US Army Corps of Engineers
Hydrologic Engineering Center

Hydrologic Engineering Center Project Benefit Accomplishment Package (HEC-PBA)

September 1994

19961018 085

Approved for Public Release. Distribution Unlimited.

CPD-67

DTIC QUALITY INSPECTED 3

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION / AVAILABILITY OF REPORT Distribution of this document is unlimited.
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Computer Program Document No. 67	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Hydrologic Engineering Center 6b. OFFICE SYMBOL (If applicable) CEWRC-HEC	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) 609 Second Street Davis, California 95616-4687	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING / SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
Hydrologic Engineering Center Project Benefit Accomplishment Package (HEC-PBA)

12. PERSONAL AUTHOR(S)
Donna M. Lydon and Penni R. Baker

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM _____ TO _____	1994 September	154

16. SUPPLEMENTARY NOTATION

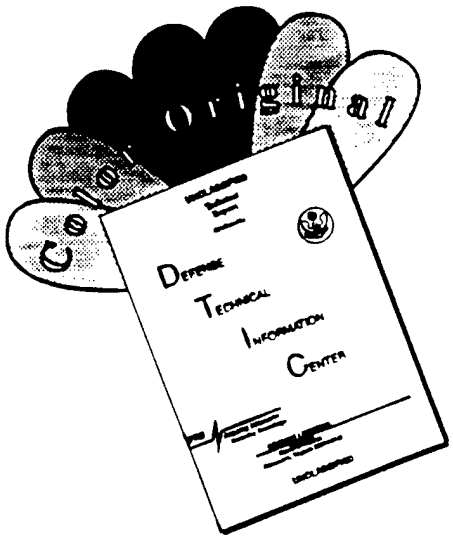
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Flood Damage, Benefit Accomplishment, Projects, Damage Reach, Levees, Reservoirs, Stage-damage, Crop Loss Functions, Urban Damage, Agricultural Damage, Hydrographs, Flood Zones, Continuous, Period of Record Analysis

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

User's manual for a pair of computer program that enables users to calculate flood damage and benefit accomplishment attributed to flood control projects. The program run in batch mode on DOS and UNIX operating system computers and are called the preprocessor (PREPBA) and the analysis program (PBA). The majority of input is defined in PREPBA, which writes the information to two binary files. PBA reads the files and a hydrograph and computes the damage and benefit. The analysis period can be the duration of a single flood event or a longer period of record. The HEC-PBA package calculates agricultural and urban damage and benefits for use after an event or annually and summarizes the results in reports.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION
22a. NAME OF RESPONSIBLE INDIVIDUAL Darryl W. Davis, Director, HEC	22b. TELEPHONE (Include Area Code) (916) 756-1104 22c. OFFICE SYMBOL CEWRC-HEC-P

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF COLOR PAGES WHICH DO NOT REPRODUCE LEGIBLY ON BLACK AND WHITE MICROFICHE.

Hydrologic Engineering Center Project Benefit Accomplishment Package (HEC-PBA)

September 1994

US Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, CA 95616-4687

(916) 756-1104

CPD-67

Project Benefit Accomplishment Package (HEC-PBA)

Table of Contents

Chapter		Page
1	Introduction	1
	1.1 Background	1
	1.2 Overview of Project Benefit Accomplishment Package	1
	1.2.1 General	1
	1.2.2 Preprocessor Program (PREPBA)	3
	1.2.3 Analysis Program (PBA)	3
	1.3 Hardware and Software Requirements	6
2	Preprocessor Program (PREPBA)	7
	2.1 Introduction	7
	2.2 Job Specifications	7
	2.2.1 Job Titles and Controls	7
	2.2.2 Watershed and Political Boundary Definitions	7
	2.2.3 Project Identification	12
	2.2.4 Stage or Discharge Hydrograph Data	12
	2.2.5 Crop Loss Function Definition for Job	12
	2.3 Damage Reach	18
	2.3.1 General	18
	2.3.2 Boundary and Project Specifications	19
	2.3.3 Flood Stage Value	19
	2.3.4 Transfer Relationships	19
	2.3.5 Damage Reach Information Stored in HEC-DSS	21
	2.3.6 Damage Reach Elevation Values	22
	2.3.7 Crop Data	22
	2.3.8 Double Cropping	23
	2.3.9 Urban Damage Data	25
	2.3.10 Order of Reach Records	26
	2.4 Using HEC-DSS to Input Paired Data into HEC-PBA	26
	2.4.1 Paired Data Variables	27
	2.4.2 Storing Paired Data in HEC-DSS	27
	2.5 Flood Zone Concepts	29
	2.6 Output Display	32
3	Preprocessor Program Input Description (PREPBA)	33
4	Analysis Program (PBA)	81
	4.1 Introduction	81
	4.2 Job Data	81
	4.2.1 Title Records	81

Table of Contents (continued)

Chapter			Page
		4.2.2 Price Indexes	81
		4.2.3 Analysis Dates	81
	4.3	Project Criteria	84
	4.4	Hydrograph Data	84
	4.5	Crop Damage Analysis Methods	86
		4.5.1 General Approach	86
		4.5.2 Multiple Flood Concepts	88
	4.6	Urban Damage	90
	4.7	Project Benefit Accomplishment	90
		4.7.1 Levees	90
		4.7.2 Reservoirs	91
		4.7.3 Levees and Reservoirs	91
	4.8	Output Displays	91
		4.8.1 Banner Page	92
		4.8.2 Input Echo	92
		4.8.3 Trace Output by Zones in a Reach	92
		4.8.4 Reach Summary Reports	92
		4.8.5 Boundary Reports	92
		4.8.6 Analysis Summary	92
5		Analysis Program Input Description (PBA)	97

Appendix

A	Glossary	A-1
B	Installing the HEC-PBA Package	B-1
C	HEC-PBA Example Application	C-1

Table of Contents (continued)

Tables

Table Number		Page
1	Example Crop Data	13
2	Julian Days of Year	14
3	Crop Loss Per Acre (Percent Loss Values)	17
4	Order of Crop Records in the Preprocessor Input File	18
5	Stream Station Hydrograph Data Transfer to Index File	22
6	Damage Reach Area Relationships	23
7	Unique Crop Area Relationships	24
8	Relationships by Category	25
9	Order of Damage-Reach Records in the Preprocessor Input File	26
10	Column Numbers Associated with Field Numbers in Input File	35
11	Example HEC-DSS Stage Hydrograph Data	86
12	Organization of Boundary Reports	94

Figures

Figure Number		
1	Project Benefit Accomplishment Package (HEC-PBA)	2
2	Division of a River Basin Into Damage Reaches	4
3	Flood Event Data	5
4	Preprocessor Program (PREPBA)	8
5	Sample Preprocessor Input File	9
6	Generalized Crop Loss Function	15
7	Crop Loss Analysis Concepts	16
8	Damage Reach Concepts	20
9	Transfer Relationships Between a Stream Station and Two Index Locations	21
10	Double Crop Loss Function	24
11	Flood Zone Concepts	30
12	Flood Zone Computation Intervals	31
13	Analysis Program (PBA) Concepts	82
14	Example of Analysis Program (PBA) Input	83
15	Analysis Period Concepts	83
16	Reservoir Benefit Allocation Concepts	85
17	Crop Loss Analysis for Various Dates in the Growing Season	87
18	Output: Reach Summary Report	93
19	Output: Congressional District Boundary Report	95
20	Output: Analysis Summary	96

Table of Contents (continued)

Figures

Figure Number		Page
C.1	Map of Arkansas River Watershed near Tulsa, Oklahoma	C-2
C.2	Crop Loss Functions, Initial (CI) and Late Plant (CL), for Sorghum, Hay, and Oats in the Arkansas River Area	C-3
C.3	Elevation-damage Functions for Reach 1 and Reach 2 of the Tulsa Data Set	C-4
C.4	PREPBA Input File	C-5
C.5	PREPBA Batch File to Run the Program	C-6
C.6	PREPBA Output File	C-7
C.7	PBA Data Input File	C-13
C.8	Hydrographs (Without- and With-project Conditions) During the Analysis Period	C-15
C.9	Catalog of Hydrograph Pathnames in the HEC-DSS File, TUL1HR.DSS	C-16
C.10	PBA's Batch File to Run the Program	C-16
C.11	PBA's Output File	C-17

Chapter 1
Introduction

1.1 Background

The Hydrologic Engineering Center's Project Benefit Accomplishment Package (HEC-PBA) enables users to calculate flood damage and benefits attributed to Corps of Engineers projects. The analysis period can be the duration of a single flood event or a longer period of time. Specifically, the HEC-PBA package: (1) calculates agricultural and urban flood damage on a near real-time basis; (2) calculates damage reduction attributed to Corps projects from events; and (3) generates summaries of project benefit accomplishment for reports to higher authorities. The program is expected to be used by economists and planners, as well as water resource personnel working in the real-time arena.

The Hydrologic Engineering Center (HEC) developed the HEC-PBA package based on the Flood Damage and Project Accomplishment (FDPA) package (1988). HEC-PBA consists of two computer programs. The preprocessor (PREPBA) program stores data in a format compatible with the requirements for the analysis program. The analysis (PBA) program calculates project benefit accomplishment by user-specified watershed and political boundaries.

The majority of the input information is defined in the PREPBA program, which formats and writes the information to two binary files. This information includes boundary and reach identification, and elevation-area-damage relationships. These binary files are read by PBA along with a small input file and a HEC-DSS file which contains hydrographs. PBA then calculates the project inundation reduction benefit accomplishment associated with flood events and creates numerous output tables based on the reach and boundary information.

The project benefit accomplishment is calculated and reported by river reaches. Flood events for each year are analyzed for "without"-project (also known as natural or unmodified) and "with"-project (also known as regulated or modified) conditions. Reach benefits are determined by subtracting damage values of with-project conditions from those of without-project conditions. The benefits are then allocated for reservoir and levee projects.

Project benefit accomplishment evaluations have traditionally been performed manually. The HEC-PBA Package is designed to automate the procedures by storing and manipulating information in an efficient manner, and thus expedite the benefit assessment process.

1.2 Overview of Project Benefit Accomplishment Package (HEC-PBA)

1.2.1 General. HEC-PBA consists of two components, PREPBA and PBA. The programs operate in batch mode. Figure 1 shows the basic interface of the programs with data management systems. Input into PREPBA includes all information regarding reaches, boundaries, protection projects, crop loss functions, urban damage functions and other

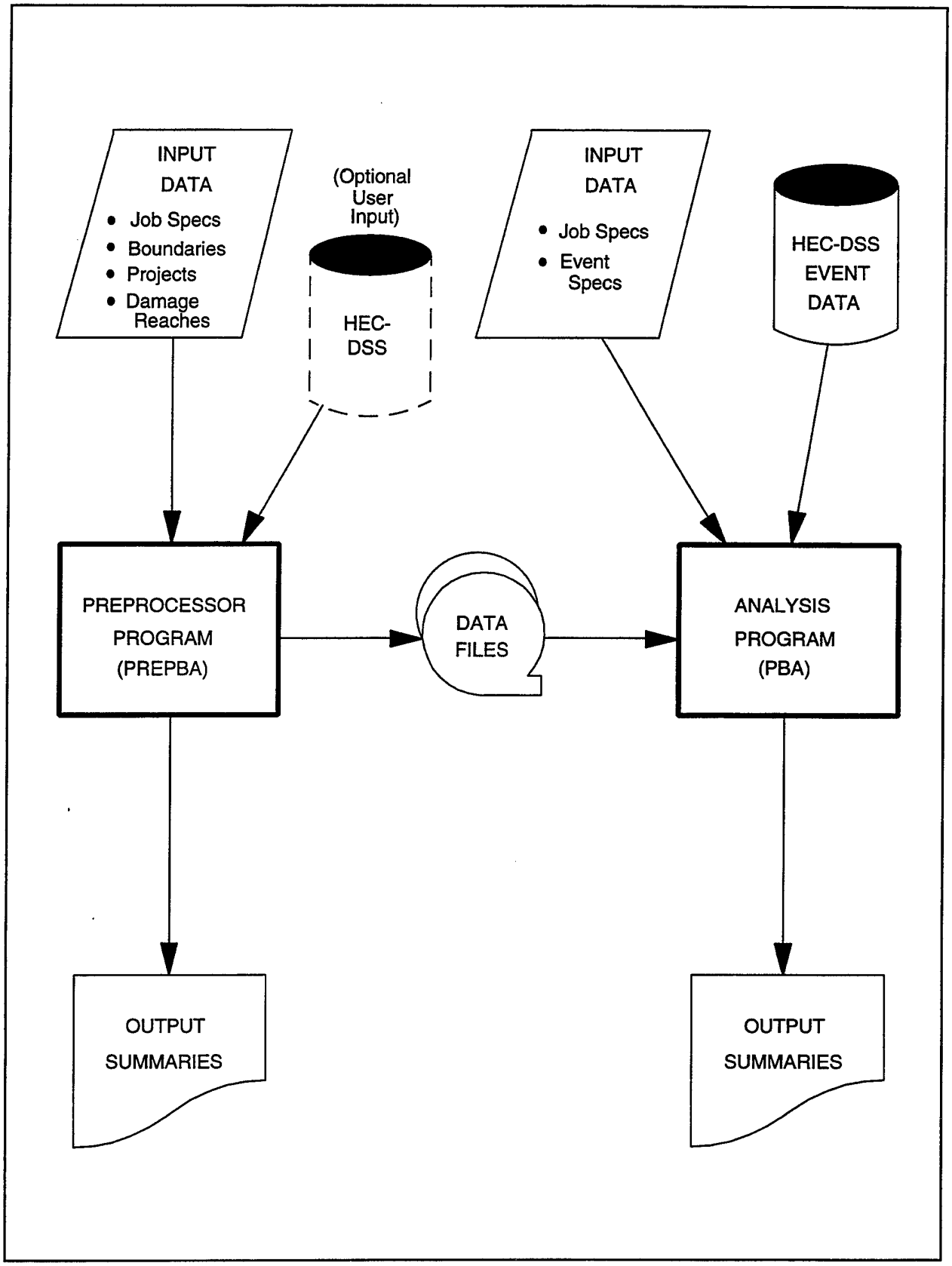


FIGURE 1 Project Benefit Accomplishment Package (HEC-PBA)

information. Rating tables, crop loss functions and crop-duration loss functions, and/or elevation versus crop area/urban damage/number of structures can be input into the PREPBA either by an input file or a HEC-DSS file. PREPBA writes the formatted information to two binary files which PBA then reads. PBA gets additional information from an input data file (such as the dates of analysis and other job information) and from a HEC-DSS file (such as the stage or flow hydrographs for the watershed). The damage and project benefits are summarized in the output from PBA. The output from PREPBA is a tabulation of the input data.

General analysis concepts of the HEC-PBA package are depicted in Figures 2 and 3. A river basin is divided into damage reaches (DR) by topographic or economic features as shown in Figure 2. Up to 400 damage reaches can be specified. Hydrographs retrieved from HEC-DSS files provide stage or flow data for flood events for both the without-project and with-project conditions. An example of this is shown in Figure 3. Damage is computed based on the current event and any previous events for the without-project and with-project conditions. Benefits are calculated as the difference in damage between the without-project and with-project conditions. Benefits are then allocated among the projects according to user's input.

The damage reach is the smallest watershed unit defined by unique watershed and political boundaries. Boundaries include any or all of the following: Corps district, state, county, township, community, congressional district, watershed, subbasin and flood control district boundaries. Levee and reservoir projects that affect the damage potential of a damage reach are defined and their allocated accomplishment are evaluated for each reach.

The flood damage and benefit accomplishment are computed for each reach. The damage and accomplishment are accumulated by reach for the entire system. Display of results, by event, by damage category, and by project, are output for watershed and/or political boundaries as specified by the user. Resulting summaries of number of structures flooded, and area flooded may also be output.

1.2.2 Preprocessor Program (PREPBA). PREPBA is designed to process and store large amounts of data that remain stable over time into a format directly accessible to PBA. It processes and stores boundary names, project specifications, and elevation-area-damage relationships. Agricultural crop and urban damage relationships are defined for a damage reach. Flood zones used in analysis for each damage reach are determined from the input elevation tables and the flood stage value.

1.2.3 Analysis Program (PBA). PBA calculations are based on with- and without-project condition hydrographs for the period of analysis and the damage potential at the damage reach. The hydrographs are obtained from records at stream index locations. To perform computations for an analysis period, PBA retrieves the damage reach records from PREPBA's binary files and the hydrographs from a HEC-DSS file. Analysis is performed considering varying durations of flooding and the current event and previous event for the without- and with-project conditions. The damage data may be updated via an urban or agricultural price index factor. Flood damage and project benefit are then determined as described in Section 1.2.1. Results are reported by user specified summary tables listed by events, projects, and watershed and political boundaries.

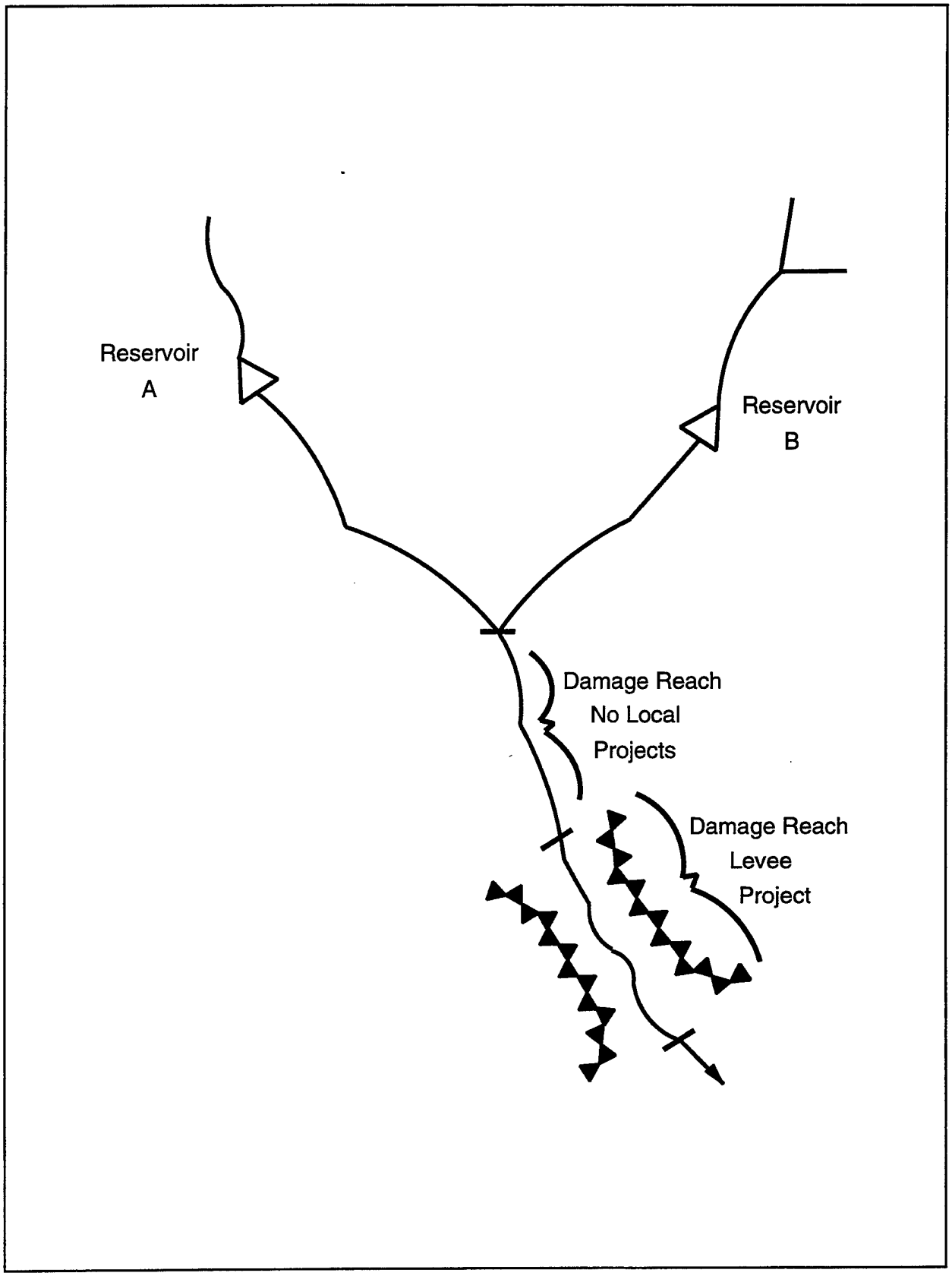


FIGURE 2 Division of a River Basin Into Damage Reaches

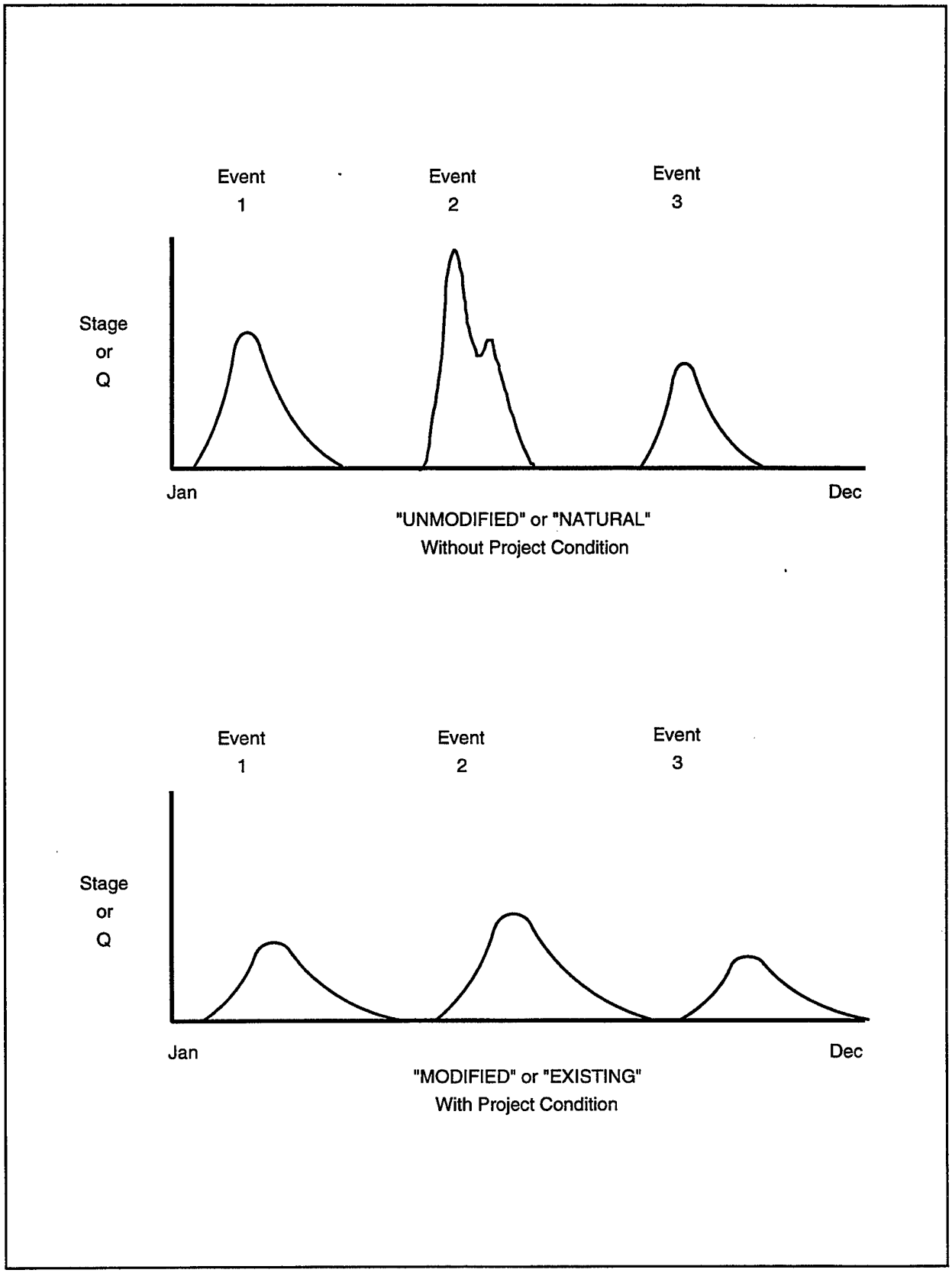


FIGURE 3 Flood Event Data

1.3 Hardware and Software Requirements

The HEC-PBA package works in a batch mode on IBM compatible personal computers (PC). The hydrographs must be available (HEC-DSS files) before the detailed analysis can be performed. Several utilities are available for loading data into HEC-DSS files from other data file formats. The HEC-PBA package is compatible with present PC equipment located at most Corps of Engineers offices. Minimum hardware and software requirements are:

Personal Microcomputer Systems:	20 MB hard disk
	360 K flexible disk drive
	640 M RAM
	DOS 5.0 or higher
	2 MB Extended Memory
	386 or higher processor

Because HEC-DSS event data files can be large, the following specifications are recommended:

100 MB hard disk
1.4 MD flexible disk drive
2 to 4 M RAM
DOS 5.0 or higher
HEC-DSS Version 6-G or higher

The following is a listing of the program's extended memory requirements.

PREPBA	760 KB
PBA	1.2 MB

Chapter 2
Preprocessor Program (PREPBA)

2.1 Introduction

The primary functions of PREPBA are to process and store information as specified by the data input for damage reaches. PREPBA first reads data from an input file and a HEC-DSS file (if available). It then converts the data into different units (if necessary), organizes this information into arrays and writes the data to two binary files. The data stored include rating tables for the flow hydrographs, the job crop loss functions (dollar loss potential for specified durations of flooding versus the time-of-year), and the relationships between elevation and these categories: discharge, area, damage, and number of structures. Instead of getting this information from the input file, it can be retrieved from a HEC-DSS file which has been created by the user. The creation of this HEC-DSS is discussed in Section 2.4. The program also processes and stores watershed and political boundary data and project specification information. The output file (ASCII) from PREPBA may be listed on the screen or sent to a printer.

Figure 4 shows the basic concepts associated with PREPBA. Figure 5 shows two sample input files. Example 1 is a data set where all the data are defined in a PREPBA input file. Example 2 is an input file where some of the data are retrieved from a HEC-DSS file. Each line, which is called a record, in the input file is discussed in general below and in greater detail in the Input Description starting on page 33. The two letter codes (for example, T1, BD, SS, CR and DR) are the record identifications and are always written in the first two columns of each record in the input file. In this manual, the record identification followed by a number indicates a particular field in a record (e.g., CR.5 indicates the 5th field on the CR record). Comment lines are encouraged in input files and always begin with an asterisk (*).

2.2 Job Specifications

2.2.1 Job Titles and Controls. The job specifications for each execution include title descriptions (T1, T2, T3 records), and job control specifications for input and output (J1 record). All titles and variable identifications in the program are alphanumeric (AN); they can be composed of letters and numbers.

2.2.2 Watershed and Political Boundary Definitions. All possible watershed and political boundary information to be used for the job are specified at the beginning of the input file using a series of "B" records. The boundary data are used to aggregate and display the results of PBA. The boundary data include all Corps districts or other agencies (BD records), states (BS records), counties (BC records), townships (BT records), watersheds (BW records), subbasins (BB records), congressional districts (BG records), communities (BX records), and flood control districts (BF records). Each record contains the identification for processing and a title used in the output summaries. The specific watershed and political boundaries for a damage reach are defined as part of the damage reach input.

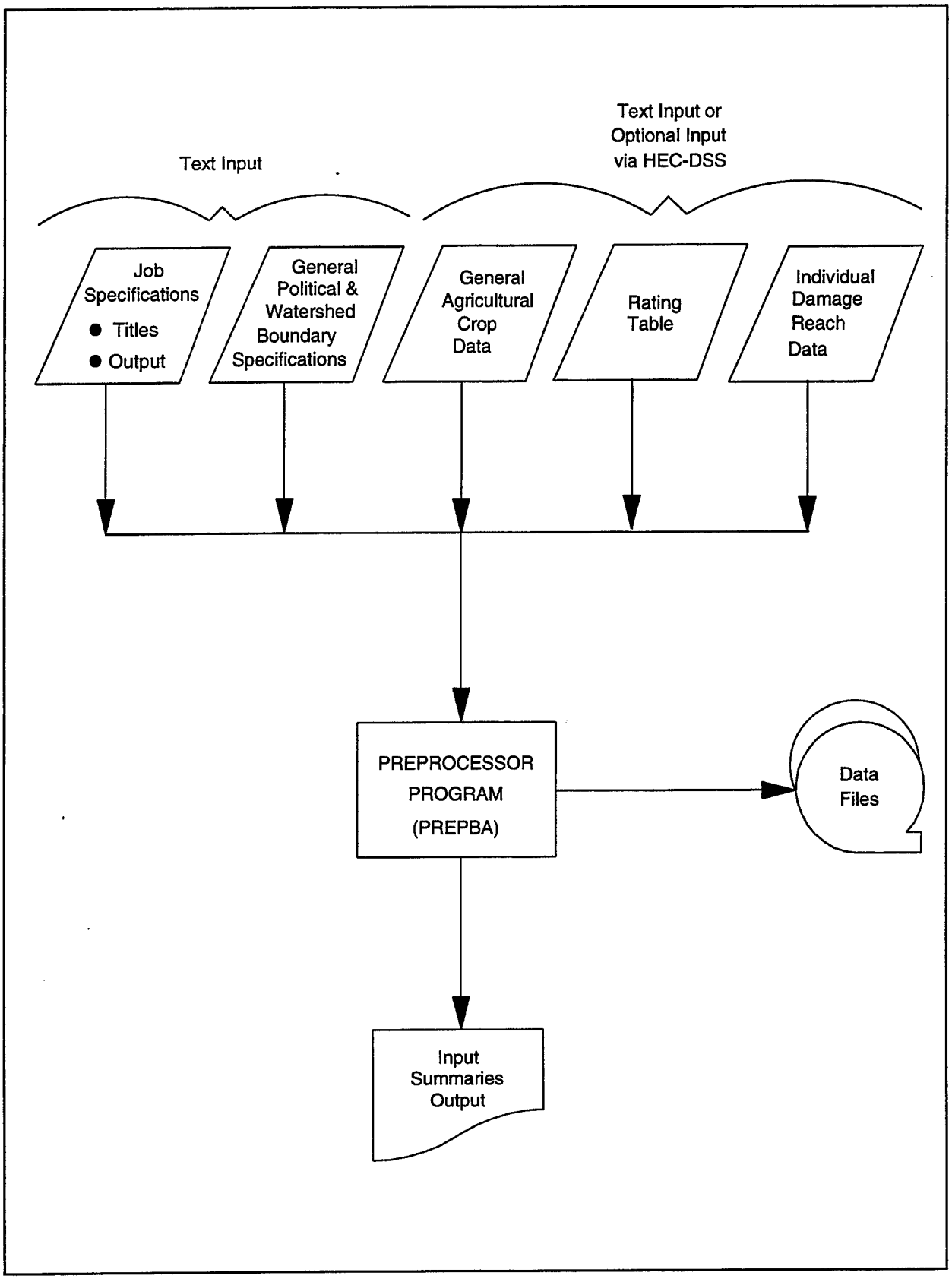


FIGURE 4 Preprocessor Program (PREPBA)

Example 1
Input File - All Data Read in from Text

```
T1 Annadell River, Ag & Urban Damage, 2 Damage Reaches, Jackson to Jillison
T2 Developed August 1994
T3 Donna Lydon and Penni Baker, HEC
J1
BD CESWT       TULSA DIST
BS    OK         OKLAHOMA
BC ALPHA     ALPHA COUNTY
BC  BETA      BETA COUNTY
BG CNGR1 REP JANET JONES
BG CNGR2 REP SHAWN SMITH
BW ANNAD ANNADELL WTRSHD
BT GARRI GARRISON TWNSHP
BB TANNR TANNER SUBBASIN
BB COOPR COOPER SUBBASIN
BX JACKS JACKSON COMUNTY
BX JILLI JILLISON COMNTY
BF BLUEF BLUEFISH FLDIST
PR COOPR      COOPER LAKE
PR GRAND GRAND RESERVOIR
PL JKLEV   JACKSON LEVEE
SS        BLUGAGE
ZU  A=ANNADELL  B=BLUGAGE E=1DAY F=NAT
ZM  A=ANNADELL  B=BLUGAGE E=1DAY F=REG
SS        JILGAGE
ZU  A=ANNADELL  B=JILGAGE E=1DAY F=NAT
ZM  A=ANNADELL  B=JILGAGE E=1DAY F=REG
EV   395     402     404     406     408     410     412     414
QQ     0     300     600     800    1200    1600    1800    2100
CR WHEAT      45      BU    3.25   11.76            WINTER WHEAT
CS WHEAT     275     305     335      90      10
CT     1      30      40      60      70      75      90     100     180     191
CT   217     227     232     242     248     275     305     335     355     365
CI    60      85      90     100     100      75       0       0       0       0
CI     0       0       0       0       0       0      10      30      50      60
CL    25      50      60      75      75      75       0       0       0       0
CL     0       0       0       0       0       0       0       0      20      25
CD     0       1       2       3       4
C1     0       0       0       0       0       0       0       0       0       0
C1     0       0       0       0       0       0       0       0       0       0
C2    25      25      25      25      25      25      25      25      25       0
C2     0       0      25      25      25      25      25      25      25      25
C3    50      50      50      50      50      50      50      50      50       0
C3     0       0      50      50      50      50      50      50      50      50
C4    75      75      75      75      75      75      75      75      75       0
C4     0       0      75      75      75      75      75      75      75      75
C5   100     100     100     100     100     100     100     100     100       0
C5     0       0     100     100     100     100     100     100     100     100
CR  CORN     110      BU    2.75   25.00              SWEET CORN
CS  CORN      90     120     150     270       8
CT     1      32      60      90     120     150     170     210     220     240
CT   250     255     270     300
CI     0       0       0       0      10      30      50      85      90     100
CI   100      75       0
CL     0       0       0       0       0       0      20      50      60      75
CL    75      75       0       0
CD     0       1       2       3       4
C1     0       0       0       0       0       0       0       0       0       0
C1     0       0       0
C2     0       0       0       0      10      20      25      25      25      25
C2    25       0       0
C3     0       0       0      20      30      40      50      50      50      50
C3    50       0       0
C4     0       0       0      30      45      60      75      75      75      75
C4    75       0       0
```

FIGURE 5 Sample Preprocessor Input File

Example 1
Input File - All Data Read in from Text

```
C5     0       0       0      50     100     100     100     100     100     100
C5   100       0       0
DR  RCH1 BLUGAGE       ANNADELL RIVER--COOPER LAKE TO BLUEFISH RIVER
DB CESWT      OK   ALPHA   GARRI   ANNAD   COOPR   CNGR1   JACKS   BLUEF
DL JKLEV     412
DS COOPR
FS   404
ES   402     406     408     410     415     420
EI 402.5   406.8   409.1   411.6   416.9   421.3
EL   400     404     407     409     411     413     415
AR     0       0     400     800    1200    1600    2000
CP WHEAT     100
UC RESID     180     RESIDENTIAL
UD     0       0    9000   13000   18000   26000   36000
ST     0       0     200     300     400     500     600
UC COMML     120     COMMERCIAL
UD     0       0       0    1200    2400    3600    4800
ST     0       0       0       5      10      15      20
DR  RCH3 JILGAGE       ANNADELL RIVER--TANNER AGRICULTURAL AREA
DB CESWT      OK    BETA   GARRI   ANNAD   TANNR   CNGR2   JILLI   BLUEF
DS COOPR
DS GRAND
FS   404
EL   404     406     407     408     409     410     411     430
AR     0     580     750     900    1040    1160    1260    1390
CP  CORN     100   WHEAT
UC RURST     215 RURAL STRUCTURE
UD     0    1100    2300    5400    7500    9400   11200   14100
ST     0      29      48      79      96     129     158     229
EJ
```

FIGURE 5 Sample Preprocessor Input File (continued)

Example 2
Input File - Some Data Read in from HEC-DSS

```
T1 Annadell River, Ag & Urban Damage, 2 Damage Reaches, Jackson to Jillison
T2 Developed August 1994
T3 Donna Lydon and Penni Baker, HEC
J1
BD CESWT       TULSA DIST
BS    OK         OKLAHOMA
BC ALPHA     ALPHA COUNTY
BC  BETA      BETA COUNTY
BG CNGR1 REP JANET JONES
BG CNGR2 REP SHAWN SMITH
BW ANNAD ANNADELL WTRSHD
BT GARRI GARRISON TWNSHP
BB TANNR TANNER SUBBASIN
BB COOPR COOPER SUBBASIN
BX JACKS JACKSON COMUNTY
BX JILLI JILLISON COMNTY
BF BLUEF BLUEFISH FLDIST
PR COOPR      COOPER LAKE
PR GRAND GRAND RESERVOIR
PL JKLEV   JACKSON LEVEE
SS        BLUGAGE
ZU  A=ANNADELL  B=BLUGAGE E=1DAY F=NAT
ZM  A=ANNADELL  B=BLUGAGE E=1DAY F=REG
ZT A=ANNADELL B=BLUGAGE C=ELEV-FLOW E=1980 F=USGS
SS        JILGAGE
ZU  A=ANNADELL  B=JILGAGE E=1DAY F=NAT
ZM  A=ANNADELL  B=JILGAGE E=1DAY F=REG
ZT A=ANNADELL B=JILGAGE C=ELEV-FLOW E=1980 F=USGS
CR WHEAT       45       BU     3.25    11.76             WINTER WHEAT
CS WHEAT      275      305      335       90       10
ZC A=ANNADELL B=WHEAT C=WINTER E=1947 F=WINTER WHEAT
CD      0        1        2        3        4
CR  CORN      110       BU     2.75    25.00               SWEET CORN
CS  CORN       90      120      150      270        8
ZC A=ANNADELL B=CORN C=SUMMER-SWEET E=1950 F=SWEET CORN
CD      0        1        2        3        4
DR  RCH1 BLUGAGE        ANNADELL RIVER--COOPER LAKE TO BLUEFISH RIVER
DB CESWT       OK    ALPHA    GARRI    ANNAD    COOPR    CNGR1    JACKS    BLUEF
DL JKLEV      412
DS COOPR
FS   404
ES   402      406      408      410      415      420
EI 402.5    406.8    409.1    411.6    416.9    421.3
ZR A=ANNADELL B=RCH1 C=ELEVATION-CURVES F=URBAN & AGRI
CP WHEAT      100
UC RESID      180      RESIDENTIAL
UC COMML      120       COMMERCIAL
DR  RCH2 JILGAGE        ANNADELL RIVER--BLUEFISH RIVER TO JILLISON
DB CESWT       OK    ALPHA    GARRI    ANNAD    COOPR    CNGR1    JILLI    BLUEF
DS COOPR
FS   404
ZR A=ANNADELL B=RCH2 C=ELEVATION-CURVES F=URBAN
UC RESID      180      RESIDENTIAL
UC COMML      120       COMMERCIAL
UC INDUS      200       INDUSTRIAL
DR  RCH3 JILGAGE        ANNADELL RIVER--TANNER AGRICULTURAL AREA
DB CESWT       OK     BETA    GARRI    ANNAD    TANNR    CNGR2    JILLI    BLUEF
DS COOPR
DS GRAND
FS   404
ZR A=ANNADELL B=RCH3 C=ELEVATION-CURVES F=AGRI
CP  CORN      100    WHEAT
UC RURST      215 RURAL STRUCTURE
EJ
```

FIGURE 5 Sample Preprocessor Input File (continued)

2.2.3 Project Identification. All project names to be used for the job are specified on the project records. Reservoirs are listed on PR records and levees are listed on PL records.

2.2.4 Stage or Discharge Hydrograph Data. The stage or discharge hydrograph data to be used in the analysis are defined at stream station locations. Up to 100 stream stations may be identified. Gaged stream locations are typically used as stations because stage or discharge hydrographs may readily be obtained from water control files. Hydrograph data may be observed, computed, or forecasted. The hydrograph data for each stream station are defined by a group of SS, ZU, ZM, EV, and QQ records or a group of SS, ZU, ZM, and ZT records. The SS record provides the identification and name of the stream station. The ZU and ZM records contain the HEC-DSS pathname parts of the unmodified and modified hydrographs. The EV and QQ records contain elevation-discharge relationships which are called rating tables and are used to convert discharge hydrograph ordinate values to stage values. Alternatively, the rating table can be stored to a HEC-DSS file and retrieved by PREPBA using the pathname contained in the ZT record.

2.2.5 Crop Loss Function Definition for Job. The crop damage potential for all crops is defined once for the entire job. The agricultural crop damage potential is defined by specifying the crops and associated area planted for each damage reach. Up to 18 corps are permitted for the job. The crop information is defined by a group of CR, CS, CT, CI, CL, CD, and C1-C6 records. Alternatively, crop information can be stored to a HEC-DSS file and retrieved by PREPBA using the ZC record together with the CR, CS, and CD records.

1) Overview. A detailed description of procedures and analysis concepts for calculating agricultural flood damage is described in the Corps of Engineers report entitled National Economic Development Procedures Manual - Agricultural Flood Damage, IWR Report 87-R-10, October 1987. The analytical procedures used by the HEC-PBA package are based on the procedures described in this report.

Damage analysis of crop areas involves a complex series of factors and considerations. Among these are: type of crop, duration and magnitude of flooding, season (time of year), cropping patterns, crop values and yields, duration of flooding a crop may withstand without damage, effects of replanting and late planting, time between flood events, and dry-out periods before re-entering the fields. Monetary damage values are determined from investment (and profit) losses, mature-crop price values, and harvest costs. Secondary business losses (loss of revenue by grain elevator managers, truck operators, equipment vendors, etc.) may also contribute to the flood losses associated with agricultural areas. Up to 18 different crops, including double cropping patterns, may be specified for analysis.

Crop data define the value and damage potential of a particular crop throughout the year. Crop data and crop loss functions are defined for the job by a series of CR, CS, CT, CI, CL, CD, and C1-C6 records. The data include: crop type, unit price, yield per acre, crop loss potential throughout the year, and effects of duration and multiple floods on the damage potential of each crop. The data associated with the CT, CI, CL, and C1-C6 records can instead be stored to a HEC-DSS file which PREPBA can retrieve. More information on the creation of this HEC-DSS file is discussed in Section 2.4.

2) Crop Value Data. Crop names and value data are input on CR records. Data include the crop yield per unit area (acre) and the price per unit (bushel, ton, etc.) value of the crop, and the harvest cost. The value of the crop per acre is determined by multiplying yield

times the value per acre. These values are applied to the crop loss function (input as percent loss versus Julian day of the year) to produce an actual damage versus day of the year crop loss relationship. Tables 1 and 2 show sample crop data and the Julian days of the year, respectively. Leap year adjustment are made internal to the program.

TABLE 1
Example Crop Data

Crop (CR.1)	Yield/Acre (CR.2)	Price/Unit (CR.3)	Gross Value/Acre (Calculated)	Harvest Cost/Acre (CR.4)	Max Dollar Damage/Acre (Calculated)	Additional Business Losses (CR.5)	Total Dollar Damage/Acre (Calculated)
Corn	40	$4.00/bu	$160.00	$30.00	$130.00	0.20	$156.00
Soybeans	25	5.00/bu	125.00	15.00	110.00	0.30	145.00
Wheat	42	3.50/bu	147.00	25.00	122.00	0.50	183.00

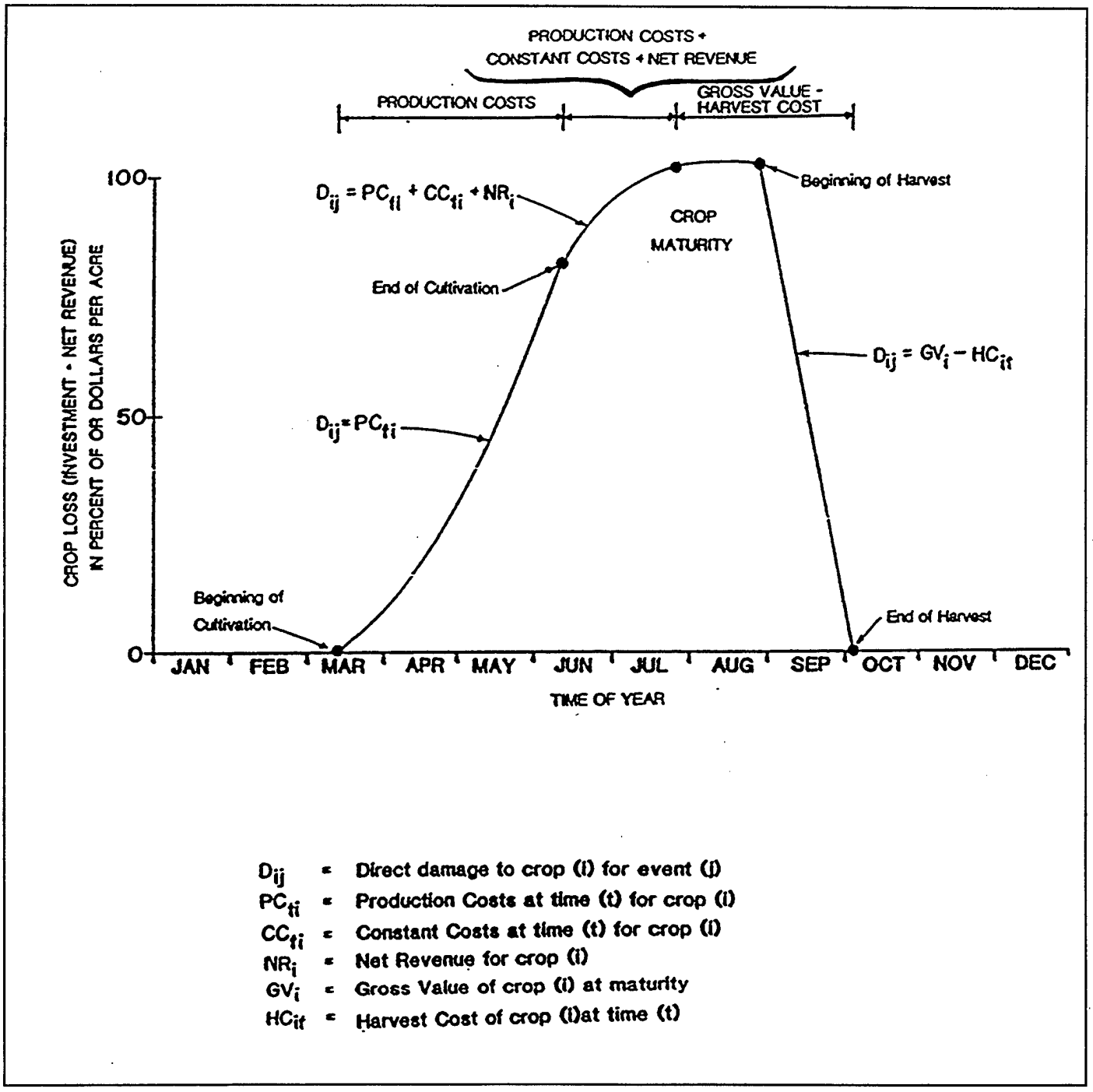
3) Crop Loss Functions. The loss potential of a specific crop varies throughout the year from initial soil preparation for planting to completion of harvest. The functions depict a continuous relationship of day-of-year versus the potential investment and profit associated with each crop. They are typically developed from investment and profit analysis of the annual crop cycle. The investment includes production costs, constant costs, harvest cost. The gross value (investment cost plus profit) minus harvest cost equals the value of the crop at maturity. The crop maturity period represents the greatest (usually 100 percent) loss potential. The potential loss subsequently decreases, once harvest begins, through the completion of harvest (zero loss potential). Figures 6 and 7 show the generalized crop loss function relationships.

Crop loss functions are defined by CS, CT, CI, and CL records. CS records contain seasonal crop data. Seasonal crop data, in Julian calendar days, are the first day of planting, the last day of planting which can produce a full yield, the last day of planting which will produce a partial yield, and the last day of harvest. These days are shown in Figure 7.

The CT records specify Julian days of one year as shown in Figure 7 and Table 3. The Julian days listed in the CT record are points which have significance on the initial loss or late plant loss curves. The CI record defines the percent loss values of the crop which correspond to the Julian day values of the CT record. The CI values represent the percent loss associated with initial planting -- no reduction in yields from replanting or late planting resulting from a previous flood event. The CL records define the last plant crop loss function that could be brought into production after a flood event. The percent loss values of the CL record represent a reduction in yield. The percent loss is entered as an integer on the CI, CL, as well as the C1 through C6 records. For example 20% is entered as 20; 100% is entered as 100. A maximum of 30 values may be input on the CT, CI, and CL records to define the crop loss functions. This information can be stored to a HEC-DSS file and then retrieved by PREPBA. Section 2.4 will provide detailed information on creating this HEC-DSS file.

TABLE 2
Julian Days of Year

Day of Month	JULIAN DAY OF CALENDAR YEAR												Day of Month
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1	1	32	60	91	121	152	182	213	244	274	305	335	1
2	2	33	61	92	122	153	183	214	245	275	306	336	2
3	3	34	62	93	123	154	184	215	246	276	307	337	3
4	4	35	63	94	124	155	185	216	247	277	308	338	4
5	5	36	64	95	125	156	186	217	248	278	309	339	5
6	6	37	65	96	126	157	187	218	249	279	310	340	6
7	7	38	66	97	127	158	188	219	250	280	311	341	7
8	8	39	67	98	128	159	189	220	251	281	312	342	8
9	9	40	68	99	129	160	190	221	252	282	313	343	9
10	10	41	69	100	130	161	191	222	253	283	314	344	10
11	11	42	70	101	131	162	192	223	254	284	315	345	11
12	12	43	71	102	132	163	193	224	255	285	316	346	12
13	13	44	72	103	133	164	194	225	256	286	317	347	13
14	14	45	73	104	134	165	195	226	257	287	318	348	14
15	15	46	74	105	135	166	196	227	258	288	319	349	15
16	16	47	75	106	136	167	197	228	259	289	320	350	16
17	17	48	76	107	137	168	198	229	260	290	321	351	17
18	18	49	77	108	138	169	199	230	261	291	322	352	18
19	19	50	78	109	139	170	200	231	262	292	323	353	19
20	20	51	79	110	140	171	201	232	263	293	324	354	20
21	21	52	80	111	141	172	202	233	264	294	325	355	21
22	22	53	81	112	142	173	203	234	265	295	326	356	22
23	23	54	82	113	143	174	204	235	266	296	327	357	23
24	24	55	83	114	144	175	205	236	267	297	328	358	24
25	25	56	84	115	145	176	206	237	268	298	329	359	25
26	26	57	85	116	146	177	207	238	269	299	330	360	26
27	27	58	86	117	147	178	208	239	270	300	331	361	27
28	28	59	87	118	148	179	209	240	271	301	332	362	28
29	29		88	119	149	180	210	241	272	303	333	363	29
30	30		89	120	150	181	211	242	273	303	334	364	30
31	31		90		151		212	243		304		365	31



D_{ij} = Direct damage to crop (i) for event (j)
PC_{ti} = Production Costs at time (t) for crop (i)
CC_{ti} = Constant Costs at time (t) for crop (i)
NR_i = Net Revenue for crop (i)
GV_i = Gross Value of crop (i) at maturity
HC_{it} = Harvest Cost of crop (i)at time (t)

FIGURE 6 Generalized Crop Loss Function

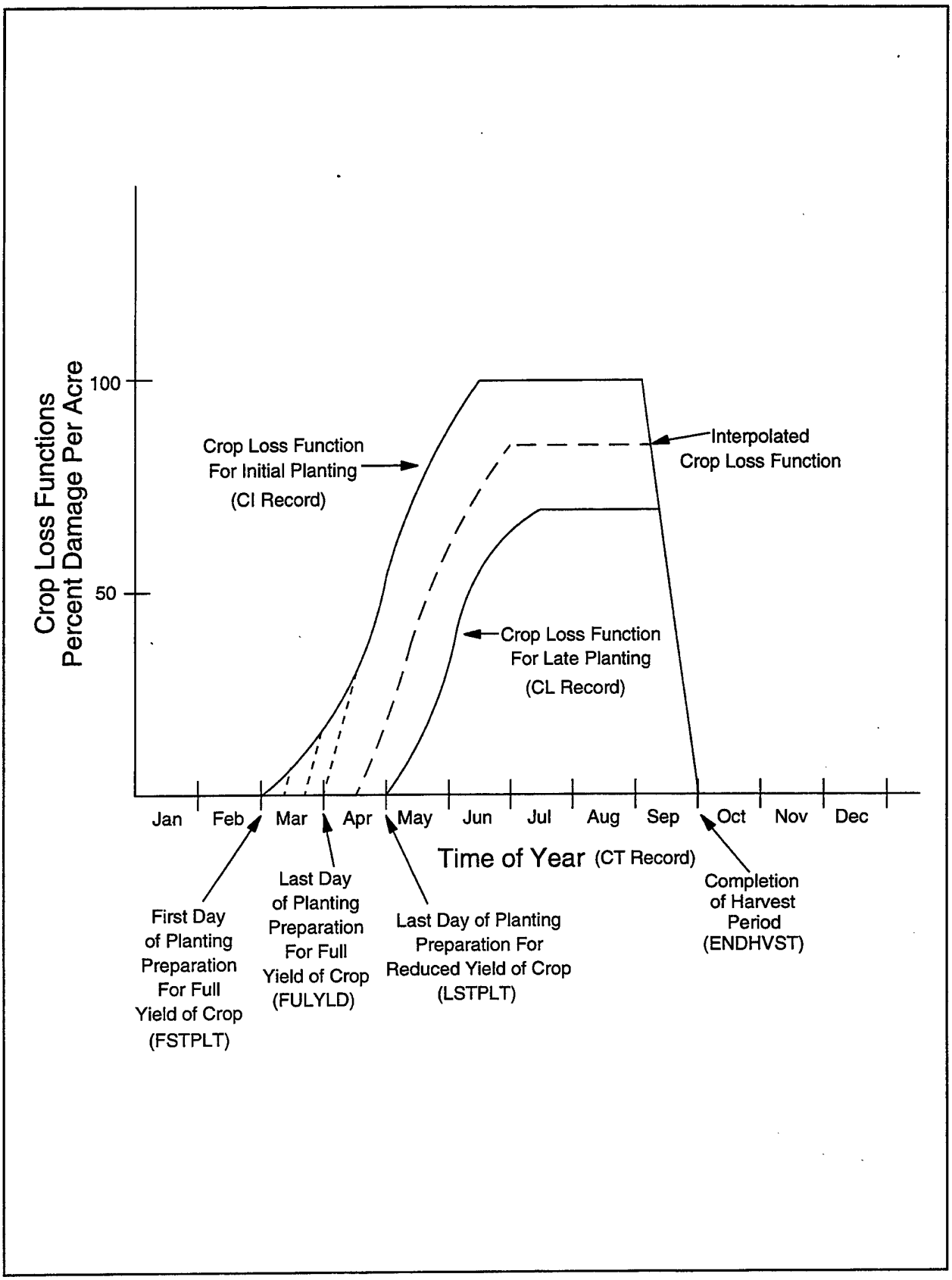


FIGURE 7 Crop Loss Analysis Concepts

4) Duration Loss Adjustments. PREPBA defines the crop damage per acre by duration of flood inundation on the CD and C1-C6 records. The crop loss values defined by the CI and CL records are adjusted by a percentage based on the length of time the crop was flooded and the time of the year of the event. A generalized duration-percent crop loss relationship is shown in Table 3. These relationships are defined corresponding to the Julian days listed on the CT record. The C1-C6 records are input directly in the PREPBA input file or retrieved from a HEC-DSS file along with the CT, CI and CL relationships (see Section 2.4). Table 3 illustrates the input using the CD records of four duration relationships (0-, 1-, 7-, and 14-day) corresponding to the estimated percent of crop that would be lost for that duration of flooding. A maximum of six duration relationships may be input. Careful definition of the duration-adjustment relationships is important because intermediate values are linearly interpolated.

TABLE 3
Crop Loss Per Acre
(Percent Loss Values)

Date	Day of Year (CT REC)	Initial Plant % Loss (CI REC)	Last Plant % Loss (CL REC)	Percent Loss by Flood Duration (Days) 0-Day (C1 REC)	1-Day (C2 REC)	7-Days (C3 REC)	14-Days (C4 REC)
1 Mar	60	0	0	0	0	0	0
10 Apr	100	25	0	0	0	0	100
1 May	121	60	0	0	0	0	100
24 May	144	85	25	0	0	0	100
9 Jun	160	100	50	0	0	0	100
15 Jul	196	100	75	0	0	80	100
5 Sep	248	100	75	0	20	80	100
15 Sep	258	75	75	0	20	80	100
1 Oct	274	0	0	0	20	80	100
31 Oct	304	0	0	0	0	0	0

Note: The initial and the last plant percent loss values are converted to dollars based on the maximum dollar damage/acre of the crop.

5) Crop Data Retrieved from HEC-DSS. The ZC record allows PREPBA to read most of the crop data from a HEC-DSS file. The ZC record contains the pathname parts for a HEC-DSS record containing paired data in the following order: CT, CI, CL, C1, C2, ..., up to C6 (similar in format to Table 3).

6) Order of Crop Records. Table 4 shows the order the crop records need to be in the input file if data are input directly into the input file or if a HEC-DSS file is going to be used. Creating or adding data to a HEC-DSS file is discussed in Section 2.4.

TABLE 4
Order of Crop Records in the Preprocessor Input File

Crop Data Read in from Input File	Crop Data Read in from HEC-DSS File
CR	CR
CS	CS
CT	ZC *
CI	CD
CL	
CD	
C1	
C2	
C3	
.	
.	
C6	

* The ZC record contains the pathname of the HEC-DSS data record which contains the following curves:

Independent Curve	Dependent Curves				
CT	CI	CL	C1	. . .	C6
.	.	.	.		.
.	.	.	.		.
.	.	.	.		.

7) Agricultural Business and Infrastructure Losses. The flood-related agricultural losses that are not direct crop losses may be estimated using variable ADLOSS (CR.5). Examples of the agricultural losses may be infrastructure damage and business losses from flooding. Applicable business losses may include reduction or loss to grain elevator operators, trucking, hauling, and other equipment utilization firms. Damage to farm roads, drainage and irrigation systems (both above and below ground), bridges and culverts, machinery and equipment, and out-structures necessary to produce and market crops may be included as infrastructure damage. This damage may represent a significant portion of the overall damage potential of an agricultural business. The loss is estimated as a percent of the total crop loss. Estimates of these losses are based on the following relationship:

Other Loss = Calculated Crop Loss x ADLOSS

2.3 Damage Reach

2.3.1 General. The damage reach (DR) represents the smallest area of analysis. Damage reaches are used to define boundaries for data aggregation, analysis, and reporting.

Figure 8 shows the division and aggregation of damage reaches. The damage reach records (DR, DB, DL, DC, DS, FS, ES, EI, ZR, EL, AR, CP, CA, UC, UD, and ST) specify damage reach data and criteria used for subsequent analysis by PBA. Damage reach data include: damage reach title, watershed and political boundaries, levees and reservoirs associated with the reach, crop categories found in the reach, crop distribution patterns, elevation-area relationships, and elevation-damage and elevation-structure relationships for urban categories.

Damage reach specifications are input on the required DR record. The DR record contains the reach identification, the stream index location, and a reach damage title.

2.3.2 Boundary and Project Specifications. All the watershed and political boundaries associated with the damage reach are contained on the required DB record. The boundary names must be identical to the names used on the "B" records.

Project specifications are required for each damage reach where a project exists. One levee project may exist for a damage reach, and up to 20 reservoirs may affect a damage reach. Levee specifications are input by DL records, and reservoirs by DS records. The entire system can have up to 50 levees and up to 50 reservoirs.

The with-project condition assumes all potential damage to be behind the levee (line-of-protection), so no damage occurs unless levee is overtopped. If damage potential exists on the exterior side, another damage reach must be used to properly account for the damage. Interior flooding is not accounted for in the computations.

2.3.3 Flood Stage Value. The elevation associated with the top of the bank or highest elevation with no damage is called the flood stage (FS). This value is defined on the FS record and must be one of the values in the EL record. If the FS record is missing, the flood stage is assumed to be the first value on the elevation record. Because the flood stage is the highest elevation where **no loss** has occurred, there may be nc area, damage, or structures associated with elevations **at or below** the flood stage.

2.3.4 Transfer Relationships. For a given reach, the water surface elevations at the stream station may not be the same as the water surface elevations at the damage index location. To account for this difference, the ES and EI records are used. The ES and EI records together provide a relationship which permits PBA to transfer the hydrograph data from the stream station to the index location by accounting for the slope difference in a series of water surface profiles. Intermediate hydrograph values are linearly interpolated. Damage is then computed at the index location based on the adjusted hydrograph at the damage reach index location.

For example, Figure 9 shows the water surface profiles for two damage reaches. The stream station hydrograph data location is also shown. The water surface elevations are recorded in the ES and EI records. Three values are used to simplify the illustration. As many as practical, up to 30, should be used for an actual study for better interpolation. Although hydrograph elevation values above or below the transfer relationship will be linearly extrapolated, it is better than the transfer values encompass the entire range of hydrograph ordinate values that will affect the results. Normally, these range from an annual event through a 0.2 percent chance exceedance event. The shown range elevation from the 2-year (50% chance exceedance) event to the 500-year (0.2% chance exceedance) event.

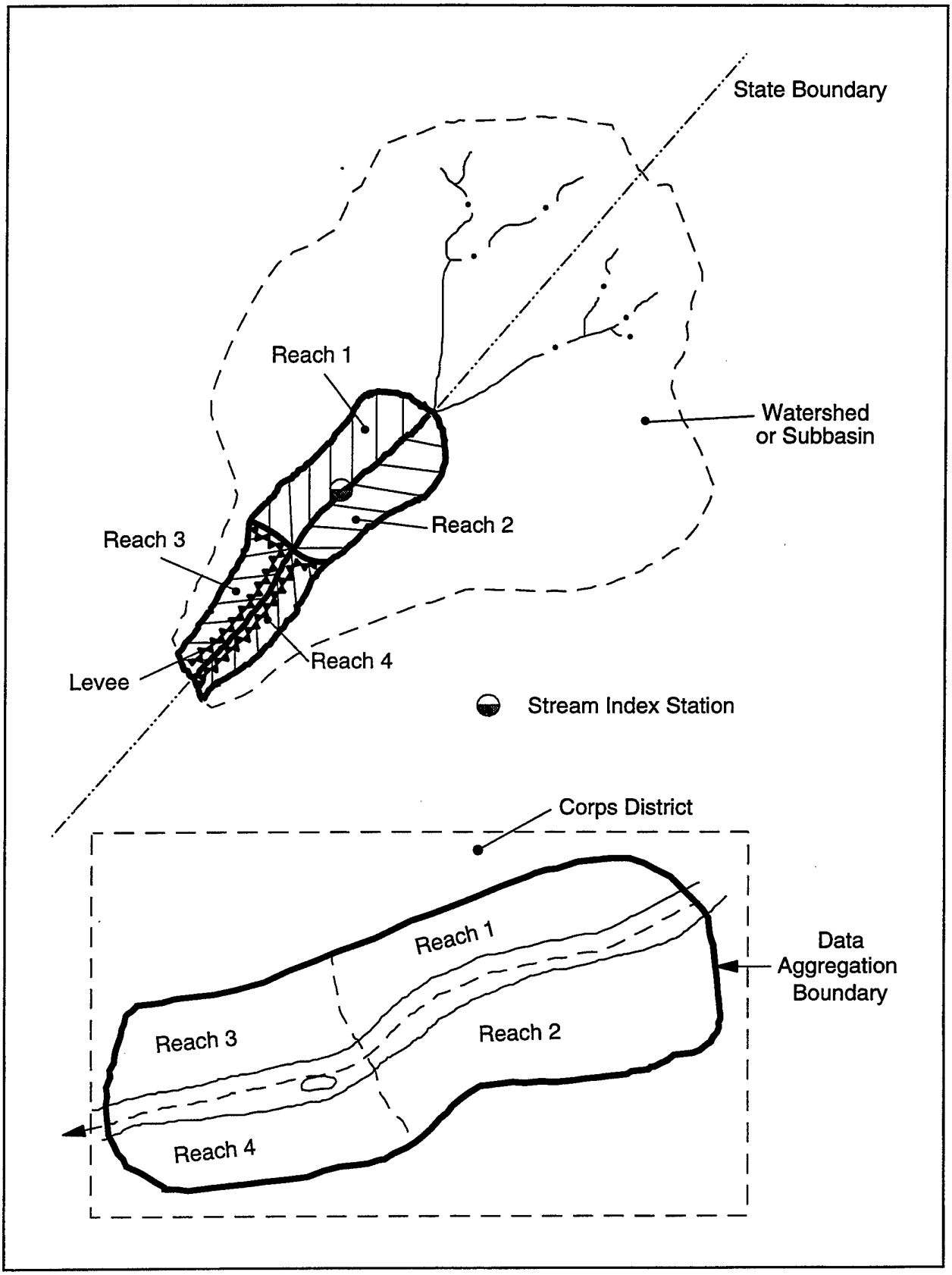


FIGURE 8 Damage Reach Concepts

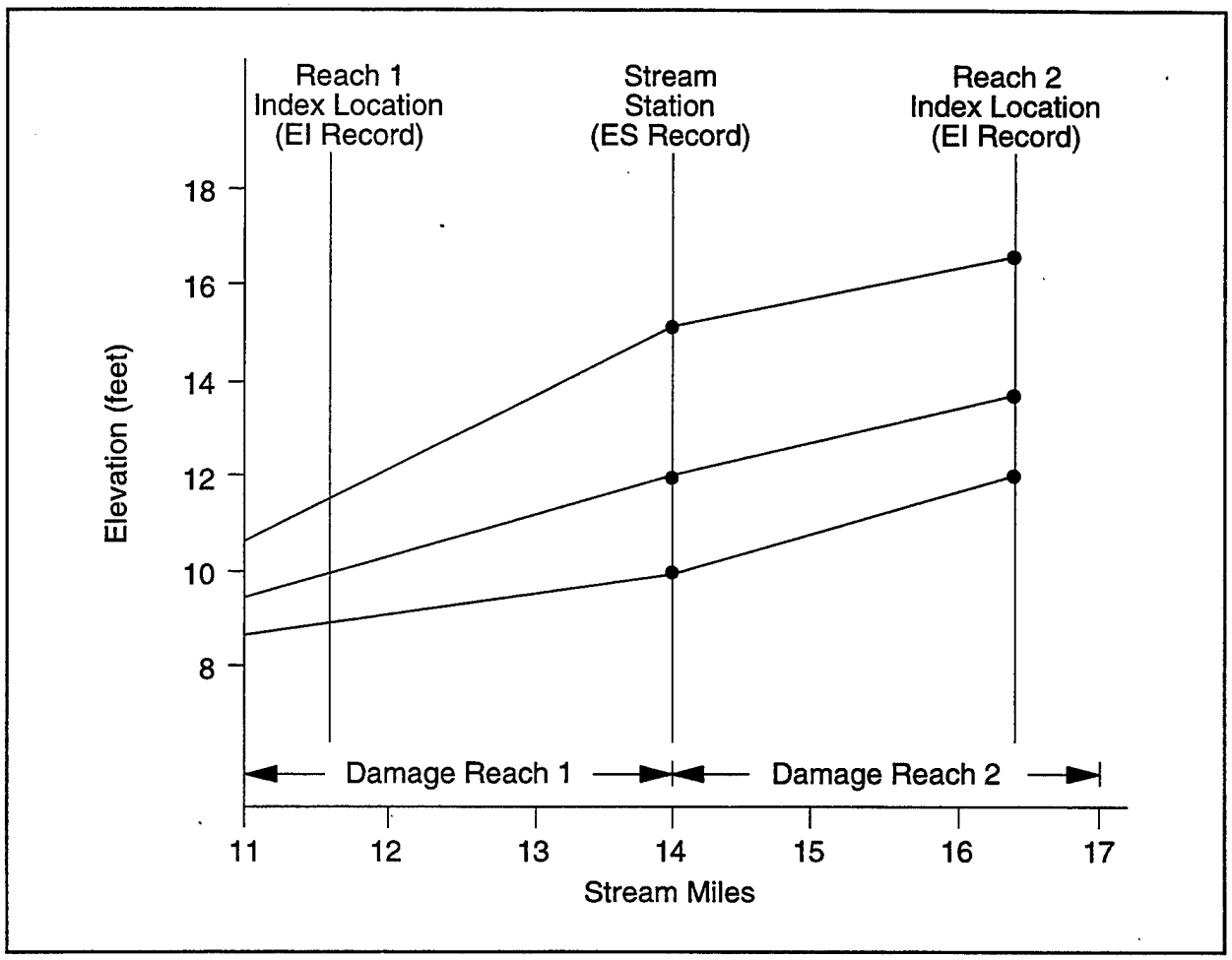


FIGURE 9 Transfer Relationships Between a Stream Station and Two Index Locations

```
Reach 1:   ES     10       12       15
           EI    8.5      9.5     10.5

Reach 2:   ES     10       12       15
           EI     12     13.5     16.5
```

A hydrograph from the stream station containing values would translate to the values shown in Table 5.

2.3.5 Damage Reach Information Stored in HEC-DSS. Damage reach information can be defined in the PREPBA input file or retrieved from a HEC-DSS file. The ZR record has all the pathname parts for the HEC-DSS paired data record containing the reach information. The ZR record may be used instead of the EL, AR, UD, and ST records.

TABLE 5
Stream Station Hydrograph Data Transfer to Index File

Elevation Hydrograph Data Stream Station	Transferred Elevation Hydrograph Data Damage Reach 1 Index Location	Damage Reach 2 Index Location
10.1	8.6	12.1
11.3	9.2	13.0
14.9	10.5	16.4
14.1	10.2	15.6
12.8	9.8	14.3
11.2	9.1	12.9
10.5	8.8	12.4

2.3.6 Damage Reach Elevation Values. The elevation values associated with the damage reach discharge values, crop area values, and urban damage and structure values are input on EL records. The EL records are required to do the analysis. The elevation values of the EL records are used to define the flood zones for the damage computations for different durations of flooding. Flood zones are discussed further in Section 2.5.

2.3.7 Crop Data. Crop patterns define how the crops are distributed spatially (by area) throughout the range of elevations of the reach. The elevation-area relationships are used to determine the cultivated area flooded. The area values are subsequently used in agricultural damage computations to determine the amount of damage associated with the flood event.

In a damage reach, there are two possible types of crop patterns: for those which the crop distribution is constant over the elevation range of the entire agricultural area, and for those which the crop distribution varies over the agricultural area elevation range. If a constant crop distribution is assumed, the AR and CP records are required. The AR record represents the total area over the range of damage reach elevations and the CP record represents the distribution percentages of each crop. The AR records are input one time for the reach. The CP records are required for each crop planted in the reach. Crop identification (must be identical to the one of the names on the CR records) and distribution percentage are specified on CP records, by variables CROP1D (CP.1) and CROPAR (CP.2), respectively, for the individual crops.

A constant distribution of crops throughout the entire elevation range is often assumed in study applications. However, a constant distribution may not be representative of the crop distribution pattern for the damage reach. For example, lower areas that flood more frequently may be planted in a more water tolerant crop, whereas adjacent higher grounds are planted in another crop. To adequately reflect a varying crop distribution, unique elevation-area functions for each crop must be used. The distribution of area for each crop is input by CA records. The area values must coincide with the elevation values, EL record, for the reach. To indicate the CA record will be used, a zero is input into the percent distribution (CROPAR)

on the CP record (CP.2). If a positive value appears in CROPAR and a CA record is present, the percent value in CROPAR is ignored. Area values on the CA record are cumulative, so the values must increase.

Table 6 shows the elevation-area relationship used where constant crop distributions are assumed throughout the elevation range as a percentage of the total area on the AR record. Table 7 shows the unique elevation-area distribution for each crop with varying distribution.

TABLE 6
Damage Reach Area Relationships

	Damage Reach Elevation or Stage (feet) (EL Record)	Damage Reach Area (acres) (AR Record)
	5	0
	10	1,000
	17	2,400
	20	7,400
	22	10,000
	24	24,000
	25	50,000
	30	60,000
	40	64,000
	(CP Record)	
Crop A	40%	
Crop B	60%	

2.3.8 Double Cropping. Sometimes, a second crop can be planted in the same field during the same year after the harvest of the first crop. This is called double cropping. The program allows one or more (up to 17) double crops can be specified for a reach. The crop functions for the two crops specified as double crops are conceptually combined into one function based on the CP record variables CRPID (CP.1) and DBCROPID (CP.3). (See Figure 10.) The crop listed in DBCROPID is considered to be the secondary crop and the crop listed in CRPID is the primary crop. Both crop functions must be defined on the CR through C6 records. The damage and benefits of both crops are computed and reported while only the area flooded of the primary crop is computed and reported.

TABLE 7
Unique Crop Area Relationships

Damage Reach Elevation or Stage (EL Record)	Crop A Area (acres) (CA Record)	Crop B Area (acres) (CA Record)
5	0	0
10	400	600
17	960	1,440
20	2,960	4,440
22	4,000	6,000
24	9,600	14,400
25	20,000	30,000
30	24,000	36,000
40	26,600	38,400

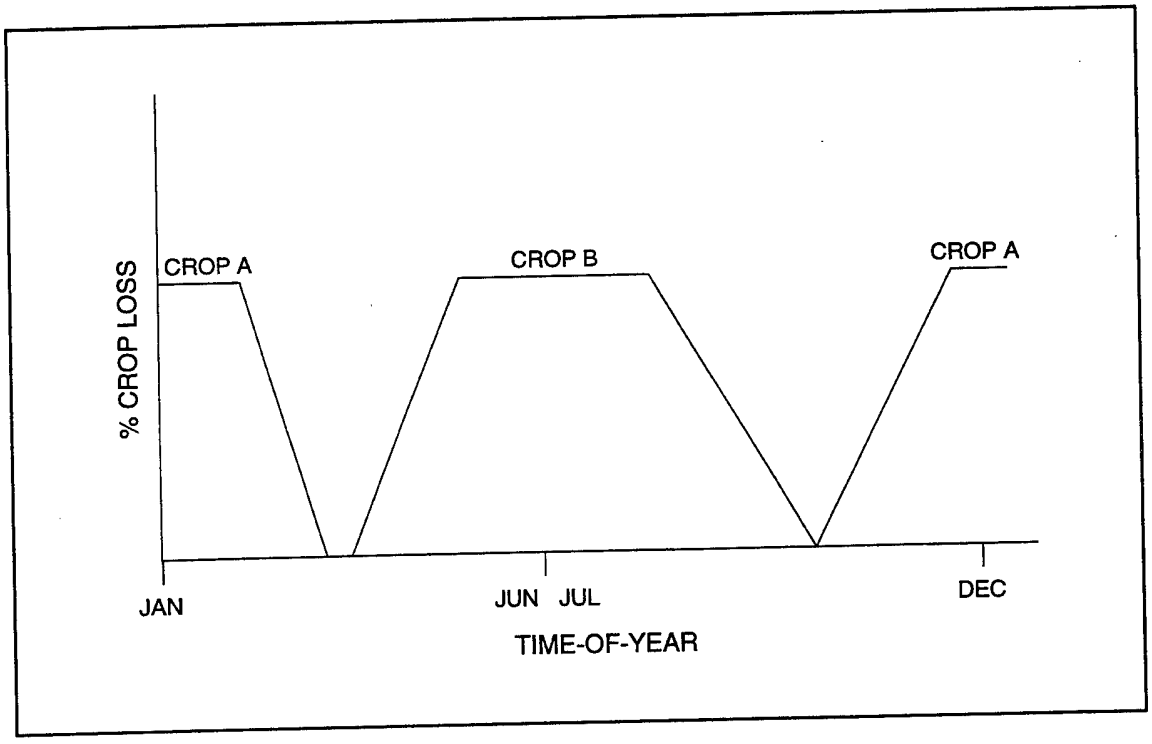


FIGURE 10 Double Crop Loss Function

Crop identifications on the CP records (CP.1 and CP.3) must be unique for each reach. Each primary and secondary crop name must be different than any other in the reach. If a particular crop (say WHEAT) is double cropped with two crops, WHEAT must be given two different names. For example,

```
CP   CORN        50   WHEAT1
CP    SOY        50   WHEAT2
```

If a crop is a primary crop and a double crop, it also needs a unique name.

```
CP   CORN        50   WHEAT1
CPWHEAT1         50   WHEAT2
```

The primary and secondary crop names must match crop identifications on the CR records (CR.1).

2.3.9 Urban Damage Data. Urban damage categories include residential, public, commercial, and industrial buildings, roads, bridges, open space, etc. The analysis of these types of damage are traditionally based on peak flood stages and do not normally consider flood duration or the time of year. However, for multiple flood analyses, a reconstruction period (days to rebuild a damaged structure) may be considered. PREPBA accepts elevation-damage functions for up to 30 urban type damage categories and up to five can be used per defined reach. Damage categories are specified on the UC record.

Elevation-damage relationships are defined for each of the urban categories on the EL and UD records. Up to 30 values may be used to define the damage potential. Table 8 shows the elevation-damage-structures relationships.

TABLE 8
Relationships by Category
Urban Damage and No. of Structures

Damage Reach Elevation or Stage (EL Record)	Urban $ Dam Category A (UD Record)	Urban $ Dam Category B (UD Record)	No. Structures Category A (ST Record)	No. Structures Category B (ST Record)
5	0	0	0	0
10	500	10,000	0	0
17	20,000	80,000	2	6
20	100,000	600,000	4	10
22	900,000	4,000,000	10	22
24	3,000,000	20,000,000	50	300
25	20,000,000	60,000,000	600	2,000
30	40,000,000	110,000,000	1,200	3,500

The reconstruction period for urban damage categories is the time in days required after a flood event to reconstruct the structure to its condition prior to the flood. Typical values might range from 120 to 365 days. Damage from a second event occurring during the reconstruction period is proportioned linearly based on the number of days remaining before the rebuilding is 100 percent completed. The reconstruction time period for each damage category is defined on the UC record by variable RCONST (UC.2).

2.3.10 Order of Reach Records. Table 9 shows the order that the reach data should be in when all data is read from the input file. It also diagrams the order of the records when using a HEC-DSS file to input the data.

TABLE 9
Order of Damage-Reach Records in the Preprocessor Input File

Reach Data Read in from Input File	Reach Data Read in from HEC-DSS File
DR	DR
DB	DB
DL	DL
DS	DS
FS	FS
EL	ZR *
AR	CP or CA
CP or CA	UC
UC	
UD	
ST	

* The ZR record contains the pathname of the HEC-DSS data record which contains the following curves:

Independent Curve	Dependent Curves				
EL	AR	UD1	ST1	UD2	ST2
Required Curve Names:	AREA	UDAM1	STRUT1	UDAM2	STRUT2
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

2.4 Using HEC-DSS to Input Paired Data into HEC-PBA

HEC-DSS is used to manage and process time series and paired-function data. The time-series stage and/or flow hydrographs used by HEC-PBA are read from a HEC-DSS file. Using HEC-DSS is also a convenient way to store and retrieve paired-function data for use in

HEC-PBA. Paired data files can be created with DSSPD (see Section 2.4.2). Input data can be verified by plotting them with HEC-DSS's graphics program, DSPLAY. PREPBA can retrieve the paired-function data from HEC-DSS.

The following section describes HEC-DSS's role in HEC-PBA. For more information, please refer to HEC's publication HEC-DSS User's Guide and Utility Program Manuals (CPD-45), December 1990.

2.4.1 Paired Data Variables. The HEC-PBA package uses three different types of paired data sets: 1) rating tables, 2) crop data, and 3) reach data. Each type is described in the following section.

Rating tables are required for each stream station that has flow data. The rating table is elevation (EV) versus stage (QQ) with elevation as the independent variable and stage as the dependent variable. In giving the rating table a pathname, the A-part contains the name of the river or watershed, the B-part contains the stream gage name or index location, the C-part contains ELEV-FLOW and the D-, E-, and F-parts contain additional descriptors or are left blank. It is important to be consistent in naming the pathname parts.

Crop data are unique for each crop used. They consist of the Julian day of the year (CT), the independent variable, and up to eight dependent curves. The dependent curves are the initial plant loss curve (CI), the late plant loss curve (CL), and at least two and up to six curves for duration loss (C1, C2, . . . C6). In giving the crop data a pathname, the A-part contains the basin, area or river name, the B-part contains the crop name, the C-part contains the data parameters separated by a hyphen (DAY-LOSS), and the D-, E-, and F-parts contain additional descriptors or are left blank.

Reach data are unique for each damage reach. Reach data consist of elevation (EL), the independent variable, and up to twelve dependent variables. The dependent variables are area (AR), up to five urban damage for individual urban damage categories (UD1 through UD5), and number of structures for individual urban damage categories (ST1 through ST5). The order of the dependent variables does not matter, but the following "curve names" must be given to the appropriate curve in the program DSSPD: AREA, UDAM1, STRUT1, UDAM2, STRUT2, . . ., UDAM5 and STRUT5. In giving the reach data a pathname, the A-part contains the basin, area or river name, the B-part contains the reach name, the C-part contains the data parameters separated by a hyphen (i.e., ELEVATION-CURVES) and the D-, E-, and F-parts contain additional descriptors or are left blank.

2.4.2 Storing Paired Data in HEC-DSS. The HEC-DSS input program DSSPD is used to store paired data in HEC-DSS. DSSPD is an interactive program where the user can input attributes about the data relationships as well as input the data relationships themselves. Alternatively, the attributes and data can be entered as a batch job where they are written on lines in a text file, then DSSPD is used to read the text file. If necessary, the data and attributes can later be edited with DSSUTL, a utility program. The HEC-DSS filename is written on PREPBA's run command line.

The following two examples illustrate DSSPD's interactive input and batch input respectively. To run DSSPD in interactive mode, simply type DSSPD at the DOS prompt and answer the queries as shown in Example 1. To run DSSPD in batch mode, create an input file as shown in Example 2, then at the DOS prompt, type **DSSPD IN = <input file name>**.

Example 1
DSSPD Interactive Input Mode
(Rating Table)

```
   DSSPD:  3.4.0 ;  June, 1993

Enter DSS File Name
File = ALLEG.DSS
   -----DSS---ZOPEN:  New File Opened,  File: alleg.dss
                      Unit:  71;  DSS Version: 6-IB

Enter Pathname, or Pathname Part(s), or FINISH
I>/ALLEGANY/ALLO/ELEV-FLOW//1980//
/ALLEGANY/ALLO/ELEV-FLOW//1980//
Enter the number of FLOW curves
Number of Curves: 1
Enter the units of the ELEV data (e.g., CFS, FEET)
Units: FEET
Enter the data type for the ELEV data (e.g., UNT, LOG)
Type: UNT
Enter the units of the FLOW data
Units: CFS
Enter the data type for the FLOW data
Type: UNT
For DSPLAY plots, do you want the ELEV data
to be on the X (horizontal) axis, or on the Y (vertical) axis?
Enter X or Y: Y
Enter a label for the FLOW curve (or blank to store no label)
Label: FLOW
Enter data in pairs (i.e., ELEV, FLOW)
Enter END at the beginning of the line when done.
I>1 100
I>2 200
I>3 300
I>4 400
I>5 500
I>6 600
I>7 700
I>8 800
I>9 900
I>END
-----DSS---ZWRITE Unit  71; Vers.    1:  /ALLEGANY/ALLO/ELEV-FLOW//1980//

Enter Pathname, or Pathname Part(s), or FINISH
I>FINISH
   -----DSS---ZCLOSE Unit:  71,   File: alleg.dss
              Pointer Utilization:  0.25
              Number of Records:      1
              File Size:     11.4  Kbytes
              Percent Inactive:   0.0
```

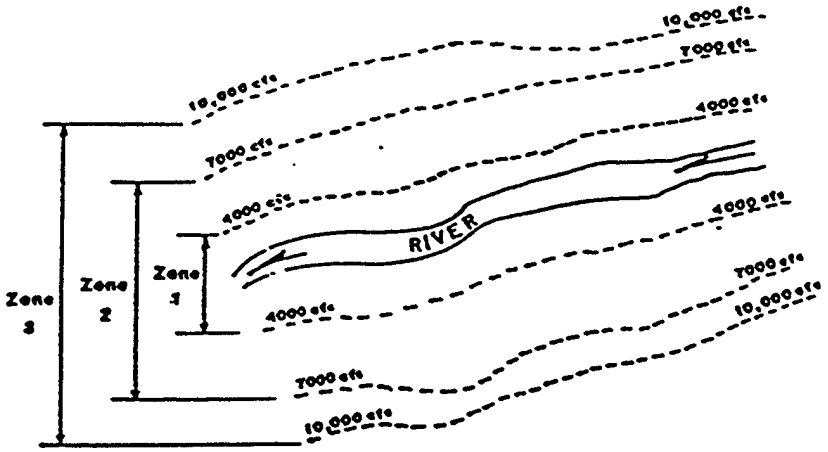
Example 2
DSSPD Batch Input Mode
(Crop Data)

```
ALLEG.DSS
/ALLEGHENY/CORN/DAY-LOSS//1972/SWEET CORN/
7
JULIAN
UNT
PERCENT
UNT
X
INIT-LS
LATE-LS
DUR-0DAY
DUR-1DAY
DUR-2DAY
DUR-3DAY
DUR-4DAY
  1    0   0 0 100 100 100 100
 32    0   0 0 100 100 100 100
 60    6   0 0 100 100 100 100
 91   15   0 0 100 100 100 100
121   30   0 0 100 100 100 100
152   45   0 0 100 100 100 100
171   60  12 0  90 100 100 100
176  100  10 0  60  75 100 100
206  100  42 0 100 100 100 100
220  100  60 0 100 100 100 100
258   60  60 0  50  75 100 100
283   20  20 0  50  75 100 100
304    0   0 0  50  75 100 100
END
FINISH
```

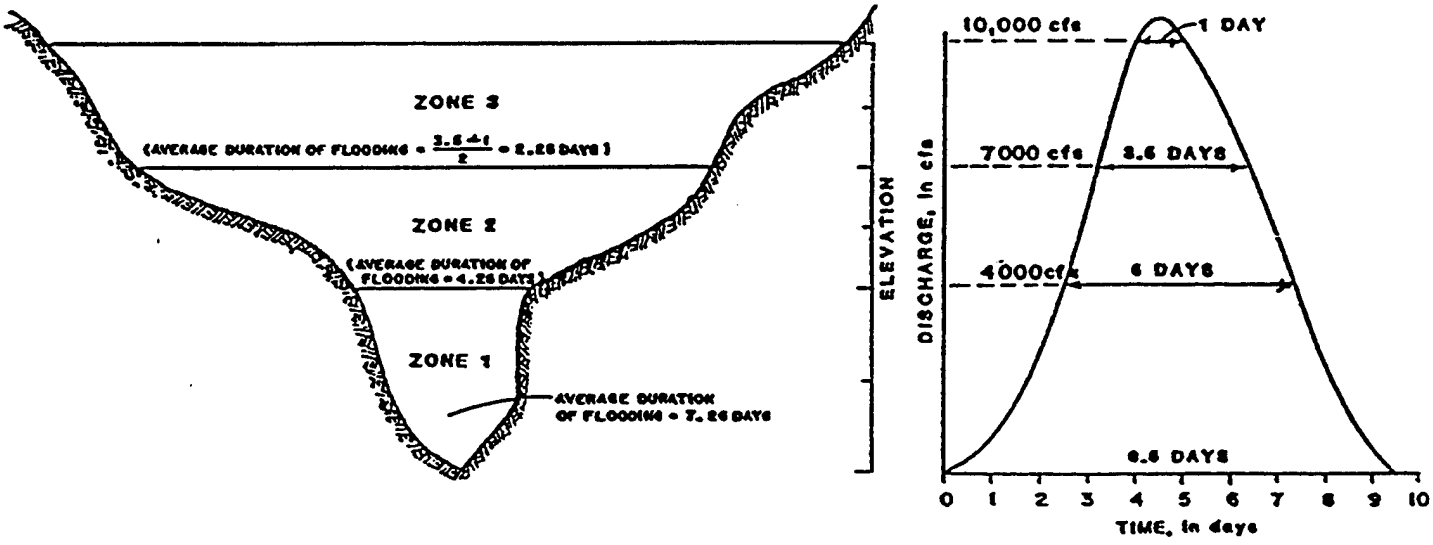
2.5 Flood Zone Concepts

PREPBA divides and stores the damage reach's damage potential data by flood zones for analysis (see Figures 11 and 12). The flood zones are used to assess varying levels of duration damage, dry-out time, and reconstruction periods for the floodplain area between flood events. Damage potential values are developed and stored by crop and urban damage categories, flood zones, and specified watershed and political boundaries for each damage reach.

The delineation of the range of elevations for each zone is based on the damage reach elevation values defined by the EL records. When delineating elevation values, the user should consider the following. The duration and peaks of the without-project condition hydrographs will normally govern the number of zones required, although upstream reservoirs under with-project conditions can produce prolonged flooding in the lower zones of the damage reach. Other factors governing the zone delineation are the start of damage, stage (or discharge), area relationships, and the type of damage categories being evaluated.



TOP VIEW
OF FLOOD PLAIN



CROSS SECTION VIEW OF FLOOD PLAIN

FLOOD HYDROGRAPH

FIGURE 11 Flood Zone Concepts

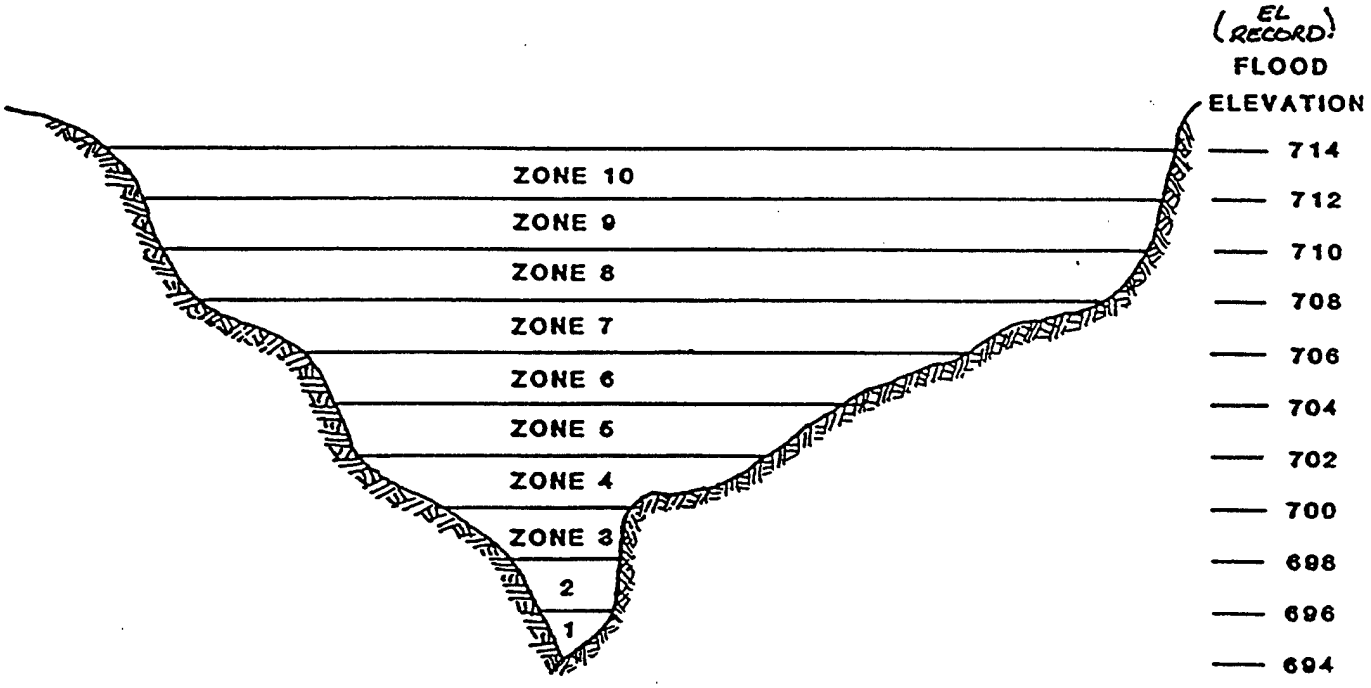


FIGURE 12 Flood Zone Computation Intervals

2.6 Output Display

The output of PREPBA is used primarily to verify that information being processed by PBA is correct. The output includes: crop distribution and damage potential functions; elevation-area-urban damage relationships; and flood zone definitions. The output generated may be substantial. Therefore, suppression options are available for the job on the J1 record. The normal sequence would be initially to output all data and subsequently to suppress information once it is verified. The user may also specify to output or suppress the record image data (the input data are written in the output).

Chapter 3
Preprocessor Program Input Description (PREPBA)

Table of Contents

Section		Page
1	T1, T2 and T3 Records - Job Titles	36
2	J1 Record - Job Control Specifications	37
3	* - Comment Lines	38
4	Boundary Specification Records	39
4.1	BD Record - Corps District Identification	39
4.2	BS Record - State Identification	40
4.3	BC Record - County Identification	41
4.4	BT Record - Township Identification	42
4.5	BW Record - Watershed Identification	43
4.6	BB Record - Subbasin Identification	44
4.7	BG Record - Congressional District Identification	45
4.8	BX Record - Community Identification	46
4.9	BF Record - Flood District Identification	47
5	Stream Index Station Records	48
5.1	PL Record - Levee Identification	48
5.2	PR Record - Reservoir Identification	49
6	Stream Index Station Records	50
6.1	SS Record - Stream Index Location Name	50
6.2	ZU Record - Unmodified Hydrograph HEC-DSS Pathname	51
6.3	ZM Record - Hydrograph HEC-DSS Pathname	52
6.4	EV Record - Stream Index Location Rating Elevation Values	53
6.5	QQ Record - Stream Index Location Rating Flow Values	54
6.6	ZT Record - Rating Table HEC-DSS Pathname	55
7	Job Crop Records - Damage Functions	56
7.1	CR Record - Crop Production Data	56
7.2	CS Record - Seasonal Crop Data	57
7.3	CT Record - Julian Days of Year	58
7.4	CI Record - Crop Loss Function For Initial Planting	59
7.5	CL Record - Crop Loss Function for Latest Planting	60

Table of Contents (continued)

Section **Page**

7.6 CD Record - Duration Values 61
7.7 C1-C6 Records - Percent Loss From Flood Duration 62

7.7.1 C1 Record - Duration Loss Values 62
7.7.2 C2 Record - Duration Loss Values 63
7.7.3 C3-C6 Records - Duration Loss Values 63

7.8 ZC Record - Pathname for Crop Information Stored in HEC-DSS 64

8 Damage Reach 65

8.1 DR Record - Damage Reach Specifications 65
8.2 DB Record - Damage Reach Boundary Specifications 66
8.3 DL Record - Levee Project Specifications 67
8.4 DS Record - Reservoir Project Specifications 68
8.5 FS Record - Flood Stage Value 68
8.6 ES Record - Water Surface Elevation Values at the Stream Station for the Hydrograph Transfer Relationship 69
8.7 EI Record - Water Surface Elevation Values at the Index Location for the Hydrograph Transfer Relationship 70
8.8 ZR Record - Pathname for Reach Information Stored in HEC-DSS 71
8.9 EL Record - Damage Reach Elevation Values 72
8.10 AR Record - Damage Reach Area Values 73
8.11 CP Record - Damage Reach Crop Specifications 74
8.12 CA Record - Individual Crop Area Values 75
8.13 UC Record - Urban Damage Specifications 76
8.14 UD Record - Urban Damage Values 77
8.15 ST Record - Number of Structures 78

9 EJ Record - End of Job 79

Table 10 can be used to assist the user in putting the data in the correct field. **NOTE: Data should be right justified in each field unless otherwise stated.** PREPBA requires data to be in the proper columns for it to run correctly. Many initial errors may be due to improperly justified input.

TABLE 10
Column Numbers Associated with
Field Numbers in Input Files

Field	Column
0	1 - 2
1	3 - 8
2	9 - 16
3	17 - 24
4	25 - 32
5	33 - 40
6	41 - 48
7	49 - 56
8	57 - 64
9	65 - 72
10	73 - 80

T1-T3

HEC-PBA Input Description
Preprocessor Program (PREPBA)

1 T1, T2 and T3 Records - Job Titles

These three records are required to provide three lines of information at the top of each page of output.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	T1, T2, T3	Record identification (3 records).
1-10	TT	AN*	Title information (center of title falls in record column 41).

*NOTE: **AN** indicates an **Alphanumeric** identifier which is a variable label or a title consisting of letters and/or numbers.

Example:

```
T1 ANNADELL RIVER BASIN - JACKSON TO JILLISON
T2 Developed NOVEMBER 7, 1991
T3  by Donna Lydon at HEC
```

2 J1 Record - Job Control Specifications

The required J1 record specifies the type of analysis to be performed and the record listing and printout options.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	J1	Record identification.
1	LISTINPT	0	A listing of the input records from the PREPBA input file is printed.
		1	A listing of the input records from the PREPBA input file is not printed.
2	IMAGE	0	A detailed listing of the input records from the PREPBA input file is printed.
		1	A detailed listing of the input records from the PREPBA input file is not printed.
3	TPRINT	0	The elevation-area-damage relationship tables for all damage reaches are output.
		1	The elevation-area-damage relationships tables for all damage reaches are not output.
4	DSSTC	0	HEC-DSS trace output is printed (if input is supplied through a HEC-DSS file).
		1	HEC-DSS trace output is not printed.

Example:

```
J1      0       0       1       1
```

3 * - Comment Lines

This is a comment record that is printed only with the input echo listing. The comment occupies columns 2 through 80. Any number of comment records may be inserted at any point in the input data stream, however, the first comment record may not be inserted until after the J1 record. Use comment records often to increase readability of the data set.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	LINE (1)	*	Record
1-10	LINE (2:80)	AN	User comments on the data set.

Example:

```
* Crop Functions for Alpha and Beta Counties
```

4 Boundary Specification Records

The "B" records define the boundary data used to aggregate and display the results for the PBA program. The boundary type data specified may include Corps Districts, states, counties, townships, watersheds, subbasins, congressional districts, communities, and flood control districts.

4.1 BD Record - Corps District Identification

The optional BD record defines Corps of Engineers Districts that may be specified by damage reach locations for analysis. A BD record is required for each Corps District to be included in the output summaries of PBA. Up to five BD records are allowed.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	BD	Record identification.
1	DIST	AN	Alphanumeric identification of U. S. Army Corps of Engineers District (six characters). Used to specify Districts for damage reach data aggregation for output summaries. Must be consistent with identification specified by variable DIST (DB.1). (Right justify in field.)
2-3	DISTIT	AN	Alphanumeric title of Corps District for output summaries. (Up to 16 characters).

Example:

```
BD CESWT  TULSA DISTRICT
```

4.2 BS Record - State Identification

The optional BS record is required when output summaries by states are desired. A BS record identifies each state to be included in output summaries for PBA. STATE is used to summarize damage by congressional district and county. Up to five BS records are allowed.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	BS	Record identification.
1	STATE	AN	Alphanumeric identification of states (six characters). Used to specify states for damage reach data aggregation for output summaries on DB records. Must be consistent with identification specified by variable STATE (DB.2). (Right justify in field.)
2-3	STATIT	AN	Alphanumeric title of state for output summaries (16 characters).

Example:

```
BS    OK        OKLAHOMA
```

4.3 BC Record - County Identification

The optional BC record is required when output summaries by county categories are desired. A BC record is required for each county to be included in the output summaries of PBA. Up to 50 BC records are allowed.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	BC	Record identification.
1	COUNTY	AN	Alphanumeric identification of county (six characters). Used to specify counties for damage reach data aggregation for output summaries. Must be consistent with identification specified by variable COUNTY (DB.3). (Right justify in field.)
2-3	CUNTIT	AN	Alphanumeric title of county for output summaries (16 characters).

Example:

```
BC ALPHA     ALPHA COUNTY
BC  BETA      BETA COUNTY
```

4.4 BT Record - Township Identification

The optional BT record is required when output summaries by townships are desired. A BT record is required for each township to be included in the output summaries of PBA. Up to 100 BT records are allowed.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	BT	Record identification.
1	TOWN	AN	Alphanumeric identification of townships (six characters) used to specify townships for damage reach data aggregation for output summaries. Must be consistent with identification specified by variable TOWN (DB.4). (Right justify in field.)
2-3	TWNTIT	AN	Alphanumeric title of township for output summaries (16 characters).

Example:

```
BT GARRI GARRISON TWNSHP
```

4.5 BW Record - Watershed Identification

The optional BW record is required when output summaries by watersheds are desired. A BW record is required for each watershed to be used in PBA output summaries. WATSHD is used is used to summarize damage by damage reach, flood control district, levee project and reservoir project. Up to 5 BW records are allowed.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	BW	Record identification.
1	WATSHD	AN	Alphanumeric identification of watershed (six characters). Used to specify watersheds for damage reach data aggregation and output summaries. Must be consistent with identification specified by variable WATSHD (DB.5). (Right justify in field.)
2-3	WATIT	AN	Alphanumeric title of watershed for output summaries (16 characters).

Example:

```
BW ANNAD ANNADELL WTRSHD
```

4.6 BB Record - Subbasin Identification

The optional BB record is required when output summaries by subbasins are desired. A BB record is input for each subbasin included in the output summaries of PBA. SUBASIN is used is used to aggregate damage by damage reach and flood control district. Up to 100 BB records are allowed.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	BB	Record identification.
1	SUBASN	AN	Alphanumeric identification of subbasins (six characters). Used to specify subbasins for damage reach data aggregation for output summaries. Must be consistent with identification specified by variable SUBASN (DB.6). (Right justify in field.)
2-3	SBSTIT	AN	Alphanumeric title of subbasin for output summaries (16 characters).

Example:

```
BB TANNE TANNER SUBBASIN
```

4.7 BG Record - Congressional District Identification

The optional BG record is required when output summaries by congressional district are desired. A BG record is input for each congressional district to be included in the output summaries of PBA. Up to 25 BG records are allowed.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	BG	Record identification.
1	CONG	AN	Alphanumeric identification of the congressional district (six characters). Used to specify congressional district for damage reach data aggregation for output summaries. Must be consistent with identification specified by variable CONGR (DB.7). (Right justify in field.)
2-3	CNGTIT	AN	Alphanumeric title of congressional district for output summaries (16 characters).

Example:

```
BG CNGR1 REP JANET JONES
BG CNGR2 REP SHAWN SMITH
```

4.8 BX Record - Community Identification

The optional BX record specifies the community where the damage reach is located. A BX record is required for each community to be specified in the output summaries of PBA. Up to 25 BX records are allowed.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	BX	Record identification.
1	CMNTY	AN	Alphanumeric identification communities (six characters). Used to specify communities for damage reach data aggregation for output summaries. Must be consistent with identification specified by variable CMNTY (DB.8). (Right justify in field.)
2-3	CMNTIT	AN	Alphanumeric title of community for output summaries (16 characters).

Example:

```
BX JACKS JACKSON COMUNTY
BX JILLI JILLISON COMNTY
```

4.9 BF Record - Flood District Identification

The optional BF record specifies the flood district where the damage reach is located. A BF record is input for each flood district to include in the output summaries of PBA. Up to 25 BF records are allowed.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	BF	Record identification.
1	FLDIST	AN	Alphanumeric identification of flood control districts (six characters). Used to specify flood control districts for damage reach data aggregation for output summaries. Must be consistent with identification specified by variable FLDIST (DB.9). (Right justify in field.)
2-3	FLDTIT	AN	Alphanumeric title of flood control district for output summaries (16 characters).

Example:

```
BF BLUEF  BLUEFISH FLDIST
```

5 Project Records

The project records specify the projects used in the analysis. All reservoirs and levees in the system must be defined.

5.1 PL Record - Levee Identification

The optional PL record is required when there are levees in the system being analyzed. A PL record is input for each levee included in a damage reach (only one levee per damage reach). The benefits allocated to levees are summarized by watershed. Up to 50 PL records are allowed for the entire system.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	PL	Record identification.
1	LEVID	AN	Alphanumeric identification of levees (six characters). Used to specify levees for damage reach data aggregation for output summaries. Must be consistent with identification specified by variable LEVRCH (DL.1). (Right justify in field.)
2-3	LEVTIT	AN	Alphanumeric title of levee for output summaries (16 characters).

Example:

```
PL JKLEV   JACKSON LEVEE
```

5.2 PR Record - Reservoir Identification

The optional PR record is required when there are reservoirs in the system being analyzed. A PR record is input for each reservoir included in any damage reach (only five reservoirs per damage reach). The benefits allocated to reservoirs are summarized by watershed. Up to 30 PR records are allowed for the entire system.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	PR	Record identification.
1	RESID	AN	Alphanumeric identification of reservoirs (six characters). Used to specify reservoirs for damage reach data aggregation for output summaries. Must be consistent with identification specified by variable RESRCH (DS.1). (Right justify in field.)
2-3	RESTIT	AN	Alphanumeric title of reservoir for output summaries (16 characters).

Example:

```
PR COOPR  COOPER RESERVR
PR GRAND      GRAND LAKE
```

6 Stream Index Station Records

The stream index station records (SS, ZH, EV and QQ or ZT records) are input to define hydrograph data used at corresponding damage reaches to perform the flood damage and project accomplishment analysis. The ZH record identifies the pathname of where hydrograph data are located in HEC-DSS to be used by PBA. The EV and QQ records are rating table relationships (EV is elevation data and QQ is discharge data) used to convert HEC-DSS flow hydrograph data to stage hydrograph data. For each stream index location, data must be entered in this order: SS, ZH, EV and QQ. For example, Stream Station-1: SS, ZH, EV, QQ; Stream Station-2: SS, ZH, EV, QQ; etc. Alternately, the rating table relationship can be read from HEC-DSS with the ZT record. In this case the order is SS, ZH, ZT. Up to 100 stream index stations are permitted.

6.1 SS Record - Stream Index Location Name

A SS record is required for each stream index location specified on the following damage reach records. Several damage reaches may specify the same set of stream station records for analysis.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	SS	Record identification.
1		BLANK	
2	STRMSTA	AN	Eight character stream index record name which must be identical to STRMLOC on the DR record (DR.2). (Right justify in field.)

Example:

```
SS        BLUGAGE
```

6.2 ZU Record - Unmodified Hydrograph HEC-DSS Pathname

The ZU record is required to obtain unmodified hydrograph data for this scream index location from a HEC-DSS file. The ZU record specifies the pathname for retrieving the unmodified (without-project) condition hydrograph. After the record identification, this record is free format and requires the pathname parts used in the HEC-DSS file[1].

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	ZU	Record identification.
1-10		"A="AN	HEC-DSS pathname Part A.
		"B="AN	HEC-DSS pathname Part B.
		"E="AN	HEC-DSS pathname Part E[2].
		"F="AN	HEC-DSS pathname Part F.

NOTE: HEC-DSS requires pathnames in the following format:

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

Where A is the "group" - the watershed name, river name etc.
B is the "location" - the stream index location, gage name, etc.
E is the "time interval" - e.g., 1DAY, 12HOUR, etc.
F is a "descriptor" - a word which further describes the data, e.g., OBSERVED, NATURAL, etc.

Example:

```
ZU  A=ANNADELL B=BLUGAGE E=1DAY F=NATURAL
```

---

[1]HEC-PBA expects Part C to be either **STAGE** or **FLOW** only; one of these must be used in the HEC-DSS pathname, but it is not written on the ZU record.

[2]Must be one of the valid HEC-DSS data intervals:

1HOUR, 2HOUR, 3HOUR, 4HOUR, 6HOUR, 8HOUR, 12HOUR 1DAY

6.3 ZM Record - Hydrograph HEC-DSS Pathname

The EM record is required to obtain modified hydrograph data for this stream index location from a HEC-DSS file. The ZM record specifies the pathname for retrieving the hydrograph data. After the record identification, this record is free format and requires the pathname parts used in the HEC-DSS file[1]. If the ZM record is omitted, the modified condition hydrograph is assumed to be the same as the unmodified condition hydrograph.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	ZM	Record identification.
1-10		"A="AN	HEC-DSS pathname Part A.
		"B="AN	HEC-DSS pathname Part B.
		"E="AN	HEC-DSS pathname Part E[2].
		"F="AN	HEC-DSS pathname Part F.

NOTE: HEC-DSS requires pathnames in the following format:

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

Where A is the "group" - the watershed name, river name etc.
B is the "location" - the stream index location, gage name, etc.
E is the "time interval" - e.g., 1DAY, 12HOUR, etc.
F is a "descriptor" - a word which further describes the data, e.g., OBSERVED, NATURAL, etc.

Example:

```
ZM  A=ANNADELL B=BLUGAGE E=1DAY F=REGULATED
```

---

[1]HEC-PBA expects Part C to be either **STAGE** or **FLOW** only; one of these must be used in the HEC-DSS pathname, but it is not written on the ZM record.

[2]Must be one of the valid HEC-DSS data intervals:

1HOUR, 2HOUR, 3HOUR, 4HOUR, 6HOUR, 8HOUR, 12HOUR 1DAY

6.4 EV Record - Stream Index Location Rating Elevation Values

The optional EV records are required if flow hydrographs are used. The corresponding discharge values are input on QQ records. The EV values must be in ascending order and have the same number of values as the QQ record. The rating table may be input on the EV and QQ records **or** read from a HEC-DSS file with the ZT record.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	EV	Record identification.
1	EV(1)	+	Elevation corresponding to zero flow input by QQ (1).
2	EV(2)	+	Elevation corresponding to QQ(2).
3-18	EV(n)	+	Elevation corresponding to QQ(n). Up to 30 values may be input.

Example:

```
EV    0    10    14    15    17    19    21    25
```

6.5 QQ Record - Stream Index Location Rating Flow Values

The optional QQ records are required if flow hydrographs are used. The values correspond to elevation values input by the EV record.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	QQ	Record identification.
1	QQ(1)	+	Flow corresponding to EV(1). Must be zero.
2	QQ(2)	+	Flow corresponding to elevation EV(2).
3-18	QQ(n)	+	Flow corresponding to elevation EV (n).

Example:

```
QQ    0   12000   20000   26000   32000   39000   47000   70000
```

6.6 ZT Record - Rating Table HEC-DSS Pathname

The ZT record may be used instead of the EV and QQ records to retrieve rating table data for this stream index location from a HEC-DSS paired data file. The ZT record specifies the pathname for retrieving the rating table. After the record identification, this record is free format and requires all the pathname parts used in the HEC-DSS file. If a pathname part is blank, the "'letter'= " is not needed.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	ZT	Record identification.
1-10		"A="AN	HEC-DSS pathname Part A.
		"B="AN	HEC-DSS pathname Part B.
		"C="AN	HEC-DSS pathname Part C.
		"D="AN	HEC-DSS pathname Part D.
		"E="AN	HEC-DSS pathname Part E.
		"F="AN	HEC-DSS pathname Part F.

NOTE: HEC-DSS expects rating table pathnames in the following format:

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

Where A is the "group" - the watershed name, river name etc.
B is the "location" - the site name, gaged location, etc.
C is the "parameters" - the data parameters separated by a hyphen (e.g., ELEV-FLOW).
D is the "optional descriptor" - further describes data, often is left blank.
E is the "time descriptor" - can be year or date the curve was developed or left blank.
F is a "general descriptor" - a word which generally describes the data, such as who developed the curve (e.g., USGS) or left blank.

Example:

```
ZT A=ANNADELL     B=JILGAGE    C=ELEV-FLOW  E=1982  F=USGS
```

7 Job Crop Records - Damage Functions

A set of crop records (CR, CS, CT, CI, CL, CD and C1-C6 records) is input to define the potential crop loss versus time-of-year relationship for each crop. If crop damage is to be computed, the CR, CS, CT, CI, CL, CD and C1-C6 records are required to define the crop and production characteristics, such as: yield; unit price; cultivation, constant and harvest costs; dry-out periods, and critical dates. The CI records define the loss potential for the initial planting cycle of the greatest yield. The CL records define the latest plant cycle with a reduced yield. These values are necessary for multiple flood analyses. Alternately, the information from the CT, CI, CL and C1-C6 records can be input into HEC-DSS then retrieved with the ZC record. In this case, the order of the records is CR, CS, ZC, CD. Up to 18 crops are permitted.

7.1 CR Record - Crop Production Data

The CR record is required for analyzing crop data. This record specifies the type of crop, unit price, and costs associated with cultivation, pre-harvest, and harvest of the crop.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	CR	Record identification.
1	CROPID	AN	Crop identification (corn, wheat, etc.) (six characters).
2	CYA	+	Yield per acre of crop (in tons, bushels, pounds, etc.). The value is multiplied by variable CUP (CR.4) to obtain the value per acre at harvest.
3	CRUNIT	AN	Unit of yield (ton, pound, etc.).
4	CUP	+	Unit price value of crop (dollars per bushel, ton, etc.).
5	HRVCST	+	Harvest cost in dollars per acre.
6	ADLOSS	+	Factor for calculating additional business and infrastructure losses. Value must be between zero and 100 (i.e., 50% is entered as 50). Multiplied by the crop damage.
7-8	CRPTIT	AN	An alphanumeric crop title to be used in output summaries (16 characters).

Example:

```
CR WHEAT   30.00      BU    2.77   11.76            WINTER WHEAT
```

7.2 CS Record - Seasonal Crop Data

The required CS record specifies the type of crop, and Julian dates associated with the first and last days that crops can reach a full or reduced yield. Julian days range from 1 to 366.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	CS	Record identification.
1	CROPID	AN	Crop identification (corn, wheat, etc.).
2	FSTPLT	+	Julian day for the first date of the season planting will occur.
3	FULYLD	+	Julian day for the last date planting can occur without reduction in yield.
4	LSTPLT	+	Julian day for latest date planting can occur with a reduction in yield.
5	ENDHRVST	+	Julian day for the completion of harvest (the end of the growing season).
6	DRYOUT	+	Dry-out period in days after flood event. Must be between zero and 366.

Example:

```
CS WHEAT     217     248     319     111       7
```

7.3 CT Record - Julian Days of Year

The required CT record specifies the Julian day of the calendar year corresponding to the crop loss and duration loss adjustments on the CI, CL, and C1-C6 records, respectively. A maximum of 30 Julian days may be input to define the crop loss and duration data. Julian days range from 1 to 366.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	CT	Record identification.
1	CDAY(1)	+	Julian day of the calendar year associated with first field values on the CI, CL and C1-C6 records. (Examples are January 15 input as 15, March 1, input as 31+28+1 or 60. See Table 2.)
2	CDAY(2)	+	Julian day associated with second field values on CI, CL and C1-C6 records.
3-30	CDAY(n)	+	Julian day associated with n-field values on CI, CL and C1-C6 records. A maximum of 30 values may be input. The eleventh value is input on first field of second CT record.

Example:

```
CT    1   60   74   84   89  120  166  176  186  191
CT  217  227  232  242  248  258  268  288  319  365
```

7.4 CI Record - Crop Loss Function For Initial Planting

The CI record defines the crop loss function for initial planting. Potential crop loss values are input as percentages associated with the Julian calendar days input on the CT record. For example, 20% is entered as 20. Must have same number of values as CT record.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	CI	Record identification.
1	ILOSS(1)	+	Percent loss associated with day of calendar year CDAY1 (CT.1).
2	ILOSS(2)	+	Percent loss associated with day of calendar year CDAY2 (CT.2).
3-30	ILOSS(n)	+	Percent loss associated with day of calendar year CDAYn (CT.n). A maximum of 30 values may be input that corresponds to Julian day values. The eleventh value is input on first field of second CI record.

Example:

```
CI   63   65   67   83   100  100  100  53   21   0
CI   0    3    6    11   14   20   27   41   55   55
```

7.5 CL Record - Crop Loss Function for Latest Planting

The required CL record is required for multiple flood analysis. The crop loss function is defined for the latest possible replant conditions. Yields are considered reduced over those of initial planting. The program assumes the replant loss potential by linearly interpolating between the initial and latest plant crop loss functions. Percent values are entered as integers; 20% is entered as 20. Must have same number of values as CT record.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	CL	Record identification.
1	LLOSS(1)	+	Percent loss associated with the Julian day of the calendar year CDAY1 (CT.1).
2	LLOSS(2)	+	Percent loss associated with the Julian day of the calendar year CDAY2 (CT.2).
3-30	LLOSS(n)	+	Percent loss associated with the Julian day of the calendar year CDAY(n) (CT.n). A maximum of 30 values may be input that corresponds to Julian day values. The eleventh value is input on first field of second CL record.

Example:

```
CL   10   20   26   31   34   53   53   53   21    0
CL    0    0    0    0    0    0    0    0    0    5
```

7.6 CD Record - Duration Values

The required CD record specifies duration of flooding values. The values are flood duration in days associated with the percent damage values input on the following C1-C6 records. There must be at least one duration greater than zero (i.e., values are required in DUR(1) and DUR (2)). Fractions of days are acceptable (e.g., 2.5 days).

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	CD	Record identification.
1	DUR(1)	+	Flood duration value in days associated with percent loss values input on C1 records. Normally input as zero (zero-days duration).
2	DUR(2)	+	Flood duration value in days associated with percent loss values input on C2 records.
3-6	DUR(n)	+	Same as above for up to six sets of values. Typical durations may be 1 day, 3 days, 7 days, 14 days, etc.

Example:

```
CD    0      1      2      3      4
```

7.7 C1-C6 Records - Percent Loss From Flood Duration

The C1 through C6 records specify the percent adjustment to the crop loss functions (CI and CL records) due to the duration of flooding. The C1 records correspond to duration values for DUR(1) (CD.1); the C2 record DUR(2) (CD.2), etc., and to the Julian dates on the CT record. C1 through C6 must have the same number of values as the CT record. Minimally, the C1 and C2 records are required.

7.7.1 C1 Record - Duration Loss Values

This record specifies the percent adjustment to crop loss function values due to duration of flooding. Each value corresponds to an input Julian calendar day of the year on the CT record. The values correspond to the duration specified by variable DUR(1) (CL.1). Values on the C1 record typically refer to zero days of flooding (loss potential zero). Percent values are entered as integers; 0% is entered as 0.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	C1	Record identification.
1	PCTDAM(1,1)	+	Percent loss of crop corresponding to duration of flooding specified by DUR(1) (CD.1), and day of calendar year CDAY(1) (CT.1). (For zero-day duration, zero percent loss values associated with each day on the CT record.)
2	PCTDAM(2,1)	+	Percent loss of crop corresponding to duration of flooding specified by DUR(1) (CD.1) and day of calendar year CDAY(2) (CT.2).
3-30	PCTDAM(n,1)	+	Same as above for each day of calendar year input on CT record.

Example:

```
C1  0  0  0  0  0  0  0  0  0  0
C1  0  0  0  0  0  0  0  0  0  0
```

7.7.2 C2 Record - Duration Loss Values

The C2 record specifies percent crop loss values associated with variable DUR(2) (CD.2) and each day of calendar year input on CD records. Percent values are entered as integers; 20% is entered as 20.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	C2	Record identification.
1	PCTDAM(1,2)	+	Percent loss of crop corresponding to duration of flooding specified by DUR(2) (CD.2), and day of calendar year CDAY(1) (CT.1).
2	PCTDAM(2,2)	+	Percent loss of crop corresponding to duration of flooding specified by DUR(2) (CD.2), and day of calendar year CDAY(2) (CT.2).
3-30	PCTDAM(n,2)	+	Same as above for duration value and each day of calendar record.

Example:

```
C2   25   25   25   25   25   25   25   25   25    0
C2    0   25   25   25   25   25   25   25   25   25
```

7.7.3 C3-C6 Records - Duration Loss Values

These records continue the percent damage by duration input for each duration specified on the CD record and day of the calendar year specified on the CT record.

Example:

```
C3   50   50   50   50   50   50   50   50   50    0
C3    0   50   50   50   50   50   50   50   50   50
C4   75   75   75   75   75   75   75   75   75    0
C4    0   75   75   75   75   75   75   75   75   75
C5  100  100  100  100  100  100  100  100  100    0
C5    0  100  100  100  100  100  100  100  100  100
```

7.8 ZC Record - Pathname for Crop Information Stored in HEC-DSS

The ZC record may be used instead of the CT, CI, CL, and C1 through C6 records to obtain the crop information from a HEC-DSS paired data file. The ZC record specifies the pathname for retrieving the crop information. After the record identification, this record is free format and requires all the pathname parts used in the HEC-DSS file. If a pathname part is blank, the "'letter'= " is not needed.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	ZC	Record identification.
1-10		"A="AN	HEC-DSS pathname Part A.
		"B="AN	HEC-DSS pathname Part B.
		"C="AN	HEC-DSS pathname Part C.
		"D="AN	HEC-DSS pathname Part D.
		"E="AN	HEC-DSS pathname Part E.
		"F="AN	HEC-DSS pathname Part F.

NOTE: HEC-DSS expects paired data pathnames in the following format:

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

Where A is the "group" - the basin, area, or river name.
B is the "crop" - the crop name.
C is the "parameters" - the data parameters separated by a hyphen: DAY-LOSS.
D is the "optional descriptor" - further describes data, often is left blank.
E is the "time descriptor" - can be year or date the curve was developed or left blank.
F is a "general descriptor" - a word which generally describes the data, such as who developed the curves (e.g., USDA) or left blank.

Example:

```
ZC A=ANNADELL  B=WHEAT   C=DAY-LOSS  E=1947  F=WINTER WHEAT
```

8 Damage Reach

The damage reach records (DR, ZR, DB, DL, DC, DS, EL, AR, CP, CA, UC, UD, ST, and PO records) specify damage reach data and criteria used for subsequent analysis by PBA. The records define the watershed and political boundaries, crop damage categories, and elevation-discharge-area-urban damage relationships for with- and without-project conditions.

8.1 DR Record - Damage Reach Specifications

Required record used to indicate damage reach specifications and subsequent input requirements.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	DR	Record identification.
1	DRID	AN	Alphanumeric identification of this damage reach (six characters).
2	STRMLOC	AN	Stream index location or gage name (eight characters) to be used for hydrographs in analysis. Must be identical to a STRMSTA (SS.2) name. (Must also be right justified in field.)
3-10	DRTIT	AN	Alphanumeric title for damage reach (56 characters).

Example:

```
DR  RCH1 BLUGAGE        0   ANNADELL RIVER--COOPER LAKE TO BLUEFISH RIVER
```

8.2 DB Record - Damage Reach Boundary Specifications

The required DB record is used to define the location of the damage reach with regards to watershed and political boundaries. The damage reach is the smallest unit. The specified boundaries are used in aggregation of damage reach data for output summaries. Variable names must be **right justified** and **identical** to the names used on the "B" records.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	DB	Record identification.
1	DRDIST	AN	Alphanumeric identification (BD record) of Corps District where damage reach is located (six characters).
2	DRSTATE	AN	Alphanumeric identification of state (BS record) where damage reach is located (six characters).
3	DRCOUNTY	AN	Alphanumeric identification of county (BC record) where damage reach is located (six characters).
4	DRTOWN	AN	Alphanumeric identification of township (BT record) where damage reach is located (six characters).
5	DRWATER	AN	Alphanumeric identification of watershed (BW record) when damage reach is located (six characters).
6	DRSUBBAS	AN	Alphanumeric identification of subbasin (BB record) where damage reach is located (six characters).
7	DRCONG	AN	Alphanumeric identification of congressional district (BG record) where damage reach is located (six characters).
8	DRCMNTY	AN	Alphanumeric identification of community/ district (BX record) where damage reach is located (six characters).
9	DRFLDCTL	AN	Alphanumeric identification of flood control district (BF record) where damage reach is located (six characters).

Example:

```
DB CESWT      OK   ALPHA   GARRI   ANNAD   TANNE   CNGR1   JACKS   BLUEF
```

8.3 DL Record - Levee Project Specifications

The DL record is required when a levee project is to be analyzed for the damage reach. Only one levee project may be analyzed for a damage reach. If more than one levee is in the damage reach, divide the damage reaches. The levees listed here must be one of the 50 possible levees listed on the PL records.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	DL	Record identification.
1	LEVRCH	AN	Alphanumeric identification (six characters) associated with this levee project. Used to aggregate damage for output summaries. Must be identical to one of the levee identifications or the PL records. (Right justify in field.)
2	LEVTOP	+	Elevation of levee where failure is assumed to occur. The top of the levee must be within the range of values on the EL record specified for the reach associated with this levee.

Example:

```
DL JKLEV      12
```

8.4 DS Record - Reservoir Project Specifications

A DS record is required for each reservoir project that affects the damage reach. A maximum of five reservoir projects may be analyzed for a given damage reach. The benefits of the project are proportioned based on specifications in PBA. The reservoirs listed here must be one of the 30 possible reservoirs listed in the PR records.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	DS	Record identification.
1	RESRCH	AN	Alphanumeric identification (six characters) associated with this reservoir project. Must be identical to one of the reservoir identifications RESID (PR.1) on the PR records. (Right justify in field.)

Example:

```
DS COOPR
```

8.5 FS Record - Flood Stage Value

The flood stage is the elevation associated with the zero damage. In other words, it is the highest elevation that has zero damage. This value must be one of the values on the EL Record. If the FS record is missing, the flood stage is assumed to be the first value on the EL record.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	FS	Record identification.
1	FS(1)	+	Zero damage elevation.

Example:

```
FS     6
```

8.6 ES Record - Water Surface Elevation Values at the Stream Station for the Hydrograph Transfer Relationship

If the water surface elevations are not the same at the stream station and index location for a particular reach, the optional ES and EI records are used. The ES and EI records together provide a relationship which permits PBA to transfer the hydrograph data from the stream station to the index location. Intermediate hydrograph values are interpolated. Damage is then computed at the index location.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	ES	Record identification.
1	ES(1)	+	First elevation value.
2	ES(2)	+	Second elevation value.
3-30	ES(n)	+	Continue for up to 30 values.

Example:

```
ES    0    5    7    9    11   13   15   17   19   29
```

8.7 EI Record - Water Surface Elevation Values at the Index Location for the Hydrograph Transfer Relationship

If the water surface elevations are not the same at the stream station and index location for a particular reach, the optional ES and EI records are used. The ES and EI records together provide a relationship which permits PBA to transfer the hydrograph data from the stream station to the index location. Intermediate hydrograph values are interpolated. Damage is then computed at the index location.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	EI	Record identification.
1	EI(1)	+	First elevation value.
2	EI(2)	+	Second elevation value.
3-30	EI(n)	+	Continue for up to 30 values.

Example:

```
EI   0.1    5.2    7.4    9.6    11.8   13.9   15.5   17.8   20.0   30.0
```

8.8 ZR Record - Pathname for Reach Information Stored in HEC-DSS

The ZR record may be used instead of the EL, AR, UD, and ST records to obtain the reach information from a HEC-DSS paired data file. The ZR record specifies the pathname for retrieving the reach information. After the record identification, this record is free format and requires all the pathname parts used in the HEC-DSS file. If a pathname part is blank, the "'letter'= " is not needed.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	ZR	Record identification.
1-10		"A="AN	HEC-DSS pathname Part A.
		"B="AN	HEC-DSS pathname Part B.
		"C="AN	HEC-DSS pathname Part C.
		"D="AN	HEC-DSS pathname Part D.
		"E="AN	HEC-DSS pathname Part E.
		"F="AN	HEC-DSS pathname Part F.

NOTE: HEC-DSS expects paired data pathnames in the following format:

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

Where A is the "group" - the basin, area, or river name.
B is the "reach" - the reach name.
C is the "parameters" - the data parameters separated by a hyphen (e.g., ELEVATION-CURVES).
D is the "optional descriptor" - further describes data, often is left blank.
E is the "time descriptor" - can be year or date the curve was developed or left blank.
F is a "general descriptor" - generally describes the data, such as URBAN or AG, or left blank.

Example:

```
ZR A=ANNADELL     B=RCH1    C=ELEVATION-CURVES  F= URBAN & AGRI
```

8.9 EL Record - Damage Reach Elevation Values

The damage reach elevation values are used for all damage reach calculations involving rating tables, crop areas, and urban damage and number of structures flooded. Also defines flood zones. The EL records are required if not included in the HEC-DSS file read by the ZR record. If no flood stage (FS) is provided, EL(1) is assumed to be the elevation where damage begins.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	EL	Record identification.
1	EL(1)	+	First elevation value.
2	EL(2)	+	Second elevation value.
3-30	EL(n)	+	Continue for up to 30 values.

Example:

```
EL    0     6     8     10    12    14    16    18    20    30
```

8.10 AR Record - Damage Reach Area Values

The optional AR record specifies the total crop area (acres) values of the damage reach that correspond to the elevation values on the EL records. The EL and AR records must be included if the crop areas are specified as percentages of the total damage reach area and if the area flooded data for the damage reach is desired in the output. Area values are cumulative.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	AR	Record identification.
1	AREA(1)	+	Area value associated with the first field values on the EL record. Must be zero.
2	AREA(2)	+	Area value associated with the second field value on the EL record.
3-30	AREA(n)	+	Same as above for up to 30 values.

Example:

```
AR    0     0   2000   3200   4000   5600   7600   9600  12000  17200
```

8.11 CP Record - Damage Reach Crop Specifications

The CP records are required if agricultural crop damage analysis for specific crops is to be performed for the damage reach. The CP record and optional CA record is used for each crop. To use the CA record CROPAR (CP.2) must be zero. If a positive value appears in CROPAR and a CA record is present, the value in CROPAR is ignored. The crop identifications must be unique for all CP records in a damage reach.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	KODE	CP	Record identification.
1	CRPID	AN	Crop identification (six characters). Must match a crop defined in job CR record (CR.1).
2	CROPAR	0	Area values for this crop only must be entered on CA record.
		+	Percent (50% entered as 50) of total damage reach area (AR records) planted in this crop. (NOTE: 100 = 100% and 1.0 = 1%)
3	DBCROPID	AN	Double crop identification (six characters). Must match a crop defined in job CR record (CR.1). Blank if not a double crop.

Example:

```
CP WHEAT      80
CP  CORN      20
```

8.12 CA Record - Individual Crop Area Values

The CA record is required if CROPAR (CP.2) is zero where the crop area is to be input individually for this crop. The CA values correspond to the damage reach elevation values specified by the EL records. The CA area values are cumulative.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	CA	Record identification.
1	CA(1)	+	Initial area value (must be) that corresponds to the initial elevation value (EL.1) of the EL record.
2	CA(2)	+	Second area value that corresponds to the second elevation value EL (EL.2).
3-30	CA(n)	+	Continue for up to 30 values.

Example:

```
CA    0    0    2000    3200    4000    5600    7600    9600    12000    17200
```

8.13 UC Record - Urban Damage Specifications

A maximum of five urban categories may be analyzed for each reach. The associated number of days between flood events required for reconstruction of structures, contents, etc., is also input. A set of UC and UD records are required for each urban damage category. The ST records are optional.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	UC	Record identification.
1	URBAN	AN	Urban damage category identification (six characters) for this damage reach.
2	RCONST	+	Time in days for reconstruction to be 100 percent completed. Damage from a second flood occurring during the reconstruction period is linearly proportioned based on number of days remaining before reconstruction is 100 percent. RCONST must be between zero and 366.
3-4	URBTIT	AN	Urban damage category title (16 characters) to be analyzed for this reach. Used in output summaries.

Example:

```
UC URBST      60 URBAN STRUCTURE
```

8.14 UD Record - Urban Damage Values

The UD record is required for each urban damage category specified by the UC record if not included in the HEC-DSS file read by the ZR record. The UD values define the thousands of dollars of damage of the category that corresponds to the damage reach elevation values specified by the EL records. Must have the same number of values as the EL record. The damage values are cumulative through the zones. Up to five (5) urban categories are permitted per reach.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	UD	Record identification.
1	UDAM(1)	+	Damage values for this category that corresponds to the damage reach elevation value (EL.1). Normally zero.
2	UDAM(2)		Damage value for this category that corresponds to the damage reach elevation value (EL.2).
3-30	UDAM(n)	+	Same as above for up to 30 values.

Example:

```
UD      0       0    2000    2800    3200    4400    6000    7600    9200   11200
```

8.15 ST Record - Number of Structures

The optional ST record is required when the number of structures inundated by a flood event is desired. The ST values must correspond to elevation (EL record) and damage (UD record) values for the category. Up to five (5) structure records are permitted, one for each urban damage record. ST records are not required for each urban damage record. ST values are cumulative and must have the same number of values as the EL record.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	ST	Record identification.
1	STRUCT(1)	+	Number of structures for this damage category located below elevation specified on the first field of the EL record (EL.1). Normally zero.
2	STRUCT(2)	+	Number of structures for this damage center located below the elevation specified on the EL record, second field (EL.2).
3-30	STRUCT(n)	+	Same as above for up to 30 values.

Example:

```
ST    0    0    20    28    32    44    60    76    92    112
```

9 EJ Record - End of Job

The required EJ record specifies the end-of-job.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	EJ	Record identification.

Example:

```
EJ
```

Chapter 4
Analysis Program (PBA)

4.1 Introduction

The Analysis program (PBA) is designed to calculate with- and without-project conditions damage and project benefit accomplishment associated with flood events. The input requirements are minimized by using stored data from PREPBA. Analyses are performed based on user specified periods of events. Output displays are tabulated by damage reach, Corps district, watershed, subbasin, political and congressional boundaries, and damage reach. The user may select several levels of output of information on damage, area flooded, and number of structures flooded for with- and without-project conditions, and the project benefit accomplishment for the period analyzed. Figure 13 schematically shows the basic data processing of PBA. Figure 14 is an example of the input data for PBA.

4.2 Job Data

4.2.1 Title Records. The job titles are input on T1, T2, and T3 records. These titles are output on each page.

4.2.2 Price Indexes. The agricultural and urban damage potential data defined by PREPBA may be updated using separate price indexes. Variables AINDEX and ADATE (J1.3 and J1.4), respectively, are used to input the price index factor and date for the agricultural crop values per acre. Variables UINDEX and UDATE (J1.4 and J1.5), respectively, are used to input the price index and date for adjusting the urban damage relationships. The indexes and dates are output for each program execution for documentation purposes.

4.2.3 Analysis Dates. The beginning and ending dates of analysis define the period for which the with- and without-project condition damage and project benefit accomplishment are computed. The beginning date is input by variable BDATE (JE.1) and the ending date of the period for analysis is specified by variable EDATE (JE.2).

The damage potential for a given period of analysis may be dependent upon previous floods which can result in replanting of crops and re-construction of urban properties for the period of analysis. A look-back period may be specified by variable LDATE (JE.3) to assess these affects. To determine the damage status at the start of analysis, the damage potential is continuously computed and tracked by agricultural and urban categories for each flood zone from the look-back date to the beginning date of analysis. Figure 15 shows the period of analysis and look-back date concepts. A look-back date is not necessary to run the program. If a look-back date is not provided, the look-back date is assumed to be the same as the beginning date.

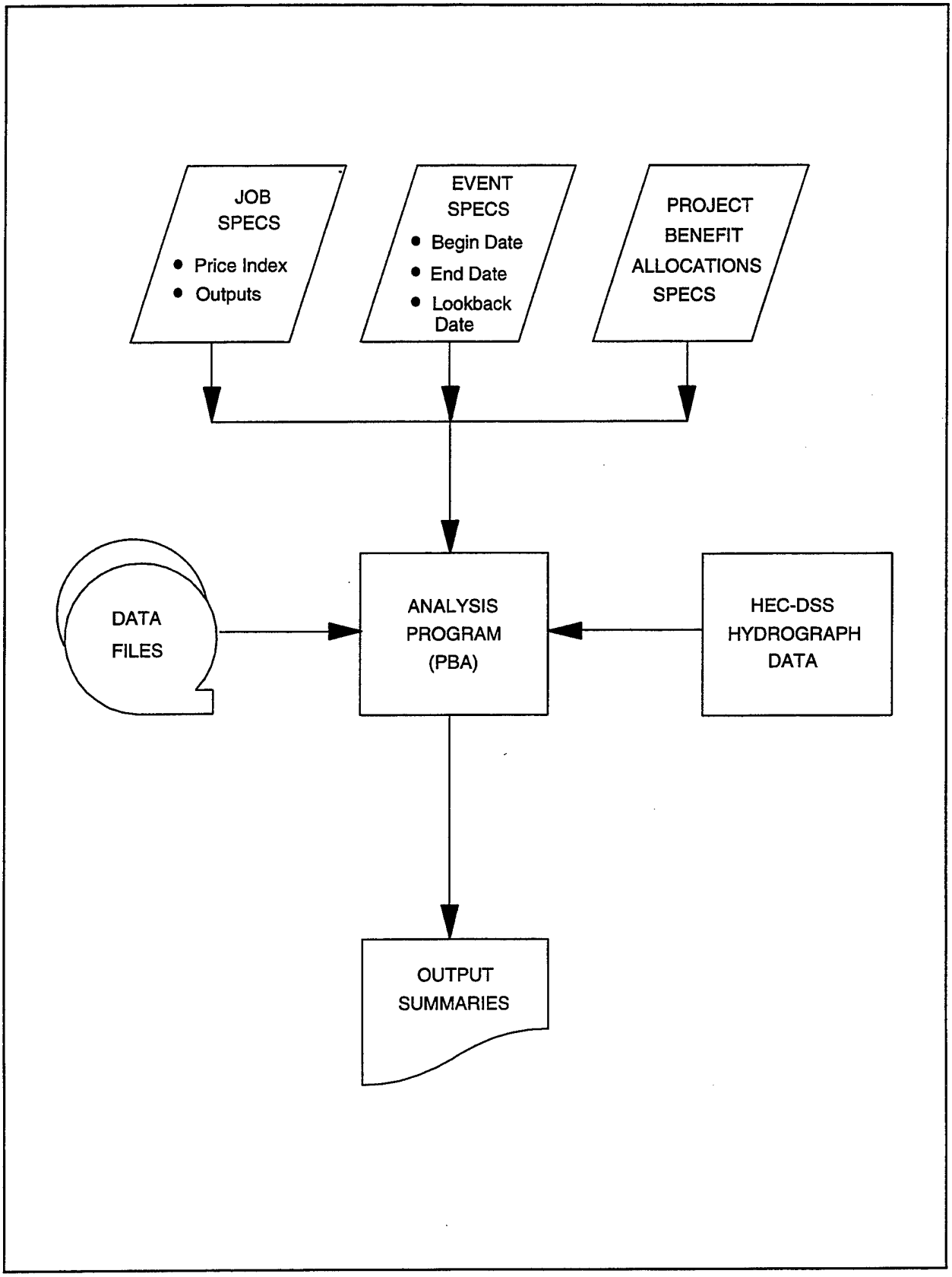


FIGURE 13 Analysis Program (PBA) Concepts

```
T1 ANNADELL RIVER BASIN - JACKSON TO JILLISON
T2 ANNUAL REPORT for 1993
T3 SEPTEMBER 2, 1994 RUN #2
J1      0
JE      01JAN1990     2400        31DEC1990     2400        01JAN1990     2400     1DAY
PB COOPR        60
PB GRAND        40
TA TRACE       ALL
EJ
```

FIGURE 14 Example of Analysis Program (PBA) Input

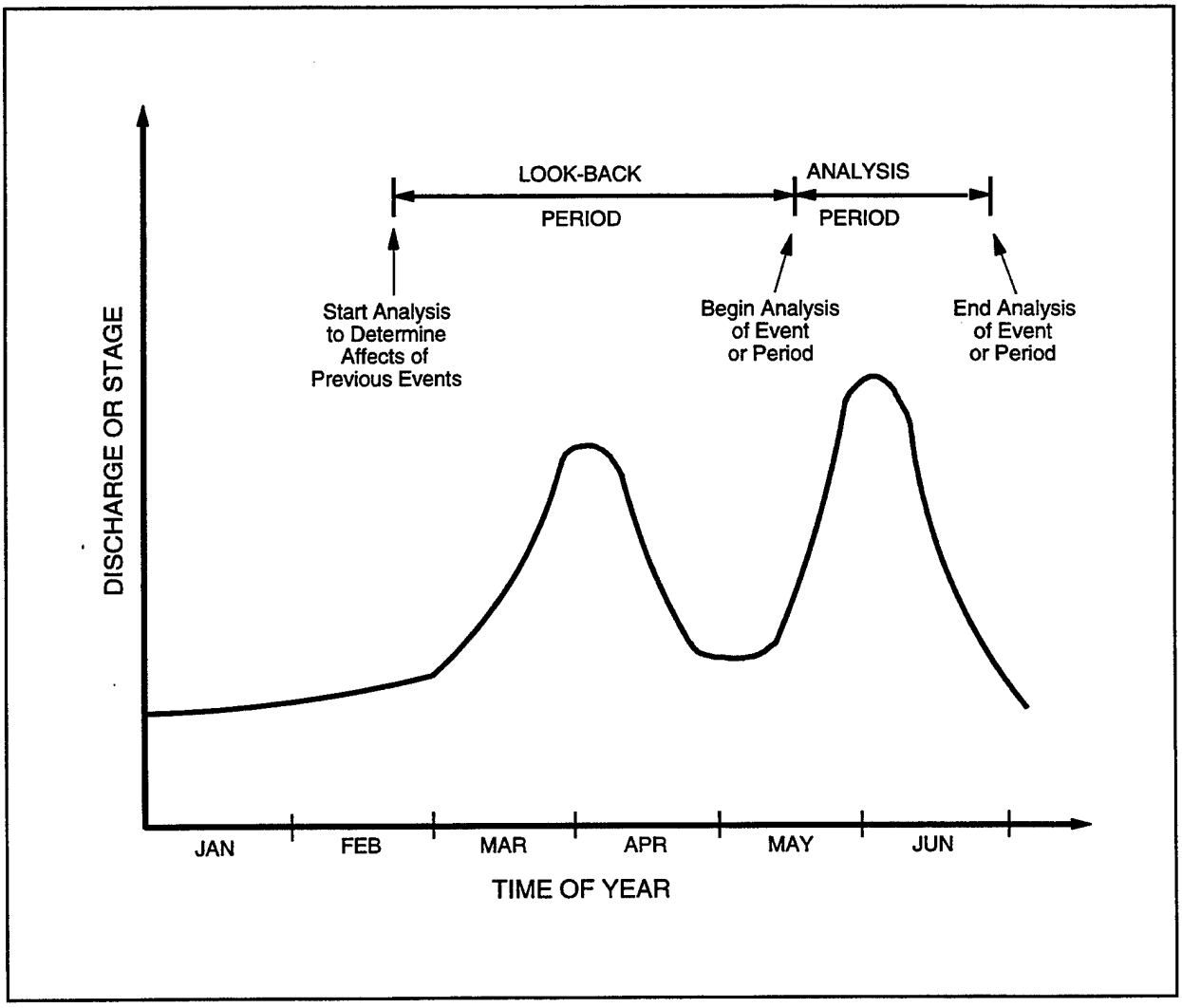


FIGURE 15 Analysis Period Concepts

4.3 Project Criteria

Projects include reservoirs and local protection works (levees) designed and implemented to reduce flood related losses. The with- and without-project conditions and project benefit accomplishment are calculated for each damage reach. The project parameter data are defined in PREPBA.

Local protection projects are assumed functional for the entire damage reach. A levee may protect only one damage reach. In other words, each damage reach protected by a levee must have a different levee name associated with it in the PREPBA input file. The program assumes that a levee is completely contained in one reach and the whole reach is protected by that levee (i.e., Levee-A protects Reach-A and no other reach.) If that is not feasible because a levee is very long, or it crosses a state, county, Corps district or congressional district boundary, or a tributary joins the stream across from the levee, then the levee must have different names in the adjacent reaches (e.g., Levee-A is divided so Reach-1 has Levee-1, Reach-2 has Levee-2, etc.). The benefits for the whole levee can be accumulated as a FLOOD DISTRICT (e.g., Reach-1 is in Flood District-A, Reach-2 is in Flood District-A, etc.).

A reservoir project may accrue benefits for more than one damage reach. There is no limit to the number of reaches which can be protected by a reservoir. Additionally, one reach can be protected by more than one reservoir. Up to 20 reservoirs can be associated with a damage reach. If more than one reservoir affects a damage reach, the benefits are proportioned based on user-selected benefit percent assignments by PB record for each reservoir based on hydrologic and other related studies outside of the HEC-PBA Package. This is shown in Figure 16. It is a limitation of the program that the project benefit allocations (as assigned on the PB record) are applied to all flood events equally.

Project benefits are further discussed in Section 4.7.

4.4 Hydrograph Data

PBA retrieves the hydrograph data for a stream index location from the HEC-DSS file. The pathname specified on the ZU and ZM records of PREPBA are used to retrieve the unmodified and modified data. If the hydrographs are flow hydrographs the ordinates are converted to stage using the rating relationship data defined by EV and QQ records from PREPBA for the stream index station.

To compute project accomplishment, PBA requires two hydrographs, one for the without- project conditions and one for the with-project conditions. Both hydrographs are retrieved from a HEC-DSS file and used in the analysis. Table 11 shows an example portion of stage hydrograph data at stream index stations typical of that which might be used in the analysis. The data may include observed or computed stages as well as forecasted stages.

PBA will compute damage if one hydrograph is provided. The program assumes both conditions are the same so no accomplishment is computed.

The program will accept hydrographs with any of the following valid HEC-DSS data intervals: 1HOUR, 2HOUR, 3HOUR, 4HOUR, 6HOUR, 8HOUR, 12HOUR, and 1DAY.

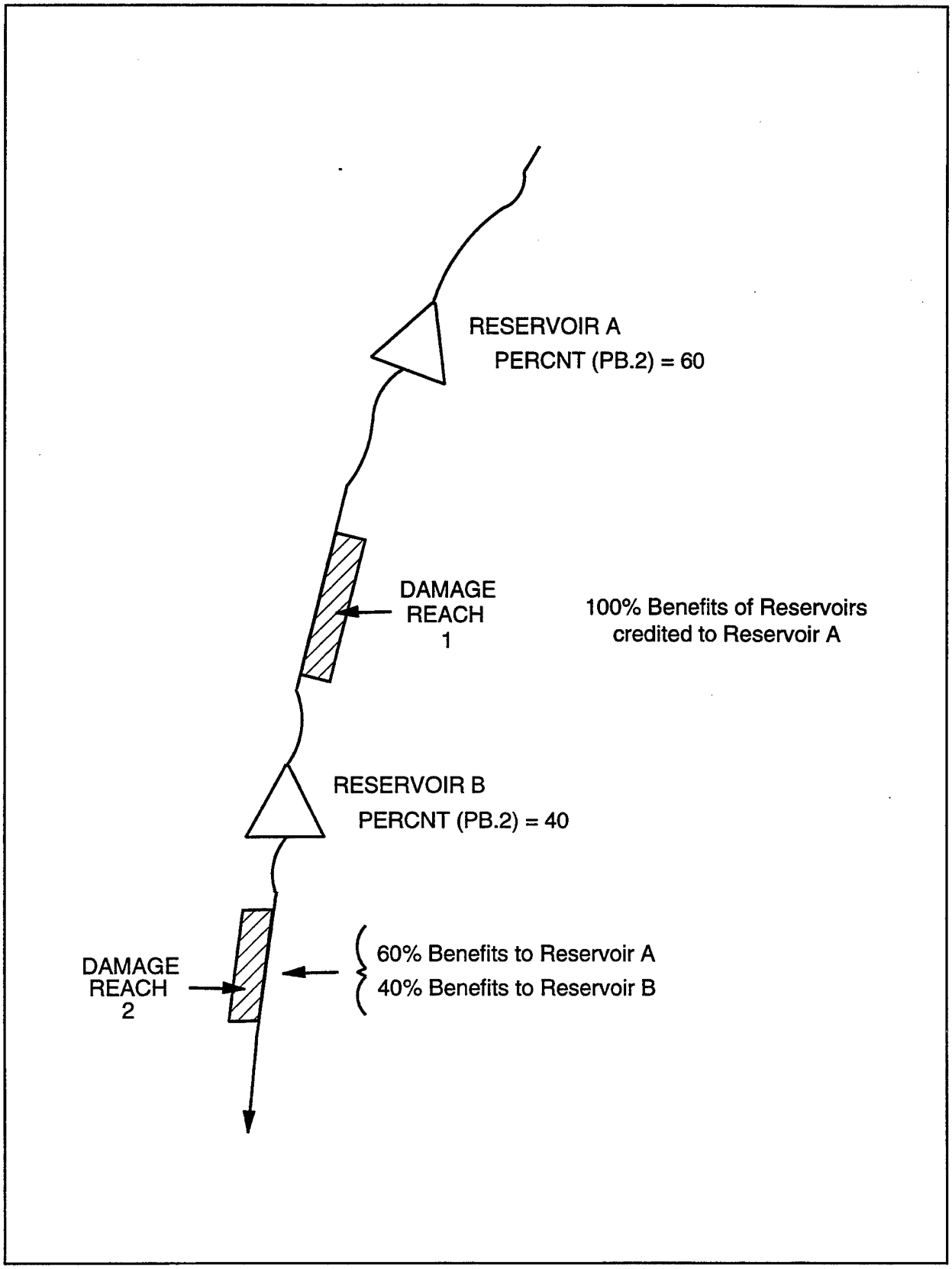


FIGURE 16 Reservoir Benefit Allocation Concepts

TABLE 11
Example HEC-DSS Stage Hydrograph Data

	Stream Stations			
Date	BLUEFISH	JILLISON	SULLIVAN	TULSA
01JAN90	433.7	423.6	417.4	403.2
02JAN90	433.8	423.8	417.5	403.3
03JAN90	434.0	424.1	418.0	403.6
04JAN90	434.8	425.0	419.1	404.2
05JAN90	434.6	424.9	419.0	404.0
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
06JUN90	444.0	433.8	428.1	413.7
07JUN90	444.5	434.1	428.5	414.2

During execution, PBA processes the requested HEC-DSS data and reports invalid pathnames and invalid data points. If data or pathnames are invalid, execution will halt and the user must correct errors listed. PBA expects HEC-DSS records to contain data for the entire analysis time interval specified on the JE record.

4.5 Crop Damage Analysis Methods

4.5.1 General Approach. Crop damage assessment concepts and definitions described in PREPBA should be reviewed. The damage analysis procedures for crops are complex, involving: the type of crop and time-of-year; magnitude and duration of flooding; dry-out periods; the flood duration a crop may withstand without damage; and replant adjustments to the area planted due to late season conditions or a succeeding flood. These are shown in Figure 17. It was assumed that duration is more significant than depth of flooding on the crops, so depth is not taken into account.

The damage analyses are performed and continuously tracked by flood zone so that the damage potential status for each crop and zone is known (internally in the program) at any given time. The following summarizes the damage analysis concepts of PBA.

(1) Hydrographs are checked by stage ordinate to find when a flood event exceeds flood stage and the zone in which the stage value is located.

(2) When the stage exceeds the top of a zone, PBA computes the times the flood passed in and out of the zone. The midpoint time of the rising side is computed from the two rising side time endpoints. Based on the rising side midpoint time, PBA evaluates the season in which the flood begins for each zone.

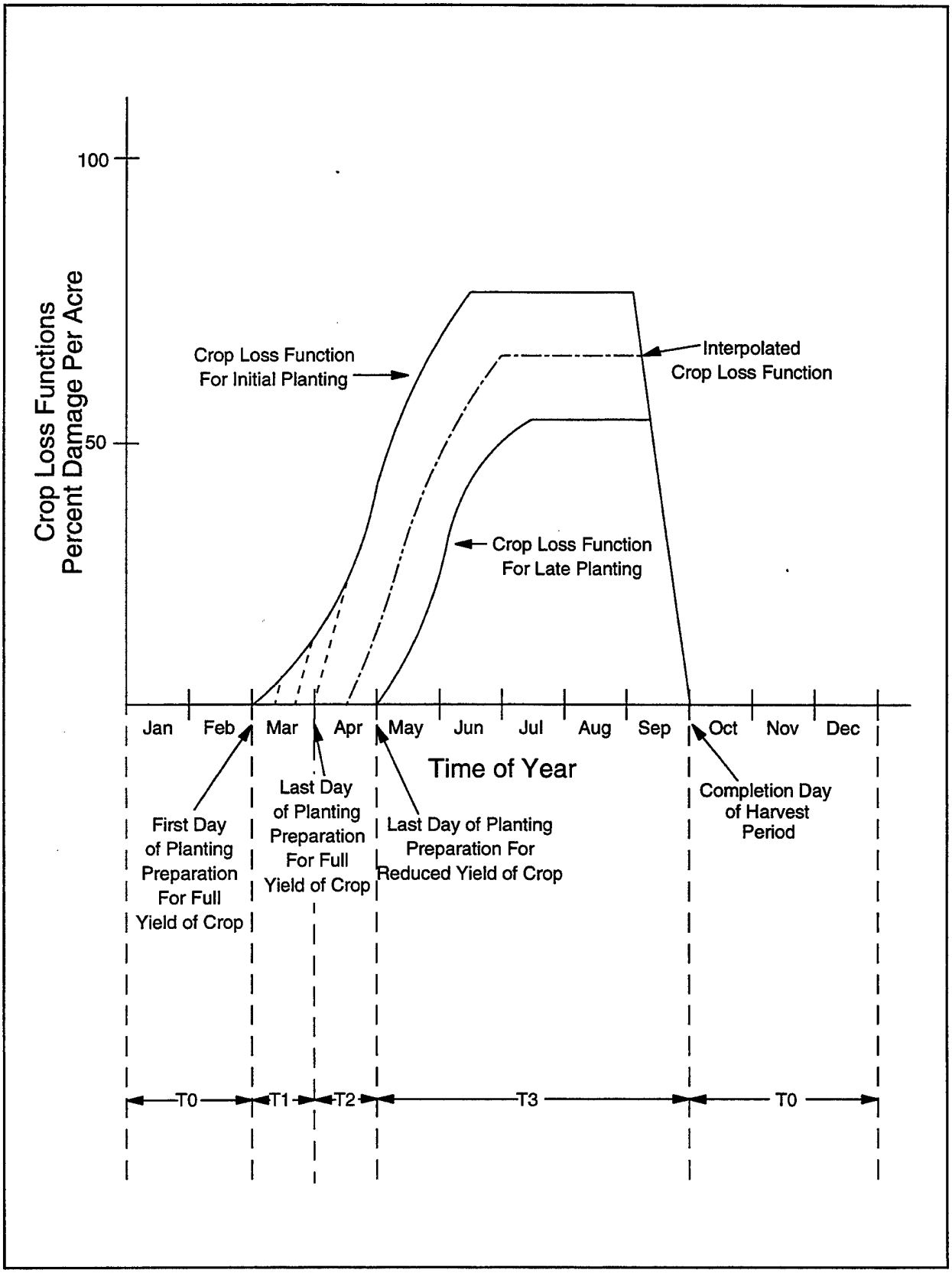


FIGURE 17 Crop Loss Analysis for Various Dates in the Growing Season

(3) On the falling side of the hydrograph, when the stage goes below the bottom of a zone, PBA again computes the times the flood passed in and out of the zone. The midpoint time of the falling side is computed from the two falling side time endpoints. Based on the falling side midpoint time, PBA evaluates the season in which the flood ends for each zone. Duration is computed as the midpoint time of the falling side minus midpoint time of the rising side.

(4) For the flood zone where the peak occurs, damage values are proportioned based on the percentage of area affected. If the peak is sustained at the same stage value over two or more time intervals, the time of the peak is assumed to be the first time the peak is reached. This is the value which is used in computing midpoint times of the rising and falling sides.

(5) Agricultural damage associated with each flood zone is computed based on time of the rising midpoint and the crop loss function. The damage computation also uses loss due to duration, percent of the zone which was flooded, the agricultural index value, area flooded, yield per acre, dollar value of the yield and the harvest costs. If a previous event has occurred, the effects of dry-out period and replant (described in Section 4.5.2) are determined for the flood situation. The continuous tracking of potential status is performed internally in the program.

(6) The damage of each zone is summed to obtain the total damage at the damage reach for the event. The area flooded is computed for each zone only once per event.

4.5.2 Multiple Flood Concepts. The damage associated with a flood event may be influenced by previous events. The impact is dependent on the type of crop and the magnitude, duration, and time-of-the-year of the events. The loss or damage is based on the capability to replant following a flood.

Replanting costs represent investments made after a flood event to produce a subsequent crop. Seasonal factors and replant requirements resulting from a previous event can cause a reduction in replant area and crop yield. The reduction in revenue is due to reduction in area replanted, direct yields or change in crops as a result of a shorter growing season. The capability to replant is a function of the time-of-year and dry-out time since the previous event.

After a flood occurs, a dry-out period (DRYOUT) is necessary to allow the soil to become sufficiently dry so that replant activities can begin. Following the dry-out period, additional time is needed to recultivate the fields and replant the crops so that the growth of the crops can return to the schedule following the initial loss curve. This period is called the full recovery period (FULREC). It is assumed to be seven days from the end of the dry-out period.

For the first flood of any analysis period, the crop loss is interpolated on the initial crop loss curve (CI record). If a subsequent flood occurs during the previous flood's dry-out period, no additional damage is possible in previously flooded zones because the land is still drying out and no new investments have been made.

The time of the year in which the flood event occurs affects the computation of crop damage for each zone if a previous event has occurred. To clarify the different levels of damage which can occur during the life of a crop, the growing season was divided into four seasons: T0 through T3. Each season is described below. (Refer to Figure 16 while reading the descriptions.)

(1) T0 is the time before planting has begun or after harvest is completed. Any flood occurring during this period will result in no damage.

(2) T1 is the time between the first date of the cultivation and planting season (FSTPLT) and the last date that the area can be planted and still reach a full yield (FULYLD). If the end of previous flood falls within this growing season period, one of three conditions can happen to the subsequent event: 1) it occurs during the dry-out period; 2) it occurs during the recovery period; or 3) it occurs after there has been enough time for dry out and complete replanting.

In the first case, no new damage has occurred. In the second case, where the second flood occurs during the full recovery period, some investment has been made because some recultivation and replanting has occurred. Crop loss is computed as the value on the initial loss curve times the percent of the investment in the field at the time of the second flood. This is a function of the length of time between events minus the dry-out period divided by the full recovery period. Duration loss is not used in season T1. In the third case, because the area has been fully replanted, the crop loss for the second planting is interpolated from the initial crop loss curve with no other reductions.

(3) T2 is the time from the last day when the soil can be replanted and a maximum full yield can be achieved to the last day of planting when a minimum reduced yield can be achieved. The crop will not reach its maximum yield, only a fraction of it. The fraction is interpolated based on the maximum initial crop loss value, the maximum late planting crop loss value, the date of the event and the date of last planting and date of full yield. The maximum interpolated value, called the maximum potential yield, is compared with the current potential yield in the field. If the maximum potential yield is greater, it is assumed that the farmer will disk the crop currently in the field and replant to get the greater yield. If the current yield is greater than the maximum potential yield, the potential value remains at the current yield. The interpolated crop loss is computed as the ratio of maximum potential yield to maximum initial loss multiplied by the initial loss curve value at the beginning date of the subsequent event.

(4) T3 is the time after the date of last planting to produce any yield. No new planting can occur after this time, so any subsequent floods will cause damage to the crop in place until there is no yield left to lose.

(5) A flood event may begin in one season and end in another. In this situation, damage is computed for the event based on the season in which the event begins, but potential yield status is based on the season in which the event ends.

4.6 Urban Damage

Urban structure damage categories include those normally classified as residential, commercial, industrial, and to the general infrastructure (roads, streets, bridges, power lines, etc.) of a community. Damage analysis procedures are based on peak flood stages for the flood event. Damage values are determined directly from the elevation-damage relationships input in PREPBA. Intermediate values are linearly interpolated. A period of reconstruction is normally assumed after a flood event before complete restoration (return to the existing damage potential) occurs. Reconstruction periods range from one to 12 months. The reconstruction status is continuously tracked for each flood zone. If a second event occurs during this period, the damage of each zone is prorated; it is determined as the proportion of time of the reconstruction period remaining times the total damage value.

The damage for each zone is subsequently added to produce the total damage to the event. The procedure is used for both with- and without-project conditions. Area flooded is computed for each zone only once per event.

4.7 Project Benefit Accomplishment

Project benefit accomplishment associated with Corps of Engineers projects is determined for the period of analysis by subtracting the damage (area flooded or structures flooded) associated with the with-project condition from the without-project condition. This becomes more complex if more than one project is associated with the region. Benefits are computed for each damage reach, then summed for the system. Benefits are allocated based on the type of reach protection (levee or reservoir) whether the levee was overtopped or not, and for reservoirs, the user specified allocation percentages (from the PB record).

4.7.1 Levees. If the peak of hydrograph is greater than the top of the levee, the levee is overtopped for the reach. There are several scenarios which can occur in a reach that affect the assumptions made by the program about the allocation of benefits.

If the peak of the hydrograph for both the with- and without-project conditions does not exceed the height of the levee top during the analysis period, the levee gets all the project benefits. The total levee benefits are computed as the total without-project damage minus the with-project damage. Since no damage occurred in the with-project condition because the levee was in place, the levee benefits equal the total without-project damage.

Typically, when there is only a levee protecting a reach, the without-project hydrograph and the with-project hydrograph are identical. However, there is the possibility that a reservoir upstream could affect the with-project hydrograph, but the user chooses to ignore the reservoir in benefit allocation. This can be accomplished by not listing the reservoir on the DS record for the reach. There is also the condition that the levee increases stage in the reach and therefore increases flood damage. Overtopping of the levee in these three cases is discussed in the following paragraphs.

If the levee is overtopped in the first two cases, where 1) both the hydrographs are the same or 2) the with-project hydrograph is slightly lower than the without project hydrograph, the levee benefits are computed up to the time the levee would have overtopped in the without-project condition. The benefits up to the time of overtopping are calculated as the dollar damage, computed in the without-project condition minus the damage in the with-project condition. Because the dollar damage in the with-project condition, if the levee is not overtopped, is zero, the levee benefits are simply the damage accrued up to the time the levee would have been overtopped in the without-project condition.

For the third overtopping case, when the levee project makes the with-project condition higher, it is assumed for simplicity that the levee gets no benefits at all.

4.7.2 Reservoirs. If a single reservoir project provides protection for a reach, the reservoir benefits are computed as the without-project dollar damage minus the with-project dollar damage. Each reach can have up to 20 reservoirs affecting the damage. If there is more than one reservoir protecting the reach, the total reach benefits are allocated proportionally to each reservoir according to the users input on the PB record in PBA. If a reservoir protects more than one reach, the benefits are accumulated to contain the benefits of all the reaches involved.

4.7.3 Levees and Reservoirs. When the user specifies that one or more reservoirs and a levee protect a reach, it is assumed that the levee gets all the benefits unless it is overtopped.

If the levee is overtopped (or would have been overtopped in the without-project condition) the levee gets the benefits up to the time it is overtopped as described in Section 4.7.1. The reservoir then gets, as benefits, the total without-project condition damage minus the total with-project condition damage minus the benefit allocated to the levee. If there is more than one reservoir, the total reservoir benefits are proportioned to each reservoir based on the PB record.

In the rare situation that the protection makes the flooding worse, it is assumed that the levee gets no benefits and the reservoir gets negative benefits, computed as the without-project condition damage minus the with-project condition damage.

4.8 Output Displays

The output display capability of PBA is important for reporting purposes and verification of results. Several output options are available which range from extensive amounts of data for damage categories, events, and projects by reaches and basins, to compact summaries of the same items. For most situations the user will use the summary options after reviewing more complete output for accuracy. Suppressed job input listing summaries may be obtained using the J1 record. User designed types of output summaries of analyses are specified using the TA record.

Generally the output has the following format. For convenience, the output is described by printed page. The output can be viewed on a computer screen or printed out.

4.8.1 Banner Page. This includes the program title, version number, and the time and date the user ran the program.

4.8.2 Input Echo. The PBA input file can be written to the output file. The first variable on the J1 card (IMAGE) controls if the input is echoed back. Zero means echo the input, one means suppress the input.

4.8.3 Trace Output by Zones in a Reach. This feature is initiated by typing TRACE on the TA record. Trace shows the damage for each zone in each reach. It is only used when verifying the model.

4.8.4 Reach Summary Reports. A damage summary is printed for each reach. The summary contains the reach's boundary information, urban damage summary, agricultural damage summary and project summary as shown in Figure 18. This feature is activated when DETAIL or ALL are typed on the TA record.

4.8.5 Boundary Reports. Damage and accomplishment reports can be generated by boundary definitions. The code name of the report on the TA record initiates the report. The code name ALL prints all the boundary reports as well as the reach summary reports. The following summary reports (with their code names) are available: damage reach (REACH), congressional district (CONG), county (COUNTY), flood control district (FLDIST), Corps district (USACE), community (COMMTY), and project (PROJCT). Table 12 shows how the boundary reports are organized. Figure 19 shows the Congressional District Summary.

4.8.6 Analysis Summary. The analysis summary is always printed. It summarizes system-wide damage and accomplishment as shown in Figure 20.

Damage Report
for
ANNADELL RIVER--COOPER LAKE TO BLUEFISH RIVER

Beginning Date: 01JAN1990 Ending Date: 31DEC1990 Lookback Date: 01JAN1990
AG Price Index: 1.00 AG Price Index Date:
Urban Price Index: 1.00 Urban Price Index Date:

Damage Reach ID: RCH1
Gauge ID: BLUGAGE
USACE: TULSA DIST
State: OKLAHOMA
Congressional District: REP JANET JONES
County: ALPHA COUNTY
Community: JACKSON COMUNTY
Township: GARRISON TWNSHP
Flood Control District: BLUEFISH FLDIST
Watershed: ANNADELL WTRSHD
Subbasin: COOPER SUBBASIN
Levee: JACKSON LEVEE
Reservoir(s): COOPER LAKE

****

Urban Damage Summary

	Structures Flooded Without Project	Structures Flooded With Project	Structures Project Accomplishment
RESIDENTIAL	4957	0	4957
COMMERCIAL	178	0	178
Total	5135	0	5135

	Flood Damage Without Project ($1000)	Flood Damage With Project ($1000)	Flood Damage Reduced ($1000)
RESIDENTIAL	88428.53	0.00	88428.53
COMMERCIAL	14137.30	0.00	14137.30
Total	102565.83	0.00	102565.83

****

Agricultural Damage Summary

	Acreage Flooded Without Project (acres)	Acreage Flooded With Project (acres)	Acreage Accomplishments (acres)
WINTER WHEAT	11466.00	0.00	11466.00
Total	11466.00	0.00	11466.00

	Flood Damage Without Project ($1000)	Flood Damage With Project ($1000)	Flood Damage Reduced ($1000)
WINTER WHEAT	143.79	0.00	143.79
Total	143.79	0.00	143.79

****

Reach Summary

	Without Project Conditions	With Project Conditions	Project Accomplishment
Damage ($1000)	102709.62	0.00	102709.62
Structures	5135	0	5135
Crop Acres Flooded	11466.00	0.00	11466.00

****

Project Benefit Accomplishment Summary

	Agri ($1000)	Area (acres)	Urban ($1000)	Structures
JACKSON LEVEE	4.81	0.00	10757.74	219
COOPER LAKE	138.97	11466.00	91808.09	4914
Reservoir Subtotal	138.97	11466.00	91808.09	4914
Total	143.78	11466.00	102565.83	5133

FIGURE 18 Output: Reach Summary Report

TABLE 12
Organization of Boundary Reports

I. Damage Reach Summary
  A. Watershed 1
    1. Subbasin 1
      i. Damage Reach 1
      ii. Damage Reach 2
    2. Subbasin 2
      i. Damage Reach 3
      ii. Damage Reach 4
  B. Watershed 3
    1. Subbasin 2
      i. Damage Reach 5

II. Congressional District Summary
  A. State 1
    1. Congressional District 1
    2. Congressional District 2

III. County Summary
  A. State 1
    1. County 1
      i. Township 1
      ii. Township 2

IV. Flood Control District Summary
  A. Flood District 1
  B. Flood District 2

V. Community Summary
  A. Community 1
  B. Community 2

VI. Corps District Summary
  A. Corps District 1
  B. Corps District 2

VII. Project Summary
  A. Levees
    1. Levee 1
    2. Levee 2
  B. Reservoirs
    1. Reservoir 1
    2. Reservoir 2

Congressional District Summary

Beginning Date: 01JAN1990 Ending Date: 31DEC1990 Lookback Date: 01JAN1990

Damage Without Project Conditions

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
OKLAHOMA				
REP JANET JONES	143.79	11466.00	102565.83	5135
REP SHAWN SMITH	223.00	8843.95	158034.20	2185
Congressional District Totals	366.79	20309.95	260600.03	7320
State Totals	366.79	20309.95	260600.03	7320

****

Damage With Project Conditions

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
OKLAHOMA				
REP JANET JONES	0.00	0.00	0.00	0
REP SHAWN SMITH	189.44	7700.00	132825.02	1553
Congressional District Totals	189.44	7700.00	132825.02	1553
State Totals	189.44	7700.00	132825.02	1553

****

Project Accomplishments

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
OKLAHOMA				
REP JANET JONES	143.79	11466.00	102565.83	5135
REP SHAWN SMITH	33.56	1143.95	25209.19	632
Congressional District Totals	177.35	12609.95	127775.02	5767
State Totals	177.35	12609.95	127775.02	5767

FIGURE 19 Output: Congressional District Boundary Report

********** Analysis Summary **********

Damage Categories

Reduction	Without Project Conditions Damage ($1000)	With Project Conditions Damage ($1000)	Project Damage ($1000)
Agricultural			
WINTER WHEAT	276.96	107.30	169.66
SWEET CORN	89.83	82.14	7.69
Other Losses	0.00	0.00	0.00
Subtotal	366.79	189.44	177.35
Urban			
RESIDENTIAL	88428.53	0.00	88428.53
COMMERCIAL	14137.30	0.00	14137.30
RURAL STRUCTURE	158034.20	132825.02	25209.19
Subtotal	260600.03	132825.02	127775.02
Grand Total	260966.83	133014.45	127952.37

****

Summary Totals

	Without Project Conditions	With Project Conditions	Project Accomplishment
Damage ($1000)	260966.83	133014.45	127952.37
Structures	7320	1553	5767
Crop Acres Flooded	20309.95	7700.00	12609.95

FIGURE 20 Output: Analysis Summary

Chapter 5
Analysis Program Input Description (PBA)

Table of Contents

Section		Page
1	T1, T2, T3 Records - Title Information	99
2	J1 Record - Job Specifications	100
3	JE Record - Analysis Dates	101
4	PB Record - Reservoir Benefit Allocation	102
5	PI Record - Price Index Adjustment by Reach	103
6	TA Record - Report Table Selection	104
7	EJ Record - End of Record	105

1 T1, T2, T3 Records - Title Information

These required records provide three lines of information at the top of each page of output. Title records should specifically identify the type of job, location and other pertinent data, such as, the ENR price index base used.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	T1, T2, T3	Record identification.
1-10	TITLE	AN	Title information (center of title is column 41).

Example:

```
T1 ANNADELL RIVER BASIN - JACKSON TO JILLISON
T2 ANNUAL REPORT 1991
T3 FEBRUARY 21, 1992  RUN #2
```

J1

HEC-PBA Input Description
Analysis Program (PBA)

2 J1 Record - Job Specifications

The required J1 record specifies the record listings and price indices.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	J1	Record identification.
1	IMAGE	0	The list of input records is displayed in the output.
		1	The list of input records are not be displayed in the output.
2	AINDEX	+	Global price index factor for adjusting the potential agricultural damage values. A value of 1.1 would increase the crop, agricultural infrastructure and business damage values by 10%. (Optional; if blank, assumed to be 1.0.)
3	ADATE	AN	Date of the agricultural price index factor AINDEX (J1.2). Dates are used for information only and may be entered in the following formats: 03JUN88 or 1990 or 12-17-89. (Only necessary if AINDEX (J1.2) is used.)
4	UINDEX	+	Global price index factor for adjusting urban damage values. (Optional; if blank, assumed to be 1.0.)
5	UDATE	AN	Date of urban price index (ddmmmyy). (Only necessary if UINDEX (J1.4) is used.)

Example:

```
J1      0
```

3 JE Record - Analysis Dates

The JE record is used to specify the beginning, ending, and look-back dates of the analysis.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	JE	Record identification.
1-2	BDATE	AN	Beginning date of analysis (ddmmmyy or ddmmmyyyy).
3	BTIME		Beginning time of analysis in military hours (i.e., 0100)
4-5	EDATE	AN	Ending date of analysis (ddmmmyy or ddmmmyyyy).
6	ETIME		Ending time of analysis in military hours (i.e., 2400)
7-8	LDATE	AN	Look-back or beginning date (ddmmmyy or ddmmmyyyy) of time-series record for analysis of previous event effects of the analysis period. If blank, is assumed the beginning day of the analysis BDATE (JE.2).
9	LTIME		Lookback time of analysis in military hours (i.e., 1200)
10	TIMINT		Time interval (e.g., 1DAY, 1HOUR, 6HOUR, etc.)

Example:

```
JE    01JAN1990    2400    28FEB1990    2400    01JAN1990    2400    1DAY
```

4 PB Record - Reservoir Benefit Allocation

The PB record specifies percent of the reservoir total benefits that are attributed to this reservoir project. A PB record is required for each reservoir project. The values input by variable PERCNT (PB.2) are used to proportion the reservoir benefits when more than one reservoir affects a damage reach.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	PB	Record identification.
1	RESVR	AN	Alphanumeric identification (six characters) associated with this reservoir project. ID must be the same as specified by variable RESID (DS.1) on the PREPBA PR record.
2	PERCNT	+	Percent of total flood damage reduction benefits to be attributed to this project. (A value of 100 means 100%; a value of 1.0 means 1%.)

Example:

```
PB COOPR      60
PB GRAND      40
```

5 PI Record - Price Index Adjustment by Reach

The optional PI record specifies the price index factor for adjusting the potential agricultural and/or urban damage values for a given reach. The global price index factors, AINDEX (J1.2) and UINDEX (J1.4), will change the price index for all reaches unless a PI record specifies a reach and a different price index. The PI record values take precedence over the J1 record values.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	PI	Record identification.
1	PIDRID	AN	Damage reach identification. Damage reach associated with the following price indices and dates.
2	PIAINDEX	+	Price index factor for adjusting the potential agricultural damage values at a specific reach. A value of 1.1 would increase the crop, agricultural infrastructure and business damage values by 10%. (If blank, assumed to be 1.0.)
3	PIADATE	AN	Date of the agricultural price index factor PINDEX (PI.2). Dates are used for information only and may be entered in the following formats: 03JUN88 or 1990 or 12-17-89. (Only necessary if PIAINDEX (PI.2) is used.)
4	PIUINDEX	+	Price index factor for adjusting urban damage values at a specific reach. A value of 1.1 would increase the damage values by 10%. (If blank, assumed to be 1.0.)
5	PIUDATE	AN	Date of urban price index factor PINDEX (P1.2). Dates are used for information only and may be entered in the following formats: 03JUN88 or 1990 or 12-17-89. (Only necessary if PIUINDEX (PI.4) is used.)

Example:

```
PI   DR1     2.4 03JUN88     3.2 01JUN90
```

6 TA Record - Report Table Selection

The TA record is used to specify the desired types and levels of output reports. The available reports are by damage reach (REACH), project (PROJCT), community (COMMTY), Corps District/Division Office (USACE), congressional district (CONG), counties (COUNTY), flood control district (FLDIST), detailed report (DETAIL) listing damage for each damage reach, trace output (TRACE) listing damage for each zone, (ALL) all reports except for trace output and the detailed report. The reports are specified by entering the appropriate report nomenclature in any order in fields 1 through 7.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	TA	Record identification.
1	TACODE(1)	AN	Report name.
2	TACODE(2)	AN	Report name.
3-7	TACODE(n)	AN	Report name.

Example:

```
TA TRACE  DETAIL   REACH  PROJCT
```

7 EJ Record - End of Record

The required EJ record specifies the end-of-job.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ID	EJ	Record identification.

Example:

```
EJ
```

Appendix A
Glossary

Variable Name	Definition
Acre	A unit of area in English units used in calculation of agricultural crop damage.
Agricultural Infrastructure Factor	A multiplier factor applied to the total crop damage account for damage to roads, drains, culverts, etc.
Area	Area in acres used to define the distribution of a crop for a range of elevation.
Boundary Information	Watershed and political area delineation such as Corps districts, congressional districts, states, counties, townships, communities, watersheds, subbasins and flood control districts.
Business Loss Factor	Secondary loss adjustment. Percentage of a crop damage value for a flood event that is assumed incrementally lost due to grain elevator operations, trucking, hauling, etc.
Crop Distribution	The elevation-crop area relationship for a specific crop for a damage reach.
Crop Production Data	The price and yield per acre of a specific crop multiplied times the percent loss potential values throughout the period of a year.
Crop Recovery Period	Time after a flood event and dryout period from start of cultivation for crop to recover to the normal production function. Applicable when the recovery can occur so this is not reduction in yield. Assumed as 25% of the time from the start of cultivation to the flood event
Crop Unit	Bushels, tons, etc., used to define the amount of crop harvested per acre.
Crop Value	Price of crop times the yield.
Crop Yield	Number of tons, bushels, etc., per acre harvested.
Damage Reach	The range of elevation for a WRU used to relate discharge area, damage, and number of structures.
Discharge	The flow rate in cubic feet/second that passes a specific location.

Variable Name	Definition
Double Cropping	The planting of two crops per year. Requires the use of two crop loss functions.
Dryout Period	Time required for field to dry-out sufficiently so replanting activities can begin.
Duration of Flooding	The period of time in days that a crop is inundated by flood waters.
Event Data	Daily streamgage, rainfall total, rainfall frequency or stage hydrograph data associated with a flood event.
Flood Damage	Dollar loss associated with a given flood event. Includes agricultural and urban related losses.
Flood Event	An event with sufficiently high water and/or prolonged duration of water inundation that result in losses.
Flood Stage	Elevation associated with the top of the bank or last point where zero damage can occur.
Flood Zone	Calculation interval between input damage reach elevation values used to determine the damage potential between flood events.
Hydrographs	The discharge (or stage) versus time relationship that constitutes a flood event.
Initial Crop Loss Function	The crop loss potential vs. Julian day of the year relationship associated with the initial or most likely planting and harvesting conditions.
Julian Day	Numeric day of year beginning the first day of January.
Levee Project	An earthen barrier (or floodwall) that protects an area from direct flooding.
Peak Daily Stage	The highest stage (elevation) of flooding for a given day.
Political Boundaries	Corps districts, congressional districts, states, counties, townships, communities, and flood control districts area delineation.
Price Index	An index value such as published by Engineering News Record, related to the damage and crop price values which may subsequently be up-dated by a multiple adjustment.

Variable Name	Definition
Project Benefits	The difference in damage between the without-project condition damage and the with-project condition damage.
Projects	Channels, levees, and reservoirs that affect or modify the damage potential for a damage reach.
Rainfall Amounts	The amount in inches of rainfall in a day.
Rainfall Frequency	The percent chance exceedance of daily rainfall. An event with a 10 percent chance exceedance is input as 10.
Rainfall Records	Daily records of the rainfall amounts or rainfall frequency.
Rating Table	The elevation-discharge relationship for a damage reach.
Reconstruction Period	The time, in days, for a building or structure to be completely rebuilt. A second flood event occurring during the reconstruction period is assumed to cause damage based on a linear interpolation between the days between the events and the reconstruction period.
Reservoirs	An upstream storage project that affects the damage potential by reducing flood peaks. However, duration of flooding for lower flood zones may be longer. Maximum of five reservoir projects may be analyzed for a damage reach.
Streamgage Records	Daily records of the stream elevation or stage taken at a streamgage location.
Structures	Buildings or infrastructure facilities that may be analyzed during flood events in urban areas.
Urban Damage	Damage to structures including buildings and infrastructure facilities located in urban areas. Damage is determined as a function of peak flood elevations and reconstruction time between flood events.
Watershed Boundaries	Area delineations of watersheds and subbasins.
With-Project Conditions	Status of the damage reach under study after a project has been implemented. May alter elevation-discharge-crop area-damage relationships of the without-project conditions. Also called modified conditions.
Without-Project Conditions	Status of damage reach under study prior to implementation of flood loss reduction projects. Characterized by the damage reach elevation-area-damage-number of structure relationships. Also called unmodified conditions.

Appendix B
Installing the HEC-PBA Package

This appendix contains instructions on how to install the HEC-PBA program on your computer.

B.1 HEC-PBA Program Disks and Files

The HEC-PBA (BETA Version, September 1993) Package is supplied on one (1) high-density 5.25" program disk and contains programs, example input data, and example output. Also included is the HEC-DSS Package diskette, which has its own separate installation.

The **HEC-PBA Package Diskette** contains the following files:

ASKME.COM
INSTALL.BAT
TEMPINS.BAT: These three files are the "INSTALL" procedure.

PKZIP.EXE: Software used to archive the HEC-PBA Package of programs into smaller files with the extension ".ZIP". An archive is a collection of one or more files placed into a single archive file. Each file in an archive is compressed to save disk space, backup storage space, and file transfer time.

PKUNZIP.EXE: Software used to extract archived files with the extension ".ZIP" into their original form.

PKZIPMAN.ZIP: An archive of the documentation for PKZIP and PKUNZIP programs.

HECPBA.ZIP: This archive contains the following files:

- PBA.EXE: The executable PBA program.
- PREPBA.EXE: The executable PREPBA program.
- F77L3.EER: The Lahey FORTRAN error message file.
- LIST.COM: A file viewing (list) utility program written by Vernon Buerg and licensed by HEC for distribution with the HEC-PBA package.
- LIST.DOC: Documentation for LIST.

README.DOC: File containing this implementation guide.

PBADAT.ZIP: This archive contains the following files:

TUL1HR.DSS:	An HEC-DSS file which contains the hydrographs for the example study described in Appendix C of the HEC-PBA User's Manual.
TUL1HR.DSC:	An HEC-DSS catalog file of the above HEC-DSS file.
TULSA.DAT:	The input file for the analysis program for the example study described in Appendix C of the HEC-PBA User's Manual.
TULSA.ANS:	The output file for the analysis program for the example study described in Appendix C of the HEC-PBA User's Manual.
TULSA.BAT:	The batch file for the analysis program for the example study described in Appendix C of the HEC-PBA User's Manual.

PREDAT.ZIP: This archive contains the following files:

TULSA.IN:	The input file for the preprocessor program for the example study described in Appendix C of the HEC-PBA User's Manual.
TULSA.ANS:	The output file for the preprocessor program for the example study described in Appendix C of the HEC-PBA User's Manual.
TULSA.BAT:	The batch file for the preprocessor program for the example study described in Appendix C of the HEC-PBA User's Manual.

B.2 Installing the HEC-PBA Package on a Computer

The HEC-PBA computer program requires the following computer system:

1. An IBM PC compatible computer based on an 80386DX, 80386SX, 80486DX or 80486SX microprocessors. HEC-PBA also requires that an appropriate math coprocessor be installed.

2. MS DOS 5.0 or greater.

3. At least 2 megabytes (Mb) of available Random Access Memory (RAM).

4. At least a 20Mb (or larger) hard disk.

B.2.1 Making Backup Copies of the Program Disks

You should make a back-up copy of the program disks immediately, and then put the original program disks in a safe place. Your own efforts to protect your original disks are your best protection.

B.2.2 Using HEC-PBA on a Computer with a Hard Disk

The INSTALL.BAT file is provided to perform HEC-PBA package installation. To install HEC-PBA on your computer's hard disk drive, complete the following steps:

1. Start your computer and go to the drive (e.g., C: or D:) in which you would like to install this software.

2. Place the INSTALL DISKETTE into the A: drive.

3. Type **A:INSTALL** and then press the **<ENTER>** key.

4. At this point the INSTALL program will lead you through the installation of the HEC-PBA Package. The following is a summary of what the INSTALL program accomplishes:

    a. Allows the user to select the drive (e.g., C: or D:) for which directories will be created and to which files will be copied.

    b. Creates directories \HECEXE and \HECEXE\SUP. The \HECEXE directory is used to store all the executable programs and the \HECEXE\SUP subdirectory is used for any supplemental files required by the executable programs.

    c. The F77L3.EER, LIST.COM and LIST.DOC are copied to the \HECEXE directory.

    d. The input and output files for the preprocessor (PREPBA) and the analysis (PBA) program are copies to the respective directories, \PREPBA and \PBA.

5. To allow access of the executable programs from any directory, it will be necessary to edit the AUTOEXEC.BAT file to include a path to the \HECEXE directory. The AUTOEXEC.BAT file should be in the root (C:\) directory. The following is an example PATH command that would allow access to the \HECEXE directory as well as the root (C:\) directory:

    PATH C:\;C:\HECEXE

    The PATH may also include other directories on the system. If so, just add the names of the directories to this command. For more information on the PATH command and the AUTOEXEC.BAT file, consult a DOS manual.

6. The final step will be to modify your CONFIG.SYS file. Many HEC programs require the capability to open more than eight (8) files at any one time. Because eight is the system default, you will need to modify your CONFIG.SYS file to include the following two lines:

FILES=20
BUFFERS=20

For more information concerning the CONFIG.SYS file, consult your DOS manual. Use COED or another text editor to make these changes. **AFTER THE CHANGES ARE MADE YOU WILL NEED TO RE-BOOT YOUR MACHINE.**

B.2.3 Alternative Installation

As stated previously, the preferred method for installation is to use the INSTALL procedure, which will install the software using the HEC recommended directory configuration. If for some reason you do not use INSTALL, you will need to do the following to install the HEC-PBA Package.

1. You will need to create two directories. One of the directories should be labeled \HECEXE. This directory will be used to store all of the HEC executable programs. A second directory should be labeled \HECEXE\SUP. This directory will be used to store all of the supplemental files required by the executable programs. To accomplish these tasks do the following:

   * Go to the drive (e.g. C:) in which you would like to install the software.
   * Type **MD\HECEXE** then press the **<ENTER>** key.
   * Type **MD\HECEXE\SUP** then press the **<ENTER>** key.

2. Place the INSTALL Diskette into the A drive. You will need to copy the PKUNZIP.EXE file from this diskette to the root (C:\) directory. Use the following MS DOS command:

   * Type **COPY A:PKUNZIP.EXE** then press the **<ENTER>** key.

   The PKUNZIP.EXE program will be used to extract the archived HEC-PBA Package of programs into the correct directory.

3. The next step is to extract the archive PBA program, PREPBA program, the Lahey FORTRAN error message file (F77L3.EER), and LIST.COM. To extract the PBA and PREPBA programs, the F77L3.EER file, and the LIST files, use the following command:

   * Type **PKUNZIP A:HECPBA \HECEXE** then press the **<ENTER>** key.

4. The next step will be to extract the test input and output files that have been provided for the PBA and PREPBA programs. If you do not want these files on your hard disk, skip this step and proceed to the next step. For the data directory name, we are using the program name (i.e., PBA, PREPBA) as an example. You

can use any name you prefer. If you would like these files copied, use the following commands:

* Type **MD\PBA** then press the **<ENTER>** key.
* Type **PKUNZIP A:PBADAT \PBA** then press the **<ENTER>** key.

* Type **MD\PREPBA** then press the **<ENTER>** key.
* Type **PKUNZIP A:PREDAT \PREPBA** then press the **<ENTER>** key.

5. To allow access of the executable programs from any directory, it will be necessary to edit the AUTOEXEC.BAT file to include a path to the \HECEXE directory. The AUTOEXEC.BAT file should be in the root (C:\) directory. The following is an example PATH command that would allow access to the \HECEXE directory as well as the root (C:\) directory:

   PATH C:\;C:\HECEXE

   The PATH may also include other directories on the system. If so, just add the names of the directories to this command. For more information on the PATH command and the AUTOEXEC.BAT file, consult a DOS manual.

6. The final step will be to modify your CONFIG.SYS file. Many HEC programs require the capability to open more than eight (8) files at any one time. Because eight is the system default, you will need to modify your CONFIG.SYS file to include the following two lines:

   FILES=20
   BUFFERS=20

   For more information concerning the CONFIG.SYS file, consult your DOS manual. Use COED or another text editor to make these changes. **AFTER THE CHANGES ARE MADE YOU WILL NEED TO RE-BOOT YOUR MACHINE.**

B.3 Execution of the HEC-PBA Package

The execution of the HEC-PBA package is accomplished through the execution of two separate programs. The preprocessor which is titled PREPBA, and the analysis program which is titled PBA. The following explains the steps necessary for executing the HEC-PBA Package:

1. Go to the directory containing the preprocessor data files (e.g., CD \PREPBA).

2. Build a PREPBA input file (e.g., TULSA.IN), if one does not exist.

3. Build a PREPBA batch file as shown in the study example in Appendix C of the HEC-PBA User's Manual.

4. To execute the job, type the name of the batch file (e.g., TULSA.BAT).

5. Examine the output file (e.g., TULSA.OUT) for errors.

6. Be sure the JFILE and RFILE are copied to the directory containing the analysis program data files (e.g., PBA).

7. Go to the directory containing the analysis program data files (e.g., CD \PBA).

8. Build a PBA input file (e.g., TULSA.DAT), if one does not exist.

9. Build a PBA batch file as shown in the study example in Appendix C of the HEC-PBA User's Manual.

10. To execute the job, type the name of the batch file (e.g., TULSA.BAT).

11. Examine the output file (e.g., TULSA.OUT) for errors.

B.4 Program Verification

In the above example you executed the HEC-PBA package by using one of the example data files provided to you. At this point you should compare your output file (TULSA.OUT) with the one provided to you (TULSA.ANS). Comparing the two output files can be accomplished by viewing each file with the LIST utility, or by using the DOS compare command (COMP or FC). Check your results to ensure that they are the same as what we provided to you. This will ensure that the program is working correctly on your computer system.

B.5 HEC Data Storage System (HEC-DSS)

The HEC-PBA package uses the HEC-DSS Version 6 files for storing and retrieving data. The program will not read data using earlier HEC-DSS version files and you will not be able to use earlier versions of HEC-DSS utility programs (DSPLAY, DSSUTL) with HEC-DSS Version 6 output files generated by the HEC-PBA package. For this reason, a diskette and instructions for installing the HEC-DSS Package are included. If you do not already have HEC-DSS Version 6 on your PC, please follow the instructions and install the HEC-DSS Package.

B.6 Program Problems

If any errors are encountered which indicate potential problems in this HEC-PBA Package, please contact HEC.

Hydrologic Engineering Center
U.S. Army Corps of Engineers
609 Second Street
Davis, CA 95616-4687
USA
(916) 756-1104

Appendix C
HEC-PBA Example Application

This appendix demonstrates the application of the Project Benefit Accomplishment (HEC-PBA) computer program to a sample portion of a watershed. Damage and benefit accomplishments will be completed for an area which has five reservoirs and one levee as protection projects. Note: the procedures described in this appendix are based on the assumption that the HEC-PBA program and data files have been installed as described in Appendix B.

The example uses adopted data from Corps of Engineers, Tulsa District. The study area consists of two damage reaches near Tulsa, downstream of Keystone Dam. Figure C.1 shows a map of the Arkansas River area. The first damage reach is the Tulsa urban and agricultural area, the second is the Jenks urban area. Both reaches are protected by five reservoirs: Great Salt Plains, Cheny, El Dorado, Kaw and Keystone. The Jenks area is additionally protected by a levee. Three crops are grown in the region: oats, sorghum, and hay. The crop loss functions for these crops are shown in Figure C.2. The elevation-damage functions for each damage reach are shown in Figure C.3.

The data were all input through PREPBA's input file; none were retrieved through HEC-DSS. The PREPBA input file is shown in Figure C.4. This file is called TULSA.IN in the \PREPBA directory.

C.1 PREPBA Execution

PREPBA is executed by running the Tulsa batch file (TULSA.BAT in the \PREPBA directory) shown in Figure C.5. The batch file contains the PREPBA command line. To read or edit the data, any editor can be invoked. To get a listing of all the keywords and abbreviations associated with the PREPBA command line, type "PREPBA ?". This lists the file names which can be specified at run time.

To run the program, type "TULSA" at the DOS prompt in the PREPBA directory. The batch file will run PREPBA using the Tulsa input file. Also, two binary files (TULSA.JFL and TULSA.RFL) will be created and copied to the \PBA directory, and an output file will be created. The output file is shown in Figure C.6.

PREPBA's output is used primarily to check the data input. The information output can be quite detailed or suppressed. It is best to begin with a more detailed output to locate errors then later suppress the output.

This example shows a mid-sized output. Crop information is tabulated for easy examination of the data. Elevation-damage-area relationships are also tabulated. Warnings are issued when information is provided in the boundary, project or crop sections, but not used in a reach. In this example, a project record for a levee was entered, but no levee record is input in reach one because there is no levee located there. Similarly, crop records were included for the job, but none were used in reach two, so the warning indicates no crop damage will be computed there.

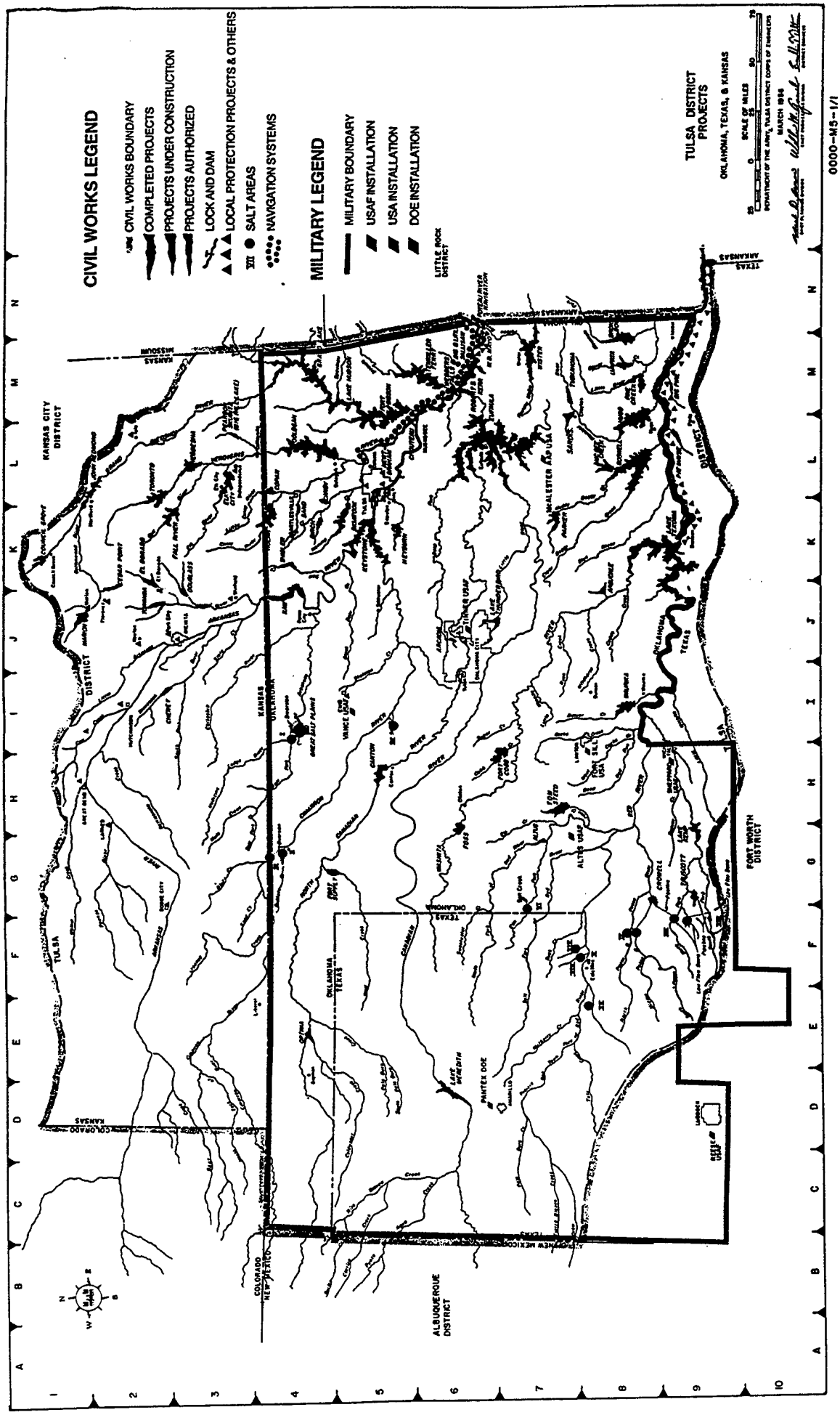


FIGURE C.1 Map of Arkansas River Watershed near Tulsa, Oklahoma

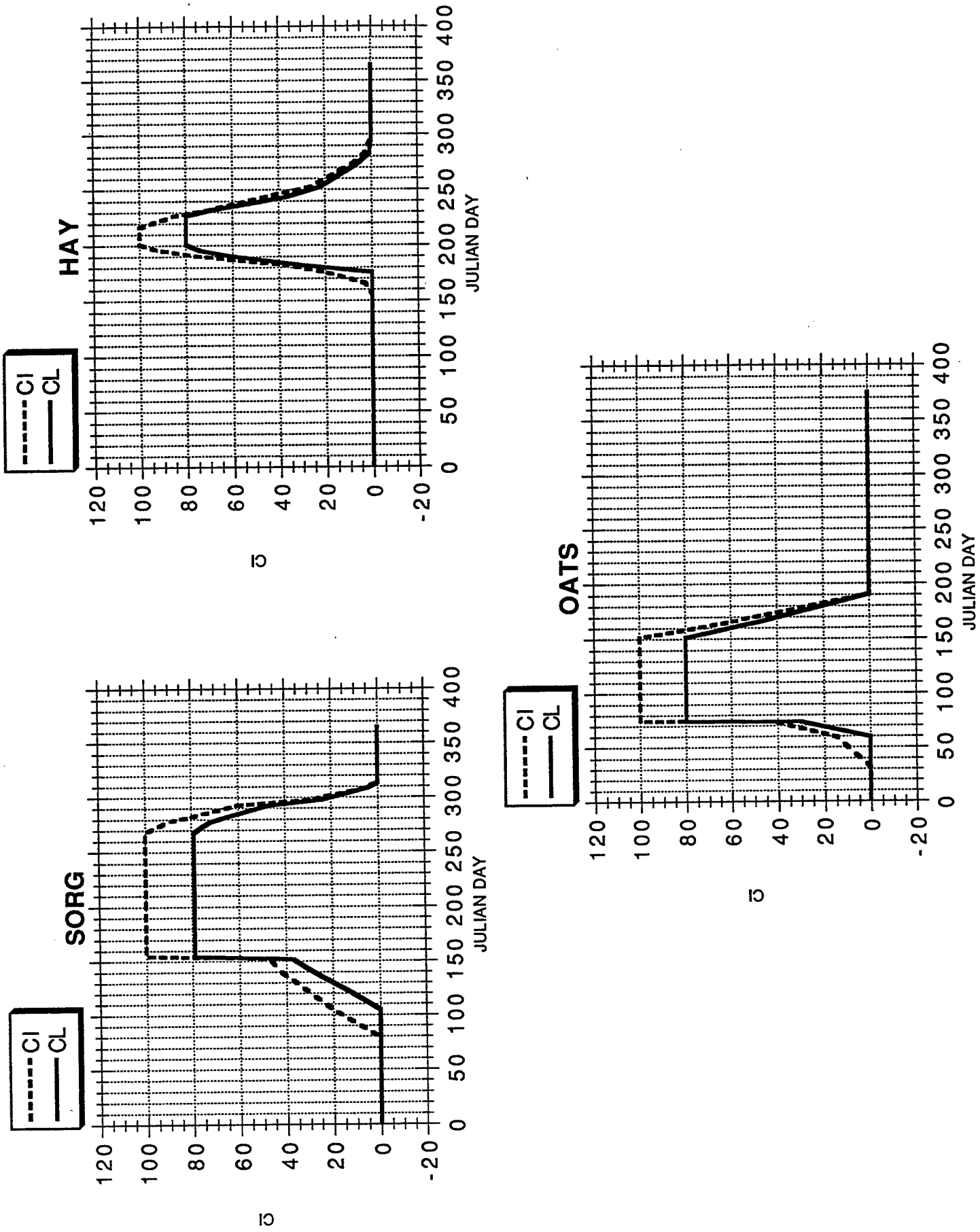


FIGURE C.2 Crop Loss Functions, Initial (CI) and Late Plant (CL), for Sorghum, Hay, and Oats in the Arkansas River Area

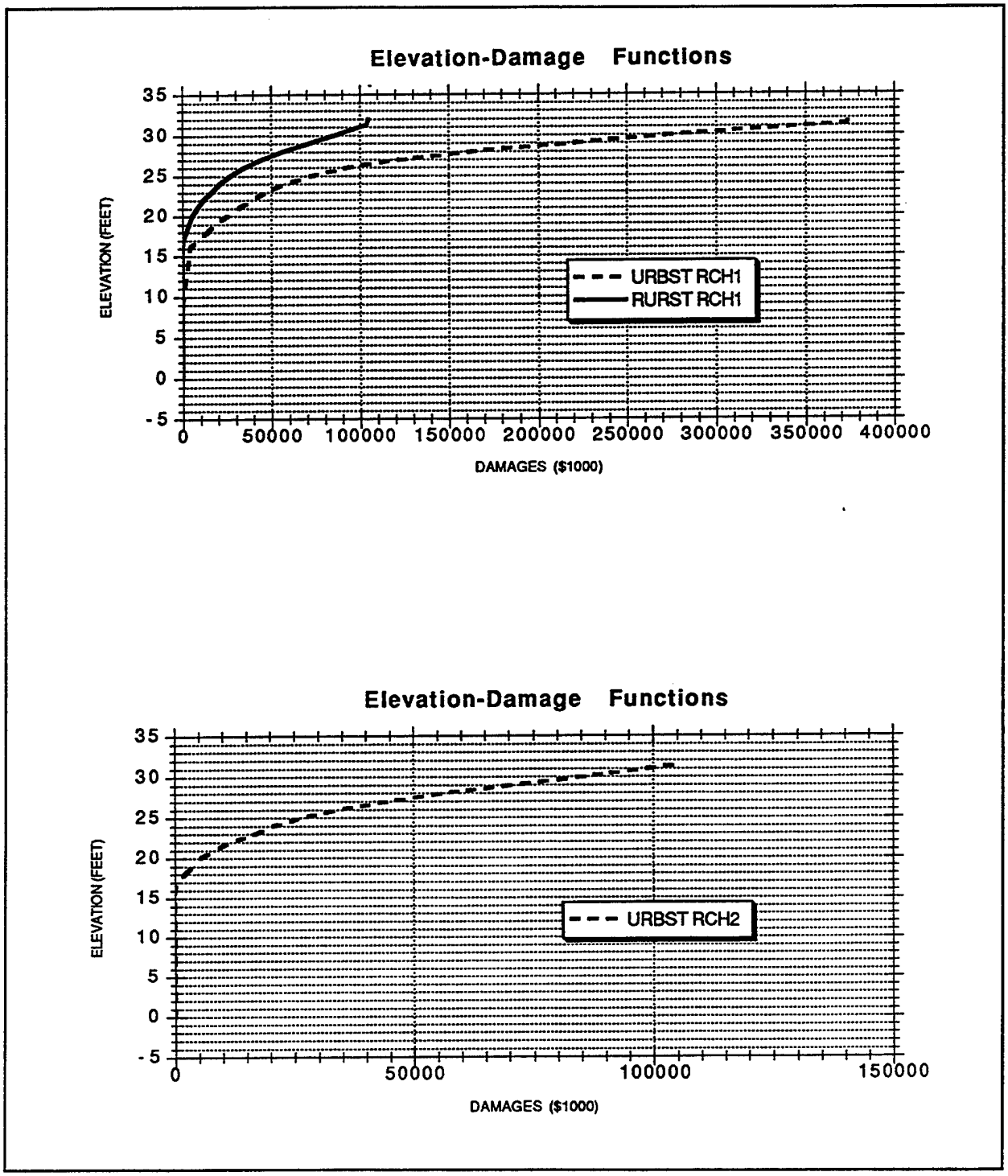


FIGURE C.3 Elevation-damage Functions for Reach 1 and Reach 2 of the Tulsa Data Set

```
T1  TULHR.IN - Arkansas River
T2  Keystone Dam to Verdigris River
T3  Tests Crops (3), Urban Areas (2), 2 Damage Reaches, 1 Levee, 5 Reservoirs
J1     1       1       0       0
* Boundary Information
BD TULSA Tulsa District
*
BS    OK Oklahoma
*
BC TULSA Tulsa County
BC MUSKO Muskogee County
BC WAGON Wagoner County
*
BW ARKAN Arkansas River
*
BG CONG1 Rep. Inhoff
BG CONG2 Rep. Synar
*
BX TULSA Tulsa Community
BX JENKS Jenks Community
* Projects
PR KEYST Keystone Lake
PR   KAW Kaw Lake
PR  CHEN Cheney Lake
PR ELDOR El Dorado Lake
PR   GSPGreat Salt Plain
PLWESTULWest Tulsa Levee
* Station or Gage Data
SS          TULA
ZU A=ARKANSAS B=TULA E=1HOUR F=COMPUTED
ZM A=ARKANSAS B=TULA E=1HOUR F=OBSERVED
*Rating Table
EV     0       6       7       8       9      10      12      14      15      16
EV    18      20      22      23      32
QQ     0    9000   12000   18000   24000   31000   48000   70000   82000   95000
QQ125000  165000  219000  250000  480000
* Crop Data
CR  OATS      60     BU.    2.60   25.54                  Oats
CS  OATS      32      60      74     191      10
CT     1      32      60      74      75     105     152     166     191     365
CI     0       0      15      42     100     100     100      60       0       0
CL     0       0       0      30      80      80      80      48       0       0
CD     0       1       2
C1     0       0       0       0       0       0       0       0       0       0
C2   100     100     100     100     100      50      50     100     100     100
C3   100     100     100     100     100     100     100     100     100     100
CR  SORG    4000     LBS    .035   14.00          Grain Sorghum
CS  SORG      79      91     105     314      10
CT     1      79      91     105     121     140     152     153     154     155
CT   196     227     244     268     274     278     283     293     298     305
CT   309     314     365
CI     0       0       9      20      30      42      47      55      83     100
CI   100     100     100     100      94      90      79      60      29      13
CI     5       0       0
CL     0       0       0       0      12      28      37      44      67      79
CL    79      79      79      79      75      72      64      47      24      11
CL     4       0       0
CD     0       1       2
C1     0       0       0       0       0       0       0       0       0       0
C1     0       0       0       0       0       0       0       0       0       0
C1     0       0       0
C2   100     100     100     100     100     100     100     100      67      56
C2    56      56      56      68      68      68     100     100     100     100
C2   100     100     100
C3   100     100     100     100     100     100     100     100      83      83
C3    83      83      83     100     100     100     100     100     100     100
```

FIGURE C.4 PREPBA Input File

```
CR    HAY     2.0     TONS    35.00    30.14              Native Hay
CS    HAY     156      166      176      298       10
CT      1     156      166      176      182      186      191      196      201      206
CT    217     227      232      244      253      274      283      298      365
CI      0       0        3       20       35       54       77       92      100      100
CI    100      85       71       46       26        8        3        0        0
CL      0       0        0        0       28       43       62       74       80       80
CL     80      80       70       37       22        6        1        0        0
CD      0       1
C1      0       0        0        0        0        0        0        0        0        0
C1      0       0        0        0        0        0        0        0        0
C2    100     100      100      100      100      100      100      100      100      100
C2    100     100      100      100      100      100      100      100      100      100
* Damage Reach--TUL01 Data
DR TUL01     TULA Arkansas River - Keystone Dam to Verdigris River
DB TULSA       OK    TULSA            ARKAN            CONG1    TULSA
DS KEYST
DS   KAW
DS  CHEN
DS ELDOR
DS   GSP
FS     9
EL     0       9       16       17       18       19       20       21       22       23
EL    24      25       26       27       28       30     31.3       32
AR     0       0     1600     2800     4000     5600     7600     9600    12000    17400
AR 26400   37000    46400    54800    62000    73400    78100    80000
CP  OATS      36
CP  SORG      54
CP   HAY      10
UC URBST      60      Tulsa Urban
UD     0       0     4220     8440    14348    18568    25320    31650    39668    47264
UD 57814   73428    92840   124490   166268   280208   373508   375000
UC RURST      60      Rural Struct
UD     0       0        0      422     2110     3798     5486     8440    11816    16880
UD 20678   27008    34604    45154    56548    86088   103985   105000
* Damage Reach--TUL02 Data
DR TUL02     TULA Arkansas River - West Tulsa
DB TULSA       OK    TULSA            ARKAN            CONG1    TULSA
DLWESTUL    29.1
DS KEYST
DS   KAW
DS  CHEN
DS ELDOR
DS   GSP
FS    10
EL     0      10       16       17       18       19       20       21       22       23
EL    24      25       26       27       28       30     31.3       32
UC URBST      60West Tulsa Urban
UD     0       0        0      422     2110     3798     5486     8440    11816    16880
UD 20678   27008    34604    45154    56548    86088   103985   105000
EJ
```

FIGURE C.4 PREPBA Input File (continued)

```
C:\HECEXE\PREPBA.EXE J=TULSA.JFL R=TULSA.RFL I=TULSA.IN O=TULSA.OUT
COPY TULSA.JFL ..\PBA\TULSA.JFL
COPY TULSA.RFL ..\PBA\TULSA.RFL
```

FIGURE C.5 PREPBA Batch File to Run the Program

```
                XXXXX    XXXXXX   XXXXXXX  XXXXXX   XXXXXX      X
                X    X   X     X  X     X  X     X  X     X    X X
                X    X   X     X  X        X     X  X     X   X   X
                XXXXX    XXXXXX    XXXX    XXXXXX   XXXXXX   XXXXXXX
                X        X   X    X        X        X     X  X     X
                X        X    X   X     X  X        X     X  X     X
                X        X   . X  XXXXXXX  X        XXXXXX   X     X


                      Project Benefit Accomplishment
                           Pre-Processor Program


                      Hydrologic Engineering Center
                        US Army Corps of Engineers
                            609 Second Street
                          Davis, CA  95616-4687

                              (916) 756-1104
                           FAX (916) 756-8250


                              September 1994
                              Version:  1.0


                       **************************
                       * Run Date:  23 Aug 1994 *
                       * Run Time:  14:03:29    *
                       **************************

  Suppress Detailed Listing = 1
```

FIGURE C.6 PREPBA Output File

1
TULHR.IN - Arkansas River
Keystone Dam to Verdigris River
Tests Crops (3), Urban Areas (2), 2 Damage Reaches, 1 Levee, 5 Reservoirs

Crop ID = OATS (CROPID)
Crop Title = Oats (CRPTIT)
Yield per Acre for Crop = 60.00 (CYA)
Unit Price Value for Crop = 2.60 (CUP)
Harvest Cost in Dollars per are for crop = 25.54 (HRVCST)
Additional Business and Infrastructure Losses for Crop = 0.00 (ADLOSS)
First Date to Plant = 32 (FSTPLT)
Last Date to Plant without Loss of Yield = 60 (FULYLD)
Last Date to Plant = 74 (LSTPLT)
End of Harvest Date = 191 (ENDHRVST)
Dry-out period in days = 10 (DRYOUT)

Crop Loss Table (Percent Loss Values)

Date	Day of Year	Initial Loss (%)	Late Plant Loss (%)	Percent Loss by Flood Duration (days) 0.0	1.0	2.0
1 JAN	1.	0.0	0.0	0.0	100.0	100.0
1 FEB	32.	0.0	0.0	0.0	100.0	100.0
1 MARCH	60.	15.0	0.0	0.0	100.0	100.0
15 MARCH	74.	42.0	30.0	0.0	100.0	100.0
16 MARCH	75.	100.0	80.0	0.0	100.0	100.0
15 APRIL	105.	100.0	80.0	0.0	50.0	100.0
1 JUNE	152.	100.0	80.0	0.0	50.0	100.0
15 JUNE	166.	60.0	48.0	0.0	100.0	100.0
10 JULY	191.	0.0	0.0	0.0	100.0	100.0

Crop Loss Table (Dollar Loss Values)

Date	Day of Year	Initial Loss ($)	Late Plant Loss ($)	Dollar Loss by Flood Duration (days) per Acre 0.0	1.0	2.0
1 JAN	1.	0.00	0.00	0.00	0.00	0.00
1 FEB	32.	0.00	0.00	0.00	0.00	0.00
1 MARCH	60.	19.57	0.00	0.00	19.57	19.57
15 MARCH	74.	54.79	39.14	0.00	54.79	54.79
16 MARCH	75.	130.46	104.37	0.00	130.46	130.46
15 APRIL	105.	130.46	104.37	0.00	65.23	130.46
1 JUNE	152.	130.46	104.37	0.00	65.23	130.46
15 JUNE	166.	78.28	62.62	0.00	78.28	78.28
10 JULY	191.	0.00	0.00	0.00	0.00	0.00

FIGURE C.6 PREPBA Output File (continued)

1
TULHR.IN - Arkansas River
Keystone Dam to Verdigris River
Tests Crops (3), Urban Areas (2), 2 Damage Reaches, 1 Levee, 5 Reservoirs

Crop ID = SORG (CROPID)
Crop Title = Grain Sorghum (CRPTIT)
Yield per Acre for Crop = 4000.00 (CYA)
Unit Price Value for Crop = 0.04 (CUP)
Harvest Cost in Dollars per are for crop = 14.00 (HRVCST)
Additional Business and Infrastructure Losses for Crop = 0.00 (ADLOSS)
First Date to Plant = 79 (FSTPLT)
Last Date to Plant without Loss of Yield = 91 (FULYLD)
Last Date to Plant = 105 (LSTPLT)
End of Harvest Date = 314 (ENDHRVST)
Dry-out period in days = 10 (DRYOUT)

Crop Loss Table (Percent Loss Values)

Date	Day of Year	Initial Loss (%)	Late Plant Loss (%)	Percent Loss by Flood Duration (days) 0.0	1.0	2.0
1 JAN	1.	0.0	0.0	0.0	100.0	100.0
20 MARCH	79.	0.0	0.0	0.0	100.0	100.0
1 APRIL	91.	9.0	0.0	0.0	100.0	100.0
15 APRIL	105.	20.0	0.0	0.0	100.0	100.0
1 MAY	121.	30.0	12.0	0.0	100.0	100.0
20 MAY	140.	42.0	28.0	0.0	100.0	100.0
1 JUNE	152.	47.0	37.0	0.0	100.0	100.0
2 JUNE	153.	55.0	44.0	0.0	100.0	100.0
3 JUNE	154.	83.0	67.0	0.0	67.0	83.0
4 JUNE	155.	100.0	79.0	0.0	56.0	83.0
15 JULY	196.	100.0	79.0	0.0	56.0	83.0
15 AUG	227.	100.0	79.0	0.0	56.0	83.0
1 SEPT	244.	100.0	79.0	0.0	56.0	83.0
25 SEPT	268.	100.0	79.0	0.0	68.0	100.0
1 OCT	274.	94.0	75.0	0.0	68.0	100.0
5 OCT	278.	90.0	72.0	0.0	68.0	100.0
10 OCT	283.	79.0	64.0	0.0	100.0	100.0
20 OCT	293.	60.0	47.0	0.0	100.0	100.0
25 OCT	298.	29.0	24.0	0.0	100.0	100.0
1 NOV	305.	13.0	11.0	0.0	100.0	100.0
5 NOV	309.	5.0	4.0	0.0	100.0	100.0
10 NOV	314.	0.0	0.0	0.0	100.0	100.0
31 DEC	365.	0.0	0.0	0.0	100.0	100.0

FIGURE C.6 PREPBA Output File (continued)

1
TULHR.IN - Arkansas River
Keystone Dam to Verdigris River
Tests Crops (3), Urban Areas (2), 2 Damage Reaches, 1 Levee, 5 Reservoirs

Crop Loss Table (Dollar Loss Values)

Date	Day of Year	Initial Loss ($)	Late Plant Loss ($)	Dollar Loss by Flood Duration (days) per Acre 0.0	1.0	2.0
1 JAN	1.	0.00	0.00	0.00	0.00	0.00
20 MARCH	79.	0.00	0.00	0.00	0.00	0.00
1 APRIL	91.	11.34	0.00	0.00	11.34	11.34
15 APRIL	105.	25.20	0.00	0.00	25.20	25.20
1 MAY	121.	37.80	15.12	0.00	37.80	37.80
20 MAY	140.	52.92	35.28	0.00	52.92	52.92
1 JUNE	152.	59.22	46.62	0.00	59.22	59.22
2 JUNE	153.	69.30	55.44	0.00	69.30	69.30
3 JUNE	154.	104.58	84.42	0.00	70.07	86.80
4 JUNE	155.	126.00	99.54	0.00	70.56	104.58
15 JULY	196.	126.00	99.54	0.00	70.56	104.58
15 AUG	227.	126.00	99.54	0.00	70.56	104.58
1 SEPT	244.	126.00	99.54	0.00	70.56	104.58
25 SEPT	268.	126.00	99.54	0.00	85.68	126.00
1 OCT	274.	118.44	94.50	0.00	80.54	118.44
5 OCT	278.	113.40	90.72	0.00	77.11	113.40
10 OCT	283.	99.54	80.64	0.00	99.54	99.54
20 OCT	293.	75.60	59.22	0.00	75.60	75.60
25 OCT	298.	36.54	30.24	0.00	36.54	36.54
1 NOV	305.	16.38	13.86	0.00	16.38	16.38
5 NOV	309.	6.30	5.04	0.00	6.30	6.30
10 NOV	314.	0.00	0.00	0.00	0.00	0.00
31 DEC	365.	0.00	0.00	0.00	0.00	0.00

1
TULHR.IN - Arkansas River
Keystone Dam to Verdigris River
Tests Crops (3), Urban Areas (2), 2 Damage Reaches, 1 Levee, 5 Reservoirs

Crop ID = HAY (CROPID)
Crop Title = Native Hay (CRPTIT)
Yield per Acre for Crop = 2.00 (CYA)
Unit Price Value for Crop = 35.00 (CUP)
Harvest Cost in Dollars per are for crop = 30.14 (HRVCST)
Additional Business and Infrastructure Losses for Crop = 0.00 (ADLOSS)
First Date to Plant = 156 (FSTPLT)
Last Date to Plant without Loss of Yield = 166 (FULYLD)
Last Date to Plant = 176 (LSTPLT)
End of Harvest Date = 298 (ENDHRVST)
Dry-out period in days = 10 (DRYOUT)

Crop Loss Table (Percent Loss Values)

Date	Day of Year	Initial Loss (%)	Late Plant Loss (%)	Percent Loss by Flood Duration (days) 0.0	1.0
1 JAN	1.	0.0	0.0	0.0	100.0
5 JUNE	156.	0.0	0.0	0.0	100.0
15 JUNE	166.	3.0	0.0	0.0	100.0
25 JUNE	176.	20.0	0.0	0.0	100.0
1 JULY	182.	35.0	28.0	0.0	100.0
5 JULY	186.	54.0	43.0	0.0	100.0
10 JULY	191.	77.0	62.0	0.0	100.0
15 JULY	196.	92.0	74.0	0.0	100.0
20 JULY	201.	100.0	80.0	0.0	100.0
25 JULY	206.	100.0	80.0	0.0	100.0
5 AUG	217.	100.0	80.0	0.0	100.0
15 AUG	227.	85.0	80.0	0.0	100.0
20 AUG	232.	71.0	70.0	0.0	100.0
1 SEPT	244.	46.0	37.0	0.0	100.0
10 SEPT	253.	26.0	22.0	0.0	100.0
1 OCT	274.	8.0	6.0	0.0	100.0
10 OCT	283.	3.0	1.0	0.0	100.0
25 OCT	298.	0.0	0.0	0.0	100.0
31 DEC	365.	0.0	0.0	0.0	100.0

FIGURE C.6 PREPBA Output File (continued)

```
1
  TULHR.IN - Arkansas River
  Keystone Dam to Verdigris River
  Tests Crops (3), Urban Areas (2), 2 Damage Reaches, 1 Levee, 5 Reservoirs


                          Crop Loss Table ( Dollar Loss Values)

            Day of   Initial   Late Plant   Dollar Loss by Flood Duration (days) per Acre
     Date    Year    Loss ($)  Loss ($)       0.0        1.0
     ----   ------   --------- ---------      ----       ----


    1 JAN      1.       0.00      0.00        0.00       0.00
    5 JUNE   156.       0.00      0.00        0.00       0.00
   15 JUNE   166.       1.20      0.00        0.00       1.20
   25 JUNE   176.       7.97      0.00        0.00       7.97
    1 JULY   182.      13.95     11.16        0.00      13.95
    5 JULY   186.      21.52     17.14        0.00      21.52
   10 JULY   191.      30.69     24.71        0.00      30.69
   15 JULY   196.      36.67     29.50        0.00      36.67
   20 JULY   201.      39.86     31.89        0.00      39.86
   25 JULY   206.      39.86     31.89        0.00      39.86
    5 AUG    217.      39.86     31.89        0.00      39.86
   15 AUG    227.      33.88     31.89        0.00      33.88
   20 AUG    232.      28.30     27.90        0.00      28.30
    1 SEPT   244.      18.34     14.75        0.00      18.34
   10 SEPT   253.      10.36      8.77        0.00      10.36
    1 OCT    274.       3.19      2.39        0.00       3.19
   10 OCT    283.       1.20      0.40        0.00       1.20
   25 OCT    298.       0.00      0.00        0.00       0.00
   31 DEC    365.       0.00      0.00        0.00       0.00

*** WARNING - A PL record has been entered.
If a levee project is to be analyzed for this
damage reach, a DL record is required! ***

1
   TULHR.IN - Arkansas River
   Keystone Dam to Verdigris River
   Tests Crops (3), Urban Areas (2), 2 Damage Reaches, 1 Levee, 5 Reservoirs

    Arkansas River - Keystone Dam to Verdigris River

   Damage Reach ID: TUL01
   Gauge ID: TULA
   USACE: Tulsa District
   State: Oklahoma
   Congressional District: Rep. Inhoff
   County: Tulsa County
   Community: Tulsa Community
   Watershed: Arkansas River
   Reservoir(s): Keystone Lake
                 Kaw Lake
                 Cheney Lake
                 El Dorado Lake
                 Great Salt Plain

 CUMULATIVE CROP AREA (ACRES)
    ELEVATION       AREA        OATS        SORG         HAY


         9.00        0.00        0.00        0.00        0.00
        16.00     1600.00      576.00      864.00      160.00
        17.00     2800.00     1008.00     1512.00      280.00
        18.00     4000.00     1440.00     2160.00      400.00
        19.00     5600.00     2016.00     3024.00      560.00
        20.00     7600.00     2736.00     4104.00      760.00
        21.00     9600.00     3456.00     5184.00      960.00
        22.00    12000.00     4320.00     6480.00     1200.00
        23.00    17400.00     6264.00     9396.00     1740.00
        24.00    26400.00     9504.00    14256.00     2640.00
        25.00    37000.00    13320.00    19980.00     3700.00
        26.00    46400.00    16704.00    25056.00     4640.00
        27.00    54800.00    19728.00    29592.00     5480.00
        28.00    62000.00    22320.00    33480.00     6200.00
        30.00    73400.00    26424.00    39636.00     7340.00
        31.30    78100.00    28116.00    42174.00     7810.00
```

FIGURE C.6 PREPBA Output File (continued)

```
 URBAN PROPERTY DAMAGE ($1000)
    ELEVATION       URBST       RURST


         9.00        0.00        0.00
        16.00     4220.00        0.00
        17.00     8440.00      422.00
        18.00    14348.00     2110.00
        19.00    18568.00     3798.00
        20.00    25320.00     5486.00
        21.00    31650.00     8440.00
        22.00    39668.00    11816.00
        23.00    47264.00    16880.00
        24.00    57814.00    20678.00
        25.00    73428.00    27008.00
        26.00    92840.00    34604.00
        27.00   124490.00    45154.00
        28.00   166268.00    56548.00
        30.00   280208.00    86088.00
        31.30   373508.00   103985.00
        32.00   375000.00   105000.00

1

*** WARNING - A CR record was entered, if crop
analysis is to take place, a CP record must be
in the input file! ***


1
   TULHR.IN - Arkansas River
   Keystone Dam to Verdigris River
   Tests Crops (3), Urban Areas (2), 2 Damage Reaches, 1 Levee, 5 Reservoirs

    Arkansas River - West Tulsa

   Damage Reach ID: TUL02
   Gauge ID: TULA
   USACE: Tulsa District
   State: Oklahoma
   Congressional District: Rep. Inhoff
   County: Tulsa County
   Community: Tulsa Community
   Watershed: Arkansas River
   Levee: West Tulsa Levee
   Reservoir(s): Keystone Lake
                 Kaw Lake
                 Cheney Lake
                 El Dorado Lake
                 Great Salt Plain

 URBAN PROPERTY DAMAGE ($1000)
    ELEVATION       URBST


        10.00        0.00
        16.00        0.00
        17.00      422.00
        18.00     2110.00
        19.00     3798.00
        20.00     5486.00
        21.00     8440.00
        22.00    11816.00
        23.00    16880.00
        24.00    20678.00
        25.00    27008.00
        26.00    34604.00
        27.00    45154.00
        28.00    56548.00
        30.00    86088.00
        31.30   103985.00
        32.00   105000.00

1
```

FIGURE C.6 PREPBA Output File (continued)

In addition to creating an output file, PREPBA has stored data in two binary files. PBA will retrieve and read these files to do the damage analysis.

C.2 PBA Execution

PBA's data is input in the \PBA directory TULSA.DAT, which is shown in Figure C.7. The dates of analysis selected for this example were 01 OCT 1986 to 20 OCT 1986. This is the largest flood event in Tulsa's recent history. A look-back date of 01 SEP 1986 was also used. A plot of the data in the analysis period is shown in Figure C.8. The hydrograph data is stored in a HEC-DSS file in \PBA called TUL1HR.DSS. The catalog of the HEC-DSS file containing two years of actural with-project, but hypothetical without-project hourly data is shown in Figure C.9.

```
T1 TULSA - Arkansas River, Keystone Dam to Verdigris River
T2
T3
J1      1      1.0 14FEB80      1.0 01JUL78
JE      01OCT1986                 20OCT1986                01SEP1986            1HOUR
PB KEYST       50
PB   KAW       20
PB  CHEN       15
PB ELDOR        5
PB   GSP       10
TA TRACE      ALL
EJ
```

FIGURE C.7 PBA Data Input File

HEC-PBA is executed by running the Tulsa batch file (TULSA.BAT in the PBA directory) shown in Figure C.10. The batch file contains the PBA command line. The data file, TULSA.DAT, and the batch file (TULSA.BAT) can be viewed or edited using any viewing or editing program. To get a listing of all the keywords and abbreviations associated with the PBA command line, type "PBA ?". This lists the file names which can be specified at run time.

To run HEC-PBA, type "TULSA" at the DOS prompt in the \PBA director, the batch file will run HEC-PBA using the data which PREPBA stored in the two binary files (TULSA.JFL and TULSA.RFL), the input data from TULSA.DAT and the hydrograph data from the HEC-DSS file TUL1HR.DSS. Results are output to a file called TULSA.OUT and listed in Figure C.11. The following paragraphs will describe the output.

HEC-PBA's output can be quite detailed or limited. Figure C.11 shows an average amount of output. Summaries of each damage reach are followed by boundary and project reports for the whole job.

The first sheet shows the HEC-PBA banner with the date and time the program was run. It also lists the HEC-DSS file which was opened.

The next section shows the flood damages for the with- and without-project conditions for Reach 1 (TUL01). This damage reach has three crops (oats, grain sorghum and native hay) in addition to urban - type data (Tulsa Urban and Rural Structures). The flood damages and acres flooded or structures flooded are reported for each elevation flood zone. It can be seen here that the peak of the hydrograph in the without-project condition got into zone 15 and the peak in the with-project condition got into zone 11.

Following the flood zone reports, the damage and accomplishment are summarized in the Damage Report for TUL01. This shows for the without-and with-project conditions, the urban damage by category and summed, agricultural damage by crop and summed, and the acres flooded. The damage (or acres flooded) from the without- and with-project condition are subtracted to compute the reduced flood damage or project benefit accomplishment.

The second reach (TUL02) has similar reports except there are no crops in this reach. Also, a levee which has not been overtopped protects the area, so there is no damage in the with-project condition. This particular data set did not include number of structures so zeros are printed in those columns.

Following the individual damage reach reports, a number of summary reports can be printed. Because the PBA input file (TULSA.DAT) had "ALL" written in the second column of the TA record, all the possible reports were printed. These summaries are by: Damage Reach, Congressional District, County, Flood Control District, Project Community, Corps of Engineers District, and Analysis (summary of entire system).

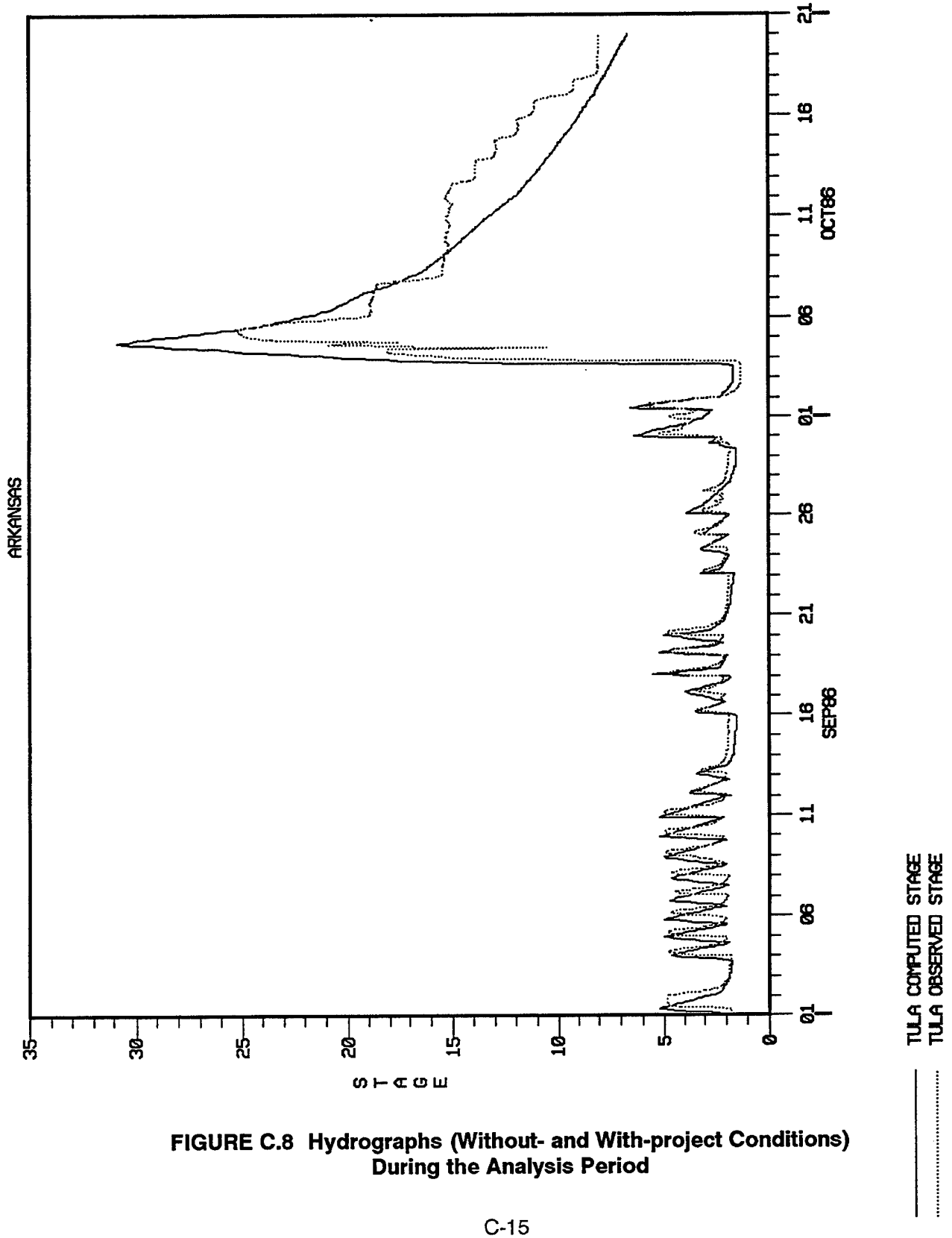


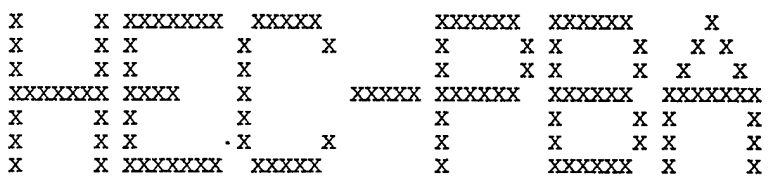
FIGURE C.8 Hydrographs (Without- and With-project Conditions) During the Analysis Period

```
     HECDSS Complete Catalog of Record Pathnames in File TUL1HR.DSS

     Catalog Created on Sep 8, 1993 at 16:31     File Created on Jan 22, 1993
     Number of Records:     48                   DSS Version 6-GN
     Sort Order: ABCFED

  Ref.
 Number   Tag           Record Pathname

     1  T26        /ARKANSAS/TULA/STAGE/01JAN1986/1HOUR/COMPUTED/
     2  T27        /ARKANSAS/TULA/STAGE/01FEB1986/1HOUR/COMPUTED/
     3  T28        /ARKANSAS/TULA/STAGE/01MAR1986/1HOUR/COMPUTED/
     4  T29        /ARKANSAS/TULA/STAGE/01APR1986/1HOUR/COMPUTED/
     5  T30        /ARKANSAS/TULA/STAGE/01MAY1986/1HOUR/COMPUTED/
     6  T31        /ARKANSAS/TULA/STAGE/01JUN1986/1HOUR/COMPUTED/
     7  T32        /ARKANSAS/TULA/STAGE/01JUL1986/1HOUR/COMPUTED/
     8  T33        /ARKANSAS/TULA/STAGE/01AUG1986/1HOUR/COMPUTED/
     9  T50        /ARKANSAS/TULA/STAGE/01SEP1986/1HOUR/COMPUTED/
    10  T52        /ARKANSAS/TULA/STAGE/01OCT1986/1HOUR/COMPUTED/
    11  T54        /ARKANSAS/TULA/STAGE/01NOV1986/1HOUR/COMPUTED/
    12  T37        /ARKANSAS/TULA/STAGE/01DEC1986/1HOUR/COMPUTED/
    13  T38        /ARKANSAS/TULA/STAGE/01JAN1987/1HOUR/COMPUTED/
    14  T39        /ARKANSAS/TULA/STAGE/01FEB1987/1HOUR/COMPUTED/
    15  T40        /ARKANSAS/TULA/STAGE/01MAR1987/1HOUR/COMPUTED/
    16  T41        /ARKANSAS/TULA/STAGE/01APR1987/1HOUR/COMPUTED/
    17  T42        /ARKANSAS/TULA/STAGE/01MAY1987/1HOUR/COMPUTED/
    18  T43        /ARKANSAS/TULA/STAGE/01JUN1987/1HOUR/COMPUTED/
    19  T44        /ARKANSAS/TULA/STAGE/01JUL1987/1HOUR/COMPUTED/
    20  T45        /ARKANSAS/TULA/STAGE/01AUG1987/1HOUR/COMPUTED/
    21  T46        /ARKANSAS/TULA/STAGE/01SEP1987/1HOUR/COMPUTED/
    22  T47        /ARKANSAS/TULA/STAGE/01OCT1987/1HOUR/COMPUTED/
    23  T48        /ARKANSAS/TULA/STAGE/01NOV1987/1HOUR/COMPUTED/
    24  T49        /ARKANSAS/TULA/STAGE/01DEC1987/1HOUR/COMPUTED/
    25  T1         /ARKANSAS/TULA/STAGE/01JAN1986/1HOUR/OBSERVED/
    26  T2         /ARKANSAS/TULA/STAGE/01FEB1986/1HOUR/OBSERVED/
    27  T3         /ARKANSAS/TULA/STAGE/01MAR1986/1HOUR/OBSERVED/
    28  T4         /ARKANSAS/TULA/STAGE/01APR1986/1HOUR/OBSERVED/
    29  T5         /ARKANSAS/TULA/STAGE/01MAY1986/1HOUR/OBSERVED/
    30  T6         /ARKANSAS/TULA/STAGE/01JUN1986/1HOUR/OBSERVED/
    31  T7         /ARKANSAS/TULA/STAGE/01JUL1986/1HOUR/OBSERVED/
    32  T8         /ARKANSAS/TULA/STAGE/01AUG1986/1HOUR/OBSERVED/
    33  T9         /ARKANSAS/TULA/STAGE/01SEP1986/1HOUR/OBSERVED/
    34  T10        /ARKANSAS/TULA/STAGE/01OCT1986/1HOUR/OBSERVED/
    35  T11        /ARKANSAS/TULA/STAGE/01NOV1986/1HOUR/OBSERVED/
    36  T12        /ARKANSAS/TULA/STAGE/01DEC1986/1HOUR/OBSERVED/
    37  T1         /ARKANSAS/TULA/STAGE/01JAN1987/1HOUR/OBSERVED/
    38  T2         /ARKANSAS/TULA/STAGE/01FEB1987/1HOUR/OBSERVED/
    39  T3         /ARKANSAS/TULA/STAGE/01MAR1987/1HOUR/OBSERVED/
    40  T4         /ARKANSAS/TULA/STAGE/01APR1987/1HOUR/OBSERVED/
    41  T5         /ARKANSAS/TULA/STAGE/01MAY1987/1HOUR/OBSERVED/
    42  T6         /ARKANSAS/TULA/STAGE/01JUN1987/1HOUR/OBSERVED/
    43  T7         /ARKANSAS/TULA/STAGE/01JUL1987/1HOUR/OBSERVED/
    44  T8         /ARKANSAS/TULA/STAGE/01AUG1987/1HOUR/OBSERVED/
    45  T9         /ARKANSAS/TULA/STAGE/01SEP1987/1HOUR/OBSERVED/
    46  T10        /ARKANSAS/TULA/STAGE/01OCT1987/1HOUR/OBSERVED/
    47  T11        /ARKANSAS/TULA/STAGE/01NOV1987/1HOUR/OBSERVED/
    48  T12        /ARKANSAS/TULA/STAGE/01DEC1987/1HOUR/OBSERVED/
```

FIGURE C.9 Catalog of Hydrograph Pathnames in the HEC-DSS File, TUL1HR.DSS

```
PBA J=TULSA.JFL RF=TULSA.RFL I=TULSA.DAT O=TULSA.OUT DSS=TUL1HR.DSS
```

FIGURE C.10 PBA's Batch File to Run the Program



Project Benefit Accomplishment Analysis Program

Hydrologic Engineering Center
US Army Corps of Engineers
609 Second Street
Davis, CA 95616-4687

(916) 756-1104
FAX (916) 756-8250

September 1994
Version: 1.0

```
**************************
* Run Date:  23 Aug 1994 *
* Run Time:  14:18:55    *
**************************

-----DSS---ZOPEN:  Existing File Opened,  File: TUL1HR.DSS
                  Unit:  71;  DSS Version: 6-GN
```

FIGURE C.11 PBA's Output File

1
TULSA - Arkansas River, Keystone Dam to Verdigris River

Arkansas River - Keystone Dam to Verdigris River

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986
AG Price Index: 1.00 AG Price Index Date: 14FEB80
Urban Price Index: 1.00 Urban Price Index Date: 01JUL78

Damage Reach ID: TUL01
Gauge ID: TULA
USACE: Tulsa District
State: Oklahoma
Congressional District: Rep. Inhoff
County: Tulsa County
Community: Tulsa Community
Watershed: Arkansas River
Reservoir(s): Keystone Lake
Kaw Lake
Cheney Lake
El Dorado Lake
Great Salt Plain

Oats

Without Project Conditions

Zone	Elevation	Flood Damage ($1000)	Other Losses ($1000)	Acreage Flooded (acres)
1	9.0 - 16.0	0.00	0.00	203.94
2	16.0 - 17.0	0.00	0.00	432.00
3	17.0 - 18.0	0.00	0.00	432.00
4	18.0 - 19.0	0.00	0.00	576.00
5	19.0 - 20.0	0.00	0.00	720.00
6	20.0 - 21.0	0.00	0.00	720.00
7	21.0 - 22.0	0.00	0.00	864.00
8	22.0 - 23.0	0.00	0.00	1944.00
9	23.0 - 24.0	0.00	0.00	3240.00
10	24.0 - 25.0	0.00	0.00	3816.00
11	25.0 - 26.0	0.00	0.00	3384.00
12	26.0 - 27.0	0.00	0.00	3024.00
13	27.0 - 28.0	0.00	0.00	2592.00
14	28.0 - 30.0	0.00	0.00	4104.00
15	30.0 - 31.3	0.00	0.00	1193.08
16	31.3 - 32.0	0.00	0.00	0.00
	Totals	0.00	0.00	27245.02

With Project Conditions

Zone	Elevation	Flood Damage ($1000)	Other Losses ($1000)	Acreage Flooded (acres)
1	9.0 - 16.0	0.00	0.00	21.39
2	16.0 - 17.0	0.00	0.00	432.00
3	17.0 - 18.0	0.00	0.00	432.00
4	18.0 - 19.0	0.00	0.00	576.00
5	19.0 - 20.0	0.00	0.00	720.00
6	20.0 - 21.0	0.00	0.00	720.00
7	21.0 - 22.0	0.00	0.00	864.00
8	22.0 - 23.0	0.00	0.00	1944.00
9	23.0 - 24.0	0.00	0.00	3240.00
10	24.0 - 25.0	0.00	0.00	3816.00
11	25.0 - 26.0	0.00	0.00	846.00
12	26.0 - 27.0	0.00	0.00	0.00
13	27.0 - 28.0	0.00	0.00	0.00
14	28.0 - 30.0	0.00	0.00	0.00
15	30.0 - 31.3	0.00	0.00	0.00
16	31.3 - 32.0	0.00	0.00	0.00
	Totals	0.00	0.00	13611.39

FIGURE C.11 PBA's Output File (continued)

1
TULSA - Arkansas River, Keystone Dam to Verdigris River

Arkansas River - Keystone Dam to Verdigris River

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986
AG Price Index: 1.00 AG Price Index Date: 14FEB80
Urban Price Index: 1.00 Urban Price Index Date: 01JUL78

Damage Reach ID: TUL01
Gauge ID: TULA
USACE: Tulsa District
State: Oklahoma
Congressional District: Rep. Inhoff
County: Tulsa County
Community: Tulsa Community
Watershed: Arkansas River
Reservoir(s): Keystone Lake
Kaw Lake
Cheney Lake
El Dorado Lake
Great Salt Plain

Grain Sorghum

Without Project Conditions

Zone	Elevation	Flood Damage ($1000)	Other Losses ($1000)	Acreage Flooded (acres)
1	9.0 - 16.0	35.55	0.00	305.91
2	16.0 - 17.0	75.26	0.00	648.00
3	17.0 - 18.0	75.22	0.00	648.00
4	18.0 - 19.0	100.22	0.00	864.00
5	19.0 - 20.0	125.19	0.00	1080.00
6	20.0 - 21.0	125.11	0.00	1080.00
7	21.0 - 22.0	150.03	0.00	1296.00
8	22.0 - 23.0	316.04	0.00	2916.00
9	23.0 - 24.0	474.32	0.00	4860.00
10	24.0 - 25.0	502.86	0.00	5724.00
11	25.0 - 26.0	407.34	0.00	5076.00
12	26.0 - 27.0	309.89	0.00	4536.00
13	27.0 - 28.0	211.46	0.00	3888.00
14	28.0 - 30.0	200.88	0.00	6156.00
15	30.0 - 31.3	16.04	0.00	1789.62
16	31.3 - 32.0	0.00	0.00	0.00
	Totals	3125.41	0.00	40867.53

With Project Conditions

Zone	Elevation	Flood Damage ($1000)	Other Losses ($1000)	Acreage Flooded (acres)
1	9.0 - 16.0	3.72	0.00	32.09
2	16.0 - 17.0	15.09	0.00	648.00
3	17.0 - 18.0	8.91	0.00	648.00
4	18.0 - 19.0	0.34	0.00	864.00
5	19.0 - 20.0	11.98	0.00	1080.00
6	20.0 - 21.0	4.26	0.00	1080.00
7	21.0 - 22.0	104.01	0.00	1296.00
8	22.0 - 23.0	219.78	0.00	2916.00
9	23.0 - 24.0	303.42	0.00	4860.00
10	24.0 - 25.0	217.70	0.00	5724.00
11	25.0 - 26.0	14.18	0.00	1269.00
12	26.0 - 27.0	0.00	0.00	0.00
13	27.0 - 28.0	0.00	0.00	0.00
14	28.0 - 30.0	0.00	0.00	0.00
15	30.0 - 31.3	0.00	0.00	0.00
16	31.3 - 32.0	0.00	0.00	0.00
	Totals	903.39	0.00	20417.09

FIGURE C.11 PBA's Output File (continued)

1
TULSA - Arkansas River, Keystone Dam to Verdigris River

Arkansas River - Keystone Dam to Verdigris River

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986
AG Price Index: 1.00 AG Price Index Date: 14FEB80
Urban Price Index: 1.00 Urban Price Index Date: 01JUL78

Damage Reach ID: TUL01
Gauge ID: TULA
USACE: Tulsa District
State: Oklahoma
Congressional District: Rep. Inhoff
County: Tulsa County
Community: Tulsa Community
Watershed: Arkansas River
Reservoir(s): Keystone Lake
Kaw Lake
Cheney Lake
El Dorado Lake
Great Salt Plain

Native Hay

Without Project Conditions

Zone	Elevation	Flood Damage ($1000)	Other Losses ($1000)	Acreage Flooded (acres)
1	9.0 - 16.0	0.16	0.00	56.65
2	16.0 - 17.0	0.33	0.00	120.00
3	17.0 - 18.0	0.33	0.00	120.00
4	18.0 - 19.0	0.44	0.00	160.00
5	19.0 - 20.0	0.55	0.00	200.00
6	20.0 - 21.0	0.55	0.00	200.00
7	21.0 - 22.0	0.65	0.00	240.00
8	22.0 - 23.0	1.46	0.00	540.00
9	23.0 - 24.0	2.42	0.00	900.00
10	24.0 - 25.0	2.84	0.00	1060.00
11	25.0 - 26.0	2.50	0.00	940.00
12	26.0 - 27.0	1.94	0.00	840.00
13	27.0 - 28.0	1.32	0.00	720.00
14	28.0 - 30.0	1.24	0.00	1140.00
15	30.0 - 31.3	0.10	0.00	331.41
16	31.3 - 32.0	0.00	0.00	0.00
	Totals	16.83	0.00	7568.06

With Project Conditions

Zone	Elevation	Flood Damage ($1000)	Other Losses ($1000)	Acreage Flooded (acres)
1	9.0 - 16.0	0.02	0.00	5.94
2	16.0 - 17.0	0.10	0.00	120.00
3	17.0 - 18.0	0.06	0.00	120.00
4	18.0 - 19.0	0.00	0.00	160.00
5	19.0 - 20.0	0.07	0.00	200.00
6	20.0 - 21.0	0.03	0.00	200.00
7	21.0 - 22.0	0.61	0.00	240.00
8	22.0 - 23.0	1.33	0.00	540.00
9	23.0 - 24.0	1.83	0.00	900.00
10	24.0 - 25.0	1.30	0.00	1060.00
11	25.0 - 26.0	0.08	0.00	235.00
12	26.0 - 27.0	0.00	0.00	0.00
13	27.0 - 28.0	0.00	0.00	0.00
14	28.0 - 30.0	0.00	0.00	0.00
15	30.0 - 31.3	0.00	0.00	0.00
16	31.3 - 32.0	0.00	0.00	0.00
	Totals	5.43	0.00	3780.94

FIGURE C.11 PBA's Output File (continued)

1
TULSA - Arkansas River, Keystone Dam to Verdigris River

Arkansas River - Keystone Dam to Verdigris River

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986
AG Price Index: 1.00 AG Price Index Date: 14FEB80
Urban Price Index: 1.00 Urban Price Index Date: 01JUL78

Damage Reach ID: TUL01
Gauge ID: TULA
USACE: Tulsa District
State: Oklahoma
Congressional District: Rep. Inhoff
County: Tulsa County
Community: Tulsa Community
Watershed: Arkansas River
Reservoir(s): Keystone Lake
Kaw Lake
Cheney Lake
El Dorado Lake
Great Salt Plain

Tulsa Urban

Without Project Conditions

Zone	Elevation	Flood Damage ($1000)	Structures Flooded
1	9.0 - 16.0	1494.14	0.00
2	16.0 - 17.0	4220.00	0.00
3	17.0 - 18.0	5908.00	0.00
4	18.0 - 19.0	4220.00	0.00
5	19.0 - 20.0	6752.00	0.00
6	20.0 - 21.0	6330.00	0.00
7	21.0 - 22.0	8018.00	0.00
8	22.0 - 23.0	7596.00	0.00
9	23.0 - 24.0	10550.00	0.00
10	24.0 - 25.0	15614.00	0.00
11	25.0 - 26.0	19412.00	0.00
12	26.0 - 27.0	31650.00	0.00
13	27.0 - 28.0	41778.00	0.00
14	28.0 - 30.0	113940.01	0.00
15	30.0 - 31.3	65788.59	0.00
16	31.3 - 32.0	0.00	0.00
	Totals	343270.75	0.00

With Project Conditions

Zone	Elevation	Flood Damage ($1000)	Structures Flooded
1	9.0 - 16.0	156.74	0.00
2	16.0 - 17.0	4228.35	0.00
3	17.0 - 18.0	5924.14	0.00
4	18.0 - 19.0	4222.81	0.00
5	19.0 - 20.0	6762.55	0.00
6	20.0 - 21.0	6346.59	0.00
7	21.0 - 22.0	8018.00	0.00
8	22.0 - 23.0	7596.00	0.00
9	23.0 - 24.0	10550.00	0.00
10	24.0 - 25.0	15614.00	0.00
11	25.0 - 26.0	4853.00	0.00
12	26.0 - 27.0	0.00	0.00
13	27.0 - 28.0	0.00	0.00
14	28.0 - 30.0	0.00	0.00
15	30.0 - 31.3	0.00	0.00
16	31.3 - 32.0	0.00	0.00
	Totals	74272.18	0.00

FIGURE C.11 PBA's Output File (continued)

1
TULSA - Arkansas River, Keystone Dam to Verdigris River

Arkansas River - Keystone Dam to Verdigris River

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986
AG Price Index: 1.00 AG Price Index Date: 14FEB80
Urban Price Index: 1.00 Urban Price Index Date: 01JUL78

Damage Reach ID: TUL01
Gauge ID: TULA
USACE: Tulsa District
State: Oklahoma
Congressional District: Rep. Inhoff
County: Tulsa County
Community: Tulsa Community
Watershed: Arkansas River
Reservoir(s): Keystone Lake
Kaw Lake
Cheney Lake
El Dorado Lake
Great Salt Plain

Rural Struct

Without Project Conditions

Zone	Elevation	Flood Damage ($1000)	Structures Flooded
1	9.0 - 16.0	0.00	0.00
2	16.0 - 17.0	422.00	0.00
3	17.0 - 18.0	1688.00	0.00
4	18.0 - 19.0	1688.00	0.00
5	19.0 - 20.0	1688.00	0.00
6	20.0 - 21.0	2954.00	0.00
7	21.0 - 22.0	3376.00	0.00
8	22.0 - 23.0	5064.00	0.00
9	23.0 - 24.0	3798.00	0.00
10	24.0 - 25.0	6330.00	0.00
11	25.0 - 26.0	7596.00	0.00
12	26.0 - 27.0	10550.00	0.00
13	27.0 - 28.0	11394.00	0.00
14	28.0 - 30.0	29540.00	0.00
15	30.0 - 31.3	12619.71	0.00
16	31.3 - 32.0	0.00	0.00
	Totals	98707.71	0.00

With Project Conditions

Zone	Elevation	Flood Damage ($1000)	Structures Flooded
1	9.0 - 16.0	0.00	0.00
2	16.0 - 17.0	422.84	0.00
3	17.0 - 18.0	1692.61	0.00
4	18.0 - 19.0	1689.12	0.00
5	19.0 - 20.0	1690.64	0.00
6	20.0 - 21.0	2961.74	0.00
7	21.0 - 22.0	3376.00	0.00
8	22.0 - 23.0	5064.00	0.00
9	23.0 - 24.0	3798.00	0.00
10	24.0 - 25.0	6330.00	0.00
11	25.0 - 26.0	1899.00	0.00
12	26.0 - 27.0	0.00	0.00
13	27.0 - 28.0	0.00	0.00
14	28.0 - 30.0	0.00	0.00
15	30.0 - 31.3	0.00	0.00
16	31.3 - 32.0	0.00	0.00
	Totals	28923.95	0.00

FIGURE C.11 PBA's Output File (continued)

1

Damage Report
for
Arkansas River - Keystone Dam to Verdigris River

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986
AG Price Index: 1.00 AG Price Index Date: 14FEB80
Urban Price Index: 1.00 Urban Price Index Date: 01JUL78

Damage Reach ID: TUL01
Gauge ID: TULA
USACE: Tulsa District
State: Oklahoma
Congressional District: Rep. Inhoff
County: Tulsa County
Community: Tulsa Community
Watershed: Arkansas River
Reservoir(s): Keystone Lake
Kaw Lake
Cheney Lake
El Dorado Lake
Great Salt Plain

****

Urban Damage Summary

	Flood Damage Without Project ($1000)	Flood Damage With Project ($1000)	Flood Damage Reduced ($1000)
Tulsa Urban	343270.75	74272.18	268998.56
Rural Struct	98707.71	28923.95	69783.77
Total	441978.47	103196.13	338782.31

****

Agricultural Damage Summary

	Acreage Flooded Without Project (acres)	Acreage Flooded With Project (acres)	Acreage Accomplishments (acres)
Oats	27245.02	13611.39	13633.63
Grain Sorghum	40867.53	20417.09	20450.44
Native Hay	7568.06	3780.94	3787.12
Total	75680.61	37809.42	37871.19

	Flood Damage Without Project ($1000)	Flood Damage With Project ($1000)	Flood Damage Reduced ($1000)
Oats	0.00	0.00	0.00
Grain Sorghum	3125.41	903.39	2222.02
Native Hay	16.83	5.43	11.40
Total	3142.24	908.82	2233.42

****

Reach Summary

	Without Project Conditions	With Project Conditions	Project Accomplishment
Damage ($1000)	445120.72	104104.95	341015.72
Crop Acres Flooded	75680.61	37809.42	37871.19

****

Project Benefit Accomplishment Summary

	Agri ($1000)	Area (acres)	Urban ($1000)	Structures
Keystone Lake	1116.71	18935.59	169391.17	0
Kaw Lake	446.68	7574.24	67756.46	0
Cheney Lake	335.01	5680.68	50817.35	0
El Dorado Lake	111.67	1893.56	16939.12	0
Great Salt Plain	223.34	3787.12	33878.23	0
Reservoir Subtotal	2233.41	37871.18	338782.31	0
Total	2233.41	37871.18	338782.31	0

FIGURE C.11 PBA's Output File (continued)

1
TULSA - Arkansas River, Keystone Dam to Verdigris River

Arkansas River - West Tulsa

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986
AG Price Index: 1.00 AG Price Index Date: 14FEB80
Urban Price Index: 1.00 Urban Price Index Date: 01JUL78

Damage Reach ID: TUL02
Gauge ID: TULA
USACE: Tulsa District
State: Oklahoma
Congressional District: Rep. Inhoff
County: Tulsa County
Community: Tulsa Community
Watershed: Arkansas River
Levee: West Tulsa Levee
Reservoir(s): Keystone Lake
Kaw Lake
Cheney Lake
El Dorado Lake
Great Salt Plain

Tulsa Urban

Without Project Conditions

Zone	Elevation	Flood Damage ($1000)	Structures Flooded
1	10.0 - 16.0	0.00	0.00
2	16.0 - 17.0	422.00	0.00
3	17.0 - 18.0	1688.00	0.00
4	18.0 - 19.0	1688.00	0.00
5	19.0 - 20.0	1688.00	0.00
6	20.0 - 21.0	2954.00	0.00
7	21.0 - 22.0	3376.00	0.00
8	22.0 - 23.0	5064.00	0.00
9	23.0 - 24.0	3798.00	0.00
10	24.0 - 25.0	6330.00	0.00
11	25.0 - 26.0	7596.00	0.00
12	26.0 - 27.0	10550.00	0.00
13	27.0 - 28.0	11394.00	0.00
14	28.0 - 30.0	29540.00	0.00
15	30.0 - 31.3	12619.71	0.00
16	31.3 - 32.0	0.00	0.00
	Totals	98707.71	0.00

With Project Conditions

Zone	Elevation	Flood Damage ($1000)	Structures Flooded
1	10.0 - 16.0	0.00	0.00
2	16.0 - 17.0	0.00	0.00
3	17.0 - 18.0	0.00	0.00
4	18.0 - 19.0	0.00	0.00
5	19.0 - 20.0	0.00	0.00
6	20.0 - 21.0	0.00	0.00
7	21.0 - 22.0	0.00	0.00
8	22.0 - 23.0	0.00	0.00
9	23.0 - 24.0	0.00	0.00
10	24.0 - 25.0	0.00	0.00
11	25.0 - 26.0	0.00	0.00
12	26.0 - 27.0	0.00	0.00
13	27.0 - 28.0	0.00	0.00
14	28.0 - 30.0	0.00	0.00
15	30.0 - 31.3	0.00	0.00
16	31.3 - 32.0	0.00	0.00
	Totals	0.00	0.00

FIGURE C.11 PBA's Output File (continued)

1

Damage Report
for
Arkansas River - West Tulsa

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986
AG Price Index: 1.00 AG Price Index Date: 14FEB80
Urban Price Index: 1.00 Urban Price Index Date: 01JUL78

Damage Reach ID: TUL02
Gauge ID: TULA
USACE: Tulsa District
State: Oklahoma
Congressional District: Rep. Inhoff
County: Tulsa County
Community: Tulsa Community
Watershed: Arkansas River
Levee: West Tulsa Levee
Reservoir(s): Keystone Lake
Kaw Lake
Cheney Lake
El Dorado Lake
Great Salt Plain

****

Urban Damage Summary

	Flood Damage Without Project ($1000)	Flood Damage With Project ($1000)	Flood Damage Reduced ($1000)
Tulsa Urban	98707.71	0.00	98707.71
Total	98707.71	0.00	98707.71

****

Reach Summary

	Without Project Conditions	With Project Conditions	Project Accomplishment
Damage ($1000)	98707.71	0.00	98707.71

****

Project Benefit Accomplishment Summary

	Agri ($1000)	Area (acres)	Urban ($1000)	Structures
West Tulsa Levee	0.00	0.00	42159.71	0
Keystone Lake	0.00	0.00	28274.00	0
Kaw Lake	0.00	0.00	11309.60	0
Cheney Lake	0.00	0.00	8482.20	0
El Dorado Lake	0.00	0.00	2827.40	0
Great Salt Plain	0.00	0.00	5654.80	0
Reservoir Subtotal	0.00	0.00	56548.00	0
Total	0.00	0.00	98707.70	0

FIGURE C.11 PBA's Output File (continued)

1 Damage Reach Summary

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986

Damage Reach ID	Agricultural Price Index	Agricultural Price Index Date	Urban Price Index	Urban Price Index Date
TUL01	1.00	14FEB80	1.00	01JUL78
TUL02	1.00	14FEB80	1.00	01JUL78

****

Damage Without Project Conditions

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Arkansas River				
TUL01	3142.24	75680.61	441978.47	0
TUL02	0.00	0.00	98707.71	0
Reach Totals	3142.24	75680.61	540686.19	0
Watershed Totals	3142.24	75680.61	540686.19	0

****

Damage With Project Conditions

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Arkansas River				
TUL01	908.82	37809.42	103196.13	0
TUL02	0.00	0.00	0.00	0
Reach Totals	908.82	37809.42	103196.13	0
Watershed Totals	908.82	37809.42	103196.13	0

****

Project Accomplishments

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Arkansas River				
TUL01	2233.42	37871.19	338782.31	0
TUL02	0.00	0.00	98707.71	0
Reach Totals	2233.42	37871.19	437490.03	0
Watershed Totals	2233.42	37871.19	437490.03	0

FIGURE C.11 PBA's Output File (continued)

1 Congressional District Summary

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986

Damage Without Project Conditions

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Oklahoma				
Rep. Inhoff	3142.24	75680.61	540686.19	0
Congressional District Totals	3142.24	75680.61	540686.19	0
State Totals	3142.24	75680.61	540686.19	0

****

Damage With Project Conditions

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Oklahoma				
Rep. Inhoff	908.82	37809.42	103196.13	0
Congressional District Totals	908.82	37809.42	103196.13	0
State Totals	908.82	37809.42	103196.13	0

****

Project Accomplishments

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Oklahoma				
Rep. Inhoff	2233.42	37871.19	437490.03	0
Congressional District Totals	2233.42	37871.19	437490.03	0
State Totals	2233.42	37871.19	437490.03	0

FIGURE C.11 PBA's Output File (continued)

1 County Summary

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986

Damage Without Project Conditions

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Oklahoma				
Tulsa County	3142.24	75680.61	540686.19	0
Muskogee County	0.00	0.00	0.00	0
Wagoner County	0.00	0.00	0.00	0
County Totals	3142.24	75680.61	540686.19	0
State Totals	3142.24	75680.61	540686.19	0

****

Damage With Project Conditions

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Oklahoma				
Tulsa County	908.82	37809.42	103196.13	0
Muskogee County	0.00	0.00	0.00	0
Wagoner County	0.00	0.00	0.00	0
County Totals	908.82	37809.42	103196.13	0
State Totals	908.82	37809.42	103196.13	0

****

Project Accomplishments

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Oklahoma				
Tulsa County	2233.42	37871.19	437490.03	0
Muskogee County	0.00	0.00	0.00	0
Wagoner County	0.00	0.00	0.00	0
County Totals	2233.42	37871.19	437490.03	0
State Totals	2233.42	37871.19	437490.03	0

1 Flood Control District Summary

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986

Damage Without Project Conditions

Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures

A flood control district was not given, therefore no report!

FIGURE C.11 PBA's Output File (continued)

1 Project Summary

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986

Project Accomplishments

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Arkansas River				
West Tulsa Levee	0.00	0.00	42159.71	0
Subtotal for Levees	0.00	0.00	42159.71	0
Keystone Lake	1116.71	18935.59	197665.17	0
Kaw Lake	446.68	7574.24	79066.06	0
Cheney Lake	335.01	5680.68	59299.55	0
El Dorado Lake	111.67	1893.56	19766.52	0
Great Salt Plain	223.34	3787.12	39533.03	0
Subtotal for Reservoirs	2233.41	37871.18	395330.34	0
Grand Total	2233.41	37871.18	437490.06	0

1 Community Summary

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986

Damage Without Project Conditions

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Tulsa Community	3142.24	75680.61	540686.19	0
Community Totals	3142.24	75680.61	540686.19	0

****

Damage With Project Conditions

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Tulsa Community	908.82	37809.42	103196.13	0
Community Totals	908.82	37809.42	103196.13	0

****

Project Accomplishments

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Tulsa Community	2233.42	37871.19	437490.03	0
Community Totals	2233.42	37871.19	437490.03	0

FIGURE C.11 PBA's Output File (continued)

1 Corps of Engineers District Summary

Beginning Date: 01OCT1986 Ending Date: 20OCT1986 Lookback Date: 01SEP1986

Damage Without Project Conditions

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Tulsa District	3142.24	75680.61	540686.19	0
USACE Totals	3142.24	75680.61	540686.19	0

****

Damage With Project Conditions

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Tulsa District	908.82	37809.42	103196.13	0
USACE Totals	908.82	37809.42	103196.13	0

****

Project Accomplishments

	Agri ($1000)	Area (acres)	Urban ($1000)	No. of Structures
Tulsa District	2233.42	37871.19	437490.03	0
USACE Totals	2233.42	37871.19	437490.03	0

FIGURE C.11 PBA's Output File (continued)

1****************************** Analysis Summary ******************************

Damage Categories

	Without Project Conditions Damage ($1000)	With Project Conditions Damage ($1000)	Project Damage Reduction ($1000)
Agricultural			
Oats	0.00	0.00	0.00
Grain Sorghum	3125.41	903.39	2222.02
Native Hay	16.83	5.43	11.40
Other Losses	0.00	0.00	0.00
Subtotal	3142.24	908.82	2233.42
Urban			
Tulsa Urban	441978.47	74272.18	367706.28
Rural Struct	98707.71	28923.95	69783.77
Subtotal	540686.19	103196.13	437490.06
Grand Total	543828.44	104104.95	439723.47

****

Summary Totals

	Without Project Conditions	With Project Conditions	Project Accomplishment
Damage ($1000)	543828.44	104104.95	439723.47
Crop Acres Flooded	75680.61	37809.42	37871.19

-----DSS---ZCLOSE Unit: 71, File: TUL1HR.DSS
Pointer Utilization: 0.08
Number of Records: 48
File Size: 410.5 Kbytes
Percent Inactive: 40.5

FIGURE C.11 PBA's Output File (continued)