CHAPTER 1

SWAT INPUT DATA: OVERVIEW

SWAT is a comprehensive model that requires a diversity of information in order to run. Novice users may feel a little overwhelmed by the variety and number of inputs when they first begin to use the model. However, many of the inputs are used to simulate special features that are not common to all watersheds.

This chapter provides an overview of model inputs. The inputs are organized by topic and emphasis is given to differentiating required inputs from optional inputs. This chapter focuses on assisting the user in identifying inputs that must be defined for their particular dataset. The remaining chapters list variables by file and discuss methods used to measure or calculate values for the input parameters.

1.1 WATERSHED CONFIGURATION

The first step in setting up a watershed simulation is to partition the watershed into subunits. SWAT allows several different subunits to be defined within a watershed.

- Subbasins
  - unlimited number of HRUs (1 per subbasin required)
  - one pond (optional)
  - one wetland (optional)
- Reach/main channel segments (1 per subbasin)
- Impoundments on main channel network (optional)
- Point sources (optional)

1.1.1 SUBBASINS

The first level of subdivision is the subbasin. Subbasins possess a geographic position in the watershed and are spatially related to one another, e.g. outflow from subbasin #5 enters subbasin #7. The subbasin delineation may be obtained from subwatershed boundaries that are defined by surface topography so that the entire area within a subbasin flows to the subbasin outlet. Alternatively, the subbasin delineation may be obtained from grid cell boundaries. Since most spatial input is grid-based (i.e. DEM, NEXRAD, LULC), grid cells are an appealing approach for subbasin delineation. However unlike the subwatershed discretization, grid cells do not preserve routing reaches and topographic flow paths.

A subbasin will contain at least one HRU, a tributary channel and a main channel or reach. Two types of impoundments, a pond and/or wetland, may also be defined within a subbasin. These features are reviewed in the following sections.

1.1.2 HYDROLOGIC RESPONSE UNITS

The land area in a subbasin may be divided into hydrologic response units (HRUs). Hydrologic response units are portions of a subbasin that possess unique landuse/management/soil attributes. HRUs were incorporated into SWAT as part of the HUMUS (Hydrologic Unit Model for the United States) project. Prior to

the HUMUS project, only one landuse/management/soil combination could be defined per subbasin in SWAT. HUMUS used U.S.G.S. 2-digit hydrologic boundaries to divide the contiguous United States into watersheds while 8-digit hydrologic boundaries were used to define subbasins within the watersheds. Only percentages of soil and landuse were known within the 8-digit hydrologic units—the geographic location of the landuse and soils within each subbasin was unknown. To capture the diversity of land use and soils that could be encompassed in an 8-digit hydrologic unit, a method was needed to account for the complexity of the landscape within the boundaries of the subbasins. The inclusion of HRUs allowed SWAT to account for this diversity.

An HRU is not synonymous to a field. Rather it is the total area in the subbasin with a particular landuse, management and soil. While individual fields with a specific landuse, management and soil may be scattered throughout a subbasin, these areas are lumped together to form one HRU. HRUs are used in most SWAT runs since they simplify a run by lumping all similar soil and land use areas into a single response unit. It is often not practical to simulate individual fields.

Implicit in the concept of the HRU is the assumption that there is no interaction between HRUs in one subbasin. Loadings (runoff with sediment, nutrients, etc. transported by the runoff) from each HRU are calculated separately and then summed together to determine the total loadings from the subbasin. If the interaction of one landuse area with another is important, rather than defining those landuse areas as HRUs they should be defined as subbasins. It is only at the subbasin level that spatial relationships can be specified.

The benefit of HRUs is the increase in accuracy it adds to the prediction of loadings from the subbasin. The growth and development of plants can differ greatly among species. When the diversity in plant cover within a subbasin is accounted for, the net amount of runoff entering the main channel from the subbasin will be much more accurate.

As a general rule, a given subbasin should have 1-10 HRUs. For those wishing to incorporate more complexity into a dataset, we would recommend that

the user define a greater number of subbasins in the watershed rather than many HRUs within a few subbasins. Of course, there are exceptions to this rule. An example of such an exception would be the requirement that the project uses a particular subbasin delineation that doesn't allow the user to capture landuse diversity without the incorporation of many HRUs.

1.1.3 REACH/MAIN CHANNELS

One reach or main channel is associated with each subbasin in a watershed. Loadings from the subbasin enter the channel network of the watershed in the associated reach segment. Outflow from the upstream reach segment(s) will also enter the reach segment. Processes involved in routing water, sediment and other constituents through the reach are reviewed in Section 7 of the Theoretical Documentation.

1.1.4 TRIBUTARY CHANNELS

The term tributary channel is used to differentiate inputs for channelized flow of surface runoff generated in a subbasin. Tributary channel inputs are used to calculate the time of concentration for channelized flow of runoff generated within the subbasin and transmission losses from runoff as it flows to the main channel.

Tributary channel inputs define the longest flow path in the subbasin. For some subbasins, the main channel may be the longest flow path. If so, tributary channel dimensions will be the same as those for the main channel. In other subbasins, the tributary channel dimensions will be significantly different than the main channel.

1.1.5 PONDS/WETLANDS/RESERVOIRS

In order to process USGS landuse maps, the GIS interfaces will allow HRUs to be created with water as the land use. If at all possible this should be avoided. Water bodies within a watershed should be modeled as ponds, wetlands or reservoirs.

Water bodies located on the stream network of the watershed are modeled as reservoirs. While the term "reservoir" is commonly used for man-made structures and "lake" for naturally occurring water bodies, the use of the term "reservoir" in SWAT is not meant to imply that the water body is man-made. With the terms "reservoir" and "pond" we are differentiating impoundments by location. Because impoundments on the main channel network tend to be larger than impoundments off the main channel network, a difference in size is also implied with the use of these terms. It would probably be more appropriate to refer to the different types of water bodies as main channel impoundments and subbasin impoundments, but the need for different file extensions to store inputs makes the use of these two terms convenient.

Two water bodies (pond/wetlands) may be defined within each subbasin. Water entering these impoundments is generated in the subbasin—they cannot receive water originating in other subbasins. In contrast, reservoirs receive water contributed to the channel network from all upstream subbasins.

1.1.6 POINT SOURCES

SWAT directly models the loading of water, sediment and nutrients from land areas in a watershed. However, some watersheds will have loadings to the stream network from sources not associated with a land area. These are referred to as point sources. The most common point source is a sewage treatment plant.

In order to account for the loadings from a point source, SWAT allows users to add daily or average daily loading data for point sources to the main channel network. These loadings are then routed through the channel network along with the loadings generated by the land areas.

In the GIS interfaces, a subbasin map is produced which allows the user to easily see the spatial relationship between subbasins. In the Windows (non-GIS) interface, the user can set up the spatial positioning of subbasins with drag and drop objects and connecting arrows to show direction of flow. The core SWAT program is not able to access maps or displays. Instead, it uses the information provided in the watershed configuration file (.fig) to link the individual subbasins together in the watershed. The watershed file is an ASCII or text file. The file

format is described in Chapter 2 and example watershed configurations are provided in Appendix B.

1.2 OVERVIEW OF INPUT FILES

Input for SWAT is defined at one of several different levels of detail: watershed, subbasin, or HRU. Unique features such as reservoirs or point sources must have input data provided for each individual feature included in the watershed simulation.

Watershed level inputs are used to model processes throughout the watershed. For example, the method selected to model potential evapotranspiration will be used in all HRUs in the watershed. Subbasin level inputs are inputs set at the same value for all HRUs in the subbasin if the input pertains to a process modeled in the HRU. Because there is one reach per subbasin, input data for main channels is defined at the subbasin level also. An example of subbasin level data is rainfall and temperature information. The same rainfall and maximum and minimum temperature are used for all HRUs, the main channel and any ponds or wetlands located within the subbasin. HRU level inputs are inputs that can be set to unique values for each HRU in the watershed. An example of an HRU input is the management scenario simulated in an HRU.

An attempt was been made to organize input information according to the type of input. However, there are a few files that have had to serve as “catch-alls”. These files contain input data for various processes modeled in the watershed that do not fit into any of the specialized files.

Input files for SWAT include:

file.cio (watershed level file)	Master watershed file. This required file contains the names of watershed level files and parameters related to printing.
.fig (watershed level file)	Watershed configuration file. This required file defines the routing network in the watershed and lists input file names for the different objects in the watershed.
.bsn (watershed level file)	Basin input file. This required file defines values or options used to model physical processes uniformly over the entire watershed.
.pcp (watershed level file)	Precipitation input file. This optional file contains daily measured precipitation for a measuring gage(s). Up to 18 precipitation files may be used in each simulation and each file can hold data for up to 300 stations. The data for a particular station is assigned to a subbasin in the subbasin input file (.sub).
.tmp (watershed level file)	Temperature input file. This optional file contains daily measured maximum and minimum temperatures for a measuring gage(s). Up to 18 temperature files may be used in each simulation and each file can hold data for up to 150 stations. The data for a particular station is assigned to a subbasin in the subbasin input file (.sub).
.slr (watershed level file)	Solar radiation input file. This optional file contains daily solar radiation for a measuring gage(s). The solar radiation file can hold data for up to 300 stations. The data for a particular station is assigned to a subbasin in the subbasin input file (.sub).
.wnd (watershed level file)	Wind speed input file. This optional file contains daily average wind speed for a measuring gage(s). The wind speed file can hold data for up to 300 stations. The data for a particular station is assigned to a subbasin in the subbasin input file (.sub).
.hmd (watershed level file)	Relative humidity input file. This optional file contains daily relative humidity values for a measuring gage(s). The relative humidity file can hold data for up to 300 stations. The data for a particular station is assigned to a subbasin in the subbasin input file (.sub).
.pet (watershed level file)	Potential evapotranspiration input file. This optional file contains daily PET values for the watershed.

.cst (watershed level file)	Weather forecast input file. This optional file contains the statistical data needed to generate representative daily climatic data for the subbasins during the forecast period.
.cal (watershed level file)	Auto-calibration input file. This optional file contains the data needed to operate the auto-calibration algorithms.
crop.dat (watershed level file)	Land cover/plant growth database file. This required file contains plant growth parameters for all land covers simulated in the watershed.
till.dat (watershed level file)	Tillage database file. This required file contains information on the amount and depth of mixing caused by tillage operations simulated in the watershed.
pest.dat (watershed level file)	Pesticide database file. This required file contains information on mobility and degradation for all pesticides simulated in the watershed.
fert.dat (watershed level file)	Fertilizer database file. This required file contains information on the nutrient content of all fertilizers and manures simulated in the watershed.
urban.dat (watershed level file)	Urban database file. This required file contains information on the build-up/wash-off of solids in urban areas simulated in the watershed.
septic.dat (watershed level file)	Septic database file. This file contains information on septic systems.
.sub (subbasin level file)	Subbasin input file. This required file for each subbasin defines climatic inputs, tributary channel attributes, and the number and types of HRUs in the subbasin.
.wgn (subbasin level file)	Weather generator input file. This required file contains the statistical data needed to generate representative daily climatic data for a subbasin.
.pnd (subbasin level file)	Pond/wetland input file. This optional file contains information for impoundments located within a subbasin.
.wus (subbasin level file)	Water use input file. This optional file contains information for consumptive water use in a subbasin.
.rte (subbasin level file)	Main channel input file. This required file contains parameters governing water and sediment movement in the main channel of a subbasin.
.sep (subbasin level file)	Septic input file. This optional file contains information for septic systems.

.wwq (watershed level file)	Watershed water quality input file. This optional file contains parameters used to model QUAL2E transformations in the main channels.
.swq (subbasin level file)	Stream water quality input file. This optional file contains parameters used to model pesticide and QUAL2E nutrient transformations in the main channel of the subbasin.
.hru (HRU level file)	HRU input file. Required file for HRU level parameters. Catch-all file.
.mgt (HRU level file)	Management input file. This required file contains management scenarios and specifies the land cover simulated in the HRU.
.sol (HRU level file)	Soil input file. This required file contains information about the physical characteristics of the soil in the HRU.
.chm (HRU level file)	Soil chemical input file. This optional file contains information about initial nutrient and pesticide levels of the soil in the HRU.
.gw (HRU level file)	Groundwater input file. This required file contains information about the shallow and deep aquifer in the subbasin. Because land covers differ in their interaction with the shallow aquifer, information in this input file is allowed to be varied at the HRU level.
.res (reservoir file)	Reservoir input file. This optional file contains parameters used to model the movement of water and sediment through a reservoir.
.lwq (reservoir file)	Lake water quality input file. This optional file contains parameters used to model the movement of nutrients and pesticides through a reservoir.
rechour.dat recday.dat recmon.dat recyear.dat reccnst.dat (point source file)	Point source input files. These optional files contain information about loadings to the channel network from a point source. The type of file used to store the data depends on how the data is summarized (hourly, daily, monthly, yearly, or average annual).

1.3 MODEL INPUTS BY TYPE

The following tables group inputs by type. Detailed explanations of the variables are given in the input file chapter. Please keep in mind that in the GIS interfaces, some of these variables are automatically set by the interface and users will not be allowed to edit them.

WATERSHED DIMENSIONS

SWAT calculates total watershed dimensions from the watershed configuration given in the .fig file and variables located in various files. The variables listed here are the ones used in the calculation.

Variable		File
SUB_KM	.sub	Chapter 5
HRUTOT	.sub	Chapter 5
HRU_FR	.hru	Chapter 19

Length of Simulation

Variable		File
NBYR	file.cio	Chapter 3
IYR	file.cio	Chapter 3
IDAF	file.cio	Chapter 3
IDAL	file.cio	Chapter 3

Output Print Options/Output Summary Options

Variable		File
IPRINT	file.cio	Chapter 3
NYSKIP	file.cio	Chapter 3
ILOG	file.cio	Chapter 3
IPRP	file.cio	Chapter 3
IPRS	file.cio	Chapter 3
IPDVAR(1-20)	file.cio	Chapter 3
IPDVAB(1-20)	file.cio	Chapter 3
IPDVAS(1-20)	file.cio	Chapter 3
IPDHRU(1-20)	file.cio	Chapter 3
TITLE	file.cio	Chapter 3
save command	.fig	Chapter 2
saveconc command	.fig	Chapter 2

Random Number Generator

Variable		File
IGEN	file.cio	Chapter 3

Special Project Flag

Variable		File
ISPROJ	file.cio	Chapter 3

CLIMATE

Precipitation

Variable		File
PCPSIM	file.cio	Chapter 3
IDT	file.cio	Chapter 3
IDIST	file.cio	Chapter 3
REXP	file.cio	Chapter 3
NRGAGE	file.cio	Chapter 3
NRTOT	file.cio	Chapter 3
NRGFIL	file.cio	Chapter 3
RFILE(1-18)	file.cio	Chapter 3
IEVENT	.bsn	Chapter 4
ISED_DET	.bsn	Chapter 4
RAIN_YRS	.wgn	Chapter 12
PCPMM(1-12)	.wgn	Chapter 12
PCPSTD(1-12)	.wgn	Chapter 12
PCPSKW(1-12)	.wgn	Chapter 12
PR_W(1,1-12)	.wgn	Chapter 12
PR_W(2,1-12)	.wgn	Chapter 12
PCPD(1-12)	.wgn	Chapter 12
RAINHHMX(1-12)	.wgn	Chapter 12
FPCPMM(1-12)	.cst	Chapter 13
FPCPSTD(1-12)	.cst	Chapter 13
FPCPSKW(1-12)	.cst	Chapter 13
FPR_W(1,1-12)	.cst	Chapter 13
FPR_W(2,1-12)	.cst	Chapter 13
FPCPD(1-12)	.cst	Chapter 13
PRECIPITATION	.pcp	Chapter 6
IRGAGE	.sub	Chapter 5
PLAPS	.sub	Chapter 5
RFINC(1-12)	.sub	Chapter 5

Snow Processes

Variable		File
SFTMP	.bsn	Chapter 4
SMTMP	.bsn	Chapter 4
SMFMX	.bsn	Chapter 4
SMFMN	.bsn	Chapter 4
TIMP	.bsn	Chapter 4
SNOCOVMX	.bsn	Chapter 4
SNO50COV	.bsn	Chapter 4
SNO_SUB	.sub	Chapter 5

Snow Processes, cont.

Variable		File
SNOEB(1-10)	.sub	Chapter 5

Temperature

Variable		File
TMPSIM	file.cio	Chapter 3
NTGAGE	file.cio	Chapter 3
NTTOT	file.cio	Chapter 3
NTGFIL	file.cio	Chapter 3
TFILE(1-18)	file.cio	Chapter 3
TMPMX(1-12)	.wgn	Chapter 12
TMPMN(1-12)	.wgn	Chapter 12
TMPSTDMX(1-12)	.wgn	Chapter 12
TMPSTDMN(1-12)	.wgn	Chapter 12
FTMPMX(1-12)	.cst	Chapter 13
FTMPMN(1-12)	.cst	Chapter 13
FTMPSTDMX(1-12)	.cst	Chapter 13
FTMPSTDMN(1-12)	.cst	Chapter 13
MAX TEMP	.tmp	Chapter 7
MIN TEMP	.tmp	Chapter 7
ITGAGE	.sub	Chapter 5
TLAPS	.sub	Chapter 5
TMPINC	.sub	Chapter 5

Solar Radiation

Variable		File
SLRSIM	file.cio	Chapter 3
NSTOT	file.cio	Chapter 3
SLRFILE	file.cio	Chapter 3
WLATITUDE	.wgn	Chapter 12
SOLARAV(1-12)	.wgn	Chapter 12
SOL_RAD	.slr	Chapter 8
ISGAGE	.sub	Chapter 5
SUB_LAT	.sub	Chapter 5
RADINC(1-12)	.sub	Chapter 5

Relative Humidity Input

Variable		File
RHSIM	file.cio	Chapter 3
NHTOT	file.cio	Chapter 3
RHFILE	file.cio	Chapter 3
DEWPT(1-12)	.wgn	Chapter 12
RHD	.hmd	Chapter 10
IHGAGE	.sub	Chapter 5
HUMINC(1-12)	.sub	Chapter 5

Wind Speed Input

Variable		File
WNDSIM	file.cio	Chapter 3
NWTOT	file.cio	Chapter 3
WNDFILE	file.cio	Chapter 3
IWGAGE	.sub	Chapter 5
WNDAV(1-12)	.wgn	Chapter 12
WND_SP	.wnd	Chapter 9

Elevation Bands

Variable		File
WELEV	.wgn	Chapter 12
ELEVATION	.pcp	Chapter 6
ELEVATION	.tmp	Chapter 7
ELEVB(1-10)	.sub	Chapter 5
ELEV_FR(1-10)	.sub	Chapter 5
SNOEB(1-10)	.sub	Chapter 5
PLAPS	.sub	Chapter 5
TLAPS	.sub	Chapter 5

Climate Change

Variable		File
CO2	.sub	Chapter 5
RFINC(1-12)	.sub	Chapter 5
TMPINC(1-12)	.sub	Chapter 5
RADINC(1-12)	.sub	Chapter 5
HUMINC(1-12)	.sub	Chapter 5
CO2HI	crop.dat	Chapter 14
BIOEHI	crop.dat	Chapter 14

Weather Forecast

Variable		File
FCSTYR	file.cio	Chapter 3
FCSTDAY	file.cio	Chapter 3
FCSTCYCLES	file.cio	Chapter 3
FCSTFILE	file.cio	Chapter 3
FCSTREG	.sub	Chapter 5
FCST_REG	.cst	Chapter 13
FTMPMX(1-12)	.cst	Chapter 13
FTMPMN(1-12)	.cst	Chapter 13
FTMPSTDMX(1-12)	.cst	Chapter 13
FTMPSTDMN(1-12)	.cst	Chapter 13
FPCPMM(1-12)	.cst	Chapter 13
FPCPSTD(1-12)	.cst	Chapter 13
FPCPSKW(1-12)	.cst	Chapter 13
FPR_W(1,1-12)	.cst	Chapter 13
FPR_W(2,1-12)	.cst	Chapter 13
FPCPD(1-12)	.cst	Chapter 13

HYDROLOGIC CYCLE

Potential and Actual Evapotranspiration

Variable		File
IPET	.bsn	Chapter 4
PETFILE	.bsn	Chapter 4
ESCO	.bsn, .hru	Chapter 4, 19
EPCO	.bsn, .hru	Chapter 4, 19
PET_MEAS	.pet	Chapter 11
SUB_ELEV	.sub	Chapter 5
CANMX	.hru	Chapter 19
SOL_ALB	.sol	Chapter 22
GW_REVAP	.gw	Chapter 24
REVAPMN	.gw	Chapter 24

Surface Runoff

Variable		File
IEVENT	.bsn	Chapter 4
ICN	.bsn	Chapter 4
CNCOEF	.bsn	Chapter 4
SURLAG	.bsn	Chapter 4

Surface Runoff, cont.

Variable		File
CN2	.mgt	Chapter 20
CNOP (***plant operation***)	.mgt	Chapter 20
CNOP (***harv & kill op***)	.mgt	Chapter 20
CNOP (***tillage operation***)	.mgt	Chapter 20
URBCN2	urban.dat	Chapter 18

Time of Concentration

Variable		File
CH_L(1)	.sub	Chapter 5
CH_S(1)	.sub	Chapter 5
CH_N(1)	.sub	Chapter 5
SLSUBBSN	.hru	Chapter 19
OV_N	.hru	Chapter 19

Crack Flow

Variable		File
ICRK	.bsn	Chapter 4
SOL_CRK	.sol	Chapter 22

Transmission Losses from Surface Runoff

Variable		File
CH_L(1)	.sub	Chapter 5
CH_W(1)	.sub	Chapter 5
CH_K(1)	.sub	Chapter 5

Soil Water

Variable		File
FFCB	.bsn	Chapter 4
SOL_Z	.sol	Chapter 22
SOL_BD	.sol	Chapter 22
SOL_AWC	.sol	Chapter 22
SOL_K	.sol	Chapter 22
irrigation operation	.mgt	Chapter 20
auto-irrigation operation	.mgt	Chapter 20
FLOW_OVN, ***route command***	.fig	Chapter 2

Lateral Flow

Variable		File
HRU_SLP	.hru	Chapter 19
LAT_TTIME	.hru	Chapter 19
SLSOIL	.hru	Chapter 19

High Water Table

Variable		File
IWATABLE	.hru	Chapter 19

Groundwater

Variable		File
SHALLST	.gw	Chapter 24
DEEPST	.gw	Chapter 24
GW_DELAY	.gw	Chapter 24
ALPHA_BF	.gw	Chapter 24
GWQMN	.gw	Chapter 24
GW_REVAP	.gw	Chapter 24
REVAPMN	.gw	Chapter 24
RCHRG_DP	.gw	Chapter 24
WUSHAL(1-12)	.wus	Chapter 21
WUDEEP(1-12)	.wus	Chapter 21

SEDIMENT

Sediment Erosion

Variable		File
ADJ_PKR	.bsn	Chapter 4
SLSUBBSN	.hru	Chapter 19
HRU_SLP	.hru	Chapter 19
LAT_SED	.hru	Chapter 19
FILTERW	.mgt	Chapter 20
CLAY	.sol	Chapter 22
SILT	.sol	Chapter 22
SAND	.sol	Chapter 22
ROCK	.sol	Chapter 22
USLE_K	.sol	Chapter 22
USLE_P	.mgt	Chapter 20
USLE_C	crop.dat	Chapter 14

NUTRIENTS

Nitrogen Cycle/Runoff

Variable		File
RCN	.bsn	Chapter 4
CMN	.bsn	Chapter 4
CDN	.bsn	Chapter 4
SDNCO	.bsn	Chapter 4
N_UPDIS	.bsn	Chapter 4
NPERCO	.bsn	Chapter 4
RSDCO	.bsn	Chapter 4
ANION_EXCL	.sol	Chapter 22
SOL_NO3	.chm	Chapter 23
SOL_ORGN	.chm	Chapter 23
SOL_CBN	.sol	Chapter 22
ERORGN	.hru	Chapter 19
FILTERW	.mgt	Chapter 20
BIOMIX	.mgt	Chapter 20
fertilizer application	.mgt	Chapter 20
FMINN	fert.dat	Chapter 17
FORGN	fert.dat	Chapter 17
FNH3N	fert.dat	Chapter 17
tillage operation	.mgt	Chapter 20
EFFMIX	till.dat	Chapter 15
DEPTIL	till.dat	Chapter 15
grazing operation	.mgt	Chapter 20
auto-fertilization operation	.mgt	Chapter 20
continuous fertilization operatio	.mgt	Chapter 20
CNYLD	crop.dat	Chapter 14
PLTNFR(1)	crop.dat	Chapter 14
PLTNFR(2)	crop.dat	Chapter 14
PLTNFR(3)	crop.dat	Chapter 14
GWNO3	.gw	Chapter 24

Phosphorus Cycle/Runoff

Variable		File
P_UPDIS	.bsn	Chapter 4
PPERCO	.bsn	Chapter 4
PHOSKD	.bsn	Chapter 4
PSP	.bsn	Chapter 4
RSDCO	.bsn	Chapter 4
SOL_SOLP	.chm	Chapter 23
SOL_ORGP	.chm	Chapter 23
ERORGP	.hru	Chapter 19

Phosphorus Cycle/Runoff, cont.

Variable		File
FILTERW	.mgt	Chapter 20
BIOMIX	.mgt	Chapter 20
fertilizer application	.mgt	Chapter 20
FMINP	fert.dat	Chapter 17
FORGP	fert.dat	Chapter 17
tillage operation	.mgt	Chapter 20
EFFMIX	till.dat	Chapter 15
DEPTIL	till.dat	Chapter 15
grazing operation	.mgt	Chapter 20
auto-fertilization operation	.mgt	Chapter 20
continuous fertilization operation	.mgt	Chapter 20
CPYLD	crop.dat	Chapter 14
PLTPFR(1)	crop.dat	Chapter 14
PLTPFR(2)	crop.dat	Chapter 14
PLTPFR(3)	crop.dat	Chapter 14
GWSOLP	.gw	Chapter 24

PESTICIDE

Pesticide in Soil/Runoff

Variable		File
PERCOP	.bsn	Chapter 4
PESTNUM	.chm	Chapter 23
PLTPST	.chm	Chapter 23
SOLPST	.chm	Chapter 23
FILTERW	.mgt	Chapter 20
PSTENR	.chm	Chapter 23
BIOMIX	.mgt	Chapter 20
pesticide application	.mgt	Chapter 20
SKOC	pest.dat	Chapter 16
WOF	pest.dat	Chapter 16
HLIFE_F	pest.dat	Chapter 16
HLIFE_S	pest.dat	Chapter 16
AP_EF	pest.dat	Chapter 16
WSOL	pest.dat	Chapter 16
tillage operation	.mgt	Chapter 20
EFFMIX	till.dat	Chapter 15
DEPTIL	till.dat	Chapter 15

BACTERIA

Bacteria in Soil/Runoff

Variable		File
WDPQ	.bsn	Chapter 4
WGPQ	.bsn	Chapter 4
WDLPQ	.bsn	Chapter 4
WGLPQ	.bsn	Chapter 4
WDPS	.bsn	Chapter 4
WGPS	.bsn	Chapter 4
WDLPS	.bsn	Chapter 4
WGLPS	.bsn	Chapter 4
BACTKDQ	.bsn	Chapter 4
THBACT	.bsn	Chapter 4
WOF_P	.bsn	Chapter 4
WOF_LP	.bsn	Chapter 4
WDPF	.bsn	Chapter 4
WGPF	.bsn	Chapter 4
WDLPF	.bsn	Chapter 4
WGLPF	.bsn	Chapter 4
BACT_SWF	.bsn	Chapter 4
BACTMIX	.bsn	Chapter 4
BACTMIN	.bsn	Chapter 4
FILTERW	.mgt	Chapter 20
BIOMIX	.mgt	Chapter 20
tillage operation	.mgt	Chapter 20
EFFMIX	till.dat	Chapter 15
DEPTIL	till.dat	Chapter 15
fertilizer application	.mgt	Chapter 20
BACTPDB	fert.dat	Chapter 17
BACTLPDB	fert.dat	Chapter 17
BACTKDDB	fert.dat	Chapter 17
grazing operation	.mgt	Chapter 20
auto-fertilization operation	.mgt	Chapter 20
continuous fertilization operation	.mgt	Chapter 20

WATER QUALITY

Subbasin Water Quality Indices

Variable		File
ISUBWQ	.bsn	Chapter 4

PLANTS

Plant Growth

Variable		File
SOL_ZMX	.sol	Chapter 22
PHU_PLT/HEAT UNITS	.mgt	Chapter 20
BIO_MIN	.mgt	Chapter 20
plant operation	.mgt	Chapter 20
harvest & kill operation	.mgt	Chapter 20
harvest operation	.mgt	Chapter 20
kill operation	.mgt	Chapter 20
grazing operation	.mgt	Chapter 20
CO2	.sub	Chapter 5
IDC	crop.dat	Chapter 14
BIO_E	crop.dat	Chapter 14
HVSTI	crop.dat	Chapter 14
BLAI	crop.dat	Chapter 14
FRGRW1	crop.dat	Chapter 14
LAIMX1	crop.dat	Chapter 14
FRGRW2	crop.dat	Chapter 14
LAIMX2	crop.dat	Chapter 14
DLAI	crop.dat	Chapter 14
CHTMX	crop.dat	Chapter 14
RDMX	crop.dat	Chapter 14
T_OPT	crop.dat	Chapter 14
T_BASE	crop.dat	Chapter 14
CNYLD	crop.dat	Chapter 14
CPYLD	crop.dat	Chapter 14
PLTNFR(1)	crop.dat	Chapter 14
PLTNFR(2)	crop.dat	Chapter 14
PLTNFR(3)	crop.dat	Chapter 14
PLTPFR(1)	crop.dat	Chapter 14
PLTPFR(2)	crop.dat	Chapter 14
PLTPFR(3)	crop.dat	Chapter 14
WSYF	crop.dat	Chapter 14
GSI	crop.dat	Chapter 14
VPDFR	crop.dat	Chapter 14
FRGMAX	crop.dat	Chapter 14
WAVP	crop.dat	Chapter 14
CO2HI	crop.dat	Chapter 14
BIOEHI	crop.dat	Chapter 14

Plant Growth, cont.

Variable		File
ALAI_MIN	crop.dat	Chapter 14
BIO_LEAF	crop.dat	Chapter 14

Residue

Variable		File
RSDIN	.hru	Chapter 19
RSDCO	.bsn	Chapter 4
harvest & kill operation	.mgt	Chapter 20
harvest operation	.mgt	Chapter 20
kill operation	.mgt	Chapter 20
grazing operation	.mgt	Chapter 20
RSDCO_PL	crop.dat	Chapter 14
BIO_LEAF	crop.dat	Chapter 14

MANAGEMENT

Management-Land Cover

Variable		File
IGRO	.mgt	Chapter 20
NROT	.mgt	Chapter 20
PLANT_ID	.mgt	Chapter 20
LAI_INIT	.mgt	Chapter 20
BIO_INIT	.mgt	Chapter 20
PHU_PLT	.mgt	Chapter 20
BIO_MIN	.mgt	Chapter 20
plant operation	.mgt	Chapter 20
HEAT UNITS	.mgt	Chapter 20
PLANT_ID	.mgt	Chapter 20
HI_TARG	.mgt	Chapter 20
BIO_TARG	.mgt	Chapter 20
LAI_INIT	.mgt	Chapter 20
BIO_INIT	.mgt	Chapter 20
harvest & kill operation	.mgt	Chapter 20
harvest operation	.mgt	Chapter 20
HI_OVR	.mgt	Chapter 20
HARVEFF	.mgt	Chapter 20
kill operation	.mgt	Chapter 20

Management-Land Cover, cont.

Variable		File
grazing operation	.mgt	Chapter 20
BIO_EAT	.mgt	Chapter 20
GRZ_DAYS	.mgt	Chapter 20
BIO_TRMP	.mgt	Chapter 20

Management-Nutrients

Variable		File
BIOMIX	.mgt	Chapter 20
fertilizer application	.mgt	Chapter 20
FRT_SURFACE	.mgt	Chapter 20
FERT_ID	.mgt	Chapter 20
FERT_KG	.mgt	Chapter 20
tillage operation	.mgt	Chapter 20
TILLAGE_ID	.mgt	Chapter 20
grazing operation	.mgt	Chapter 20
MANURE_KG	.mgt	Chapter 20
MANURE_ID	.mgt	Chapter 20
auto-fertilization operation	.mgt	Chapter 20
AUTO_NSTRS	.mgt	Chapter 20
AFERT_ID	.mgt	Chapter 20
AUTO_NAPP	.mgt	Chapter 20
AUTO_NYR	.mgt	Chapter 20
AUTO_EFF	.mgt	Chapter 20
AFRT_SURFACE	.mgt	Chapter 20
continuous fertilization op	.mgt	Chapter 20
FERT_DAYS	.mgt	Chapter 20
CFRT_ID	.mgt	Chapter 20
IFRT_FREQ	.mgt	Chapter 20
CFRT_KG	.mgt	Chapter 20

Management-Pesticide

Variable		File
BIOMIX	.mgt	Chapter 20
pesticide application	.mgt	Chapter 20
PEST_ID	.mgt	Chapter 20
FERT_KG	.mgt	Chapter 20
tillage operation	.mgt	Chapter 20
TILLAGE_ID	.mgt	Chapter 20

Management-Water

Variable		File
IRRSC	.mgt	Chapter 20
IRRNO	.mgt	Chapter 20
FLOWMIN	.mgt	Chapter 20
DIVMAX	.mgt	Chapter 20
FLOWFR	.mgt	Chapter 20
DDRAIN	.mgt	Chapter 20
TDRAIN	.mgt	Chapter 20
GDRAIN	.mgt	Chapter 20
POT_FR	.hru	Chapter 19
POT_TILE	.hru	Chapter 19
POT_VOLX	.hru	Chapter 19
POT_VOL	.hru	Chapter 19
EVLAI	.bsn	Chapter 4
irrigation operation	.mgt	Chapter 20
IRR_AMT	.mgt	Chapter 20
auto-irrigation operation	.mgt	Chapter 20
WSTRS_ID	.mgt	Chapter 20
AUTO_WSTR	.mgt	Chapter 20
release/impound operation	.mgt	Chapter 20
IMP_TRIG	.mgt	Chapter 20

Management-Urban

Variable		File
IURBAN	.mgt	Chapter 20
URBLU	.mgt	Chapter 20
street sweeping operation	.mgt	Chapter 20
SWEEPEFF	.mgt	Chapter 20
FR_CURB	.mgt	Chapter 20
FIMP	urban.dat	Chapter 18
FCIMP	urban.dat	Chapter 18
CURBDEN	urban.dat	Chapter 18
URBCOEF	urban.dat	Chapter 18
DIRTMX	urban.dat	Chapter 18
THALF	urban.dat	Chapter 18
TNCONC	urban.dat	Chapter 18
TPCONC	urban.dat	Chapter 18
TNO3CONC	urban.dat	Chapter 18
URBCN2	urban.dat	Chapter 18

CHANNEL PROCESSES

Channel Water Routing

Variable		File
IEVENT	.bsn	Chapter 4
IRTE	.bsn	Chapter 4
TRNSRCH	.bsn	Chapter 4
EVRCH	.bsn	Chapter 4
MSK_CO1	.bsn	Chapter 4
MSK_CO2	.bsn	Chapter 4
MSK_X	.bsn	Chapter 4
CH_W(2)	.rte	Chapter 25
CH_D	.rte	Chapter 25
CH_S(2)	.rte	Chapter 25
CH_L(2)	.rte	Chapter 25
CH_N(2)	.rte	Chapter 25
CH_K(2)	.rte	Chapter 25
ALPHA_BNK	.rte	Chapter 25
FLOWMIN	.mgt	Chapter 20
DIVMAX	.mgt	Chapter 20
FLOWFR	.mgt	Chapter 20
WURCH(1-12)	.wus	Chapter 21
transfer command	.fig	Chapter 2
FLOW_OVN, ***route command***	.fig	Chapter 2

Channel Sediment Routing

Variable		File
IDEG	.bsn	Chapter 4
PRF	.bsn	Chapter 4
SPCON	.bsn	Chapter 4
SPEXP	.bsn	Chapter 4
CH_W(2)	.rte	Chapter 25
CH_D	.rte	Chapter 25
CH_S(2)	.rte	Chapter 25
CH_EROD	.rte	Chapter 25
CH_COV	.rte	Chapter 25
CH_WDR	.rte	Chapter 25

Channel Nutrient Routing

Variable		File
IWQ	.bsn	Chapter 4
AI1	.wwq	Chapter 26
AI2	.wwq	Chapter 26
P_N	.wwq	Chapter 26
RS2	.swq	Chapter 27
RS3	.swq	Chapter 27
RS4	.swq	Chapter 27
RS5	.swq	Chapter 27
BC1	.swq	Chapter 27
BC2	.swq	Chapter 27
BC3	.swq	Chapter 27
BC4	.swq	Chapter 27

Channel Water Quality Indices

Variable		File
IWQ	.bsn	Chapter 4
LAO	.wwq	Chapter 26
IGROPT	.wwq	Chapter 26
AI0	.wwq	Chapter 26
AI1	.wwq	Chapter 26
AI2	.wwq	Chapter 26
AI3	.wwq	Chapter 26
AI4	.wwq	Chapter 26
AI5	.wwq	Chapter 26
AI6	.wwq	Chapter 26
MUMAX	.wwq	Chapter 26
RHOQ	.wwq	Chapter 26
TFACT	.wwq	Chapter 26
K_L	.wwq	Chapter 26
K_N	.wwq	Chapter 26
K_P	.wwq	Chapter 26
LAMBDA0	.wwq	Chapter 26
LAMBDA1	.wwq	Chapter 26
LAMBDA2	.wwq	Chapter 26
P_N	.wwq	Chapter 26
RS1	.swq	Chapter 27
RK1	.swq	Chapter 27
RK2	.swq	Chapter 27
RK3	.swq	Chapter 27
RK4	.swq	Chapter 27
structure command	.fig	Chapter 2

Channel Pesticide Routing Input

Variable		File
IWQ	.bsn	Chapter 4
IRTPEST	.bsn	Chapter 4
CHPST_REA	.swq	Chapter 27
CHPST_VOL	.swq	Chapter 27
CHPST_KOC	.swq	Chapter 27
CHPST_STL	.swq	Chapter 27
CHPST_RSP	.swq	Chapter 27
CHPST_MIX	.swq	Chapter 27
SEDPST_CONC	.swq	Chapter 27
SEDPST_REA	.swq	Chapter 27
SEDPST_BRY	.swq	Chapter 27
SEDPST_ACT	.swq	Chapter 27

IMPOUNDMENT PROCESSES

Impoundment Water Routing—Pond

Variable		File
PND_FR	.pnd	Chapter 28
PND_PSA	.pnd	Chapter 28
PND_PVOL	.pnd	Chapter 28
PND_ESA	.pnd	Chapter 28
PND_EVOL	.pnd	Chapter 28
PND_VOL	.pnd	Chapter 28
PND_K	.pnd	Chapter 28
IFLOD1	.pnd	Chapter 28
IFLOD2	.pnd	Chapter 28
NDTARG	.pnd	Chapter 28
WUPND(1-12)	.wus	Chapter 21

Impoundment Water Routing—Wetland

Variable		File
WET_FR	.pnd	Chapter 28
WET_NSA	.pnd	Chapter 28
WET_NVOL	.pnd	Chapter 28
WET_MXSA	.pnd	Chapter 28
WET_MXVOL	.pnd	Chapter 28
WET_VOL	.pnd	Chapter 28
WET_K	.pnd	Chapter 28

Impoundment Water Routing—Pothole

Variable		File
POT_FR	.hru	Chapter 19
POT_TILE	.hru	Chapter 19
POT_VOLX	.hru	Chapter 19
POT_VOL	.hru	Chapter 19
EVLAI	.bsn	Chapter 4
release/impound operation	.mgt	Chapter 20

Impoundment Water Routing—Reservoir

Variable		File
RES_SUB	.res	Chapter 29
MORES	.res	Chapter 29
IYRES	.res	Chapter 29
RES_ESA	.res	Chapter 29
RES_EVOL	.res	Chapter 29
RES_PSA	.res	Chapter 29
RES_PVOL	.res	Chapter 29
RES_VOL	.res	Chapter 29
RES_K	.res	Chapter 29
IRESCO	.res	Chapter 29
OFLOWMX(1-12)	.res	Chapter 29
OFLOWMN(1-12)	.res	Chapter 29
RES_RR	.res	Chapter 29
RESMONO	.res	Chapter 29
IFLOD1R	.res	Chapter 29
IFLOD2R	.res	Chapter 29
NDTARGR	.res	Chapter 29
STARG(1-12)	.res	Chapter 29
RESDAYO	.res	Chapter 29
WURESN(1-12)	.res	Chapter 29
WURTNF	.res	Chapter 29
RES_OUTFLOW	resdayo.dat	Chapter 29
RESOUT	resmono.dat	Chapter 29

Impoundment Sediment Routing

Variable		File
PND_SED	.pnd	Chapter 28
PND_NSED	.pnd	Chapter 28
WET_SED	.pnd	Chapter 28
WET_NSED	.pnd	Chapter 28
POT_NSED	.hru	Chapter 19

Impoundment Sediment Routing

Variable		File
RES_SED	.res	Chapter 29
RES_NSED	.res	Chapter 29
RES_D50	.res	Chapter 29

Impoundment Nutrient Routing—Pond

Variable		File
PSETLP1	.pnd	Chapter 28
PSETLP2	.pnd	Chapter 28
NSETLP1	.pnd	Chapter 28
NSETLP2	.pnd	Chapter 28
PND_NO3	.pnd	Chapter 28
PND_SOLP	.pnd	Chapter 28
PND_ORGN	.pnd	Chapter 28
PND_ORGP	.pnd	Chapter 28
IPND1	.pnd	Chapter 28
IPND2	.pnd	Chapter 28

Impoundment Nutrient Routing—Wetland

Variable		File
PSETLW1	.pnd	Chapter 28
PSETLW2	.pnd	Chapter 28
NSETLW1	.pnd	Chapter 28
NSETLW2	.pnd	Chapter 28
WET_NO3	.pnd	Chapter 28
WET_SOLP	.pnd	Chapter 28
WET_ORGN	.pnd	Chapter 28
WET_ORGP	.pnd	Chapter 28
IPND1	.pnd	Chapter 28
IPND2	.pnd	Chapter 28

Impoundment Nutrient Routing—Reservoir

Variable		File
IRES1	.lwq	Chapter 30
IRES2	.lwq	Chapter 30
PSETLR1	.lwq	Chapter 30
PSETLR2	.lwq	Chapter 30
NSETLR1	.lwq	Chapter 30
NSETLR2	.lwq	Chapter 30

Impoundment Nutrient Routing—Reservoir, cont.

Variable		File
RES_ORGP	.lwq	Chapter 30
RES_SOLP	.lwq	Chapter 30
RES_ORGN	.lwq	Chapter 30
RES_NO3	.lwq	Chapter 30
RES_NH3	.lwq	Chapter 30
RES_NO2	.lwq	Chapter 30

Impoundment Water Quality Indices

Variable		File
CHLAP	.pnd	Chapter 28
SECCIP	.pnd	Chapter 28
CHLAW	.pnd	Chapter 28
SECCIW	.pnd	Chapter 28
CHLAR	.lwq	Chapter 30
SECCIR	.lwq	Chapter 30

Impoundment Pesticide Routing—Reservoir

Variable		File
IRTPEST	.bsn	Chapter 4
LKPST_CONC	.lwq	Chapter 30
LKPST_REA	.lwq	Chapter 30
LKPST_VOL	.lwq	Chapter 30
LKPST_KOC	.lwq	Chapter 30
LKPST_STL	.lwq	Chapter 30
LKPST_RSP	.lwq	Chapter 30
LKPST_MIX	.lwq	Chapter 30
LKSPST_CONC	.lwq	Chapter 30
LKSPST_REA	.lwq	Chapter 30
LKSPST_BRY	.lwq	Chapter 30
LKSPST_ACT	.lwq	Chapter 30