

4.5 FTABLES Block

```
*****
      1         2         3         4         5         6         7         8
1234567890123456789012345678901234567890123456789012345678901234567890
*****
Layout
*****
```

FTABLES

```
      FTABLE      <t>
<----ftab-parms---->
<----- row-of-values ----->
.....
line above repeats until function has been described through desired range
.....
      END FTABLE<t>
```

Any number of FTABLES may appear in the block

END FTABLES

```
*****
```

Details

Symbol	FORTTRAN Name(s)	Format	Comment
<t>	NUMBR	I3	User's ID number for this FTABLE.
<ftab-parms>	Fparms(4)	4I5	Up to 4 control parameters may be supplied for an Ftable, e.g. number of rows, number of columns, etc. Exact details depend on the FTABLE concerned.
<row-of-values>	VAL(*)	variable	Each column is dedicated to one of the variables in the function. Each row contains a full set of corresponding values of these variables, e.g., depth, surface area, volume, and outflow for a RCHRES.

Explanation

An FTABLE is used to specify, in discrete form, a functional relationship between two or more variables. For example, in the RCHRES module, it is assumed that there is a fixed relationship between depth, surface area, volume, and volume-dependent (F(vol)) discharge component. An FTABLE is used to document this non-analytic function in numerical form. Each column of the FTABLE is dedicated to one of the above variables, and each row contains corresponding values of the set. That is, each row contains the surface area, volume, and discharge for a given depth. The number of rows in the FTABLE will depend on the range of depth to be covered and the desired resolution of the function.

4.5(3) FTABLES for the RCHRES Application Module

4.5(3).1 FTABLE for HYDR section

The geometric and hydraulic properties of a RCHRES are summarized in a function table (FTABLE). Every RCHRES must be associated with one FTABLE; the association is done in Table-type HYDR-PARM2 (Section 4.4(3).2.2 above). Usually, every RCHRES will have its own FTABLE; however, if RCHRES's are identical they can share the same FTABLE. FTABLE's may be included in the user's input (FTABLES Block) or they may be stored in a WDM File.

```
*****
      1         2         3         4         5         6         7         8
1234567890123456789012345678901234567890123456789012345678901234567890
*****
Layout
*****
```

```
      FTABLE      <t>
<-nr><-nc>
<-depth--><--area--><-volume-><----- f(VOL)-values ----->
.....
The above row repeats until values have been supplied to cover the entire
cross-section at the desired resolution
.....
      END FTABLE<t>
```

Example

```
*****
```

```
      FTABLE      103
rows cols
      3      5
      depth      area      volume  outflow1  outflow2 ***
      (ft)      (acres) (acre-ft)  ( ft3/s)  ( ft3/s) ***
      0.0        0.0        0.0        0.0        0.0
      5.0       10.0       25.0       20.5       10.2
      20.0     120.0     1000.0     995.0     200.1
      END FTABLE103
*****
```

Details

Symbol	Name(s)	Format	Comment
<t>	see Sect. 4.5	I3	ID No. of FTABLE
<nr>	NROWS	I5	Number of rows in FTABLE
<nc>	NCOLS	I5	Number of columns in FTABLE
<depth>	Depth	F10.0	Depth of RCHRES; Units: English = ft; Metric = m
<area>	Surface area	F10.0	Surface area of RCHRES; Units: English = acres; Metric = ha
<volume>	Volume	F10.0	Volume of RCHRES; The volume in the first row must be 0.0; Units: English= acre.ft; Metric= Mm3 (10**6 m3)
<f(vol)- values>	F(V)	(NCOLS-3)* F10.0	Units: English = ft3/s; Metric = m3/s

Explanation

This FTABLE lists depth, surface area and, optionally, one or more other values (typically discharge rates) as functions of volume. HSPF interpolates between the specified values to obtain the geometric and hydraulic characteristics for intermediate values of volume.

The FTABLE must satisfy the following conditions:

1. (NCOLS*NROWS) must not exceed 100
2. NCOLS must be between 3 and 8
3. There must be at least one row in the FTABLE
4. The first row must have volume = 0.0
5. No negative values are permitted
6. The depth and volume fields may not decrease as the row number increases

In the example given above, we have a reach with two outflows, both of which are functions of volume. Thus, there are 5 columns in the FTABLE.

The values for this type of FTABLE can either be supplied directly by the user or generated by a subsidiary program from more basic information (e.g., by backwater analysis or Manning's equation for assumed uniform flow).

WDM FTABLES are stored in WDM "table" data sets, and accessed directly by HSPF. These data sets may be created and modified through the use of the ANNIE program. WDM FTABLES follow the same structure, and must satisfy the same conditions as FTABLES contained in the UCI.

4.6 TIME SERIES LINKAGES

4.6.1 General Discussion

In the EXTERNAL SOURCES, NETWORK, EXTERNAL TARGETS, and SCHEMATIC/MASS-LINK blocks, the user specifies those time series which are to be passed between pairs of operations in the same INGRP or between individual operations and external sources/targets (WDM Data sets, DSS Data records, or sequential files). The blocks are arranged in the form of tables, each containing one or more entries (rows). Each entry contains source information, a multiplication factor, a transformation function, and target information.

The entries in these blocks may be in any order.

When a time series associated with a data set in a WDM file is referred to, the user supplies the data-set number and the data-set name. This information must agree with data supplied when the data set was created. WDM data sets and associated attributes are created using the interactive program ANNIE. The user should refer to the ANNIE User's manual for additional information.

Time series may also be associated with DSS data records in up to five different DSS files. Each record, or group of records, is identified by a pathname, which is specified in the PATHNAMES block, where it is associated with a data-set number in the context of the current UCI file. No data-set name is specified.

If a DSS record is accessed as an external target, it is not necessary that the record, or even the file, exist before the run. DSS records used as external sources, however, must be already present in the specified DSS file.

The user specifies time series which are input to, or output from, an operating module by supplying a group name (<sgrp>, <tgrp>) and a member name plus one or two subscripts (<smem><m#>, <tmem><m#>). The member information must be compatible with data given in the Time Series Catalog for the applicable operating module and group (Section 4.7).

The user may route the same source to several targets by making several separate entries in a block, each referring to the same field source, or by making use of the "range" feature provided in the <tvol>< range> field. This latter feature does not apply to entries in the EXT TARGETS Block. In either case the implication is that data from the source will be used repetitively, and each time will be multiplied by the specified factor and added to whatever else has already been routed to the specified target. Conversely, several sources may be routed to a single target, except in the EXT TARGETS Block. This happens when several entries specify different sources but the same target. Here, the implication is that the data obtained from the several sources must be accumulated (added) before being used by the target.

4.6.1.1 WDM File Concepts

The WDM file is a binary, direct-access file that is organized into discrete data sets. Each data set consists of data as well as "attributes" that describe the data. Disk space for a WDM file is allocated as needed in 40,960-byte increments. Space from deleted data sets within a WDM file is reused as new data are added to the file. Thus the WDM file needs no special maintenance processing.

HSPF accesses WDM files for both input and output time series data. HSPF requires that a data set be created in an existing WDM file prior to any run that writes to the data set. Maintenance of WDM files and creation of new data sets is accomplished using the USGS's ANNIE program (Flynn, K.M., P.R. Hummel, A.M. Lumb, and J.L. Kittle, Jr. 1995. User's Manual for ANNIE, Version 2, a Computer Program for Interactive Hydrologic Data Management. WRI Report 95-4085. U.S. Geological Survey, Reston, VA).

Within the HSPF UCI file, a WDM data set is referred to by its data-set number and its name (i.e., its TSTYPE attribute), which is a four-character alpha-numeric identifier. As stated above, WDM data-set attributes are created when the data set is first created using the ANNIE program. The attributes that are associated with time series data sets can be divided into two types: 1) those that describe how the data are stored in the data set, and 2) those that are purely descriptive or provide information about the data. Examples of the second type are station name (STANAM), station ID (STAID), latitude and longitude (LATDEG, LNGDEG), and data-set description (DESCRP). Attributes of the first type are more critical, and are considered "required" attributes for time series data sets. These attributes are defined below:

TCODE	Time units code for defining the time interval of the data set (1-seconds, 2-minutes, 3-hours, 4-days, 5-months, 6-years); valid values in HSPF are 2, 3, 4, and 5.
TSSTEP	Time interval of data set in TCODE units (used in combination with TCODE)
TSFORM	Form of data; valid values in HSPF context are: (1-mean over time step, 2-total over time step, 3-instantaneous); 1 and 2 correspond to "mean" time series, and 3 corresponds to "point" time series.
TSBYR	Starting year of data set; defaults to 1900; generally should be set to a year just prior to start of data.
TGROUP	Unit for group pointers (3-hours, 4-days, 5-months, 6-years, 7-centuries); it may affect speed of data retrievals and total amount of data storage available in data set; see table in ANNIE manual for recommended values.
TSFILL	Filler value for missing data; default = 0.0.
COMPFG	Compression flag (1-data are compressed, 2-data are not compressed)
TOLR	Compression tolerance; data values within TOLR are compressed.
VBTIME	Variable time step flag; must be 1 (all data at same time step) for HSPF.

4.6.1.2 DSS File Concepts

DSS Pathnames

DSS files access time series data in a somewhat different manner than WDM files. The latter refers to a time series by a single data-set number. DSS files refer to time series by "pathnames", which follow different conventions for different kinds of data. HSPF uses only one of the allowed kinds, i.e., "Regular" Time Series. The PATHNAMES block is used to temporarily assign or associate a data-set number with each time series needed in the run. (See Section 4.6.6.)

An entire DSS time series is not necessarily stored in one logical piece in the DSS file. Data are broken up into separate records with definite sizes and starting dates, which depend on the time step of the data. For instance, hourly data is stored in records each containing one month of values and starting with the first hour of the month. Daily data, on the other hand, is stored yearly, in records starting on January 1st.

The pathname can consist of up to 80 characters; because of limitations on UCI line length, HSPF only allows 64 characters in DSS pathnames. Pathnames are separated into six parts (delimited by slashes "/"), which are referenced by the characters "A" through "F". For a "regular" time series, the conventions for the contents of the six parts are:

- A River basin or project name
- B Location or gage identifier
- C Data variable, e.g. FLOW, PRECIP
- D Starting date for block of data in the format 01JAN1980.
This part is not used by HSPF, and should be left empty.
- E Time interval - valid values are:
5MIN, 10MIN, 15MIN, 30MIN, 1HOUR, 2HOUR, 3HOUR, 4HOUR, 6HOUR,
12HOUR, 1DAY, 1WEEK, 1MON, 1YEAR
- F Additional user-defined descriptive information, e.g. OBSERVED, PLAN A

Any single part may contain up to 32 characters, but the total including slashes must remain less than 80 for general DSS use, and less than 64 characters for HSPF (leaving the D part empty). A typical HSPF pathname might be:

```
/PATUXENT/BRIGHTON DAM/DIVERSION//1DAY/OBSERVED-CFS/
```

Note the double slash indicating the empty D part. A D part may be provided by the user, but HSPF ignores it; this allows the DSS system to generate it, as needed, based on the starting and ending dates of the run. For additional information, users should refer to the HECDSS Users Guide (US Army Corps of Engineers Hydrologic Engineering Center, April 1990).

DSS Data Types

Each DSS data record also may have a data **type** string and/or a **units** string stored with it. Units strings are ignored by HSPF. Data type strings are used to determine whether the time series is point-valued or mean-valued in the context of HSPF. Valid values of the data type string are:

- INST-VAL - point-valued: instantaneous at end of interval
- PER-AVER - mean-valued: average over interval
- PER-CUM - mean-valued: total over interval

A fourth type, INST-CUM, which is used for mass curves, is not valid for HSPF. The data type string for each time series (input or output) must be specified in the PATHNAMES block.

The data type should not change over time (i.e. between subsequent records) for a given time series. If a data record already exists before the run, any value specified in the PATHNAMES block must match the stored value, if it exists. If a data record is created by the run, it is stored with the value given in the PATHNAMES block, if any. If neither the record itself nor the PATHNAMES block specifies a data type, the data is treated by the program as a mean-valued time series.

4.6.2 EXT SOURCES Block (External sources)

In this block the user specifies those time series which are to be supplied to operations in a RUN from sources external to it; external sources are WDM data sets, DSS data sets, and sequential (SEQ) files.

```
*****
      1          2          3          4          5          6          7          8
1234567890123456789012345678901234567890123456789012345678901234567890
*****
```

Layout

EXT SOURCES

```
<svol><s#> <exsm>qf <ss><sg><-mfact--><tr> <tvol>< range> <tgrp> <tmem><m#>
      or
      <sfmt>f#
```

.....
Above line repeats until all external sources have been specified
.....

END EXT SOURCES

Example

EXT SOURCES

```
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name>    # <Name> # tem strg<-factor->strg <Name>    #    #    <Name> # #    ***
SEQ       3 HYDDAY  ENGL          1.0    RCHRES    1    EXTNL  ICON
WDM1     22 PREC    METRZERO          SUM  IMPLND    2    EXTNL  PREC
DSS      132        ENGL          SAME  PLTGEN   10    INPUT  POINT  1
END EXT SOURCES
```

Details

Symbol	FORTTRAN Name(s)	Start Column	Format	Comment
<svol>	SVOL	1	A6	External source volume. Valid values are WDMn (Watershed Data Management System File, where n is 1-4 or blank), DSS (Data Storage System), and SEQ (sequential file).
<s#>	SVOLNO	7	I4	Data-set number if SVOL = WDMn, or DSS; file unit number if SVOL = SEQ
<exsm>	SMEMN	12 12	A6 A4	Data-set TSTYP attribute if SVOL = WDMn; blank for SVOL = DSS
<sfmt>	SFCLAS	12	A6	SFCLAS is a string indicating the class of format used in the sequential file.
qf	QLFG	18	I2	Quality-of-data flag if SVOL = WDMn; specifies the minimum quality of WDM data which will be accepted by HSPF; valid values = 0-31; default = 31
f#	SFNO	18	I2	SFNO identifies an object-time format supplied in the FORMATS Block. Default: standard format.
<ss>	SSYST	21	A4	Unit system of data in the source if SVOL = SEQ, WDMn, or DSS; valid values: ENGL and METR; default = ENGL
<sg>	SGAPST	25	A4	String indicating how missing lines in the sequential file, missing data in a DSS file, or WDM data of insufficient quality will be regarded; used if SVOL = SEQ, WDMn, or DSS. Valid values are ZERO (assign value 0) and UNDF (assign undefined value). Defaults to UNDF. See below for explanation.
<mfact>	MFACTR	29	F10.0	The factor by which data from the source will be multiplied before being added to the target. Default = 1.0
<tr>	TRAN	39	A4	String indicating which transformation function to use in transferring time series from source to target. See Section 4.6.7 for valid values and defaults.
<tvol>	TVOL	44	A6	TVOL is the Operation-type of the target.

Time Series Linkages

< range>	TOPFST	51	I3	TOPFST & TOPLST specify the range of operations
	TOPLST	55	I3	which are targets (e.g., PERLND 1 5). If TOPLST field is blank, the target is a single operation.
<tgrp>	TGRPN	59	A6	Group to which the target time series belong(s).
<tmem>	TMEMN	66	A6	Target time series member name.
<m#>	TMEMSB(2)	72	2A2	Target time series member name subscripts; may be 2-character CATEGORY tag if applicable; must be integer otherwise. See Time Series Catalog.

Explanation

If an entry specifies the source volume as SEQ, it is referring to a time series coming from a sequential file. The entry must therefore supply the file unit number and format information for the file.

If an entry specifies the source volume as WDMn or DSS, the user is referring to a time series contained in the corresponding direct access data file: a Watershed Data Management System file, or an HEC Data Storage System file. If the "n" portion of a WDM file reference is left blank, the program (by default) looks in the first WDM file only.?

Note: TSS functionality is not included in the documentation.

When data are read from a WDM data set, the user may optionally supply a data quality flag (QLFG), which will be compared with the data quality "tag" associated with all WDM time series data. Any data having lower quality than specified (value greater than QLFG) will be rejected and assigned the value specified by the WDM attribute TSFILL (if defined for the data set), or alternatively, if TSFILL is not available, by SGAPST.

When data are read from a sequential file the user supplies:

1. A "format class code". It fixes the nature and sequence of data in a typical record (e.g. day and hour, followed by 12 hourly values).
2. The number of an object-time format, situated in the FORMATS Block. It fixes the exact format of the data in a record. A default format can be selected by supplying the number 0, or leaving the field blank.

The format classes and associated default formats presently supported in the HSPF system are documented in Section 4.9.

Note: All character strings must be left-justified in their fields except WDM data set names (<exsm>) which must be justified in the same way that they were when the data-set label or WDM attribute TSTYP was created.

4.6.3 NETWORK Block

In this block the user specifies those time series which will be passed between operations via the internal scratch pad (INPAD). If there are no such linkages the block can be omitted. For many applications, particularly large or complex watersheds that have many entries in the NETWORK block, the alternative use of the SCHEMATIC/MASS-LINK blocks may provide a simpler and more conceptual format for specifying the linkages in the NETWORK block.

```
*****
      1         2         3         4         5         6         7         8
1234567890123456789012345678901234567890123456789012345678901234567890
*****
```

Layout

NETWORK

```
<svol><o#> <sgrp> <smem><m#><-mfact--><tr> <tvol>< range> <tgrp> <tmem><m#>
```

.....

Above line repeats until all network entries have been made

.....

END NETWORK

Example

NETWORK

```
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
```

```
<Name> # <Name> # #<-factor->strg <Name> # # <Name> # # ***
```

```
RCHRES 1 HYDR ROVOL 0.5 RCHRES 2 EXTNL IVOL
```

```
RCHRES 2 HYDR ROVOL RCHRES 5 EXTNL IVOL
```

```
RCHRES 4 HYDR ROVOL RCHRES 5 EXTNL IVOL
```

END NETWORK

Details

Symbol	FORTTRAN Name(s)	Start Column	Format	Comment
<svol>	SVOL	1	A6	SVOL is the Operation-type of the source operation
<o#>	SVOLNO	7	I4	Source Operation-type number (e.g., PERLND 5)
<sgrp>	SGRPN	12	A6	Group to which the source time series belong(s).
<smem>	SMEMN	19	A6	Source time series member name; see Time Series Catalog.
<m#>	SMEMSB(2)	25	2A2	Source member name subscripts; may be 2-character CATEGORY tag if applicable; must be integer otherwise. See Time Series Catalog.
<mfact>	MFACTR	29	F10.0	The factor by which data from the source will be multiplied before being added to the target. Default (blank field)= 1.0
<tr>	TRAN	39	A4	String indicating which transformation function to use in transferring time series from source to target. See Section 4.6.7 for defaults, etc.
<tvol>	TVOL	44	A6	Operation-type of the target.
< range>	TOPFST, TOPLST	51 55	I3 I3	TOPFST & TOPLST specify the range of operations which are targets (e.g. PERLND 1 5). If TOPLST field is blank, the target is a single operation.
<tgrp>	TGRPN	59	A6	Group to which the target time series belong(s).
<tmem>	TMEMN	66	A6	Target member name; see Time Series Catalog.
<m#>	TMEMSB(2)	72	2A2	Target member name subscripts; may be 2-character CATEGORY tag if applicable; must be integer otherwise. See Time Series Catalog.

Explanation

The example above shows how this block is used to specify the connectivity of a set of reaches of stream channel (RCHRES 1 flows to RCHRES 2, RCHRES 2 and 4 flow to RCHRES 5). It can also be used to specify the flow of time series data from utility operations to simulation operations and vice versa. The network can be extremely complex, or non-existent (e.g., if the RUN involves only one operation).

Because the time series are transferred via the INPAD, each source and target pair must be in the same INGRP.

4.6.4 SCHEMATIC and MASS-LINK Blocks

The SCHEMATIC and MASS-LINK blocks work in tandem to allow the user to specify the watershed structure and linkages in a more efficient and conceptual manner than is possible using the NETWORK block.

The SCHEMATIC block contains global specifications of the watershed structure, i.e., connections of land segments to stream reaches and reach-reach connections. This block permits the user to input the area of a land segment that is tributary to a stream reach in a single entry, instead of including the area in multiple entries in the NETWORK block. Each entry in the SCHEMATIC block refers to a table in the MASS-LINK block where the detailed time series connections for that entry are specified.

The MASS-LINK block contains the specific time series to be transferred from one operation to another. This block also contains any required units conversion factors or other multiplication factors that may be needed in addition to the area. For example, when runoff from a land segment is transferred to a stream reach, a conversion factor of 1/12 (0.08333) is needed to convert the runoff from inches to acre-feet if the area units are acres. (The corresponding factor for metric units is 10^{-5} if the area units are hectares.) Each MASS-LINK table contains the set of time series transfers that are to be associated with one or more of the linkages in the SCHEMATIC block. The HSPF program combines the schematic linkages with the mass time series transfers and automatically generates all of the necessary time series connections; these time series connections are automatically included in the NETWORK block by the program.

The example shown below illustrates the use of these blocks. In this example, the watershed consists of three pervious land segments and two stream reaches. One of the land segments contributes loadings to both reaches. Loadings of flow, sediment, heat and one dissolved pesticide are being transferred from the land to the stream, and the sediment loading from the land surface is assumed to consist of 10% sand, 35% silt and 55% clay. The SCHEMATIC and MASS-LINK blocks to accomplish the required connections are shown below:

```
*****
      1      2      3      4      5      6      7
123456789012345678901234567890123456789012345678901234567890
*****
```

SCHEMATIC

```
<-Source->          <--Area-->    <-Target->    MSLK    ***
<Name>   #          <-factor->    <Name>   #    Tbl#    ***
PERLND   1          200.          RCHRES   1      1
PERLND   2          120.          RCHRES   1      1
PERLND   2          235.          RCHRES   2      1
PERLND   3          360.          RCHRES   2      1
RCHRES   1                                RCHRES   2      2
END SCHEMATIC
```

MASS-LINK

```
<Volume>  <-Grp> <-Member-><--Mult-->    <-Target>          <-Grp> <-Member->***
<Name>          <Name> # #<-factor->    <Name>          <Name> # #***
  MASS-LINK      1
PERLND    PWATER  PERO          0.0833333    RCHRES          INFLOW  IVOL
PERLND    SEDMNT  SOSED   1    0.10          RCHRES          INFLOW  ISED   1
PERLND    SEDMNT  SOSED   1    0.35          RCHRES          INFLOW  ISED   2
PERLND    SEDMNT  SOSED   1    0.55          RCHRES          INFLOW  ISED   3
PERLND    PWTGAS  POHT                                RCHRES          INFLOW  IHEAT
PERLND    PEST    TOPST                                RCHRES          INFLOW  IDQUAL 1
  END MASS-LINK      1

  MASS-LINK      2
RCHRES    ROFLOW                                RCHRES          INFLOW
  END MASS-LINK      2

END MASS-LINK
```

```
*****
```

The SCHEMATIC block contains the global watershed linkages, i.e., PLS 1 provides loadings to Reach 1, PLS 2 provides loadings to Reaches 1 and 2, PLS 3 provides loadings to Reach 2, and Reach 1 is upstream of Reach 2. The areas of PLS's 1 and 3 are 200 acres and 360 acres, respectively, and the area of PLS 2 is 355 acres, of which 120 acres are tributary to Reach 1 and 235 acres are tributary to Reach 2.

The MASS-LINK block contains details of the individual time series connections that need to be specified for each of the watershed linkages. Each of the four PLS-to-Reach entries in the SCHEMATIC block refers to MASS-LINK Table 1, which contains six time series connections from the PLS to the Reach. The Reach 1-to-Reach 2 entry refers to MASS-LINK Table 2; this table contains the ROFLOW-INFLOW connection, which is automatically expanded by the program to generate all necessary time series connections from one reach to another.

The time series connections in the MASS-LINK block are combined with the SCHEMATIC linkages to generate the full set of connections needed in the simulation. In this

Time Series Linkages

process, the program sets up a set of connections for each [SCHEMATIC entry]/[MASS-LINK table] pair. The multiplication factor for each connection is obtained by combining the 'area' factor from the SCHEMATIC block and the 'units/other conversion' factor from the MASS-LINK block. The explicit time series connections generated by HSPF and included in the NETWORK Block for this example are shown below:

NETWORK

**** PLS 1 to RCH 1

PERLND	1	PWATER	PERO	16.66	SAME	RCHRES	1	INFLOW	IVOL	
PERLND	1	SEDMNT	SOSED 1	20.	SAME	RCHRES	1	INFLOW	ISED	1
PERLND	1	SEDMNT	SOSED 1	70.	SAME	RCHRES	1	INFLOW	ISED	2
PERLND	1	SEDMNT	SOSED 1	110.	SAME	RCHRES	1	INFLOW	ISED	3
PERLND	1	PWTGAS	POHT	200.	SAME	RCHRES	1	INFLOW	IHEAT	
PERLND	1	PEST	TOPST	200.	SAME	RCHRES	1	INFLOW	IDQUAL	1

**** PLS 2 to RCH 1

PERLND	2	PWATER	PERO	10.	SAME	RCHRES	1	INFLOW	IVOL	
PERLND	2	SEDMNT	SOSED 1	12.	SAME	RCHRES	1	INFLOW	ISED	1
PERLND	2	SEDMNT	SOSED 1	42.	SAME	RCHRES	1	INFLOW	ISED	2
PERLND	2	SEDMNT	SOSED 1	66.	SAME	RCHRES	1	INFLOW	ISED	3
PERLND	2	PWTGAS	POHT	120.	SAME	RCHRES	1	INFLOW	IHEAT	
PERLND	2	PEST	TOPST	120.	SAME	RCHRES	1	INFLOW	IDQUAL	1

**** PLS 2 to RCH 2

PERLND	2	PWATER	PERO	19.58	SAME	RCHRES	2	INFLOW	IVOL	
PERLND	2	SEDMNT	SOSED 1	23.50	SAME	RCHRES	2	INFLOW	ISED	1
PERLND	2	SEDMNT	SOSED 1	82.25	SAME	RCHRES	2	INFLOW	ISED	2
PERLND	2	SEDMNT	SOSED 1	129.25	SAME	RCHRES	2	INFLOW	ISED	3
PERLND	2	PWTGAS	POHT	235.	SAME	RCHRES	2	INFLOW	IHEAT	
PERLND	2	PEST	TOPST	235.	SAME	RCHRES	2	INFLOW	IDQUAL	1

**** PLS 3 to RCH 2

PERLND	3	PWATER	PERO	30.	SAME	RCHRES	2	INFLOW	IVOL	
PERLND	3	SEDMNT	SOSED 1	36.	SAME	RCHRES	2	INFLOW	ISED	1
PERLND	3	SEDMNT	SOSED 1	126.	SAME	RCHRES	2	INFLOW	ISED	2
PERLND	3	SEDMNT	SOSED 1	198.	SAME	RCHRES	2	INFLOW	ISED	3
PERLND	3	PWTGAS	POHT	360.	SAME	RCHRES	2	INFLOW	IHEAT	
PERLND	3	PEST	TOPST	360.	SAME	RCHRES	2	INFLOW	IDQUAL	1

**** RCH 1 to RCH 2 (HYDR, HTRCH, SEDTRN, and GQUAL sections are active)

RCHRES	1	ROFLOW	ROVOL	1.0	SAME	RCHRES	2	INFLOW	IVOL	
RCHRES	1	ROFLOW	ROHEAT	1.0	SAME	RCHRES	2	INFLOW	IHEAT	
RCHRES	1	ROFLOW	ROSED 1	1.0	SAME	RCHRES	2	INFLOW	ISED	1
RCHRES	1	ROFLOW	ROSED 2	1.0	SAME	RCHRES	2	INFLOW	ISED	2
RCHRES	1	ROFLOW	ROSED 3	1.0	SAME	RCHRES	2	INFLOW	ISED	3
RCHRES	1	ROFLOW	RODQAL	1.0	SAME	RCHRES	2	INFLOW	IDQAL	1
RCHRES	1	ROFLOW	ROSQAL 1 1	1.0	SAME	RCHRES	2	INFLOW	ISQAL	1 1
RCHRES	1	ROFLOW	ROSQAL 2 1	1.0	SAME	RCHRES	2	INFLOW	ISQAL	2 1
RCHRES	1	ROFLOW	ROSQAL 3 1	1.0	SAME	RCHRES	2	INFLOW	ISQAL	3 1

END NETWORK

4.6.4.1 SCHEMATIC Block

In this block the user specifies the global linkages of land segments with stream reaches and between stream reaches. Each of these linkages is combined with the detailed time series connections specified in one of the MASS-LINK tables to generate a complete set of time series connections for the linkage.

```
*****
      1         2         3         4         5         6         7         8
1234567890123456789012345678901234567890123456789012345678901234567890
*****
```

Layout

SCHEMATIC

```
<svol>< #>                <-afact-->      <tvol>< #>  <ML#>
```

```
.....
Above line repeats until all network entries have been made
```

```
.....
END SCHEMATIC
```

Example

SCHEMATIC

```
<-Source->                <--Mult-->      <-Target >      MSLK      ***
<Name>   #                <-factor->      <Name>   #      Tbl#      ***
PERLND   1                200.             RCHRES   2        1
PERLND   2                300.             RCHRES   5        1
RCHRES   4                 1.             RCHRES   5        2
```

END SCHEMATIC

```
*****
```


Details

Symbol	FORTTRAN Name(s)	Start Column	Format	Comment
<svol>	SVOL	1	A6	SVOL is the Operation-type of the source operation.
< #>	SVOLNO	7	I4	SVOLNO is the source Operation-type number (e.g., PERLND 5)
<afact>	AFACTR	29	F10.0	The area factor by which data from the source will be multiplied before being added to the target. This factor will be combined with the factor in the MASS-LINK Block. Default (blank field)= 1.0
<tvol>	TVOL	44	A6	TVOL is the Operation-type of the target.
< #>	TVOLNO	50	I4	TVOLNO is the target Operation-type number (e.g., RCHRES 5)
<ml#>	MSLKNO	57	I4	MASS-LINK table number that will be used to generate the NETWORK entries for this linkage.

4.6.4.2 MASS-LINK Block

In this block the user specifies those time series connections which will be combined with the linkages in the SCHEMATIC Block to generate a set of time series connections in the NETWORK Block.

```
*****
      1          2          3          4          5          6          7          8
1234567890123456789012345678901234567890123456789012345678901234567890
*****
```

Layout

MASS-LINK

```
      MASS-LINK          #
<svol>          <sgrp> <smem><m#><-mfact-->          <tvol>          <tgrp> <tmem><m#>
.....
Above line repeats until all mass-link entries have been made
.....
      END MASS-LINK          #
```

END MASS-LINK

Example

MASS-LINK

```
      MASS-LINK          1
<-Volume-> <-Grp> <-Member-><--Mult-->          <-Target vols> <-Grp> <-Member-> ***
<Name>          <Name> # #<-factor->          <Name>          #          <Name> # # ***
PERLND          PWATER PERO          0.08333          RCHRES          INFLOW IVOL
PERLND          SEDMNT SOSED          RCHRES          INFLOW ISED          1
PERLND          PQUAL POQUAL 1          RCHRES          INFLOW OXIF          2
      END MASS-LINK          1
END MASS-LINK
```

Details

Symbol	FORTTRAN Name(s)	Start Column	Format	Comment
<svol>	SVOL	1	A6	SVOL is the Operation-type of the source operation.
<sgrp>	SGRPN	12	A6	Group to which the source time series belong(s).
<smem>	SMEMN	19	A6	Source member name.
<m#>	SMEMSB(2)	25	2A2	Source member name subscripts; may be 2-character CATEGORY tag if applicable; must be integer otherwise. See Time Series Catalog.
<mfact>	MFACTR	29	F10.0	The factor by which data from the source will be multiplied before being added to the target. Default (blank field)= 1.0
<tvol>	TVOL	44	A6	TVOL is the Operation-type of the target.
<tgrp>	TGRPN	59	A6	Group to which the target time series belong(s).
<tmem>	TMEMN	66	A6	Target member name.
<m#>	TMEMSB(2)	72	2A2	Target member name subscripts; may be 2-character CATEGORY tag if applicable; must be integer otherwise. See Time Series Catalog.

4.6.5 EXT TARGETS Block (External targets)

In this block the user specifies those time series which will be output from the operations in a RUN, to data sets in the WDM or DSS Files. If there are no such transfers the block may be omitted.

```
*****
      1          2          3          4          5          6          7          8
1234567890123456789012345678901234567890123456789012345678901234567890
*****
```

Layout

EXT TARGETS

```
<svol><o#> <sgrp> <smem><m#><-mfact--><tr> <tvol><t#> <extm>qf <ts> <ag> <am>
```

```
.....
```

Above line repeats until all external targets have been specified

```
.....
```

END EXT TARGETS

Example

EXT TARGETS

```
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Aggr Amd ***
<Name>    #          <Name> # #<-factor->strg <Name>    # <Name>qf  tem strg strg***
RCHRES    6 GQUAL  DQAL   3      1.  AVER WDM4    25 CONC      ENGL AGGR REPL
PERLND 301 NITR   PONITR              SUM  DSS    122      ENGL      REPL
END EXT TARGETS
```

```
*****
```

Details

Symbol	FORTTRAN Name(s)	Start Column	Format	Comment
<svol>	SVOL	1	A6	SVOL is the Operation-type of the source operation.
<o#>	SVOLNO	7	I4	SVOLNO is the source Operation-type number (e.g., PERLND 5)
<sgrp>	SGRPN	12	A6	Group to which the source time series belong(s).
<smem>	SMEMN	19	A6	Source member name.
<m#>	SMEMSB(2)	25	2A2	Source member name subscripts; may be 2-character CATEGORY tag if applicable; must be integer otherwise. See Time Series Catalog.
<mfact>	MFACTR	29	F10.0	The factor by which data from the source will be multiplied before being added to the target. Default (blank field)= 1.0
<tr>	TRAN	39	A4	String indicating which transformation function to use in transferring time series from source to target. See Section 4.6.7 for defaults.
<tvol>	TVOL	44	A6	External target volume. Valid values are WDMn (Watershed Data Management System file, where n is 1-4 or blank) and DSS (Data Storage System).
<t#>	TVOLNO	50	I4	Data-set Number (if TVOL = WDMn, or DSS).
<extm>	TMEMN	55	A6 A4	Data-set TSTYP attribute (if TVOL = WDMn). (Blank if TVOL = DSS.)
qf	QLFG	61	I2	Quality-of-data (if TVOL = WDM); specifies the quality tag to be attached to data placed in a WDM data set; valid values = 0 - 31; default = 0.
<ts>	TSYST	64	A4	Unit system of data to be written to WDM or DSS data set; valid values = ENGL and METR; default = ENGL.
<ag>	AGGST	69	A4	String indicating whether the data should be aggregated when placed in a WDM data set having a time step greater than the source time step; valid value is AGGR; default is no aggregation.
<am>	AMDST	74	A4	String indicating how the target data set is to be accessed. Valid values are: ADD or REPL for a WDM or DSS file. See below for explanation.

Explanation

This block is similar to the EXT SOURCES Block, but serves the opposite purpose. Thus, the entries have similar formats (but are reversed). In addition, each entry in the EXT TARGETS Block has the <am> field, which indicates how the target data set will be accessed. The user should be aware of the differences between these options when the target data set is in a WDM or DSS file. The valid values and the meaning of each are:

ADD For a WDM data set, this option is designed to add data when no pre-existing data are present for any period after the starting time of the run, including times after the time span of the run.

For a DSS data record, this option preserves pre-existing data before and after the beginning of the run, and requires that no data pre-exist during the time span of the run.

REPL For a WDM data set, this option will result in the overwriting of any existing data which follows the starting time of the run, including data after the time span of the run.

For a DSS data record, pre-existing data during the time span of the run is overwritten, but pre-existing data before and after the run are preserved.

In summary, for a WDM data set, the ADD option is used to add data when no pre-existing data are present after the starting time of the run, while the REPL option results in overwriting existing data, both during and after the time span of the run.

Data placed in a WDM data set will normally have a time step equal to the time step of the run, **even if the data set has a different time step than the run**. However, the user may optionally specify that aggregation occur if the target data-set time step is an integer multiple (2 or greater) of the run time step. The time step of a WDM data set is specified by the TCODE and TSSTEP attributes of the data set. Disaggregation is not permitted when placing data in WDM data sets.

For a DSS data record, only data during the actual time span of the run are affected. The ADD option specifies that such data cannot pre-exist, while the REPL option allows any pre-existing data to be overwritten.

4.6.6 PATHNAMES Block

In this block the user associates data-set numbers with the time series to be accessed from the DSS (HEC Data Storage System) files, and specifies the data types of the time series.

```
*****
      1         2         3         4         5         6         7         8
1234567890123456789012345678901234567890123456789012345678901234567890
*****
```

Layout

PATHNAMES

```
<ds>f# <ctype-> <-----pathname----->
```

```
.....
```

Above line repeats until all external targets have been specified

```
.....
```

END PATHNAMES

Example

PATHNAMES

```
<ds>f# <ctype-> <*****pathname*****>
```

```
  41 1 PER-CUM  /TEST/FARM COOP WS/EVAP//1DAY/OBSERVED-INCHES|DAY/
```

END PATHNAMES

```
*****
```

Details

Symbol	FORTTRAN Name(s)	Start Column	Format	Comment
<ds>	DSSDSN	1	I4	DSSDSN is the temporary data-set number assigned to the DSS record(s) which make up the time series.
f#	DSSFL	5	I2	DSSFL is the index number for the DSS file containing these data record(s); it is assigned to each DSS file in the FILES block
<ctype->	CTYPE	8	A8	Data type string for the data record(s). Valid values are: INST-VAL, PER-AVER, PER-CUM.
pathname	CPATH	17	A64	Pathname for DSS record(s). It is recommended that the D part be left empty, as it is generated by HSPF as needed.

Explanation

This section is required if any time series data are to be accessed from DSS files. In this section, unique ID numbers are assigned to "data sets" in the DSS file(s); these ID numbers are used in the EXT-SOURCES and EXT-TARGETS blocks to specify (i.e., identify) the data sets.

See Section 4.6.1.1 for further discussion of DSS concepts.

4.6.7 Time Series Transform Functions

Whenever time series are transferred from a source to a target, a "transformation" takes place. The user can specify the transformation function in field <tr>; if it is blank the default function is supplied. The range of permissible functions is:

Interval relation	Source Type		Target Type	<----- Functions ----->	
				Defaults	Others
SDELT = TDELT	Point	to	Point	SAME	none
	Mean	to	Mean	SAME	none
	Point	to	Mean	AVER	none
SDELT > TDELT (b)	Point	to	Point	INTP/AVER (a)	none
	Mean	to	Mean	DIV	SAME
	Point	to	Mean	AVER	none
SDELT < TDELT	Point	to	Point	LAST/AVER (a)	none
	Mean	to	Mean	SUM	AVER,MAX,MIN
	Point	to	Mean	AVER	SUM,MAX,MIN

Key: SDELT Time interval of source time series

TDELT Time interval of target time series

(a) Second default keyword applies to WDM source time series and all DSS external time series.

(b) This interval relation is invalid for WDM target; i.e., output disaggregation is not permitted to WDM data sets

Notes:

1. See below (Note 2 and next page) for explanations of the transform keywords.
2. For WDM data sets, TDELT and SDELT refer to the time step defined by the WDM attributes TCODE and TSSTEP; however, data may be stored in the data set at other time steps.

3. For WDM or DSS data sets, the functions AVER and SAME imply either AVER or SAME; and the functions SUM and DIV imply either SUM or DIV, whichever is appropriate for the actual time step of the data.
4. The type of WDM data sets is determined by the attribute TSFORM. If TSFORM = 1 or 2, the type is MEAN; if TSFORM = 3, the type is POINT.
5. The type of sequential (SEQ) time series is not defined; consequently, these time series are assumed to have the same type as the target time series.
6. The type of DSS data records is determined from the data type string. (See Section 4.6.1.1 above for discussion.) If none is specified, the time series is assumed to be mean-valued.
7. Keywords less than 4 characters long must be left-justified in the field.
8. For further information, see Appendix V and Time Series Catalog (Section 4.7 of this part).

The time series transform functions given above are completed before the multiplication factor given in the EXTERNAL SOURCES, EXTERNAL TARGETS and NETWORK blocks are applied. These transform functions are defined as follows:

AVER	Compute the integral of the source time series over each target time step, divide by the target time step and assign the value to the time step in the target time series. See Appendix V for definition of the integral of a time series.
DIV	Divide each mean value of the source time series by the ratio of the source time step to the target time step and assign the results to each of the target time steps contained in the source time step.
INTP	Interpolate linearly between adjacent point values in the source time series and assign the interpolated values to each time point in the target time series.
LAST	Take the value at the last time point of the source time series which belongs to the time step of the target time series and assign the value to the time step of the target time series. See Appendix V for a definition of the meaning of "belonging".
MAX	Find the maximum value of the source time series for all points belonging to the target time step (point-value time series) or find the maximum value of the source time series for all time steps contained within the target time step (mean-value time series). Assign the maximum value to the time step of the target time series. The definition of "belonging" (given in Appendix V) was motivated by the desire to make MAX and MIN unique for point-value time series.

MIN	Find the minimum value of the source time series for all points belonging to the target time step (point-value time series) or find the minimum value of the source time series for all time steps contained within the target time series (mean-value time series). Assign the minimum value to the time step of the target time series.
SAME	Take the value at each time step or time point of the source time series and assign the value to the corresponding time point (point-value time series), the corresponding time step (mean-value time series), or all the contained time steps (mean-value time series with time step less than the source time step) of the target time series.
SUM	For point-value source time series: Compute the sum of the values for all points in the source time series belonging to the target series time step plus the value of the source time series at the initial point of the target time step and assign the sum to the target time step. For mean-value source time series: Compute the sum of the values for all time steps in the source time series contained within the target series time step and assign the sum to the target time step.

4.6.8 Warning

1. In this block it is not permissible to route several sources to the same external target. If you want to combine several time series and write the result to an external target, first use a utility operation (COPY) to combine the data, and then use this block to route the result to the external target.

4.7 Time Series Catalog

This section documents all the time series which are required by, and which can be output by, all the operating modules in the HSPF system.

The time series are arranged in groups. Thus, to specify an operation associated time series in the EXT SOURCES, NETWORK or EXT TARGETS Blocks, the user supplies a group name followed, optionally, by a member name and subscripts.

The time series documented in this section can be separated into three categories:

1. Input only. Some time series can only be input to their operating module (e.g. member PREC of group EXTNL in module PERLND).
2. Input or output. Some time series can either be input to their operating module or output from it, depending on the options in effect. For example, if snow accumulation and melt on a Previous Land-segment (PLS) is being simulated in a given RUN, time series WYIELD in group SNOW can be output to the WDM file. Then, if section SNOW is inactive but section PWATER is active in a subsequent RUN, the same time series WYIELD may be specified as an input to the PERLND module. This feature makes it possible to calibrate an application module in an incremental manner. First, the outputs from section 1 are calibrated to the field data; then the outputs from section 2 are calibrated using outputs from section 1 as inputs, etc. Sections calibrated in earlier runs need not be re-run if the needed outputs from them have been stored.
3. Output only. Some time series can be computed by and output from their operating module, but never serve as inputs to it (e.g. member ALBEDO of group SNOW in module PERLND).

To run an operating module, the user must ensure that all the input time series which it requires are made available to it. This is done by making appropriate entries in the EXT SOURCES or NETWORK blocks. To ascertain which time series are required, one should consult the Time Series Catalog for the appropriate module. For example, assume that sediment production and washoff/scour from a PLS are being simulated using the snow and water budget results from a previous RUN. In this scenario, section SEDMNT would be active, but sections ATEMP, SNOW and PWATER would not be active. Then, Table 4.7(1).5 shows the following:

1. member (time series) PREC of group EXTNL is a required input time series (member SLSED is optional)
2. members RAINF and SNOCOV of group SNOW are required inputs, because section SNOW is inactive
3. members SURO and SURS of group PWATER are required inputs, because section PWATER is inactive

The user can obtain further details on the above time series by consulting the table for the appropriate group (e.g. Table 4.7(1).1 for group EXTNL). Table 4.7(1).5 shows which time series are computed in the SEDMNT section of the PERLND module and may therefore be output (members DETS through SOSDB).

Thus, in the EXT SOURCES and/or NETWORK blocks, entries must appear which specify members PREC, RAINF, etc (groups EXTNL, SNOW, PWATER) as targets to which source time series are routed. Also, in the NETWORK and/or EXT TARGETS blocks, entries may appear which specify one or more of members DETS through SOSDB (of group SEDMNT) as source time series, which are routed to other operations or to the WDM.

The tables which follow are otherwise self explanatory, except for the abbreviation "ivld" which appears frequently in the "Units" fields. It means "interval of the data" (to distinguish it from the internal, or simulation interval). Thus, if a WDM or DSS data set containing 1-hour precipitation data is input to an operation with a DELT of two hours, ivld is 1 hour.

4.7.1 Connection of Surface and Instream Application Modules

In HSPF, the operational connection between the land surface and instream simulation modules is accomplished through the NETWORK Block and/or the SCHEMATIC/MASS-LINK Blocks. Time series of runoff, sediment, and pollutant loadings generated on the land surface are passed to the receiving stream for subsequent transport and transformation instream. This connection of the IMPLND and/or PERLND modules with the RCHRES module requires explicit definition of corresponding time series in the linked modules. A one-to-one correspondence exists between several land segment outflow time series and corresponding stream reach inflow time series (e.g. runoff, sediment, dissolved oxygen, etc.); however in order to maintain flexibility, some of the time series are more general, and no unique correspondence exists. Also, in some cases, a process or material simulated in the stream will have no corresponding land surface quantity. For example, the inflow of plankton to a stream occurs only from upstream reaches and not from a land segment.

4.7.2 Atmospheric Deposition of Water Quality Constituents

Input time series are available in HSPF to aid in the simulation of atmospheric deposition of quality constituents. Atmospheric deposition inputs can be specified in two possible ways depending on the form of the available data. If the deposition is in the form of a flux (mass per area per time), then it is considered "dry deposition". If the deposition is in the form of a concentration in rainfall, then it is considered "wet deposition", and the program automatically combines it with the input rainfall time series to compute the resulting flux. Either type of deposition data can be input as a time series, which covers the entire simulation period, or alternatively, as a set of monthly values that is used for each year of the simulation. The specific atmospheric deposition time series for each operational module (PERLND, IMPLND, RCHRES) are documented in the EXTNL table of the Time Series Catalog for that module.

Time Series Catalog

An additional use of these atmospheric deposition time series is the specification of agricultural chemical and fertilizer inputs to the soil. These input time series thus provide an alternative to the SPEC-ACTIONS block as a means for changing soil storages of chemicals in the AGCHEM sections of the program. For this purpose, "deposition" to the upper soil layer in addition to the surface soil layer is available in PERLND sections NITR, PHOS, and TRACER. (Section PEST has time series only for the surface layer, since pesticides are not normally incorporated into the soil as are fertilizers.) Depending on the complexity of the agricultural practices being modeled, the user should decide whether the SPEC-ACTIONS or the time series inputs are simpler to construct.

4.7(1) Catalog for PERLND module

The time series groups associated with this module are shown in Figure 4.7(1)-1.

The members contained within each group are documented in the following tables.

4.7(1).1 Group EXTNL

<---- Member ---->		K	Units		Description/comment
Name	Max subscr values	i	(external)		
	1 2	n	Engl	Metr	

Time series always external (input only) to module PERLND:

GATMP	1	1	-	Deg F	Deg C	Measured air temperature
PREC	1	1	-	in/ivld	mm/ivld	Measured precipitation
DTMPG	1	1	-	Deg F	Deg C	Measured dewpoint temperature
WINMOV	1	1	-	mi/ivld	km/ivld	Measured wind movement
SOLRAD	1	1	-	Ly/ivld	Ly/ivld	Measured solar radiation
CLOUD	1	1	-	tenths	tenths	Cloud cover (range: 0 - 10)
PETINP	1	1	-	in/ivld	mm/ivld	Input potential E-T
SURLI	1	1	-	in/ivld	mm/ivld	Surface lateral inflow
IFWLI	1	1	-	in/ivld	mm/ivld	Interflow lateral inflow
AGWLI	1	1	-	in/ivld	mm/ivld	Active groundwater lateral inflow
SLSED	1	1	-	tons/	tonnes/	Lateral input of sediment
				ac.ivld	ha.ivld	
PQADFX	NQ	1	-	qty/	qty/	Dry or total atmospheric deposition
				ac.ivld	ha.ivld	of QUALOF
PQADCN	NQ	1	-	qty/ft3	qty/l	Concentration of QUALOF in rain
						for wet atmospheric deposition
PEADFX	NPST	3	-	lb/	kg/	Dry or total atmospheric deposition
				ac.ivld	ha.ivld	of pesticide. The first subscript
						indicates the pesticide; the second
						indicates the species: crystalline,
						adsorbed, or solution
PEADCN	NPST	3	-	mg/l	mg/l	Concentration of pesticide in rain
						for wet atmospheric deposition.
						Subscripts same as above.
NIADFX	3	2	-	lb/	kg/	Dry or total atmospheric deposition
				ac.ivld	ha.ivld	of nitrogen. First subscript indi-
						cates species: NO3, NH3, organic N;
						the second subscript indicates the
						affected soil layer: surface or
						upper.
NIADCN	3	2	-	mg/l	mg/l	Concentration of nitrogen in rain
						for wet atmospheric deposition.
						Subscripts as above.

Catalog for PERLND Module

PHADFX	2	2	-	lb/ ac.ivld	kg/ ha.ivld	Dry or total atmospheric deposition of phosphorus. The first subscript indicates species: PO ₄ , organic P; the second subscript indicates the affected soil layer (see above)
PHADCN	2	2	-	mg/l	mg/l	Concentration of phosphorus in rain for wet atmospheric deposition. Subscripts as above.
TRADFX	2	1	-	lb/ ac.ivld	kg/ ha.ivld	Dry or total atmospheric deposition of tracer substance. Subscript indicates affected soil layer (see above)
TRADCN	2	1	-	mg/l	mg/l	Concentration of tracer in rain. Subscript as above.

4.7(1).2 Group ATEMP

<---- Member ---->		K	Units	
Name	Max subscr values	i	(external)	Description/comment
	1 2	d	Engl Metr	

Time series computed by module section ATEMP:

AIRTMP	1	1	-	Deg F	Deg C	Estimated surface air temperature over the Land-segment
--------	---	---	---	-------	-------	---

Input time series required to compute the above:

Group EXTNL	always required
GATMP	gage air temperature
PREC	precipitation

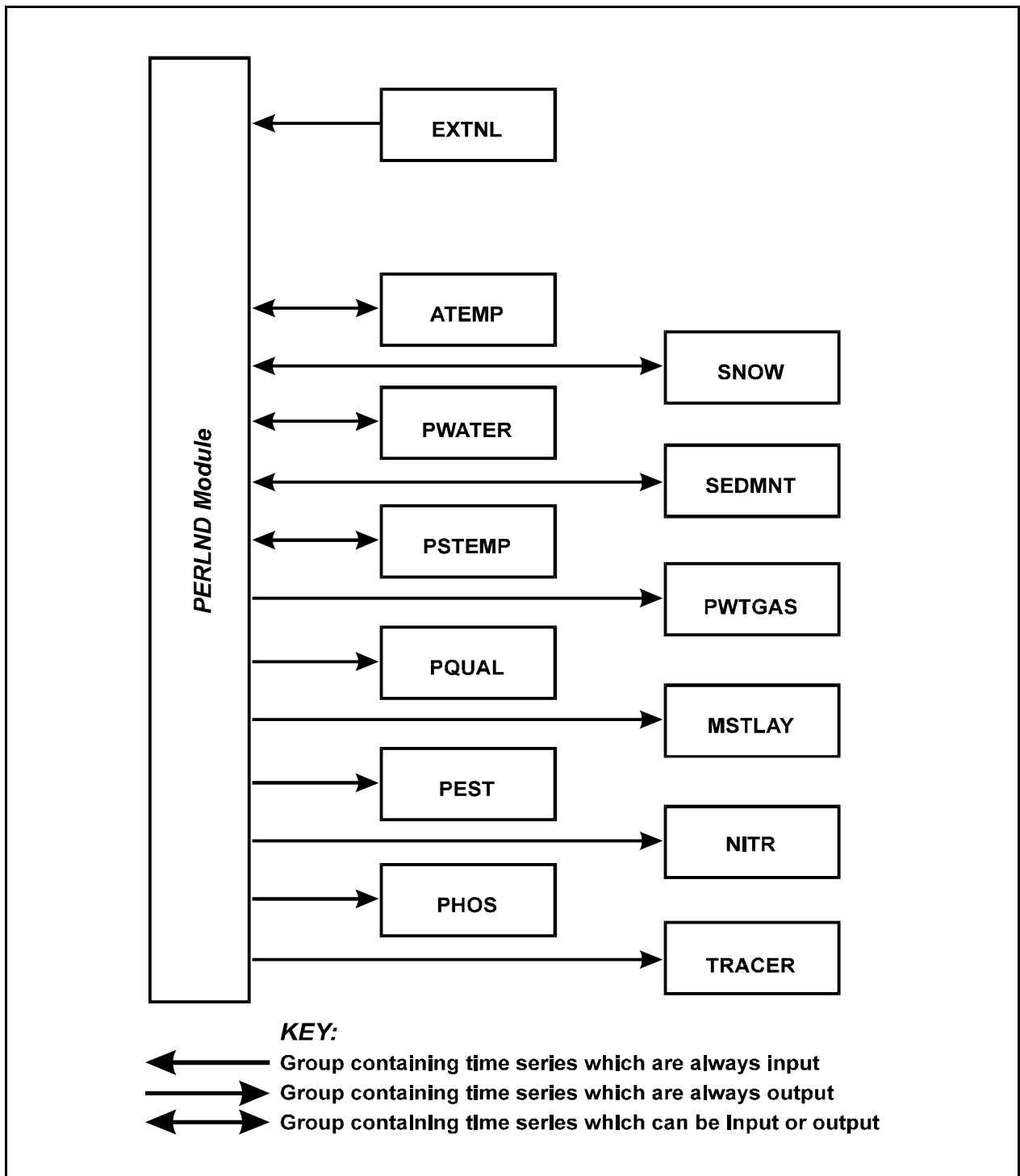


Figure 4.7(1)-1 Groups of time series associated with the PERLND Module

4.7(1).3 Group SNOW

<hr/>						
<---- Member ---->			K	Units		Description/comment
Name	Max	subscr	i	(external)		
	values	n				
	1	2	d	Engl	Metr	

Time series computed by module section SNOW:

PACK	1	1	*	in	mm	Total contents of pack (water equiv)
PACKF	1	1	*	in	mm	Frozen contents of pack, ie. snow + ice (water equivalent)
PACKW	1	1	*	in	mm	Liquid water in pack
PACKI	1	1	*	in	mm	Ice in pack (water equivalent)
PDEPTH	1	1	*	in	mm	Pack depth
RDENPF	1	1	*	none	none	Relative density of frozen contents of pack (PACKF/PDEPTH)
SNOCOV	1	1	*	none	none	Fraction of Land-segment covered by pack
ALBEDO	1	1	*	none	none	Albedo of the pack
PAKTMP	1	1	*	Deg F	Deg C	Mean temperature of the pack
SNOWF	1	1	-	in/ivld	mm/ivld	Snowfall, water equivalent
SNOWE	1	1	-	in/ivld	mm/ivld	Evaporation from PACKF (sublimation), water equivalent
WYIELD	1	1	-	in/ivld	mm/ivld	Water yielded by the pack (released to the land-surface)
MELT	1	1	-	in/ivld	mm/ivld	Quantity of melt from PACKF (water equivalent)
RAINF	1	1	-	in/ivld	mm/ivld	Rainfall

Input time series required to compute the above:

Group EXTNL	always required
PREC	precipitation
DTMPG	dewpoint temperature
WINMOV	wind movement
SOLRAD	solar radiation
Group ATEMP	required if section ATEMP inactive
AIRTMP	air temperature

4.7(1).4 Group PWATER

<hr/>					
<---- Member ---->		K	Units		Description/comment
Name	Max subscr values	i	(external)		
	1 2	n	Engl	Metr	

Time series computed by module section PWATER:

Land-segment-wide values:

PERS	1	1	*	in	mm	Total water stored in the PLS
CEPS	1	1	*	in	mm	Interception storage
SURS	1	1	*	in	mm	Surface (overland flow) storage
UZS	1	1	*	in	mm	Upper zone storage
IFWS	1	1	*	in	mm	Interflow storage
LZS	1	1	*	in	mm	Lower zone storage
AGWS	1	1	*	in	mm	Active groundwater storage
RPARM	1	1	-	in/ivld	mm/ivld	Current value of maximum lower zone E-T opportunity
SURO	1	1	-	in/ivld	mm/ivld	Surface outflow
IFWO	1	1	-	in/ivld	mm/ivld	Interflow outflow
AGWO	1	1	-	in/ivld	mm/ivld	Active groundwater outflow
PERO	1	1	-	in/ivld	mm/ivld	Total outflow from PLS
IGWI	1	1	-	in/ivld	mm/ivld	Inflow to inactive (deep) groundwater
PET	1	1	-	in/ivld	mm/ivld	Potential E-T, adjusted for snow cover and air temperature
CEPE	1	1	-	in/ivld	mm/ivld	Evap. from interception storage
UZET	1	1	-	in/ivld	mm/ivld	E-T from upper zone
LZET	1	1	-	in/ivld	mm/ivld	E-T from lower zone
AGWET	1	1	-	in/ivld	mm/ivld	E-T from active groundwater storage
BASET	1	1	-	in/ivld	mm/ivld	E-T taken from active groundwater outflow (baseflow)
TAET	1	1	-	in/ivld	mm/ivld	Total simulated E-T
IFWI	1	1	-	in/ivld	mm/ivld	Interflow inflow (excluding any lateral inflow)
UZI	1	1	-	in/ivld	mm/ivld	Upper zone inflow
INFIL	1	1	-	in/ivld	mm/ivld	Infiltration to the soil
PERC	1	1	-	in/ivld	mm/ivld	Percolation from upper to lower zone
LZI	1	1	-	in/ivld	mm/ivld	Lower zone inflow
AGWI	1	1	-	in/ivld	mm/ivld	Active groundwater inflow (excluding any lateral inflow)
SURI	1	1	-	in/ivld	mm/ivld	Surface inflow (including any lateral inflow)

Input time series required to compute the above:

Group EXTNL		
SURLI		optional
IFWLI		optional
AGWLI		optional
PETINP		
PREC		required if snow not considered (CSNOFG= 0)
Group ATEMP		
AIRTMP		only required if section ATEMP is inactive and CSNOFG= 1
Group SNOW		
RAINF		only required if section SNOW is inactive and snow is considered (CSNOFG= 1)
SNOCOV		
WYIELD		
PACKI		only required if ICEFG= 1
Group PSTEMP		
LGTMP		only required if section PSTEMP is inactive and IFFCFG= 2

4.7(1).5 Group SEDMNT

```

-----
<---- Member ---->  K      Units
                    Max subscr i    (external)      Description/comment
Name      values    n
          1      2      d  Engr      Metr
-----

```

Time series computed by module section SEDMNT:

Land-segment-wide values:

DETS	1	1	*	tons/ac	tonnes/ha	Storage of detached sediment
STCAP	1	1	*	tons/ ac.ivld	tonnes/ ha.ivld	Sediment transport capacity by surface runoff
WSSD	1	1	-	tons/ ac.ivld	tonnes/ ha.ivld	Washoff of detached sediment
SCRSD	1	1	-	tons/ ac.ivld	tonnes/ ha.ivld	Scour of matrix (attached) soil
SOSED	1	1	-	tons/ ac.ivld	tonnes/ ha.ivld	Total removal of soil and sediment
DET	1	1	-	tons/ ac.ivld	tonnes/ ha.ivld	Quantity of sediment detached from soil matrix by rainfall impact

Input time series required to compute the above:

Group EXTNL	always required
PREC	
SLSSED	optional
Group SNOW	only required if section SNOW
RAINF	is inactive and snow is considered
SNOCOV	(CSNOFG= 1)
Group PWATER	only required if section PWATER
SURO	is inactive
SURS	

4.7(1).6 Group PSTEMP

<hr/>					
<---- Member ---->		K	Units		Description/comment
Max subscr		i	(external)		
Name	values		n		
	1	2	d	Engl	Metr

Time series computed by module section PSTEMP:

AIRTC	1	1	-	Deg F	Deg C	Air temperature on the PLS
SLTMP	1	1	-	Deg F	Deg C	Surface layer soil temperature
ULTMP	1	1	-	Deg F	Deg C	Upper layer soil temperature
LGTMP	1	1	-	Deg F	Deg C	Lower and groundwater layer soil temperature

Input time series required to compute the above:

Group ATEMP	only required if section ATEMP is
AIRTMP	inactive

4.7(1).7 Group PWTGAS

<hr/>					
<---- Member ---->		K	Units		Description/comment
Max subscr		i	(external)		
Name	values		n		
	1	2	d	Engl	Metr

Time series computed by module section PWTGAS:

SOTMP	1	1	*	Deg F	Deg C	Temperature of surface outflow
IOTMP	1	1	*	Deg F	Deg C	Temperature of interflow outflow
AOTMP	1	1	*	Deg F	Deg C	Temperature of active groundwater outflow
SODOX	1	1	*	mg/l	mg/l	DO concentration in surface outflow
SOCO2	1	1	*	mg/l	mg/l	CO2 concentration in surface outflow
IODOX	1	1	*	mg/l	mg/l	DO concentration in interflow outflow
IOCO2	1	1	*	mg/l	mg/l	CO2 concentration in interflow outflow
AODOX	1	1	*	mg/l	mg/l	DO concentration in active groundwater outflow

(continued)

AOCO2	1	1	*	mg/l	mg/l	CO2 concentration in active groundwater outflow
SOHT	1	1	-	BTU/ ac.ivld	kcal/ ha.ivld	Heat energy in surface outflow (relative to freezing point)
IOHT	1	1	-	BTU/ ac.ivld	kcal/ ha.ivld	Heat energy in interflow outflow
AOHT	1	1	-	BTU/ ac.ivld	kcal/ ha.ivld	Heat energy in active groundwater outflow
POHT	1	1	-	BTU/ ac.ivld	kcal/ ha.ivld	Heat energy in total outflow from PLS
SODOXM	1	1	-	lb/ ac.ivld	kg/ ha.ivld	Flux of DO in surface outflow
SOCO2M	1	1	-	lb/ ac.ivld	kg/ ha.ivld	Flux of CO2 in surface outflow
IODOXM	1	1	-	lb/ ac.ivld	kg/ ha.ivld	Flux of DO in interflow outflow
IOCO2M	1	1	-	lb/ ac.ivld	kg/ ha.ivld	Flux of CO2 in interflow outflow
AODOXM	1	1	-	lb/ ac.ivld	kg/ ha.ivld	Flux of DO in active groundwater outflow
AOCO2M	1	1	-	lb/ ac.ivld	kg/ ha.ivld	Flux of CO2 in active groundwater outflow
PODOXM	1	1	-	lb/ ac.ivld	kg/ ha.ivld	DO in total outflow from PLS
POCO2M	1	1	-	lb/ ac.ivld	kg/ ha.ivld	CO2 in total outflow from PLS

Input time series required to compute the above:

Group SNOW WYIELD	only required if section SNOW is inactive and snow is considered (CSNOFG= 1)
Group PWATER SURO IFWO AGWO	only required if section PWATER is inactive
Group PSTEMP SLTMP ULTMP LGTMP	only required if section PSTEMP is inactive

4.7(1).8 Group PQUAL

----->					
<---- Member ---->			K	Units	
Max subscr			i	(external)	
Name	values	n		Description/comment	
	1	2	d	Engl	Metr
----->					

Time series computed by module section PQUAL:

SQO	NQOF	1	*	qty/ac	qty/ha	Storage of QUALOF on the surface
PQADDR	NQ	1	-	qty/ ac.ivld	qty/ ha.ivld	Dry or total atmospheric deposition of QUAL
PQADWT	NQ	1	-	qty/ ac.ivld	qty/ ha.ivld	Wet deposition of QUAL
WASHQS	NQSD	1	-	qty/ ac.ivld	qty/ ha.ivld	Removal of QUALSD by association with detached sediment washoff
SCRQS	NQSD	1	-	qty/ ac.ivld	qty/ ha.ivld	Removal of QUALSD by association with scour of matrix soil
SOQS	NQSD	1	-	qty/ ac.ivld	qty/ ha.ivld	Total flux of QUALSD from surface
SOQO	NQOF	1	-	qty/ ac.ivld	qty/ ha.ivld	Washoff of QUALOF from surface
SOQUAL	NQ	1	-	qty/ ac.ivld	qty/ ha.ivld	Total outflow of QUAL from the surface
IOQUAL	NQIF	1	-	qty/ ac.ivld	qty/ ha.ivld	Outflow of QUAL in interflow (QUALIF)
AOQUAL	NQGW	1	-	qty/ ac.ivld	qty/ ha.ivld	Outflow of QUAL in active ground- water outflow (QUALGW)
POQUAL	NQ	1	-	qty/ ac.ivld	qty/ ha.ivld	Total flux of QUAL from the PLS
SOQOC	NQOF	1	-	qty/ft3	qty/l	Concentration of QUALOF in surface outflow
SOQC	NQ	1	-	qty/ft3	qty/l	Concentration of QUAL (QUALSD+ QUALOF) in surface outflow
POQC	NQ	1	-	qty/ft3	qty/l	Concentration of QUAL (total) in total outflow from PLS

Input time series required to compute the above:

Group EXTNL

PQADFX

only required if dry or total
atmospheric deposition is being
simulated

PQADCN

PREC

only required if wet atmospheric
deposition is being simulated

Catalog for PERLND Module

Group PWATER		only required if PWATER is inactive
SURO		only required if one or more QUALs are QUALOFs, or if SOQC is required for one or more QUALs
IFWO		only required if one or more QUALs are QUALIFs
AGWO		only required if one or more QUALs are QUALGWs
PERO		only required if POQC is required for one or more QUALs
Group SEDMNT		only required if section SEDMNT is inactive and one or more QUALs are QUALSD's
WSSD		
SCRSD		

4.7(1).9 Group MSTLAY

```

-----
<---- Member ----> K      Units
      Max subscr i      (external)      Description/comment
Name      values  n
      1      2      d  Engl      Metr
-----

```

Time series computed by module section MSTLAY:

```

MST      5      1      *  lb/ac      kg/ha      Water in surface, upper principal,
                                         upper auxiliary, lower, and
                                         groundwater storages
FRAC      8      1      *  /ivl      /ivl      Fractional fluxes through soil:
                                         FSO,FSP,FII,FUP,FIO,FLP,FLDP,FAO

```

Input time series required to compute the above:

```

Group PWATER:                                only required if section PWATER
  SURI,LZS,IGWI,AGWI,AGWS,AGWO,              is inactive
  SURS,SURO,INFIL,IFWI,UZI,UZS,
  PERC,IFWS,IFWO

```

4.7(1).10 Group PEST

<---- Member ---->				K	Units		Description/comment
Name	Max	subscr	i		(external)		
	values	n					
	1	2	d	Engl		Metr	

Time series computed by module section PEST:

SPS	3	NPST	*	lb/ac	kg/ha	Amount of pesticide in surface storage
UPS	3	NPST	*	lb/ac	kg/ha	Amount of pesticide in upper principal storage
IPS	NPST	1	*	lb/ac	kg/ha	Amount of pesticide in upper auxiliary (interflow) storage
LPS	3	NPST	*	lb/ac	kg/ha	Amount of pesticide in lower layer storage
APS	3	NPST	*	lb/ac	kg/ha	Amount of pesticide in active groundwater layer storage
TPS	3	NPST	*	lb/ac	kg/ha	Total amount of pesticide in the soil

Note: SPS,UPS,LPS,APS and TPS give the storage of each pesticide by species. The first subscript indicates the species: crystalline, adsorbed, or solution, The second indicates the pesticide. For example, UPS(2,3) is the quantity of adsorbed pesticide in the upper layer principal storage, for the 3rd pesticide. The second subscript for IPS has a maximum value of one because only solution pesticide is modeled in the upper layer auxiliary (interflow) layer.

TOTPST	NPST	1	*	lb/ac	kg/ha	Total amount of pesticide in the soil (sum of all species).
PEADDR	NPST	3	-	lb/ ac.ivld	kg/ ha.ivld	Dry or total atmospheric deposition of pesticide. The second subscript indicates the species: crystalline, adsorbed, or solution.
PEADWT	NPST	3	-	lb/ ac.ivld	kg/ ha.ivld	Wet deposition of pesticide form. Subscripts as above.
SDPS	2	NPST	-	lb/ ac.ivld	kg/ ha.ivld	Outflow of sediment-associated pesticide (SDPSY and SDPSA for each pesticide)
TSPSS	5	NPST	-	lb/ ac.ivld	kg/ ha.ivld	Fluxes of solution pesticide for the topsoil layers: SOPSS,SPPSS, UPPSS,IIPSS,IOPSS
SSPSS	3	NPST	-	lb/ ac.ivld	kg/ ha.ivld	Fluxes of solution pesticide for the subsoil layers: LPPSS,LDPSS, AOPSS

Catalog for PERLND Module

SDEGPS	NPST	1	-	lb/ ac.ivld	kg/ ha.ivld	Amt. of degradation in surface layer
UDEGPS	NPST	1	-	"	"	Amount of degradation in upper layer
LDEGPS	NPST	1	-	"	"	Amount of degradation in lower layer
ADEGPS	NPST	1	-	"	"	Amount of degradation in groundwater
TDEGPS	NPST	1	-	"	"	Total amount of degradation in soil
SOSDPS	NPST	1	-	"	"	Total outflow of sediment-associated pesticide (SDPSY + SDPSA)
POPST	NPST	1	-	"	"	Total outflow of solution pesticide from the PLS
TOPST	NPST	1	-	"	"	Total outflow of pesticide from the PLS

Note: The subscript with maximum value NPST selects the particular pesticide. For example, POPST(2,1) is the outflow from the PLS of the second pesticide (in solution).

Input time series required to compute the above:

Group EXTNL

PEADFX	only required if dry or total atmospheric deposition is being simulated
PEADCN	only required if wet atmospheric deposition is being simulated
PREC	

Group SEDMNT

SOSED	only required if section SEDMNT is inactive
-------	---

Group PSTEMP

SLTMP	only required if section PSTEMP is inactive and ADOPFG = 1
ULTMP	
LGTMP	

Group MSTLAY

MST	only required if section MSTLAY is inactive
FRAC	

4.7(1).11 Group NITR

```

-----
<---- Member ---->  K      Units
                    Max subscr i  (external)      Description/comment
Name      values  n
           1      2      d  Engl      Metr
-----

```

Time series computed by module section NITR:

```

AGPLTN      1      1      *  lb/ac      kg/ha      N in above-ground plant storage
LITTRN      1      1      *      "      "      N in litter storage

```

The above time series are available only if ALPNFG= 1

```

SN          8      1      *  lb/ac      kg/ha      N in surface layer storage
UN          8      1      *      "      "      N in upper layer principal storage
LN          8      1      *      "      "      N in lower layer storage
AN          8      1      *      "      "      N in groundwater layer storage
TN          8      1      *      "      "      Total N in soil, by species

```

In the above, the first subscript selects the species of N: 1 means particulate labile organic N, 2 means adsorbed ammonium, 3 means solution ammonium, 4 means nitrate, 5 means plant N, 6 means solution labile organic N, 7 means particulate refractory organic N, 8 means solution refractory organic N

```

IN          4      1      *  lb/ac      kg/ha      N in upper layer auxiliary
                                           (interflow) storage

```

In the above, the first subscript selects the species of N: 1 means solution ammonium, 2 means nitrate, 3 means solution labile organic N, 4 means solution refractory organic N (only soluble species are modelled in this storage)

```

TOTNIT      1      1      *  lb/ac      kg/ha      Total N stored in the PLS (all
                                           species)

```

```

NDFCT       5      1      *  lb/ac      kg/ac      Deficit in yield-based plant uptake
                                           of N from the each soil layer:
                                           1-surface, 2-upper, 3-lower,
                                           4-active groundwater, 5-total

```

```

NUPTG       4      1      -  lb/      kg/
                        ac.ivld  ha.ivld  Yield-based plant uptake target for
                                           N from each soil layer: 1-surface,
                                           2-upper, 3-lower, 4-active groundwater

```

Catalog for PERLND Module

NIADDR	3	2	-	lb/ ac.ivld	kg/ ha.ivld	Dry or total atmospheric deposition of nitrogen. The first subscript indicates the species: NO ₃ , NH ₃ , organic N; the second subscript indicates the affected soil layer: surface or upper.
NIADWT	3	2	-	"	"	Wet atmospheric deposition of nitrogen. Subscripts as above.
SEDN	3	1	-	"	"	Outflows of sediment-associated N

In the above, the first subscript selects the flux: 1 means labile organic N removal, 2 means adsorbed ammonium removal, 3 means refractory organic N removal.

SOSDN	1	1	-	lb/ ac.ivld	kg/ ha.ivld	Total outflow of sediment-associated N (organic N + adsorbed ammonium)
TSAMS	5	1	-	"	"	Fluxes of solution ammonium in the topsoil
TSNO ₃	5	1	-	"	"	Fluxes of nitrate in the topsoil
TSSLN	5	1	-	"	"	Fluxes of solution labile organic N in the topsoil
TSSRN	5	1	-	"	"	Fluxes of solution refractory organic N in the topsoil

In the above, the first subscript selects the flux:

1 means outflow with surface water outflow

2 means percolation from surface to upper layer principal storage

3 means percolation from upper layer principal storage to lower layer storage

4 means flow from upper layer principal to upper layer auxiliary (interflow) storage

5 means outflow from PLS with water from upper layer auxiliary (interflow) storage

SSAMS	3	1	-	lb/ac.ivld	kg/ha.ivld	Fluxes of solution ammonium in the subsoil
SSNO ₃	3	1	-	"	"	Fluxes of nitrate in the subsoil
SSSLN	3	1	-	"	"	Fluxes of solution labile organic N in the subsoil
SSSRN	3	1	-	"	"	Fluxes of solution refractory organic N in the subsoil

In the above, the first subscript selects the flux:

1 means percolation from the lower layer to the active groundwater storage

2 means deep percolation, from the lower layer to inactive groundwater

3 means outflow from the PLS with water from the active groundwater storage

Catalog for PERLND Module

PON03	1	1	-	lb/ac.ivld	kg/ha.ivld	Total outflow of NO3 from the PLS
PONH4	1	1	-	"	"	Total outflow of NH4 from the PLS
POORN	1	1	-	"	"	Total outflow of ORGN from the PLS
PONITR	1	1	-	"	"	Total outflow of N (NO3+NH4+ORGN) from the PLS.
TDENIF	1	1	-	"	"	Total denitrification in the PLS
NFIXFX	5	1	-	"	"	N fixation flux to the PLS
AMVOL	5	1	-	"	"	Ammonia volatilization from the PLS

In the above, the first subscript selects soil layer: 1-surface, 2-upper, 3-lower, 4-active groundwater, 5-total

Input time series required to compute the above:

Same as for section PEST, except NIADFX and NIADCN are required for atmospheric deposition. An input time series need only be supplied if section PEST and the section which computes it (SEDMNT, PSTEMP or MSTLAY) are inactive.

4.7(1).12 Group PHOS

<div><---- Member ----></div>							
Pame	Max subscr		K	Units		Description/comment	
	values		i	(external)			
	1	2	n	d	Engl	Metr	

Time series computed by module section PHOS:

SP	4	1	*	lb/ac	kg/ha	P in surface layer storage
UP	4	1	*	"	"	P in upper layer principal storage
LP	4	1	*	"	"	P in lower layer storage
AP	4	1	*	"	"	P in groundwater layer storage
TP	4	1	*	"	"	Total P in soil, by species

In the above, the first subscript selects the species of P:

1 means organic P, 2 means adsorbed phosphate, 3 means solution phosphate, 4 means plant P derived from this layer

IP	1	1	*	lb/ac	kg/ha	P in upper layer auxiliary storage (interflow) (solution P ₀₄) (only soluble species are modeled in this storage)
TOTPHO	1	1	*	lb/ac	kg/ha	Total P stored in the PLS (all species)
SPDFC	1	1	*	lb/ac	kg/ac	Deficit in yield-based plant uptake of P from the surface soil layer
PDFCT	5	1	*	lb/ac	kg/ac	Deficit in yield-based plant uptake of P from the each soil layer: 1-surface, 2-upper, 3-lower, 4-active groundwater, 5-total
PUPTG	4	1	-	lb/ ac.ivld	kg/ ha.ivld	Yield-based plant uptake target for P from each soil layer: 1-surface, 2-upper, 3-lower, 4-active groundwater
PHADDR	2	2	-	lb/ ac.ivld	kg/ ha.ivld	Dry or total atmospheric deposition of phosphorus. The first subscript indicates the species: P ₀₄ or organic P; the second subscript indicates the affected soil layer: surface or upper.
PHADWT	2	2	-	lb/ ac.ivld	kg/ ha.ivld	Wet atmospheric deposition of phosphorus. Subscripts as above.

Catalog for PERLND Module

SEDP 2 1 - lb/ac.ivld kg/ha.ivld Outflows of sediment-associated P

In the above, the first subscript selects the flux: 1 means organic P removal,
2 means adsorbed phosphate removal

SOSEDP 1 1 - lb/ac.ivld kg/ha.ivld Total outflow of sediment-associated
P (organic P + adsorbed phosphate)

TSP4S 5 1 - lb/ac.ivld kg/ha.ivld Fluxes of solution phosphate in the
in the topsoil.

In the above, the first subscript selects the flux:

1 means outflow with surface water outflow

2 means percolation from surface to upper layer principal storage

3 means percolation from upper layer principal storage to lower layer storage

4 means flow from upper layer principal to upper layer auxiliary (interflow)
storage

5 means outflow from PLS with water from upper layer auxiliary (interflow) storage

SSP4S 3 1 - lb/ac.ivld kg/ha.ivld Fluxes of solution phosphate
in the subsoil.

In the above, the first subscript selects the flux:

1 means percolation from the lower layer to the active groundwater storage

2 means deep percolation, from the lower layer to inactive groundwater

3 means outflow from the PLS with water from the active groundwater storage

POPHOS 1 1 - lb/ac.ivld kg/ha.ivld Total outflow of P from the PLS.

Input time series required to compute the above:

Same as for section PEST, except PHADFX and PHADCN are required for atmospheric
deposition. An input time series need only be supplied if sections PEST and NITR
and the module section which computes it (SEDMNT, PSTEMP or MSTLAY) are inactive.

4.7(1).13 Group TRACER

```

-----
<---- Member ----> K      Units
                   Max subscr i    (external)      Description/comment
Name              values  n
                   1      2      d  Engr      Metr
-----

```

Time series computed by module section TRACER:

Name	1	2	d	Engr	Metr	Description/comment
STRSU	1	1	*	lb/ac	kg/ha	Tracer in surface layer storage
UTRSU	1	1	*	"	"	Tracer in upper principal storage
ITRSU	1	1	*	"	"	Tracer in upper auxiliary storage
LTRSU	1	1	*	"	"	Tracer in lower layer storage
ATRSU	1	1	*	"	"	Tracer in groundwater layer storage
TRSU	1	1	*	"	"	Total tracer stored in the PLS
TRADDR	2	1	-	lb/ ac.ivld	kg/ ha.ivld	Dry or total atmospheric deposition of tracer. The subscript indicates the soil layer: surface or upper.
TRADWT	2	1	-	"	"	Wet atmospheric deposition of tracer. Subscripts as above.
TSTRS	5	1	-	lb/ac.ivld	kg/ha.ivld	Fluxes of tracer in topsoil

In the above, the first subscript indicates the flux:

- 1 means outflow with surface water outflow
- 2 means percolation from surface to upper layer principal storage
- 3 means percolation from upper layer principal to lower layer storage
- 4 means flow from upper principal to upper auxiliary (interflow) storage
- 5 means outflow from the PLS from upper layer transitory (interflow) storage

SSTRS	3	1	-	lb/ac.ivld	kg/ha.ivld	Fluxes of tracer in subsoil
-------	---	---	---	------------	------------	-----------------------------

In the above, the first subscript indicates the flux:

- 1 means percolation from lower layer to active groundwater storage
- 2 means deep percolation, from lower layer to inactive groundwater
- 3 means outflow from the PLS from the active groundwater storage

POTRS	1	1	-	lb/ac.ivld	kg/ha.ivld	Total outflow of tracer from the PLS
-------	---	---	---	------------	------------	--------------------------------------

Input time series required to compute the above:

Group EXTNL

TRADFX	only required if dry or total atmospheric deposition is being simulated
TRADCN	only required if wet atmospheric deposition is being simulated
PREC	

Group MSTLAY

MST	only required if MSTLAY, PEST, NITR and PHOS are all inactive; else these time series will already have been supplied
FRAC	

4.7(2) Catalog for IMPLND module

The time series groups associated with this application module are shown in Figure 4.7(2)-1. The members contained within each group are documented in the tables which follow.

4.7(2).1 Group EXTNL

<hr/>					
<---- Member ---->		K	Units		Description/comment
Name	Max subscr values	i	(external)		
	1 2	n	Engl	Metr	

Time series always external (input only) to module IMPLND:

GATMP	1	1	-	Deg F	Deg C	Measured air temperature
PREC	1	1	-	in/ivld	mm/ivld	Measured precipitation
DTMPG	1	1	-	Deg F	Deg C	Measured dewpoint temperature
WINMOV	1	1	-	mi/ivld	km/ivld	Measured wind movement
SOLRAD	1	1	-	Ly/ivld	Ly/ivld	Measured solar radiation
CLOUD	1	1	-	tenths	tenths	Cloud cover (range: 0 - 10)
PETINP	1	1	-	in/ivld	mm/ivld	Input potential E-T
SURLI	1	1	-	in/ivld	mm/ivld	Surface lateral inflow
SLSLD	1	1	-	tons/ ac.ivld	tonnes/ ha.ivld	Lateral input of solids
IQADFX	10	1	-	qty/ ac.ivld	qty/ ha.ivld	Dry or total atmospheric deposition of QUALOF
IQADCN	10	1	-	qty/ft3	qty/l	Concentration of QUALOF in precip for wet atmospheric deposition

4.7(2).2 Group ATEMP

Identical to group ATEMP in module PERLND. See Section 4.7(1).2 for documentation.

4.7(2).3 Group SNOW

Identical to group SNOW in module PERLND. See Section 4.7(1).3 for documentation.

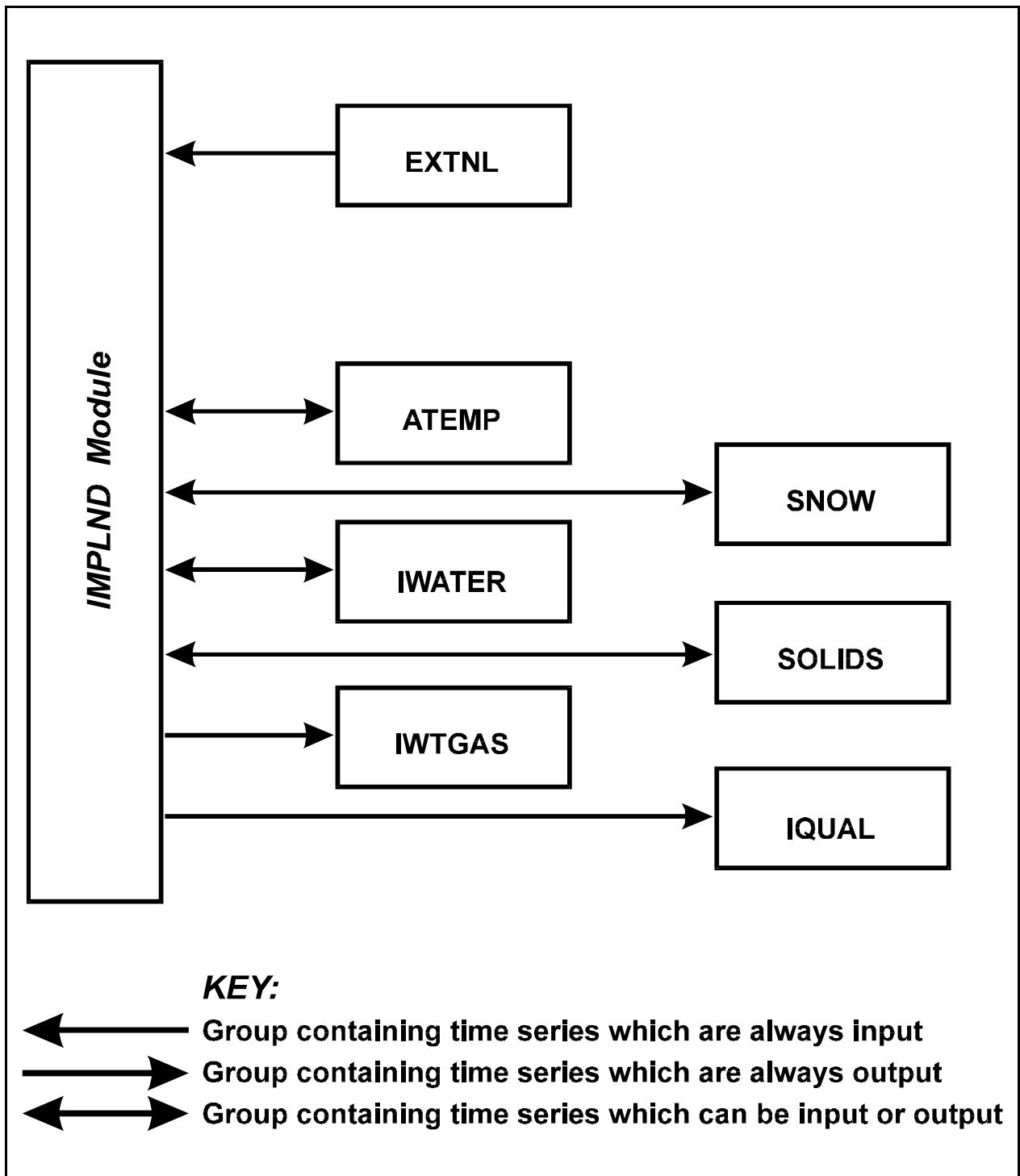


Figure 4.7(2)-1 Groups of time series associated with the IMPLND Module

4.7(2).4 Group IWATER

```

-----
<---- Member ----> K      Units
      Max subscr i      (external)      Description/comment
Name      values  n
      1      2      d  Engr      Metr
-----

```

Time series computed by module section IWATER:

Name	1	2	d	Engr	Metr	Description/comment
IMPS	1	1	*	in	mm	Total water stored in the ILS
RETS	1	1	*	in	mm	Retention storage
SURS	1	1	*	in	mm	Surface (overland flow) storage
SURO	1	1	-	in/ivld	mm/ivld	Surface outflow
PET	1	1	-	in/ivld	mm/ivld	Potential E-T, adjusted for snow cover and air temperature
IMPEV	1	1	-	in/ivld	mm/ivld	Total simulated E-T
SURI	1	1	-	in/ivld	mm/ivld	Surface inflow (including any lateral inflow if RTLIFG=1)

Input time series required to compute the above:

Group EXTNL

PETINP	
PREC	required if snow not considered (CSNOFG= 0)
SURLI	optional

Group ATEMP

AIRTMP	only required if section ATEMP is inactive and CSNOFG= 1
--------	--

Group SNOW

RAINF	only required if section SNOW is inactive and snow is considered (CSNOFG= 1)
SNOCOV	
WYIELD	

4.7(2).5 Group SOLIDS

```

-----
<---- Member ----> K      Units
                   Max subscr i    (external)      Description/comment
Name      values  n
          1      2  d  Engl      Metr
-----

```

Time series computed by module section SOLIDS:

```

SLDS      1      1      *  tons/ac   tonnes/ha  Storage of solids on surface
SOSLD     1      1      -  tons/     tonnes/    Washoff of solids from surface
                   ac.ivld   ha.ivld

```

Input time series required to compute the above:

```

Group EXTNL                                always required
  PREC
  SLSLD                                    optional

Group IWATER                                only required if section IWATER
  SURO                                    is inactive
  SURS
-----

```

4.7(2).6 Group IWTGAS

```

-----
<---- Member ----> K      Units
      Max subscr i      (external)      Description/comment
Name      values  n
      1      2      d  Engr      Metr
-----

```

Time series computed by module section IWTGAS:

SOTMP	1	1	*	Deg F	Deg C	Temperature of surface outflow
SODOX	1	1	*	mg/l	mg/l	DO concentration in surface outflow
SOCO2	1	1	*	mg/l	mg/l	CO2 concentration in surface outflow
SOHT	1	1	-	BTU/ ac.ivld	kcal/ ha.ivld	Heat energy in surface outflow (relative to freezing point)
SODOXM	1	1	-	lb/ ac.ivld	kg/ ha.ivld	Flux of DO in surface outflow
SOCO2M	1	1	-	lb/ ac.ivld	kg/ ha.ivld	Flux of CO2 in surface outflow

Input time series required to compute the above:

Group ATEMP AIRTMP	only required if section ATEMP is inactive
Group SNOW WYIELD	only required if section SNOW is inactive and snow is considered (CSNOFG= 1)
Group IWATER SURO	only required if section IWATER is inactive

4.7(2).7 Group IQUAL

----->					
<---- Member ---->			K	Units	
Max subscr			i	(external)	
Name	values		n	Description/comment	
	1	2	d	Engl	Metr
----->					

Time series computed by module section IQUAL:

SQO	NQOF	1	*	qty/ac	qty/ha	Storage of QUALOF on the surface
IQADDR	NQ	1	-	qty/ ac.ivld	qty/ ha.ivld	Dry or total atmospheric deposition of QUAL
IQADWT	NQ	1	-	qty/ ac.ivld	qty/ ha.ivld	Wet deposition of QUAL
SOQS	NQSD	1	-	qty/ ac.ivld	qty/ ha.ivld	Total flux of QUALSD from surface
SOQO	NQOF	1	-	qty/ ac.ivld	qty/ ha.ivld	Washoff of QUALOF from surface
SOQUAL	NQ	1	-	qty/ ac.ivld	qty/ ha.ivld	Total outflow of QUAL from the surface
SOQOC	NQOF	1	-	qty/ft3	qty/l	Concentration of QUALOF in surface outflow
SOQC	NQ	1	-	qty/ft3	qty/l	Concentration of QUAL in surface outflow (QUALSD+QUALOF)

Input time series required to compute the above:

Group EXTNL

IQADFX	only required if dry or total atmospheric deposition is being simulated
IQADCN	only required if wet atmospheric deposition is being simulated
PREC	

Group IWATER

SURO	only required if section IWATER is inactive
	only required if one or more QUALs are QUALOFs, or if SOQC is required for one or more QUALs

Group SOLIDS

SOSLD	only required if section SOLIDS is inactive and one or more QUALs are QUALSDs
-------	---

4.7(3) Catalog for RCHRES module

The time series groups associated with this application module are shown in Figure 4.7(3)-1.

The members contained within each group are documented in the following tables.

Note: exit-specific, output time series are computed (available) only when NEXITS is greater than 1.

4.7(3).1 Group EXTNL

<---- Member ---->			K	Units		Description/comment
Name	Max	subscr	i	(external)		
	values	n				
	1	2	d	Engl	Metr	

Time series external to module RCHRES (input only):

PREC	1	1	-	in/ivld	mm/ivld	Precip on surface of the RCHRES (requires AUX1FG = 1)
POTEV	1	1	-	in/ivld	mm/ivld	Potential evaporation from the surface (requires AUX1FG = 1)
COLIND	NEXITS	1	-	none	none	Time series indicating which (pair of) columns in RCHTAB are used to evaluate f(VOL) component of outflow demand
OUTDGT	NEXITS	1	-	ft3/s	m3/s	g(t) component of outflow demand if no CATEGORY block is present.
COTDGT	NEXITS	CAT	-	ft3/s	m3/s	g(t) component of outflow demand by category if CATEGORY block is present
IVOL	1	1	-	ac.ft/ivld	Mm3/ivld	Inflow to the RCHRES if no CATEGORY block is present (Mm3 = 10**6 m3)
CIVOL	CAT	1	-	ac.ft/ivld	Mm3/ivld	Inflow of water belonging to each category if CATEGORY block is present
ICON	NCONS	1	-	qty/ivld	qty/ivld	Inflow of conservative constituents
SOLRAD	1	1	-	Ly/ivld	Ly/ivld	Solar radiation
CLOUD	1	1	-	tenths	tenths	Cloud cover (range 0 - 10)
DEWTMP	1	1	-	DegF	DegC	Dewpoint
GATMP	1	1	-	DegF	DegC	Air temperature at met. station
WIND	1	1	-	miles/ivld	km/ivld	Wind movement

Catalog for RCHRES Module

TGRND	1	1	-	DegF	DegC	Temperature of ground beneath stream bed
PHVAL	1	1	-			pH (used in Section GQUAL)
ROC	1	1	-	moles/l	moles/l	Free radical oxygen concentration (used in Section GQUAL)
BIO	NGQUAL	1	-	mg(bio)/l	mg(bio)/l	Biomass active in biodegradation (used in Section GQUAL)
COADFX	NCONS	1	-	qty/ ac/ivld	qty/ ha/ivld	Dry or total atmospheric deposition of conservative
COADCN	NCONS	1	-	conc	conc	Concentration of conservative in rain for wet atmospheric deposition
GQADFX	NGQUAL	1	-	qty/ ac/ivld	qty/ ha/ivld	Dry or total atmospheric deposition of qual
GQADCN	NGQUAL	1	-	concu/l	concu/l	Concentration of qual in rain for for wet atmospheric deposition
NUADFX	3	1	-	lb/ ac.ivld	kg/ ha.ivld	Dry or total atmospheric deposition of inorganic nutrient. Subscript indicates: NO3, NH3, PO4.
NUADCN	3	1	-	mg/l	mg/l	Concentration of nutrient in rain for wet atmospheric deposition
PLADFX	3	1	-	lb/ ac/ivld	kg/ ha/ivld	Dry or total atmospheric deposition of organics. Subscript indicates: nitrogen, phosphorus, carbon
PLADCN	3	1	-	mg/l	mg/l	Concentration of organic in rain for wet atmospheric deposition. Subscript same as above.

Note: CAT = one of the two-character ID tags from the CATEGORY block

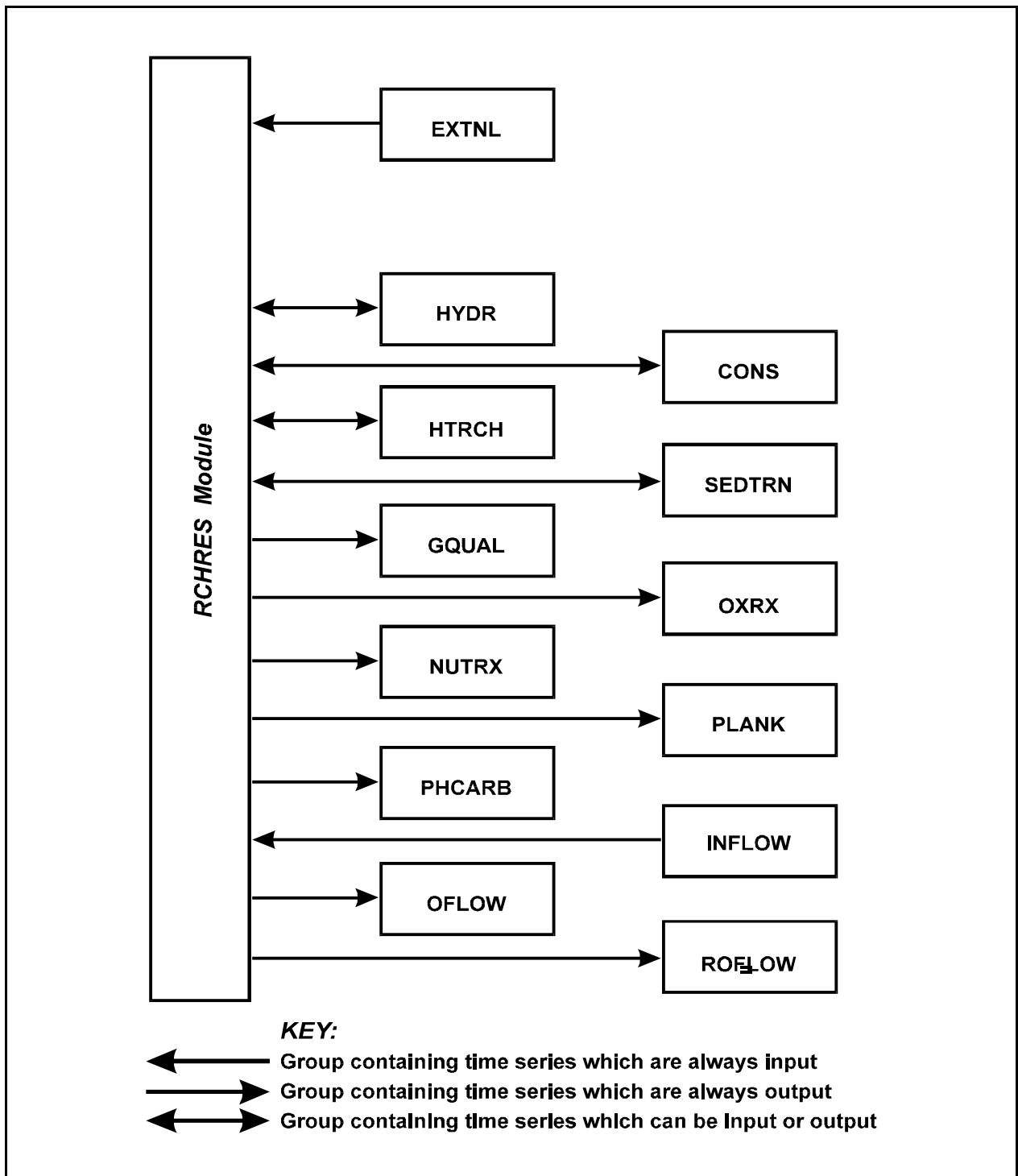


Figure 4.7(3)-1 Groups of time series associated with the RCHRES Module

4.7(3).2 Group HYDR

<----- Member ----->						
	Max subscr		i	Units (external)		Description/comment
Name	values		n			
	1	2	d	Engl	Metr	

Time series computed by module section HYDR:						
VOL	1	1	*	ac.ft	Mm3	Volume of water in the RCHRES
AUX1FG must be 1 for next 5 members to be computed:						
DEP	1	1	*	ft	m	Depth at specified location
STAGE	1	1	*	ft	m	Stage (DEP+STCOR)
AVDEP	1	1	*	ft	m	Average depth (volume/surface area)
TWID	1	1	*	ft	m	Mean topwidth (surface area/length)
HRAD	1	1	*	ft	m	Hydraulic radius
SAREA	1	1	*	ac	ha	Surface area
AUX2FG must be 1 for next 2 members to be computed:						
AVVEL	1	1	*	ft/s	m/s	Average velocity (RO/VOL)
AVSECT	1	1	*	ft2	m2	Average cross-sectional area of RCHRES (VOL/length)
AUX3FG must be 1 for next 2 members to be computed:						
USTAR	1	1	*	ft/s	m/s	Shear velocity
TAU	1	1	*	lb/ft2	kg/m2	Bed shear stress
RO	1	1	*	ft3/s	m3/s	Total rate of outflow from RCHRES
CRO	CAT	1	*	ft3/s	m3/s	Rates of outflow of each category
O	NEXITS	1	*	ft3/s	m3/s	Rates of outflow through individual exits (available only if NEXITS > 1)
CO	NEXITS	CAT	*	ft3/s	m3/s	Rates of outflow through individual exits of each category
CDFVOL	NEXITS	CAT	*	ac.ft	Mm3	Current cumulative deficit of each category demand by exit
PRSUPY	1	1	-	ac.ft/ ivld	Mm3/ ivld	Volume of water contributed by precipitation on surface
VOLEV	1	1	-	ac.ft/ ivld	Mm3/ ivld	Volume of water lost by evaporation
ROVOL	1	1	-	ac.ft/ ivld	Mm3/ ivld	Total volume of outflow from RCHRES
CROVOL	CAT	1	-	ac.ft/ ivld	Mm3/ ivld	Total volume of outflow from RCHRES of each category
OVOL	NEXITS	1	-	ac.ft/ ivld	Mm3/ ivld	Volume of outflow through individual exits (available only if NEXITS > 1)
COVOL	NEXITS	CAT	-	ac.ft/ ivld	Mm3/ ivld	Volume of outflow through individual exits of each category

Notes: 1. Mm3 = 10**6 m3
2. Exit-specific time series are computed only if NEXITS > 1
3. CAT = must be one of the two-character tags from the CATEGORY block rather than an integer

Input time series required to compute the above:

Group EXTNL

IVOL (also in group INFLOW)	optional - not used if CATEGORY block is present
CIVOL (also in group INFLOW)	optional - used only if CATEGORY block is present
PREC	optional
POTEV	optional
COLIND	required only if ODFVFG is negative for one or more outflow demands
OUTDGT	required only if ODGTFG is >0 for one or more outflow demands
COTDGT	required only if ODGTFG is >0 for one or more outflow demands

If there are any active categories, then the total inflow to a reach is the sum of all category inflows. These inflows are input as time series CIVOL, and IVOL is calculated (by the program) as their sum instead of being input.

4.7(3).3 Group ADCALC

```

-----
<---- Member ----> K      Units
      Max subscr i      (external)      Description/comment
Name      values  n
      1      2      d  Engl      Metr
-----

```

Time series computed by module section ADCALC:

None of the computed time series are outputtable; they are passed internally to any active "quality" sections of the RCHRES module

Input time series required to compute the above:

```

Group HYDR                                only required if section HYDR
  VOL                                       is inactive
  O
-----

```

4.7(3).4 Group CONS

<div><---- Member ----></div>							
Max subscr		K	Units		Description/comment		
values		i	(external)				
Name			n				
	1	2	d	Engl	Metr		

Time series computed by module section CONS:

CON	NCONS	1	*	concid	concid	Concentration of conservative constituents
COADDR	NCONS	1	-	qty/ivld	qty/ivld	Dry or total atmospheric deposition of conservative
COADWT	NCONS	1	-	qty/ivld	qty/ivld	Wet atmospheric deposition of conservative
ROCON	NCONS	1	-	qty/ivld	qty/ivld	Total outflow of conservatives
OCON	NEXITS	NCONS	-	qty/ivld	qty/ivld	Outflow of conservatives through individual exits; available if NEXITS > 1

Input time series required to compute the above:

Group EXTNL

COADFX	only required if dry or total atmospheric deposition is being simulated
COADCN	only required if wet atmospheric deposition is being simulated
PREC	optional
ICON (also in group INFLOW)	optional

Group HYDR

SAREA	only required if atmospheric deposition is being simulated
-------	--

4.7(3).5 Group HTRCH

```

-----
<---- Member ---->  K      Units
                    Max subscr i    (external)      Description/comment
Name      values      n
          1      2      d  Engr      Metr
-----

```

Time series computed by module section HTRCH:

Name	1	2	d	Engr	Metr	Description/comment
TW	1	1	*	DegF	DegC	Simulated water temperature
AIRTMP	1	1	*	DegF	DegC	Air temperature, adjusted for elev. difference between gage and RCHRES
HTEXCH	1	1	-	BTU/ivld	kcal/ivld	Net heat exchanged with atmosphere and stream bed
ROHEAT	1	1	-	"	"	Total outflow of thermal energy through active exits
OHEAT	NEXITS	1	-	"	"	Outflow of thermal energy through individual exits
HTCF4	7	1	-	BTU/ft2/ivld	kcal/m2/ivld	Components of heat exchange per unit area of surface: 1) total, 2) solar radiation, 3) longwave radiation, 4) evaporation, 5) conduction, 6) precipitation, 7) bed exchange (positive = gain of heat).

Input time series required to compute the above:

Group INFLOW	optional
IHEAT	optional
Group EXTNL	always required
SOLRAD	
PREC	optional
CLOUD	
DEWTMP	
GATMP	
WIND	
Group HYDR	only required if section HYDR is inactive
AVDEP	

4.7(3).6 Group SEDTRN

<----- Member ----->		K	Units						
Max subscr		i	(external)		Description/comment				
Name	values		n						
	1	2	d	Engl	Metr				

Time series computed by module section SEDTRN

SSED	4	1	*	mg/l	mg/l	Suspended sediment concentrations
RSED	10	1	*	ton	tonne	Sediment storages
BEDDEP	1	1	*	ft	m	Bed depth (thickness)
DEPSCR	4	1	-	ton/ivld	tonne/ivld	Deposition (positive) or scour (negative)
ROSED	4	1	-	"	"	Total outflows of sediment from the RCHRES
USED	NEXITS	4	-	"	"	Outflows of sediment through individual exits

Note: In the above, the subscript with maximum value =4 selects the sediment fraction - 1 for sand, 2 for silt, 3 for clay, and 4 for the sum of sand silt and clay. The subscript with maximum value =10 selects the following: 1 suspended sand, 2 suspended silt, 3 suspended clay, 4 bed sand, 5 bed silt 6 bed clay, 7 total sand, 8 total silt, 9 total clay, and 10 total of 7,8,9.

Input time series required to compute the above:

Group INFLOW

ISED(*) inflows of sand, silt, and clay
to the RCHRES; optional

Group HYDR

TAU inactive

AVDEP

AVVEL

RO

HRAD

TWID

— — —

1

— — —

only required if SANDFG = 1 or 2

Group HTRCH

TW

only required if Section HTRCH is
inactive and SANDFG = 1 or 2

4.7(3).7 Group GQUAL

<---- Member ---->			K	Units		Description/comment
Max subscr			i	(external)		
Name	values		n			
	1	2	d	Engl	Metr	

Time series computed by module section GQUAL:						
DQAL	NGQUAL	1	*	concu/l	concu/l	Dissolved concentration of qual.
SQAL	6	NGQUAL	*	concu/mg	concu/mg	Concentration of qual on sediment.
						First subscript selects:
						1 susp sand 2 susp silt 3 susp clay
						4 bed sand 5 bed silt 6 bed clay
RDQAL	NGQUAL	1	*	qty	qty	Total storage of qual in dissolved form
RSQAL	12	NGQUAL	*	qty	qty	Storage of sediment-associated qual.
						First subscript selects:
						1 susp sand 2 susp silt 3 susp clay
						4 susp total 5 bed sand 6 bed silt
						7 bed clay 8 bed total
						9 total on sand 10 total on silt
						11 total on clay 12 grand total
RRQAL	NGQUAL	1	*	qty	qty	Total storage of qual in the RCHRES
PDQAL	NGQUAL	1	-	qty/ivld	qty/ivld	Input to this qual in this RCHRES, from decay of parent quals
GQADDR	NGQUAL	1	-	qty/ivld	qty/ivld	Dry or total atmospheric deposition of qual
GQADWT	NGQUAL	1	-	qty/ivld	qty/ivld	Wet atmospheric deposition of qual
DDQAL	7	NGQUAL	-	qty/ivld	qty/ivld	Decay of dissolved qual. First subscript selects decay path:
						1 hydrolysis 2 oxidation
						3 photolysis 4 volatilization
						5 biodegradation 6 general (other)
						7 total of 1-6 .
RODQAL	NGQUAL	1	-	qty/ivld	qty/ivld	Total outflow of dissolved qual from the RCHRES
DSQAL	4	NGQUAL	-	qty/ivld	qty/ivld	Deposition/scour of qual. First subscript selects carrier:
						1 sand 2 silt 3 clay 4 total
ROSQAL	4	NGQUAL	-	qty/ivld	qty/ivld	Total outflow of sediment-associated qual from RCHRES.
						First subscript selects carrier:
						1 sand 2 silt 3 clay 4 total
SQDEC	7	NGQUAL		qty/ivld	qty/ivld	Decay of sediment-associated qual on:
						1 susp sand 2 susp silt
						3 susp clay 4 bed sand
						5 bed silt 6 bed clay 7 total

Catalog for RCHRES Module

ADQAL	7	NGQUAL	-	qty/ivld	qty/ivld	Adsorption/desorption between dissolved state and: 1 susp sand 2 susp silt 3 susp clay 4 bed sand 5 bed silt 6 bed clay 7 total
ODQAL	NEXITS	NGQUAL-		qty/ivld	qty/ivld	Outflow of dissolved qual through individual exits.
OSQAL	NEXITS	NGQ3	-	qty/ivld	qty/ivld	Outflows of sediment-associated qual through individual exits. Second subscript selects: 1 sand, first qual 2 silt, first qual 3 clay, first qual (NGQ3= 4 sand, second qual NGQUAL*3) etc.

Input time series required to compute the above:

Group INFLOW

IDQAL	optional
ISQAL(*)	optional

Group EXTNL

GQADFX	only required if dry or total atmospheric deposition is being simulated
GQADCN	only required if wet atmospheric deposition is being simulated
PREC	
PHVAL	if there is hydrolysis, PHFLAG=1, and Section PHCARB is inactive
ROC	if there is free radical oxidation, and ROXFG=1
BIO(I)	if qual number I undergoes biodegradation and GQPM2(7,I)=1
CLOUD	if there is photolysis, and CLDFG=1
WIND	if there is volatilization and water body is a lake (LKFG=1)

Group HYDR

AVDEP	only required if Section HYDR is inactive
AVVEL	See below
	if volatilization is on and water body is a flowing stream (LKFG=0)
SAREA	only required if atmospheric deposition is being simulated

Group HTRCH

TW	only required if Section HTRCH is inactive and TEMPFG=1
----	---

Group PLANK

only required if Section PLANK is inactive or PHYFG=0

PHYTO	if there is photolysis and PHYTFG=1
Group SEDTRN	only required if Section SEDTRN is inactive
SSSED(4)	if there is photolysis and SDFG=1

Note: AVDEP is required if Section HYDR is inactive and:

- 1. There is photolysis
- or 2. There is volatilization and
 - a. The water body is a lake
 - or b. The water body is a free-flowing stream and REAMFG>1

4.7(3).8.1 Group OXRX

```

-----
<---- Member ----> K      Units
      Max subscr i      (external)      Description/comment
Name      values  n
      1      2      d  Engr      Metr
-----

```

Time series computed by module section OXRX:

```

DOX      1      1      *  mg/l      mg/l      DO concentration
BOD      1      1      *  mg/l      mg/l      BOD concentration
SATDO    1      1      *  mg/l      mg/l      Saturation DO concentration

OXCF1     2      1      -  lb/ivld   kg/ivld   Total outflows of DO (OXCF1(1,1))
                                           and BOD (OXCF1(2,1)) from the RCHRES

OXCF2  NEXITS  2      -  lb/ivld   kg/ivld   Outflows of DO and BOD through
                                           individual exits

```

In the above, the first subscript selects the exit. The second selects the constituent: 1 means DO, 2 means BOD.

Input time series required to compute the above:

```

Group INFLOW
  IDOX                                optional
  IBOD                                optional

Group EXTNL
  WIND                                only needed if LKFG=1 (lake)

Group HYDR
  AVDEP                              only required if section HYDR
  AVDEP                              is inactive

Group HTRCH
  TW                                  only required if section HTRCH
                                     is inactive
-----

```

4.7(3).8.2 Group NUTRX

<div><----- Member -----></div>						
	Max	subscr	K	Units		Description/comment
Name		values	i	(external)		
	1	2	n	Engl	Metr	

Time series computed by module section NUTRX:						
DNUST	6	1	*	mg/l	mg/l	Dissolved nutrient concentrations; Subscript 1: 1=NO3, 2=TAM, 3=NO2, 4=PO4, 5=NH4+, 6=NH3.
SNH4	3	1	*	mg/kg	mg/kg	Particulate NH4-N concentrations; Subscript 1: 1=sand, 2=silt, 3=clay
SPO4	3	1	*	mg/kg	mg/kg	Particulate PO4-P concentrations; Subscript 1: 1=sand, 2=silt, 3=clay
DNUST2	6	1	*	lbs	kg	Dissolved nutrient storages; same subscript values as DNUST
RSNH4	12	1	*	lbs	kg	Particulate NH4-N storages; 1-3= suspended sand, silt, clay, 4=total suspended, 5-7=bed sand, silt, clay, 8=total bed, 9-11=total sand, total silt, total clay, 12=grand total
RSPO4	12	1	*	lbs	kg	Particulate PO4-P storages; same subscript values as RSNH4
NUST	4	1	*	lbs	kg	Total nutrient storages in RCHRES, (dissolved + particulate); Subscript 1: 1=NO3,2=TAM,3=NO2,4=PO4
NUADDR	3	1	-	lb/ivld	kg/ivld	Dry or total atmospheric deposition of nutrient; Subscript 1: 1=NO3, 2=TAM, 3=PO4
NUADWT	3	1	-	lb/ivld	kg/ivld	Wet atmospheric deposition of nutrient; Subscript same as NUADDR
NUCF1	4	1	-	lb/ivld	kg/ivld	Total outflow of dissolved nutrient; Same subscript values as NUST
NUCF2	4	2	-	lb/ivld	kg/ivld	Total outflow of particulate NH4 and PO4; Subscript 1: 1=(on) sand, 2=silt, 3=clay, 4=total; Subscript 2: 1 = NH4, 2 = PO4
NUCF3	4	2	-	lb/ivld	kg/ivld	Scour/deposition fluxes of particulate NH4 and PO4; + = scour, - = deposition; same subscript values as NUCF2

Catalog for RCHRES Module

NUCF4	6	1	-	lb/ivld	kg/ivld	Process fluxes for NO3; Subscript 1: 1=nitrification, 2=denitrification, 3=BOD decay, 4=phytoplankton growth/respir., 5=zooplankton death/respir., 6=benthic algae growth/respir.
NUCF5	7	1	-	lb/ivld	kg/ivld	Process fluxes for TAM; Subscript 1: 1=nitrification, 2=volatilization, 3=benthic release, 4=BOD decay, 5=phytoplankton growth/respir., 6=zooplankton death/respir., 7=benthic algae growth/respir.
NUCF6	1	1	-	lb/ivld	kg/ivld	Nitrification flux for NO2; (net gain (+) or loss (-) of NO2)
NUCF7	5	1	-	lb/ivld	kg/ivld	Process fluxes for PO4; Subscript 1: 1=benthic release, 2=BOD decay, 3=phytoplankton growth/respir., 4=zooplankton death/respir., 5=benthic algae growth/respir.
NUCF8	4	2	-	lb/ivld	kg/ivld	Adsorption (+) or desorption (-) of NH4 and PO4; Subscript 1: 1=sand, 2=silt, 3=clay; Subscript 2: 1=NH4, 2=PO4
NUCF9	5	4	-	lb/ivld	kg/ivld	Outflow of dissolved nutrients through individual exits; Subscript 1 selects exit, Subscript 2: same as NUCF1
OSNH4	5	3	-	lb/ivld	kg/ivld	Outflows of particulate NH4; Subscript 1 selects exit, Subscript 2: 1=sand, 2=silt, 3=clay
OSPO4	5	3	-	lb/ivld	kg/ivld	Outflows of particulate PO4-P; Subscript values same as OSNH4

Input time series required to compute the above:

Group INFLOW

INO3, ITAM, INO2,
IPO4, ISNH4, ISPO4

all optional

Group EXTNL

NUADFX

only required if dry or total
atmospheric deposition is being
simulated

NUADCN
PREC

only required if wet atmospheric
deposition is being simulated

Group HYDR

SAREA

only required if atmospheric
deposition is being simulated

Catalog for RCHRES Module

Group HTRCH TW	only required if section HTRCH is inactive
Group SEDTRN RSED, SSED, OSED, ROSED, DEPSCR	only required if Section SEDTRN is inactive and if particulate NH4 or PO4 is simulated

NOTE: Ammonia, nitrite and ortho-phosphate may, or may not, be simulated, depending on the values the user assigns to TAMFG, NO2FG and PO4FG. If a constituent is not simulated, those time series associated with it in this list should be ignored.

4.7(3).8.3 Group PLANK

```

-----
<---- Member ----> K      Units
                   Max subscr i    (external)      Description/comment
Name              values  n
                   1    2    d  Engl      Metr
-----

```

Time series computed by module section PLANK:

PKST3 7 1 * mg/l mg/l A group of state variables

In the above, the first subscript selects the state variable:

1 for dead refractory organic N (ORN)

2 for dead refractory organic P (ORP)

3 for dead refractory organic C (ORC)

4 for total organic N (TORN)

5 for total organic P (TORP)

6 for total organic C (TORC)

7 for potential BOD (POTBOD)

PHYTO 1 1 * mg/l mg/l Phytoplankton concentration

ZOO 1 1 * organism/l organism/l Zooplankton population

BENAL 1 1 * mg/m2 mg/m2 Benthic algae

PHYCLA 1 1 * ug/l ug/l Phytoplankton as chlorophyll a

BALCLA 1 1 * ug/m2 ug/m2 Benthic algae as chlorophyll a

PLADDR 3 1 - lb/ivld kg/ivld Dry or total atmospheric deposition
of organics

PLADWT 3 1 - lb/ivld kg/ivld Wet atmospheric deposition of
organics

In the above, the first subscript selects the constituent:

1 for ORN, 2 for ORP, 3 for ORC

PKCF1 5 1 - lb/ivld kg/ivld Total outflows from the RCHRES

In the above, the first subscript selects the constituent:

1 for phytoplankton, 2 for zooplankton, 3 for ORN, 4 for ORP, 5 for ORC

PKCF2 NEXITS 5 - lb/ivld kg/ivld Outflows through individual exits

In the above, the first subscript selects the exit, the second selects the
constituent -- same code as for PKCF1.

Input time series required to compute the above:

Group INFLOW

IPHYTO, IZOO, IORN,

all are optional

IORP, IORC

Catalog for RCHRES Module

Group EXTNL		
SOLRAD		required
PLADFX		only required if dry or total atmospheric deposition is being simulated
PLADCN		only required if wet atmospheric deposition is being simulated
PREC		
Group HYDR		
SAREA		only required if atmospheric deposition is being simulated
Group HTRCH		
TW		only required if section HTRCH is inactive
Group SEDTRN		
SSED(2)		only required if section SEDTRN is inactive
SSED(3)		

NOTE: Phytoplankton, zooplankton and benthic algae may, or may not, be simulated, depending on the values the user assigns to PHYFG, ZOFG and BALFG. If a constituent is not simulated, those time series associated with it in this list should be ignored.

4.7(3).8.4 Group PHCARB

<-----	Member	----->	K	Units	
	Max subscr		i	(external)	Description/comment
Name	values		n		
	1	2	d	Engl	Metr

Time series computed by module section PHCARB:

PHST 3 1 * see below State variables

In the above, the first subscript selects the state variable:

1 for total inorganic carbon (TIC) -- units mg/l

2 for carbon dioxide (CO2) -- units mg/l

3 for pH

PHCF1 2 1 - lb/ivld kg/ivld Total outflows of TIC and CO2
In the above, the first subscript selects the constituent:
1 for TIC, 2 for CO2

PHCF2 NEXITS 2 - lb/ivld kg/ivld Outflows of TIC and CO2 through individual exits

In the above, the first subscript selects the exit and the second the constituent -- same code as for PHCF1

Input time series required to compute the above:

Group INFLOW

ITIC	optional
IC02	optional

Group CONS

group CONS	only required if section CONS is inactive
CON(ALKCON)	concentration units must be mg/l as CaCO3

Group HTRCH

TW is inactive

4.7(3).10 Groups INFLOW, ROFLOW and OFLOW

The members in these groups represent the total inflow, total outflow and outflow through individual RCHRES exits of every simulated constituent. These groups were included in the catalog to make it easier for users to specify the linkages representing time series passed from one RCHRES to another. For example, assume the RCHRES's in a run have sections HYDR, HTRCH and OXRX active, and the NETWORK Block contains:

```
*****
NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name>    #      <Name> # #<-factor->strg <Name>    #    #      <Name> # # ***

RCHRES    1 ROFLOW                                RCHRES    2      INFLOW
RCHRES    2 OFLOW                                RCHRES    3      INFLOW
*****
```

These entries mean that the entire outflow from RCHRES 1 goes to RCHRES 2, and that the outflow through exit 2 of RCHRES 2 goes to RCHRES 3. Because the "member name" fields have been left blank, HSPF will automatically expand the above entries, generating an entry for each member which is active in this run. In this case, there will be 4 generated entries because 4 constituents are being simulated (water, heat, DO and BOD). The second set of generated entries would be:

```
*****
NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name>    #      <Name> # #<-factor->strg <Name>    #    #      <Name> # # ***

RCHRES    2 OFLOW  OVOL    2 1      1.0      RCHRES    3      INFLOW  IVOL    1 1
RCHRES    2 OFLOW  OHEAT   2 1      1.0      RCHRES    3      INFLOW  IHEAT   1 1
RCHRES    2 OFLOW  OXCF2   2 1      1.0      RCHRES    3      INFLOW  OXIF    1 1
RCHRES    2 OFLOW  OXCF2   2 2      1.0      RCHRES    3      INFLOW  OXIF    2 1
*****
```

Thus, the user can specify the linkage between two RCHRES's with a single entry, instead of having to supply an entry for every constituent passed between them.

4.7(3).10.1 GROUP INFLOW

The members in this group represent the inflows to a RCHRES. Note that each member listed below is "available" for use only if the module section to which it belongs is active.

Name	<---- Member ---->		K i n d	Units (external)		Module section	Constituent
	Max subscr			Engl	Metr		
	values 1	2					

IVOL	1	1	-	ac.ft/ ivld	Mm3/ ivld	HYDR	Water (Note: Mm3=10**6 m3)
CIVOL	CAT	1	-	ac.ft/ ivld	Mm3/ ivld	HYDR	Water, by Category (Note: CAT=Category tag)
ICON	NCONS	1	-	qty/ ivld	qty/ ivld	CONS	Conservatives
IHEAT	1	1	-	BTU/ ivld	kcal/ ivld	HTRCH	Heat (relative to freezing)
ISED	3	1	-	ton/ ivld	tonne/ ivld	SEDTRN	Sand, silt, and clay
IDQAL	NGQUAL	1	-	qty/ ivld	qty/ ivld	GQUAL	Dissolved general quality constituents
ISQAL	3	NGQUAL	-	qty/ ivld	qty/ ivld	GQUAL	General quality const- ituent associated with: 1 Sand, 2 Silt, 3 Clay
OXIF	2	1	-	lb/ivld	kg/ivld	OXRX	1=DO, 2=BOD
NUIF1	4	1	-	lb/ ivld	kg/ ivld	NUTRX	1=NO3, 2=TAM, 3=NO2, 4=PO4
NUIF2	3	2	-	lb/ ivld	kg/ ivld	NUTRX	1=particulate NH4, 2=particulate PO4 on 1=sand, 2=silt, 3=clay
PKIF	5	1	-	lb/ ivld	kg/ ivld	PLANK	1=Phyto, 2=Zoo, 3=ORN, 4=ORP, 5=ORC
PHIF	2	1	-	lb/ivld	kg/ivld	PHCARB	1=TIC, 2=CO2

4.7(3).10.2 Group ROFLOW

The members in this group represent the total outflow from a RCHRES. Note that a member is "available" for use only if the module section to which it belongs is active.

<----- Member ----->			K	Units		Module section	Constituent
Max subscr			i	(external)			
values			n				
1	2		d	Engl	Metr		

ROVOL	1	1					Water
CROVOL	CAT	1					Water, by category (CAT=Category ID tag)
ROCON	NCONS	1					Conservatives
ROHEAT	1	1					Heat
ROSED	3	1					Sand, silt, and clay
RODQAL	NGQUAL	1		See data for corresponding member in group			Dissolved general qual.
ROSQAL	3	NGQUAL		INFLOW			Sediment-associated qual.
OXCF1	2	1					DO, BOD
NUCF1	4	1					NO3, TAM, NO2, PO4
NUCF2	3	2					Particulate NH4 and PO4 (sand, silt, clay)
PKCF1	5	1					Phyto, Zoo, ORN, ORP, ORC
PHCF1	2	1					TIC, CO2

4.7(3).10.3 Group OFLOW

The members in this group represent the outflows through the individual exits of a RCHRES. Note that a member is available for use only if the module section to which it belongs is active. Also, these time series are available for use only if the number of exit gates (NEXITS) is greater than 1.

For each member, the RCHRES exit is selected by the value given to the first subscript.

<---- Member ---->		K	Units		Constituent
Max subscr		i	(external)		
Name	values	n	Module		
	1 2	d	Engl	Metr	

OVOL	NEXITS	1			Water
CROVOL	NEXITS	CAT			Water, by category (CAT=Category ID tag)
OCON	NEXITS	NCONS			Conservatives
OHEAT	NEXITS	1			Heat
OSD	NEXITS	3			Sand, silt, and clay
ODQAL	NEXITS	NGQUAL		See data for corresponding member in group INFLOW	Dissolved general qual.
OSQAL	NEXITS	NGQ3			Sediment-associated qual.
OXCF2	NEXITS	2			DO, BOD
NUCF9	NEXITS	4			NO3, NH3, NO2, PO4
OSNH4	NEXITS	3			Particulate NH4 (sand, silt, clay)
OSPO4	NEXITS	3			Particulate PO4 (sand, silt, clay)
PKCF2	NEXITS	5			Phyto, Zoo, ORN, ORP, ORC
PHCF2	NEXITS	2			TIC, CO2

4.7(11) Catalog for COPY module

The members contained within each group are documented in the tables which follow.

4.7(11).1 Group INPUT

<----- Member ----->					
Max subscr		i	Units		Description/comment
Name	values	n	(external)		
	1	2	d	Engl	Metr

Time series input to module COPY:					
POINT	NPT	1	*	anything	Point-valued input time series
MEAN	NMN	1	-	anything	Mean-valued input time series

4.7(11).2 Group OUTPUT

<---- Member ---->						K	Units		Description/comment
Max subscr						i	(external)		
Name	values		n						
	1	2	d	Engl	Metr				

Time series output by module COPY:									
POINT	NPT	1	*	anything	Point-valued output time series				
MEAN	NMN	1	-	anything	Mean-valued output time series				

Input time series required to produce the above:

Group INPUT

POINT	required if NPT> 0
MEAN	required if NMN> 0

4.7(12) Catalog for PLTGEN module

There is only one time series group associated with this module; group INPUT, which contains all point-valued and/or mean-valued members that are to be plotted. This module does not have an output group because all its output goes to the "plot file", which is documented in Section 4.4(12) of Part E.

4.7(12).1 Group INPUT

```

-----
<---- Member ----> K      Units
      Max subscr  i      (external)      Description/comment
Name      values  n
      1      2      d  Engl      Metr
-----

```

Time series input to module PLTGEN:

```

POINT      NPT      1      *      anything      Point-valued input time series
MEAN       NMN      1      -      anything      Mean-valued input time series
-----

```

4.7(13) Catalog for DISPLY module

There is only one time series group (INPUT) with one member (TIMSER) associated with this module since the module displays only one time series at a time. This module does not have an output group because all its output goes to the "display file" (printed).

4.7(13).1 Group INPUT

<---- Member ---->		K	Units		
	Max subscr	i	(external)		
Name	values	n	Description/comment		
	1 2	d	Engl	Metr	

Time series input to module DISPLY:					
TIMSER	1 1	-	anything	A mean-valued input time series	

4.7(14) Catalog for DURANL module

There is only one time series group (INPUT) with one member (TIMSER) associated with this module since the module analyzes only one time series at a time. This module does not have an output group because all its output is printed. The format is documented in Section 4.2(14) of Part E.

4.7(14).1 Group INPUT

```

-----
<---- Member ----> K      Units
      Max subscr i      (external)      Description/comment
Name      values  n
      1      2      d  Engr      Metr
-----

```

Time series input to module DURANL:

```

TIMSER      1      1      -      anything      A mean-valued input time series
-----

```

4.7(15) Catalog for GENER module

This module has both input and output groups, like module COPY.

The members contained within each group are documented in the tables which follow.

4.7(15).1 Group INPUT

<---- Member ---->					
	Max	subscr	i	Units	
				(external)	Description/comment
Name	values	n			
	1	2	d	Engl	Metr

Time series input to module GENER:					
ONE	1	1	-	anything	First input time series
TWO	1	1	-	anything	Second input time series

4.7(15).2 Group OUTPUT

<---- Member ---->					
	Max	subscr	i	Units	
				(external)	Description/comment
Name	values	n			
	1	2	d	Engl	Metr

Time series output by module GENER:					
TIMSER	1	1	-	anything	Output time series (mean-valued)
Input time series required to produce the above:					
Group INPUT					
ONE					Always required, unless OPCODE=24.
TWO					Only required if generation option needs two inputs.

4.7(16) Catalog for MUTSIN module

The members contained within each group are documented in the tables which follow.

4.7(16).1 Group OUTPUT

```

-----
<---- Member ----> K      Units
      Max subscr  i      (external)      Description/comment
Name      values  n
      1      2      d  Engl      Metr
-----

```

Time series output by module MUTSIN

```

POINT      NPT      1      *      anything      Point-valued output time series
MEAN        NMN      1      -      anything      Mean-valued output time series
-----

```

4.8 FORMATS Block

```
*****
      1          2          3          4          5          6          7          8
1234567890123456789012345678901234567890123456789012345678901234567890
*****
Layout
*****
```

```
FORMATS
***
<ft><----- obj-fmt ----->
.
*** line immed above repeats until all formats have been covered
.
.
END FORMATS
```

```
*****
```

Details

Symbol	FORTTRAN Name(s)	Format	Comment
<ft>	FMTCOD	I4	Identifying number which corresponds to format number in EXT SOURCES or TARGETS Blocks.
<obj-fmt>	FORM(19)	19A4	Standard FORTRAN object-time format.

Explanation

This block is only required if a user wishes to override the default format for reading data on a sequential file (see Section 4.9).

4.9 Sequential and PLTGEN/MUTSIN File Formats

Two types of ASCII file formats are available for transfer of data into/out of HSPF. "Sequential" files allow transfer into HSPF, and PLTGEN/MUTSIN files allow transfer into and out of HSPF. These file formats are documented below:

4.9.1 Format class HYDFIV - Sequential

It is used for the input of 5-minute data. The sequence of information is:

1. Alpha-numeric station number or identifier (this field is not read)
2. Last two digits of calendar year
3. Month
4. Day
5. Card number 1 is for midnight to 3 am.
2 is for 3 am to 6 am.
3 is for 6 am to 9 am.
4 is for 9 am to noon.
5 is for noon to 3 pm.
6 is for 3 pm to 6 pm.
7 is for 6 pm to 9 pm.
8 is for 9 pm to midnight.
6. 36 fields for 5-minute data.

The default format is: (1X,3I2,I1,36F2.0)

4.9.2 Format class HYDFIF - Sequential

It is used for the input of 15-minute data. The sequence of information is:

1. Alpha-numeric station number or identifier (this field is not read).
2. Last two digits of the calendar year
3. Month
4. Day
5. Card number (same as for HYDFIV above)
6. 12 fields for 15-minute data

The default format is: (1X,3I2,I1,12F6.0)

4.9.3 Format class HYDHR - Sequential

It is used for input of hourly observations. The sequence of information is:

1. Alpha-numeric station number or identifier. (This field is not read)
2. Last two digits of calendar year
3. Month
4. Day
5. Card no: 1 is for a.m. hours
 2 is for p.m. hours
6. Twelve fields for hourly data

The default format is: (10X,I2,1X,I2,1X,I2,1X,I1,12F5.0)

4.9.4 Format class HYDDAY - Sequential

It is used for input of daily observations. The sequence of information is:

1. Alpha-numeric station number or identifier. (This field is not read)
2. Last two digits of calendar year
3. Month
4. Card no: 1 is for days 1-10
 2 is for days 11-20
 3 is for days 21-
5. Ten fields, for the daily data (11 fields for card number 3)

The default format is: (7X,2I2,I1,11F6.0)

4.9.5 Format class HYDSMN - Sequential

It is used for input of semi-monthly observations.
The sequence of information is:

1. Alpha-numeric station number or identifier. (This field is not read)
2. Last two digits of calendar year
3. Card no: 1 for January through June
 2 for July through December
4. Twelve semi-monthly fields

The default format is: (7X,I2,I1,12F5.0)

Semi-monthly values are distributed to daily values with a transformation function of SAME.

4.9.6 Format class HYDMON - Sequential

It is used for input of monthly observations. The sequence of information is:

1. Alpha-numeric station number or identifier. (This field is not read)
2. Last two digits of calendar year
3. Twelve monthly fields

The default format is: (6X,I2,12F6.0)

Monthly values are distributed to daily values with a transformation function of SAME.

Note that the user can override the above default formats with his own format, supplied in the FORMATS BLOCK. However, the sequence of information within each record cannot be altered.

4.9.7 PLTGEN/MUTSIN File Format

Time series data can be transferred to or from ASCII files having the PLTGEN/MUTSIN format, i.e., the format of files created by the PLTGEN module and readable by the MUTSIN module. This file contains a header, which is 25 lines for PLTGEN and at least one line for MUTSIN. Each line of data contains a date-time and between one and ten data values (curves). The sequence of information for each data line is as follows:

1. Identifier (four characters)
 2. Year
 3. Month
 4. Day
 5. Hour
 6. Minute
 7. Value for curve 1, for this date/time
 8. Value for curve 2, for this date/time
- etc (repeats until data for all curves are supplied)

Format: A4,1X,I5,4I3,10(2X,G12.5)

4.10 SPEC-ACTIONS Block

```
*****
      1         2         3         4         5         6         7         8
1234567890123456789012345678901234567890123456789012345678901234567890
*****
Layout
*****
```

SPEC-ACTIONS

Action line:

```

                                <addrss>-----  ----<uvqn>
      dc ds                                d t      or                                or      tc ts num
<oper><f><-l><>< ><yr><m><d><h><m><><>  <vari><1><2><3><a><-value--> <> < >< >
```

Distribute line:

```

      ds  ct tc ts
<kwrd>< > < > <> < > <dff>  <frc><frc><frc><frc><frc><frc><frc><frc><frc><frc>
```

User-defined/multiple variable line:

```

      cnt                                act                                act
<kwrd>  <unam>< > <vari><1><2><3> <frc> < >      <vari><1><2><3> <frc> < >
      or
      <addrss>-----
```

User-defined variable quantity line:

```

                                lc ls ac as agfn
<kwrd> <uqnm> <oper> <#> <vari><1><2><3><t><multfact> <>< > <>< > < >
      or
      <addrss>-----
```

Condition line (free format):

```

IF ( ( <quan> <comp> <quan> ) <logop> ( <quan> <comp> <quan> ) ) THEN
...
ELSE IF ( <quan> <comp> <quan> ) THEN
...
ELSE
...
END IF
```

```

. . . . .
(repeats until all special actions have been specified)
. . . . .
```

END SPEC-ACTIONS

Example

SPEC-ACTIONS

*** Distributions

```
*** kwd  ds  ct  tc  ts    dff      f1    f2    f3    f4    f5    f6    f7    f8    f9    f10
    <****>< > < > < > < > <----> <----><----><----><----><----><----><----><---->
    DISTRB  1    3  DY    7  ACCUM    0.25  0.5  0.25
```

*** User-Defined Target Variable Names

```
***          addr                      addr
***          <----->                <----->
*** kwd    varnam ct  vari  s1 s2 s3  frac oper    vari  s1 s2 s3  frac oper
    <****>  <-----><-> <-----><-><-><-> <----> <-->  <-----><-><-><-> <----> <-->
    UVNAME  MANURE   3  SAMSU                      0.7  QUAN  SNO3                      0.2  QUAN
                      SORGN                      0.3  QUAN
```

*** User-Defined Variable Quantity Lines

```
***          addr
***          <----->
*** kwd    varnam optyp  opn  vari  s1 s2 s3  tp multiply  lc ls ac as agfn ***
    <****>  <-----> <-----> <-> <-----><-><-><-><-><-----> <-><-> <-><-> <--> ***
    UVQUAN  puncom  RCHRES    2  CVOL   tx          4
```

*** Action Lines

```
***          addr                      uvquan
***          <----->                <----->
***optyp range dc ds yr  mo da hr mn d t  vari  s1 s2 s3 ac  value      tc ts num
    <****><-><--><>< ><--><-><-><-><-><-><-> <-----><-><-><-> <-----> <-> <-> <->
    PERLND  1    DY  11991/03/15 16:00 1 3  MANURE                      +=      10.0 YR   1  5
IF (puncom > 10000) THEN
    RCHRES  2                      4  CVOL   pw                      +=      puncom
END IF
END SPEC-ACTIONS
```

Explanation

In the SPEC-ACTIONS block, the user can change the values of program variables at specified dates and times. This permits one to model such things as: 1) human intervention, i.e., plowing or application of fertilizer and pesticide; 2) changes to parameters in ways not possible with the standard inputs; and 3) conditional actions, i.e., those that are dependent on the value of another program variable.

Special Actions can be performed on variables in the PERLND, IMPLND, RCHRES, COPY, PLTGEN, and GENER modules. The user's input is contained in the SPEC-ACTIONS block of the UCI file. It is specified in the five different types of lines shown above and described fully in the following sections. Output is printed in the Run Interpreter Output (echo) file, and consists of two types: 1) a listing of all Special Actions as interpreted by the program, and 2) a summary of each Special Action (value of affected variable before and after the action) as it is implemented during the run.

Details of Action line (including REPEAT function)

Symbol	Fortran name(s)	Format	Comment																																																
<hr/>																																																			
<oper>	OPTYP	A6	operation type - valid values are PERLND, IMPLND, RCHRES, or PLTGEN																																																
<f>	TOPFST	I3	first operation to act upon																																																
<-l>	TOPLST	I4	last operation to act upon, 0 or blank means use first operation only																																																
dc	CTCODE(1)	A2	code specifying time units of deferral of action when an applicable logic condition fails - (MI,HR,DY,MO,YR)																																																
ds	TSTEP(1)	I3	number of CTCODE(1) intervals to defer the action																																																
<yr>	DATIM(1)	I4	year (see starting date field in GLOBAL block for more information) if the date is left blank, then the action is performed every interval of the run																																																
<m>	DATIM(2)	1X,I2	month																																																
<d>	DATIM(3)	1X,I2	day																																																
<h>	DATIM(4)	1X,I2	hour																																																
<m>	DATIM(5)	1X,I2	minute																																																
d	DSIND	I2	ID number of "DISTRB" line, blank if none																																																
t	TYPCOD	I2	2-INTEGGER, 3-REAL, 4-DOUBLE PRECISION																																																
<vari>	VNAME	A6	variable to act upon, left-justified																																																
<1><2><3>	CSUB(1-3)	3A3	subscripts for VNAME, blank if none may be 2-character CATEGORY tag if applicable must be integer otherwise																																																
<addrss>	ADDR	I8	memory location (in the OSV) of variable (optional method to specify variable)																																																
<a>	ACTCOD	A3	action code: id number (#) or character (ch). T= target variable, A= action value: <table><tr><th>#</th><th>ch</th><th>effect</th><th>#</th><th>ch</th><th>effect</th></tr><tr><td>1</td><td>=</td><td>T= A</td><td>2</td><td>+=</td><td>T= T+ A</td></tr><tr><td>3</td><td>-=</td><td>T= T- A</td><td>4</td><td>*=</td><td>T= T*A</td></tr><tr><td>5</td><td>/=</td><td>T= T/A</td><td>6</td><td>MIN</td><td>T= Min(T,A)</td></tr><tr><td>7</td><td>MAX</td><td>T= Max(T,A)</td><td>8</td><td>ABS</td><td>T= Abs(A)</td></tr><tr><td>9</td><td>INT</td><td>T= Int(A)</td><td>10</td><td>^=</td><td>T= T^A</td></tr><tr><td>11</td><td>LN</td><td>T= Ln(A)</td><td>12</td><td>LOG</td><td>T= Log10(A)</td></tr><tr><td>13</td><td>MOD</td><td>T= Mod(T,A)</td><td></td><td></td><td></td></tr></table>	#	ch	effect	#	ch	effect	1	=	T= A	2	+=	T= T+ A	3	-=	T= T- A	4	*=	T= T*A	5	/=	T= T/A	6	MIN	T= Min(T,A)	7	MAX	T= Max(T,A)	8	ABS	T= Abs(A)	9	INT	T= Int(A)	10	^=	T= T^A	11	LN	T= Ln(A)	12	LOG	T= Log10(A)	13	MOD	T= Mod(T,A)			
#	ch	effect	#	ch	effect																																														
1	=	T= A	2	+=	T= T+ A																																														
3	-=	T= T- A	4	*=	T= T*A																																														
5	/=	T= T/A	6	MIN	T= Min(T,A)																																														
7	MAX	T= Max(T,A)	8	ABS	T= Abs(A)																																														
9	INT	T= Int(A)	10	^=	T= T^A																																														
11	LN	T= Ln(A)	12	LOG	T= Log10(A)																																														
13	MOD	T= Mod(T,A)																																																	
<value>	RVAL or IVAL	F10.0 I10	"value" of the action to be taken - see notes below																																																
<uvqn>	UVQNAM	A6	name of User-defined variable quantity containing the "value" of the action																																																
tc	CTCODE(2)	A2	code specifying time units of "repeat" action - (MI,HR,DY,MO,YR)																																																
ts	TSTEP(2)	I3	number of CTCODE(2) intervals to skip before repeating the action																																																
num	NUMINC	I3	number of times to repeat action																																																

Details of Distribution line

Symbol	Fortran name(s)	Format	Comment
<kwrd>	-	A6	keyword (DISTRB) - specifies current line as a "Distribution" line
ds	DSIND	I3	index number - corresponds to the value specified on the standard line
ct	CNT	I3	number of separate actions or applications to divide the total application into
tc	CTCODE	A2	code specifying time units of the interval between separate applications or actions - (valid values: MI,HR,DY,MO,YR)
ts	TSTEP	I3	number of CTCODE intervals between separate applications (see CTCODE below)
<dff>	CDEFFG	A5	deferral flag - indicates how to treat deferral of the action(s) under a conditional situation - (valid values: SKIP, SHIFT, ACCUM; default = SKIP)
<frc>	FRACT(CNT)	10F5	fractions for each of the separate applications

Details of User-defined Variable Name line

Symbol	Fortran name(s)	Format	Comment
<kwrd>	-	A6	keyword (UVNAME) - specifies current line as a "User-defined variable name" line
<unam>	UNAME	A6	user-defined variable name
cnt	CNT	I3	number of actual variables included in aggregate group
Following inputs repeat CNT times (continuation lines if CNT>2)			
<vari>	VNAME	A6	actual variable name
<1><2><3>	CSUB(1-3)	3A3	subscripts for VNAME, blank if none may be 2-character CATEGORY tag if applicable must be integer otherwise
<addrss>	ADDR	I4	address of actual variable
<frc>	FRAC	F5.2	fraction of total application allocated to each of the actual variables
act	ACTCD	A4	action code - QUAN, MOV1, MOV2 (see notes on UVNAME action code options)

Details of User-defined Variable Quantity line

Symbol	Fortran name(s)	Format	Comment
<kwrd>	-	A6	keyword (UVQVAN) - specifies current line as a "User-defined variable quantity" line
<uqnm>	UVQNAM	A6	user-defined variable quantity name
<oper>	OPTYP	A6	operation type of base variable
<#>	OPTNO	I3	operation type number of variable
<vari>	VNAME	A6	actual variable name of variable
<1><2><3>	CSUB(1-3)	3A3	subscripts for VNAME, blank if none may be 2-character CATEGORY tag if applicable must be integer otherwise
<addrss>	ADDR	I4	address of actual variable
<t>	TYP COD	I2	2-INTEG ER, 3-REAL, 4-DOUBLE PRECISION
<multfact>	UVQMUL	F10.0	multiplier to apply to base variable
lc	CTCODE(1)	A2	code specifying time units of the period to lag base variable (valid values: MI,HR,DY,MO,YR)
ls	TSTEP(1)	I3	number of CTCODE intervals to lag base variable
ac	CTCODE(2)	A2	code specifying time units of the period to aggregate base variable (valid values: MI,HR,DY,MO,YR)
as	TSTEP(1)	I3	number of CTCODE intervals to aggregate base variable
agfn	CTRAN	A4	transformation function to use for aggregation of base variable (valid values: SUM, AVER, MAX, MIN.)

Details of Free-Format Conditional lines

Symbol	Fortran name(s)	Format	Comment
IF	-	-	Keyword specifying the beginning of a logical condition
<quan>	CITEM	free(10)	May be either a UVQUAN name (format A6) or a numeric value (format up to F10.0)
<comp>	CCODE	free(2)	Numerical comparison operator. Valid values are: = equal /= not equal > greater than >= greater than or equal > less than >= less than or equal
<logop>	CLOGOP	free(3)	Logical operator: AND or OR
THEN	-	-	Keyword specifying the end of a logical condition
ELSE	-	-	Keyword specifying that following special actions are an alternative to previous IFs and ELSE IFs
ELSE IF	-	-	Keyword specifying that following special actions are an alternative to previous IFs and ELSE IFs, provided that the additional condition is also satisfied. Exactly one space must occur between the two words.
END IF	-	-	Keyword specifying the end of a logical block. Exactly one space must occur between the two words.

*** free(N) denotes that the field may be any length up to N characters, and may appear in any column, subject to a maximum line length of 80 characters.

Notes:

The <value> field contains quantitative data for the action to be taken. If the variable or array element to be acted on is an integer (TYPCOD=2) <value> is read as an integer (IVAL); If it is REAL or DOUBLE PRECISION (TYPCOD=3 or 4), <value> is read as a real number (RVAL). Note that the value must be given in the units used internally for the quantity concerned, because no conversion is performed when it is read in. You can find the internal units by looking up the quantity in the Operations Status Vector (for the module concerned), contained in the Programmer's Supplement. For example:

1. Pesticide storage (module PERLND) has units of lb/ac (English) and kg/ha (Metric); the same units are used internally and externally.
2. Sediment storage (module PERLND) has internal units of tons/acre (in both English and Metric systems) but the external units (English and Metric) are tons/acre and tonnes/ha respectively.

Repeat definition

This feature allows a single Special Action to be repeated at regular intervals. The input that defines the repetition is contained entirely on the standard action line. The date-time specified on the line is the starting date-time. The repetition is specified by: 1) CTCODE(2), which defines the time units of the interval between repetitions, 2) TSTEP(2), which defines the number of CTCODE(2) time steps between repetitions, and 3) NUMINC, which is the number of times to perform the action (for example: if NUMINC is 3, the action will be performed three times, i.e., on the specified date-time and two repetitions).

Distribute definition

This option allows a single Special Action to be split into multiple actions. The primary purpose is to distribute a chemical application over time so that it is not all applied to the land segment at once. The additional information needed to define the distribution is specified on an "associated" line in the Special Actions block. An ID number (DSIND) is included on the standard Special Actions line which points to the associated line. This line contains: 1) the keyword "DISTRB", which identifies the line as a "distribution" definition line, 2) DSIND, the ID number corresponding to the value on the standard line, 3) CNT, the number of separate applications to divide the total application into, 4) CTCODE and TSTEP, which define the time interval between applications (see discussion of REPEAT definition above), and 5) FRACT(CNT), the fraction of the total application represented by each of the separate applications. Note, the total application is given by <value> (or RVAL), which is specified on the standard Special Action line.

User-defined variable (UVNAME)

This option allows the user to define a single name (UVNAME) for one or more standard variables to be used as the target of a Special Action. If a UVNAME is applied to multiple standard variables, then any action line referring to that UVNAME as a target will cause multiple Special Actions to occur. This line contains: 1) a user defined name (UNAME), limited to six characters; 2) the number (count) of standard variables that are included in the set; 3) the variable names; 4) the fractions of the total Special Action quantity that will be applied to each variable; and 5) and an optional action code. (See below.)

UVNAME action code options

- QUAN Specify multiple Special Action variables in one line. Each quantity specified in the UVNAME line is multiplied by the quantity in the corresponding standard line to generate the final quantity applied to each of the variables specified in the UVNAME line. This option is designed primarily to allow a total chemical amount to be applied to multiple soil layers with a single line. This is the default.
- MOVT Redistribute current total quantity contained in multiple variables using predetermined factors. Each quantity specified in the UVNAME line is multiplied by the total quantity obtained by summing the current values of the individual variables specified in the UVNAME line. This option is designed to simulate a plowing operation that completely mixes all material in two or more zones. This would be accomplished by using quantities that are the fractions of soil or depth in the individual layers. (This option does not use the "quantity" or Action Code specified in standard line.)
- MOV1, Redistribute two quantities in following manner: Variable No. 1 is computed
MOV2 by multiplying current value of variable No. 2 by quantity associated with Variable 1 in the UVNAME line. Variable No. 2 is computed by multiplying current value of Variable No. 2 by quantity associated with Variable No. 2 in the UVNAME line plus the current value of Variable No. 1. This option is designed to simulate a plowing operation that transfers the material in the surface zone to the upper zone, and results in the new surface zone having the original concentration of the upper zone. This would be accomplished by using the following two quantities: 1) ratio of amount of soil (or depth) in surface layer to amount in upper layer, and 2) subtract surface layer soil amount from upper layer soil amount and divide the result by the upper layer soil amount. (This option does not use the "quantity" or Action Code specified in standard line.)

User-defined variable quantity (UVQUAN)

This option creates a variable quantity which can be used either as an action value for a Special Action or as a value to be compared in a condition. A UVQUAN refers to a single "base variable" in a single operation. By default, the UVQUAN contains the last-calculated value of that base variable. Optionally, it may contain a lagged value (e.g. 5 hours ago); an aggregated value (e.g. the average over the previous day); or a combination (e.g. the sum over three days ending 24 hours ago). The resulting value can also be multiplied by a constant factor. It is important to note the difference between a UVQUAN and a UVNAME. A UVQUAN is a **value**, just like a constant. A UVNAME is a **target address** for a special action.

Logical conditions

Special Actions may depend on whether a user-specified logical condition is true or false, and can be either skipped or deferred if it is false. They can be grouped into logical blocks by placing IF, ELSE IF, ELSE, and END IF lines appropriately among the action lines. For example, actions placed between an IF line and the next logical delimiter are executed only if the condition specified on the IF line is true on the date and time of the each action.

A simple logical condition is defined as a comparison between two numerical values. Either or both of these values may be UVQUANs. For example:

```
month <= 2
6226.0 <= tstage
tfish < faradj
```

are all simple logical conditions. Complex conditions are built by connecting simple conditions together with the logical operators AND and OR:

```
[month = 10 OR (tstage >= 6226.0 AND {month >= 11 OR month <= 2} )]
```

Parentheses are used to specify the order of evaluation, just as in a programming language. By default, the logical operators are evaluated from right to left, but it is good practice to use them in all cases to ensure clarity. There are three types: round (), square [], and curly {}. They are equivalent, but the program requires that matching left-right pairs must be of the same type, in order to help the user prevent unintended effects in complicated conditions.

IF lines consist of the keyword IF, a logical condition, and the keyword THEN. The IF keyword may appear anywhere on the line, as long as it is the first non-blank. The condition may be simple or complex, and may span multiple physical lines. When an IF line is found, HSPF keeps reading lines until the THEN keyword is found. ELSE IF lines are processed in the same manner. ELSE and END IF are expected to appear alone on a line, and anything after the keyword is ignored. Note that the "ELSE IF" and "END IF" keywords must contain **exactly** one space between the two words.

SPEC- ACTIONS Block

The following example illustrates how HSPF decides whether to perform a special action. Each condition may be simple or complex. Note the effect of nesting IF-END IF blocks. They may be nested up to ten levels deep.

```

*** Condition A
IF month >= 9 THEN
  *** Action 1
    RCHRES130                4  CVOL  pw      +=      TAVLQ
  *** Action 2
    RCHRES130                4  CVOL  tx      -=      TAVLQ

*** Condition B
IF (tstage > 6226.0) THEN
  *** Action 3
    RCHRES100                4  CVOL  tx      +=      PUNCOM

*** Condition C
ELSE IF (tstage > 6225.0) THEN
  *** Action 4
    RCHRES100                4  CVOL  pw      +=      PUNCOM

ELSE
  *** Action5
    RCHRES130                4  CVOL  na      -=      PUNCOM
  *** Action6
    RCHRES130                4  CVOL  ac      +=      PUNCOM
END IF

*** Action7
  RCHRES130                4  CVOL  sp      +=      TAVLQ

*** Condition D
ELSE IF month >= 6 THEN
  *** Action8
    RCHRES130                4  CVOL  tc      +=      TAVLQ

*** Condition E
ELSE IF (tfish <= 0.0) THEN
  *** Action9
    RCHRES130                1991/04/29 12:00  4  CVOL  pw      +=      PUNCOM
  *** Action10
    RCHRES130                1991/05/01 12:00  4  CVOL  tx      -=      PUNCOM

ELSE
  *** Action11
    RCHRES130                4  CVOL  na      -=      TAVLQ
END IF

*** Action12
  RCHRES130                4  CVOL  ac      +=      TAVLQ

```

In this case:

Actions 1, 2, and 7 are performed only if Condition A is true.

Action 3 is performed only if Conditions A and B are both true.

Action 4 is performed only if Conditions A and C are true and Condition B is false.

Actions 5 and 6 are performed only if Condition A is true and Conditions B and C are false.

Action 8 is performed only if Condition A is false and Condition D is true.

Actions 9 and 10 are performed only if Conditions A and D are false and Condition E is true.

Action 11 is performed only if Conditions A, D, and E are false.

Action 12 is always performed.

Evaluation Order

Each IF or ELSE IF line is evaluated a maximum of once per interval, at the time of execution of the first Special Action that depends on it in that interval. The UVQUAN values used for the numerical comparisons are computed from the base variables at the point of evaluation, taking into account Special Actions appearing before the Condition line, but not those after it.

Assume that in the example above, **month** = 10, **tstage** = 6224.5, and **tfish** = 0. HSPF will:

- 1) Fetch the value of **month**.
- 2) Evaluate Condition A as true.
- 3) Perform Action 1, since A is true.
- 4) Perform Action 2, since A is true.
- 5) Fetch the value of **tstage**.
- 6) Evaluate Condition B as false.
- 7) Skip Action 3, since B is false.
- 8) Re-fetch the value of **tstage**.
- 9) Evaluate Condition C as false.
- 10) Skip Action 4, since C is false.
- 11) Perform Actions 5 and 6, since A is true, while B and C are both false.
- 12) Perform Action 7, since A is true.
- 13) Skip Action 8, since A is true. Note that Condition D does not need to be evaluated because the action is skipped regardless of D's value.
- 14) Ignore Actions 9 and 10, since they do not occur on this date.
- 15) Skip Action 11, since A is true. Conditions D and E can be ignored.
- 16) Perform Action 12, which is unconditional.

The use of dated special actions within logical blocks requires caution. For instance, for Actions 9 and 10 above, it is possible that the value of **tfish** changes between April 29 and May 1 such that one of the Actions is performed while the other is not, even though they have the same logical conditions. The user must make sure that this is the intended result.

Another situation requiring care is a Special Action that alters one of the variables which define the logical conditions upon which that Action depends. For instance, if Action 4 above changed the value of the UVQUAN **tstage** to 6224.0 by altering its base variable, then Actions 5 and 6 will still not be executed that interval, since Condition C is not re-evaluated until the following interval.

4.11 MONTH-DATA Block

```

*****
      1          2          3          4          5          6          7          8
1234567890123456789012345678901234567890123456789012345678901234567890
*****
Layout
*****

```

MONTH-DATA

```

      MONTH-DATA      <t>
<val-><val-><val-><val-><val-><val-><val-><val-><val-><val-><val-><val->
      END MONTH-DATA <t>

```

Up to 50 MONTH-DATA tables may appear in the block

END MONTH-DATA

```

*****
Example
*****

```

MONTH-DATA

```

      MONTH-DATA      3
***  atmospheric deposition fluxes (kg/ha/month) of NO3-N
      1.3  1.5  2.0  2.1  2.2  2.2  3.0  2.3  2.0  2.0  1.7  1.4
      END MONTH-DATA  3

```

END MONTH-DATA

```

*****

```

Details

Symbol	FORTTRAN Name(s)	Format	Comment
<t>	NUMBR	I3	Users identifying number for this MONTH-DATA table
<val->	MTHVAL(12)	12F6.0	Monthly values

Explanation

A MONTH-DATA table is used to specify monthly-varying values for parameters that do not have specific input tables for that purpose. Currently, MONTH-DATA tables are implemented for atmospheric deposition inputs. See descriptions for table types PQL-AD-FLAGS, PEST-AD-FLAGS, etc. for further details.

4.12 CATEGORY Block

```
*****
      1          2          3          4          5          6          7          8
1234567890123456789012345678901234567890123456789012345678901234567890
*****
```

Layout

CATEGORY

<cat> <----catnam---->

.

Above line repeats until all categories have been specified

.

END CATEGORY

Example

CATEGORY

tag ***

<> <----catnam----> ***

UN UNCOMMITTED

WP WESTPAC CREDIT

CU CUI-UI CREDIT

CA CALIF CREDIT

TX TAHOE EXCHANGE

END CATEGORY

Details

Symbol	FORTTRAN Name(s)	Start Column	Format	Comment
<cat>	CAT	4	A2	Category tag: a two-character identifier used wherever a subscript is called for. First character must be a letter. Tags are case-sensitive, and must be unique.
<catnam>	CATNAM	7	A16	Category name

Explanation

In this block the user declares and names active water categories.

The CATEGORY block is used to facilitate the modeling of water rights in the HYDR section of RCHRES. Each RCHRES in the run tracks the categories of all inflows, storages, demands, and outflows. Up to 100 categories may be specified. (See the discussion of Water Rights Categories in Part E, Section 4.2(3).1).