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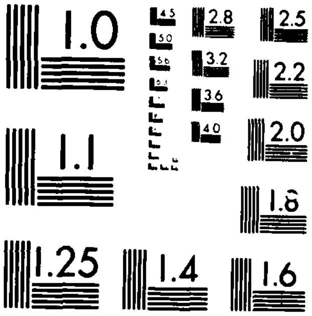

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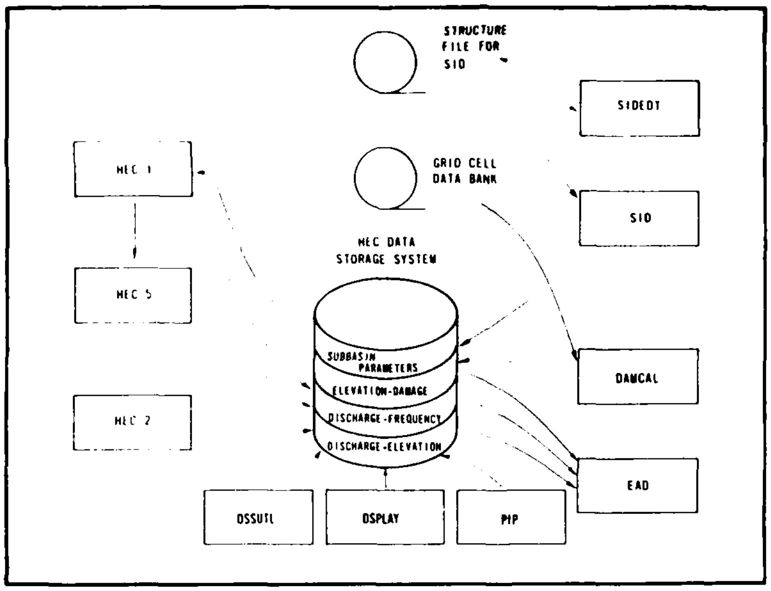
FLOOD DAMAGE ANALYSIS PACKAGE

Description, User Guidance and Example



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January 1986

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TRAINING DOCUMENT NUMBER 21

FLOOD DAMAGE ANALYSIS PACKAGE

Description, User Guidance and Example

January 1986

The Hydrologic Engineering Center
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FLOOD DAMAGE ANALYSIS PACKAGE
(FDA)

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I. Introduction

A. Purpose of the Package

The purpose of the Flood Damage Analysis (FDA) Package is to link hydrologic and economic computer programs developed by the Hydrologic Engineering Center (HEC). The programs are linked through a data management system, developed by HEC, which is called the Hydrologic Engineering Center Data Storage System (HECDSS) or the Data Storage System (DSS). This linkage facilitates the automatic transfer of data between computer programs with minimal effort by the analyst. Instead of manually entering data, the analyst assigns an alphanumeric label to the data and that label is used to store and retrieve data. The HEC has completed the development and documentation of this coordinated, linked family of programs.

B. Background and Overview

Flood damage analysis is performed to provide quantitative information on the social cost of flooding and to provide a basis for formulating, evaluating, and implementing a range of remedial construction projects and other management actions. Flood damage potential assessments of existing flood plain development provide the basis for identifying critical problem areas and for development of actuarial insurance premiums for government and private industry. Damage appraisals performed in the aftermath of flood events provide the data used as the basis for the efficient and equitable allocation of relief funds and other emergency assistance. Damage estimates of potential future development scenarios can encourage local government agencies and private individuals to make wise land use decisions considering the flood hazard consequences. Several types of analysis for a range of development conditions and careful segmenting of damageable areas are required to meet these information needs.

For a number of years, the HEC has been active in developing a variety of computer programs to meet these needs. The programs have been used extensively individually and occasionally congruently. Recent developments in data management computer software have provided an opportunity to link these programs in a highly efficient data file management mode that now permits packaging (in a conceptual analysis sense) to form a coordinated, linked family of flood damage analysis programs.

The programs collectively provide capability for flood damage analysis for the full range of structural and nonstructural flood plain management measures. The package presently includes three computer programs for performing hydrologic engineering analysis, three programs for flood damage analysis, and the HEC Data Storage System. Evaluation of structural measures such as reservoirs, channels, levees, diversions, and non-structural measures such as flood proofing, structure relocation, and management of future development can be accomplished by the appropriate use and linking of the programs. The programs may be used individually, or in any needed combination, and the system can accommodate direct data input as might be available from computer programs in use by others or from published data.

This document briefly overviews the basic concepts of flood damage computations, describes the coordinated linked set of programs (referred to as the Flood Damage Analysis Package), and provides suggested study procedures to efficiently use the package. Also included are supplementary user documentation as needed, data management information and a complete narrated and executed example.

The package of programs is maintained and distributed by the Hydrologic Engineering Center, Water Resources Support Center, U.S. Army Corps of Engineers, 609 Second Street, Davis, California 95616.

C. Acknowledgements

This document was prepared as part of the continuing Hydrologic Engineering Center Research and Development activities directed to improving the Corps capability to perform comprehensive, efficient and cost effective flood damage analysis. The research is an element of the Corps Civil Works Research and Development program. The research effort is ongoing and it is anticipated that the "package" described herein will continue to grow in capability and useability. Near term efforts are being devoted to developing more simplified, higher level user control of files and computer processing to make the package easier to use while requiring less computer specific processing expertise by the user. Several important technical additions are also planned for the near future. Suggestions are welcomed.

This document was prepared by several persons. Mr. Brian Smith, formerly with the HEC, Robert Carl and Darryl Davis developed the basic text. Mr. Carl developed the illustrated example based on a case example prepared for the HEC by the Ft. Worth District, Flood Plain Management Services Section. The development of the flood damage analysis computer programs and documentation, such as this training document on the "package," is under the supervision of Darryl W. Davis, Chief, Planning Division. Substantial contributions to the development of the flood damage analysis computer programs has been by Harold Kubik, Chief, Computer Support Office, and Michael Burnham, Hydraulic Engineer and Rochelle Barkin, Computer Systems Analyst, Planning Division. Mr. Bill S. Eichert was the Director of the HEC throughout the duration of this project.

II. Flood Damage Computation Overview

A. Basic Approaches

Expected annual flood damage computations may be performed by two distinctly different approaches. One is to develop a chronologically long period of annual damage values and compute the average value. The value may be derived either from historic records of incurred damage data or simulation of damage as it might occur on an annual basis. Projects and other management measures are evaluated in terms of their expected effect on the chronologically long period of annual damage values.

Another approach to annual damage computations is to develop the data in a way that determines the potential for damage from specific flood events and weights the damage values with the probability that these events might be exceeded. The result is the expected annual damage value (sometimes referred to as average annual damage). Projects and other management actions are evaluated by determining their expected effect on the basic relationships that determine the damage in any year and then recomputing the expected annual damage. This latter approach, often referred to as the frequency method, is the primary reason that the Flood Damage Analysis Package has been developed.

B. Flood Damage By Frequency Method

The Expected Annual Flood Damage Computation (EAD) Users Manual (3) describes the frequency method, illustrates basic concepts with charts, and provides guidance for developing data to perform the computations. This section contains excerpts from that material. The reader is referred to the EAD manual for a more complete discussion of the method.

The frequency method is based on the principle that flood damage to an individual structure, group of structures, or damageable property within a flood plain reach can be estimated by determining the dollar value of flood damage for different magnitudes of flooding and by estimating the percent chance of exceedance of each of these flood magnitudes. The damage caused by a single flood event of known magnitude is estimated directly from a damage relationship. When it is desired to compute the damage which can be expected in an average year, then the damage corresponding to each magnitude of flooding is weighted by the probability of each being exceeded (damage caused by rare events are thus weighted less). The sum of the weighted damage represents the expected annual flood damage. The objective of much of the preparatory technical analysis is the development of an exceedance frequency-damage relationship that subsequently can be integrated numerically to yield the expected annual value.

There are several different combinations in which the stage, flow, damage and frequency data can be expressed to develop the final frequency-damage relationship. The simplest way is to relate stage or flow to damage and to relate stage or flow to exceedance frequency. The common parameter, stage or flow, can be used to relate damage to exceedance frequency. If the damage and frequency data are not directly related to a common parameter, then another relationship must be used. This is commonly a stage-flow relationship. Thus, if damage is expressed as a function of stage and exceedance frequency as a function of flow, damage can be related to frequency with the stage-flow function. Figure 1, taken from (3), summarizes the basic technical analysis needed, derived functional relationships, and general processing to develop the damage-exceedance frequency function.

Because stage, flow, frequency and damage relationships vary along a river, it is common practice to divide a river into reaches and designate a set of these relationships to represent the stage, flow, frequency and damage data for a reach. An index location is selected within the reach and a single stage or flow-frequency relationship and stage-flow relationship are applied at that location and considered representative of these variables for the entire reach. In the case of damage, several relationships are usually used, each representative of a particular damage category.

One reason for computing flood damage is to evaluate several basin conditions. A typical analysis includes the determination of expected annual damage for without conditions. Appropriate simulations must be performed including (as needed) reservoir operations, channel improvements, levees, diversions, etc. If it is forecast that future development (i.e. increased urbanization) will occurr in the basin or that flood plain occupants will enjoy an increase in affluence, the without condition must be evaluated in terms of equivalent annual damage. Regulations prohibit the inclusion of inflation (or deflation) in the economic evaluations. However, to compute equivalent annual damage, the present value of damage at some future points in time must be determined and then it must be amoritized into an equivalent annual value. This establishes the expected annual damage for without conditions.

A principal reason for computing flood damage is to determine the effectiveness of different flood plain management plans in reducing damage. If significant damage occurs in the basin, responsible agencies will try to formulate measures to reduce it. These measures might include building a reservoir, modifying the channel, or floodproofing structures. To evaluate these measures, the analyst will define several flood damage mitigation plans. Each plan will consist of one or more damage reduction measures. This reduction commonly is referred to as an inundation reduction benefit and is measured as the difference in expected annual flood damage with and without a plan. Different management plans alter the stage, flow, frequency, and/or damage relationships in different ways. Table 1 summarizes these concepts and changing relationships. With a modified relationship the damage is different, usually lower, than without the plan. Thus, for any plan which causes a change which can be quantified, damage with the plan can be computed.

The HEC flood damage analysis package has tied specific HEC programs together through the mechanism of an HEC-developed data management system in such a way that all the relevant functions can be developed and computations performed in a highly automated yet user controlled manner. The next section describes the overall structure for the package and briefly reviews the individual components.

III. HEC Flood Damage Analysis Package

A. Basic Components

The HEC Flood Damage Analysis Package is schematically illustrated in Figure 2. The package is comprised of the following computer programs:

1. Hydrologic Analysis Computer Programs

   - o HEC-1 Flood Hydrograph Package (5); simulates rainfall-runoff, simple reservoirs and hydrologic channel routing; used to develop existing, without conditions, and modified conditions flow-frequency curves.

   - o HEC-2 Water Surface Profiles (15); computes steady-state, uniform flow profiles; used to develop elevation-flow rating curves.

   - o HEC-5 Simulation of Flood Control and Conservation Systems (11); simulates complex reservoir systems; used to develop existing, without and modified flow-frequency curves.

2. Flood Damage Analysis Computer Programs

   - o SID, Structure Inventory For Damage Analysis (12); processes inventories of structures located in the flood plain; used to develop elevation-damage relationships.

   - o SIDEDT, Structure Inventory For Damage Analysis Edit Program (13); edits structure inventory and damage function files used for the SID program.

   - o DAMCAL, Damage Reach Stage-Damage Calculation (2); performs same analysis as SID except based on a geographic (spatial) unit; used to develop elevation-damage relationships.

   - o Expected Annual Damage Computation - EAD (3); computes expected (or equivalent) annual damage and inundation reduction benefits; used to compare flood damage mitigation plans.

3. HEC-DSS (Data Management) Utility Programs

   - o PIP, Interactive Paired-Function Input Program (10); directly inputs paired function relationships to a DSS data file, for example, an elevation-damage relationship derived by hand from field data..

   - o DSSUTL, HEC-DSS Utility Program (8); provides the means of performing utility functions on data stored in the HEC-DSS data file, for example, cataloging, editing, and deleting data.

   - o DSPLAY, HEC-DSS Display Program (8); Provides the means to tabulate and plot data stored in a HEC-DSS data file.

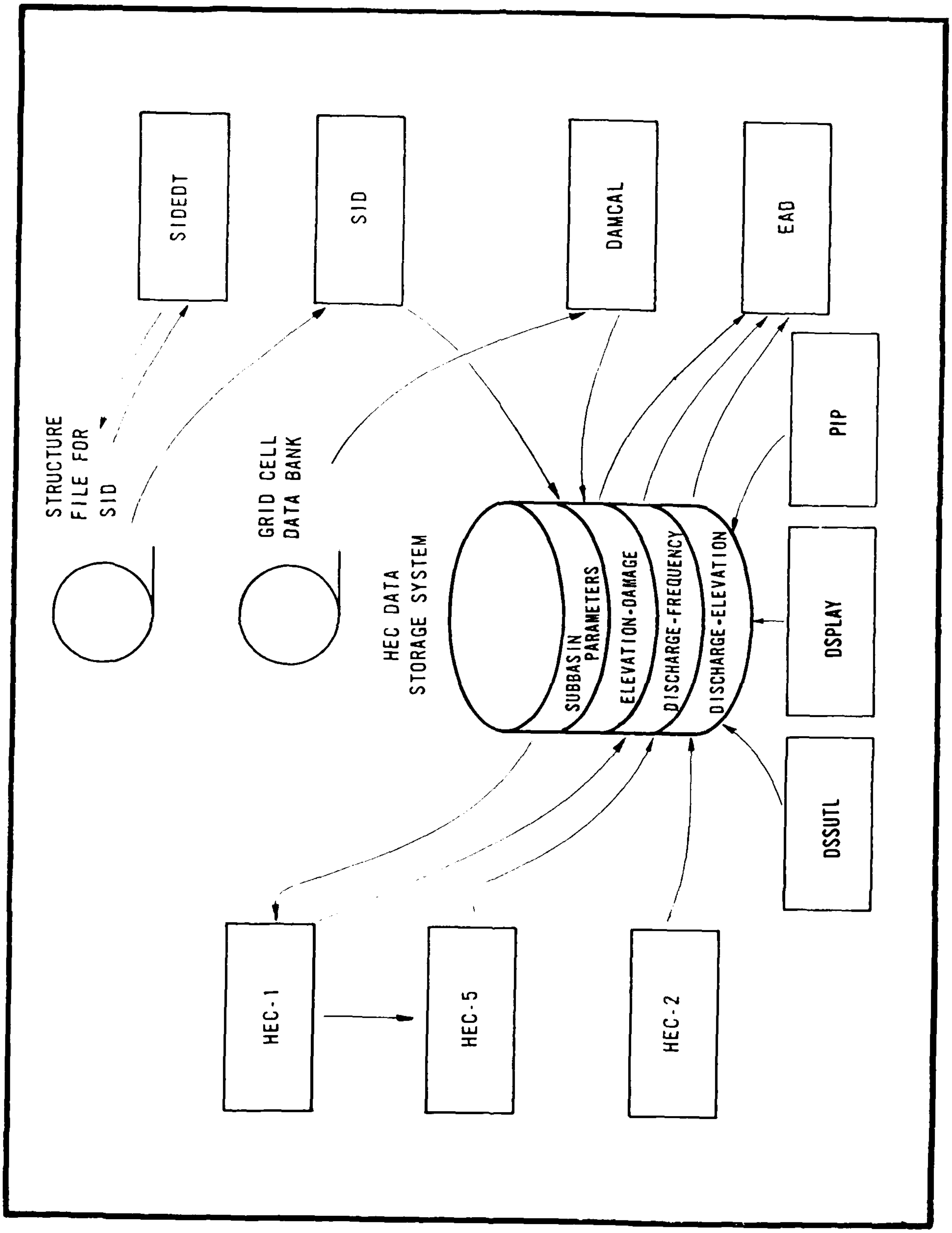


Figure 2 Flood Damage Analysis Package

If flood damage computations are based on conventional structure inventories, then a structure file is constructed based on a field inventory of structures vulnerable to flood damage. If damage computations are spatially based, then a grid cell data bank is constructed. It is possible that both damage approaches may be used for a given study, in which case both files will exist. HEC's Data Storage System is a set of software that allows the user to store data in a file and manage that data. The components are described in more detail later in this section and the capabilities of each component are summarized in Appendix A.

B. Terminology

The basic terminology used to define the flood magnitude, frequency and damage vary among Corps Districts. For the FDA package, the water surface descriptors are stage and elevation. Stage is used herein as a term to represent both the situation in which a local datum is used for each location in the study area and also for the more general case of a common datum for the entire study area. In the latter case, "elevation" is often used by others as an appropriate term. This document uses stage and elevation interchangeably. It is desirable for all participants in a study to use "elevation" based on common datum. An exception to this is the stage-damage functions (or stage-percent damage functions) input to the SID program. They usually reference the first floor as a stage of zero. The aggregated elevation-damage relationships for each reach are then computed from the known first floor elevation.

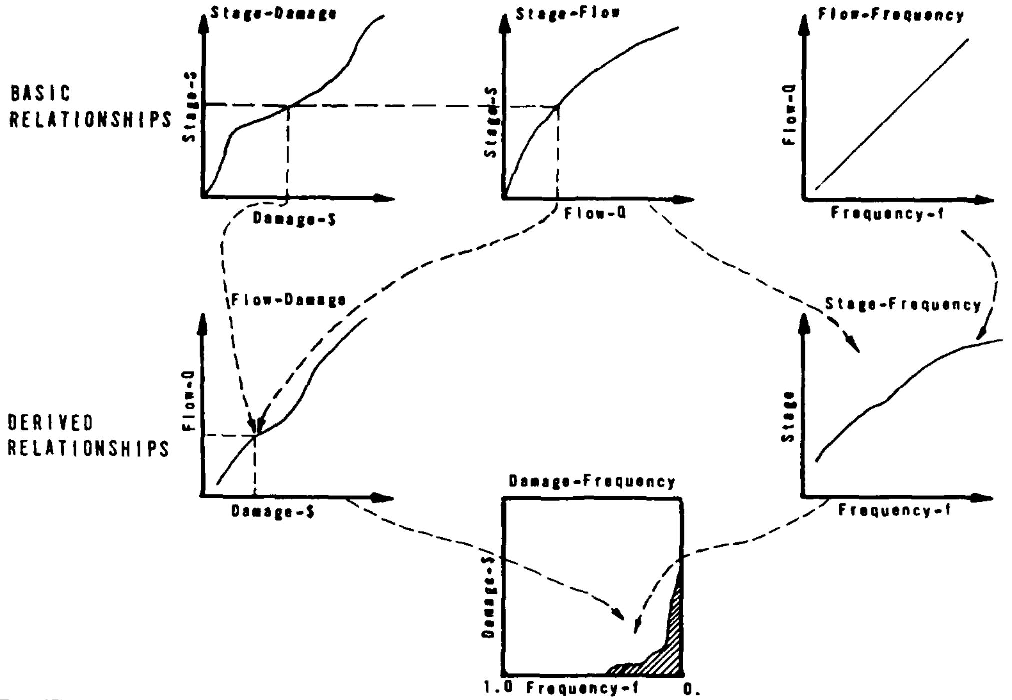
C. Parametric Relationships Used in the Package

The package of programs and data management elements are designed to be used as an integrated set, as partial separate elements, or even as a final repository/processing capability for data developed by other programs or procedures. It is envisioned that each of the hydrologic engineering and flood damage function development programs would be used independently by the specialist working in their respective areas. For example, a hydraulic engineer will determine elevation-discharge rating curves at selected locations using HEC-2 and store the curves in the DSS data file. Simultaneously, an economist will inventory structures in the flood plain to compute elevation-damage relationships for those same index locations using SID and store the curves in the same DSS data file. Other analyses also will be performed simultaneously (such as rainfall-runoff and reservoir systems) and the pertinent parametric relationships (flow-frequency curves) stored in the same DSS file. Each of the analysts must meet with the study manager to establish:

(1) a list of index locations at which the pertinent relationships will be computed, and

(2) a convention for the alphanumeric labels which will identify the locations, the damage alternative plans, and the study (this is discussed in Appendix A).

The basic concept is that each of the major data types is developed by the applicable computer programs and the results written to the DSS file with



The basic and derived evaluation relationships are shown above. Concepts important to their construction are described herein.

Stage-Flow Relationship: This is a basic hydraulic function that shows for a specific location, the relationship between flow rate and stage. It is frequently referred to as a 'rating curve' and is normally derived from water surface profile computations.

Stage-Damage Relationship: This is the economic counterpart to the stage-flow function and represents the damage which will occur for various river stages. Usually the damage represents an aggregate of the damage which could occur some distance upstream and downstream from the specified location. It is usually developed from field damage surveys.

Flow-Frequency Relationship: This defines the relationship between exceedance frequency and flow at a location. It is the basic function describing the probability nature of stream flow and is commonly determined from either statistical analysis of gaged flow data or through watershed model calculations.

Damage-Frequency Relationship: This relationship is derived by combining the basic relationships using the common parameters stage and flow. For example, the damage for a specific exceedance frequency is determined by ascertaining the corresponding flow rate from the flow-frequency function, the corresponding stage from the stage flow function and finally the corresponding damage from the stage-damage relationship. Any changes which occur in the basic relationships because of watershed development or flood plain management measure implementation will change the damage-frequency function and therefore the expected annual damage that is computed as the integral of the function (area underneath).

Other Functional Relationship: The flow-damage relationship is developed by combining the stage-damage with the stage-flow relationship using stage as the common parameter. The stage frequency relationship is developed by combining the stage-flow with the flow-frequency relationship using flow as the common parameter. The damage-frequency relationship could then be developed as a further combination of these derived relationships.

Figure 1 Basic and Derived Relationships

Table 1: Effect of Flood Plain Management Measures

	Impacted Relationship[1]				
Measure	Stage-flow	Stage-Damage	Flow-Damage	Flow-Frequency	Damage-Frequency
Reservoir[2]	NC	NC	NC	M	M
Levee or floodwall[2]	M	M	M	M[3]	M
Channel Modification[2]	M	NC	M	M[3]	M
Diversion[2]	NC	NC	NC	M	M
Flood Forecasting	NC	NC	NC	M	M
Flood Proofing	NC	M	M	NC	M
Relocation	NC	M	M	NC	M
Flood Warning	NC	M	M	NC	M
Land Use Control[4]	NC	M	M	M	M

[1] The following codes apply to the table above:

NC = No Change in parametric relationship
M = Modification to parametric relationship

[2] Long-term effects resulting from a change in stream regime induced by these measures could affect the basic stage-flow relationship and thus other derived relationships at some future date.

[3] Elimination of significant amounts of flood plain storage can result in downstream effects on flow-frequency relationship.

[4] The impact indicated is that which would occur to a future condition in the absence of the measure.

The basic relationships that comprise the frequency method (Figure 1) are developed in a variety of ways by Corps field offices. Most analysts derive the stage-flow (rating curve) by computing water surface profiles with one of the readily available computer programs. Some analysts combine the stage-flow and stage-damage steps in an alternative approach wherein flow lines (flood plain outlines for a range of flood events) are drawn on maps, potential damage identified within the flooded areas, and flow-damage relationships developed directly. More commonly, stage-damage relationships are developed through an inventory process (of individual or groups of structures), and then the inventory results are aggregated to form one or more categories of damage relationships. Flow-frequency is developed through either direct analysis of historic records or by use of computations with hydrologic models, or a combination of both. Corps field offices often manipulate the resulting functions with their own annual damage computer programs or use one or more of the HEC programs.

appropriate identifying labels. The data can then be subsequently retrieved and used by other computation programs if the appropriate identifying label is input to the program.

1. Flow-Frequency Data

The hydrologic engineer will perform conventional analysis to develop a rainfall-runoff model (HEC-1) of the study area and set the program to run in the multi-plan evaluation mode (see HEC-1 User's Manual). Execution would cause the base condition and subsequent alternative conditions flow-exceedance frequency curves developed automatically during HEC-1 program execution to be written to the DSS file with the appropriate identifying labels. If reservoir system operation is an element of the study, then hydrographs would instead be written to the DSS file for subsequent retrieval and operation with the HEC-5 program. The HEC-5 program is then executed for the alternatives of interest in its plan evaluation mode (see HEC-5 User's Manual) and the subsequent flow-frequency results written to the DSS file with the appropriate identifying labels.

2. Elevation-Discharge Data

Water surface profile computations would be performed conventionally. After completion of calibration analysis, HEC-2 is executed for the stream conveyance alternatives of interest using the multiple profile mode (see HEC-2 User's Manual) and the resulting elevation-flow results written to the DSS file with appropriate pathname labels.

3. Elevation-Damage Data

Two alternatives are possible for development of elevation-damage relationships using programs in this package. One is conventional structure inventory based (SID) and the other is geographically (spatially) based (DAMCAL) using a grid cell data bank. The subsequent elevation-damage function development capability is virtually identical for both. Damage functions may be developed by reach, by damage category and for a wide range of non-structural flood plain management measures. References are available describing an overview of spatial versus inventory approach (4), guidance on preparation of grid cell data banks (7), and examples of the application in Corps studies (14). Other analysis features are available for hydrologic and economic aspects of studies using the spatial approach but are not discussed herein. Reference (6) is a descriptive overview of the spatially-based HEC-SAM system. Regardless of the approach taken the program (SID or DAMCAL) is executed for the without condition and then with alternatives of interest and the computed results written to the DSS file with the appropriate identifying labels. The user's manuals for SID and DAMCAL describe their specific capabilities and provide instructions for their use.

The SIDEDT program is a specially designed editor that can manipulate the structure inventory data file that would be developed for use with SID. It has capabilities to enable easy data editing to correct errors, updating by any number of mathematical operations and windowing out data sets for a more geographically confined analysis.

These programs are generally considered to be intermediate steps to annual damage computations but the careful analyst can develop very useful plan formulation/evaluation data as a by product to development of the elevation damage functions. For example, the analyst could compute such data as the damage resulting from specific frequency-flood events and the number of inundated structures (or acres of land) by category and flood frequency zone using either SID or DAMCAL.

4. Expected Annual Damage Computations

At this point, the DSS file contains flow-exceedance frequency, elevation flow rating, and elevation-damage potential data for a variety of conditions and alternatives. The final step to compute expected annual damage is the execution of the EAD program for the specific conditions and alternatives desired. The EAD program is executed conventionally except that instead of defining each of the various relationships in an input data file, the appropriate data is retrieved from the DSS file by recalling data sets with the appropriate identifying labels. In effect the annual damage computations are performed by orchestrating the data from the DSS file into groupings needed for the alternative evaluation.

D. Typical Applications of the Package

Various components of the package come into play for specific types of analysis. Selected evaluation situations are described below to provide the reader with the flavor of the significant capability that the integrated package provides. Assume for this discussion that basic computer runs have been made so that the DSS file contains base condition evaluation data of flow-frequency, elevation-flow, and elevation-damage for locations of interest within an area under investigation. Several alternate watershed conditions and alternative flood damage mitigation measures will be evaluated.

1. Future Watershed Urbanization

Increased urban development in a watershed can have a direct effect on storm runoff. To evaluate future runoff impacts, HEC-1 is executed in the multi-plan mode with runoff and routing coefficients representative of both the base condition and projected future conditions. The resulting sets of flow-exceedance frequency data are written to the DSS file. The coefficients for existing and future conditions are developed conventionally through study of historic storms, or through the use of a grid cell data bank - see references (7) and (1) for details. The EAD program is executed, if desired, to determine the effect of future urban development on annual damage by retrieving the future condition frequency curves along with the other base condition data rather than the base condition frequency data.

2. Storage Reservoirs

Storage reservoirs for flood control are of two types - uncontrolled (sometimes referred to as "ungated") where outflow is a function of storage in the reservoir; and controlled (sometimes referred to as "gated") wherein reservoir releases are made based on downstream flow conditions. In the former case, the simple uncontrolled reservoirs to be studied are characterized by storage-outflow routing functions and these are inserted into the HEC-1 data set. HEC-1 is executed and the resulting regulated flow-frequency data are written to the DSS file. In the latter (gated case), inflow data for HEC-5 is derived by alternate means, or HEC-1 is executed to develop a set of inflow hydrographs using an HEC-1 run set-up similar to that needed for the ungated analysis, except that hydrographs are written to the DSS file. HEC-5 is then executed, retrieving the flow hydrographs from the DSS file and performing a simulation analysis for the proposed storage reservoirs. The resulting flow-frequency data are written to the DSS file.

These regulated frequency curves, along with appropriate rating and damage functions, are then retrieved by the EAD program to determine the reduction in annual damage due to the storage reservoirs. Detailed guidance for performing the modeling needed to evaluate reservoirs is contained in the HEC-1 and HEC-5 user manuals.

3. Flood Plain Management Actions and Policies

Mitigation measures that modify the damage potential of flood plain occupant properties are evaluated with SID and DAMCAL - the specific program used depends on whether spatial data or structure inventory data are used. SIDEDT is used to "window" a larger structure data set to a smaller subset if a subunit of the study area is to be investigated. It is also used to correct and update data contained in a SID file to represent the conditions of interest.

The SID (or DAMCAL) programs are then executed for the mitigation measures of interest (flood proofing, relocation, temporary emergency action, management of future development) and the resulting elevation-damage data written to the DSS file. The EAD program is then executed, if desired, to determine the annual damage reduction resulting from the proposed measures. The full range of these program capabilities are contained in their respective user's manuals (references 12 and 2).

4. Channel and Levees

Channel modifications directly impact on the geometry of the stream conveyance system. The HEC water surface profiles program is therefore the evaluation tool. HEC-2 runs are made for the alternatives of interest, whether clearing and snagging (smoothing roughness) or channel enlargement or straightening or both and the resulting multiple profile data are written to the DSS file. If levees are studied, and their placement adjacent to the stream results in a measurable reduction in conveyance, HEC-2 runs are made for these cases as well and the resulting altered profile data written to the DSS file. The EAD program is then used to retrieve appropriate rating functions and other data to compute the annual damage reduction that would result from the measures. Evaluation of levees alone are often satisfactorily analyzed by adjustment of functions (truncation of damage or frequency functions) at the time of EAD execution and thus need not require re-analysis with other programs.

IV. Study Management

A. Organizational Matters

Studies that are intended to realize the full potential of the Flood Damage Analysis (FDA) package need to be particularly careful to ensure coordination among participating study group members with respect to common data sets, elevation datum, study area partitioning, alternatives to be considered, and naming conventions. Study management and the participating technical analysts should meet early (and often) to adopt the necessary common items. Most often, study participants will work in separate District units, and to a significant degree, independent of others. It is essential that the following be accomplished:

1. Assignment of responsibility for coordination of data management activities. This can be performed by any element but can usually best be accomplished by the staff of the coordinating unit - usually a technical assistant to the study manager.

2. Agreement on those items that must be coordinated (e.g. damage reaches, index locations, stage/elevation datum, reporting subdivisions, naming conventions, etc.) and the mechanism for ensuring agreement.

3. Performance of first-pass coordination on key items to enable study activities to begin.

4. Development of a phased work plan schedule for each participant to permit orderly progression of computer processing that is dependent upon data in computer files to be developed by others.

B. Computer Program/File Management

The FDA package programs should all exist on a single computer system so that files may be written in a straight-forward manner. The programs must be the proper versions; e.g. Districts with versions of HEC-1, HEC-2 etc. that do not contain the DSS software system calls will not be able to write data to DSS files. Recent HEC official library versions resident on the Harris 500 (or 1000) and the CDC Cybernet systems have the necessary features incorporated. Other program versions may not. It is prudent to arrange for acquisition/testing of the needed programs early, and to work closely with District ADP elements to ensure availability of needed hardware and dedicated system file space (e.g. disc storage space). The features of the programs that make them linkable through the DSS system are significant. If a District wishes to use their own version of one of the programs that had been modified to accommodate local District practices, the incorporation of the DSS features could be a major and difficult task. It would be best to acquire the official HEC library program with the DSS features already incorporated and then add, at the District level, the local modifications as needed.

Efficient use of the FDA package (or the HEC programs independent of the FDA features for that matter) requires experienced program users. Novices should be trained in the basic use and capabilities of the individual programs (through in-house or other training mechanisms) and then introduced to the more advanced integrated use made available through the FDA package. Technical assistance from HEC staff may be useful for early aspects of studies. Several Districts have made use of the capability and are likewise valuable contacts for ideas regarding the FDA package, (for example, New York, Ft. Worth, St. Louis, and Little Rock).

C. Data Management

Planning studies which make significant use of computerized analysis are the rule rather than the exception within the Corps of Engineers. Planning studies, by their increasingly comprehensive nature, involve several District elements. Assignments change and staff change positions. Studies that use the FDA Package depend upon data placed in computer files by the several District elements. It is therefore important that each element be businesslike in recording at regular intervals in notebooks/study files, the status of computer runs, location and conditions for which files were written to the DSS file, and any notations needed to enable the "next person" to continue the study from that point with minimum disruption. File management and archiving for future reference are also important.

Another common tendency in the present highly-computerized environment of studies is to concentrate on making computer runs and obtaining output and files to the neglect of narrative documentation of important assumptions, data adjustment, and insights obtained. It is a useful practice to prepare regularly (along with the recording of the status of computer data and runs described separately) narrative descriptions of these aspects of the study so that they likewise may provide for continuity of study progress should interruptions occur. Even without application of the FDA package, businesslike during-study documentation discussed herein is a good idea.

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Appendix A
Data Management

A. Data Management

1. Introduction

This appendix describes data manipulations when using the previously mentioned programs as a package. The traditional manner of performing a study is to prepare data input to a specific applications program in a single, human-readable file, execute the program, obtain computed results printed on paper, and then prepare data input in another-human readable file to another applications program that utilizes computed results from the first program. This method requires the user to manually read results from printed output and enter them as input. This method has the following disadvantages and advantages:

- Disadvantages:
  - The user can easily make an error in transferring the data.
  - The user might have to expend considerable time and energy to transfer the data.
- Advantages:
  - The user need not have any knowledge of a data management system.
  - The user does not need data management software. Data management software are generally more computer system dependent than the application programs and thus may not be as available.

When using the Flood Damage Analysis programs as a package, the user must still prepare data input in a human readable file and obtain printed output. However, some input normally entered by the user may be retrieved from a data base file and some output that is printed may also be written to that file. This reduces the amount of user input and allows the user to retain computed results on a computer system and subsequently view and compare alternatives. HEC has developed a data storage system (DSS) that allows the user to transfer data between programs, has modified the application programs to utilize it, and has developed utility programs to manipulate DSS data files. To take advantage of DSS, the user will need to make minor modifications to the job control language (JCL) used to execute the program and to the input data files. These modifications are described in detail later in this section under "Application Programs".

2. DSS Description

DSS is a collection of subroutines that can be called by application programs (such as HEC-1). The programs retrieve from the DSS software or pass to the DSS software some kind of data and associated descriptors. DSS in turn accesses a disk file and either retrieves data from or stores data in that file. The data file remains permanently on the computer system until saved on tape and eliminated by the user. The user can access data in that file by executing an applications program (such as EAD) that will read data from it, or by executing a DSS utility program (such as DSPLAY) that can tabulate or plot data from it. The description contained herein is very general. The user may obtain more detailed information on the DSS and its utilities from reference (8).

DSS utilizes a direct access (versus sequential) disk file. A direct access file permits more efficient data access than a sequential file when used in a data management environment. The fact that the DSS file is a direct access file is important to the user for two reasons:

- The data stored in the file is not stored in a human readable format --- the user cannot "list" the file but must execute a program to look at the data.
- The user may have to create the DSS file in a special way --- this is computer system dependent and will be addressed later under Application Programs.

A DSS file stores data by records. It may contain only one record or as many records as the user wishes. A unique alphanumeric string of 80 or fewer characters identifies each record. This identifier is referred to as a "pathname". There is one pathname for every record and no two pathnames can be identical. The pathname begins and ends with the slash ("/") character and consists of six parts, each separated by a slash ("/"). For discussion purposes, the parts will be identified as A,B,C,D,E, and F. Thus, a possible pathname would be:

/A/B/C/D/E/F/

In practice, pathname parts follow certain naming conventions as shown below:

Pathname Part	Description
A	River basin or Project identifier.
B	Location, reach, or gage identifier.
C	Data variable or variables (i.e. FLOW).
E	Year corresponding to data (for Flood Damage Analysis).
F	Alternative name or data variable qualifier.

For instance, if HEC-1 was executed to compute a flow-frequency curve for two plans and those curves were stored in a DSS file, the resulting pathnames for these curves might look like this:

/SILVER CREEK/RCH 1/FREQ-FLOW//1980/BASE/
/SILVER CREEK/RCH 1/FREQ-FLOW//1980/UNGTD RES/

DSS data records internally follow certain conventions. They include regular time series, irregular time series, and paired function data. The user need not know much of anything about these conventions other than that they exist. To perform flood damage analysis, the user need utilize only the paired function convention. Paired data is data that represents a two variable relationship. The relationships used in flood damage analysis include: flow-frequency, stage-discharge, and stage-damage. One or more paired data curves may be stored in a single DSS record. However, each record contains data for only one location, one alternative or plan, and one point in time (year). A record may contain more than one curve if one variable has a single set of ordinates. SID and DAMCAL are the only Flood Damage Analysis programs that store multiple curves in a single DSS record. They generate stage-damage curves where, for a single set of stages, there might be several corresponding sets of damage values such as residential, light commercial, and heavy commercial.

The regular time series convention is not required for the flood damage analysis package but may be beneficial to the user in the application of HEC-1 or HEC-5. This convention is used to store hydrographs containing ordinates spaced uniformly in time. Thus, the user could store and compare flood hydrographs for several plans for each ratio.

Each DSS record is comprised of two parts: a header and a data area. The data area contains application program input or output such as flow hydrographs or paired functions. The header part contains index or descriptive information for the data. This includes such things as the data units (CFS, FEET, ...), data type (average for the period, instantaneous, or probabilistic), and the number of values or ordinates.

When using the Flood Damage Analysis Package, the user must maintain the integrity of the DSS data file. As with any other file, it can be damaged by a computer system crash, a user directed application program abort, or an involuntary application program abort. File integrity is maintained by software within the DSS system and by the user maintaining backup files. DSS software performs file pointer cleanup when an application program aborts. Under some conditions, a computer system crash may irreparably damage a DSS file and require that the user generate a new file from a backup file.

Any analysis will require archiving study materials. Computer files may be archived in conjunction with normal, periodic system backup by ADP support personnel or as a result of specific user instruction. It usually involves storing data on a low cost, mass storage device such as a magnetic tape. The tape may be written in different formats ranging from very efficient but computer system dependent to less efficient but computer system independent. Application program input data, program source code, and output may be stored in any of the above formats. However, application program executables and DSS data files may only be stored in a computer system dependent format. If the user anticipates archiving data that will be subsequently transferred to a different system, the data and source codes must be selectively stored. A DSS file can be recreated on another computer system by:

- o Either re-running all application programs on that system.
- o Or creating human readable system independent files of data to transfer between systems.

The creation of a system transferable file requires the use of the DSS utility program DSSUTL (8) to retrieve data from a DSS file on the original system and store it in a transferable file. That file is then transferred to the new system and DSSUTL is used to recreate the DSS file on that system. The user should consult his support personnel for help in archiving data on magnetic tape. Documentation for DSS describes the use of DSSUTL in detail.

3. Application Programs

a. Description

Flood Damage Analysis application programs communicate with each other through a DSS data file. For example, EAD uses frequency curves computed by HEC-1. EAD retrieves those curves by knowing the identification of the data record in the DSS file and the format of the frequency curve data. Some of this information is transparent to the user whereas some information must be supplied by the user. If the user supplies incorrect information, the application program will not obtain the required data and will compute erroneous results. This section will describe the specific user actions required to successfully utilize the DSS linkage.

EAD is the "bottom line" application program. It produces the user's final objective --- either damage for a specific event or expected annual damage. EAD processes computed results from one or more of the following programs: HEC-1, HEC-2, HEC-5, SID, and DAMCAL. Thus, when using the DSS link, EAD can be executed only after at least one of these other programs has been executed. For most applications, the programs HEC-1, HEC-2, HEC-5, SID, and DAMCAL can be executed independently and in any order. There are always exceptions. For example, significant channel modifications may change the stage-discharge rating curve (HEC-2), the storage routing coefficients (HEC-2 results must be used in HEC-1), and the flow-frequency curve (HEC-1). The user may also wish to use the HYDPAR (9) program to develop parameters which would be stored in a DSS file and used as input to HEC-1. In that case, the order of program execution is important --- HEC-2, followed by HYDPAR, followed by HEC-1, followed by EAD.

To utilize DSS, the user must execute the following tasks:

1. Generate the DSS file. If the file does not exist, the application programs will generate it using default specifications. It is necessary to generate only one DSS file although it is sometimes helpfull to use more than one file.

2. Modify job control language (JCL) to connect the DSS file to the execution of a desired program and the user's input.

3. Enter application program input data to trigger the storage or retrieval of data from a DSS file.

4. Enter application program input data to define the DSS record identification (pathname) for the desired data.

b. Creating a DSS file

The first step required to use DSS is the creation of a DSS file. This is a system dependent action. The users main goal is to generate a DSS file in such a manner that will maximize data integrity. When more than one person will use the file, the user must insure that one user will not destroy another user's DSS data. The following recommendations are specific to Harris and CDC computers. However, the concepts can be applied to other computers. The Harris computer allows multiple users to simultaneously access the same file whereas a CDC machine allows only single user access.

- o To generate a file on a Harris system:

  1. If only one user at a time will access the file, enter:

     ```
     $GENERATE,filename,U
     ```

     This creates an unblocked file called "filename" which can be accessed by only one user at a time.

  2. If more than one user will simultaneously access the file, enter:

     ```
     $GENERATE,filename,R
     ```

     This creates a direct access file called "filename" which can be accessed by several users simultaneously.

- o To generate a file on a CDC system, the user should enter:

  ```
  DEFINE,filename/M=W.
  ```

  This creates a file called "filename" with write access. It is a direct access file that can be used by only one person at a time.

The filename should be three through seven characters starting with an alpha character (A through Z). Many systems allow filenames with eight characters, but some (like CDC) limit them to seven. Also, on the Harris, the DSS system generates a file that inventories the data file pathnames. This file is called a catalog file. Its name is generated by appending the character "C" to the name of the data file. Thus, if the data filename is seven characters, the catalog filename is eight characters.

c. Accessing a DSS File

The second step is to access the DSS file when executing an applications program. This is done through job control language (JCL) and it is computer system dependent. When created, the DSS file is empty. The first execution of an application program must store (write) data to the file and not retrieve (read) data.

To access a DSS file on a Harris: perform "file substitution" at the time of execution. For example, if the DSS file name is "SLVAAEZ", the user executes HEC-1 by entering:

```
HLIB*HEC1X,DSSFILE=SLVAAEZ
```

Unfortunately, the programs are not consistent in their use of a file name identifier. Each program is executed with DSS file access by using the following JCL lines where "(filename)" is the name of the users DSS file:

```
HLIB*HYDPAR,TAPE71=(filename)
HLIB*HEC1X,DSSFILE=(filename)
HLIB*HEC2X,DSSFILE=(filename)
HLIB*HEC5BX,DSSOUT=(filename)
HLIB*SIDX,TAPE71=(filename)
```

```
HLIB*DAMCALX,TAPE71=(filename)
HLIB*EADX,TAPE71=(filename)
```

The user may determine the identifier quite easily on the Harris. For example, to determine the identifier for HEC-1, the user would type the following on the computer terminal keyboard:

```
HLIB*HEC1X,?
```

HEC-1 would list each local file number (FORTRAN unit), identifier, and default file assignment as shown below.

```
HLIB*HEC1X,?

DEFAULT ASSIGNMENTS
LFN   KEYWORD     DEFAULT
 7    INPUT       *0
 6    OUTPUT      LO
 8    PUNCH       W8
 21   TAPE21      W1
 22   TAPE22      W2
 23   TAPE23      W3
 24   TAPE24      W4
 25   TAPE25      W5
 32   TAPE32      U2
 33   TAPE33      U3
 34   TAPE34      U4
 35   TAPE35      U5
 36   TAPE36      U6
 38   TAPE38      U8
 71   DSSFILE     U1
```

The user would find the local file number 71 or LFN 71 (except for HEC-5 which uses 72) and then find the corresponding identifier to use in the execution JCL (it would be either TAPE71, DSSFILE, or DSSOUT).

To access a DSS file on a CDC machine, the user may either perform file substitution or make a file assignment. File substitution requires the user to know the order of file declarations on the program card within the FORTRAN source code. This information may be difficult to obtain. Thus, the user is encouraged to use the second method of accessing a DSS file as described below. All programs utilize Fortran unit 71 for the DSS file except HEC-5 which stores data on unit 72. In JCL, unit 71 is identified as "TAPE71". To access the DSS file, the user would assign that unit before executing that program. For example, to access the DSS file "SLVAAEZ", the user would enter:

```
          ATTACH,TAPE71=SLVAAEZ/M=W.
    or    ATTACH,TAPE71=SLVAAEZ.
```

The inclusion of "/M=W" allows the user to write data to the file and it may be eliminated if the user is only reading data from the file.

Example JCL files are listed below:

1. Harris --- JCL and input data stored in same file:

```
$JOB,HEC1,...........
HLIB*HEC1X,DSSFILE=SLVAAEZ
  (HEC-1 input data)
           .
           .
$EOJ
```

2. Harris --- Input data stored in a separate file (called SLVA01I) from JCL:

```
$JOB,HEC1,.........
HLIB*HEC1X,INPUT=SLVA01I,DSSFILE=SLVAAEZ
$EOJ
```

3. CDC Cybernet --- JCL and input data stored in same file:

```
HEC,CM377000,P=3,T=70.
USER,CEL7xx,password,KOE.
CHARGE,CEL7xxx,xxxxx.
GET,HEC1/UN=CECELB.
ATTACH,TAPE71=SLVAAEZ/M=W.
HEC1.
/*EOR
   (HEC-1 input data)
            .
            .
            .
/*EOF
```

4. CDC Cybernet --- Input data stored in a separate file (called SLVA01I) from JCL:

```
HEC,CM377000,P=3,T=70.
USER,CEL7xx,password,KOE.
CHARGE,CEL7xxx,xxxxx.
GET,HEC1/UN=CECELB.
ATTACH,TAPE71=SLVAAEZ/M=W.
GET,SLVA01I.
HEC1,SLVA01I.
/*EOF
```

d. JCL and Data Modifications

The next steps require the user to enter certain application program input data that will trigger a read or write of data to a DSS file and specify the desired record identifier (called pathname). The user triggers a retrieval (or read) from DSS file by entering one or more "ZR" cards. The "ZR" refers to the card code identifier that is entered in columns one and two of a data input record. Similarly, the user triggers a storage (or write) to DSS file operation by entering one or more "ZW" cards. User input on the ZR and ZW cards define some parts of the DSS pathname, but not all. The user must generally define parts A, E, and F on the ZR/ZW cards. As mentioned earlier, part A defines the Basin or River, E the year that the data represents, and F the alternative or plan identification. When defining parts, leading and trailing blanks are ignored and embedded blanks are significant.

For Flood Damage Analysis, part A will be identical for all application programs for a given study area. Each plan will have an identical F pathname part, and each data year will have an identical E pathname part. Input to each program will be discussed in more detail below. However, it would be helpful to show one example.

For the HEC-1 economic analysis mode, the ZW card defines parts A,E, and F of the pathname. Part A is entered in columns three through sixteen, part E in columns forty-five through forty-eight, and part F in columns seventeen through forty. For discussion purposes, assume a study is being performed in "Bedrock Creek" for the plan "Base", and for the year 1980. HEC-1 writes frequency curves to DSS and EAD will later read those curves. Pathname parts entered on the ZW card for HEC-1 will have to be exactly duplicated on the ZR card for EAD. It so happens that the ZR card for EAD contains pathname part A in columns three through sixteen, and part F in columns seventeen through forty. Examples below depict user input which would trigger DSS interaction.

<u>Valid example</u>:

```
ZW  SILVER CREEK  BASE                      1980
ZR SILVER CREEK         BASE                  QF       1
```

EAD will be able to read frequency curves written to DSS by HEC-1 because leading and trailing blanks of a pathname part are ignored. DSS software will ignore the leading blank before "SILVER CREEK" on the ZW card and the leading blanks before "BASE" on the ZR card.

<u>Invalid example</u>:

```
ZWSILVER  CREEK                     BASE   1980
ZRSILVER CREEK  BASE                          QF       1
```

EAD will not be able to retrieve the frequency curve written by HEC-1 for two reasons:

- The HEC-1 ZW card contains two blank columns between "SILVER" and "CREEK" whereas the EAD ZR card contains only one.
- The HEC-1 ZW card contains the year "1980" outside of the required columns forty-five through forty-eight.

The users manuals for programs HEC-1, HEC-5, HYDPAR, SID, and EAD describe DSS input data cards ZR and ZW. Appendix B of this document describes DSS input data cards for the programs HEC-2 and DAMCAL.

Earlier sections of this document describe analysis scenarios and the type of data stored in or retrieved from a DSS file when performing Flood Damage Analysis. In summary, HEC-1 and HEC-5 store flow-frequency curves, HEC- 2 stores stage-discharge curves, SID and DAMCAL store stage-damage curves, and EAD reads all of these curves. Storage of computed results essentially duplicates printed output. Retrieval of data from a DSS file replaces user input. Thus, the user may associate certain EAD input cards with data stored in a DSS file. This association for EAD is described later. In general, the user specifies pathname parts A, E, and F on the ZR and ZW cards. The other pathname parts may be either automatically generated by the applications program or entered by the user as a normal input data item even for non DSS jobs. Table 2 summarizes the location of pathname parts entered to each program.

A pathname cannot exceed 80 characters including the "/" (slash) separators. DSS limits individual parts to thirty-two characters. Application programs further limit those pathname parts by allowing a limited number of columns of user input. As a result, the following limitations apply to pathname parts when used in Flood Damage Analysis:

Part	Maximum number of characters
A	14
B	6
E	4
F	22

TABLE 2: Location of DSS Pathname Parts [1]

	Pathname Part					
Program	A	B	C	D	E	F
HYDPAR	ZW.1-2	SB-5	AG	NA	ZW.6	ZW.3-5
HEC-1	ZW.1-2	FR.1[2]	AG	NA	ZW.6	ZW.3-5
HEC-2	ZW.1-2	X1.1	AG	NA	ZW.6	ZW.3-5
HEC-5	ZW [3]	ID.1-2	AG	NA	ZW [3]	ZW [3]
SID	ZW.1-2	DR.1	AG	NA	ZW.6	ZW.3-5
DAMCAL	ZW.1-2	DT.1	AG	NA	ZW.6	ZW.3-5
EAD	ZR.1-2	[4]	AG [5]	NA	[6]	ZR.3-5
EAD	ZR.1-2	QF.1	AG	NA	QF.2	ZR.3-5
EAD	ZR.1-2	QS.1	AG	NA	QS.2	ZR.3-5
EAD	ZR.1-2	DG.1	AG	NA	DG.2	ZR.3-5

note:

[1] The part location is identified by the code:

"xx.n-m"

where:

xx   is the card code identifier entered in columns one and two for an application program (i.e. "ZW").

n-m   is the field locations on that card. If only one field is occupied, then "-m" is not entered. Sometimes, partial fields are used. That is documented with the detailed card descriptions.

The code "NA" indicates that part is not used and the code "AG" indicates that part is automatically generated by the applications program.

[2] HEC-1 generates part B from field one of the FR card. If it is blank, then it uses the first field of the preceding KK card.

[3] HEC-5 requires the user to enter "ZWQF" in columns one through four to store flow-frequency data in a DSS file. Parts A, E, and F are entered in a free format style. For example:

```
ZWQF A=BEDROCK CREEK, E=1990, F=BASE
```

[4] EAD generates part B from field one of the following cards: QF,QS,DG.

[5] EAD automatically generates part C based on the type of card input: QF,QS, or DG.

[6] EAD generates part E from field 2, columns nine through twelve of the following cards: QF,QS, or DG.

e. Data Link to the EAD Program

User input which triggers DSS interaction is most critical for the EAD program. This input must exactly agree with that previously entered for the other programs. Therefore, some additional discussion of this link is warranted. It is organized by data type. Example usage is included with each description.

(1) Flow-Frequency

EAD reads flow-frequency data from FR and QF cards. To read flow- frequency data from DSS, the user must execute either HEC-1 or HEC-5:

(1a) Execute HEC-1. For example:

```
HLIB*HEC1X,DSSFILE=SLVAAEZ
```

- A DSS file has been generated and attached to this execution. For example, if the file does not exist, generate it:

```
$GE SLVAAEZ R PR PW OD G=100
```

- A ZW card must be entered after the EC card and after each PN card.

- The ZW card must contain:
  - Pathname part A in columns three through sixteen.
  - Pathname part F in columns seventeen through forty.
  - Pathname part E in columns forty-five through forty-eight.

- Pathname part B is entered on each FR card in columns three through eight.

- Example HEC-1 input:

```
ID......
....
....
EC
PN     1EXISTING CONDITIONS
ZW SILVER CREEK BASE                        1985
PN     2UNGATED RESERVOIR
ZW SILVER CREEK UNGTD RES                   1985
KK RCH 1
FR RCH 1      16 ............
QF ....................
ZZ
```

(1b) Execute HEC-5

- HEC-5 must be executed in two parts. Example JCL is:

```
HLIB*HEC5AX
HLIB*HEC5BX,DSSOUT=SLVAAEZ
```

- DSS file is generated and attached to this execution. For example, if the file does not exist, generate it:

```
$GE SLVAAEZ R PR PW OD G=100
```

- Appropriate flags are set on the J4 card:

  - A positive integer is entered in field one of the J4 card.
  - A "2" is entered in field ten of the J4 card.

- A ZW card is entered after the BF and FC cards.

- The ZW card contains:

  - Pathname part A in free format.
  - Pathname part F in free format.
  - Pathname part E in free format.

- Pathname part B is entered on each ID card in columns three through sixteen. Only six characters are entered for flood damage analysis.

- Example HEC-5 input:

```
T1.....
.......
.......
J4     1                                                  2
.......
CP     2 ......
ID RCH 1
RT ....
DA ..
DF ....
DQ ....
DC ...
ED
BF     2 ....
FC    .2 ....
ZW A=SILVER CREEK E=1985 F=GATED RES
 ....
 ....
EJ
ER
```

(1c) Execute EAD

- The DSS file used for the HEC-1 or HEC-5 job must be attached to the EAD execution. Example JCL is:

```
HLIB*EADX,TAPE71=SLVAAEZ
```

- A ZR card must be entered and contain:
  - Pathname part A in columns three through sixteen.
  - Pathname part F in columns seventeen through forty.
  - The characters "QF" in columns forty-seven and forty-eight.
  - A numeric plan identifier in columns fifty-five and fifty-six (right justified).
  - Example EAD input for ZR cards:

```
ZR SILVER CREEK BASE                          QF       1
ZR SILVER CREEK UNGTD RES                     QF       2
ZR SILVER CREEK GATED RES                     QF       3
```

- A QF card must be entered at the location that the FR and QF cards are normally entered. The QF card must contain:
  - Pathname part B in columns three through eight which is identical to a reach identification entered either in columns three through eight of a FR card in the economics section of the HEC-1 data deck or columns three through sixteen of an ID card in the HEC-5 input data file.
  - Pathname part E in columns nine through twelve which is identical to that entered in columns forty-five through forty-eight of the HEC-1 ZW card or on the HEC-5 ZW card.
  - The plan number in columns thirteen and fourteen (right justified). This must agree with the plan number entered on a ZR card.
  - "-1" in columns twenty-three and twenty-four to instruct EAD to read the flow-frequency curve from a DSS file.

- Example EAD input data:

```
ZR SILVER CREEK BASE                          QF       1
ZR SILVER CREEK UNGTD RES                     QF       2
ZR SILVER CREEK GATED RES                     QF       3
RN
FR RCH 1 .......
QF RCH 11985 1        -1
 ....
EP     1
QF RCH 11985 2        -1
EP     2
QF RCH 11985 3        -1
EJ     3
```

HEC-1, HEC-5, and EAD automatically generate pathname part C to be:

"FREQ-FLOW"

(2) Elevation-Discharge Data

EAD reads elevation-discharge rating curves from SQ and QS cards. To read elevation-discharge data from DSS, the user must:

(1a) Execute HEC-2. Example JCL is:

```
HLIB*HEC2X,DSSFILE=SLVAAEZ
```

- A DSS file has been generated and attached to this execution. For example, if the file does not exist, generate it:

```
$GE SLVAAEZ R PR PW OD G=100
```

- A ZW card must be the first input data record.
- The ZW card must contain:
  - Pathname part A in columns three through sixteen.
  - Pathname part F in columns seventeen through forty.
  - Pathname part E in columns forty-five through forty-eight.
- Pathname part B is entered on every X1 card in columns three through eight.
- Conditional modifications are made to the J2 and J3 cards.
- Example HEC-2 input data:

```
ZW SILVER CREEK BASE                        1985
T1 ....
  ....
  ....
X1  49.0 .....
  ....
EJ
```

(1b) Execute EAD

- The DSS file used for the HEC-2 job must be attached to the EAD execution. An example execution of EAD is:

```
HLIB*EADX,TAPE71=SLVAAEZ
```

- A ZR card must be entered and contain:
  - Pathname part A in column three through sixteen.
  - Pathname part F in columns seventeen through forty.
  - The characters "QS" in columns forty-seven and forty-eight.
  - A numeric plan identifier in columns fifty-five and fifty-six (right justified).

- A QS card must be entered at the location that the QS and SQ cards are normally entered. The QS card must contain:
  - Pathname part B in columns three through eight which corresponds to the cross-section number entered in columns three through eight of a X1 card in the *HEC-2* data deck. HEC-2 stores the section number as a numeric (as opposed to alpha) quantity. It must then convert that numeric quantity to an alpha identification when used as part B of the pathname. This conversion process may slightly alter what the user has input on the X1 card. For example, the section number "32" would have a DSS pathname part B of "32.".
  - Pathname part E in columns nine through twelve which is identical to that entered in columns forty-five through forty-eight of the HEC-2 ZW card.
  - A numeric plan number in columns thirteen and fourteen that matches columns fifty-five through fifty-six of the ZR card for EAD.
  - A "-1" in columns twenty-three and twenty-four to instruct EAD to read the elevation-discharge curve from a DSS file.
  - Example EAD input data:

```
TT
 ....
 ....
ZR SILVER CREEK BASE                          QS       1
ZR SILVER CREEK CHIMP-20FT BW                 QS       5
 ....
RN
FR RCH 1 .......
QF RCH 11985 1        -1
QS49.0001985 1        -1
 ....
EP     1
 ....
 ....
QS49.0001985 5        -1
EJ     5
```

HEC-2 and EAD automatically generate pathname part C to be: "ELEV-FLOW".

(3) Elevation-Damage Data

EAD reads elevation-damage relationships from SD and DG cards. These relationships may be written to a DSS file by either SID or DAMCAL. They are slightly different in format from both the flow-frequency and elevation-discharge curves. elevation-damage relationships may consist of several curves identified by a single pathname whereas flow-frequency and elevation-discharge relationships consist of a single curve identified by a single pathname.

Elevation-damage curves correspond to damage categories. If the user enters this data as input, he would enter one SD card followed by a separate DG card for each category. To read elevation-damage data from a DSS file, the user would enter only one DG card to retrieve all categories (maximum of eighteen categories allowed). To read elevation-damage data from DSS, the user must:

(1a) Execute a flood damage analysis program (either SID or DAMCAL).

- Execute SID. Example JCL is:

```
HLIB*SIDX,TAPE71=SLVAAEZ
```

  - A DSS file has been generated and attached to this execution. For example, if the file does not exist, generate it:

```
$GE SLVAAEZ R PR PW OD G=100
```

  - A ZW card must be included and contain:
    - Pathname part A in columns three through sixteen.
    - Pathname part F in columns seventeen through forty.
    - Pathname part E in columns forty-five through forty-eight.
  - Pathname part B must be entered on every DR card in columns three through eight.

- Execute DAMCAL. Example JCL is:

```
HLIB*DAMCALX,TAPE71=SLVAAEZ
```

  - A DSS file has been generated and attached to this execution. For example, if the file does not exist, generate it:

```
$GE SLVAAEZ R PR PW OD G=100
```

  - A ZW card must be included and contain:
    - Pathname part A in columns three through sixteen.
    - Pathname part F in columns seventeen through forty.
    - Pathname part E in columns forty-five through forty-eight.

- Pathname part B must be entered on every DT card in columns three through eight.

- Example input data for SID (DAMCAL is very similiar):

```
T1 ...
 ....
 ....
ZW SILVER CREEK BASE                        1985
DF ....
```

```
 ....
 ....
DR RCH 1 ......
DT ....
SL ....
SD ....
 ....
ES
```

(1b) Execute EAD

- The DSS file used for either the SID or DAMCAL job must be attached to the EAD execution. Example JCL is:

  ```
  HLIB*EADX,TAPE71=SLVAAEZ
  ```

- A ZR card must be entered and contain:
  - Pathname part A in columns three through sixteen.
  - Pathname part F in columns seventeen through forty.
  - A numeric plan identifier in columns fifty-five and fifty-six (right justified).

- A DG card must be entered at the location that the SD and DG cards are normally entered. The DG card must contain:
  - Pathname part B in columns three through eight which is identical to a reach identification code entered in columns three through eight of a DR card in the SID input data deck or columns 3 through 8 of a DT card in a DAMCAL input data deck.

  - Pathname part E in columns nine through twelve which is identical to that entered in columns forty-five through forty-eight of the SID ZW card or DAMCAL ZW card.

  - A numeric plan number in columns thirteen and fourteen that matches columns fifty-five and fifty-six of the ZR card for EAD.

  - A "-1" in columns twenty-three and twenty-four to instruct EAD to read the stage-damage curve from a DSS file.

  - Example EAD input data:

    ```
    TT
     ....
     ....
    ZR SILVER CREEK BASE
    DG        1
    ZR SILVER CREEK FP-3 FT
    DG        4
     ....
    ```

```
RN
FR RCH 1 .......
QF RCH 11985 1        -1
QS49.0001985 1        -1
DG RCH 11985 1        -1
EP      1
 ....
 ....
DG RCH 11985 4        -1
EP      4
 ....
EJ
```

SID, DAMCAL, and EAD automatically generate pathname part C to be:

"ELEVATION-DAMAGE".

4. Summary

Appendix A has described the process of transferring computed results from programs HEC-1, HEC-2, HEC-5, SID, and DAMCAL to the EAD program by using a data management system called DSS. To access DSS, the user need only make minor changes to job control language and application program input data. Appendix B describes DSS input modifications to HEC-1, HEC-2, and DAMCAL. The published user's manuals describe DSS input requirements for programs HEC-5, SID, and EAD. The publication "HECDSS Users Guide and Utility Program Manuals" (8) describes in detail the DSS data management system and its associated utilities. The DSS utility program DSSUTL inventories data pathnames, provides data file housekeeping capability (such as eliminate or rename records), and generates computer system independent data files. The DSS utility program DSPLAY tabulates and graphs data stored in a data file. The interactive program PIP, documented in a separate user's manual, enables insertion of flow-exceedance frequency, flow-damage elevation-exceedance frequency, elevation-flow, elevation-damage, and exceedance frequency-damage data into the DSS file system where it then may be used identical to computer program generated DSS data records. Although the application of the Flood Damage Analysis Package does not require the use of these DSS utilities, they provide the user with significant additional flexibility and capabilities.

Appendix B
Supplementary User Documentation

B. Supplementary User Documentation

1. Introduction

Each program referenced in this document has a user's manual which describes the analytical procedures used by the program, the input to the program, the output from the program, and results from test examples. All but two of the user's manuals (HEC-2 and DAMCAL) also describe the procedures for use of the DSS (data storage system) to store and extract data. These two manuals will address the use of the DSS in future revisions. This appendix is designed to supplement these two user documents to describe the use of the DSS and the required input to enable the use of this feature.

2. Supplementary HEC-2 User Information

The computer program HEC-2 computes water surface profiles for river channels of any cross section for either subcritical or supercritical flow conditions. The principle use of the program is for determining profiles for various frequency floods for both natural and modified conditions. HEC-2 generates elevation-flow (rating) curves which can be written to a DSS file. To accurately define the rating curves, the user should enter the maximum allowable number of water surface profiles. These profiles should span the range of the flow-frequency curves. The EAD program utilizes the elevation-flow rating curves to convert elevation-damage into discharge-damage relationships. The conversion is performed by linear interpolation. However, the EAD program will not extrapolate the rating curve if an elevation-damage coordinate exceeds the maximum elevation ordinate in the rating curve or is less than the minimum elevation ordinate. HEC-2 writes a rating curve to the DSS file for every cross-section. The analyst may wish to use a temporary DSS file to store all the rating curves in a reach, and then copy the one required rating curve at the index point into the permanent DSS file. Required additions to the HEC-2 program input follow.

ZW Card --- DSS Write Card (Optional, required for DSS write)

To write elevation-flow (rating) curves to a DSS file, the user must insert a ZW card as the first input card of the data deck. The ZW card contains DSS pathname parts A,E, and F. HEC-2 develops a rating curve and stores that rating curve in the DSS file for every cross-section. HEC-2 will use variable SECNO (field X1-1 in the HEC-2 input) to define part B of the DSS pathname. Care must be exercised because HEC-2 stores variable SECNO as a floating point variable and must convert it to a character string for use as a pathname part. Many times, the result will differ from that which was input by the user. For example, the user may define the section number to be "49" but HEC-2 will generate part B of the pathname to be "49.000".

Field	Value	Description
0	ZW	Card identification.
1-2	(AN)	Study or Project name (part A of the DSS pathname).
3-5	(AN)	Plan or alternative name (part F of the DSS pathname).
6	(AN)	Year of data (part E of the DSS pathname). Must be entered in columns 45 - 48.

J2 Card --- Job Card (required for DSS write)

The J2 card is used to specify printout, plot, trace, and computational options. In order to initiate the write to a DSS file, the last J2 card must contain a "15" in field 1 (J2-1) which requests the summary printout.

Field	Variable	Value	Description
0	IA	J2	Card Identification.
1	NPROF	15	Indicates last profile and requests a summary printout.
2-10			No change from users manual.

J3 Card --- Job Card

The J3 card is an optional card. However, if it is entered, the user must request "Table 150". If the J3 card is omitted, Table 150 is provided by default.

3. Supplementary DAMCAL User Information

The computer program DAMCAL can evaluate a broad range of alternative flood damage reduction measures that will provide flood damage relief for existing and future land use conditions. It accesses a spatial grid cell data base file from which it extracts information for flood damage computations. This information includes: topographic elevation, reference flood elevation, damage reach delineation, existing land use classification, and alternative future land use patterns. Each alternative analysis results in the creation of an aggregated elevation-damage function for each land use category at each damage reach index location. The aggregated elevation-damage function can then be stored in a DSS file by following the supplementary instructions listed below.

ZW Card -- Write elevation-damage function to a DSS file

The ZW card flags the DAMCAL program that elevation-damage functions will be stored in a data storage system (DSS) data file. The functions are stored by land use for each reach. The ZW card contains the study, project, or basin name, the study or plan alternative, and the data year associated with the computed results. The ZW card is placed after the last job card (J) and before the format (FT) card.

Field	Value	Description
0	ZW	Card Identification.
1-2	(AN)	Study, Project, or Basin name (part A of the DSS pathname).
3-5	(AN)	Study or plan alternative (part F of the DSS pathname).
6	(AN)	Data year (part E of the DSS pathname). The data year must be entered in columns 45-48.

DT Card --- Damage Reach Title Card

The DT card labels the damage reach and provides the unique identifier (name or location) for each reach.

Field	Value	Description
0	DT	Card Identification.
1	(AN)	Damage reach location or name (part B of the DSS pathname).
2-10	(AN)	Description of the damage reach on the preceding DR card (DR.1).

Appendix C
Flood Damage Analysis Package - Application Example

C. Flood Damage Analysis Package - Application Example

1. Purpose

The purpose of this appendix is to provide specific examples of Flood Damage Analysis Package program executions and the transfer of data through a data management system. This will include study management considerations, example Job Control Language (JCL), input data considerations, output analysis, and DSS utility program application. The problem presented is hypothetical and unrealistically simple --- but it demonstrates the logic in applying the Flood Damage Analysis FDA Package. The logic and procedures are the same for a large basin with tens of thousands of structures and several hundred damage reaches. For the novice computer user, the mechanics of applying the FDA Package are not trivial.

2. Problem Description

The town of Riverton is a relatively new development located on the banks of Silver Creek. See Figure 3. It consists of one residential property and one commercial building. This year, both structures suffered severe flooding. The town's citizen(s) have demanded relief from the flooding and have insisted that the government determine an effective flood control measure to immediately implement.

3. Description of Study Area

Silver Creek remains in its natural state with a slope of thirty feet per mile. The channel capacity is limited. Surrounding hills slope steeply into the channel except in the vicinity of Riverton where a small flat area exists.

4. Action

In response to the public, the government has initiated a study to evaluate the existing flood problems and to formulate and analyze several flood damage mitigation plans.

5. Study Management

An important first step in perfoming a flood damage analysis study is to define the scope of the study. This might include conceptualizing the study procedure, estimating the required personnel, determining the necessary technical capability, estimating the field surveys, and estimating the amount of required data. Based on this early assessment, a study team is formed, a study manager is selected, and the individuals are asked to help refine the study procedure. For Riverton, several alternatives are considered feasible. They include: building an ungated or gated reservoir, improving the channel, and floodproofing the residential and comercial structures. The following sequence of activities has been adopted for flood damage analysis aspects of the Riverton study.

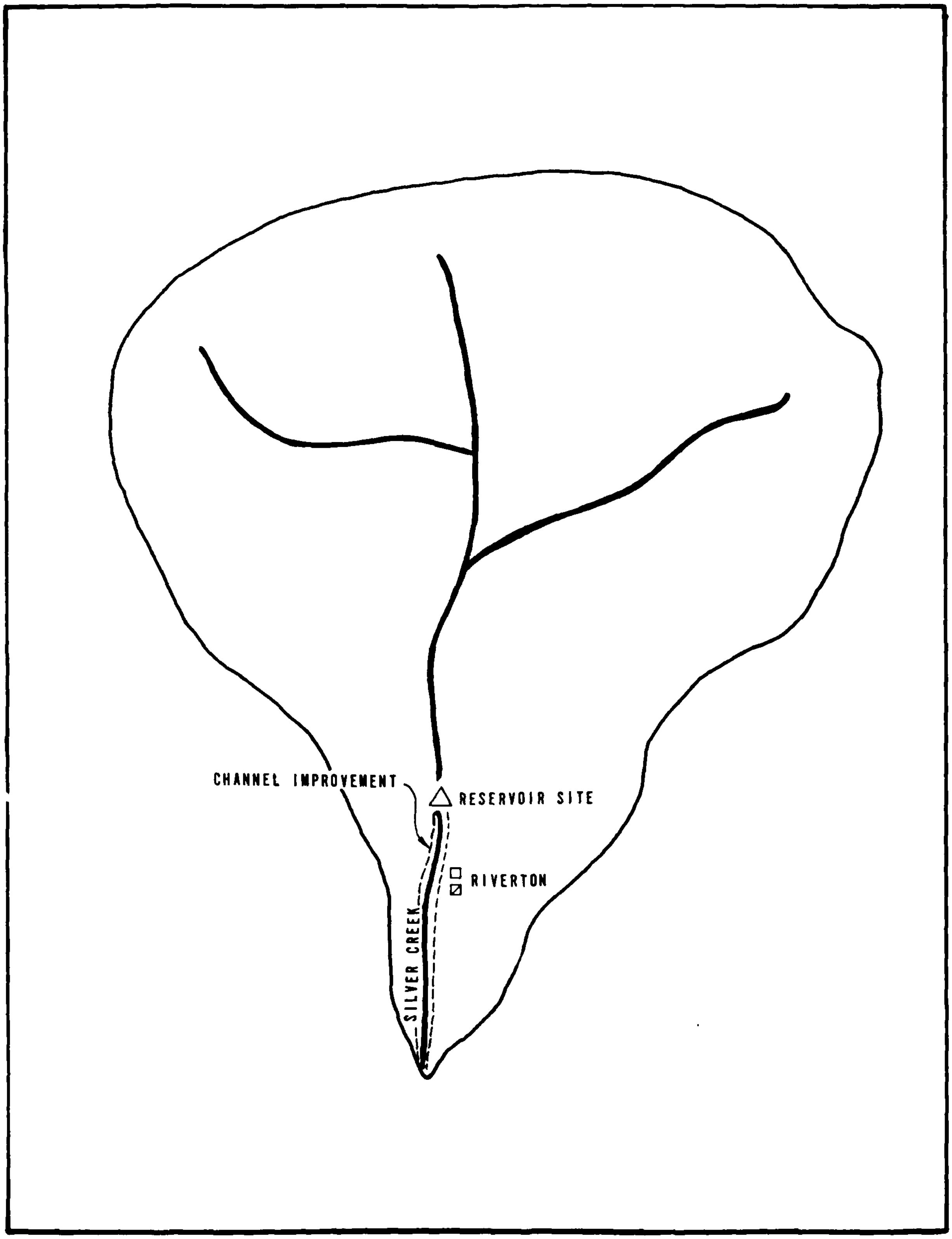


Figure 3 Silver Creek, Vicinity of Riverton

No.	Task
a	Define the scope of the study, including the likely conceptual array of flood damage mitigation alternatives.
b	Subdivide the watershed into hydrologic sub-basins and damage reaches and select damage index locations.
c	Assign alphanumeric identifiers for data management.
d	Define the computer file naming conventions for all the analyses files including input, output, job control language (JCL), DSS and other data files.
e	Compute a base (without) condition discharge-exceedance frequency curve for each index location for Riverton.
f	Obtain cross-section information and compute profiles.
g	Determine the reference flood elevations at the index locations and at each of the structures.
h	Inventory the damageable structures within the study area and compute elevation-damage relationships at the index locations.
i	Compute the expected annual damage for the base condition.
j	Adjust the study procedure or change naming conventions if problems have occurred.
k	Simulate an ungated reservoir.
l	Simulate a gated reservoir.
m	Simulate a channel improvement.
n	Floodproof structures.
o	Compute the expected annual damage for the base condition and all alternatives.

6. Study Procedure

At this point, the individual tasks are implemented. The following descriptions follow the flood damage analysis of Riverton through the tasks as outlined above.

a. Formulate flood damage mitigation alternatives.

It is advantageous to define the conceptual array of likely flood damage mitigation alternatives as early as possible. This enables systematic subdivision of the watershed and definition of damage reaches for efficient study of the alternatives. In addition, it also provides a reference for developing data for the base condition with the idea of expanding the analysis to study the alternatives. It also provides a basis for defining the alphanumeric identifiers for data management. Table 3 describes the preliminary plans formulated for Riverton.

Table 3: Flood Damage Mitigation Plans For Riverton

Plan	Description
1	Existing without (Base) Conditions. No flood plain management measures in place.
2	Flood proof both structures to 3 feet. The SID program will be used to develop a modified elevation-damage relationship.
3	Construct an ungated reservoir upstream of Riverton. The HEC-1 program will be used to develop a modified discharge-exceedance frequency curve.
4	Construct a controlled (gated) reservoir upstream of Riverton. The HEC-5 program will be used to develop a modified discharge-exceedance frequency curve.
5	Improve the Silver Creek channel through Riverton by excavating a trapezoidal section with a bottom width of 20 feet and a side slope of 1.5 on 1.

Each of these plans will be evaluated by executing the EAD program. Often times is not possible to formulate all of the specifics of a given plan. For example, the above formulation does not define the size of the reservoir nor the allocation of space within that reservoir for either plan three or four. As the study proceeds, it may require studying several sizes and pool storage allocations. It then is beneficial to define those other alternavtives at this point. For this simple example, only one size of reservoir is considered.

b. Select damage index locations.

Only one damage reach and one index location are needed for this study. Many factors influence the selection of the index locations. These include the location of stream gaging stations, the uniformity of stream profiles, the location of governmental boundaries, and the characteristics of alternatives under investigation. It is desirable but not always possible to correctly identify all index locations at the outset of the study. For example, the hydraulic engineer later may change stream profiles for reaches that orginally were thought to have uniform profiles. For Riverton, this is not the case. The hydraulic engineer is consulted to determine suitable locations for cross-sections and the economist is consulted to determine the location of damageable property. This information might be entered on a topographic map as shown in Figure 4. From this information, a cross-section at river mile 49.0 is selected as the index location at which elevation-discharge rating curves, elevation-damage relationships, and flow exceedance frequency curves for Riverton will be developed.

c. Assign alphanumeric identifiers for data management.

Identifiers are chosen for defining data records in the DSS file. The same river name (or basin) is used for part A of the DSS pathname for all index locations; the damage reach index location identifier is used for part B of the DSS pathname; the data-year is used for part E of the pathname; and the alternative is used for part F of the DSS pathname.

The river name "SILVER CREEK" is used for part A of the pathname. This assignment is valid since it is less than fifteen characters.

The reach identifier "RCH 1" is used for part B of the pathname (must be six characters or less). If possible, the identifier is chosen in such a way that index locations can be added later and assigned logical names. It is anticipated that no reaches will be added for the Silver Creek study.

Blank characters are used for part E of the pathname. The relationships do not vary with time so equivalent annual damage will not be computed.

Part F of the DSS pathname is defined according to Table 4 (this part must be twenty-two characters or less).

Table 4: Pathname Part F For Silver Creek

Plan	Part F of the DSS pathname
1	BASE
2	FP-3 FT
3	UNGTD RES
4	GATED RES
5	CHIMP-20 FT BW

d. Define the computer file naming conventions for all files.

The Riverton study involves the application of HEC-1 (ungated reservoir), HEC-5 (gated reservoir), HEC-2 (rating curves), SID (inventory structures), and EAD (expected annual damage). A consistent file naming scheme simplifies file management and facilitates better communication. File names are limited to seven characters. File naming extensions are used to identify the type of file. For example, the characters ".J" or just "J" are used to identify a file containing job control language (JCL). Part of the basin name is included to identify files associated with this study. Additional characters identify the program and the alternative. The following naming convention is used for the Riverton study.

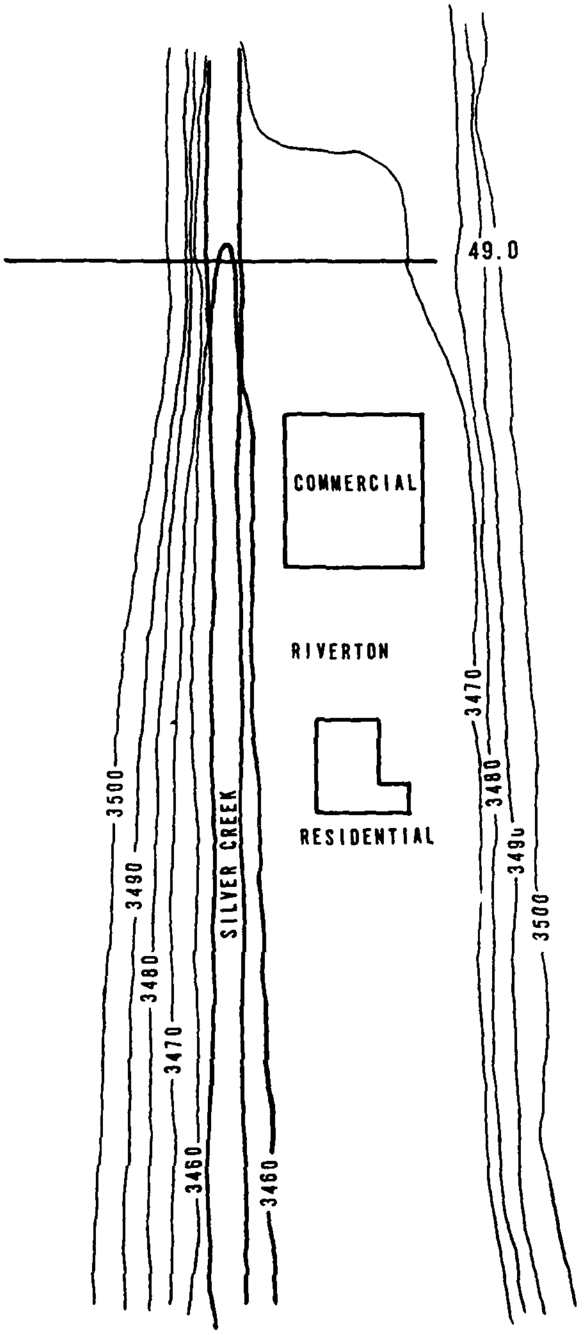


Figure 4 Damage Index Location, Riverton

<table>
<tr><th>Character
Location</th><th>Contents</th></tr>
<tr><td>1-3</td><td>River name abbreviation to indicate study; "SLV" is used for all files.</td></tr>
<tr><td>4-5</td><td>Alternative indicator; "A0" would indicate base condition ("0") for alternative "A" whereas "A1" would indicate condition "1" for alternative "A". The condition assumes an alphanumeric value for some cases. Examples of this are the EAD input data file which analyzes multiple conditions or the DSS file that contains results for many alternatives.</td></tr>
<tr><td>6</td><td>Computer program identifier; indicates with which program the file is associated. Character is taken from the reference list shown below:
<table>
<tr><th>Character</th><th>Program</th></tr>
<tr><td>1</td><td>HEC-1</td></tr>
<tr><td>2</td><td>HEC-2</td></tr>
<tr><td>5</td><td>HEC-5</td></tr>
<tr><td>S</td><td>SID</td></tr>
<tr><td>D</td><td>DAMCAL</td></tr>
<tr><td>E</td><td>EAD</td></tr>
</table></td></tr>
<tr><td>7</td><td>Type of file; indicates the nature of the file. Taken from the reference list below:
<table>
<tr><th>Character</th><th>File Type</th></tr>
<tr><td>I</td><td>Input data file.</td></tr>
<tr><td>O</td><td>Computer program output listing.</td></tr>
<tr><td>J</td><td>Job control language to execute program.</td></tr>
<tr><td>Z</td><td>DSS data file.</td></tr>
</table></td></tr>
</table>

Typical file names are listed below.

Filename	Description
SLVA01I	Input data file to HEC-1 for base condition.
SLVA01J	Job control language to execute HEC-1 for base condition.
SLVA01O	Program printout from HEC-1 for base condition.
SLVA0SI	Input data file to SID for base condition.
SLVA0EI	Input data file to EAD for base condition.
SLVAA1Z	Intermediate DSS file containing HEC-1 computed hydrographs.

The most important file is the DSS file through which all FDA programs communicate. Only one file is used for storing and retrieving the basic economic relationships --- frequency curves, elevation-discharge rating curves, and elevation-damage relationships. The Riverton DSS file is named "SLVAAEZ". Other variations are possible. Some analysts like to include the characters "DSS" in the file name or add a specific character extension. Examples using this notation include: "SILVDSS" or "DSSSILV", or "SILVR.Z".

There is merit to using more than one DSS file in a flood damage analysis study. Separate files are maintained for time series data and paired function data to reduce the management overload of large DSS data files. In the Riverton study, four DSS files are used. The file names and descriptions are shown below:

File	Description
SLVAAEZ	Master DSS file. It contains all flow-frequency curves, elevation-discharge rating curves at index locations, and elevation-damage relationships for each reach. The EAD program will access this file to retrieve all the parametric relationships used in the computation of expected annual damage for base condition and all alternatives.
SLVAA1Z	DSS file to contain hydrographs and frequency curves which were computed by the HEC-1 program. HEC-1 writes hydrographs and frequency curves to the same DSS file. The use of this intermediate DSS file facilitates the storage of hydrographs separate from the the master DSS file which will contain only the basic economic relationships. The DSS utility program DSSUTL is used to "copy" the flow-frequency curves from this DSS file into the master DSS file "SLVAAEZ". When analyzing a gated reservoir, HEC-5 will utilize hydrographs from this file as incremental local inflows. If HEC-1 does not store hydrographs in a DSS file, then the frequency curves are stored directly into the master DSS file "SLVAAEZ".
SLVAA2Z	DSS file to contain elevation-discharge rating curves for each cross-section as computed by HEC-2. This temporary DSS file is used because HEC-2 stores rating curves in the DSS file for all of the cross-sections input to it. Subsequent analyses will require rating curves at only the index points. This intermediate DSS file facilitates the screening out of unnecessary rating curves. The DSS utility program DSSUTL is used to "copy" the rating curve at the damage index point into the master DSS file "SLVAAEZ".
SLVAA5Z	DSS file to contain hydrographs computed by the HEC-5 program.

e. Compute base frequency curve for each index location.

A stream gaging station does not exist near Riverton. If one were present for a reasonable length of time (twenty years or more) or if it were in existence during a significant storm, the data could be used to help construct a discharge-exceedance frequency curve. Since a gaging station does not exist, a rainfall-runoff model is developed. The analyst is given the location of cross-section 49.0 at which the frequency curve is developed. The frequency curves may be developed using any number of publications such as the National Weather Service's Technical Paper 40 (TP-40), the National Oceanic and Atmospheric Administration Technical Memorandum NWS Hydro-35, the U.S. Army Corps of Engineers Civil Engineer Bulletin No. 52-8, "Standard Project Flood Determinations", as well as any local technical publications or newspapers. Rainfall-runoff modeling requires the estimation of runoff response hydrograph parameters and rainfall loss parameters such as infiltration. For Riverton, a simple rainfall runoff model is developed since the watershed is small. It is determined that hydrologic routing parameters are not required. This document will not address the details of the frequency curve development. Other HEC publications are available on the subject. The analyst has determined the base condition frequency curve shown in Table 5.

Table 5: Base Condition Discharge-Exceedance Frequency

Exceedance Frequency(%)	Discharge (cfs)
90	1000
80	1150
70	1270
60	1400
50	1550
40	1700
30	1860
20	2100
10	2550
5	3000
2	3750
1	4350
0.5	5300
0.2	6700
0.1	7800
0.01	12000

Notice the extreme exceedance frequencies used to define the curve (90% through .01% chance exceedance). The lowest flow point on the curve must be less than the "zero" damage discharge (no damage occurrs for flow below this discharge) and the highest point on the curve should be a rare event (.1 percent or greater) so expected annual damage may be accurately computed. The base condition flow-frequency curve is either stored directly into the master DSS file "SLVAAEZ" using for example the PIP program as an input aid or is input to the HEC-1 program as part of a rainfall-runoff simulation input data file. For Riverton, the flow-frequency curve is input to HEC-1. The file SLVA01I contains data to simulate rainfall-runoff above Riverton. It contains three control points --- two at the location of a proposed reservoir and one at the damage index point in Riverton. The damage index point corresponds to cross-section 49.0. The HEC-1 input and output is shown below.

EXECUTE HEC-1 FOR BASE CONDITION

```
===> HLIB*HEC1X,INPUT=SLVA01I,DSSFILE=DSHEC1

                                    HEC-1 INPUT                                          PAGE  1

LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1         ID        SILVER CREEK
  2         IT     120 01JAN80    0200      30
  3         IO       4       0       0
  4         JP       1
  5         JR    PREC     .39     .60     .70     .83     .95     1.0     1.3     1.5     1.8

  6         KK       1INFLOW TO RESERVOIR SITE ABOVE RIVERTON
  7         BA      23
  8         BF      60    1000     2.5
  9         LU      .8      .1
 10         PI     .05     .10     .07     .15     .30     .20     .05       0       0       0
 11         PI       0       0
 12         PB     8.2
 13         US      16     .80
 14         ZW   A=SILVER CREEK, B=RES 1, C=FLOW,F=INFLOW

 15         KK   RES 1
 16         RN

 17         KK       1LOCAL INFLOW TO INDEX POINT FOR REACH 1 IN RIVERTON
 18         BA       5
 19         BF      14     100     1.2
 20         LU      .8      .1
 21         PB     8.2
 22         US     3.4     .80
 23         ZW   A=SILVER CREEK, B=RCH 1, C=FLOW, F=LOCAL

 24         KK   RCH 1INDEX POINT FOR REACH 1 IN RIVERTON
 25         HC       2
 26         EC
 27         PN       1EXISTING CONDITIONS
 28         ZW   SILVER CREEK  BASE
 29         KK   RCH 1RIVERTON - REACH 1
 30         FR   RCH 1      16      90      80      70      60      50      40      30      20
 31         FR      10       5       2       1     0.5     0.2     0.1    0.01
 32         QF                    1000    1150    1270    1400    1550    1700    1860    2100
 33         QF    2550    3000    3750    4350    5300    6700    7800   12000
 34         ZZ
```

Intermediate DSS File

Only base condition

Maximum of nine ratios used of precip. These may need adjusting by trail and error to define frequency curve.

Hydrology Records (lines 1–25)

Write computed inflow to DSS file for later use by HEC-5.

Write computed local incremental inflow to DSS file for later use by HEC-5.

Must be unique and Identi-cal

Economics Records (lines 26–34)

Write frequency curve to DSS file.

Part A of pathname.

Part F of pathname.

Part B of pathname.

Base condition frequency curve contains frequency extremes (90% - .01%)

```
*****************************************                          *****************************************
*                                       *                          *                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                          *   U.S. ARMY CORPS OF ENGINEERS        *
*             FEBRUARY 1981             *                          * THE HYDROLOGIC ENGINEERING CENTER     *
*           REVISED 31 JAN 85           *                          *        609 SECOND STREET              *
*                                       *                          *     DAVIS, CALIFORNIA 95616           *
* RUN DATE  9 MAY 85    TIME   9:38:42  *                          * (916) 440-3285 OR (FTS) 448-3285      *
*                                       *                          *                                       *
*****************************************                          *****************************************




                                   SILVER CREEK

  3 IO          OUTPUT CONTROL VARIABLES
                      IPRNT           4  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN         120  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1JAN80  STARTING DATE
                      ITIME        0200  STARTING TIME
                         NQ          30  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      3JAN80  ENDING DATE
                     NDTIME        1200  ENDING TIME

                  COMPUTATION INTERVAL    2.00 HOURS
                       TOTAL TIME BASE   58.00 HOURS

       ENGLISH UNITS
            DRAINAGE AREA          SQUARE MILES
            PRECIPITATION DEPTH    INCHES
            LENGTH, ELEVATION      FEET
            FLOW                   CUBIC FEET PER SECOND
            STORAGE VOLUME         ACRE-FEET
            SURFACE AREA           ACRES
            TEMPERATURE            DEGREES FAHRENHEIT

    JP          MULTI-PLAN OPTION
                      NPLAN           1  NUMBER OF PLANS

    JR          MULTI-RATIO OPTION
                    RATIOS OF PRECIPITATION
                  0.39      0.60      0.70      0.83      0.95      1.00      1.30      1.50      1.80
```

ADDITIONAL OUTPUT

```
          -----DSS---ZOPEN EXISTING FILE OPENED   71  0000A10C*DSHEC1
-----DSS---ZWRITE FILE  71, VERS.   4   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+1/
-----DSS---ZWRITE FILE  71, VERS.   4   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+2/
-----DSS---ZWRITE FILE  71, VERS.   4   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+3/
-----DSS---ZWRITE FILE  71, VERS.   4   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+4/
-----DSS---ZWRITE FILE  71, VERS.   4   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+5/
-----DSS---ZWRITE FILE  71, VERS.   4   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+6/
-----DSS---ZWRITE FILE  71, VERS.   4   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+7/
-----DSS---ZWRITE FILE  71, VERS.   4   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+8/
-----DSS---ZWRITE FILE  71, VERS.   4   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+9/


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


           **************
           *            *
 15 KK     *    RES 1   *
           *            *
           **************

              HYDROGRAPH ROUTING DATA

 16 RN          NO ROUTING

                                             ***
```

Write reservoir inflow hydrographs for all nine ratios to the intermediate DSS file "SLVAA1Z."

ADDITIONAL OUTPUT

```
              ***************
              *             *
   29 KK      *    RCH 1    *        RIVERTON - REACH 1
              *             *
              ***************


NO DAMAGE DATA (QD OR SD CARDS) FOR THIS LOCATION,
SO DAMAGES WILL NOT BE CALCULATED.

     FR          PERCENT EXCEEDANCE
                                             90.0      80.0      70.0      60.0      50.0      40.0      30.0      20.0
                             10.0      5.0    2.0       1.0       0.5       0.2       0.1       0.0

     QF          PEAK FLOW
                                             1000.     1150.     1270.     1400.     1550.     1700.     1860.     2100.
                            2550.     3000.  3750.     4350.     5300.     6700.     7800.    12000.

PLAN 1

FREQUENCY     72.43     14.18      5.94      2.37      1.06      0.85      0.27      0.13      0.05
PEAK FLOW     1240.     2322.     2875.     3602.     4277.     4560.     6263.     7403.     9118.
-----DSS---ZWRITE FILE  71, VERS.   2  /SILVER CREEK/RCH 1/FREQ-FLOW//BASE/


                 -----DSS---ZCLOSE FILE   71
                            NO. RECORDS=      21
                            FILE SIZE=      15656 WORDS,     140 SECTORS
                            PERCENT INACTIVE=  0.00


*** NORMAL END OF HEC-1 ***
STOP 101
```

User input "Base Condition" frequency curve.

"Base Condition" frequency curve written to DSS file. Nine points are taken from nine ratios. Frequencies are interpolated using input curve and peak discharge for each ratio.

Pathname for "Base Condition" Frequency Curve.

EXAMPLE DSSUTL RUN

```
HLIB*DSSUTLX          Execute DSSUTL
ENTER DSS FILE NAME
FILE = SLVAA1Z        HEC-1 Intermediate DSS File
          -----DSS---ZOPEN EXISTING FILE OPENED    71  0000A10C*SLVAA1Z
U>CA.N          Catalog DSS file.  Option "N" indicates generation of a
GENERATED AREANAME CALLED 0000A10C*SLVAA1ZC    new catalog (data has been written
CATALOG FILE = 0000A10C*SLVAA1ZC               to file since last "catalog").

    HECDSS COMPLETE CATALOG OF RECORD PATHNAMES ON FILE  0000A10C SLVAA1Z

    CATALOG DATE = 10MAY85,  TIME = 17:04:51    FILE CREATED ON 10MAY85;   VERSION 4-CA
    NUMBER OF RECORDS =   19
    SORT ORDER = ABCFED


 REF            WRITTEN
 NO.  PROG    DATE      TIME    VER HEAD  DATA              RECORD PATHNAME

   1  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RCH 1/FLOW/01JAN1980/2HOUR/LOCAL+1/
   2  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RCH 1/FLOW/01JAN1980/2HOUR/LOCAL+2/
   3  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RCH 1/FLOW/01JAN1980/2HOUR/LOCAL+3/
   4  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RCH 1/FLOW/01JAN1980/2HOUR/LOCAL+4/
   5  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RCH 1/FLOW/01JAN1980/2HOUR/LOCAL+5/
   6  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RCH 1/FLOW/01JAN1980/2HOUR/LOCAL+6/
   7  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RCH 1/FLOW/01JAN1980/2HOUR/LOCAL+7/
   8  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RCH 1/FLOW/01JAN1980/2HOUR/LOCAL+8/

PUSH CARRIAGE RETURN TO CONTINUE, OR ENTER NEW COMMAND
U>
   9  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RCH 1/FLOW/01JAN1980/2HOUR/LOCAL+9/
  10  HEC1  10MAY85  16:56:25    1   30    18   /SILVER CREEK/RCH 1/FREQ-FLOW//BASE/
  11  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+1/
  12  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+2/
  13  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+3/
  14  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+4/
  15  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+5/
  16  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+6/
  17  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+7/
  18  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+8/
  19  HEC1  10MAY85  16:56:25    1   15   372   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+9/
```

1. *Catalog intermediate HEC-1 DSS file.*
2. *Copy frequency curve into master DSS file.*

Base condition frequency curve. Pathname reference number "10". (paired function data)

Reservoir inflow Hydrographs (regular time series data)

DSS file to which data is copied.

Copy all frequency curves to a different DSS file.

```
U>COPY SLVAAEZ C=FREQ-FLOW
               -----DSS---ZOPEN EXISTING FILE OPENED   72  0000A10C*SLVAAEZ
RECORD COPIED: /SILVER CREEK/RCH 1/FREQ-FLOW///BASE/

U>FI
               -----DSS---ZCLOSE FILE   71
                          NO. RECORDS=       19
                          FILE SIZE=     15404 WORDS,     138 SECTORS
                          PERCENT INACTIVE=  0.00
               -----DSS---ZCLOSE FILE   72
                          NO. RECORDS=        2
                          FILE SIZE=       680 WORDS,       7 SECTORS
                          PERCENT INACTIVE=  0.00
STOP
```

List of DSS records copied to file "SLVAAEZ". (only one in this case).

Copy DSS records from one file to another.

f. Obtain cross-section information and compute profiles.

In extensive studies, aerial photography is used in addition to field surveys to derive cross-section data. Sometimes, local communities have obtained detailed topography (two-foot contour interval). For the Riverton study, field surveys are used to obtain cross-section data. Care is taken to obtain data at the damage index location identified as river mile 49.0. A plot of this cross-section and computed water surface elevations is shown in Figure 5. Additional topography is needed for reservoir sites. Some estimation is made of the elevation-storage capacity possible at the damsite upstream from Riverton.

An HEC-2 data file is constructed to compute stream profiles on Silver Creek through Riverton. A "ZW" card is included to store rating curves in an intermediate DSS file names "SLVAA2Z". After executing HEC-2, DSSUTL is executed to copy the rating curve at river mile 49.0 from the intermediate DSS file named "SLVAA2Z" into the master DSS file called "SLVAAEZ". Below is a selective listing of the HEC-2 output. It is followed by the execution of DSSUTL to copy the rating curve into the master DSS file.

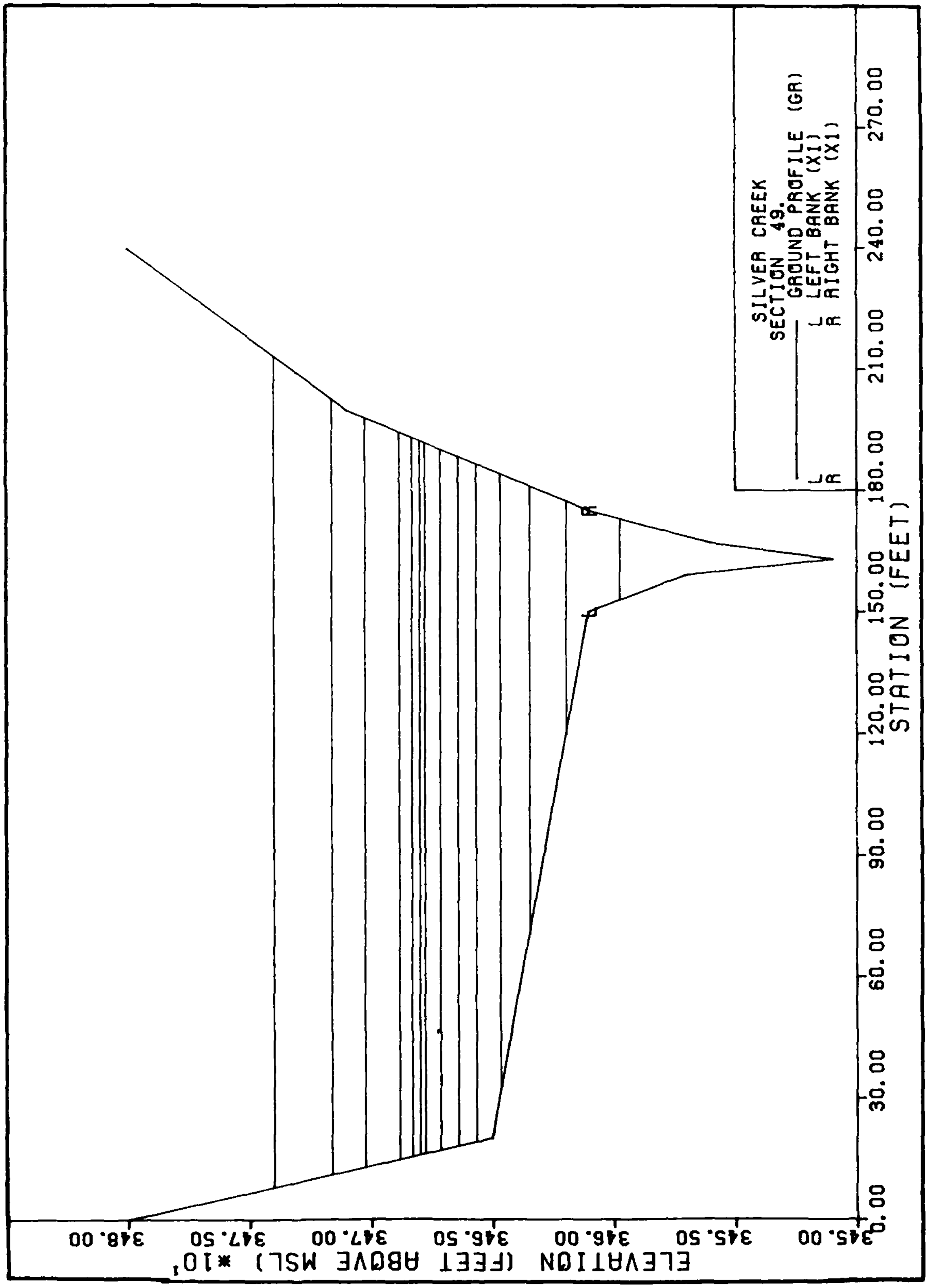


Figure 5 Riverton Cross-section at River Mile 49.0

BASE CONDITION HEC-2

```
===> HLIB*HEC2X,INPUT=SLVA021,DSSFILE=SLVAA22,TAPE95=SLV952A
```

Intermediate HEC-2 DSS file.

Write rating curves to DSS file.

```
                                                                THIS RUN EXECUTED 10 MAY 85   16:57:22
 ****************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
 ****************************************************
```

Part A of DSS pathname

Part F of DSS pathname

```
ZWSILVER CREEK  BASE
            -----DSS---ZOPEN     NEW FILE OPENED   71  0000A10C*SLVAA2Z
      DATA STORAGE SYSTEM OPTION ACTIVATED
```

Must ask for "Table 150".

Request for simplified table which includes rating curve.

```
T1
T2
T3      SILVER CREEK

J1  ICHECK     INQ      NINV       IDIR      STRT     METRIC    HVINS     Q        WSEL       FQ

        0.       2.        0.        0.  0.005700     0.00      0.0       0.  3440.000    0.000

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH       FN     ALLDC      IBW     CHNIM     ITRACE

     1.000     0.000    -1.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000

J3  VARIABLE CODES FOR SUMMARY PRINTOUT

   150.000   38.000     1.000    43.000    55.000    56.000    26.000     0.000     0.000     0.000

J5  LPRNT    NUMSEC                  *********REQUESTED SECTION NUMBERS*********

   -10.000   -10.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000

NC     0.070     0.060     0.040     0.100     0.100     0.000     0.000     0.000     0.000     0.000
QT    14.000   500.000  1000.000  1500.000  2000.000  2500.000  3000.000  3500.000  4000.000  4500.000
QT  5000.000  6000.000  8000.000 10000.000 15000.000     0.000     0.000     0.000     0.000     0.000
X1    48.300    11.000    50.000    70.000     0.000     0.000     0.000     0.000     0.000     0.000
GR  3471.000     0.000  3461.000    20.000  3445.000    30.000  3440.000    50.000  3432.000    54.000
GR  3430.000    60.000  3432.000    66.000  3440.000    70.000  3445.000    90.000  3461.000   100.000
GR  3471.000   120.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000

X1    48.500     9.000   130.000   165.000  1056.000  1056.000  1056.000     0.000     0.000     0.000
GR  3477.000     0.000  3449.000    20.000  3445.000   130.000  3438.000   140.000  3436.000   143.000
GR  3438.000   146.000  3445.000   165.000  3456.000   190.000  3477.000   220.000     0.000     0.000
```

```
X1    48.800      9.000   150.000    180.000   1584.000   1584.000   1584.000      0.000      0.000      0.000
GR  3480.000      0.000  3462.000     20.000   3458.000    150.000   3449.000    154.000   3445.000    162.000
GR  3449.000    170.000  3458.000    180.000   3465.000    203.000   3480.000    240.000      0.000      0.000
1
 10 MAY 85    16:57:22                                                                          PAGE    2
                                  Reach 1 damage index location.
X1    49.000      9.000   150.000    175.000   1056.000   1056.000   1056.000      0.000      0.000      0.000
GR  3480.000      0.000  3465.000     20.000   3461.000    150.000   3457.000    159.000   3451.000    163.000
GR  3456.000    167.000  3461.000    175.000   3471.000    200.000   3480.000    240.000      0.000      0.000

X1    49.500      8.000   117.000    152.000   2506.000   2506.000   2506.000      0.000      0.000      0.000
GR  3496.000      0.000  3494.000     10.000   3475.000    117.000   3469.000    127.000   3466.000    135.000
GR  3467.000    140.000  3476.000    152.000   3496.000    190.000      0.000      0.000      0.000      0.000
EJ     0.000      0.000     0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000
1
 10 MAY 85    16:57:22                                                                          PAGE    3


**************************************************                   THIS RUN EXECUTED 10 MAY 85   16:57:29
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
**************************************************


T1
T2
T3      SILVER CREEK

J1  ICHECK     INQ      NINV      IDIR      STRT     METRIC    HVINS     Q        WSEL       FQ

       0.        3.        0.        0.  0.005700     0.00      0.0       0.  3356.000     0.000

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH       FN     ALLDC     IBW     CHNIM     ITRACE

     2.000    0.000    -1.000     0.000     0.000     0.000     0.000    0.000     0.000     0.000
```

```
10 MAY 85    16:57:22                                                                     PAGE    4
```

ADDITIONAL OUTPUT

```
                                                                  THIS RUN EXECUTED 10 MAY 85   16:57:29
1
 10 MAY 85    16:57:22                                                                    PAGE   16
**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
**************************************************


NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST


SILVER CREEK

SUMMARY PRINTOUT
```

User requested table (from V3 card).

```
      SECNO     CWSEL        Q        VLOB       VROB        VCH

      48.300   3436.67    500.00      0.00       0.00        6.33
      48.300   3439.59   1000.00      0.00       0.00        7.59
      48.300   3441.47   1500.00      1.28       1.49        8.79
      48.300   3442.85   2000.00      2.00       2.34        9.80
      48.300   3444.04   2500.00      2.52       2.94       10.51
      48.300   3445.05   3000.00      2.93       3.42       11.11
      48.300   3445.86   3500.00      3.51       4.10       11.61
      48.300   3446.61   4000.00      4.00       4.66       12.05
      48.300   3447.30   4500.00      4.41       5.15       12.46
      48.300   3447.96   5000.00      4.78       5.58       12.84
      48.300   3449.17   6000.00      5.41       6.31       13.52
      48.300   3451.32   8000.00      6.40       7.47       14.68
      48.300   3453.22  10000.00      7.18       8.38       15.67
      48.300   3457.32  15000.00      8.61      10.04       17.66

      48.500   3442.94    500.00      0.00       0.00        5.81
      48.500   3445.25   1000.00      0.36       0.02        6.31
      48.500   3446.76   1500.00      1.18       1.30        6.84
      48.500   3447.99   2000.00      1.53       1.68        7.07
      48.500   3449.02   2500.00      1.73       1.91        7.19
      48.500   3449.88   3000.00      2.06       2.03        7.16
```

```
     48.500   3450.63   3500.00       2.29       2.13       7.22
     48.500   3451.34   4000.00       2.49       2.23       7.29
     48.500   3452.00   4500.00       2.65       2.31       7.36
     48.500   3452.64   5000.00       2.79       2.38       7.43
     48.500   3453.85   6000.00       3.02       2.50       7.57
     48.500   3456.05   8000.00       3.38       2.72       7.83
     48.500   3458.04  10000.00       3.64       3.12       8.04
     48.500   3462.45  15000.00       4.13       3.70       8.54

1
  10 MAY 85     16:57:22                                                                       PAGE   17

     SECNO     CWSEL        Q        VLOB       VROB        VCH

     48.800   3451.82    500.00       0.00       0.00       5.99
     48.800   3453.73   1000.00       0.00       0.00       7.99
     48.800   3454.78   1500.00       0.00       0.00       9.97
     48.800   3455.35   2000.00       0.00       0.00      12.11
*    48.800   3455.63   2500.00       0.00       0.00      14.51
*    48.800   3456.56   3000.00       0.00       0.00      15.19
*    48.800   3457.32   3500.00       0.00       0.00      16.00
*    48.800   3458.26   4000.00       0.72       0.81      16.21
*    48.800   3460.15   4500.00       2.25       2.55      14.21
*    48.800   3461.09   5000.00       2.61       2.95      13.71
*    48.800   3462.58   6000.00       3.15       3.30      12.84
*    48.800   3463.65   8000.00       4.16       3.98      14.22
*    48.800   3464.30  10000.00       5.06       4.67      16.00
*    48.800   3466.41  15000.00       6.63       6.24      17.69

     49.000   3459.69    500.00       0.00       0.00       7.50
     49.000   3461.93   1000.00       1.19       1.33       8.24
     49.000   3463.44   1500.00       1.90       2.12       8.28
     49.000   3464.65   2000.00       2.14       2.38       8.00
     49.000   3465.65   2500.00       2.39       2.43       7.57
     49.000   3466.39   3000.00       2.64       2.53       7.53
     49.000   3467.12   3500.00       2.83       2.58       7.44
     49.000   3467.76   4000.00       2.99       2.66       7.47
     49.000   3467.97   4500.00       3.28       2.89       8.07
     49.000   3468.30   5000.00       3.51       3.06       8.44
     49.000   3468.82   6000.00       3.97       3.41       9.26
     49.000   3470.25   8000.00       4.54       3.78       9.92
     49.000   3471.59  10000.00       4.95       4.17      10.35
     49.000   3473.97  15000.00       6.00       5.17      11.86

     49.500   3472.89    500.00       0.00       0.00       4.51
     49.500   3474.98   1000.00       0.00       0.00       5.74
     49.500   3476.02   1500.00       0.86       0.00       7.12
     49.500   3476.60   2000.00       1.32       0.74       8.64
     49.500   3476.85   2500.00       1.70       1.10      10.38
     49.500   3477.16   3000.00       2.09       1.50      11.88
     49.500   3477.29   3500.00       2.46       1.83      13.58
*    49.500   3477.59   4000.00       2.84       2.23      14.87
     49.500   3478.28   4500.00       3.21       2.73      15.18
```

Rating curve written to DSS file for damage reach 1 index point-

```
 *     49.500   3478.87   5000.00      3.51      3.12     15.58
 *     49.500   3479.99   6000.00      4.00      3.74     16.22
 *     49.500   3481.91   8000.00      4.72      4.62     17.32
 *     49.500   3483.52  10000.00      5.26      5.26     18.28
 *     49.500   3486.76  15000.00      6.26      6.41     20.24


1
 10 MAY 85    16:57:22                                                                                  PAGE   18

SILVER CREEK

SUMMARY PRINTOUT TABLE  150

      SECNO     XLCH     ELTRD     ELLC     ELMIN       Q       CWSEL     CRIWS      EG      10K*S      VCH      AREA      .01K

     48.300     0.00      0.00     0.00   3430.00   500.00   3436.67     0.00   3437.29     56.45     6.33     78.93     66.55
     48.300     0.00      0.00     0.00   3430.00  1000.00   3439.59     0.00   3440.48     56.98     7.59    131.79    132.48
     48.300     0.00      0.00     0.00   3430.00  1500.00   3441.47     0.00   3442.66     57.04     8.79    177.90    198.62
     48.300     0.00      0.00     0.00   3430.00  2000.00   3442.85     0.00   3444.29     57.93     9.80    229.38    262.77
     48.300     0.00      0.00     0.00   3430.00  2500.00   3444.04     0.00   3445.64     57.25    10.51    286.23    330.41
     48.300     0.00      0.00     0.00   3430.00  3000.00   3445.05     0.00   3446.78     56.88    11.11    342.95    397.76
```

Must be requested on V3 card.

ADDITIONAL OUTPUT

```
1
 10 MAY 85    16:57:56                                                                         PAGE    1


   LIST OF HECDSS PATHNAMES WRITTEN


-----DSS---ZWRITE FILE  71, VERS.   1   /SILVER CREEK/48.300/ELEV-FLOW//BASE/
-----DSS---ZWRITE FILE  71, VERS.   1   /SILVER CREEK/48.500/ELEV-FLOW//BASE/
-----DSS---ZWRITE FILE  71, VERS.   1   /SILVER CREEK/48.800/ELEV-FLOW//BASE/
-----DSS---ZWRITE FILE  71, VERS.   1   /SILVER CREEK/49.000/ELEV-FLOW//BASE/
-----DSS---ZWRITE FILE  71, VERS.   1   /SILVER CREEK/49.500/ELEV-FLOW//BASE/
                -----DSS---ZCLOSE FILE   71
                          NO. RECORDS=       5
                          FILE SIZE=      1206 WORDS,      11 SECTORS
                          PERCENT INACTIVE=  0.00
1
 10 MAY 85    16:57:56                                                                         PAGE    1


                                                                 THIS RUN EXECUTED 10 MAY 85   16:57:56

**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
**************************************************



STOP
```

Confirmation that rating curves are written to the DSS file.

DSSUTL

1. *Copy rating curve from HEC-2 intermediate file into master DSS file.*

```
HLIB*DSSUTLX
ENTER DSS FILE NAME
FILE = SLVAA2Z
               -----DSS---ZOPEN EXISTING FILE OPENED   71  0000A10C*SLVAA2Z
U>CA.N
GENERATED AREANAME CALLED 0000A10C*SLVAA2ZC
CATALOG FILE = 0000A10C*SLVAA2ZC


    HECDSS COMPLETE CATALOG OF RECORD PATHNAMES ON FILE  0000A10C SLVAA2Z

    CATALOG DATE = 10MAY85,  TIME = 17:07:39    FILE CREATED ON 10MAY85;   VERSION 4-CA
    NUMBER OF RECORDS =    5
    SORT ORDER = ABCFED


  REF            WRITTEN
  NO.  PROG    DATE      TIME    VER HEAD  DATA               RECORD PATHNAME

    1  HEC2  10MAY85  16:57:23   1   34    28    /SILVER CREEK/48.300/ELEV-FLOW///BASE/
    2  HEC2  10MAY85  16:57:23   1   34    28    /SILVER CREEK/48.500/ELEV-FLOW///BASE/
    3  HEC2  10MAY85  16:57:23   1   34    28    /SILVER CREEK/48.800/ELEV-FLOW///BASE/
    4  HEC2  10MAY85  16:57:23   1   34    28    /SILVER CREEK/49.000/ELEV-FLOW///BASE/
    5  HEC2  10MAY85  16:57:23   1   34    28    /SILVER CREEK/49.500/ELEV-FLOW///BASE/
U>COPY SLVAAEZ B=49.000
               -----DSS---ZOPEN EXISTING FILE OPENED   72  0000A10C*SLVAAEZ
RECORD COPIED: /SILVER CREEK/49.000/ELEV-FLOW///BASE/

U>FI
               -----DSS---ZCLOSE FILE   71
                        NO. RECORDS=       5
                        FILE SIZE=      1206 WORDS,      11 SECTORS
                        PERCENT INACTIVE=  0.00
               -----DSS---ZCLOSE FILE   72
                        NO. RECORDS=       3
                        FILE SIZE=       960 WORDS,       9 SECTORS
                        PERCENT INACTIVE=  0.00
STOP
```

Execute DSSUTL

Access intermediate HEC-2 DSS file.

Get a "new" catalog list.

Copy rating curves for cross-section 49.0 from DSS file "SLVAA2Z" into the master DSS file "SLVAAEZ".

Verification of record(s) copied.

g. Determine the reference flood elevations.

Reference flood elevations are needed before an elevation-damage relationship can be compiled for the damage reach index location (river mile 49.0 in Riverton). This requires either the use of historic flood information or a stream profile analysis using HEC-2. See the SID user's manual for a discussion of the reference flood. For the Riverton study, observations from a recent major flood are used for the reference elevations. Table 6 tabulates this data.

Table 6: Reference Flood Elevations

Location	Flood Elevations
Index location	3466.5
Residential structure	3464.8
Commercial structure	3465.9

The residential and commercial structure reference flood elevations are input on the SID structure records (variable ADJ) and the index location reference flood elevation input on the reach record.

The output from the base condition SID run follows paragraph h below.

h. Compute elevation-damage relationships at the index location.

This step includes locating and categorizing all structures in the flood plain and developing or adapting standard stage percent damage functions for categories of structures and their contents in Riverton. Stage versus percent damage relationships are obtained for structures of this type in the area. Field surveys of Riverton reveal two types of structures (one residential and one commercial), their estimated real estate value in dollars (for both the structure as well as it's contents), and each structures' finished floor (first) elevations. These data are listed in Table 7.

Table 7: Structure Inventory For Riverton
Structure and Content Value ($1000)

Item	Value
Residential structure	$130.
Residential contents	$ 65.
First floor elevation	3463.8'
Commercial structure	$ 60.
Commercial contents	$250.
First floor elevation	3462.4'

The adapted damage functions were taken from a recent study within the area and are tabulated in Table 8.

Table 8: Base Condition Elevation-Damage Functions

Residential Structures

Stage (feet)	Damage to structure (percent of structure value)	Stage (feet)	Damage to Contents (percent of contents value)
-2	0	-2	0
0	19	0	0
2	31	2	75
6	53	6	100
15	100	15	100

Commercial Structures

Stage (feet)	Damage to structure (percent of structure value)	Stage (feet)	Damage to Contents (percent of contents value)
0	0	0	0
1	33	5	89
10	40	10	100
15	100		

The SID user's manual contains a sample structure inventory form which is very useful for performing field surveys. Tables 9 and 10 contain the field inventory forms for Riverton. The output from the base condition SID run then follows.

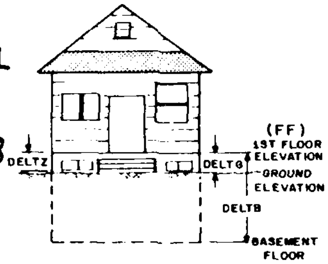
Table 9 Residence R001 Structure Survey Field Form

STUDY: Silver Creek
DATE: May 10, 1985
PREPARED BY: RDC

STRUCTURE SURVEY FIELD FORM

RESIDENT: M. R. Waters
ADDRESS: 101 Riverside Dr.
CITY: Riverton
ZIP:
RIVER MILE: 48.9

BUILDING ID(IBLDG): R001
DAMAGE REACH(IDRCH): RCH 1
DAMAGE CATEGORY(IDCAT): RESONTL
REF FLOOD ELEV(ADJ): 3969.8
STRUCTURE REF ELEV(STOPO): 3963.8
COORDINATES: NORTH (ROW): –
EAST (COLUMN): –
DELTZ (ZERO DAMAGE ELEV-FF): -2
DELTB (BASEMENT-FIRST FLOOR): –
DELTG (FIRST FLOOR-STOPO): –



LOCATION	DAMAGE TYPE	VALUE	DAMAGE FUNCTION
ABOVE FIRST FLOOR	STRUCTURE (IDAS)		
	CONTENTS (IDAC)		
	OTHER (IDAO)		
FIRST FLOOR	STRUCTURE (ID1FS)	130	RS1
	CONTENTS (ID1FC)	50%	RS2
	OTHER (ID1FO)		
BASEMENT	STRUCTURE (IDBS)		
	CONTENTS (IDBC)		
	OTHER (IDBO)		

REMARKS:

DATA CARDS

1	2	3	4	5	6	7	8	9	10

ID	IDRCH	IBLDG	ROWN	COLE	ADJ	STOPO	DELTZ	DELTB	DELTG
SL	RCH 1	R001			3969.8	3965.8	-2		

ID	IDRCH	IBLDG	IDCAT	ID1FS	V1FS	ID1FC	V1FC	ID1FO	V1FO	IADDR →
SD	RCH 1	R001	RESDNTL	RS1	130	RS2	-50			

ID	IDRCH	IBLDG	IDBS	VBS	IDBC	VBC	IDBO	VBO	IDAS	VAS	IDAC	VAC	IDAO	VAO
SO														

ID	IDRCH	IBLDG	YC	SF	TG	CG	NG	BG	BT	BC	BS	IZE	NWB	WAB	WBF	NOB	OAB	OBF	FC	FSIZE	NM	WAF	WDF	NOF	OAF	ODF	
SS																											

ID	IDRCH	IBLDG	RESID →	ADDR →	CITY →	IZIP

Table 10 Commercial C001 Structure Survey Field Form

STRUCTURE SURVEY FIELD FORM

STUDY: Silver Creek

DATE: May 10, 1985

PREPARED BY: RDC

RESIDENT: N. M. Wells

ADDRESS: 111 Riverside Dr.

CITY: Riverton

ZIP:

RIVER MILE:

BUILDING ID(IBLDG): C001

DAMAGE REACH(IDRCH): RCH 1

DAMAGE CATEGORY(IDCAT): COMERCL

REF FLOOD ELEV(ADJ): 3965.9

STRUCTURE REF ELEV(STOPO): 3962.4

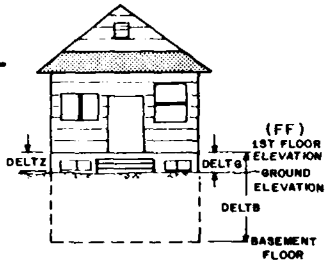
COORDINATES: NORTH (ROW): —

EAST (COLUMN): —

DELTZ (ZERO DAMAGE ELEV-FF): 0

DELTB (BASEMENT-FIRST FLOOR): 0

DELTG (FIRST FLOOR-STOPO): 0



LOCATION	DAMAGE TYPE	VALUE	DAMAGE FUNCTION
ABOVE FIRST FLOOR	STRUCTURE (IDAS)		
	CONTENTS (IDAC)		
	OTHER (IDAO)		
FIRST FLOOR	STRUCTURE (ID1FS)	60	CM1
	CONTENTS (ID1FC)	250	CM2
	OTHER (ID1FO)	0	
BASEMENT	STRUCTURE (IDBS)		
	CONTENTS (IDBC)		
	OTHER (IDBO)		

REMARKS:

DATA CARDS

ID	IDRCH	IBLDG	ROWN	COLE	ADJ	STOPO	DELTZ	DELTB	DELTG
SL	RCH 1	C001			3965.9	3962.4			

ID	IDRCH	IBLDG	IDCAT	ID1FS	V1FS	ID1FC	V1FC	ID1FO	V1FO	IADDR →
SD	RCH 1	C001	COMERCL	CM1	60	CM2	250			

ID	IDRCH	IBLDG	IDBS	VBS	IDBC	VBC	IDBO	VBO	IDAS	VAS	IDAC	VAC	IDAO	VAO
SQ														

ID	IDRCH	IBLDG	YC	SF	TG	CG	NG	BG	BT	BC	BS	IZE	NWB	WAB	WBF	NOB	OAB	OBF	FC	FSIZE	NM	WAF	WDF	NOF	OAF	ODF
SS																										

ID	IDRCH	IBLDG	RESID →	ADDR →	CITY →	IZIP

BASE CONDITION SID

```
===> HLIB*SIDX,INPUT=SLVAOSI,TAPE71=SLVAAEZ
```

Master DSS file.

Write elevation-damage relationships to DSS file.

```
                        LIST OF INPUT CARDS FOR THIS RUN

CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890

   T1      SILVER CREEK
   T2
   T3
   J1     0       0       0               0       0               0       0       0
   J2     4       2       1       1       0       1      18       1       0
   ZW SILVER CREEK  BASE
   DF   RS1       5       1       0
   DP    -2       0       2       6      15
   DD     0      15      25      42      80
   DF   RS2       5       1       0
   DP    -2       0       2       6      15
   DD     0       0      30      40      40
   DF   CM1       4       1       0
   DP     0       1      10      15
   DD     0      10      12      30
   DF   CM2       3       1       0
   DP     0       5      10
   DD     0     160     180
   DC       RESDNTL                RESIDENTIAL STRUCTURE AND CONTENTS
   DC       COMERCL                COMMERCIAL STRUCTURE AND CONTENTS
   DR RCH 1  3466.5                            3462     0.5
   DT      DAMAGE REACH 1 FOR RIVERTON
   SL RCH 1    R001                  3464.8  3463.8      -2       0
   SD RCH 1    R001 RESDNTLRS1  130RS2  -50
   SL RCH 1    C001                  3465.9  3462.4
   SD RCH 1    C001 COMERCLCM1   60CM2  250
   ES
```

Part A of DSS pathname

Part F of DSS pathname

Part E of DSS pathname.

Two damage categories.

Structure inventory

Part B of DSS pathname.

```
                         SILVER CREEK




               J1 CARD
               -------
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   J1     0       0       0       0       0       0       0       0       0       0

               THIS JOB WILL PERFORM THE FOLLOWING
               -----------------------------------


               IPOL    =    0, NO RAISE-TO-TARGET ELEVATION ANALYSIS
                               TO BE CONSIDERED FOR THIS COMPUTER RUN

               IPROF   =    0, NO FLOOD PROOFING ANALYSIS TO BE CONSIDERED FOR THIS COMPUTER RUN

               IEVAC   =    0, NO STRUCTURE RELOCATION WILL BE CONSIDERED FOR THIS COMPUTER RUN

               IPRNT   =    0, NORMAL OUTPUT

               ITRACE  =    0, NO TRACE OUTPUT

               ITYPE   =    0, SINGLE EVENT DAMAGES WILL NOT BE CALCULATED

               IAG     =    0, NO AGGREGATION OF SINGLE EVENT DAMAGES

               ISAMP   =    0, NO SAMPLING CONVERSION
```

```
SILVER CREEK


                 J2 CARD
                 -------
CC 123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
   J2     4       2       1    1.00       0       1      18       1       0

                 JOB PROCESSING INFORMATION
                 --------------------------

                 NODF   =    4, NUMBER OF DAMAGE FUNCTIONS

                 NODC   =    2, NUMBER OF DAMAGE CATEGORIES

                 NODR   =    1, NUMBER OF DAMAGE REACHES

                 AGG    = 1.00, AGGREGATION INTERVAL (IN FEET)

                 NFILE  =    0, STRUCTURE INFORMATION FILE

                 IMAGE  =    1, IMAGES OF INPUT CARDS WILL BE LISTED AND ECHOED AS READ

                 IELV   =   18, THE NUMBER OF ELEVATIONS TO BE CALCULATED FOR THE
                                ELEVATION-DAMAGE RELATIONSHIPS

                 IMARK  =    1, THE TOTAL (STRUCTURE+CONTENTS+OTHER) VALUE WILL BE
                                USED FOR THE STRUCTURE VALUE FLOOD ZONE SUMMARY

                 NDFILE =    0, DAMAGE FUNCTION FILE
```

Elevation-damage relationships are calculated on this interval. It must be large enough to capture all damageable property. "ELINTR" (card DR.7) with overide.

Number of ordinates in elevation-damage relationships which are written to the DSS file. A maximum of eighteen is allowed.

```
                    SILVER CREEK
```

Write elevation-damage relationships to DSS file.

```
                  FILE SYSTEM CARD
                  ----------------
CC 1234567890123456789012345678901234567890123456789012345678901234567890
ZW SILVER CREEK  BASE

                  FILE SYSTEM INFORMATION - A FILE WILL BE CREATED TO PASS DEPTH-DAMAGE DATA TO OTHER
                  -----------------------   HEC PROGRAMS USING THE HEC DATA STORAGE SYSTEM (HECDSS).

Part A ——→ PROJ   =    SILVER CREEK

Part F ——→ ALT    =    BASE

Part E ——→ YEAR   =

              -----DSS---ZOPEN    EMPTY  FILE  OPENED     71
0000A10C*SLVAAEZ
```

ADDITIONAL OUTPUT

```
                         SILVER CREEK


        STRUCTURE I.D.=    R001                REF. FLOOD ELEV.= 3464.80
                                               STRUCTURE REFERENCE ELEVATION = 3463.80
        DAMAGE REACH  RCH 1                    REFERENCE ELEV. AT INDEX = 3465.50
        DAMAGE CATEGORY  RESDNTL

*************************************************************************
*                    * STRUCTURE *  CONTENTS  *    OTHER    *   TOTAL    *
*************************************************************************
*                    *           *            *             *            *
*   TOTAL VALUE      *  130000.  *   65000.   *        0.   *   195000.  *
*                    *           *            *             *            *
* DAMAGE FUNCTION    *    RS1    *    RS2     *             *            *
*                    *           *            *             *            *
*************************************************************************

*************************************************************************
*         * INDEX  *           *            *             *            *
*  STAGE  * W.S.E. * STRUCTURE *  CONTENTS  *    OTHER    *   TOTAL    *
*************************************************************************
*         *        *           *            *             *            *
*   -2.0  * 3463.5 *        0. *         0. *          0. *         0. *
*         *        *           *            *             *            *
*   -1.8  * 3463.8 *     1875. *         0. *          0. *      1875. *
*         *        *           *            *             *            *
*   -1.5  * 3464.0 *     3750. *         0. *          0. *      3750. *
*         *        *           *            *             *            *
*   -1.3  * 3464.3 *     5625. *         0. *          0. *      5625. *
*         *        *           *            *             *            *
*   -1.0  * 3464.5 *     7500. *         0. *          0. *      7500. *
*         *        *           *            *             *            *
*   -0.8  * 3464.8 *     9375. *         0. *          0. *      9375. *
*         *        *           *            *             *            *
*   -0.5  * 3465.0 *    11250. *         0. *          0. *     11250. *
*         *        *           *            *             *            *
*   -0.3  * 3465.3 *    13125. *         0. *          0. *     13125. *
*         *        *           *            *             *            *
*    0.0  * 3465.5 *    15000. *         0. *          0. *     15000. *
*         *        *           *            *             *            *
*    0.3  * 3465.8 *    16250. *      3750. *          0. *     20000. *
*         *        *           *            *             *            *
*    0.5  * 3466.0 *    17500. *      7500. *          0. *     25000. *
*         *        *           *            *             *            *
*    0.8  * 3466.3 *    18750. *     11250. *          0. *     30000. *
*         *        *           *            *             *            *
*    1.0  * 3466.5 *    20000. *     15000. *          0. *     35000. *
*         *        *           *            *             *            *
*    1.3  * 3466.8 *    21250. *     18750. *          0. *     40000. *
*         *        *           *            *             *            *
*    1.5  * 3467.0 *    22500. *     22500. *          0. *     45000. *
```

```
*        *          *          *          *          *          *
*   1.8  * 3467.3   *   23750. *   26250. *      0.  *   50000. *
*        *          *          *          *          *          *
*   2.0  * 3467.5   *   25000. *   30000. *      0.  *   55000. *
*        *          *          *          *          *          *
*   2.3  * 3467.8   *   26063. *   30625. *      0.  *   56688. *
*        *          *          *          *          *          *
*   2.5  * 3468.0   *   27125. *   31250. *      0.  *   58375. *
*        *          *          *          *          *          *
*   2.8  * 3468.3   *   28188. *   31875. *      0.  *   60063. *
*        *          *          *          *          *          *
*   3.0  * 3468.5   *   29250. *   32500. *      0.  *   61750. *
*        *          *          *          *          *          *
*   3.3  * 3468.8   *   30313. *   33125. *      0.  *   63438. *
*        *          *          *          *          *          *
*   3.5  * 3469.0   *   31375. *   33750. *      0.  *   65125. *
*        *          *          *          *          *          *
*   3.8  * 3469.3   *   32438. *   34375. *      0.  *   66813. *
*        *          *          *          *          *          *
*   4.0  * 3469.5   *   33500. *   35000. *      0.  *   68500. *
*        *          *          *          *          *          *
*   4.3  * 3469.8   *   34563. *   35625. *      0.  *   70188. *
*        *          *          *          *          *          *
*   4.5  * 3470.0   *   35625. *   36250. *      0.  *   71875. *
*        *          *          *          *          *          *
*   4.8  * 3470.3   *   36688. *   36875. *      0.  *   73563. *
*        *          *          *          *          *          *
*   5.0  * 3470.5   *   37750. *   37500. *      0.  *   75250. *
*        *          *          *          *          *          *
*   5.3  * 3470.8   *   38813. *   38125. *      0.  *   76938. *
*        *          *          *          *          *          *
*   5.5  * 3471.0   *   39875. *   38750. *      0.  *   78625. *
*        *          *          *          *          *          *
*****************************************************************

DAMAGE WAS NOT CALCULATED FOR ENTIRE STAGE DAMAGE FUNCTION FOR STRUCTURE
DAMAGE WAS NOT CALCULATED ABOVE MAXIMUM ELEVATION FOR DAMAGE REACH


THE VALUE OF    FIRST FLOOR    CONTENTS OF THIS STRUCTURE IS 50.0 PERCENT OF THE    FIRST FLOOR    STRUCTURE VALUE

DAMAGE VALUES ARE TRUNCATED TO  -2.0 STAGE TO REFLECT
THE DIFFERENCE IN STAGE BETWEEN THE FIRST FLOOR AND LOWEST OPENING (DELTZ)
```

Warning Message. The elevation-damage relationship is not computed for the entire height of this structure. An elevation-frequency curve is needed to determine if the highest calculated damage elevation (3471.0 in this case) is high enough. If not, then the tabulation interval must be changed (variable "AGG", J2.4 or "ELINTR", DR.7).

ADDITIONAL OUTPUT

Elevation-damage relationship that is written to DSS file.

Part B of DSS pathname.

Possibly poor selection for variable "STRELV" (DR.6). Should be set to 3463.0 to eliminate unnecessary zero damage values).

```
                          SILVER CREEK

                                     DAMAGE REACH  RCH 1
                             DAMAGE REACH 1 FOR RIVERTON
                                  ( DAMAGES ARE IN $1000 )

                                       DAMAGE CATEGORIES
*****************************************************************************************************
*   WATER  *          *          *          *          *          *          *          *          *          *          *
*  SURFACE * RESDNTL  * COMERCL  *  OTHER   *          *          *          *          *          *          *  TOTAL   *
* ELEVATION*          *          *          *          *          *          *          *          *          *          *
*****************************************************************************************************
*          *          *          *          *          *          *          *          *          *          *          *
*   3462.0 *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3462.5 *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3463.0 *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3463.5 *     0.0  *    21.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *    21.0  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3464.0 *     3.8  *    42.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *    45.7  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3464.5 *     7.5  *    58.1  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *    65.6  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3465.0 *    11.3  *    74.2  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *    85.5  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3465.5 *    15.0  *    90.3  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   105.3  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3466.0 *    25.0  *   106.4  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   131.4  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3466.5 *    35.0  *   122.6  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   157.6  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3467.0 *    45.0  *   138.7  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   183.7  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3467.5 *    55.0  *   154.8  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   209.8  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3468.0 *    58.4  *   170.9  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   229.3  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3468.5 *    61.8  *   173.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   234.7  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3469.0 *    65.1  *   175.1  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   240.2  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3469.5 *    68.5  *   177.2  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   245.7  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3470.0 *    71.9  *   179.3  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   251.2  *
*          *          *          *          *          *          *          *          *          *          *          *
*   3470.5 *    75.2  *   181.4  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   256.7  *
*          *          *          *          *          *          *          *          *          *          *          *
*****************************************************************************************************

           DAMAGE CATEGORY  RESDNTL IDENTIFIED AS RESIDENTIAL STRUCTURE AND CONTENTS
```

```
                 DAMAGE CATEGORY  COMERCL IDENTIFIED AS COMMERCIAL STRUCTURE AND CONTENTS
                 DAMAGE CATEGORY    OTHER IDENTIFIED AS  OTHER DAMAGE CATEGORIES
1
                              SILVER CREEK


 -----DSS---ZWRITE FILE  71, VERS.   1   /SILVER CREEK/RCH 1/ELEVATION-DAMAGE///BASE/
                  -----DSS---ZCLOSE FILE   71
                             NO. RECORDS=       1
                             FILE SIZE=       456 WORDS,        5 SECTORS
                             PERCENT INACTIVE=  0.00
R
 STOP
```

Elevation-damage relationship written to DSS file for reach 1.

i. Compute the expected annual damage for the base condition.

At this point, all the pertinent relationships for the base condition have been stored in the master DSS file named "SLVAAEZ". A data file named "SLVAOEI" is developed to compute expected annual damage for the base condition.

Data stored in the DSS file may be examined at any time. It may at times be useful to check the data before submitting the EAD run. This is easily done by using the DSS utility programs DSSUTL to catalog the file and tabulate the data and DSPLAY to tabulate and plot the data. It is possible to input data directly into the DSS file. For illustration purposes, the base condition frequency curve is input and (later) compared to the automatically inserted curve. This entails directly storing the input curve into the DSS file using the PIP program (reference 10). The output below demonstrates the application of these programs. This is a good time to verify that the rating curves are properly defined (the lowest discharge is below the lowest point on the flow-frequency curve and the highest point is above the maximum damage elevation), the frequency curves are properly defined (the lowest discharge on the curve is non-damaging and the highest point is very rare (on the order of .2% chance exceedance), and the elevation-damage relationships are well defined. Careful examination of the results of the EAD run will also reveal whether the data ranges input have been appropriate. Notice that the frequency curve stored in the DSS file is virtually identical to the one which was input to HEC-1. It is based on the ratios which were selected on the JR card in the HEC-1 input data file. The flow-exceedance frequency curves are shown in Figure 6, the elevation-flow rating curve at river mile 49.0 is shown in Figure 7, and the elevation-damage relationships for both damage categories of reach one in Riverton are shown in Figure 8.

Program PIP

```
HLIB*PIPX                                               Enter base condition frequency
                                                        curve directly to DSS data file.
    O P E N I N G   M E N U

      0  EXIT PROGRAM

      1  GENERAL HELP MENU

      2  PATHNAME MENU

      3  DATA ENTRY MENU

      4  DATA-FILE MENU

ENTER ITEM NUMBER OR <H>ELP:
2 ←——————————————————— Menu to enter pathname parts (A & F).
           P A T H N A M E   M E N U

                                 OTHER MENUS

  0  EXIT PROGRAM          :  3  GENERAL HELP MENU
                           :
  1  SET PROJECT NAME      :  4  DATA ENTRY MENU
                           :
  2  SET ALTERNATIVE NAME  :  5  DATA-FILE MENU

ENTER ITEM NUMBER OR <H>ELP:
1 ←——————————————————————— Enter Part A.
ENTER PROJECT NAME (MAXIMUM 14 CHARACTERS):
SILVER CREEK ←—————————————— Part A.
ENTER ITEM NUMBER OR <H>ELP:
2 ←——————————————————————— Enter Part F.
ENTER ALTERNATIVE NAME (MAXIMUM 24 CHARACTERS):
EXISTING-INPUT ←———————————— Part F.

ENTER ITEM NUMBER OR <H>ELP:
4 ←——————————————————————— Menu to enter data and parts B and E of the pathname.

         D A T A   E N T R Y   M E N U

                             OTHER MENUS

  0  EXIT PROGRAM      :  4  GENERAL HELP MENU
                       :
  1  SET LOCATION      :  5  PATHNAME MENU
                       :
  2  SET DATA YEAR     :  6  DATA-FILE MENU
                       :
  3  SELECT DATA TYPE  :
```

```
ENTER ITEM NUMBER OR <H>ELP:
1 <-------------------------------- Enter Part B.
ENTER LOCATION (MAXIMUM 6 CHARACTERS):
RCH 1 <---------------------------- Part B.

ENTER ITEM NUMBER OR <H>ELP:
3 <-------------------------------- Menu to select data type.
                 D A T A   T Y P E   M E N U

                                                OTHER MENUS

  0  EXIT PROGRAM      :  4  FREQ-FLOW         :  8  GENERAL HELP MENU
                       :                       :
  1  ELEVATION-DAMAGE  :  5  FLOW-DAMAGE       :  9  PATHNAME MENU
                       :                       :
  2  ELEV-FLOW         :  6  FREQ-DAMAGE       : 10  DATA ENTRY MENU
                       :                       :
  3  FREQ-ELEV         :  7  DISPLAY PATHNAME  : 11  DATA-FILE MENU

ENTER ITEM NUMBER OR <H>ELP:
4 <------------------------------------------- Select frequency-flow data type.
FREQUENCY - FLOW DATA ENTRY (MAXIMUM 18 VALUES)

THIS DATA ENTRY SECTION ALLOWS YOU TO MANUALLY INPUT FREQUENCY - FLOW
FUNCTIONS TO AN HEC DSS-FILE.

THE FREQUENCY-FLOW VALUES ARE INPUT IN FREE-FORMAT, SEPARATED BY AT LEAST
ONE SPACE OR A SINGLE COMMA.  THE FLOW VALUES MUST BE INPUT IN INCREASING
ORDER.

THE FREQUENCY VALUES MUST BE INPUT AS EXCEEDANCE FREQUENCY VALUES IN PERCENT.
THE VALUES MUST BE IN DECREASING ORDER (E.G. 10. FOR THE 10-YEAR EVENT,
1.0 FOR THE 100-YEAR EVENT, ETC.).

A BLANK PAIR OF FREQUENCY-FLOW VALUES TERMINATES DATA ENTRY AND TRIGGERS DATA
VERIFICATION AND EDIT MODES.

PRESS THE CARRIAGE RETURN TO CONTINUE
```

```
ENTER FREQUENCY, FLOW
90 1000
80 1150
70 1270
60 1400
50 1550
40 1700
30 1860
20 2100
10 2550
5 3000
2 3750
1 4350
 .5 5300
 .2 6700
 .1 7800
 .01 1200
```

Frequency-flow curve for base condition (input to HEC-1). User enters curve.

Blank line (Carriage return) terminates data entry.

```

DO YOU WANT TO DISPLAY THE DATA? (Y OR N)
(YOU CANNOT EDIT THE DATA WITHOUT DISPLAYING IT)
Y
```

Display data entered above.

```
DATA DISPLAY
POINT     FREQUENCY        FLOW
    1         90.00       1000.00
    2         80.00       1150.00
    3         70.00       1270.00
    4         60.00       1400.00
    5         50.00       1550.00
    6         40.00       1700.00
    7         30.00       1860.00
    8         20.00       2100.00
    9         10.00       2550.00
   10          5.00       3000.00
   11          2.00       3750.00
   12          1.00       4350.00
   13          0.50       5300.00
   14          0.20       6700.00
   15          0.10       7800.00
   16          0.01      12000.00
DO YOU WANT TO EDIT THE DATA? (Y OR N)
N

         D A T A   E N T R Y   M E N U

                               OTHER MENUS

  0  EXIT PROGRAM      :  4  GENERAL HELP MENU
                       :
  1  SET LOCATION      :  5  PATHNAME MENU
                       :
  2  SET DATA YEAR     :  6  DATA-FILE MENU
                       :
  3  SELECT DATA TYPE  :
```

```
ENTER ITEM NUMBER OR <H>ELP:
6                                        Select Data-file menu.

            D A T A - F I L E   M E N U

                                 OTHER MENUS

  0  EXIT PROGRAM              :  3  GENERAL HELP MENU
                               :
  1  SET DATA-FILE NAME        :  4  PATHNAME MENU
                               :
  2  WRITE DATA-FILE TO DSS-FILE  :  5  DATA ENTRY MENU

ENTER ITEM NUMBER OR <H>ELP:
2                                      Write data (frequency curve) to DSS file.
ENTER DSS-FILE NAME (MAXIMUM 7 CHARACTERS):
SLVAAEZ                                          DSS file name.
               -----DSS---ZOPEN EXISTING FILE OPENED   71  0000A10C*SLVAAEZ
-----DSS---ZWRITE FILE  71, VERS.   5   /SILVER CREEK/RCH 1/FREQ-FLOW///EXISTING-INPUT/
               -----DSS---ZCLOSE FILE   71
                          NO. RECORDS=       4
                          FILE SIZE=      1124 WORDS,      11 SECTORS     Frequency curve written to DSS file.
                          PERCENT INACTIVE=  0.00

            D A T A - F I L E   M E N U

                                 OTHER MENUS

  0  EXIT PROGRAM              :  3  GENERAL HELP MENU
                               :
  1  SET DATA-FILE NAME        :  4  PATHNAME MENU
                               :
  2  WRITE DATA-FILE TO DSS-FILE  :  5  DATA ENTRY MENU

ENTER ITEM NUMBER OR <H>ELP:
0                                    Exit "PIP" program.
DO YOU WANT TO SAVE YOUR DATA? (Y OR N)
N
ARE YOU SURE? (Y OR N)
N
DO YOU WANT TO SAVE YOUR DATA? (Y OR N)
Y                                    Alternative method to write data to DSS file.
ENTER DSS-FILE NAME (MAXIMUM 7 CHARACTERS):
SLVAAEZ
               -----DSS---ZOPEN EXISTING FILE OPENED   71  0000A10C*SLVAAEZ
-----DSS---ZWRITE FILE  71, VERS.   6   /SILVER CREEK/RCH 1/FREQ-FLOW///EXISTING-INPUT/
               -----DSS---ZCLOSE FILE   71
                          NO. RECORDS=       4
                          FILE SIZE=      1124 WORDS,      11 SECTORS
                          PERCENT INACTIVE=  0.00
STOP
```

Execute DSSUTL to catalog and tabulate data.

Master DSS file.

```
ENTER DSS FILE NAME
FILE = SLVAAEZ
              -----DSS---ZOPEN EXISTING FILE OPENED   71  0000A10C*SLVAAEZ
U>CA.N
GENERATED AREANAME CALLED 0000A10C*SLVAAEZC
CATALOG FILE = 0000A10C*SLVAAEZC
```

Get a "new" (option "N") catalog listing

Catalog Listing.

```
    HECDSS COMPLETE CATALOG OF RECORD PATHNAMES ON FILE  0000A10C SLVAAEZ

    CATALOG DATE = 10MAY85,  TIME = 17:09:37    FILE CREATED ON 10MAY85;   VERSION 4-CA
    NUMBER OF RECORDS =    3
    SORT ORDER = ABCFED


 REF            WRITTEN
 NO.  PROG    DATE      TIME    VER HEAD  DATA              RECORD PATHNAME

   1  HEC2  10MAY85  16:57:23   1   34    28    /SILVER CREEK/49.000/ELEV-FLOW///BASE/
   2  SID   10MAY85  16:59:49   1   42    72    /SILVER CREEK/RCH 1/ELEVATION-DAMAGE///BASE/
   3  HEC1  10MAY85  16:56:25   1   30    18    /SILVER CREEK/RCH 1/FREQ-FLOW///BASE/
U>TA 1-3
```

DSS records in file.

Tabulate pathnames 1 through 3.

```
-----DSS---ZREAD  FILE  71, VERS.   1   /SILVER CREEK/49.000/ELEV-FLOW///BASE/
/SILVER CREEK/49.000/ELEV-FLOW///BASE/
HEADER L.=  34, # DATA PAIRS=  14, # X CURVES=  1, # Y CURVES=  1, HORIZ=  2
FEET    CFS     UNT UNT
FLOW

  3459.691  3461.926  3463.437  3464.646  3465.654  3466.392  3467.123  3467.763
  3467.973  3468.304  3468.820  3470.245  3471.594  3473.973

    500.    1000.    1500.    2000.    2500.    3000.    3500.    4000.    4500.    5000.
   6000.    8000.   10000.   15000.
-----------------------------------------------------------------------------------------
```

Elevation-discharge rating curve.

```
-----DSS---ZREAD  FILE  71, VERS.   1  /SILVER CREEK/RCH 1/ELEVATION-DAMAGE///BASE/
/SILVER CREEK/RCH 1/ELEVATION-DAMAGE///BASE/
HEADER L.=  42, # DATA PAIRS=  18, # X CURVES=  1, # Y CURVES=  3, HORIZ=  2
FEET    $1000   UNT UNT
 RESDNTL COMERCL   OTHER

  3462.000  3462.500  3463.000  3463.500  3464.000  3464.500  3465.000  3465.500  <-Elev.
  3466.000  3466.500  3467.000  3467.500  3468.000  3468.500  3469.000  3469.500
  3470.000  3470.500
                                                                                   <-- Elevation-damage relationship.
     0.00      0.00      0.00      0.00      3.75      7.50     11.25     15.00     25.00     35.00  <-Resdntl.
    45.00     55.00     58.38     61.75     65.13     68.50     71.87     75.25

     0.000     0.000     0.000    21.000    42.000    58.111    74.222    90.333
   106.444   122.556   138.667   154.778   170.889   173.000   175.111   177.222  <-Comercl.
   179.333   181.444

        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.  <-Other
        0.        0.
..............................................................................


-----DSS---ZREAD  FILE  71, VERS.   1  /SILVER CREEK/RCH 1/FREQ-FLOW///BASE/
/SILVER CREEK/RCH 1/FREQ-FLOW///BASE/
HEADER L.=  30, # DATA PAIRS=   9, # X CURVES=  1, # Y CURVES=  1, HORIZ=  1
PERCENT CFS     PROBUNT
                                                                                   <--Freq-flow curve.

   72.4310   14.1772    5.9418    2.3709    1.0643    0.8533    0.2684    0.1265  <-Freq.
    0.0474

  1240.091  2322.498  2875.303  3601.746  4277.350  4559.864  6263.014  7403.350  <-Flow
  9117.608
..............................................................................

U>FI
                 -----DSS---ZCLOSE FILE   71
                            NO. RECORDS=        3
                            FILE SIZE=       960 WORDS,      9 SECTORS
                            PERCENT INACTIVE=  0.00
STOP
```

1. *Tabulate data.*
2. *Plot data.*

Execute DSPLAY

```
HLIB*DSPLAYX
```

Execute program.

```
 .

 *************************
 *  DSS-DSPLAY PROGRAM   *
 *  VERSION NO.  7       *
 *  JAN. 25,1985         *
 *************************


 ENTER DSS DATA FILE NAME
 FILE = SLVAAEZ
SLVAAEZ
```

Master DSS file.

```
                 -----DSS---ZOPEN EXISTING FILE OPENED   71  0000A10C*SLVAAEZ

     ENTER PATHNAME  1.   OR PROCESS/MODE COMMAND.
D> ?
?
```

Get online help.

```
                                   DSPLAY

 The  following is a list of the VALID COMMANDS available under the
 DATA RETRIEVAL SUBMODULE.  To get definitions of the commands, enter ?,ALL.
 To get a definition of individual comands, enter ?,command,command,...

                      DATA RETRIEVAL SUBMODULE COMMANDS

 AXIS      CATALOG   COLOR     CURVES    DATE      DBUG
 DEVICE    FACTOR    FINISH    GETPATHN  GRID      LANGUAGE
 L1        L2        OPEN      PATHNAME  PLOT      RATE
 RESET     SCREEN    SHADE     SIZESYMB  SPLIT     SQUARE
 SYMBOL    TABULATE  TIME      USERLABE  ?         SETTING
 YRANGE    SPLOT     RPLOT     STATUS    HELP      FRAME
 XLABEL    YLABEL    Y2LABEL   ROUND     TMARK     DPATHNAM
 NORMALIZ
```

List of commands.

```
    ENTER PATHNAME  1.   OR PROCESS/MODE COMMAND.
D> ?,DEV
?,DEV
```

Get online documentation for the command "device".

```
                                  DEVICE

USE:  DE,Parameters

      The DE command is used to specify the type of terminal being used.

      Parameters:  ALPHA, INTERACTIVE, BATCH, 4014, 4027
      Example:  DE,4014 (Tektronix 4014 being used)
      Default:  ALPHA (Non-Graphics) and INTERACTIVE


    ENTER PATHNAME  1.   OR PROCESS/MODE COMMAND.
D> DE,4014
DE,4014
```

Indicate Tektronix 4014 terminal is being used.

```
    ENTER PATHNAME  1.   OR PROCESS/MODE COMMAND.
D> CA
CA
CATALOG FILE = 0000A10C*SLVAAEZC
```

Get existing catalog listing.

```
      HECDSS COMPLETE CATALOG OF RECORD PATHNAMES ON FILE  0000A10C SLVAAEZ

      CATALOG DATE = 14MAY85,  TIME = 13:59:20    FILE CREATED ON 10MAY85;   VERSION 4-CA
      NUMBER OF RECORDS =     4
      SORT ORDER = ABCFED


   REF             WRITTEN
   NO.  PROG    DATE      TIME    VER HEAD  DATA             RECORD PATHNAME

    1   HEC2  10MAY85  16:57:23   1   34    28    /SILVER CREEK/49.000/ELEV-FLOW//BASE/
    2   SID   10MAY85  16:59:49   1   42    72    /SILVER CREEK/RCH 1/ELEVATION-DAMAGE///BASE/
    3   HEC1  10MAY85  16:56:25   1   30    18    /SILVER CREEK/RCH 1/FREQ-FLOW///BASE/
    4   PIP   17APR85  14:49:02   4   34    32    /SILVER CREEK/RCH 1/FREQ-FLOW///EXISTING-INPUT/


    ENTER PATHNAME  1.   OR PROCESS/MODE COMMAND.
D> PL,1
PL,1
  /SILVER CREEK/49.000/ELEV-FLOW///BASE/
```

Plot elevation-discharge rating curve. (reference number 1).

Tabulate rating curves and damage relationships. (ref. No. 1 and 2).

```
     ENTER PATHNAME  1.   OR PROCESS/MODE COMMAND.
D> TA,1,2
TA,1,2
  /SILVER CREEK/49.000/ELEV-FLOW///BASE/
  /SILVER CREEK/RCH 1/ELEVATION-DAMAGE///BASE/

14MAY85    14:43:51                                    PAGE    1



    PATH NAME
  /SILVER CREEK/49.000/ELEV-FLOW///BASE/
D>


14MAY85    14:43:51                                    PAGE    2


    CURVE  NO   1

   X - VARIABLE DATA
    NO     TOTAL       MEAN     MINIMUM   MAXIMUM
  VALUES   VALUE       VALUE     VALUE     VALUE
     14    66500.00   4750.00    500.00  15000.00

   Y - VARIABLE DATA
    NO     TOTAL       MEAN     MINIMUM   MAXIMUM
  VALUES   VALUE       VALUE     VALUE     VALUE
     14    48537.54   3466.97   3459.69   3473.97
D>


14MAY85    14:43:51                                    PAGE    3



    PATH NAME
  /SILVER CREEK/RCH 1/ELEVATION-DAMAGE///BASE/
D>


14MAY85    14:43:51                                    PAGE    4
```

ADDITIONAL OUTPUT

```
14MAY85    14:43:51                                         PAGE    7

/SILVER CREEK/49.000/ELEV-FLOW///BASE/


                   FLOW IN  CFS

 NO     ELEV          FLOW

   1     3459.691       500.000
   2     3461.926      1000.000
   3     3463.437      1500.000
   4     3464.646      2000.000
   5     3465.654      2500.000
   6     3466.392      3000.000
   7     3467.123      3500.000
   8     3467.763      4000.000
   9     3467.973      4500.000
  10     3468.304      5000.000
  11     3468.820      6000.000
  12     3470.245      8000.000
  13     3471.594     10000.000
D>

14MAY85    14:43:51                                         PAGE    8

/SILVER CREEK/49.000/ELEV-FLOW///BASE/


                   FLOW IN  CFS

 NO     ELEV          FLOW

  14     3473.973     15000.000
D>
```

← *Tabulation of rating curve.*

```
14MAY85    14:43:51                                          PAGE    9

/SILVER CREEK/RCH 1/ELEVATION-DAMAGE///BASE/

                              DAMAGE IN  $1000

 NO    ELEVATION    RESDNTL     COMERCL       OTHER

   1    3462.000      0.000       0.000       0.000
   2    3462.500      0.000       0.000       0.000
   3    3463.000      0.000       0.000       0.000
   4    3463.500      0.000      21.000       0.000
   5    3464.000      3.750      42.000       0.000
   6    3464.500      7.500      58.111       0.000
   7    3465.000     11.250      74.222       0.000
   8    3465.500     15.000      90.333       0.000
   9    3466.000     25.000     106.444       0.000
  10    3466.500     35.000     122.556       0.000
  11    3467.000     45.000     138.667       0.000
  12    3467.500     55.000     154.778       0.000
  13    3468.000     58.375     170.889       0.000
D>

14MAY85    14:43:51                                          PAGE   10

/SILVER CREEK/RCH 1/ELEVATION-DAMAGE///BASE/

                              DAMAGE IN  $1000

 NO    ELEVATION    RESDNTL     COMERCL       OTHER

  14    3468.500     61.750     173.000       0.000
  15    3469.000     65.125     175.111       0.000
  16    3469.500     68.500     177.222       0.000
  17    3470.000     71.875     179.333       0.000
  18    3470.500     75.250     181.444       0.000
D>
```

← *Tabulation of damage relationships.*

```
    ENTER PATHNAME  1.   OR PROCESS/MODE COMMAND.
D> TA,3
TA,3
  /SILVER CREEK/RCH 1/FREQ-FLOW///BASE/
```

Tabulate frequency curve (ref No. 3).

```
14MAY85    14:43:51                                     PAGE    1



   PATH NAME
  /SILVER CREEK/RCH 1/FREQ-FLOW///BASE/
D>


14MAY85    14:43:51                                     PAGE    2


   CURVE  NO   1

  X - VARIABLE DATA
   NO     TOTAL        MEAN      MINIMUM   MAXIMUM
 VALUES   VALUE        VALUE      VALUE     VALUE
     9       97.28      10.81       0.05     72.43

  Y - VARIABLE DATA
   NO     TOTAL        MEAN      MINIMUM   MAXIMUM
 VALUES   VALUE        VALUE      VALUE     VALUE
     9    41660.82    4628.98    1240.09   9117.61
D>


14MAY85    14:43:51                                     PAGE    3

/SILVER CREEK/RCH 1/FREQ-FLOW///BASE/


                   FLOW IN  CFS

 NO     FREQ            RESDNTL

   1      72.431      1240.091
   2      14.177      2322.498
   3       5.942      2875.303
   4       2.371      3601.746
   5       1.064      4277.350
   6       0.853      4559.864
   7       0.268      6263.014
   8       0.127      7403.350
   9       0.047      9117.608
D>
```

Tabulation of frequency curve.

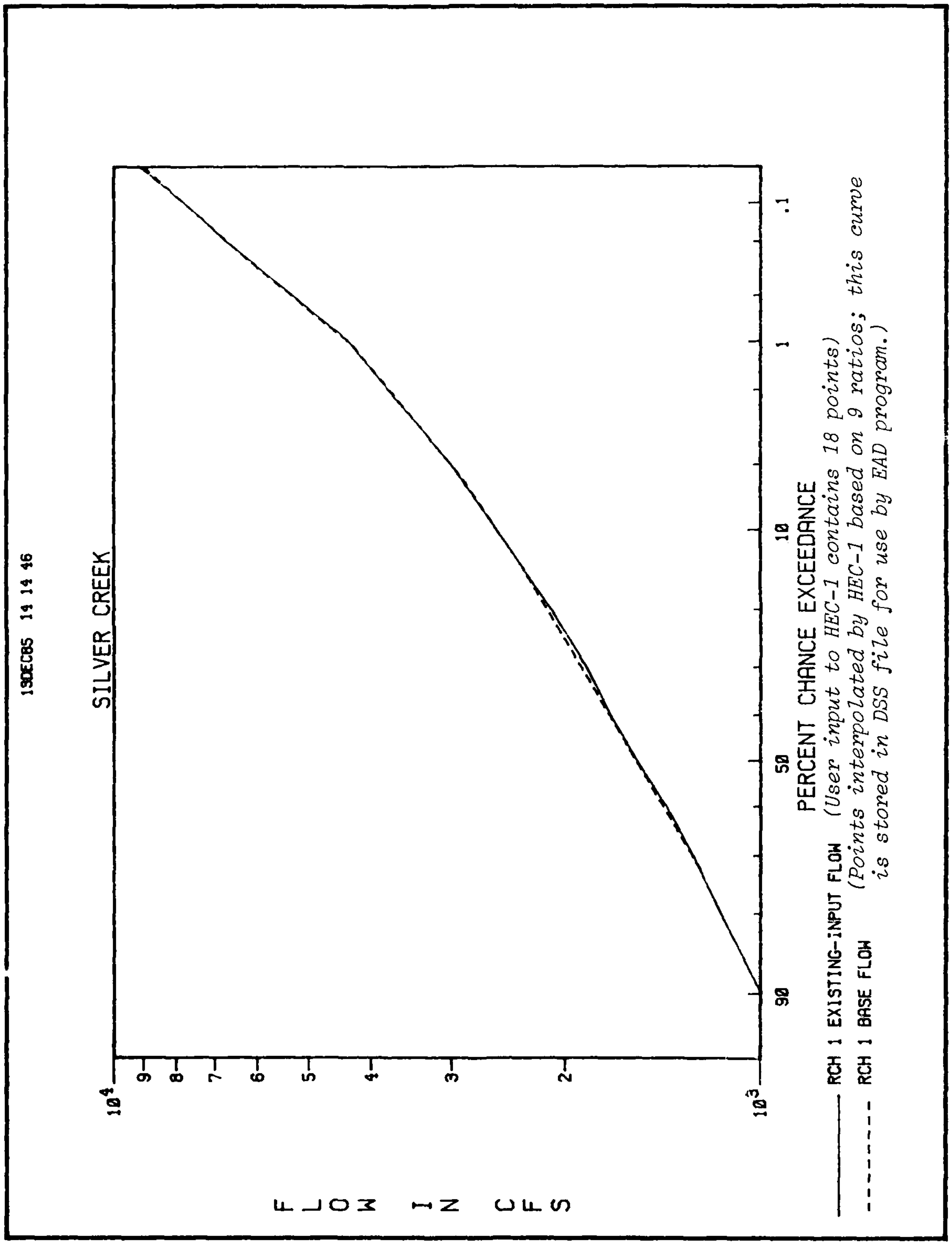


Figure 6 Base Condition Frequency Curves, Silver Creek

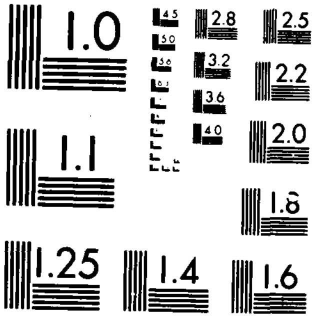
AD-A164 736 FLOOD DAMAGE ANALYSIS PACKAGE DESCRIPTION USER GUIDANCE 2/2
AND EXAMPLE(U) HYDROLOGIC ENGINEERING CENTER DAVIS CA
R CARL ET AL. JAN 86 HEC-TD-21

UNCLASSIFIED F/G 13/2 NL

END

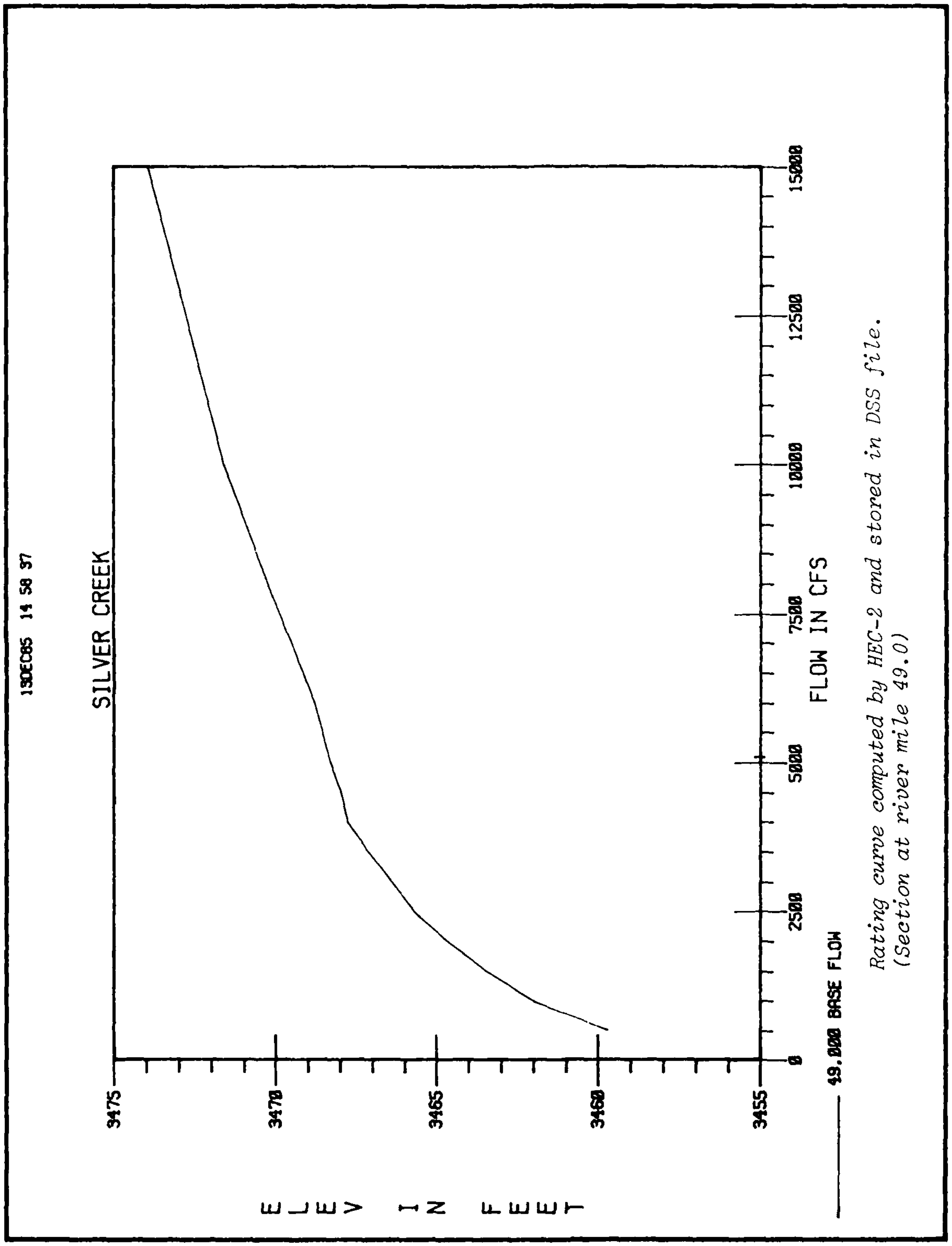
FILMED

DTIC



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A



Rating curve computed by HEC-2 and stored in DSS file.
(Section at river mile 49.0)

Figure 7 Base Condition Rating Curve, Silver Creek R.M. 49.0

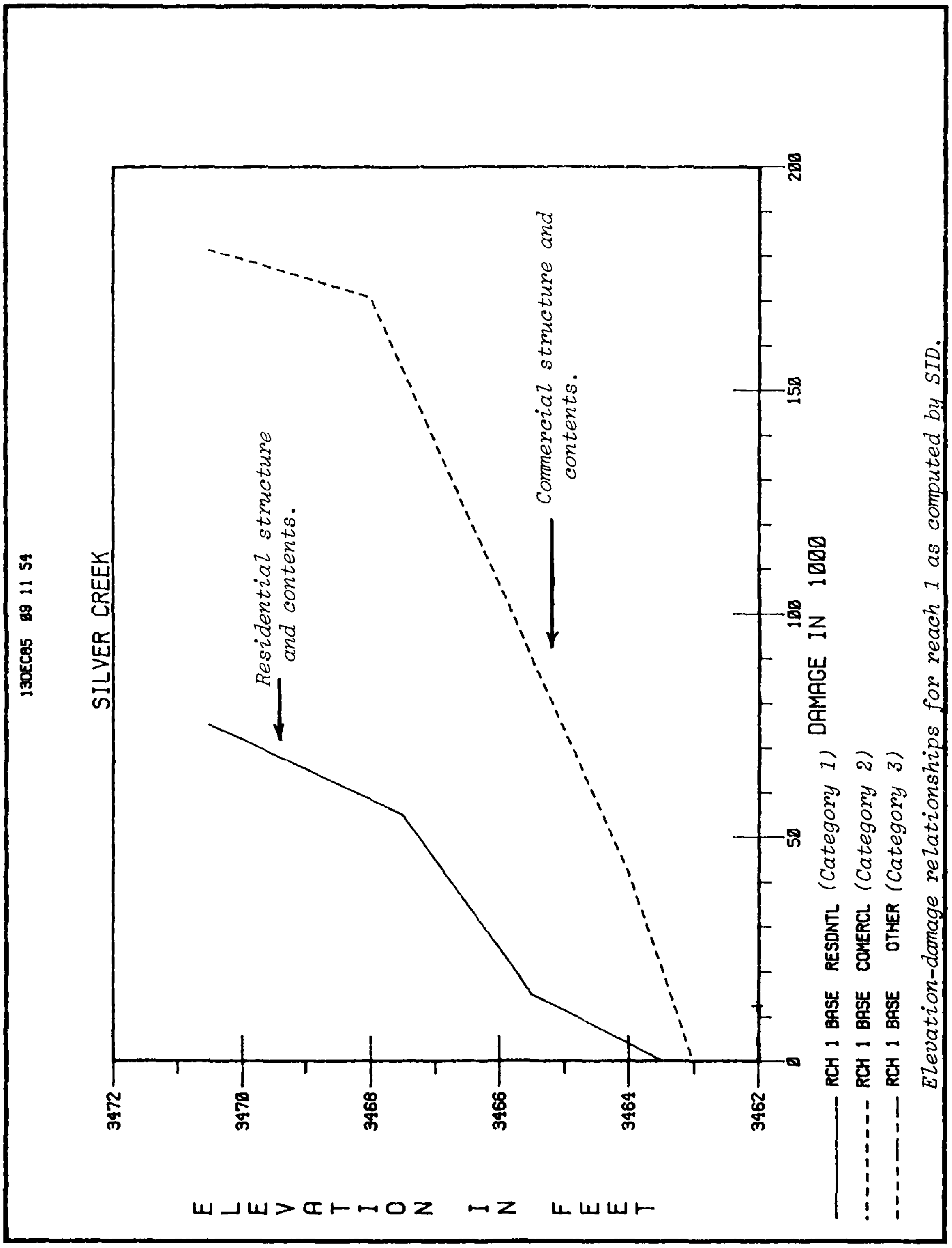


Figure 8 Base Condition Elevation-Damage, Silver Creek, RCH 1

Base Condition EAD

```
===> HLIB*EADX,INPUT=SLVAOEI,TAPE71=SLVAAEZ
```

Master DSS file.

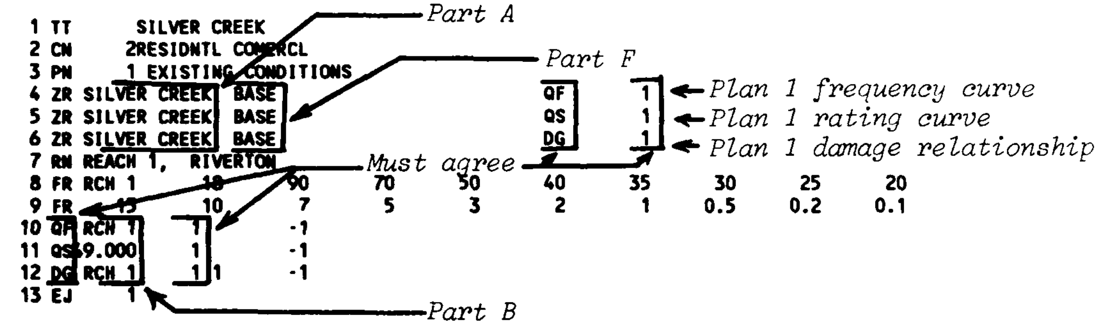
```
1*******************************************************                                ****************************************
 *  EXPECTED ANNUAL FLOOD DAMAGE PROGRAM               *                                *  U. S. ARMY CORPS OF ENGINEERS       *
 *  VERSION OF MARCH   1985                            *                                *  THE HYDROLOGIC ENGINEERING CENTER   *
 *                                                     *                                *  609 SECOND STREET                   *
 *                                                     *                                *  DAVIS, CALIFORNIA  95616-4687       *
 *  RUNDATE  14 MAY 85  TIME  14:30:38                 *                                *  (916) 440-2105  (FTS) 448-2105      *
 *******************************************************                                ****************************************




                                                   EEEEEEE      A      DDDDDD
                                                   E           A A     D     D
                                                   E          A   A    D     D
                                                   EEEE      AAAAAAA   D     D
                                                   E         A     A   D     D
                                                   E         A     A   D     D
                                                   EEEEEEE   A     A   DDDDDD
```

```
1+++++++++++++++++++++++++++++++++++++++++++++
+ EXPECTED ANNUAL FLOOD DAMAGE COMPUTATION +
+ 761-X6-L7580            FEBRUARY    1984 +
+ VERSION DATE            MARCH    5, 1985 +
++++++++++++++++++++++++++++++++++++++++++++++


** LIST OF RECORDS READ BY READIN **
RECORD
 ORDER           1         2         3         4         5         6         7         8
NUMBER 12345678901234567890123456789012345678901234567890123456789012345678901234567890
```



```
     1 TT       SILVER CREEK
     2 CN      2RESIDNTL COMERCL
     3 PN       1 EXISTING CONDITIONS
     4 ZR SILVER CREEK  BASE                            QF       1
     5 ZR SILVER CREEK  BASE                            QS       1
     6 ZR SILVER CREEK  BASE                            DG       1
     7 RN REACH 1,  RIVERTON
     8 FR RCH 1       18      90      70      50      40      35      30      25      20
     9 FR      15      10       7       5       3       2       1     0.5     0.2     0.1
    10 QF RCH 1        1       -1
    11 QS 9.000        1       -1
    12 DG RCH 1        11      -1
    13 EJ      1

READIN --    13 RECORDS WRITTEN TO LOGICAL FILE  8
```

```
1+++++++++++++++++++++++++++++++++++++++++++++
+ EXPECTED ANNUAL FLOOD DAMAGE COMPUTATION +
+ 761-X6-L7580             FEBRUARY    1984 +
+ VERSION DATE             MARCH    5, 1985 +
+++++++++++++++++++++++++++++++++++++++++++++


TT      SILVER CREEK

**DAMAGE CATEGORY NAMES**
CN   2  RESIDNTL COMERCL

**FLOOD PLAIN MANAGEMENT PLAN NAMES**
PN   1   EXISTING CONDITIONS

**FILE SYSTEM READ**
ZR SILVER CREEK  BASE                       QF      1
ZR SILVER CREEK  BASE                       QS      1
ZR SILVER CREEK  BASE                       DG      1

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

REACH   1, REACH NAME -
RN REACH 1,  RIVERTON

++++ INPUT DATA ++++

**FREQUENCIES**
FR RCH 1      18   90.00   70.00   50.00   40.00   35.00   30.00   25.00   20.00
   15.00   10.00    7.00    5.00    3.00    2.00    1.00    0.50    0.20    0.10

**FREQUENCIES READ FROM HECDSS FILE**
FR RCH 1    0 1 0   72.43   14.18    5.94    2.37    1.06    0.85    0.27    0.13
   0.05

**FLOOD PEAKS READ FROM HECDSS FILE**
QF RCH 1       9   1240.   2322.   2875.   3602.   4277.   4560.   6263.   7403.
   9118.

**INTERPOLATED FLOOD PEAKS**
QF RCH 1    0 1 0  974.58 1271.62 1536.06 1687.73 1774.03 1870.92 1982.91 2117.52
   2289.   2534.   2764.   3000.   3408.   3737.   4348.   5315.   6704.   7790.

**STAGES FOR RATING CURVE**
SQ49.000       14 3459.69 3461.93 3463.44 3464.65 3465.65 3466.39 3467.12 3467.76
 3467.97 3468.30 3468.82 3470.25 3471.59 3473.97

**FLOWS FOR RATING CURVE**
QS49.000    0 1 0  500.00 1000.00 1500.00 2000.00 2500.00 3000.00 3500.00 4000.00
   4500.   5000.   6000.   8000.  10000.  15000.
```

User input to EAD program.

Frequency curve stored in DSS file by HEC-1.

Interpolated flow values corresponding to frequencies entered by user on FT cards.

Rating curve stored in DSS file by HEC-2.

```
**STAGES FOR DAMAGE DATA**
SD RCH 1      18 3462.00 3462.50 3463.00 3463.50 3464.00 3464.50 3465.00 3465.50
 3466.00 3466.50 3467.00 3467.50 3468.00 3468.50 3469.00 3469.50 3470.00 3470.50

**FLOOD DAMAGE DATA**
DG RCH 1    0 1 1    0.00    0.00    0.00    0.00    3.75    7.50   11.25   15.00
   25.00   35.00   45.00   55.00   58.38   61.75   65.13   68.50   71.87   75.25

**FLOOD DAMAGE DATA**
DG RCH 1        2    0.00    0.00    0.00   21.00   42.00   58.11   74.22   90.33
  106.44  122.56  138.67  154.78  170.89  173.00  175.11  177.22  179.33  181.44

**END OF INPUT DATA FOR PLAN  1 **
EJ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

++DAMAGE DATA FOR PLAN 1 --  EXISTING CONDITIONS
                User input
      FREQ       FLOW --> STAGE  RESIDNTL    COMERCL     TOTAL    ACC EAD
  1  90.00       975.   3461.81      0.00       0.00      0.00      42.51
  2  70.00      1272.   3462.75      0.00       0.00      0.00      42.51
  3  50.00      1536.   3463.52      0.18      22.02     22.20      41.00
  4  40.00      1688.   3463.89      2.93      37.43     40.36      37.89
  5  35.00      1774.   3464.10      4.50      45.22     49.72      35.63
  6  30.00      1871.   3464.33      6.26      52.77     59.03      32.92
  7  25.00      1983.   3464.61      8.29      61.50     69.79      29.70
  8  20.00      2118.   3464.88     10.37      70.46     80.83      25.94
  9  15.00      2289.   3465.23     12.96      81.59     94.55      21.57
 10  10.00      2534.   3465.70     19.08      96.90    115.98      16.37
 11   7.00      2764.   3466.04     25.86     107.84    133.70      12.64
 12   5.00      3000.   3466.39     32.86     119.10    151.96       9.80
 13   3.00      3408.   3466.99     44.77     138.29    183.06       6.48
 14   2.00      3737.   3467.43     53.53     152.41    205.93       4.54
 15   1.00      4348.   3467.91     57.76     167.96    225.72       2.37
 16   0.50      5315.   3468.47     61.53     172.86    234.39       1.21
 17   0.20      6704.   3469.32     67.29     176.47    243.76       0.50
 18   0.10      7790.   3470.10     72.52     179.74    252.26       0.25
                          Interpolated flows
EXP ANNUAL DAMAGE                    6.47      36.04     42.51
1

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

     SILVER CREEK

** SUMMARY OF REACH NAMES **

 NO    ID    . . NAME . . .
---------------------------------------------------------------------------
  1  RCH 1    REACH 1,  RIVERTON

---------------------------------------------------------------------------
```

Damage relationship stored in DSS file by SID program.

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

     SILVER CREEK


** GRAND SUMMARY BY CATEGORY **

** FLOOD PLAIN MANAGEMENT PLANS
        1 -  EXISTING CONDITIONS

GRAND SUMMARY - ALL DAMAGE CATEGORIES
----------------------------------------
            . EXPECTED ANNUAL DAMAGE  .
  DAMAGE       BASE
 CATEGORY    CONDITION
             (PLAN  1)
----------------------------------------
  RESIDNTL       6.47
   COMERCL      36.04
----------------------------------------

    TOTAL       42.51

----------------------------------------


++++++++++++++++
END OF RUN
EAD PROGRAM STOP
++++++++++++++++
STOP
```

Total expected annual damage for all reaches and categories.

j. Adjust procedure or change naming conventions if needed.

At this point, the base condition damage is determined. It is a good time to assess the successfulness of the study procedure to determine if adjustments are necessary. If mistakes or misunderstandings in data management naming conventions have caused inconsistences in data storage, these are corrected both in the master data base file "SLVAAEZ", as well as all intermediate DSS files and input data files. The output from the EAD program is checked to ensure that frequency curves are properly defined, that elevation-damage relationships span the range of damageable property, and that rating curves have properly converted elevation to discharge.

Once it is determined that all relationships are properly defined and that the study procedure is sound, the flood damage mitigation measures formulated earlier are studied. This process involves study team communication because some alternatives involve interdependent modifications to the basic hydrologic relationships.

k. Simulate an ungated reservoir.

HEC-1 simulates an ungated reservoir located above Riverton. The basic hydrologic model exists as a result of analyzing the base condition. It includes the base condition frequency curve. Only minor modifications are required to simulate the reservoir and compute the modified frequency curve. The second control point was established to accomodate the ungated reservoir plan even though it was not needed for base condition. The elevation-storage-discharge relationships are entered at control point 2 in the hydrology section of input for "plan 2" (from the standpoint of HEC-1 internal computations) and apprpriate "PN" and "ZW" cards are entered in the economics section of input to trigger the writing of a modified frequency curve to the DSS file. The HEC-1 output for the ungated reservoir follows below.

HEC-1 Ungated Reservoir

```
===> HLIB*HEC1X,INPUT=SLVA11I,DSSFILE=SLVAAEZ <-- Master DSS file.  Hydrographs are not written
                                                  to DSS file so intermediate HEC-1 DSS file is
                                                  not needed.

  LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

     1        ID       SILVER CREEK
     2        IT     120 01JAN80    0200      30
     3        IO       4       0       0                  <-- 2 plans.
     4        JP       2
     5        JR    PREC     .39     .60     .70     .83     .95     1.0     1.3     1.5     1.8 <-Ratios to multiply precipitation.

     6        KK       1INFLOW TO RESERVOIR SITE ABOVE RIVERTON
     7        BA      23
     8        BF      60    1000     2.5
     9        LU      .8      .1
    10        PI     .05     .10     .07     .15     .30     .20     .05       0       0       0
    11        PI       0       0
    12        PB     8.2
    13        US      16     .80

    14        KK   RES 1
    15        KP       1  <-No routing for plan 1, base condition.
    16        RN
    17        KP       2 <------------------------------------------ Plan 2 data.
    18        RS       1    STOR      -1       0
    19        SS    3500      50     3.1     1.5
    20        SL    3492    12.5      .8     0.5                 <-- Ungated reservoir data.
    21        SV       0    1100    3000    6000   20000
    22        SE    3490    3500    3510    3520    3530

    23        KK       1LOCAL INFLOW TO INDEX POINT FOR REACH 1 IN RIVERTON
    24        BA       5
    25        BF      14     100     1.2
    26        LU      .8      .1
    27        PB     8.2
    28        US     3.4     .80

    29        KK   RCH 1INDEX POINT FOR REACH 1 IN RIVERTON
    30        HC       2

    31        EC
    32        PN       1EXISTING CONDITIONS       DSS pathname parts for plan "1", base condition.
    33        ZW   SILVER CREEK  BASE <-
    34        PN       2UNGATED RESERVOIR         DSS pathname parts for plan "2", ungated reservoir.
    35        ZW   SILVER CREEK  UNGTD RES <-

    36        KK   RCH 1RIVERTON - REACH 1
    37        FR   RCH 1      16      90      80      70      60      50      40      30      20
    38        FR      10       5       2       1     0.5     0.2     0.1    0.01
    39        QF                    1000    1150    1270    1400    1550    1700    1860    2100 <-Base condition frequency curve.
    40        QF    2550    3000    3750    4350    5300    6700    7800   12000
    41        ZZ
```

Hydrology (lines 1–30)

Reservoir Location (lines 13–23)

Economics (lines 31–41)

```
*****************************************                         ***************************************
*                                       *                         *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                         *     U.S. ARMY CORPS OF ENGINEERS    *
*             FEBRUARY 1981             *                         *  THE HYDROLOGIC ENGINEERING CENTER  *
*           REVISED 31 JAN 85           *                         *           609 SECOND STREET         *
*                                       *                         *        DAVIS, CALIFORNIA 95616      *
*  RUN DATE 14 MAY 85    TIME  15:42:08 *                         *  (916) 440-3285 OR (FTS) 448-3285   *
*                                       *                         *                                     *
*****************************************                         ***************************************




                              SILVER CREEK

 3 IO          OUTPUT CONTROL VARIABLES
                     IPRNT          4  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT          HYDROGRAPH TIME DATA
                      NMIN        120  MINUTES IN COMPUTATION INTERVAL
                     IDATE     1JAN80  STARTING DATE
                     ITIME       0200  STARTING TIME
                        NQ         30  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE     3JAN80  ENDING DATE
                    NDTIME       1200  ENDING TIME

                 COMPUTATION INTERVAL    2.00 HOURS
                      TOTAL TIME BASE   58.00 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

   JP          MULTI-PLAN OPTION
                     NPLAN          2  NUMBER OF PLANS

   JR          MULTI-RATIO OPTION
                   RATIOS OF PRECIPITATION
                  0.39      0.60      0.70      0.83      0.95      1.00      1.30      1.50      1.80
```

```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

               ***************
               *             *
  6 KK         *           1 *     INFLOW TO RESERVOIR SITE ABOVE RIVERTON
               *             *
               ***************

                 SUBBASIN RUNOFF DATA

  7 BA            SUBBASIN CHARACTERISTICS
                        TAREA       23.00  SUBBASIN AREA

  8 BF            BASE FLOW CHARACTERISTICS
                        STRTQ       60.00  INITIAL FLOW
```

ADDITIONAL OUTPUT

```
1
              PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                          FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                         TIME TO PEAK IN HOURS

                                                      RATIOS APPLIED TO PRECIPITATION
 OPERATION      STATION     AREA   PLAN          RATIO 1  RATIO 2  RATIO 3  RATIO 4  RATIO 5  RATIO 6  RATIO 7  RATIO 8  RATIO 9
                                                    0.39     0.60     0.70     0.83     0.95     1.00     1.30     1.50     1.80

 HYDROGRAPH AT
+                   1      23.00     1  FLOW       1208.    2283.    2834.    3558.    4233.    4515.    6216.    7356.    9070.
                                        TIME       24.00    24.00    24.00    24.00    24.00    24.00    24.00    24.00    24.00
                                     2  FLOW       1208.    2283.    2834.    3558.    4233.    4515.    6216.    7356.    9070.
                                        TIME       24.00    24.00    24.00    24.00    24.00    24.00    24.00    24.00    24.00

 ROUTED TO
+               RES 1      23.00     1  FLOW       1208.    2283.    2834.    3558.    4233.    4515.    6216.    7356.    9070.
                                        TIME       24.00    24.00    24.00    24.00    24.00    24.00    24.00    24.00    24.00
                                     2  FLOW        622.    1732.    2302.    3022.    3702.    3999.    5584.    6575.    8111.
                                        TIME       34.00    30.00    30.00    28.00    28.00    28.00    28.00    28.00    28.00

                                     ** PEAK STAGES IN FEET **
                                     1  STAGE       0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
                                        TIME        0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00
                                     2  STAGE    3501.73  3504.39  3505.47  3506.68  3507.80  3508.23  3510.45  3511.67  3513.50
                                        TIME       34.00    30.00    30.00    28.00    28.00    28.00    28.00    28.00    28.00

 HYDROGRAPH AT
+                   1       5.00     1  FLOW        846.    1503.    1807.    2202.    2567.    2719.    3631.    4239.    5150.
                                        TIME       12.00    12.00    12.00    12.00    12.00    12.00    12.00    12.00    12.00
                                     2  FLOW        846.    1503.    1807.    2202.    2567.    2719.    3631.    4239.    5150.
                                        TIME       12.00    12.00    12.00    12.00    12.00    12.00    12.00    12.00    12.00

  2 COMBINED AT
+               RCH 1      28.00     1  FLOW       1240.    2322.    2875.    3602.    4277.    4560.    6263.    7403.    9118.
                                        TIME       24.00    24.00    24.00    24.00    24.00    24.00    24.00    24.00    24.00
                                     2  FLOW        908.    1745.    2316.    3043.    3723     4021.    5607.    6597.    8134.
```

Peak flow for rch 1, Base condition, ratio 6.

Peak flow for rch 1, ungated reservoir, ratio 6.

```
1          ***************
           *             *
  36 KK    *    RCH 1    *        RIVERTON - REACH 1
           *             *
           ***************


NO DAMAGE DATA (QD OR SD CARDS) FOR THIS LOCATION,
SO DAMAGES WILL NOT BE CALCULATED.

     FR         PERCENT EXCEEDANCE
                                                90.0       80.0       70.0       60.0       50.0       40.0       30.0       20.0
                               10.0       5.0    2.0        1.0        0.5        0.2        0.1        0.0

     QF         PEAK FLOW
                                               1000.      1150.      1270.      1400.      1550.      1700.      1860.      2100.
                               2550.     3000.  3750.      4350.      5300.      6700.      7800.     12000.
             -----DSS---ZOPEN EXISTING FILE OPENED    71  0000A10C*SLVAAEZ

PLAN 1

FREQUENCY     72.43      14.18      5.94      2.37      1.06      0.85      0.27      0.13      0.05
PEAK FLOW     1240.      2322.     2875.     3602.     4277.     4560.     6263.     7403.     9118.
-----DSS---ZWRITE FILE   71, VERS.   3   /SILVER CREEK/RCH 1/FREQ FLOW///BASE/

PLAN 2

FREQUENCY     72.43      14.18      5.94      2.37      1.06      0.85      0.27      0.13      0.05
PEAK FLOW      908.      1745.     2316.     3043.     3723.     4021.     5607.     6597.     8134.
-----DSS---ZWRITE FILE   71, VERS.   2   /SILVER CREEK/RCH 1/FREQ-FLOW///UNGTD RES/


             -----DSS---ZCLOSE FILE   71
                        NO. RECORDS=       6
                        FILE SIZE=      1498 WORDS,      14 SECTORS
                        PERCENT INACTIVE=  0.00


*** NORMAL END OF HEC-1 ***
STOP 101
```

Ratio 6, base condition
peak flow: 4560 cfs.

Base
Condition

Ungated
Reservoir

1. Simulate a gated reservoir.

HEC-5 simulates a gated reservoir located above Riverton. A basic hydrologic model is developed that is very similiar to that developed for the ungated reservoir using HEC-1. The input data includes the base condition frequency curve. The elevation-storage-discharge relationships are entered at control point 2. HEC-5 computes and stores three frequency curves in one record --- the first curve is the modified curve representative of the gated reservoir condition, the second curve is the base condition frequency curve computed by HEC-5, and the third curve is a frequency curve derived from the local uncontrolled discharge. Only the first curve (the modified curve) is used in the expected annual damage calculations and the others are ignored.

Due to the gate operation capabilities, HEC-5 may compute a modified frequecy curve containing inconsistent flow reductions as shown in Figure 9. HEC-5 allows the user to change the order and method of arraying the points or the analyst can use the DSSUTL program to edit the modified curve, if desirable. Damage relationships are still required input in order to write the frequency curves to the DSS file. "Dummy" data is input on the DC cards as shown in the run below. An execution of DSPLAY follows the HEC-5 output. It tabulates and plots the frequency curves computed by HEC-5 for the gated reservoir condition.

Gated Reservoir HEC-5

```
===> HLIB*HEC5AX,INPUT=SLVA15I,DSSIN=SLVAA1Z,DSSOUT=SLVAA5Z <——— DSS file to which HEC-5 writes computed hydrographs.
         ^Execute part A of HEC-5.
                                      └——— DSS file containing inflow hydrographs calculated by HEC-1.
          -----DSS---ZOPEN EXISTING FILE OPENED   71  0000A10C*SLVAA1Z


      ----PATHNAMES READ FOR TIME SERIES DATA----

-----DSS---ZREAD  FILE  71, VERS.   1   /SILVER CREEK/RES 1/FLOW/01JAN1980/2HOUR/INFLOW+6/ <——— Inflow hydrographs read from
-----DSS---ZREAD  FILE  71, VERS.   1   /SILVER CREEK/RCH 1/FLOW/01JAN1980/2HOUR/LOCAL+6/        DSS file.


          -----DSS---ZCLOSE FILE   71
                 NO. RECORDS=       19
                 FILE SIZE=     18137 WORDS,    162 SECTORS
                 PERCENT INACTIVE= 13.15
1
**************************************************************                ****************************************
* HEC-5 SIMULATION OF FLOOD CONTROL AND CONSERVATION SYSTEMS *                *  U.S. ARMY CORPS OF ENGINEERS        *
*  SEGMENTED VERSION      (UPDATED   MARCH 1985)             *                *  THE HYDROLOGIC ENGINEERING CENTER   *
*                                                            *                *  609 SECOND STREET, SUITE D          *
*                                                            *                *  DAVIS, CALIFORNIA  95616            *
* RUN DATE  15 MAY 85 TIME   12:01:13                        *                *  (916) 440-2105  (FTS) 448-2105      *
**************************************************************                ****************************************
```

```
1
      HEC-5 SIMULATION OF FLOOD CONTROL
            AND CONSERVATION SYSTEMS

      SEGMENTED VERSION    (UPDATED      MARCH 1985)

      MAX DIMENSION LIMITS ARE CURRENTLY SET AT   15  RESERVOIRS AND   25  CONTROL POINTS


*INPUT LISTING FROM PRERD

       TO SUPPRESS LISTING, INSERT NOLIST CARD INTO INPUT DECK AT DESIRED POINT


T1      SILVER CREEK
T2
T3
J1     0       1       5       3       4       2              10
J2    24     1.2     .33               1
J3   129     132       0      -1       0       1       0
J4    +1                                                                       2
JZ  1.09    1.10    2.04

RL     1    1100       0     400    1100    3000   20000
RO     2       1       2
RS     5       0    1100    3000    6000   20000
RQ     5       0     227    5900   13600   26000
RE     5    3490    3500    3510    3520    3530

CP     1    3000     250     100
ID GATED RESERVOIR
RT     1       2       0

CP     2    1500     250     100
ID      RCH 1    RIVERTON
RT     2
DA     2       0
DF    16      .9      .8      .7      .6      .5      .4      .3      .2      .1
DF   .05     .02     .01    .005    .002    .001   .0001
DQ    16    1000    1150    1270    1400    1550    1700    1860    2100    2550
DQ  3000    3750    4350    5300    6700    7800   12000
DC1            0       1       1       1       1       1       1       1       1
DC     1       1       1       1       1       1       1
DC2            0       1       1       1       1       1       1       1       1
DC     1       1       1       1       1       1       1
ED
```

Expected annual damage will be calculated.

Write flow-exceedance frequency (in percent) curve to DSS file.

Dummy damage data. Required to facilitate writing frequency curves to DSS file.

```
BF     2     30      0      080010100      0      2      0
FC   .25    .40    .60    .75      .90    1.0    1.5    2.0     2.5
ZR=IN1  A=SILVER CREEK, B=RES 1, C=FLOW, F=INFLOW+6
IN     1 01JAN80
      60      9     16     70     204     510   1055   1776   2554   3299
    3931   4357   4514   4402    4043    3465   2788   2172   1682   1301
    1007    779    603    466     361     279    216    167    129     97
IN     2 01JAN80
      14      9    113    386     802    1678   2718   2633   1406    375
      93     64     45     31      21      15     10      7      5      3
       2      1      1      0       0       0      0      0      0      0
ZW   A=SILVER CREEK F=GATED RES

EJ
ER
```

9 ratios to multiple inflows to derive frequency curve.

Write hydrographs and frequency curves to DSS file.

```
 START COMPUTATIONS FOR JOB NUMBER  1  FOR  1  FLOODS READ


NRES=       1  NCPT=        2

FIXED DIM.    -  DIVS.= 10    PWR. =  7
DYNAMIC DIM.  -  RES =  1    CPTS.=  2    PERS.= 1153


*FLOWS


   FLOFMT   NPER  NPSTO  CNSTI      FLDAT   EPER    IPER . MINPER  NDAYWK  ONESUM
BF     2.    30.     0.   0.00 80010100.     0.      2      0      0.      0.
FC    0.3    0.4    0.6    0.8        0.9     1.     2.     2.     3.      0.
IN      1  1JAN80      60.0       9.0      16.0      70.0     204.0     510.0    1055.0    1776.0    2554.0    3299.0
                     3931.0    4357.0    4514.0    4402.0    4043.0    3465.0    2788.0    2172.0    1682.0    1301.0
                     1007.0     779.0     603.0     466.0     361.0     279.0     216.0     167.0     129.0      97.0
                                                                                                             SUM=     46312.
IN      2  1JAN80      14.0       9.0     113.0     386.0     802.0    1678.0    2718.0    2633.0    1406.0     375.0
                       93.0      64.0      45.0      31.0      21.0      15.0      10.0       7.0       5.0       3.0
                        2.0       1.0       1.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
                                                                                                             SUM=     10432.

EJ         0.00
1
 *INTAB


 J1 METRIC   ISTMO    NULEV   LEVCON   LEVTFC   LEVBUF   LEVPBS
        0        1        5        3        4        2        3
```

ADDITIONAL OUTPUT

```
-----DSS---ZWRITE FILE  72, VERS.   9   /SILVER CREEK/GATED RESERVO/FLOW-RES IN/01JAN1980/2HOUR/GATED RES/
-----DSS---ZWRITE FILE  72, VERS.   9   /SILVER CREEK/GATED RESERVO/FLOW-RES OUT/01JAN1980/2HOUR/GATED RES/
-----DSS---ZWRITE FILE  72, VERS.   9   /SILVER CREEK/RCH 1/FLOW-REG/01JAN1980/2HOUR/GATED RES/
0
----- OUTPUT DATA WRITTEN TO DSS -----
0
                 -----DSS---ZCLOSE FILE   72
                            NO. RECORDS=        4
                            FILE SIZE=      3221 WORDS,      29 SECTORS
                            PERCENT INACTIVE=  0.00
STOP

===>HLIB*HEC5BX,DSSOUT=SLVAAEZ
```

Execute part B of HEC-5.

Flow frequency curves are written to this DSS file.

```
1
      SILVER CREEK


COMPUTATION INTERVAL IN HOURS=  2.00

*FLOOD 1
                 ***** FLOOD NUMBER  1 *****                                      UNITS OF OUTPUT

                                                                  ALL FLOWS IN CFS OR CMS
               NFLRD=        1  NFLCON=       9                   EVAPORATION AND STORAGES IN ACRE FEET OR 1000 CU METERS
               IFLRD =       1  IFLCON=       1                   ELEVATIONS IN FEET OR METERS
                  FLOWS MULTIPLIED BY     0.250                   ENERGY IN 1000 KWH EXCEPT WHEN IPER LT 24 HOURS-IN KWH


1
*USERS.1     USER DESIGNED OUTPUT

                                          SUMMARY BY PERIOD    FLOOD=       1
LOC NO=                    1.          1.         2.
CODE=                      1.090       1.100      2.040      0.000      0.000      0.000      0.000      0.000      0.000      0.000

                          GATED RE    GATED RE      RCH
 PER HR DY MO YR DW       INFLOW      OUTFLOW     FLOW REG

   1  2  1  1 80  1        15.00      223.45      226.95
   2  4  1  1 80  1         2.25      216.24      218.49
   3  6  1  1 80  1         4.00      209.09      237.34
   4  8  1  1 80  1        17.50      202.44      298.94
   5 10  1  1 80  1        51.00      196.80      397.30
   6 12  1  1 80  1       127.50      193.19      612.69
   7 14  1  1 80  1       263.75      193.27      872.77
   8 16  1  1 80  1       444.00      198.66      856.91
   9 18  1  1 80  1       638.50      210.15      561.65
  10 20  1  1 80  1       824.75      286.10      379.85
  11 22  1  1 80  1       982.75      479.04      502.29
```

ADDITIONAL OUTPUT

```
1
*SUMF1     SINGLE FLOOD SUMMARY   COPY=   1
COMPUTATION INTERVAL IN HOURS=  2.00

        SILVER CREEK


                    ***** FLOOD NUMBER  9 *****


 LOC=     NONRESERVOIRS      MAX REG Q   MAX NAT   MAX UNC   Q BY RES   CH CAP

     2       RCH 1    RIVERTO    10094.    11398.     6795.     3299.    1500.

 LOC=     RESERVOIRS             STOR1   MAX LEVEL  MAX INFLOW  MAX REL CHAN CAP

     1  GATED RESERVOIR           1100     4.095     11285     10041     3000


         MAX SYSTEM STORAGE=     4619


1                EXPECTED ANNUAL FLOOD DAMAGE SUMMARY
                     CONTROL POINT NUMBER    2

*ECDAM 2
                                     BASE CONDITION FREQUENCY-FLOW-DAMAGE DATA
    FREQ      PEAK          SUM     TYPE 1    TYPE 2     TYPE
   0.9000    1000.         0.00      0.00      0.00
   0.8000    1150.         2.00      1.00      1.00
   0.7000    1270.         2.00      1.00      1.00
   0.6000    1400.         2.00      1.00      1.00
   0.5000    1550.         2.00      1.00      1.00
   0.4000    1700.         2.00      1.00      1.00
   0.3000    1860.         2.00      1.00      1.00
   0.2000    2100.         2.00      1.00      1.00
   0.1000    2550.         2.00      1.00      1.00
   0.0500    3000.         2.00      1.00      1.00
   0.0200    3750.         2.00      1.00      1.00
   0.0100    4350.         2.00      1.00      1.00
   0.0050    5300.         2.00      1.00      1.00
   0.0020    6700.         2.00      1.00      1.00
   0.0010    7800.         2.00      1.00      1.00
   0.0001   12000.         2.00      1.00      1.00

EXPECTED ANNUAL DAMAGES
   BASE COND-COMPUTED      1.70      0.85      0.85
   BASE COND-    INPUT     0.00      0.00      0.00


                                     BASE CONDITION FLOOD DAMAGES
```

Base condition flow-frequency curve input to HEC-5, by user.

Dummy damage; Economic calculations are performed using "EAD" program.

```
          EXCD  PROB
NO.  FLOW  FREQ   INT        SUM    TYPE 1     TYPE 2     TYPE
 1   1140.0.808 0.341       0.57     0.29       0.29
 2   1824.0.320 0.367       0.73     0.37       0.37
 3   2735.0.074 0.145       0.29     0.15       0.15
 4   3419.0.030 0.031       0.06     0.03       0.03
 5   4103.0.013 0.011       0.02     0.01       0.01
 6   4559.0.009 0.006       0.01     0.01       0.01
 7   6839.0.002 0.004       0.01     0.00       0.00
 8   9118.0.000 0.001       0.00     0.00       0.00
 9  11398.0.000 0.000       0.00     0.00       0.00

   BASE COND DAMAGES        1.70     0.85       0.85


                          MODIFIED CONDITIONS FLOOD DAMAGES
          EXCD  PROB
NO.  FLOW  FREQ   INT        SUM    TYPE 1     TYPE 2     TYPE
 1   1004.0.808 0.336       0.33     0.17       0.17
 2   1499.0.320 0.367       0.73     0.37       0.37
 3   1631.0.074 0.145       0.29     0.15       0.15
 4   3048.0.030 0.031       0.06     0.03       0.03
 5   3658.0.013 0.011       0.02     0.01       0.01
 6   3480.0.009 0.006       0.01     0.01       0.01
 7   6327.0.002 0.004       0.01     0.00       0.00
 8   8147.0.000 0.001       0.00     0.00       0.00
 9  10094.0.000 0.000       0.00     0.00       0.00

     MODIFIED DAMAGES       1.46     0.73       0.73
     DAMAGE REDUCTION       0.24     0.12       0.12


                          UNCONTROLLED LOCAL FLOW FLOOD DAMAGES
          EXCD  PROB
NO.  FLOW  FREQ   INT        SUM    TYPE 1     TYPE 2     TYPE
 1    680.0.808 0.336       0.00     0.00       0.00
 2   1087.0.320 0.367       0.28     0.14       0.14
 3   1631.0.074 0.145       0.29     0.15       0.15
 4   2039.0.030 0.031       0.06     0.03       0.03
 5   2446.0.013 0.011       0.02     0.01       0.01
 6   2718.0.009 0.006       0.01     0.01       0.01
 7   4077.0.002 0.004       0.01     0.00       0.00
 8   5436.0.000 0.001       0.00     0.00       0.00
 9   6795.0.000 0.000       0.00     0.00       0.00
     DAMAGES W/ TOTAL
   CONTROL AT PROJECTS      0.67     0.33       0.33

   REDUCTION POSSIBLE
   W/ TOTAL CONTROL         1.03     0.52       0.52

     RESIDUAL DAMAGES       0.79     0.39       0.39
```

Base condition frequency curve interpolated from user input curve using peak regulated discharge for each ratio entered on "FC" card.

Modified frequency curve. Representative of plan 4 conditions - gated reservoir built and operating.

```
     -----DSS---ZOPEN EXISTING FILE OPENED    72  0000A10C*SLVAAEZ
-----DSS---ZWRITE FILE  72, VERS.   4   /SILVER CREEK/RCH 1/FREQ-FLOW///GATED RES/
1 CONTROL POINT       2
 *EPLOT 2
```

Frequency curve written to DSS file.

```
                                                     EXCEEDENCE FREQUENCY
         99.9 99.8 99.5 99.         95.    90.    80.  70.      50.       30.   20.     10.     5.      2.   1.   0.5   0.2 0.1
  100000 :---:-----:----:-----------:------:-------:-----:---------:---------:-----:-------:------:-------:----:----:-----:---:
         :   :     :    :           :      :       :     :         :         :     :       :      :       :    :    :     :   :
   80000 :   :     :    :           :      :       :     :         :         :     :       :      :       :    :    :     :   :
         :   :     :    :           :      :       :     :         :         :     :       :      :       :    :    :     :   :
```

ADDITIONAL OUTPUT

```
         :   :     :    :           :      :       :     :         :         :     :       :      :       :    :    :     :   :
         :   :     :    :           :      :       :     :         :         :     :       :      :       :    :    :     :   :
         :   :     :    :           :      :       :     :         :         :     :       :      :       :    :    :     :   :
     100 :---:-----:----:-----------:------:-------:-----:---------:---------:-----:-------:------:-------:----:----:-----:---:
          O =BASE CONDITION PEAK    M =MODIFIED PEAK    X =INPUT FREQUENCY CURVE    $ =BEYOND PLOT RANGE    CONTROL POINT    10


          -----DSS---ZCLOSE FILE   72
                     NO. RECORDS=        8
                     FILE SIZE=      1832 WORDS,      17 SECTORS
                     PERCENT INACTIVE=  0.00
1
 *ESUMD
               SUMMARY OF SYSTEM"S EXPECTED ANNUAL FLOOD DAMAGES

                       DAMAGES                          DAMAGE REDUCTION
      CP       BASE COND   MOD COND   LOC COND   MOD COND   LOC COND   RESIDUAL
          2         1.70       1.46       0.67       0.24       1.03       0.79

     TOTALS         1.70       1.46       0.67       0.24       1.03       0.79
1
************************************************************************************************************************


 *CASES


 ** CASE=X.Y, WHERE X=CONTROLLING LOCATION AND Y=NUMBER FUTURE PERIOD CONTROLLING
 EXCEPT WHEN X=0
 THEN, TYPE OF RELEASE IS BASED ON RESERVOIR ITSELF,Y=
      Y=00 MINIMUM DESIRED FLOW WAS RELEASED
      Y=01 MAXIMUM RESERVOIR RELEASE
```

ADDITIONAL OUTPUT

Plot and tabulate frequency curves from HEC-5.

DSPLAY

```
HLIB*DSPLAYX

 .

 **************************
 *  DSS-DSPLAY PROGRAM    *
 *  VERSION NO.  7        *
 *  JAN. 25,1985          *
 **************************


 ENTER DSS DATA FILE NAME
 FILE = SLVAAEZ
SLVAAEZ
               -----DSS---ZOPEN EXISTING FILE OPENED   71  0000A10C*SLVAAEZ

      ENTER PATHNAME  1.   OR PROCESS/MODE COMMAND.
D> AXIS,LIN,LOG,LOG,
AXIS,LIN,LOG,LOG,

      ENTER PATHNAME  1.   OR PROCESS/MODE COMMAND.
D> PL,7
PL,7
CATALOG FILE = 0000A10C*SLVAAEZC
  /SILVER CREEK/RCH 1/FREQ-FLOW///GATED RES/
```

X axis is linear.

Y axis is logarithmic.

```
     ENTER PATHNAME  1.   OR PROCESS/MODE COMMAND.
D> TA,7
TA,7
  /SILVER CREEK/RCH 1/FREQ-FLOW///GATED RES/

17MAY85    16:58:11                                    PAGE    1


   PATH NAME
  /SILVER CREEK/RCH 1/FREQ-FLOW///GATED RES/
```

ADDITIONAL OUTPUT

```
D>
17MAY85    16:58:11                                    PAGE    5

/SILVER CREEK/RCH 1/FREQ-FLOW///GATED RES/

                         FLOW IN  CFS

 NO    FREQ       MODIFIED    BASE       UNCONTRL

  1    80.805     1004.121    1139.750     679.500
  2    31.987     1499.200    1823.600    1087.200
  3     7.393     1630.800    2735.400    1630.800
  4     2.976     3048.000    3419.250    2038.500
  5     1.291     3657.600    4103.100    2446.200
  6     0.854     3480.000    4559.000    2718.000
  7     0.183     6326.759    6838.500    4077.000
  8     0.046     8147.214    9118.000    5436.000
  9     0.014    10094.115   11397.500    6795.000
D>

     ENTER PATHNAME  1.   OR PROCESS/MODE COMMAND.
D> FI
FI
                -----DSS---ZCLOSE FILE   71
                           NO. RECORDS=       8
                           FILE SIZE=      1832 WORDS,      17 SECTORS
                           PERCENT INACTIVE=  0.00
```

Modified frequency curve - gated reservoir in place.

Base condition frequency curve (using HEC-5 ratios of flow).
This curve (and "uncontrl" curve) is not used in EAD computations.

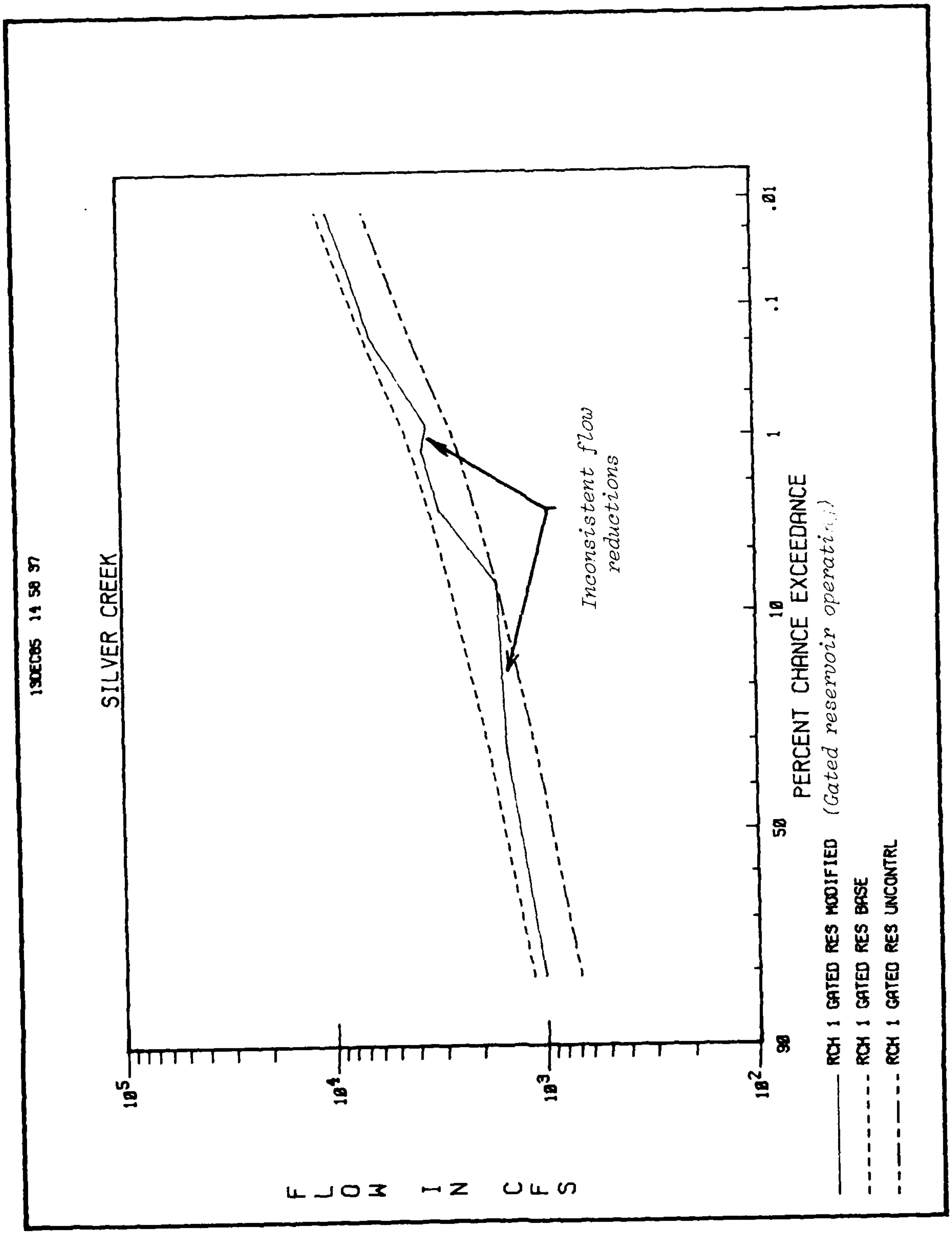


Figure 9 Gated Reservoir Frequency Curve

m. Simulate a channel improvement.

The proposed channel improvement is easily modeled using the HEC-2 program. The base condition input data file is modified by inserting a "CI" card (or cards) and modifying the "ZW" card to identify part F of the DSS pathname for this alternative plan. The improved cross-section at river mile 49.0 is shown in Figure 10. As in the base condition analysis, the computed rating curves are written to the intermediate DSS file "SLVAA2Z" and then the curve at the index location (river mile 49.0) is copied to the master DSS file "SLVAAEZ" using the DSSUTL program. Selected portions of the HEC-2 output are shown below. It is followed by the DSSUTL program execution that copies the rating curve to the master DSS file.

HEC-2 Channel Improvement

```
===> HLIB*HEC2X,INPUT=SLVA12I,DSSFILE=SLVAA2Z,TAPE95=SLV952B
```

Intermediate HEC-2 DSS file.

```
 14 MAY 85    15:44:26                                                                          PAGE    1


                                                                       THIS RUN EXECUTED 14 MAY 85   15:44:27
 *****************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
 *****************************************************
```

Part F of DSS pathname. Must be different than that for base condition. Otherwise, this job will overwrite it.

```
ZW SILVER CREEK  CHIMP-20FT BW
               -----DSS---ZOPEN EXISTING FILE OPENED   71  0000A10C*SLVAA2Z
      DATA STORAGE SYSTEM OPTION ACTIVATED


T1
T2
T3      SILVER CREEK

J1  ICHECK    INQ      NINV      IDIR      STRT      METRIC     HVINS     Q        WSEL      FQ

       0.       2.        0.        0.  0.005700      0.00       0.0        0.  3440.000     0.000

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH      FN       ALLDC      IBW      CHNIM     ITRACE

     1.000     0.000    -1.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000

J3  VARIABLE CODES FOR SUMMARY PRINTOUT
```

Must request "Table 150".

```
   150.000    38.000     1.000    43.000    55.000    56.000    26.000     0.000     0.000     0.000

J5  LPRNT    NUMSEC                 *********REQUESTED SECTION NUMBERS*********

   -10.000   -10.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000

NC      0.070      0.060      0.040      0.100      0.100      0.000      0.000      0.000      0.000      0.000
QT     14.000    500.000   1000.000   1500.000   2000.000   2500.000   3000.000   3500.000   4000.000   4500.000
QT   5000.000   6000.000   8000.000  10000.000  15000.000      0.000      0.000      0.000      0.000      0.000
X1     48.300     11.000     50.000     70.000      0.000      0.000      0.000      0.000      0.000      0.000
CI     -1.000     -1.000      0.000      1.500      1.500     20.000      0.000      0.000      0.000      0.000
GR   3471.000      0.000   3461.000     20.000   3445.000     30.000   3440.000     50.000   3432.000     54.000
GR   3430.000     60.000   3432.000     66.000   3440.000     70.000   3445.000     90.000   3461.000    100.000
GR   3471.000    120.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000
```

Channel Improvement Data.

```
X1    48.500     9.000   130.000   165.000  1056.000  1056.000  1056.000     0.000     0.000     0.000
GR  3477.000     0.000  3449.000    20.000  3445.000   130.000  3438.000   140.000  3436.000   143.000
GR  3438.000   146.000  3445.000   165.000  3456.000   190.000  3477.000   220.000     0.000     0.000

X1    48.800     9.000   150.000   180.000  1584.000  1584.000  1584.000     0.000     0.000     0.000
GR  3480.000     0.000  3462.000    20.000  3458.000   150.000  3449.000   154.000  3445.000   162.000
GR  3449.000   170.000  3458.000   180.000  3465.000   203.000  3480.000   240.000     0.000     0.000
1
 14 MAY 85    15:44:26                                                                    PAGE    2
```

"Rch 1" damage index point location.

```
X1    49.000     9.000   150.000   175.000  1056.000  1056.000  1056.000     0.000     0.000     0.000
GR  3480.000     0.000  3465.000    20.000  3461.000   150.000  3457.000   159.000  3451.000   163.000
GR  3456.000   167.000  3461.000   175.000  3471.000   200.000  3480.000   240.000     0.000     0.000

X1    49.500     8.000   117.000   152.000  2506.000  2506.000  2506.000     0.000     0.000     0.000
GR  3496.000     0.000  3494.000    10.000  3475.000   117.000  3469.000   127.000  3466.000   135.000
GR  3467.000   140.000  3476.000   152.000  3496.000   190.000     0.000     0.000     0.000     0.000
EJ     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
1
 14 MAY 85    15:44:26                                                                    PAGE    3
```

Part B of DSS pathname.

```
                                                       THIS RUN EXECUTED 14 MAY 85   15:44:40
**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
**************************************************


T1
T2
T3     SILVER CREEK

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC    HVINS    Q        WSEL      FQ

       0.       3.       0.       0.  0.005700    0.00      0.0       0.  3356.000    0.000

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM     ITRACE

     2.000    0.000   -1.000    0.000    0.000    0.000    0.000    0.000    0.000     0.000
```

ADDITIONAL OUTPUT

```
1
 14 MAY 85    15:44:26                                                                        PAGE   16



                                                                   THIS RUN EXECUTED 14 MAY 85   15:45:04
***************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
***************************************************


NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST


SILVER CREEK

SUMMARY PRINTOUT
```

User defined table (J3 card).

```
    SECNO     CWSEL        Q        VLOB       VROB       VCH

    48.300   3434.97    500.00      4.10       0.00       4.51
    48.300   3437.07   1000.00      5.06       0.00       5.77
    48.300   3438.65   1500.00      5.64       0.00       6.59
    48.300   3439.92   2000.00      6.09       0.00       7.25
    48.300   3441.05   2500.00      6.42       0.00       7.75
    48.300   3442.04   3000.00      6.70       0.00       8.19
    48.300   3442.95   3500.00      6.93       0.00       8.56
    48.300   3443.71   4000.00      7.20       0.00       8.96
    48.300   3444.46   4500.00      7.41       0.00       9.29
    48.300   3445.15   5000.00      7.61       0.00       9.60
    48.300   3446.39   6000.00      7.97       0.00      10.17
    48.300   3448.67   8000.00      8.46       0.00      10.99
    48.300   3450.57  10000.00      8.90       0.00      11.72
    48.300   3454.47  15000.00      9.76       0.00      13.15

    48.500   3439.92    500.00      0.00       0.00       4.93
    48.500   3441.87   1000.00      0.00       0.00       5.91
    48.500   3443.37   1500.00      0.00       0.00       6.57
    48.500   3444.60   2000.00      0.00       0.00       7.07
    48.500   3445.65   2500.00      0.45       0.00       7.52
    48.500   3446.55   3000.00      0.96       0.00       7.90
    48.500   3447.37   3500.00      1.30       0.00       8.18
    48.500   3448.11   4000.00      1.55       0.00       8.38
    48.500   3448.80   4500.00      1.75       0.00       8.51
    48.500   3449.45   5000.00      2.04       0.00       8.55
    48.500   3450.64   6000.00      2.54       0.00       8.56
    48.500   3452.78   8000.00      3.18       0.00       8.55
    48.500   3454.58  10000.00      3.56       0.97       8.77
    48.500   3458.44  15000.00      4.23       2.21       9.36
```

```
1
 14 MAY 85    15:44:26                                                                                     PAGE   17

      SECNO     CWSEL       Q        VLOB      VROB       VCH

      48.800   3448.32    500.00     0.00      0.00       6.03
      48.800   3449.88   1000.00     0.00      0.00       7.51
      48.800   3451.11   1500.00     0.00      0.00       8.41
      48.800   3452.16   2000.00     0.00      0.00       9.09
      48.800   3453.07   2500.00     0.00      0.00       9.65
      48.800   3453.83   3000.00     0.00      0.00      10.22
      48.800   3454.47   3500.00     0.00      0.00      10.79
      48.800   3455.03   4000.00     0.00      0.00      11.38
      48.800   3455.49   4500.00     0.00      0.00      12.00
      48.800   3455.84   5000.00     0.00      0.00      12.72
      48.800   3456.33   6000.00     0.00      0.00      14.31
 *    48.800   3457.46   8000.00     0.00      0.00      16.59
 *    48.800   3459.19  10000.00     1.19      0.00      17.07
 *    48.800   3463.16  15000.00     3.86      0.00      16.28

      49.000   3454.75    500.00     0.00      0.00       5.32
      49.000   3456.49   1000.00     0.00      0.00       6.45
      49.000   3457.81   1500.00     0.00      0.00       7.29
      49.000   3458.90   2000.00     0.00      0.00       7.94
      49.000   3459.86   2500.00     0.00      0.00       8.47
      49.000   3460.74   3000.00     0.00      0.00       8.89
      49.000   3461.55   3500.00     0.26      0.00       9.26
      49.000   3462.27   4000.00     0.86      0.00       9.60
      49.000   3462.96   4500.00     1.24      0.00       9.85
      49.000   3463.63   5000.00     1.54      0.00       9.99
      49.000   3464.90   6000.00     1.96      0.00      10.03
      49.000   3466.97   8000.00     2.92      0.00       9.88
      49.000   3468.49  10000.00     3.52      0.00      10.10
      49.000   3470.83  15000.00     4.74      0.00      11.60

      49.500   3469.34    500.00     0.00      0.00       5.98
      49.500   3470.97   1000.00     0.00      0.00       7.33
      49.500   3472.25   1500.00     0.00      0.00       8.17
      49.500   3473.33   2000.00     0.00      0.00       8.81
      49.500   3474.27   2500.00     0.00      0.00       9.33
      49.500   3475.09   3000.00     0.00      0.00       9.80
      49.500   3475.84   3500.00     0.00      0.00      10.22
      49.500   3476.48   4000.00     0.00      0.00      10.70
      49.500   3476.98   4500.00     0.73      0.00      11.24
      49.500   3477.40   5000.00     1.10      0.00      11.83
      49.500   3478.01   6000.00     1.64      0.00      13.17
      49.500   3478.63   8000.00     2.45      0.00      16.33
 *    49.500   3480.11  10000.00     3.41      0.00      17.30
 *    49.500   3483.44  15000.00     4.93      0.00      18.64
```

Rating curve for "RCH 1" with improved channel conditions. Stored in DSS file.

```
1
 14 MAY 85    15:44:26                                                                              PAGE   18

SILVER CREEK

SUMMARY PRINTOUT TABLE  150

     SECNO     XLCH      ELTRD      ELLC      ELMIN        Q        CWSEL      CRIWS       EG       10K*S      VCH      AREA      .01K

    48.300     0.00      0.00      0.00    3430.00    500.00    3434.97      0.00    3435.24     56.06      4.51    120.19     66.78
    48.300     0.00      0.00      0.00    3430.00   1000.00    3437.07      0.00    3437.50     57.26      5.77    192.30    132.15
    48.300     0.00      0.00      0.00    3430.00   1500.00    3438.65      0.00    3439.19     57.08      6.59    256.50    198.54
    48.300     0.00      0.00      0.00    3430.00   2000.00    3439.92      0.00    3440.56     57.52      7.25    314.32    263.71
    48.300     0.00      0.00      0.00    3430.00   2500.00    3441.05      0.00    3441.77     56.94      7.75    370.55    331.32
    48.300     0.00      0.00      0.00    3430.00   3000.00    3442.04      0.00    3442.83     56.75      8.19    423.41    398.25
    48.300     0.00      0.00      0.00    3430.00   3500.00    3442.95      0.00    3443.82     56.17      8.56    475.42    467.02
    48.300     0.00      0.00      0.00    3430.00   4000.00    3443.71      0.00    3444.66     57.07      8.96    521.00    529.49
    48.300     0.00      0.00      0.00    3430.00   4500.00    3444.46      0.00    3445.47     57.17      9.29    567.45    595.14
    48.300     0.00      0.00      0.00    3430.00   5000.00    3445.15      0.00    3446.22     57.35      9.60    612.26    660.27
    48.300     0.00      0.00      0.00    3430.00   6000.00    3446.39      0.00    3447.59     57.94     10.17    697.22    788.25
    48.300     0.00      0.00      0.00    3430.00   8000.00    3448.67   3443.22    3450.06     56.93     10.99    867.11   1060.25
    48.300     0.00      0.00      0.00    3430.00  10000.00    3450.57   3444.75    3452.14     56.89     11.72   1022.54   1325.82
    48.300     0.00      0.00      0.00    3430.00  15000.00    3454.47   3448.01    3456.42     56.80     13.15   1380.98   1990.26

    48.500  1056.00      0.00      0.00    3436.00    500.00    3439.92      0.00    3440.30     41.26      4.93    101.39     77.84
    48.500  1056.00      0.00      0.00    3436.00   1000.00    3441.87      0.00    3442.42     38.44      5.91    169.21    161.29
    48.500  1056.00      0.00      0.00    3436.00   1500.00    3443.37      0.00    3444.04     37.48      6.57    228.35    245.01
    48.500  1056.00      0.00      0.00    3436.00   2000.00    3444.60      0.00    3445.38     36.86      7.07    282.95    329.41
    48.500  1056.00      0.00      0.00    3436.00   2500.00    3445.65      0.00    3446.53     36.29      7.52    334.91    415.01
```

Required table.

ADDITIONAL OUTPUT

Verification of rating curves written to DSS file.

```
 14 MAY 85    15:45:20                                                                                  PAGE    1


   LIST OF HECDSS PATHNAMES WRITTEN


-----DSS---ZWRITE FILE  71, VERS.   2   /SILVER CREEK/48.300/ELEV-FLOW///CHIMP-20FT BW/
-----DSS---ZWRITE FILE  71, VERS.   2   /SILVER CREEK/48.500/ELEV-FLOW///CHIMP-20FT BW/
-----DSS---ZWRITE FILE  71, VERS.   2   /SILVER CREEK/48.800/ELEV-FLOW///CHIMP-20FT BW/
-----DSS---ZWRITE FILE  71, VERS.   2   /SILVER CREEK/49.000/ELEV-FLOW///CHIMP-20FT BW/
-----DSS---ZWRITE FILE  71, VERS.   2   /SILVER CREEK/49.500/ELEV-FLOW///CHIMP-20FT BW/
               -----DSS---ZCLOSE FILE   71
                          NO. RECORDS=      10
                          FILE SIZE=      1970 WORDS,      18 SECTORS
                          PERCENT INACTIVE=  0.00
1
 14 MAY 85    15:45:21                                                                                  PAGE    1


                                                                        THIS RUN EXECUTED 14 MAY 85   15:45:21

**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
**************************************************



STOP
```

DSSUTL

1. *Catalog HEC-2 DSS file.*
2. *Copy rating curve for improved channel into the master DSS file.*
3. *Catalog the master DSS file.*

```
HLIB*DSSUTLX
ENTER DSS FILE NAME
FILE = SLVAA2Z
                -----DSS---ZOPEN EXISTING FILE OPENED   71  0000A10C*SLVAA2Z
```

HEC-2 intermediate DSS file.

```
U>CA.N
CATALOG FILE = 0000A10C*SLVAA2ZC
```

"New" catalog.

```
    HECDSS COMPLETE CATALOG OF RECORD PATHNAMES ON FILE  0000A10C SLVAA2Z

    CATALOG DATE = 14MAY85,  TIME = 17:18:12    FILE CREATED ON 10MAY85;   VERSION 4-CA
    NUMBER OF RECORDS =   10
    SORT ORDER = ABCFED


  REF              WRITTEN
  NO.  PROG    DATE      TIME    VER HEAD  DATA              RECORD PATHNAME

    1  HEC2  10MAY85  16:57:23   1   34    28    /SILVER CREEK/48.300/ELEV-FLOW///BASE/
    2  HEC2  14MAY85  15:44:28   2   34    28    /SILVER CREEK/48.300/ELEV-FLOW///CHIMP-20FT BW/
    3  HEC2  10MAY85  16:57:23   1   34    28    /SILVER CREEK/48.500/ELEV-FLOW///BASE/
    4  HEC2  14MAY85  15:44:28   2   34    28    /SILVER CREEK/48.500/ELEV-FLOW///CHIMP-20FT BW/
    5  HEC2  10MAY85  16:57:23   1   34    28    /SILVER CREEK/48.800/ELEV-FLOW///BASE/
    6  HEC2  14MAY85  15:44:28   2   34    28    /SILVER CREEK/48.800/ELEV-FLOW///CHIMP-20FT BW/
    7  HEC2  10MAY85  16:57:23   1   34    28    /SILVER CREEK/49.000/ELEV-FLOW///BASE/
    8  HEC2  14MAY85  15:44:28   2   34    28    /SILVER CREEK/49.000/ELEV-FLOW///CHIMP-20FT BW/

PUSH CARRIAGE RETURN TO CONTINUE, OR ENTER NEW COMMAND
U>
    9  HEC2  10MAY85  16:57:23   1   34    28    /SILVER CREEK/49.500/ELEV-FLOW///BASE/
   10  HEC2  14MAY85  15:44:28   2   34    28    /SILVER CREEK/49.500/ELEV-FLOW///CHIMP-20FT BW/
```

Copy rating curve at section 49.000 for improved channel condition into the master DSS file.

```
U>COPY SILVAAEZ B=49.000 F=CHIMP-20FT BW
FILE DOES NOT EXIST  SILVAAEZ
```

Wrong DSS filename; its not fatal!

```
GENERATED RANDOM ACCESS FILE SILVAAEZ
                -----DSS---ZOPEN      NEW FILE OPENED   72  0000A10C*SILVAAEZ
RECORD COPIED: /SILVER CREEK/49.000/ELEV-FLOW///CHIMP-20FT BW/

U>COPY SLVAAEZ B=49.000 F=CHIMP-20FT BW
```

Copy it into the proper DSS file.

```
                -----DSS---ZCLOSE FILE   72
                        NO. RECORDS=       1
                        FILE SIZE=       362 WORDS,      4 SECTORS
                        PERCENT INACTIVE=  0.00
                -----DSS---ZOPEN EXISTING FILE OPENED   72  0000A10C*SLVAAEZ
RECORD COPIED: /SILVER CREEK/49.000/ELEV-FLOW///CHIMP-20FT BW/
```

"open" the master DSS file.

```
U>OP SLVAAEZ
               -----DSS---ZCLOSE FILE   71
                          NO. RECORDS=       1
                          FILE SIZE=      384 WORDS,      4 SECTORS
                          PERCENT INACTIVE=  0.00
               -----DSS---ZOPEN EXISTING FILE OPENED   71  0000A10C*SLVAAEZ
               -----DSS---ZCLOSE FILE   72
                          NO. RECORDS=       8
                          FILE SIZE=     1832 WORDS,     17 SECTORS
                          PERCENT INACTIVE=  0.00
U>CA.N
```

Get a "new" catalog listing of master DSS file.

```
CATALOG FILE = 0000A10C*SLVAAEZC


   HECDSS COMPLETE CATALOG OF RECORD PATHNAMES ON FILE  0000A10C SLVAAEZ

   CATALOG DATE = 14MAY85,  TIME = 17:21:18    FILE CREATED ON 10MAY85;   VERSION 4-CA
   NUMBER OF RECORDS =    8
   SORT ORDER = ABCFED


 REF          WRITTEN
 NO.  PROG    DATE     TIME    VER HEAD  DATA              RECORD PATHNAME

   1  HEC2  10MAY85  16:57:23   1   34    28    /SILVER CREEK/49.000/ELEV-FLOW//BASE/
   2  HEC2  14MAY85  15:44:28   2   34    28    /SILVER CREEK/49.000/ELEV-FLOW///CHIMP-20FT BW/
   3  SID   10MAY85  16:59:49   1   42    72    /SILVER CREEK/RCH 1/ELEVATION-DAMAGE///BASE/
   4  SID   14MAY85  15:31:20   1   42    72    /SILVER CREEK/RCH 1/ELEVATION-DAMAGE///FP-3 FT/
   5  HEC1  14MAY85  15:43:10   3   30    18    /SILVER CREEK/RCH 1/FREQ-FLOW///BASE/
   6  PIP   14MAY85  14:53:39   6   34    32    /SILVER CREEK/RCH 1/FREQ-FLOW///EXISTING-INPUT/
   7  HEC5  14MAY85  17:07:13   3   42    36    /SILVER CREEK/RCH 1/FREQ-FLOW///GATED RES/
   8  HEC1  14MAY85  15:43:10   2   30    18    /SILVER CREEK/RCH 1/FREQ-FLOW///UNGTD RES/

U>FI
               -----DSS---ZCLOSE FILE   71
                          NO. RECORDS=       8
                          FILE SIZE=     1832 WORDS,     17 SECTORS
                          PERCENT INACTIVE=  0.00
STOP
```

Master DSS data file now contains all the required relationships to compute expected annual damage for the 5 desired plans.

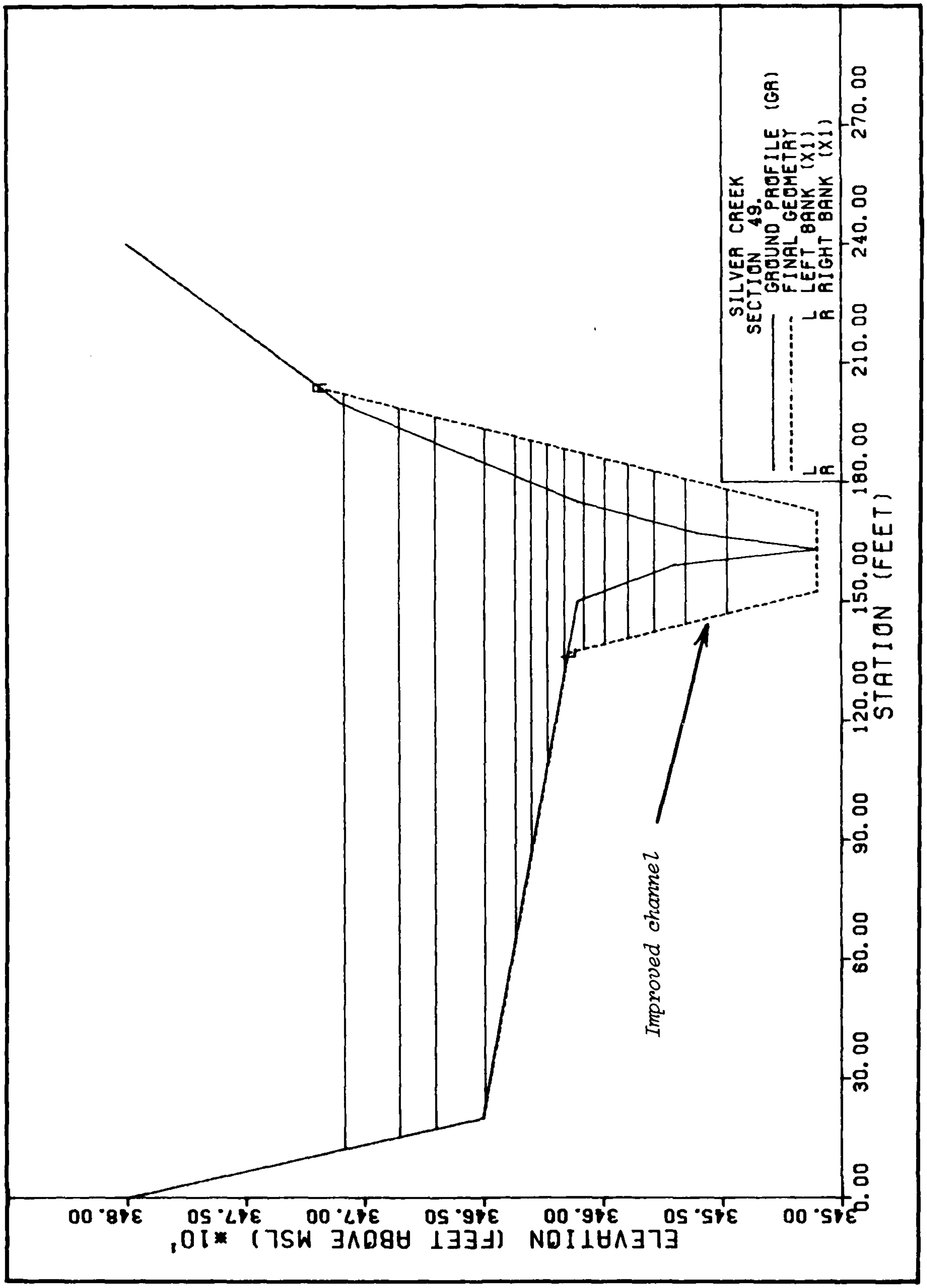


Figure 10 Channel Improvement at River Mile 49.0

n. Floodproof structures.

The floodproofing alternative plan is easily modeled using the SID program. The SID base condition input deck is modified to indicate:

a. Floodproofing of all structures
b. Floodproofing to three foot depth for both categories
c. Part F of the DSS pathname is changed to: "FP-3 FT" The SID program calculates a modified elevation-damage relationship for RCH 1 and writes it to the master DSS file "SLVAAEZ". Selected portions of the SID output are shown below.

III Flood Proofing

```
===> HLIB*SIDX,INPUT=SLVA1SI,TAPE71=SLVAAEZ
```

Master DSS file.

First alternative input for SID.

```
1


                         LIST OF INPUT CARDS FOR THIS RUN


CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   T1      SILVER CREEK
   T2
   T3
   J1     0       3       0               0       0               0       0       0
   J2     4       2       1       1       0       1      18       1       0
   J5     2 RESDNTL COMERCL
   J6             3       3
   ZW SILVER CREEK  FP-3 FT
   DF   RS1       5       1       0
   DP    -2       0       2       6      15
   DD     0      15      25      42      80
   DF   RS2       5       1       0
   DP    -2       0       2       6      15
   DD     0       0      30      40      40
   DF   CM1       4       1       0
   DP     0       1      10      15
   DD     0      10      12      30
   DF   CM2       3       1       0
   DP     0       5      10
   DD     0     160     180
   DC       RESDNTL                RESIDENTIAL STRUCTURE AND CONTENTS
   DC       COMERCL                COMMERCIAL STRUCTURE AND CONTENTS
   DR RCH 1  3466.5                            3462     0.5
   DT      DAMAGE REACH 1 FOR RIVERTON
   SL RCH 1    R001                  3464.8  3463.8      -2       0
   SD RCH 1    R001 RESDNTLRS1  130RS2  -50
   SL RCH 1    C001                  3465.9  3462.4
   SD RCH 1    C001 COMERCLCM1   60CM2  250
   ES
```

3 feet floodproofing, both categories.

Part F of DSS pathname. Must be different than base condition otherwise this run will overwrite it.

ADDITIONAL OUTPUT

```
1                SILVER CREEK



                 ORDER OF ACTION
                 ---------------

                 IOA(1)  =     1, RUN  RAISING STRUCTURES FIRST

                 IOA(2)  =     2, RUN    FLOODPROOFING    SECOND

                 IOA(3)  =     3, RUN      RELOCATION     LAST

1                SILVER CREEK



                 FILE SYSTEM CARD
                 ----------------
CC 1234567890123456789012345678901234567890123456789012345678901234567890
 ZW SILVER CREEK  FP-3 FT

                 FILE SYSTEM INFORMATION - A FILE WILL BE CREATED TO PASS DEPTH-DAMAGE DATA TO OTHER
                 -----------------------   HEC PROGRAMS USING THE HEC DATA STORAGE SYSTEM (HECDSS).

                 PROJ    =     SILVER CREEK

                 ALT     =     FP-3 FT

                 YEAR    =

               -----DSS---ZOPEN EXISTING FILE OPENED   71  0000A10C*SLVAAEZ
```

Part F of DSS pathname.

ADDITIONAL OUTPUT

Elevation-damage relationship written to DSS file for flood-proofing alternative.

Part B of DSS pathname.

```
1
                              SILVER CREEK

                                             DAMAGE REACH  RCH 1
                                    DAMAGE REACH 1 FOR RIVERTON
                                           ( DAMAGES ARE IN $1000 )

                                                  DAMAGE CATEGORIES
*************************************************************************************************************
*   WATER   *          *          *          *          *          *          *          *          *          *          *          *
*  SURFACE  * RESDNTL  * COMERCL  *  OTHER   *          *          *          *          *          *          *          *   TOTAL  *
* ELEVATION *          *          *          *          *          *          *          *          *          *          *          *
*************************************************************************************************************
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3462.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3462.5  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3463.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3463.5  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3464.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3464.5  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3465.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3465.5  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3466.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3466.5  *     0.0  *   122.6  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   122.6  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3467.0  *    45.0  *   138.7  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   183.7  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3467.5  *    55.0  *   154.8  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   209.8  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3468.0  *    58.4  *   170.9  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   229.3  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3468.5  *    61.8  *   173.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   234.7  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3469.0  *    65.1  *   175.1  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   240.2  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3469.5  *    68.5  *   177.2  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   245.7  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3470.0  *    71.9  *   179.3  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   251.2  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*   3470.5  *    75.2  *   181.4  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *     0.0  *   256.7  *
*           *          *          *          *          *          *          *          *          *          *          *          *
*************************************************************************************************************
```

```
                   DAMAGE CATEGORY  RESDNTL IDENTIFIED AS RESIDENTIAL STRUCTURE AND CONTENTS
                   DAMAGE CATEGORY  COMERCL IDENTIFIED AS COMMERCIAL STRUCTURE AND CONTENTS
                   DAMAGE CATEGORY    OTHER IDENTIFIED AS  OTHER DAMAGE CATEGORIES
1
                                SILVER CREEK



 -----DSS---ZWRITE FILE  71, VERS.   1   /SILVER CREEK/RCH 1/ELEVATION-DAMAGE///FP-3 FT/
                  -----DSS---ZCLOSE FILE   71
                              NO. RECORDS=        5
                              FILE SIZE=       1376 WORDS,      13 SECTORS
                              PERCENT INACTIVE=  0.00

R
 STOP
```

Confirmation that elevation-damage relationship for floodproofing alternative is written to the DSS file.

o. Compute the expected annual damage for all alternatives.

The EAD program will easily compute the inundation reduction benefits for the four alternative plans. All of the basic relationships are stored in the master DSS file "SLVAAEZ". The EAD input data file is enlarged to include five "PN" cards (one for each plan), seven "ZR" cards, and the additional data cards to read the parametric relationships from the DSS file for each plan. The selected portions of the EAD output are listed below. The analyst need not enter a "ZR" card for each relationship for each plan. This is demonstrated in the EAD output below. For example, the base condition flow-frequency curve is used for plans one, four, and five. "ZR" cards referencing the frequency curves are entered for plans 1, 2, and 3. The "QF" cards for plans 4 and 5 actually reference the "ZR" card for plan one (base condition). When referencing a relationship for a previous plan like this, it is good practice to enter the plan number in the first field of every "EP" (or "EJ") card so that the output will be properly labeled. Figure 11 is a plot of the damage-exceedance frequency relationship that result for each of the alternative plans. Similar plots may be produced for any of the data items involved in the damage computation process.

EAD Compare 5 Plans

```
===> HLIB*EADX,INPUT=SLVAAEI,TAPE71=SLVAAEZ
```

Master DSS file.

```
1+++++++++++++++++++++++++++++++++++++++++++++
+ EXPECTED ANNUAL FLOOD DAMAGE COMPUTATION +
+ 761-X6-L7580             FEBRUARY     1984 +
+ VERSION DATE             MARCH    5, 1985 +
++++++++++++++++++++++++++++++++++++++++++++++


** LIST OF RECORDS READ BY READIN **
RECORD
 ORDER          1         2         3         4         5         6         7         8
NUMBER 12345678901234567890123456789012345678901234567890123456789012345678901234567890

     1 TT      SILVER CREEK
     2 CN     2RESIDNTL COMERCL
     3 PN     1 EXISTING CONDITIONS
     4 PN     2 UNGATED RESERVOIR
     5 PN     3 GATED RESERVOIR
     6 PN     4 FLOOD PROOFING ALL STRUCTURES BY 3 FEET
     7 PN     5 IMPROVING THE CHANNEL BOTTOM WID[illegible]) FEET
     8 ZR SILVER CREEK  BASE                         QF       1
     9 ZR SILVER CREEK  BASE                         QS       1
    10 ZR SILVER CREEK  BASE                         DG       1
    11 ZR SILVER CREEK  UNGTD RES                    QF       2
    12 ZR SILVER CREEK  GATED RES                    QF       3
    13 ZRSILVER CREEK  FP-3 FT                       DG       4
    14 ZRSILVER CREEK  CHIMP-20FT BW                 QS       5
    15 RN REACH 1,  RIVERTON
    16 FR RCH 1      18      90      70      50      40      35      30      25      20
    17 FR    15      10       7       5       3       2       1     0.5     0.2     0.1
    18 QF RCH 1     1        -1
    19 QS49.000     1        -1
    20 DG RCH 1     1 1      -1
    21 EP     1
    22 QF RCH 1     2        -1
    23 EP     2
    24 QF RCH 1     3        -1
    25 EP     3
    26 QF RCH 1     1        -1
    27 DG RCH 1     4 1      -1
    28 EP     4
    29 DG RCH 1     1 1       1
    30 QS49.000     5        -1
    31 EJ     5

READIN --     31 RECORDS WRITTEN TO LOGICAL FILE  8
```

Base condition frequency curve (plans 4 and 5).

```
1++++++++++++++++++++++++++++++++++++++++++++
+ EXPECTED ANNUAL FLOOD DAMAGE COMPUTATION +
+ 761-X6-L7580          FEBRUARY    1984 +
+ VERSION DATE          MARCH    5, 1985 +
++++++++++++++++++++++++++++++++++++++++++++


TT      SILVER CREEK

**DAMAGE CATEGORY NAMES**
CN   2  RESIDNTL COMERCL

**FLOOD PLAIN MANAGEMENT PLAN NAMES**
PN   1   EXISTING CONDITIONS
PN   2   UNGATED RESERVOIR
PN   3   GATED RESERVOIR
PN   4   FLOOD PROOFING ALL STRUCTURES BY 3 FEET
PN   5   IMPROVING THE CHANNEL BOTTOM WIDTH TO 20 FEET

**FILE SYSTEM READ**
ZR SILVER CREEK  BASE                     QF       1
ZR SILVER CREEK  BASE                     QS       1
ZR SILVER CREEK  BASE                     DG       1
ZR SILVER CREEK  UNGTD RES                QF       2
ZR SILVER CREEK  GATED RES                QF       3
ZRSILVER CREEK  FP-3 FT                   DG       4
ZRSILVER CREEK  CHIMP-20FT BW             QS       5

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

REACH   1, REACH NAME -
RN REACH 1,  RIVERTON

++++ INPUT DATA ++++

**FREQUENCIES**
FR RCH 1       18   90.00   70.00   50.00   40.00   35.00   30.00   25.00   20.00
   15.00   10.00    7.00    5.00    3.00    2.00    1.00    0.50    0.20    0.10

**FREQUENCIES READ FROM HECDSS FILE**
FR RCH 1   0 1 0   72.43   14.18    5.94    2.37    1.06    0.85    0.27    0.13
    0.05

**FLOOD PEAKS READ FROM HECDSS FILE**
QF RCH 1        9   1240.   2322.   2875.   3602.   4277.   4560.   6263.   7403.
   9118.

**INTERPOLATED FLOOD PEAKS**
QF RCH 1   0 1 0  974.58 1271.62 1536.06 1687.73 1774.03 1870.92 1982.91 2117.52
   2289.   2534.   2764.   3000.   3408.   3737.   4348.   5315.   6704.   7790.
```

Interpolation of flow values for specified exceedance frequencies.

```
**STAGES FOR RATING CURVE**
SQ49.000      14 3459.69 3461.93 3463.44 3464.65 3465.65 3466.39 3467.12 3467.76
 3467.97 3468.30 3468.82 3470.25 3471.59 3473.97

**FLOWS FOR RATING CURVE**
QS49.000    0 1 0  500.00 1000.00 1500.00 2000.00 2500.00 3000.00 3500.00 4000.00
   4500.   5000.   6000.   8000.  10000.  15000.

**STAGES FOR DAMAGE DATA**
SD RCH 1       18 3462.00 3462.50 3463.00 3463.50 3464.00 3464.50 3465.00 3465.50
 3466.00 3466.50 3467.00 3467.50 3468.00 3468.50 3469.00 3469.50 3470.00 3470.50

**FLOOD DAMAGE DATA**
DG RCH 1    0 1 1    0.00    0.00    0.00    0.00    3.75    7.50   11.25   15.00
   25.00   35.00   45.00   55.00   58.38   61.75   65.13   68.50   71.87   75.25

**FLOOD DAMAGE DATA**
DG RCH 1        2    0.00    0.00    0.00   21.00   42.00   58.11   74.22   90.33
  106.44  122.56  138.67  154.78  170.89  173.00  175.11  177.22  179.33  181.44

**END OF INPUT DATA FOR PLAN  1 ** <------------------------------------------- Base Condition.
EP++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

++DAMAGE DATA FOR PLAN 1 --  EXISTING CONDITIONS

      FREQ       FLOW      STAGE  RESIDNTL    COMERCL     TOTAL    ACC EAD
   1  90.00       975.   3461.81      0.00       0.00      0.00      42.51
   2  70.00      1272.   3462.75      0.00       0.00      0.00      42.51
   3  50.00      1536.   3463.52      0.18      22.02     22.20      41.00
   4  40.00      1688.   3463.89      2.93      37.43     40.36      37.89
   5  35.00      1774.   3464.10      4.50      45.22     49.72      35.63
   6  30.00      1871.   3464.33      6.26      52.77     59.03      32.92
   7  25.00      1983.   3464.61      8.29      61.50     69.79      29.70
   8  20.00      2118.   3464.88     10.37      70.46     80.83      25.94
   9  15.00      2289.   3465.23     12.96      81.59     94.55      21.57
  10  10.00      2534.   3465.70     19.08      96.90    115.98      16.37
  11   7.00      2764.   3466.04     25.86     107.84    133.70      12.64
  12   5.00      3000.   3466.39     32.86     119.10    151.96       9.80
  13   3.00      3408.   3466.99     44.77     138.29    183.06       6.48
  14   2.00      3737.   3467.43     53.53     152.41    205.93       4.54
  15   1.00      4348.   3467.91     57.76     167.96    225.72       2.37
  16   0.50      5315.   3468.47     61.53     172.86    234.39       1.21
  17   0.20      6704.   3469.32     67.29     176.47    243.76       0.50
  18   0.10      7790.   3470.10     72.52     179.74    252.26       0.25

EXP ANNUAL DAMAGE                     6.47      36.04     42.51
```

```
1
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

REACH   1, REACH NAME -
RN REACH 1,  RIVERTON

++++ INPUT DATA ++++

**FREQUENCIES READ FROM HECDSS FILE**
FR RCH 1   0 2 0   72.43    14.18     5.94     2.37     1.06     0.85     0.27     0.13
    0.05

**FLOOD PEAKS READ FROM HECDSS FILE**
QF RCH 1        9    908.    1745.    2316.    3043.    3723.    4021.    5607.    6597.
   8134.

**INTERPOLATED FLOOD PEAKS**
QF RCH 1   0 2 0  720.79   930.16  1119.40  1231.86  1297.40  1372.46  1461.25  1571.02
   1716.    1952.    2199.    2443.    2849.    3179.    3798.    4742.    5994.    6939.

**END OF INPUT DATA FOR PLAN  2 **
EP+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

++DAMAGE DATA FOR PLAN 2 --  UNGATED RESERVOIR

      FREQ      FLOW     STAGE  RESIDNTL   COMERCL     TOTAL   ACC EAD
  1  90.00      721.   3460.68      0.00      0.00      0.00     18.18
  2  70.00      930.   3461.61      0.00      0.00      0.00     18.18
  3  50.00     1119.   3462.29      0.00      0.00      0.00     18.18
  4  40.00     1232.   3462.63      0.00      0.00      0.00     18.18
  5  35.00     1297.   3462.82      0.00      0.00      0.00     18.18
  6  30.00     1372.   3463.05      0.00      2.17      2.17     18.17
  7  25.00     1461.   3463.32      0.00     13.44     13.44     17.79
  8  20.00     1571.   3463.61      0.82     25.57     26.39     16.80
  9  15.00     1716.   3463.96      3.44     40.29     43.73     15.08
 10  10.00     1952.   3464.53      7.73     59.11     66.84     12.36
 11   7.00     2199.   3465.05     11.61     75.75     87.35     10.06
 12   5.00     2443.   3465.54     15.77     91.57    107.34      8.13
 13   3.00     2849.   3466.17     28.40    111.91    140.31      5.67
 14   2.00     3179.   3466.65     38.08    127.52    165.60      4.15
 15   1.00     3798.   3467.50     55.03    154.93    209.97      2.30
 16   0.50     4742.   3458.13     59.27    171.45    230.73      1.19
 17   0.20     5994.   3468.82     63.89    174.34    238.23      0.49
 18   0.10     6939.   3469.49     68.43    177.18    245.61      0.25

EXP ANNUAL DAMAGE                   2.76     15.43     18.18
```

← *Ungated reservoir - new frequency curve computed by HEC-1.*

```
1
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

REACH   1, REACH NAME -
RN REACH 1,  RIVERTON

++++ INPUT DATA ++++

**FREQUENCIES READ FROM HECDSS FILE**
FR RCH 1   0 3 0   80.80   31.99    7.39    2.98    1.29    0.85    0.18    0.05
    0.01

**FLOOD PEAKS READ FROM HECDSS FILE**
QF RCH 1       9   1004.   1499.   1631.   3048.   3658.   3480.   6327.   8147.
  10094.

**INTERPOLATED FLOOD PEAKS**
QF RCH 1   0 3 0  859.66 1143.15 1358.00 1444.88 1480.85 1509.72 1531.39 1548.24
   1565.   1596.   1648.   2073.   3040.   3446.   3536.   4027.   6168.   7159.

**END OF INPUT DATA FOR PLAN  3 **
EP++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

++DAMAGE DATA FOR PLAN 3 --  GATED RESERVOIR

       FREQ      FLOW     STAGE  RESIDNTL    COMERCL     TOTAL    ACC EAD
  1   90.00      860.   3461.30      0.00       0.00      0.00      17.02
  2   70.00     1143.   3462.36      0.00       0.00      0.00      17.02
  3   50.00     1358.   3463.01      0.00       0.34      0.34      17.01
  4   40.00     1445.   3463.27      0.00      11.36     11.36      16.41
  5   35.00     1481.   3463.38      0.00      15.93     15.93      15.73
  6   30.00     1510.   3463.46      0.00      19.34     19.34      14.84
  7   25.00     1531.   3463.51      0.10      21.54     21.64      13.81
  8   20.00     1548.   3463.55      0.40      23.26     23.66      12.68
  9   15.00     1565.   3463.59      0.71      24.98     25.69      11.45
 10   10.00     1596.   3463.67      1.26      28.07     29.33      10.08
 11    7.00     1648.   3463.79      2.21      33.38     35.59       9.13
 12    5.00     2073.   3464.79      9.70      67.56     77.26       8.08
 13    3.00     3040.   3466.45     34.00     120.95    154.95       5.81
 14    2.00     3446.   3467.04     45.87     140.07    185.94       4.09
 15    1.00     3536.   3467.17     48.36     144.09    192.45       2.20
 16    0.50     4027.   3467.77     56.85     163.61    220.46       1.18
 17    0.20     6168.   3468.94     64.72     174.86    239.58       0.49
 18    0.10     7159.   3469.65     69.49     177.84    247.32       0.25

EXP ANNUAL DAMAGE                    2.08      14.94     17.02
```

Gated reservoir - new frequency curve computed by HEC-5.

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

REACH   1, REACH NAME -
RN REACH 1,  RIVERTON

++++ INPUT DATA ++++

**FREQUENCIES READ FROM HECDSS FILE**
FR RCH 1   0 1 0   72.43   14.18    5.94    2.37    1.06    0.85    0.27    0.13
    0.05

**FLOOD PEAKS READ FROM HECDSS FILE**
QF RCH 1       9   1240.   2322.   2875.   3602.   4277.   4560.   6263.   7403.
   9118.

**INTERPOLATED FLOOD PEAKS**
QF RCH 1   0 1 0  974.58 1271.62 1536.06 1687.73 1774.03 1870.92 1982.91 2117.52
   2289.   2534.   2764.   3000.   3408.   3737.   4348.   5315.   6704.   7790.

**STAGES FOR DAMAGE DATA**
SD RCH 1      18 3462.00 3462.50 3463.00 3463.50 3464.00 3464.50 3465.00 3465.50
 3466.00 3466.50 3467.00 3467.50 3468.00 3468.50 3469.00 3469.50 3470.00 3470.50

**FLOOD DAMAGE DATA**
DG RCH 1   0 4 1    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
    0.00    0.00   45.00   55.00   58.38   61.75   65.13   68.50   71.87   75.25

**FLOOD DAMAGE DATA**
DG RCH 1       2    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
    0.00  122.56  138.67  154.78  170.89  173.00  175.11  177.22  179.33  181.44

**END OF INPUT DATA FOR PLAN  4 **
EP++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

Base condition frequency curve read from DSS file again.

New elevation-damage relationships for floodproofing as computed by SID.

```
++DAMAGE DATA FOR PLAN 4 --  FLOOD PROOFING ALL STRUCTURES BY 3 FEET

       FREQ      FLOW     STAGE  RESIDNTL    COMERCL     TOTAL    ACC EAD
   1  90.00      975.   3461.81      0.00       0.00      0.00      10.31
   2  70.00     1272.   3462.75      0.00       0.00      0.00      10.31
   3  50.00     1536.   3463.52      0.00       0.00      0.00      10.31
   4  40.00     1688.   3463.89      0.00       0.00      0.00      10.31
   5  35.00     1774.   3464.10      0.00       0.00      0.00      10.31
   6  30.00     1871.   3464.33      0.00       0.00      0.00      10.31
   7  25.00     1983.   3464.61      0.00       0.00      0.00      10.31
   8  20.00     2118.   3464.88      0.00       0.00      0.00      10.31
   9  15.00     2289.   3465.23      0.00       0.00      0.00      10.31
  10  10.00     2534.   3465.70      0.00       0.00      0.00      10.31
  11   7.00     2764.   3466.04      0.00      10.58     10.58      10.30
  12   5.00     3000.   3466.39      0.00      96.28     96.28       9.29
  13   3.00     3408.   3466.99     43.95     138.29    182.24       6.48
  14   2.00     3737.   3467.43     53.53     152.41    205.93       4.54
  15   1.00     4348.   3467.91     57.76     167.96    225.72       2.37
  16   0.50     5315.   3468.47     61.53     172.86    234.39       1.21
  17   0.20     6704.   3469.32     67.29     176.47    243.76       0.50
  18   0.10     7790.   3470.10     72.52     179.74    252.26       0.25

EXP ANNUAL DAMAGE                    2.00       8.32     10.31
```

```
1
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

REACH    1, REACH NAME -
RN REACH 1,  RIVERTON

++++ INPUT DATA ++++

**STAGES FOR DAMAGE DATA**
SD RCH 1       18 3462.00 3462.50 3463.00 3463.50 3464.00 3464.50 3465.00 3465.50
 3466.00 3466.50 3467.00 3467.50 3468.00 3468.50 3469.00 3469.50 3470.00 3470.50

**FLOOD DAMAGE DATA**
DG RCH 1    0 1 1    0.00    0.00    0.00    0.00    3.75    7.50   11.25   15.00
   25.00   35.00   45.00   55.00   58.38   61.75   65.13   68.50   71.87   75.25

**FLOOD DAMAGE DATA**
DG RCH 1        2    0.00    0.00    0.00   21.00   42.00   58.11   74.22   90.33
  106.44  122.56  138.67  154.78  170.89  173.00  175.11  177.22  179.33  181.44

**STAGES FOR RATING CURVE**
SQ49.000       14 3454.75 3456.49 3457.81 3458.90 3459.86 3460.74 3461.55 3462.27
 3462.96 3463.63 3464.90 3466.97 3468.49 3470.83

**FLOWS FOR RATING CURVE**
QS49.000    0 5 0  500.00 1000.00 1500.00 2000.00 2500.00 3000.00 3500.00 4000.00
   4500.   5000.   6000.   8000.  10000.  15000.

**END OF INPUT DATA FOR PLAN  5 **
EJ+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

++DAMAGE DATA FOR PLAN 5 --  IMPROVING THE CHANNEL BOTTOM WIDTH TO 20 FEET

      FREQ      FLOW     STAGE  RESIDNTL    COMERCL     TOTAL    ACC EAD
  1  90.00      975.   3456.41      0.00       0.00      0.00       0.61
  2  70.00     1272.   3457.21      0.00       0.00      0.00       0.61
  3  50.00     1536.   3457.89      0.00       0.00      0.00       0.61
  4  40.00     1688.   3458.22      0.00       0.00      0.00       0.61
  5  35.00     1774.   3458.41      0.00       0.00      0.00       0.61
  6  30.00     1871.   3458.62      0.00       0.00      0.00       0.61
  7  25.00     1983.   3458.87      0.00       0.00      0.00       0.61
  8  20.00     2118.   3459.13      0.00       0.00      0.00       0.61
  9  15.00     2289.   3459.46      0.00       0.00      0.00       0.61
 10  10.00     2534.   3459.92      0.00       0.00      0.00       0.61
 11   7.00     2764.   3460.33      0.00       0.00      0.00       0.61
 12   5.00     3000.   3460.74      0.00       0.00      0.00       0.61
 13   3.00     3408.   3461.40      0.00       0.00      0.00       0.61
 14   2.00     3737.   3461.89      0.00       0.00      0.00       0.61
 15   1.00     4348.   3462.75      0.00       0.00      0.00       0.61
 16   0.50     5315.   3464.03      3.96      42.90     46.86       0.53
 17   0.20     6704.   3465.63     17.59      94.51    112.10       0.31
 18   0.10     7790.   3466.75     40.07     130.73    170.80       0.17

EXP ANNUAL DAMAGE                   0.10       0.51      0.61
```

Read base condition damage relationships from DSS file again.

New rating curve for improved channel.

```
1
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
  * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

      SILVER CREEK

** SUMMARY OF REACH NAMES **

 NO     ID    . . NAME . . .
--------------------------------------------------------------------------------
  1  RCH 1     REACH 1,  RIVERTON

--------------------------------------------------------------------------------
1
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
  * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

      SILVER CREEK

** GRAND SUMMARY BY CATEGORY **

** FLOOD PLAIN MANAGEMENT PLANS
         1 -  EXISTING CONDITIONS
         2 -  UNGATED RESERVOIR
         3 -  GATED RESERVOIR
         4 -  FLOOD PROOFING ALL STRUCTURES BY 3 FEET
         5 -  IMPROVING THE CHANNEL BOTTOM WIDTH TO 20 FEET

GRAND SUMMARY - ALL DAMAGE CATEGORIES
--------------------------------------------------------------------------------------------
                . . . . . . . . . . . EXPECTED ANNUAL DAMAGE . . . . . . . . . . . . .
 DAMAGE      BASE    .... PLAN  2....  .... PLAN  3....  .... PLAN  4....  .... PLAN  5....
CATEGORY  CONDITION  DAMAGE   DAMAGE   DAMAGE   DAMAGE   DAMAGE   DAMAGE   DAMAGE   DAMAGE
           (PLAN  1) W/PLAN  REDUCED   W/PLAN  REDUCED   W/PLAN  REDUCED   W/PLAN  REDUCED
--------------------------------------------------------------------------------------------
 RESIDNTL     6.47     2.76     3.71     2.08     4.39     2.00     4.47     0.10     6.37
  COMERCL    36.04    15.43    20.62    14.94    21.11     8.32    27.73     0.51    35.54
--------------------------------------------------------------------------------------------

   TOTAL     42.51    18.18    24.33    17.02    25.50    10.31    32.20     0.61    41.91

--------------------------------------------------------------------------------------------


+++++++++++++++
END OF RUN
EAD PROGRAM STOP
+++++++++++++++
STOP
```

Inundation reduction benefit for plan 5.

Expected annual damage for plan 5.

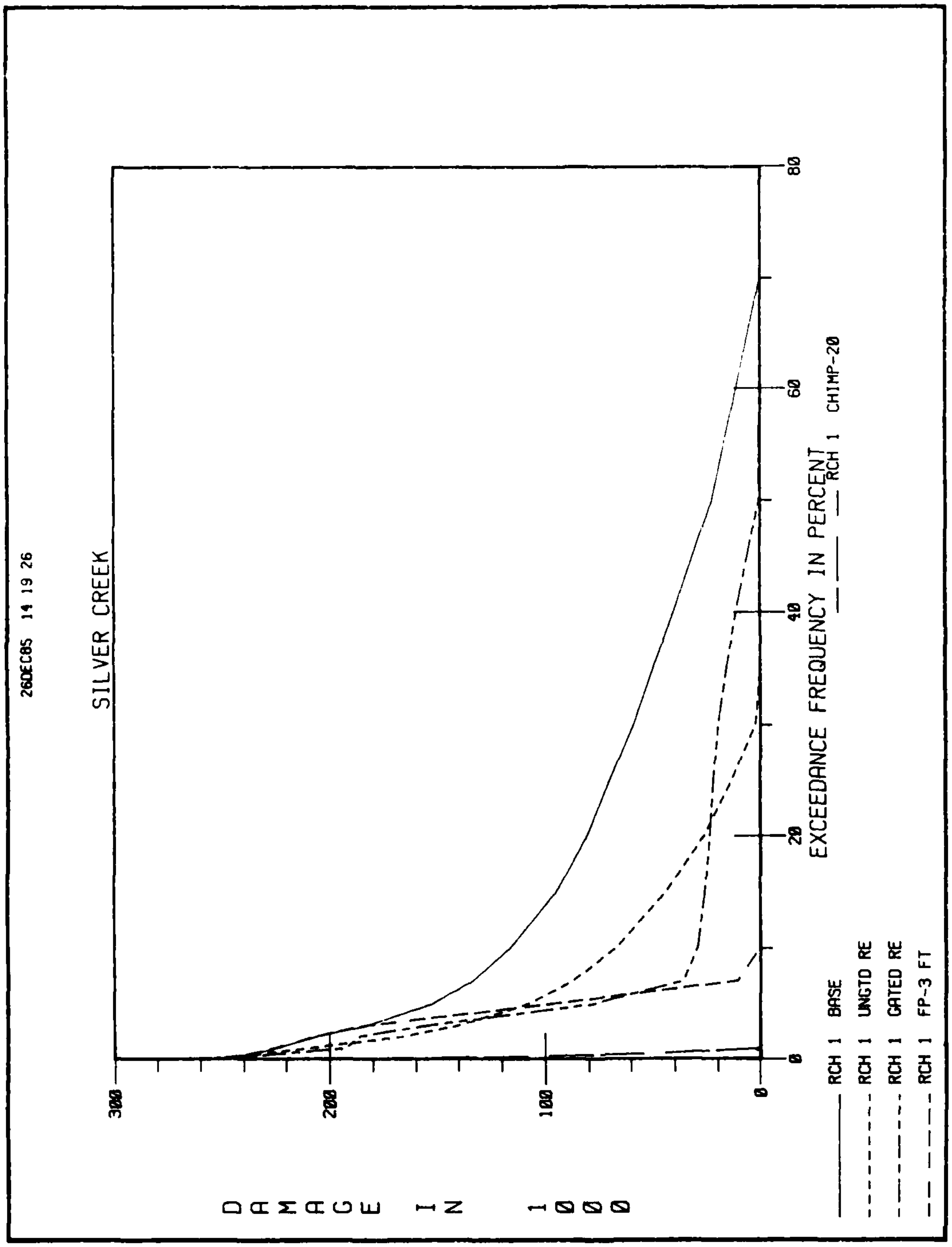


Figure 11 Damage Frequency Functions for the Base Plus Four Plans

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The Flood Damage Analysis Package document describes and illustrates the use of a set of linked hydrologic and economic computer programs developed by the Hydrologic Engineering Center (HEC). The programs are linked through data transfer provided automatically by the HEC Data Storage System. The programs collectively provide capability for flood damage analysis for the full range of structural and nonstructural flood plain management measures.

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