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# SAM 2.1 — A Computer Program for Plotting and Formatting Surveying Data for Estimating Peak Discharges by the Slope-Area Method

The U.S. Geological Survey (USGS) measures discharge in streams using several methods. However, measurement of peak discharges is often impossible or impractical due to difficult access, inherent danger of making measurements during flood events, and timing often associated with flood events. Thus, many peak discharge values often are calculated after the fact by use of indirect methods.

The most common indirect method for estimating peak discharges in streams is the slope-area method. This, like other indirect methods, requires measuring the flood profile through detailed surveys. Processing the survey data for efficient entry into computer streamflow models can be time demanding; SAM 2.1 is a program designed to expedite that process.

The SAM 2.1 computer program is designed to be run in the field on a portable computer. The program processes digital surveying data obtained from an electronic surveying instrument during slope-area measurements. After all measurements have been completed, the program generates files to be input into the SAC (Slope-Area Computation program; Fulford, 1994) or HEC-RAS (Hydrologic Engineering Center-River Analysis System; Brunner, 2001) computer streamflow models so that an estimate of the peak discharge can be calculated.

## Background

The purpose of the SAM 2.1 computer program is to aid field personnel in the completion of a slope-area measurement. More information about estimating peak discharges using the slope-area method can be found in reports by Benson and Dalrymple (1967) and Dalrymple and others (1967).

The first version of the SAM program was created by Berenbrock (1996) using Quattro Pro Version 6 for Windows software (Corel Corp., 1996). The current version of the program, SAM 2.1, was created using Microsoft Excel 2000 software (Microsoft, 2000), with Visual Basic Applications (VBA) programming (fig. 1), because newer versions of Quattro Pro would not run the original program and Excel is commonly available on USGS computer systems.

## Input Data

The program reads data from a comma-delimited text file that usually can be exported directly from the surveying instrument or data collector with few or no modifications. The input data file contains the following information, in this order: Foresight (point) number (FS), Easting, Northing, Elevation, Note, and Comments. The data file must follow the specific format and use specific descriptor labels (Note) to allow the program to identify the type of information associated with each data point. The input data file uses the same format that was used in the earlier version (Berenbrock, 1996). More information on formatting can be found in the HELP section of the program.

## High-Water-Mark Data

Because the intent of the program is for use at various steps in the slope-area process, the program first should be used after the high-water-mark (HWM) data have been collected. Once the data file has been formatted and downloaded to the computer, the “Plan View” routine should be activated. The user will be prompted for specific information: site name, site number, and location of the input data file. The user also will be prompted to determine the base line for stationing. Once all the necessary information has been input, the program will create a plan view (fig. 2) of the area and an HWM profile plot (fig. 3). The user should use the profile plot to help determine where the slope-area cross sections should be located.

## Cross-Section Data

After the cross-section data have been downloaded to the computer, the "Cross Sections" routine should be activated, which will require the user to determine the cross-section order and to verify the endpoint locations (left and right) at each cross section. The program then adjusts all data points in each cross section to a straight line between the two endpoints and determines cross-section stationing (distance across the channel) from the left endpoint. This adjustment results in a "true" distance between data points along the cross section and prevents the occurrence of "false" distances that can be created when data points are obtained in a zigzag pattern along the cross section. Finally, the routine calculates the average water-surface elevation for each cross section, generates profile plots of each cross section (fig. 4), and adds the locations of each cross section to the plan view and HWM profile plots.

## Output Data Files

After all the data have been processed, the program can output the relevant data into two types of text files that can be used as input data files for various streamflow models. The text files can be used as input data files to SAC (Fulford, 1994), WSPRO (Water-Surface PROfile computations; Shearman, 1990), HEC-2 (Hydrologic Engineering Center-2; Hydrologic Engineering Center, 1991), or HEC-RAS (Brunner, 2001). Model-specific data such as Manning's roughness coefficients (n-values), contraction or expansion coefficients, break points, and so forth, are not included in the SAM program and must be entered by the user prior to model application.

## Summary

The use of the SAM 2.1 program in the field during slope-area measurements will greatly reduce the amount of time required to plot the data. This program also allows the user to quickly make informed decisions with regard to cross-section locations and the number of cross sections needed. Finally, the ability to process the data, estimate roughness coefficients and other site-specific information, and calculate peak discharge estimates while personnel are in the field and able to revise or add information should result in better quality and more reliable estimates.

— Jon E. Hortness

## References Cited

Benson, M.A., and Dalrymple, Tate, 1967, General field and office procedures for indirect discharge measurements: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chap. A1, 30 p.

Berenbrock, Charles, 1996, A procedure to generate slope-area plots and compute estimated discharge for peak flows in the field using a portable computer [Abs.]: U.S. Geological Survey National Computer Technology Meeting, Rancho Mirage, Calif., May 19-24, 1996, U.S. Geological Survey Open-File Report 96-204.

Brunner, G.W., 2001, HEC-RAS, River analysis system user's manual: U.S. Army Corps of Engineers, CPD-68, 320 p.

Corel Corporation, 1996, Quattro Pro 6 for Windows users guide: Ottawa, Ontario, Canada, Corel Corporation.

Dalrymple, Tate, and Benson, M.A., 1967, Measurement of peak discharge by the slope-area method: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chap. A2, 18 p.

Fulford, J.M., 1994, User's guide to SAC, a computer program for computing discharge by the slope-area method: U.S. Geological Survey Open-File Report 94-360, 31 p.

Hydrologic Engineering Center, 1991, HEC-2—Water surface profiles, user's manual: Davis, Calif., U.S. Army Corps of Engineers.

Microsoft Corporation, 2000, Microsoft Excel 2000 for Windows user's guide: Redmond, Wash., Microsoft Corporation.

Shearman, J.O., 1990, User's manual for WSPRO—A computer model for water surface profile computations: Federal Highway Administration Report, FHWA-IP-89-027, 187 p.

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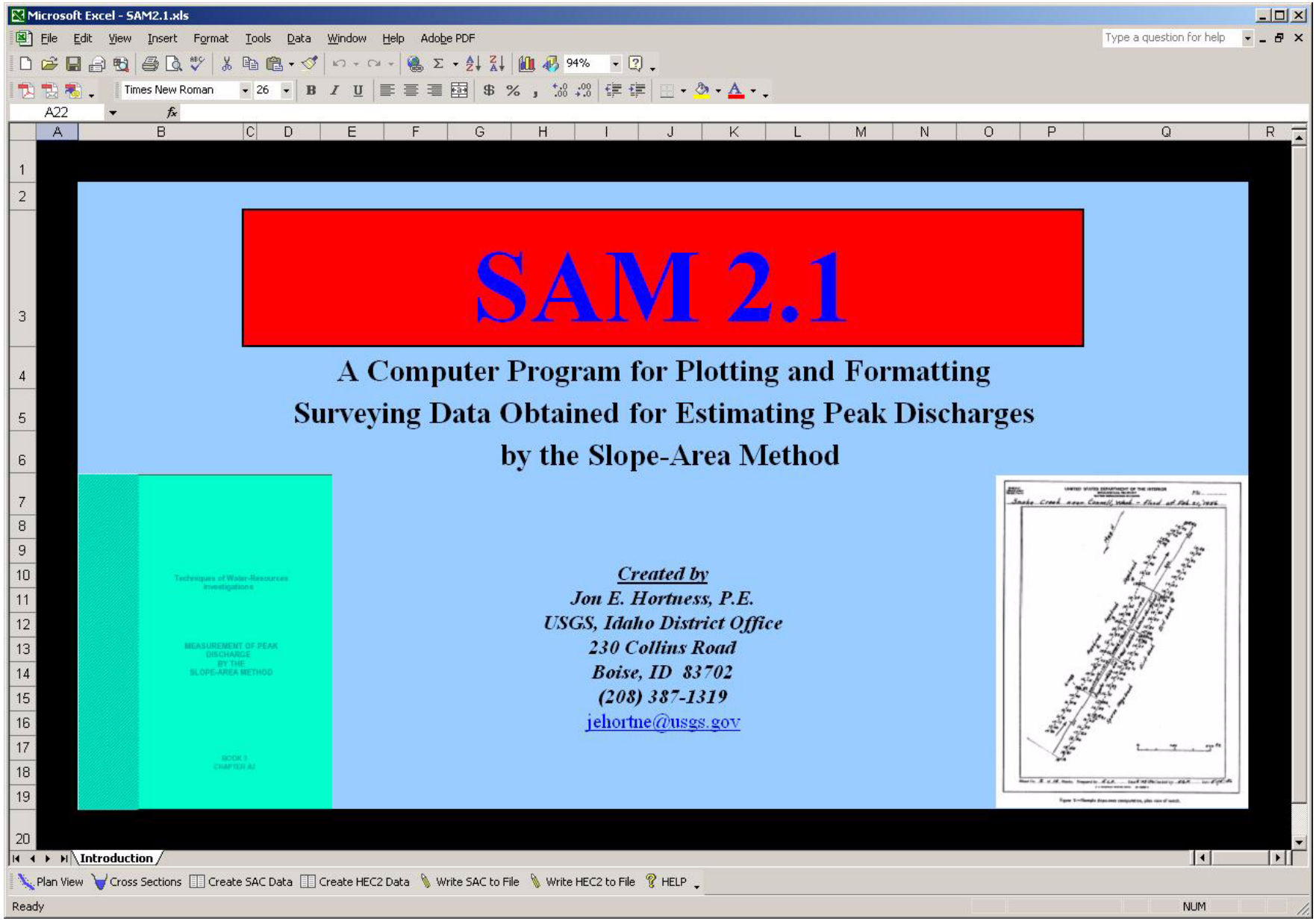


**Figure 1.** Introduction sheet for SAM 2.1 program in Microsoft Excel.

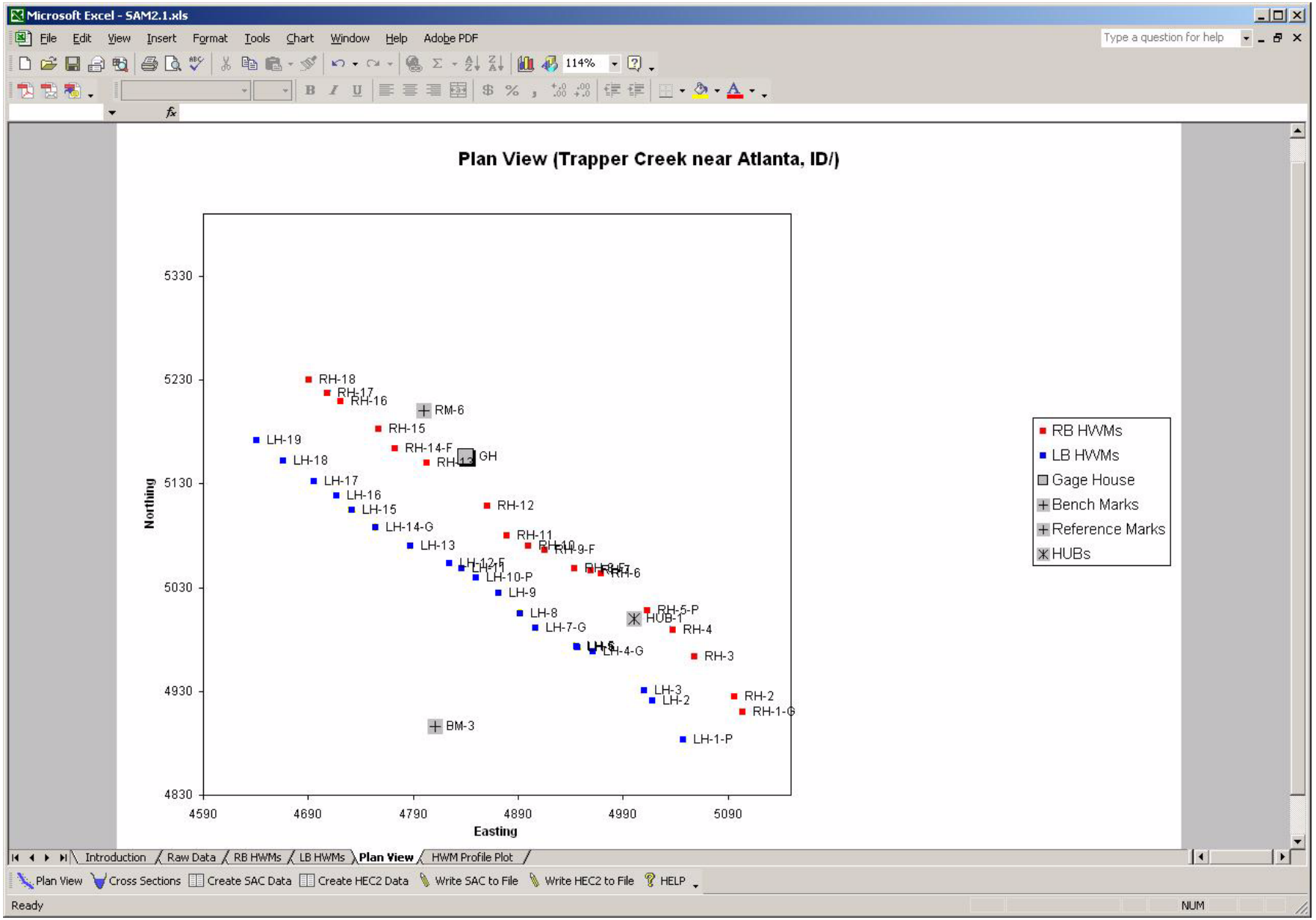


**Figure 2.** Plan view schematic of slope-area measurement site.

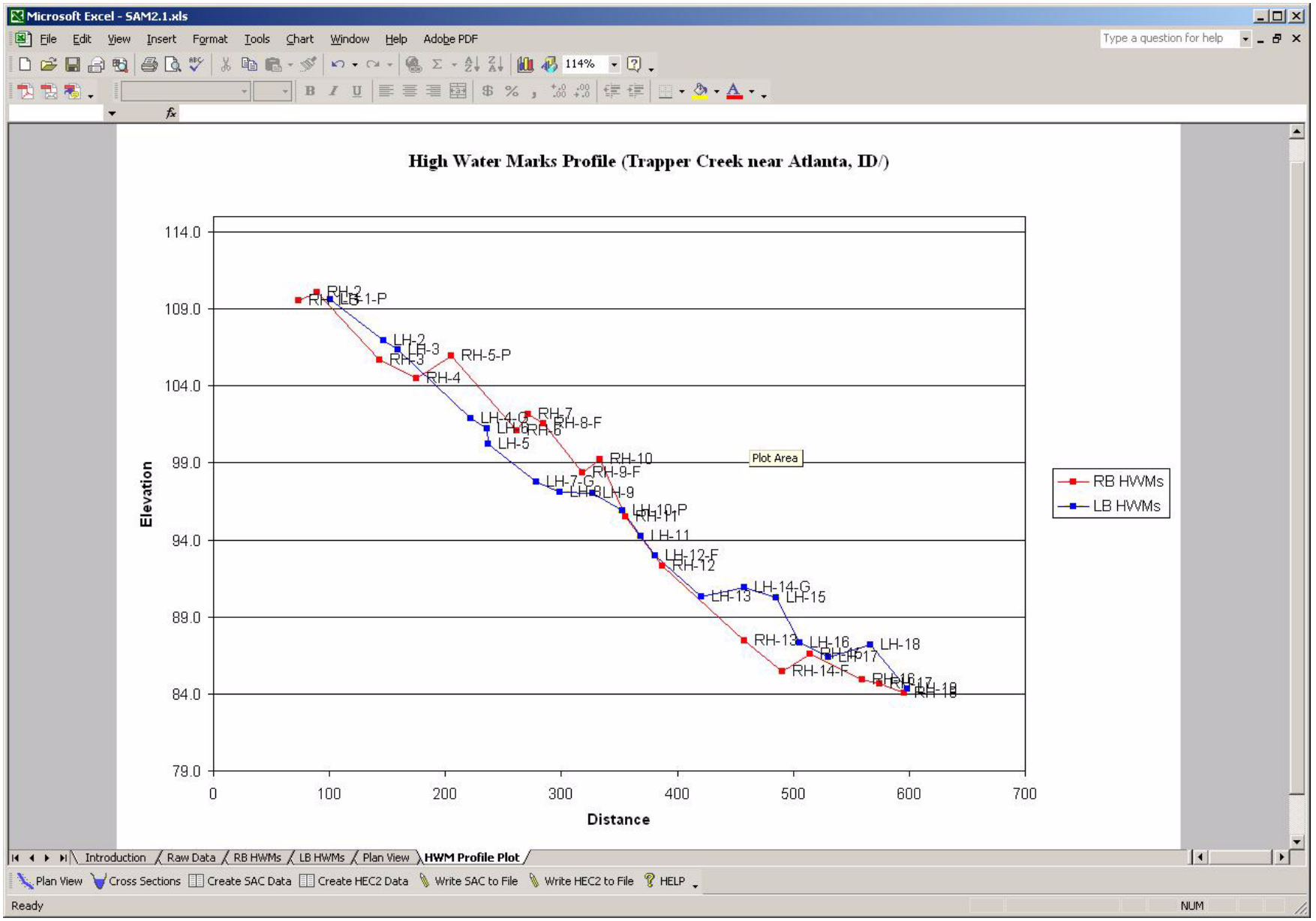


**Figure 3**. High-water-mark profiles for slope-area measurement site.

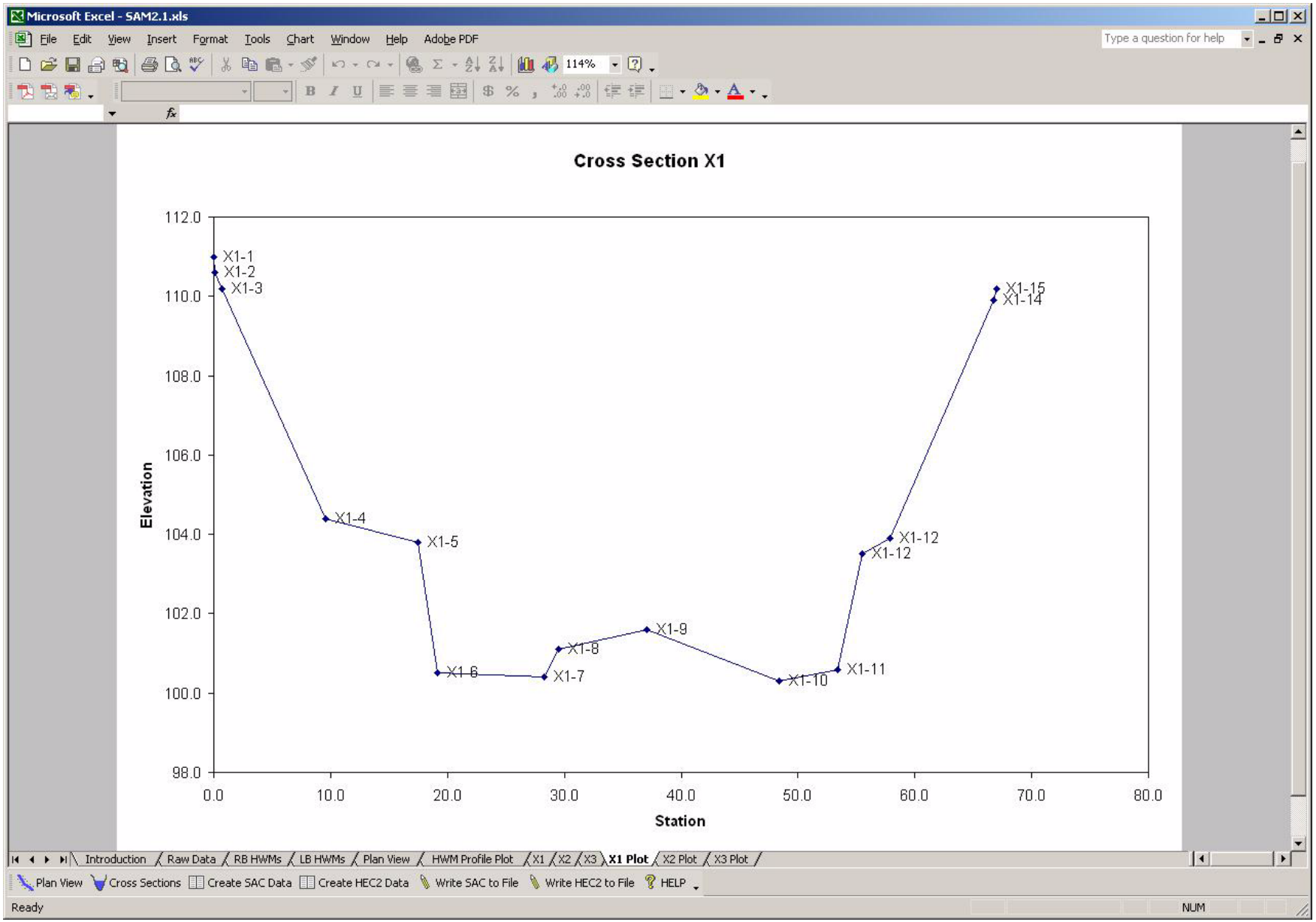


**Figure 4**. Profile of a single slope-area cross section.