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William A. Thomas, Ronald R. Copeland,
and Dinah N. McComas

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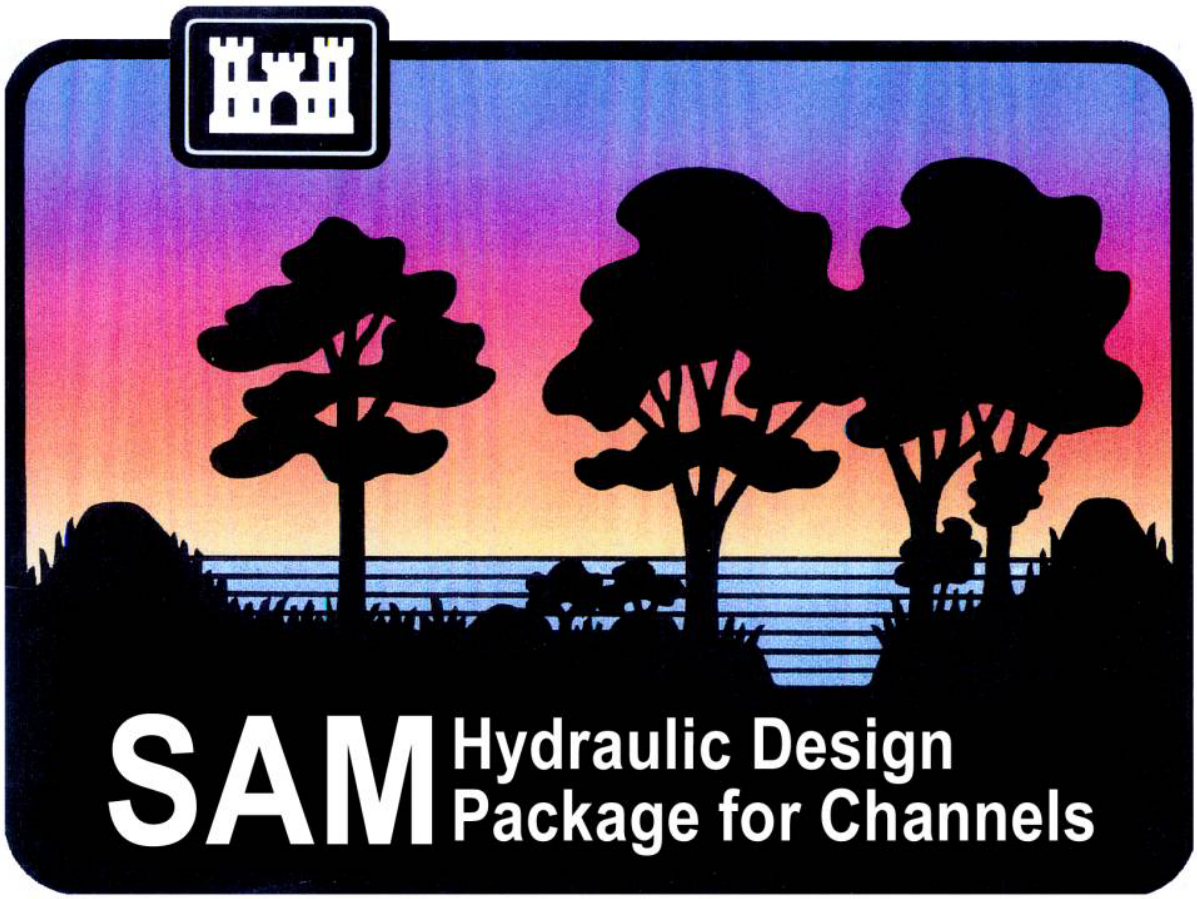

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Coastal and Hydraulics Laboratory
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

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Preface

The SAM Hydraulic Design Package for Channels has been evolving since the late 1980's. The majority of algorithms are a result of research conducted in the Flood Control Channels Research Program in the 1980's and early 1990's. Mr. W.A. Thomas (retired) was one of the driving forces behind the beginnings of SAM. Mr. Thomas, Dr. Ronald Copeland (retired), Dr. Nolan Raphelt, and Mrs. Dinah McComas, all in the former Hydraulics Laboratory (now Coastal and Hydraulics Laboratory (CHL), Engineering Research and Development Center (ERDC), Vicksburg, MS), did most of the original programming for SAM. The package has been debugged, refined and added to from its inception to the present. In 2001, CHL entered into a Cooperative Research and Development Agreement (CRDA) with Owen Ayres & Associates, Inc., Ft. Collins, CO, to put the DOS-based SAM into a more user-friendly interface. Ayres developed a Windows interface which uses the same executable programs, with necessary improvements and fixes, as the earlier DOS-based SAM package. Ayres has exclusive rights to sell and support the SAM package to the private sector and all government agencies except the Corps of Engineers. The Corps of Engineers can receive the new SAM package, and support, through CHL, free with participation in the Numerical Model Maintenance Program at ERDC.

1 Introduction

Purpose and Philosophy

SAM is an integrated system of programs developed through the Flood Damage Reduction and Stream Restoration Research Program to aid engineers in analyses associated with designing, operating, and maintaining flood control channels and stream restoration projects. The package was designed primarily to satisfy the need for qualitative, easy-to-use methodology, especially for use in preliminary screening of alternatives where funds for more extensive investigations are not available.

The SAM package, designed to run on PC computers, is intended to be used primarily as an aid in the design of stable channels. In the past, the design of a stable channel has focused on the erosion process (Simons and Senturk, 1977, and ASCE, 1975). However, erosion is only one of the five fundamental processes--erosion, entrainment, transportation, deposition and compaction--in sedimentation. SAM provides the computational capability to include all these processes except the compaction of the deposited bed sediments in the design of stable channels.

The SAM package is designed to provide hydraulic engineers smooth transition from making hydraulic calculations to calculating sediment transport capacity to making sediment yield determinations. The three main modules of the package can be used in series, as described, or their separate capabilities utilized to aid in various hydraulic design situations. SAM.hyd calculates the width, depth, slope and n-values for stable channels in alluvial material. SAM.sed calculates sediment transport capacity according to a wide range of sediment transport functions, usually using the hydraulic parameters calculated in SAM.hyd. SED.yld uses the sediment transport capacity calculated in SAM.sed to calculate the sediment yield. Channel stability can then be evaluated in terms of the cost of maintaining the constructed channel.

Overview of Manual

This manual describes the fundamental concepts, numerical model capabilities and limitations, computational procedures, input requirements and output descriptions of the various modules in SAM. A brief description of model capabilities and the organization of this manual is presented below.

Theoretical Basis for SAM.hyd, SAM.sed, and SAM.yld calculations (Chapters 2, 3, 4)

These chapters describe the theoretical bases for the hydraulic computations, the sediment transport calculations, and the sediment yield calculations in the SAM.hyd, SAM.sed, and SAM.yld modules, respectively. They present the general capabilities of the modules and describe how the computations are performed.

Theoretical Basis for SAM.aid (Chapter 5)

This chapter describes the general capabilities of this module and describes how the selection of recommended sediment transport equations is made in SAM.aid.

Input Requirements and Program Output for SAM.hyd, SAM.sed, and SAM.yld (Chapters 6, 7, and 8)

These chapters describe the general input data requirements for implementation of specific module capabilities, as well as providing information on the various output tables in each module.

Appendices

The various appendices provide specific instructions on the use of the package. These appendices are:

A. References
B. List of Variables
C. Data Records for Hydraulic Calculations (SAM.hyd)
D. Data Records for Sediment Transport Functions (SAM.sed)
E. Data Records for Sediment Yield Calculations (SAM.yld)
F. SAM.aid – Guidance in Sediment Transport Function Selection

Summary of SAM Capabilities

Geometry

SAM considers only one cross section, not a reach, of a river. However, the geometry of that cross section can be prescribed in several ways. For trapezoidal channels, either a simple or compound channel can be input. Also, an irregular channel can be prescribed with station and elevation coordinates.

SAM.hyd

This module calculates normal depth and composite hydraulic parameters for a cross section with variable roughness. The calculations can be made with a variety of bed roughness predictors. It will also calculate stable channel dimensions--channel width, depth and slope-- for a prescribed discharge and sediment load. The stable channel dimensions calculated in SAM are not constrained by the external hypothesis advocated by Chang (1980) and others. Rather, the designer is able to choose from a family of solutions to meet project constraints. These calculations use analytical equations which include bed material transport and which separate total hydraulic roughness into bank and bed components.

SAM.hyd also provides the option of calculating riprap size, either by the method prescribed in EM 1110-2-1601, "Hydraulic Design of Flood Control Channels" (USACE 1991, 1994), or through testing the results of the normal depth calculations against the Shield's Diagram for particle stability.

SAM.sed

This module calculates the bed material sediment discharge rating curve by size class using hydraulic parameters either calculated in SAM.hyd or user specified. Several sediment transport functions have been programmed into SAM.sed, covering a range of riverine conditions. SAM.sed applies the sediment transport functions at a point thus allowing for no temporal or spatial variability in the size class distribution.

SAM.yld

SAM.yld calculates sediment yield passing a cross-section during a specified period of time using the "Flow-Duration Sediment-Discharge Rating Curve method" described in EM 1110-2-4000, "Sediment Investigations in Rivers and Reservoirs" (USACE 1989). The time period considered can be a single flood event or an entire year. In SAM.yld the flow can be specified by either a flow duration curve or a hydrograph. The sediment discharge rating curve can be specified as either sediment discharge versus water discharge or sediment concentration versus water discharge.

SAM.aid

SAM.aid provides guidance in the selection of a sediment transport function(s) to use with a given project, based on five screening parameters: d_{50}, slope, velocity, width, and depth.

General

The SAM package is a product of the Flood Damage Reduction and Stream Restoration Research Program. The conception and initial development of the package were the results of the efforts of William A. Thomas, Ronald R. Copeland and Nolan Raphelt. However, many workunits and many principal investigators have contributed to the package. The US Government is not responsible for results obtained with this software. However, the office supporting the package would welcome documentation of program errors and should respond if fiscally feasible.

Files

The program operates interactively. However it saves the input data in an ASCII files and uses these files to pass data from module to module.

Theoretical Assumptions and Limitations

SAM is not a package of one-dimensional models. SAM makes calculations based on one cross section at one point in time. There are no provisions in any of the modules for simulating the effects of a hydrograph nor for looking at a reach of a river, except as it might be represented by an average. SAM is designed to be used as a tool during reconnaissance level planning studies. Broad application of SAM results must be made with caution.

Sediment transport functions in SAM must be used with care. Essentially, SAM.sed applies the sediment transport functions at a point, which allows for no variability in the size class distribution over time or space. Considering that the size class distribution of bed material in the natural river changes with discharge, reach, time of year, and other temporal factors, SAM's use of a fixed, non-varying, as-prescribed size class distribution for all calculations presents the possibility that the calculated transport rates are not truly representative of the natural river. The procedure in HEC-6, which integrates processes over several cross sections which describe a reach of the river and provides a continuity equation for sediment movement, will consequently produce a more reliable result than comes from applying a sediment transport function at a single point.

However, SAM will provide reasonable answers if the user is cognizant of the need for the careful prescribing of the bed material gradation.