

EPA BASINS Technical Note 5

Using HSPEXP with BASINS/NPSM

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Overview of HSPEXP: Function, Purpose and Limitations

The *Expert System for the Calibration of the Hydrological Simulation Program - Fortran* (HSPEXP) was developed by the United States Geological Survey (USGS) to assist watershed modelers with hydrology calibration. The program offers advice to the modeler, suggesting parameter changes that might result in better representation of a river basin. HSPEXP also provides explanations supporting the recommended parameter changes. The less experienced modeler benefits from the expert advice through increased understanding of the hydrologic processes as modeled by HSPF.

The purpose of this document is to assist BASINS/NPSM users who would like to benefit from the calibration advice offered by HSPEXP. BASINS/NPSM users can follow this step-by-step guide to build HSPEXP input from NPSM, run HSPEXP for calibration, and then insert the HSPEXP calibrated parameters back into NPSM.

The expert calibration advice in HSPEXP was provided by two experts in hydrologic modeling, Alan M. Lumb of the USGS and Norman H. Crawford of Hydrocomp, Inc., and compiled by a knowledge engineer, Richard B. McCammon of the USGS. HSPEXP is designed to use data and input files that are based on the HSPF-defined "English" unit system. Note that all examples discussed below, and in the HSPEXP documentation, assume use of English units, consistent with those used by NPSM.

Although HSPEXP is an extremely powerful and useful companion to HSPF and BASINS/NPSM, it does have limitations of which users need to be cognizant. These limitations include:

- a. no advice is available for snow or water quality calibration
- b. no guidance is provided on 'how much' to change a parameter value
- c. parameter guidance and advice is not specific to land segments or land use categories
- d. HSPEXP does not have any 'spatial memory', so that separate applications to two neighboring watersheds can result in very different parameter values **unless** the user imposes consistency based on real-world knowledge of the watersheds.
- e. seasons are fixed - summer is June through August, winter is December through February. This directly affects any seasonal statistics calculated by HSPEXP; users should review the manual (see page 3) for definitions of the error statistics. Seasonal errors tend to be the most difficult to reduce and thus may require larger tolerances.

All users need to keep these limitations in mind in order to derive the most benefit from the capabilities available in HSPEXP. In reality it is more a 'decision-support' system than it is an 'expert' system.

Step 1: Obtain HSPEXP

The primary means of obtaining HSPEXP is from the USGS web site, at <http://water.usgs.gov/software/hspexp.html>. The most recent release of HSPEXP, version 2.3, is dated March 1996. Note that the current HSPEXP release includes HSPF version 11 (i.e. the version called by NPSM); features of HSPF version 12 and beyond will not be supported in HSPEXP until a subsequent release of HSPEXP.

The users manual for HSPEXP is also available for download from the web site specified above. The manual is cited as follows:

Lumb, A.M., McCammon, R.B., and Kittle, J.L., Jr., 1994, Users manual for an expert system (HSPEXP) for calibration of the Hydrologic Simulation Program--Fortran: U.S. Geological Survey Water-Resources Investigations Report 94-4168, 102 p.

Step 2: Extract UCI file from BASINS

Both BASINS 2.0/NPSM and HSPEXP 2.3 are built around HSPF v.11, and both provide an interface for specifying HSPF inputs. At run-time HSPF expects to find these inputs in a flat ASCII file known as the User-Control-Input (UCI) file. For the BASINS/NPSM user, the UCI file is created by NPSM but does not contain all of the information HSPEXP expects to find. Thus the user must enhance the NPSM UCI file for use with HSPEXP.

When run, NPSM creates the UCI file, and stores it in the BASINS\MODELOUT\

Step 3: Set up WDM File for HSPEXP

BASINS/NPSM uses a binary direct-access file known as the Watershed Data Management (WDM) file for meteorologic data input to HSPF. HSPEXP will also access a WDM file for writing output time series data. The WDM file must be modified so that it is prepared to accept this output data.

The WDM file used in NPSM resides in the BASINS/Data/met_data folder. Since modifications

will be necessary, it is suggested that you copy this file to a new file name, such as <proj_new>.wdm. Be sure that the user has write access to this WDM file. The WDM file will be modified in steps 4 and 5.

Step 4: Add Observed Flow Data to WDM File

The HSPEXP user must select the number of sites at which to calibrate HSPF. At least one site is required for using HSPEXP, and often it is advisable to calibrate at multiple sites where observed data are available. While HSPEXP allows the user to calibrate at multiple points in the same watershed, it may be preferable to calibrate only against pour points of subwatersheds defined in the BASINS GIS. Using BASINS-defined subwatershed pour/calibration points permits the user to later present comparison plots (modeled vs. monitored) in the NPSM PostProcessor. Observed flow data must be imported wherever a HSPEXP calibration site is desired.

The observed flow data can be downloaded from the USGS as described in the BASINS User's Manual Version 2.0 Section 10.14, and imported to the WDM file using the WDM file maintenance tool, WDMUtil (available from the BASINS Web site). Record the WDM data set numbers into which the data have been imported as well as the drainage areas for each calibration site for use in step 6. Note that the period of record for the observed flow data must include the simulation period if HSPEXP is to use these data for calibration.

Step 5: Add data sets to WDM file for output

HSPEXP expects output data sets to exist in the user's WDM file. For each calibration site eight output data sets must be created, representing simulated total runoff, simulated surface runoff, simulated interflow, simulated base flow, potential evapotranspiration, actual evapotranspiration, upper zone storage, and lower zone storage.

Create the necessary data sets by creating and importing 'dummy' data sets from flat files using WDMUtil. A simple text file with two lines can be created using a text editor. The first line should include the start date of the calibration period and a value, such as '01/01/1990 1', and the second line should include the end date of the calibration period and a value, such as '12/31/1994 1'. With the WDM file open in WDMUtil, the user could open this text file and import the data sets, specifying a time step of '1', time units of 'day', '0' header lines, and the starting and ending dates of the run. The proper format would have to be entered, such as 'm2,1x,d2,1x,y4,v5' for this example. For the 'constituent' field enter the four-character time series type from the chart below. The 'Write to WDM' option should then be used to write these time series data sets to the WDM file. The user would have to repeat this process for each of the eight time series data sets for each calibration site, selecting and recording the data set numbers for step 6.

Constituent	Time Series Type
Simulated total runoff	SIMQ
Simulated surface runoff	SURO
Simulated interflow	IFWO
Simulated base flow	AGWO
Potential evapotranspiration	PETX
Actual evapotranspiration	SAET
Upper zone storage	UZSX
Lower zone storage	LZSX

Another alternative is to create the eight output data sets with the program ANNIE, as described in the HSPEXP documentation. (The ANNIE software can be obtained from the same USGS Web site as HSPEXP). The time step should be set to '1', with the time units set to 'day'. The time series type (TSTYPE attribute) should be entered according to the chart above.

Step 6: Modify the UCI file

Several changes will have to be made to the UCI file extracted from BASINS/NPSM in Step 2. Each block of the UCI file requiring modification will be discussed sequentially, with 'before' and 'after' examples. These modifications should be made using a text editor and the file saved as a text file (without any hidden control characters).

FILES Block:

The WDM line of the FILES block will have to be modified to reflect the path and name of the new WDM file.

(Original)

```

FILES
<type>    <un#>    <file name>***
WDM1      15      c:\BASINS\data\met_data\original.wdm
MESSU     16      c:\BASINS\models\NPSM\npsm.mes
          30      c:\BASINS\modelout\sample\proj\P0_ALL_P.000
          31      c:\BASINS\modelout\sample\proj\I0_ALL_I.000
          32      c:\BASINS\modelout\sample\Reaches\R0_PROJ.052
          33      c:\BASINS\modelout\sample\Reaches\R0_PROJ.053
          34      c:\BASINS\models\NPSM\00000000.MUT
          35      c:\BASINS\models\NPSM\00000001.MUT
          36      c:\BASINS\models\NPSM\00000002.MUT
          41      c:\BASINS\modelout\sample\Hspf1.smr
END FILES

```

(Modified)

```
FILES
<type>   <un#>   <file name>***
WDM1      15      c:\BASINS\data\met_data\new.wdm
MESSU     16      c:\BASINS\models\NPSM\npsm.mes
          30      c:\BASINS\modelout\sample\proj\P0_ALL_P.000
          31      c:\BASINS\modelout\sample\proj\I0_ALL_I.000
          32      c:\BASINS\modelout\sample\Reaches\R0_PROJ.052
          33      c:\BASINS\modelout\sample\Reaches\R0_PROJ.053
          34      c:\BASINS\models\NPSM\00000000.MUT
          35      c:\BASINS\models\NPSM\00000001.MUT
          36      c:\BASINS\models\NPSM\00000002.MUT
          41      c:\BASINS\modelout\sample\Hspf1.smr
END FILES
```

OPN SEQUENCE Block:

A COPY operation needs to be added to the OPN SEQUENCE block for each calibration site. Note that some COPY operations likely exist before modification. Assign new numbers to the new COPY operations (i.e. use different numbers than the existing COPY operations). Be sure to add the new COPY operations **after** all of the PERLND, IMPLND, and RCHRES operations.

(Original)

```
OPN SEQUENCE
  INGRP                INDELT 01:00
    PERLND              1
    PERLND              2
    PERLND              3
    PERLND              4
    IMPLND              1
    IMPLND              2
    IMPLND              3
    MUTSIN              1
    MUTSIN              2
    MUTSIN              3
    RCHRES              4
    RCHRES              6
    RCHRES              5
    RCHRES              3
    RCHRES              2
    RCHRES              1
    COPY                1
    COPY                2
    COPY                3
    COPY                4
    PLTGEN              1
    PLTGEN              2
    PLTGEN              3
    PLTGEN              4
  END INGRP
END OPN SEQUENCE
```

(Modified [example for one calibration site])

```
OPN SEQUENCE
  INGRP                INDELT 01:00
    PERLND              1
```

PERLND	2
PERLND	3
PERLND	4
IMPLND	1
IMPLND	2
IMPLND	3
MUTSIN	1
MUTSIN	2
MUTSIN	3
RCHRES	4
RCHRES	6
RCHRES	5
RCHRES	3
RCHRES	2
RCHRES	1
COPY	1
COPY	2
COPY	3
COPY	4
PLTGEN	1
PLTGEN	2
PLTGEN	3
PLTGEN	4
COPY	100
END INGRP	
END OPN SEQUENCE	

COPY Block:

The COPY block needs to be added, if it does not already exist. While NPSM places the COPY block between FTABLES and PLTGEN, blocks may appear in any sequence.

(Original [if pre-existing])

```
COPY
  TIMESERIES
    # - # NPT NMN ***
    1   4   10
  END TIMESERIES
END COPY
```

(Modified [if pre-existing] with one calibration site)

```
COPY
  TIMESERIES
    # - # NPT NMN ***
    1   4   10
  100      7
  END TIMESERIES
END COPY
```

(Modified [if pre-existing] with two calibration sites)

```
COPY
  TIMESERIES
    # - # NPT NMN ***
    1   4   10
  100 101  7
  END TIMESERIES
END COPY
```

(Modified [if not pre-existing] with one calibration site)

```
COPY
  TIMESERIES
    # - # NPT NMN ***
    100      7
  END TIMESERIES
END COPY
```

The purpose of this additional line or block is to create an internal scratch pad for each calibration point (e.g. copy volumes 100 and 101) that will contain seven mean-valued data sets each (i.e. SURO, IFWO, AGWO, PET, TAET, UZS, and LZS).

SCHEMATIC Block:

The appropriate time series linkages need to be added. Add the SCHEMATIC Block with records for each land surface contributing to each calibration site (see also section 4.6.4 on p. 654 in the HSPF v.11 manual). An example using four PERLND segments and three IMPLND segments follows. The area factors will need to be modified as described below.

(Original)

Assuming no SCHEMATIC Block exists

(Modified [for one calibration site])

```
SCHEMATIC
<-Volume->          <--Area-->          <-Volume->  <ML#>  ***
<Name>   x          <-factor->          <Name>   x          ***
PERLND   1          3687.6          COPY    100          90
PERLND   2          3778.8          COPY    100          90
PERLND   3          30254.4         COPY    100          90
PERLND   4          417.6           COPY    100          90
IMPLND   1          3687.6          COPY    100          91
IMPLND   2          3603.6          COPY    100          91
IMPLND   3          5847.6          COPY    100          91
END SCHEMATIC
```

(Modified [for two calibration sites within the same watershed]: The sequence of records repeats within the block for each copy operation)

```
SCHEMATIC
<-Volume->          <--Area-->          <-Volume->  <ML#>  ***
<Name>   x          <-factor->          <Name>   x          ***
PERLND   1          3687.6          COPY    100          90
PERLND   2          3778.8          COPY    100          90
PERLND   3          30254.4         COPY    100          90
PERLND   4          417.6           COPY    100          90
IMPLND   1          3687.6          COPY    100          91
IMPLND   2          3603.6          COPY    100          91
IMPLND   3          5847.6          COPY    100          91
PERLND   1          2576.5          COPY    101          90
PERLND   2          2667.7          COPY    101          90
PERLND   3          20143.3         COPY    101          90
PERLND   4          306.5           COPY    101          90
IMPLND   1          2576.5          COPY    101          91
IMPLND   2          2502.5          COPY    101          91
IMPLND   3          4736.5          COPY    101          91
END SCHEMATIC
```

The area factors in the examples must be modified for the basin being modeled. Each area factor should represent the number of acres of each land use upstream of each calibration site. These area factors can be inferred from the contents of the NETWORK Block through the area factors of PERLND/IMPLND to RCHRES records upstream of the calibration site. These area factors multiplied by twelve (a conversion factor for feet to inches) indicate the areas contributing to each calibration site in acres.

Note: The two calibration points, in the example above, are located within the same watershed.

Alternatively, separate calibration/pour points for separate subwatersheds could be delineated in BASINS/NPSM. The OPN SEQUENCE block would then have additional land segments and reaches associated with the second watershed. Additionally, the SCHEMATIC block would look like the second block above but with the land segments and land segment areas, associated with the second watershed, assigned to COPY 101.

MASS-LINK Block:

The following MASS-LINK tables must be added to the UCI file. It is assumed that no MASS-LINK Block already exists, hence the following records can be added exactly as indicated below for any number of calibration sites (see also section 4.6.4 on p. 654 in HSPF v. 11 manual):

```

MASS-LINK
  MASS-LINK          90
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->***
<Name>          <Name> x x<-factor->strg <Name>          <Name> x x***
PERLND          PWATER SURO          COPY          INPUT MEAN 1
PERLND          PWATER IFWO          COPY          INPUT MEAN 2
PERLND          PWATER AGWO          COPY          INPUT MEAN 3
PERLND          PWATER PET           COPY          INPUT MEAN 4
PERLND          PWATER TAET          COPY          INPUT MEAN 5
PERLND          PWATER UZS           COPY          INPUT MEAN 6
PERLND          PWATER LZS           COPY          INPUT MEAN 7
  END MASS-LINK    90
  MASS-LINK          91
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->***
<Name>          <Name> x x<-factor->strg <Name>          <Name> x x***
IMPLND          IWATER SURO          COPY          INPUT MEAN 1
IMPLND          IWATER PET           COPY          INPUT MEAN 4
IMPLND          IWATER IMPEV         COPY          INPUT MEAN 5
  END MASS-LINK    91
END MASS-LINK

```

EXT TARGETS Block:

Eight EXT TARGETS records must be added for each calibration site. The records may be copied from the examples below and modified accordingly (see section 4.6.5 on p. 661 of HSPF v.11 manual for additional details). In the first of the eight records the RCHRES Volume number must be modified to reflect the RCHRES number at the calibration site. The multiplication factor (Mult factor) is used to convert acre-feet to watershed-inches, and thus must be modified to represent 12 (the conversion factor from feet to inches) divided by the watershed area upstream of the site in acres. The WDM Volume number must be modified to correspond to the data set number of the WDM data set for simulated total runoff recorded in step 5.

In the second through eighth records, the COPY volume number must be set as specified elsewhere in the UCI file (see Step 6). The multiplication factor is used to convert acre-inches to watershed-inches and must be modified to represent 1 divided by the watershed area upstream of the site in acres. The WDM Volume number must be modified to correspond to the data set number of the WDM data set for that constituent as recorded in step 5.

Original:

Assuming no EXT TARGETS Block exists

(Modified [example for one calibration site])

```
EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys AggrAmd***
<Name> x <Name> x x<-factor->strg <Name> x <Name>qf temstrgstrg***
RCHRES 1 ROFLOW ROVOL 1 1 2.340E-04 WDM 420 SIMQ 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 1 1 1.950E-05 WDM 421 SURO 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 2 1 1.950E-05 WDM 422 IFWO 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 3 1 1.950E-05 WDM 423 AGWO 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 4 1 1.950E-05 WDM 425 PETX 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 5 1 1.950E-05 WDM 426 SAET 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 6 1 1.950E-05AVER WDM 427 UZSX 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 7 1 1.950E-05AVER WDM 428 LZSX 1 ENGL AGGR REPL
END EXT TARGETS
```

(Modified [example for two calibration sites])

```

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys AggrAmd***
<Name> x <Name> x x<-factor->strg <Name> x <Name>qf temstrgstrg***
RCHRES 1 ROFLOW ROVOL 1 1 2.340E-04 WDM 420 SIMQ 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 1 1 1.950E-05 WDM 421 SURO 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 2 1 1.950E-05 WDM 422 IFWO 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 3 1 1.950E-05 WDM 423 AGWO 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 4 1 1.950E-05 WDM 425 PETX 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 5 1 1.950E-05 WDM 426 SAET 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 6 1 1.950E-05AVER WDM 427 UZSX 1 ENGL AGGR REPL
COPY 100 OUTPUT MEAN 7 1 1.950E-05AVER WDM 428 LZSX 1 ENGL AGGR REPL
RCHRES 3 ROFLOW ROVOL 1 1 3.379E-04 WDM 430 SIMQ 1 ENGL AGGR REPL
COPY 101 OUTPUT MEAN 1 1 2.816E-05 WDM 431 SURO 1 ENGL AGGR REPL
COPY 101 OUTPUT MEAN 2 1 2.816E-05 WDM 432 IFWO 1 ENGL AGGR REPL
COPY 101 OUTPUT MEAN 3 1 2.816E-05 WDM 433 AGWO 1 ENGL AGGR REPL
COPY 101 OUTPUT MEAN 4 1 2.816E-05 WDM 435 PETX 1 ENGL AGGR REPL
COPY 101 OUTPUT MEAN 5 1 2.816E-05 WDM 436 SAET 1 ENGL AGGR REPL
COPY 101 OUTPUT MEAN 6 1 2.816E-05AVER WDM 437 UZSX 1 ENGL AGGR REPL
COPY 101 OUTPUT MEAN 7 1 2.816E-05AVER WDM 438 LZSX 1 ENGL AGGR REPL
END EXT TARGETS

```

Step 7: Create the HSPEXP 'Basin Specifications File'

One additional file, known as the 'Basin Specifications File', is required so HSPEXP can track the data related to the particular calibration project. This file includes data such as the number of calibration sites, the HSPEXP data set numbers, selected storm periods, drainage areas for each calibration site, and values for error terms and criteria.

The 'Basin Specifications File' can be created interactively through HSPEXP. The full details are described in the HSPEXP user's manual (p. 28-34); however, the following tips and clarifications are offered for the user:

General Parameters: Use the starting and ending dates from the GLOBAL Block of the UCI file. The WDM file name prefix was specified in the FILES Block; use the base file name without the 'WDM' extension. The number of storms to use in calibration must be specified (up to 36 storms are allowed); generally speaking, more storms enable more precise calibrations.

Location Information: For each calibration site, record the drainage area and data set numbers. The drainage areas were recorded in step 4. The data set number of the observed streamflow was recorded in step 4, while the data set numbers of the eight EXT TARGETS data sets were recorded in step 5. The data set number for the observed precipitation data set can be inferred from the EXT SOURCES block by looking at the WDM volume number on the record with a member name 'PREC' contributing to the RCHRES where the calibration site is located.

Storm Dates: Examine the precipitation data set(s) specified above in the 'Location Information' in conjunction with the observed flow. Plots of daily precipitation and daily mean flow at each calibration site are recommended as a basis for selecting storms. Choose as many storms as possible

distributed over the entire period of the simulation, with roughly equal numbers of storms for each season. A sufficient number of storm dates are needed for HSPEXP to calculate storm statistics that adequately characterize the simulation. The storm period should usually start on the first day of significant precipitation (except during snowmelt events in winter) and extend through the time when the flow returns almost to pre-storm levels. Depending on site and seasonal conditions this period could extend from 3 to 5 days, or up to 7 to 10 days. Storms should include both high and moderate to low peaks so that the full range of storm types are represented. Users should leave out any storms that demonstrate an obvious mismatch between precipitation and runoff.

Ancillary Information: Answer the questions if possible. Take the default values where uncertain.

After creating the 'basin specifications file', use the 'Basin'-'Put' option within HSPEXP to write the file to disk. **A temporary name for the 'basin specifications file' should be given, not the base name of the UCI file created above. HSPEXP will create an empty UCI file with the same base name as the 'basin specifications file'; if the base name is the same as the base of the UCI file name the UCI file modified in the steps above will be overwritten.** Exit HSPEXP, and, from the operating system, rename the 'basin specifications file' (the base name specified above with an '.exs' extension) with the base name of the UCI file modified above. At this point the 'basin specifications file' and the UCI file should have the same base name and reside in the same folder.

Step 8: Create/Edit TERM.DAT File in HSPEXP

When generating the UCI file, NPSM uses file unit numbers starting with 30 (for model output and point source loading input files [MUT format]). HSPEXP coincidentally uses default file unit numbers in the range 30 to 33. The conflicting use of the same file unit numbers will cause HSPEXP to crash if not changed. If you already have a TERM.DAT file in the same directory from where HSPEXP is run, edit it to include the line "FILUNI 60." Otherwise, create a text file with the line "FILUNI 60" and save it with the name "TERM.DAT" in the same directory as HSPEXP.BAT. More information about the TERM.DAT file can be found in the HSPEXP manual (p. 93).

Step 9: Run HSPEXP

HSPEXP takes the modeler through a series of model simulation cycles. Each cycle may consist of simulating with HSPF, computing error statistics, producing plots and output tables comparing observed and simulated output, providing the user with expert advice on which parameters should be changed to improve the calibration, and then allowing the user to edit the input file in response to the expert advice.

Most of the details of this step are described in HSPEXP users manual. When entering HSPEXP choose the 'Basin'-'Get' menu items, and specify the base name of the UCI and 'Basin Specifications File'. During the calibration procedure some users prefer to modify the parameters in the UCI file with a text editor outside of HSPEXP. To do so, exit HSPEXP prior to making the modifications.

Noted Label Errors in HSPEXP Summary Statistics:

A few errors are known to exist in the labels for HSPEXP summary statistics. ‘Total Annual Runoff’ should actually read ‘Total Runoff for the Simulation Period’, and ‘Error in Storm Volumes’ should read ‘Error in Storm Peaks’.

Step 10: Return the UCI file to BASINS

Since NPSM does not “read” HSPF UCI files, any changes made during calibration with HSPEXP in Step 9 must be re-entered using the NPSM interface. The following table shows the parameters referenced in HSPEXP advice and their corresponding block and/or table in HSPF. Compare each parameter from the final HSPEXP UCI file with the same parameter in the original NPSM project. **All** parameters that have been changed, including any not listed below, must be updated in NPSM.

<i>Parameter</i>	<i>Block and Table</i>
VCSFG	PERLND PWAT-PARM1
VLEFG	PERLND PWAT-PARM1
LZETP	PERLND PWAT-PARM4
LZSN	PERLND PWAT-PARM2
INFILT	PERLND PWAT-PARM2
AGWRC	PERLND PWAT-PARM2
DEEPR	PERLND PWAT-PARM3
BASETP	PERLND PWAT-PARM3
INTFW	PERLND PWAT-PARM4
IRC	PERLND PWAT-PARM4
KVARY	PERLND PWAT-PARM2
AGWETP	PERLND PWAT-PARM3
CEPSC	PERLND PWAT-PARM4
UZSN	PERLND PWAT-PARM4
Multipliers for Precipitation and Potential Evapotranspiration	EXT SOURCES Block (Cannot be modified in NPSM interface)

References:

Bicknell, B.R., J.C. Imhoff, J.L. Kittle, Jr., A.S. Donigian, Jr. Hydrological Simulation Program - Fortran: User's Manual for Release 11. U.S. EPA Environmental Research Laboratory, Office of Research and Development, Athens, GA. September, 1996.

Flynn, K.M., Hummel, P.R., Lumb, A.M., and Kittle, J.L., Jr., 1995, User's manual for ANNIE, version 2, a computer program for interactive hydrologic data management: U.S. Geological Survey Water-Resources Investigations Report 95-4085, 211 p.

Lumb, A.M., R.B. McCammon, and J.L. Kittle, Jr., Users Manual for an Expert System (HSPEXP) for Calibration of the Hydrological Simulation Program - Fortran. U.S.G.S. Water-Resources Investigations Report 94-4168, Reston, VA, 1994.