

APPENDIX I  
GLOSSARY OF TERMS

## 1.0 NATURE OF THE GLOSSARY

The glossary which follows is not exhaustive. Its function is to introduce terms which may be new and to assign definite meanings to ambiguous terms. It is not a dictionary. The goal is not to provide formally correct definitions but to supply explanations adequate for practical purposes. Thus in some cases, the definition of a term is followed by a further explanatory note.

## 2.0 GLOSSARY

The list that follows is arranged alphabetically. Any word enclosed in parentheses ( ) may optionally be omitted from a term in everyday use, provided that the context ensures that its use is implied.

## ACTUAL ARGUMENT

The name of an item (or set) of data which is being passed to (or retrieved from) a subprogram via an argument list. It can be:

- (1) a variable name
- (2) an array or array element name
- (3) any other expression
- (4) the name of an external procedure
- (5) a Hollerith constant

## ANNIE

An interactive program designed for management of WDM files and their data. ANNIE functions include file creation, data set management, and data analysis, modification, and display.

## APPLICATION MODULE

A module which simulates processes which occur in the real world (e.g., PERLND, IMPLND, RCHRES).

## BUFFER

A portion of machine memory space used for the temporary storage of input or output-bound data.

## COMPUTATIONAL ELEMENT

See "element."

## CONCEPTUAL DATA STREAM

A stream of related data that are independent of any physical input-output device.

### COPY

A utility module used to copy time series data. COPY is typically used to transfer data from a sequential file to the WDM file or DSS file.

### DATA SET (TIME SERIES)

A data set in the WDM or DSS file.

### DIRECT ACCESS FILE

A disk file whose records are read from or written to a specific location within the file. Any record in the file may be accessed at any time. Contrast with sequential file.

### DIRECTED GRAPH

A group of processing units arranged with unidirectional paths between them. No bi-directional paths or cycles are allowed.

### DISPLY

A utility module used to print time series data and summaries of the data.

### DUMMY ARGUMENT

The local name (in a subprogram) for an actual argument which is passed to the subprogram.

### DURANL

A utility module used to examine the behavior of a time series, computing a variety of statistics related to its' excursions above and below certain specified levels.

### ELEMENT

A collection of nodes and/or zones, e.g. segment no. 1, reach no. 20.

### ELEMENT TYPE

A name which describes elements having a common set of attributes, for example, Pervious Land-segment, Reach/Mixed Reservoir.

### EXECUTABLE PROGRAM

A self contained computing procedure. It consists of a main program and its required subprograms.

### FEEDBACK ELEMENT

An element which is situated in a loop in a network or which is connected to another element by one or more bi-directional flux linkages.

### FEEDBACK REGION

A group of connected feedback elements. Information and constituent transfers across the boundaries of a feedback region are uni-directional, but internal fluxes can be bi-directional.

### FLOWCHART

A schematic two-dimensional representation of the logic in a program or program unit. The level of detail in a flowchart depends on its purpose.

FLUX

The rate of transfer of fluid, particles or energy across a given surface.

FUNCTION (as used in program design, not in Fortran language)

A transformation which receives input and returns output in a predictable manner. Most functions within a program can be classified into one of three types: input, process, or output. Usually, there is a hierarchy of functions--high level functions contain subordinate functions.

GENER

A utility module used to perform any one of several transformations on one or more input time series.

IMPLND

An application module which simulates the water quantity and quality processes which occur on an impervious land segment.

INGRP

A group of HSPF operations which share the same internal scratch pad (INPAD).

INPAD

see INTERNAL SCRATCH PAD

INPAD AREA

The space available in memory for the storage of time series data in the INPAD. It is the difference between the area of the common block SCRTCH and the longest OSV in the INGRP.

INPAD WIDTH

The number of time intervals which are present in the INPAD during a run. This is the INPAD area divided by the maximum number of rows of the time series data. HSPF uses fewer disk input/output operations with longer INPAD widths.

INPUT TIME SERIES

Time series which are read in a given simulation run.

INSPAN

see INTERNAL SCRATCH PAD SPAN

INTER SECTION DATA TRANSFER (ISDT)

The movement of information from one section to another within a module.

INTERNAL SCRATCH PAD (INPAD)

The space in memory where time series data are accessed by modules. It functions as a large buffer for this data.

INTERNAL SCRATCH PAD SPAN (INSPAN)

The real world time which corresponds to the INPAD width.

IVL

See SIMULATION INTERVAL

### JOB

The work performed by HSPF in response to the instructions found in a complete set of User's Control Input.

### KIND

A descriptor which implies either point or mean with regard to a time series.

### MEAN VALUED DATA

Data which represents the behavior of a time series over time intervals rather than at specific points in time.

### MIXED RESERVOIR

A water body which is assumed to be completely mixed.

### MODEL

A set of algorithms, set in a logical structure, which represents a process. A model is implemented using modules of code.

### MODULE

A set of program units which performs a clearly defined function.

### MODULE SECTION

A part of an Application Module which can be executed independently of the other parts. eg. SEDMNT in module PERLND.

### MUTSIN

A utility module used to read a sequential external file which has the same format as the file produced by the PLTGEN module. MUTSIN makes the time series data on the external file available for use by other modules.

### NETWORK

A group of connected processing units. Information and/or constituents flow between processing units through uni-directional linkages. That is, no processing unit may pass output which indirectly influences itself (no feedback loops). These constraints make it possible to operate on each processing unit separately, considering them in an "upstream" to "downstream" order.

### NODE

A point in space where the value of a spatially variable function can be determined.

### OPERATING MODULE (OM)

A set of HSPF program units which perform a series of process functions for a specified time on a given set of input time series and produce a specified set of output time series.

### OPERATION

In HSPF: execution of code which transforms a set of input time series into a set of output time series, for example, execution of an application module or a utility module. See "simulation operation," "utility operation."

### OPERATIONS STATUS VECTOR (OSV)

The data structure for an operating module. The OSV contains all the information (parameters, state variables) needed to describe the status of an operation and to restart it after an interruption.

### OPERATIONS SUPERVISOR (OSUPER)

The HSPF program units which oversee the execution of operating modules and related time series movement.

### OSV

see OPERATION STATUS VECTOR

### OUTPUT TIME SERIES

Time series which are generated during a simulation run. They do not have to be stored in the WDM or DSS.

### PARAMETER

A variable used in a function which determines the transformation of the input to the function to the output of the function.

### PARTITION (an operation)

The execution of different sections of an application module in separate runs. Time series involved in inter section data transfers must be stored between runs.

### PERLND

An application module which simulates the water quantity and quality processes which occur on a pervious land segment.

### PERVIOUS LAND SEGMENT (PLS)

A segment of land with a pervious surface.

### PHYSICAL PROCESS

A process occurring in the real world.

### PLS

see PERVIOUS LAND SEGMENT

### PLTGEN

A utility module used to write a sequential external file containing up to 10 time series and related commands for a stand alone plotting program.

### POINT VALUED DATA

Data which represents the behavior of a time series at specific points in time rather than over time intervals.

### PROCESS

In the real world: A continuing activity, for example, percolation, chemical reaction. See "physical process."

### PROCESSING UNIT (PU)

An element or group of related elements which is simulated for a period of time. Input comes from external sources or Processing Units which have completed simulating for the given period of time. Output goes to other processing units or external targets.

### PROGRAM

A complete set of code, consisting of one or more program units, the first of which is the "main" program unit.

### PU

see PROCESSING UNIT

### RCHRES

An application module which simulates the water quantity and quality processes which occur in a reach of open or closed channel or a completely mixed lake.

### REACH

A free-flowing portion of a stream, simulated in HSPF using storage routing.

### RUN

A set of operations which are performed serially and cover the same period of time.

### RUN INTERPRETER

The HSPF module which reads and interprets the User's Control Input. It sets up internal information that instructs the system regarding the sequence of operations to be performed, stores parameters and state variables for each operation in the OSV, writes instructions related to the movement of time series data and performs other minor functions.

### SECTION

see MODULE SECTION

### SEGMENT

A portion of the land assumed to have areally uniform properties.

### SEQUENTIAL FILE

A file whose records are organized on the basis of their successive physical positions, such as on magnetic tape or cards. A record may be accessed only after the previous record has been accessed.

### SIMPLE ELEMENT

An element which is not a feedback element.

### SIMULATION

Imitation of the behavior of a prototype, using a model. We implement the model on a computer using an application module.

### SIMULATION INTERVAL

The internal time step used in an operation.

SIMULATION MODULE

See APPLICATION MODULE

SIMULATION (OPERATION)

Simulation of a specified prototype for a specified period.

STATE VARIABLE

A variable containing the current value of a storage or other measurable quantity. It may change through time.

STRUCTURE CHART

A diagram which documents the result of structured (program) design. It indicates the program units, their relationships (including hierarchy) and, optionally, the data passed between them.

SYSTEM DOCUMENTATION

A comprehensive set of documents which enable a user to understand and use a software product. It should include:

- (1) a discussion of the underlying principles
- (2) a discussion of the mathematical relations which the code implements
- (3) documentation of the structure of the code
- (4) a listing of the code
- (5) documentation of data and file structures, including the input required to run the program.

TIME SERIES

A series of chronologically ordered values giving a discrete representation of the variation in time of a given quantity.

(TIME SERIES) DATA SET

A data set in the WDM or DSS file.

TIME SERIES MANAGEMENT SYSTEM (TSMS)

The modules of HSPF which are concerned with manipulation of time series or the files used to store time series. It includes TSGET and TSPUT.

TIME SERIES STORE (TSS)

A direct access file used for medium/long term storage of time series. Active maintenance of the TSS system has ceased, and it has been removed from the documentation.

TIME SERIES STORE MANAGEMENT (TSSM)

The HSPF module which (in previous versions) maintained a User's Time Series Store (TSS) and performed maintenance tasks associated with the data sets in it. TSSM has been removed from the program and the documentation.

TSPUT

The HSPF module which moves time series data from the INPAD to a WDM file or DSS.

TSGET

The HSPF module which moves time series data from a WDM file, DSS, or sequential file to the INPAD.

TSS

see TIME SERIES STORE

TSSM or TSSMGR

see TIME SERIES STORE MANAGEMENT

UCI

see USER'S CONTROL INPUT

USER'S CONTROL INPUT

The file in which the user specifies the operations to be performed in a run, the parameters and initial conditions for each one, and the time series to be passed between them. HSPF reads this from an ASCII file.

UTILITY MODULE

A module which performs operations on time series which are peripheral to the simulation of physical processes, for example, data input, plot generation, statistical analysis.

UTILITY OPERATION

Execution of a utility module.

VOLUME

A source (WDM, DSS, sequential file or INPAD) or target (WDM or DSS) for the time series data.

Watershed Data Management (WDM) File

A direct-access, binary file containing multiple time series data sets. This file is the primary storage file for HSPF time series data. WDM files are created and maintained by the ANNIE program and related-software.

WORLD VIEW

A representation of the real world which includes simplifying assumptions of physical processes.

ZONE

A finite portion of the real world. It is usually associated with the integral of a spatially variable quantity.



APPENDIX II  
TIME SERIES CONCEPTS

## 1.0 Time Series Concepts

A time series is a sequence of values ordered in time. The interval of time between successive values is called the time step or the time increment or the time interval of the time series. The time step for a time series is often a constant value but may also be variable. The implementation in HSPF restricts the variability in a manner discussed below. The values in the time series may represent the behavior of a process at a point in time or an average over the time step of the time series. A time series whose values represent behavior at points in time is called a point-valued time series and is represented symbolically by "\*". Linear interpolation is used to define intermediate values in a point-valued time series. A time series whose values represent average or aggregated behavior over the time step are called mean-valued time series and are represented symbolically as "-". The meaning of "average" and "mean" is taken in a wide sense and includes any value assumed to be representative of behavior of the time series over the time step, rather than at a specific point in time.

The following figure shows the difference between the point and mean value time series in graphic form. It is important to note that only one value is needed to represent the behavior of a mean-valued time series for one time step. We visualize the value as being assigned to a time step in this case. On the other hand, two values are needed to represent the behavior of a point-valued time series over the same interval. We visualize the values as being assigned to the time points in this case. Each time point at which a value of the series is given in a point-valued time series is viewed as "belonging" to the time step which it ends. Time points belonging to all time steps contained within a larger time step are viewed as belonging to the larger time step also. For example, all time points in a point-valued time series except the first time point belong to the time interval spanning the time series duration. The first time point of a point-valued time series is viewed as belonging to the time step immediately preceding the first time step of the time series. This precise definition of belongingness for a time point is needed to avoid confusion in defining operations on the time series.

A number of operations on time series, discussed in Section 4.6 of Part F, preserve the integral of the time series between any two time points which end time steps in the time series. The integral may be visualized as the area under the broken line graph formed by connecting adjacent values in the point-valued time series or the area under the histogram representing the mean-valued time series. The trapezoidal rule applied to the point-valued time series yields the exact value of the integral whereas the simple rectangular rule yields the exact value for the mean-valued time series.

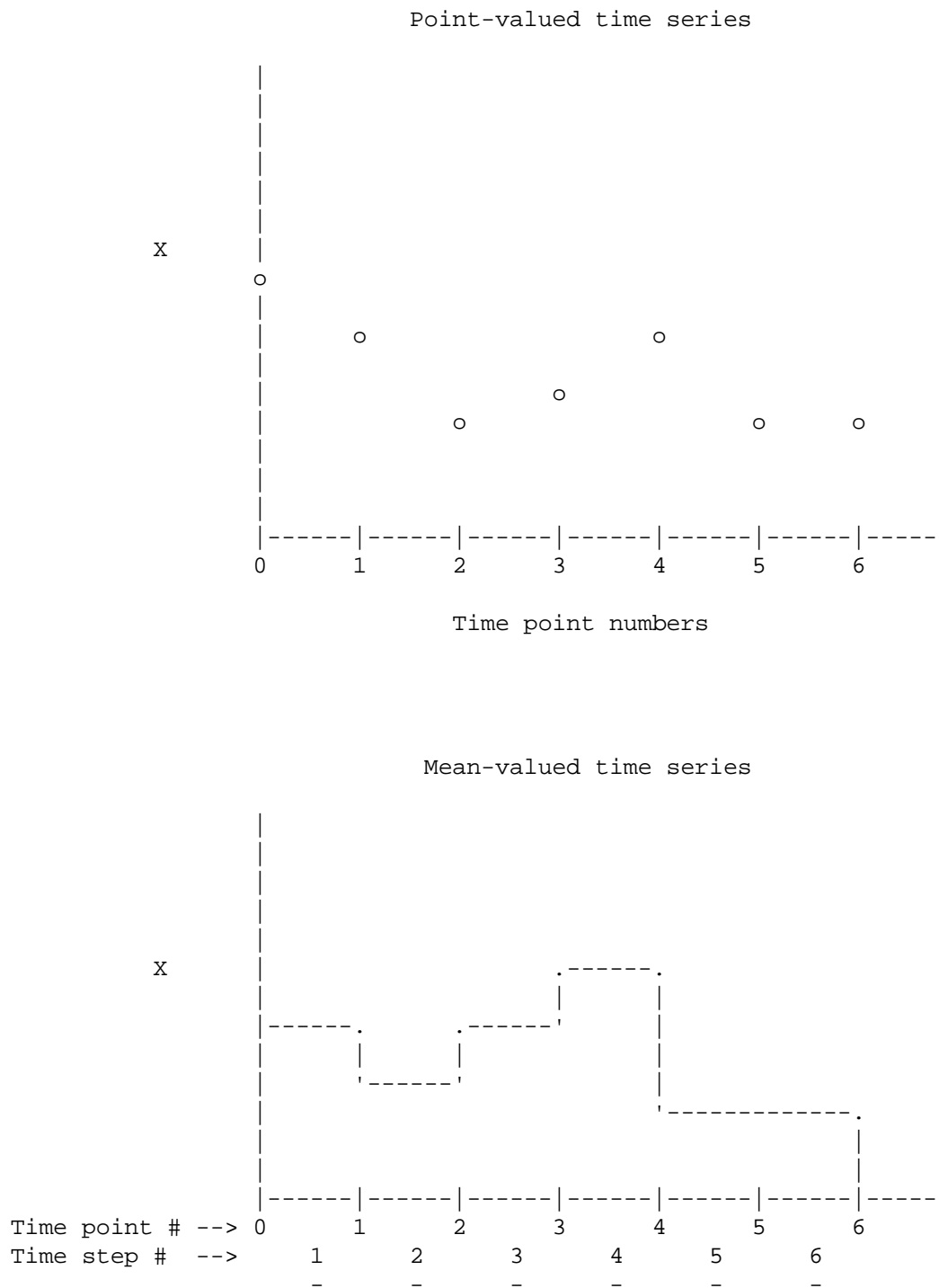


Figure 1. Comparison between point- and mean-valued time series

Time is given as year/month/day/hour/minute to completely specify either a time interval or a time point. The date/time given by the internal clock uses the "contained within" principle for all levels of the date/time. That is, each smaller interval is contained within the next larger interval. This is the conventional usage for year/month/day but is not conventional for the hour/minute. For example, the date string 1977/01/02 labels the second day of the first month of the 1977th year. On the other hand, in conventional usage the time string 10:15 refers to the end of the 15th minute after (not within) the 10th hour of the day. This change in meaning is eliminated in the internal date/time clock for HSPF. In the internal system, time string 10/15 labels the 15th minute of (ie. within) the 10th hour of the day. A comparable time to 10:15 in the conventional sense would be 11/15; that is, the 15th minute of the 11th hour of the day.

In summary, the internal clock convention labels time intervals at all levels of date/time whereas conventional usage labels time intervals for year/month/day but labels time points for hour/minute. In HSPF, time points are then referenced uniquely by the minute which ends at the time point in question.

The time steps in a time series are labelled with the minute which ends the time step. Thus, the values in a mean-valued time series are treated logically as having occurred at the end time point of the time step. Note that for purposes of the internal clock and for description of internal concepts each time point has one and only one label. This means that we refer to the instant in time forming the boundary between two days using the label associated with the first day even though our interest is centered on the second day. This convention is called the ending time convention.

A starting time convention is used externally for some purposes because traditional usage requires both conventions depending on the context of the statement about time. Users are more comfortable using the traditional clock and both a starting time and an ending time convention. The starting time convention is used when the start of some time span is in mind and the ending time convention is used when the end of some time span is in mind.

The time span associated with a time series must be defined. Logically, a time series is of infinite length. Realistically, every time series has a finite length and may be broken into short segments for convenience in recording the values on some medium such as the printed page, a magnetic tape, a data card or a magnetic disk. These shorter segments are made necessary by various software and hardware constraints. Therefore, a time span is associated with each medium used to record or store the time series.

A further practical complication is created by the variety of representations used for time series. The user's most likely mental image is a line drawn in some coordinate system on the printed page. This method of representing time series is most convenient for the user but a series of discrete numbers is most convenient for the digital computer. The time series of indefinite length must be subdivided into shorter time spans to fit the card images or the records on the tape or disk. In some cases data for the time series may be incomplete (some values not present) or, in some cases, many of the values are zero so that not all values for the time series are stored on the medium. In such cases a date/time indicator is given on the record. As an example, think of the format used for data cards punched by the National Weather Records Center. The date/time information on each record of the medium permits the reconstruction of the complete time series (except for the missing values) even though not all values are recorded on the medium. However, conventions must be established so that missing records on a given recording medium are properly interpreted. For example, are the missing data merely zeros or did they occur because of instrument malfunction? If the data are missing, a "filler" should be inserted when the data are placed on the WDM or DSS so that it can be changed at a later time or so that such missing periods can be properly handled by other parts of the HSPF system. The filler value is called the TSFILL attribute in the WDM system.

The time step for a time series can vary in multiples of a basic time step established for the time series. The basic time step for the time series must be truly a constant value. For example, a time series at a monthly interval does not have a constant time step. Therefore, the basic time step assigned to such a time series is daily because a day is of constant length and is commensurable with all months.