HEC-DSS VUE
HEC DATA STORAGE SYSTEM VISUAL UTILITY ENGINE

William J. Charley, Senior Technical Specialist,
Water Management Systems Division,
U.S. Army Corps of Engineers Hydrologic Engineering Center
609 Second Street, Davis, CA 95616; Phone (530) 756-1104, Fax (530) 756-8250
William.Charley@usace.army.mil

Abstract: The U.S. Army Corps of Engineers Hydrologic Engineering Center has developed and released HEC-DSSVue (Visual Utility Engine), a graphical user interface for the HEC Data Storage System. The HEC Data Storage System, or HEC-DSS (not to be confused with a Decision Support System), is a database system designed to efficiently store and retrieve scientific data that is typically sequential. Such data includes, but is not limited to, time-series data, curve data, spatial-oriented gridded data, textual data, and others. HEC-DSS is used by the HEC modeling programs to store and exchange data.

With HEC-DSSVue a user can plot, tabulate, edit and manipulate data in HEC-DSS database files. The main display lists the contents of a DSS file as a sorted and filtered catalog of data set names (pathnames) and allows the user to select individual data sets for display or manipulation with a mouse click. The graphics produced by HEC-DSSVue are highly customizable and can be saved in several formats, including "jpeg" and "png" (portable network graphics), and can be printed or copied to the system clipboard for inclusion in reports. HEC-DSSVue allows users to enter data into HEC-DSS database files, and to rename, delete, and copy data sets to other DSS files. HEC-DSSVue provides over 50 mathematical functions to operate on data. Optional plug-ins can automatically retrieve and store data into HEC-DSS from the USGS and the CDEC (California Data Exchange Center) web sites.

Routine sequences of steps can be programmed in HEC-DSSVue with the "Jython" scripting language, and executed from user-defined buttons or from "batch" processes. HEC-DSSVue was written using the Java programming language, which allows it to run under a variety of operating systems. Fully supported systems include Microsoft Windows, Sun Solaris Unix and Red Hat Linux.

INTRODUCTION

Overview of HEC-DSS: The HEC Data Storage System, or HEC-DSS (not to be confused with a Decision Support System), is a database system designed to efficiently store and retrieve scientific data that is typically sequential. Such data includes, but is not limited to, time-series data, curve data, spatial-oriented gridded data, textual data, and others. It originated in 1978 in order for hydrologic modeling programs to exchange time-series data. The original version was written for programs using the Fortran and "C" programming languages. Over time, it has migrated to include programming interfaces for C++, Visual Basic and Java. HEC hydrologic and hydraulic modeling

programs, including HEC-RAS, HEC-HMS, HEC-ResSim, as well as a variety of others past and present, are interfaced with HEC-DSS. A assortment of utility programs have been developed to 1) load and import data from a range of formats; 2) export data; 3) graph, tabulate and edit data; 4) mathematically manipulate data; and 5) perform various database utility and maintenance functions. Several of these functions have been incorporated into HEC-DSSVue, a graphical user interface program for HEC-DSS.

HEC-DSS has been installed on a variety of operating systems including Microsoft Windows, Apple Macintosh and a variety of Unix flavors. There are no licenses or fees required for HEC-DSS or its utilities; the software is in the public domain and can be obtained free of charge from the HEC web site at http://www.hec.usace.army.mil.

HEC-DSS Use: The HEC-DSS is generally considered to be a "model-oriented" or a "working" database system. Currently it is used extensively in Corps offices for both project studies and real time water control and reservoir operations, such as in the Corps Water Management System or "CWMS" (HEC, 2005a). Data for CWMS (such as precipitation and stream flow values) are typically received from field collection platforms via satellite and stored in a corporate database. When a CWMS modeling run is to be executed, data is extracted into a subset HEC-DSS file for that run. HEC-HMS, a rainfall-runoff model, uses gridded precipitation data from radar or gage readings, observed flows and estimated future rainfall in HEC-DSS, to compute forecasted flows. The forecasted flows are used by HEC-ResSim, a reservoir operations model, to simulate reservoir operations and compute regulated flows. River stages and inundation maps are then computed by HEC-RAS, a river hydraulics modeling program. HEC-FIA, an economic benefits / flood impact model, uses the stages or flow to compute damages and project benefits. HEC-DSS is used to exchange the various data sets between the modeling programs. This allows water managers to make effective quick evaluations of hydro-meteorological scenarios and operational decisions in a real-time environment. The new HEC Watershed Analysis Tool (HEC-WAT) uses HEC-DSS to exchange data between the modeling programs incorporated in it in a similar manner to CWMS.

HEC-DSS Characteristics: HEC-DSS incorporates a modified hashing algorithm and hierarchical design for database accesses that is designed specifically for the storage and retrieval of large sets of data. This includes (but is not limited to) computed or observed daily flow values, hourly precipitation amounts, rating tables, and radar rainfall measurements. HEC-DSS is not optimized for dealing with small data sets or single data values, nor is it effective at conditional data searches common to relational database systems. In contrast, most commercial databases are designed for smaller sets of data, or elements, such as employee records, accounting data, and inventory of stock.

Data in HEC-DSS is stored in blocks, or records, and each record is identified by a unique name called a "pathname". A pathname consists of six parts that describe the data, including its region, location, parameter, beginning time and version. This convention makes the data set self-documenting. An example pathname for observed hourly time-series flow data is:

/SACRAMENTO RIVER/RED BLUFF/FLOW/01MAR1995/1HOUR/OBSERVED/

HEC-DSS VUE

HEC-DSSVue is a Java-based visual utilities program for users to plot, tabulate, edit and manipulate data in HEC-DSS database files (HEC, 2005b). HEC-DSSVue will display data in an HEC-DSS file in a tabular or graphical form. The graphics are highly customizable and can be saved in various formats, including "jpeg" and "png" (portable network graphics), as well as printed or copied to the system clipboard. Data may also be edited in a table or a graph or, in a development version, in Microsoft Excel. HEC-DSSVue incorporates over fifty mathematical functions, including those that were available in the DSSMATH program. HEC-DSSVue also has several utility functions for entering data, renaming record pathnames, copying data to other HEC-DSS files, as well as a variety of other functions. It is fully supported on computers running Sun Solaris, Red Hat Linux and Microsoft Windows. HEC-DSSVue and supporting documentation can be downloaded for free from the HEC web site at http://www.hec.usace.army.mil.

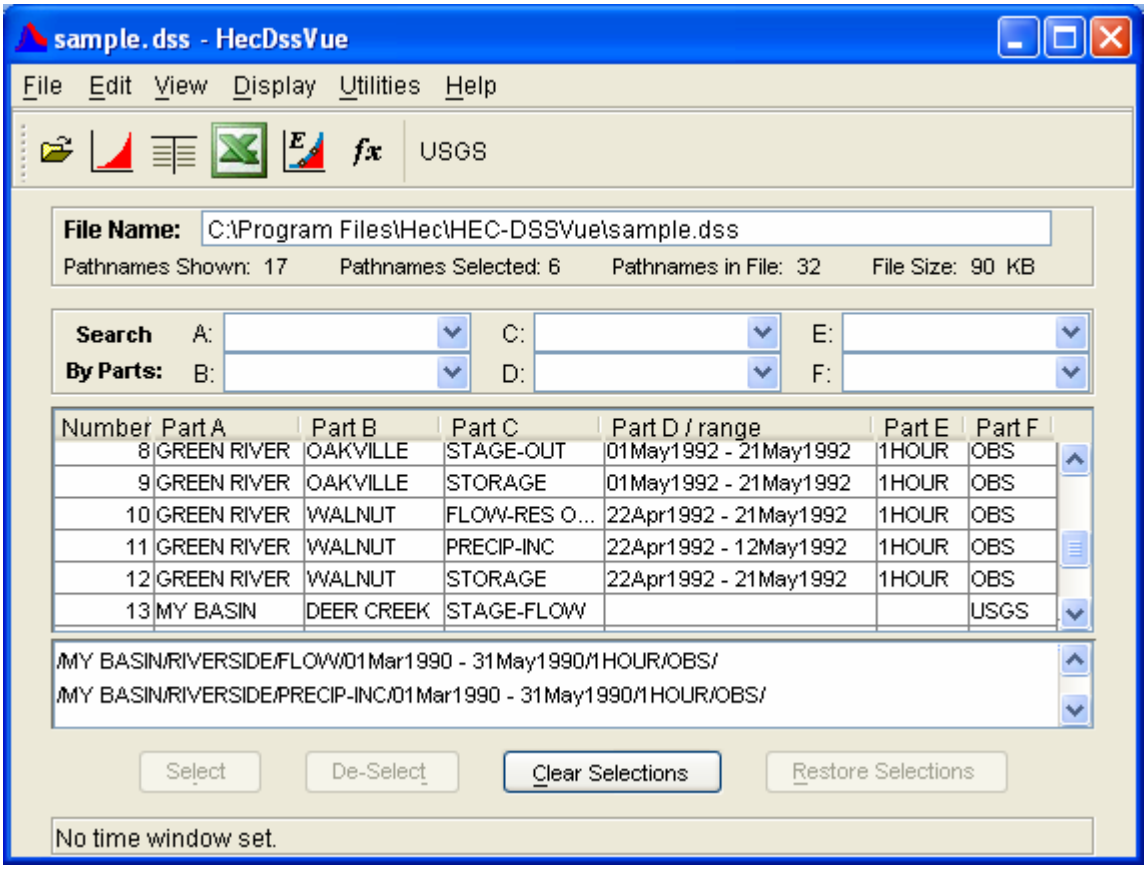

Figure 1 - HEC-DSSVue Main Screen

HEC-DSSVue provides a sorted, filtered list of pathnames to select data sets from, as show in Figure 1. Pathnames from the file are displayed as either an alphabetized list of individual pathnames, a list of pathnames broken into their six parts, or a pathname part list where time-series data start and end dates are shown. Pathnames can be filtered in the list by selecting parts from pull-down boxes, giving the user the capability of quickly selecting the category of data he or she is interested in. Data sets to view or manipulate

are chosen by selecting the rows with their pathnames and then pressing the “Select” button. The user can then access the selected data by choosing the appropriate function from the menu bar or tool bar.

Plots: An example HEC-DSSVue plot is shown in Figure 2. On the left side of the plot window are pointer and zoom mouse tools, which change the functionality of the mouse when selected. A curve’s properties editor, which is used to change such things as the color, style and weight of the curve, is displayed by right-clicking on the curve with the pointer tool selected. With the zoom tool selected, the user can zoom in on the plot. Scroll bars will appear in the window allowing the user to scroll through different parts of the enlarged graph.

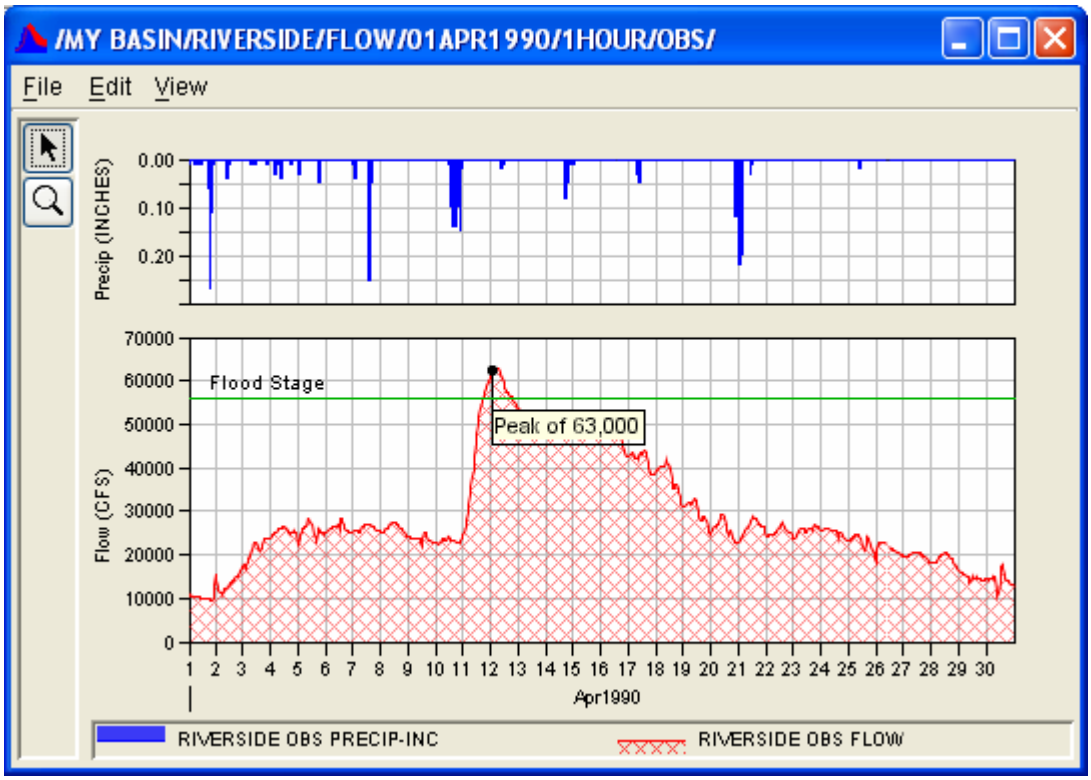

Figure 2 - Example Plot

From the plot’s File menu, a user can print the plot, copy it to the clipboard, or save it in a graphics format file such as jpeg or portable network graphics. The “Plot Properties Editor”, selected through the Edit menu, provides for customizing the plot appearance. This includes setting the title, legend, viewport size, background, curve colors, weights and styles, and the axes. Once set, the plot attributes can be saved as a “template”. A template is essentially a file with a list of the changes made to the plot, which can be used in subsequent plots with the same or similar data sets.

Tabulation and Editing: Data may be tabulated or edited in a table window or through Microsoft Excel, as depicted in Figure 3. Data is displayed in a columnar fashion with the date and time preceding values in each row for time-series data. The table, or

portions of it, can be printed from the “Print” menu item or exported to an ASCII delimited file from the “Export” menu item, both available from the table’s File menu.

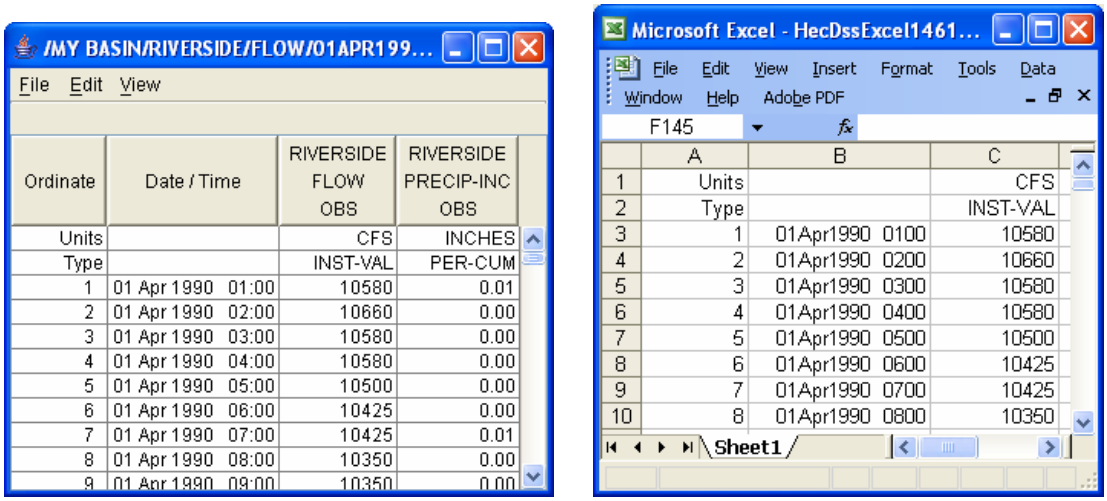

Figure 3 - Example Table in a Table Window and Microsoft Excel

Data can also be edited in a table window or through Microsoft Excel. Individual values can be changed by selecting a cell and typing in a new value. Multiple values within a column can be set to a constant or to interpolated values by selecting the cells, right-clicking the mouse and picking the “Fill” option from the shortcut menu. Data can be pasted into the table from the system clipboard by selecting the beginning cell and choosing the “Paste” menu item (or control-V). Selected cells are copied to the clipboard with the “Copy” menu item (or control-C).

Graphical Editor: Data may also be edited using a graphical editor, which has a combination of a plot and table together in the same window, as depicted in Figure 4. A green hatch pattern is drawn in the plot to correspond to the data that is shown in the visible part of the table. The user can draw portions of the curve by selecting the “line draw” tool on the left and left click the mouse at various points along the desired curve. As data is modified in the plot, those changes are reflected in the table. Conversely, data changed in the table is immediately reflected in the plot. Other tools allow individual points to be edited graphical or plot attributes to be modified.

Data Entry: Data can be entered into a HEC-DSS file using the “Manual Data Entry” screen, as depicted in Figure 5. This screen provides an area to enter the pathname, units, start date and time, along with a blank table to enter values in. Frequently this screen is used to copy data into HEC-DSS from the values on the clipboard. A user can also generate a given number of constant values from an option on this screen.

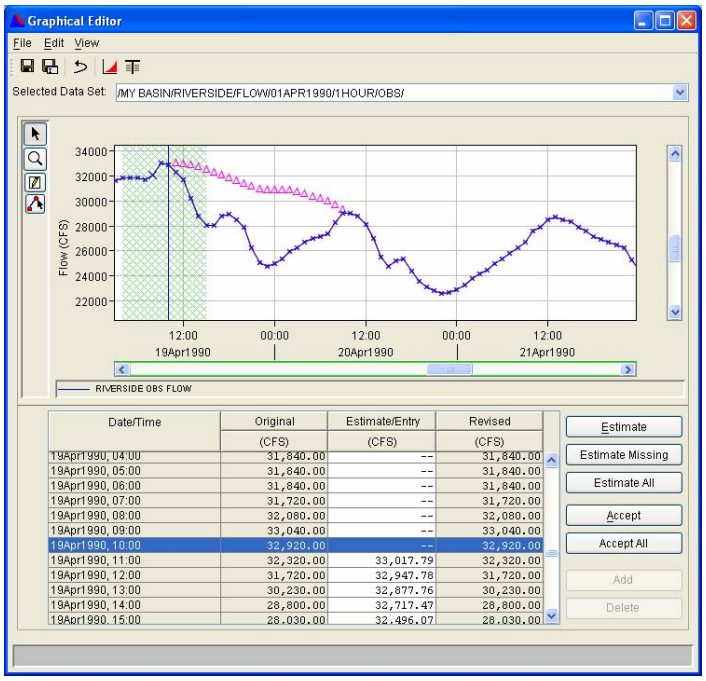

Figure 4 – Graphical Editor

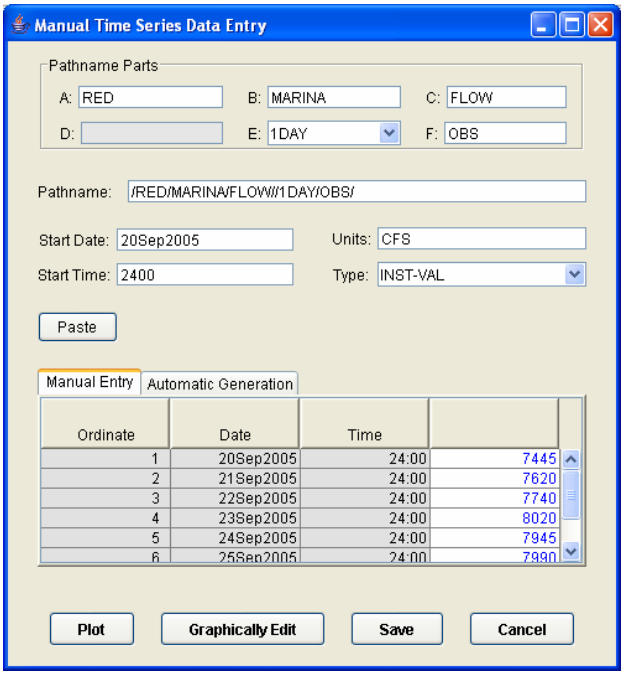

Figure 5 – Manual Data Entry Window

Time-series data can be retrieved and imported from various web sites, including the USGS and CDEC (California Data Exchange Center), using optional “plug-ins”. A HEC-DSSVue plug-in is a set of Java software that is compiled and put into a Java “.jar” file. This file is placed into an install directory where it is automatically loaded and accessible from the main program. The purpose of a plug-in is similar to the scripting

capability that is available in HEC-DSSVue. However, since plug-ins are written in the Java language, there are extended capabilities and controls available. The plug-in code can access the HEC-DSSVue API (Application Program Interface) directly. Typical uses for plug-ins are: complex mathematical operations; specialized formatting of data for entry into another application (such as a program that uses a "card format"); and, retrieval of data from a web site. An example of the USGS data retrieval plug-in screen is given in Figure 1. Currently this plug-in will retrieve and store historical and recent daily flow data and real-time flow data, which are typically provided on a hourly or 15 minute time interval basis.

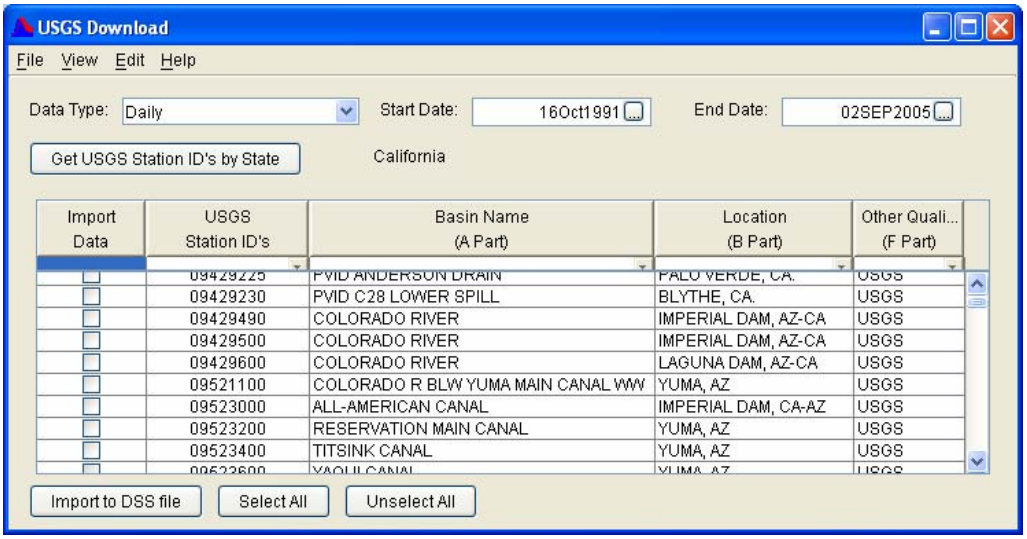

Figure 6 – USGS Data Retrieval Plug-in

Math Functions: HEC-DSSVue has over fifty mathematical functions for manipulating data, including all of the functions that were originally in the DSSMATH program (HEC, 1995). The "Math Functions" screen subdivides these functions into six categories accessible from note-tabs. Arithmetic operations, such as add, subtract, multiply and divide of a constant or another data set, trigonometry and logarithmic functions, accumulation and difference calculations are accessible from the "Arithmetic" tab. Functions in the "General" tab include unit conversion, estimation of missing values, and rounding and truncation of data values. For time-series data, the "Time Conversion" tab provides a means of transforming data to regular interval or irregular interval, changing the time interval, shifting data in time and other options. Hydrologic computations include a variety of routing algorithms, rating table lookups, conic interpolation and the calculation of regression coefficients from multiple linear regression analysis. Smoothing algorithms and several statistic calculations can also be computed from the Math Functions window. The resultant data can be plotted or tabulated along with the original data prior to being saved, if desired.

Utility Functions: HEC-DSSVue has several database utility and maintenance functions. These include renaming pathname records, duplicating records and copying records to other or new HEC-DSS files. Other utility functions include Merge, which

will combine all of the records in one HEC-DSS file into another, and Squeeze, which removes inactive space caused by deleting records and rebuilds the file's index tables.

Scripting: HEC-DSSVue incorporates the Jython scripting language to perform sequences of operations in an automated fashion. An example use of a script is to plot current data with the desired options, then save the resultant plot in a jpeg file for use on a web page. Jython is a standard scripting language that is an implementation of the Python programming language designed specifically for integration with Java. Scripts may be executed in batch mode by starting HEC-DSSVue with the script file name as a program argument.

Jython scripts are a series of object-oriented commands loosely based on Java. They are simple enough that non-programmers can construct them with relative ease, but powerful enough to give experienced users full access to all of the functions and capabilities in HEC-DSS Vue. A further description of scripting and the list of scripting functions available (the API or Application Program Interface) are given in the HEC-DSSVue User's Manual (HEC, 2005b).

CONCLUSIONS

HEC-DSS provides an efficient database for storing and retrieving serial data for application and utility programs. It has been incorporated into the current hydrologic and hydraulic modeling programs developed by HEC, as well as programs developed by other organizations. HEC-DSSVue is a Java-based graphical user interface program for graphing, tabulating, editing and manipulating HEC-DSS data. It is supported on Sun Solaris and Microsoft Windows platforms. It may be obtained free of charge for the Windows environment from the HEC web site at: http://www.hec.usace.army.mil.

REFERENCES

HEC, 2005a. "CWMS User's Manual", U.S. Army Corps of Engineers, Davis, CA, July 2005

HEC, 1995. "HEC-DSS User's Guide and Utility Manuals, User's Manual", CPD-45, U.S. Army Corps of Engineers, Davis, CA, March 1995.

HEC, 2005b. "HEC-DSSVue User's Manual, Version 1.2", CPD-79, U.S. Army Corps of Engineers, Davis, CA, May 2005