CHAPTER 4

SWAT INPUT DATA:
.BSN

General watershed attributes are defined in the basin input file. These attributes control a diversity of physical processes at the watershed level. The interfaces will automatically set these parameters to the "default" or recommended values listed in the variable documentation. Users can use the default values or change them to better reflect what is happening in a given watershed. Variables governing bacteria or pesticide transport need to be initialized only if these processes are being modeled in the watershed. Even if nutrients are not being studied in a watershed, some attention must be paid to these variables because nutrient cycling impacts plant growth which in turn affects the hydrologic cycle.

Following is a brief description of the variables in the basin input file. They are listed by topic.

4.1 TITLE

Variable name	Definition
TITLE	The first line is reserved for a description. The description may take up to 80 spaces. The title line is not processed by the model and may be left blank. Optional.

4.2 MODELING OPTIONS: LAND AREA

WATER BALANCE

Variable name	Definition
SFTMP	Snowfall temperature (ºC). Mean air temperature at which precipitation is equally likely to be rain as snow/freezing rain. The snowfall temperature should be between –5 ºC and 5 ºC. A default recommended for this variable is SFTMP = 1.0. Required in watersheds where snowfall is significant.
SMTMP	Snow melt base temperature (ºC). The snow pack will not melt until the snow pack temperature exceeds a threshold value, T_{mlt}. The snow melt base temperature should be between –5 ºC and 5 ºC. A default recommended for this variable is SMTMP = 0.50. Required in watersheds where snowfall is significant.

Variable name	Definition
SMFMX	Melt factor for snow on June 21 (mm H_2O/ºC-day). If the watershed is in the Northern Hemisphere, SMFMX will be the maximum melt factor. If the watershed is in the Southern Hemisphere, SMFMX will be the minimum melt factor. SMFMX and SMFMN allow the rate of snow melt to vary through the year. The variables account for the impact of snow pack density on snow melt. In rural areas, the melt factor will vary from 1.4 to 6.9 mm H_2O/day-°C (Huber and Dickinson, 1988). In urban areas, values will fall in the higher end of the range due to compression of the snow pack by vehicles, pedestrians, etc. Urban snow melt studies in Sweden (Bengston, 1981; Westerstrom, 1981) reported melt factors ranging from 3.0 to 8.0 mm H_2O/day-°C. Studies of snow melt on asphalt (Westerstrom, 1984) gave melt factors of 1.7 to 6.5 mm H_2O/day-°C. If no value for SMFMX is entered, the model will set SMFMX = 4.5. Required in watersheds where snowfall is significant.
SMFMN	Melt factor for snow on December 21 (mm H_2O/ºC-day). If the watershed is in the Northern Hemisphere, SMFMN will be the minimum melt factor. If the watershed is in the Southern Hemisphere, SMFMN will be the maximum melt factor. SMFMX and SMFMN allow the rate of snow melt to vary through the year. The variables account for the impact of snow pack density on snow melt. In rural areas, the melt factor will vary from 1.4 to 6.9 mm H_2O/day-°C (Huber and Dickinson, 1988). In urban areas, values will fall in the higher end of the range due to compression of the snow pack by vehicles, pedestrians, etc. Urban snow melt studies in Sweden (Bengston, 1981; Westerstrom, 1981) reported melt factors ranging from 3.0 to 8.0 mm H_2O/day-°C. Studies of snow melt on asphalt (Westerstrom, 1984) gave melt factors of 1.7 to 6.5 mm H_2O/day-°C. If no value for SMFMN is entered, the model will set SMFMN = 4.5. Required in watersheds where snowfall is significant.

Variable name	Definition
TIMP	Snow pack temperature lag factor. The influence of the previous day's snow pack temperature on the current day's snow pack temperature is controlled by a lagging factor, ℓ_{sno}. The lagging factor inherently accounts for snow pack density, snow pack depth, exposure and other factors affecting snow pack temperature. TIMP can vary between 0.01 and 1.0. As ℓ_{sno} approaches 1.0, the mean air temperature on the current day exerts an increasingly greater influence on the snow pack temperature and the snow pack temperature from the previous day exerts less and less influence. As TIMP goes to zero, the snow pack's temperature will be less influenced by the current day's air temperature. If no value for TIMP is entered, the model will set TIMP = 1.0. Required in watersheds where snowfall is significant.
SNOCOVMX	Minimum snow water content that corresponds to 100% snow cover, SNO_{100}, (mm H_2O). Due to variables such as drifting, shading and topography, the snow pack in a subbasin will rarely be uniformly distributed over the total area. This results in a fraction of the subbasin area that is bare of snow. This fraction must be quantified to accurately compute snow melt in the subbasin. The factors that contribute to variable snow coverage are usually similar from year to year, making it possible to correlate the areal coverage of snow with the amount of snow present in the subbasin at a given time. This correlation is expressed as an areal depletion curve, which is used to describe the seasonal growth and recession of the snow pack as a function of the amount of snow present in the subbasin (Anderson, 1976). The areal depletion curve requires a threshold depth of snow, SNO_{100}, to be defined above which there will always be 100% cover. The threshold depth will depend on factors such as vegetation distribution, wind loading of snow, wind scouring of snow, interception and aspect, and will be unique to the watershed of interest.

Variable name	Definition
SNOCOVMX, cont.	If the snow water content is less than SNOCOVMX, then a certain percentage of ground cover will be bare. It is important to remember that once the volume of water held in the snow pack exceeds SNO_{100} the depth of snow over the HRU is assumed to be uniform, i.e. sno_{cov} = 1.0. The areal depletion curve affects snow melt only when the snow pack water content is between 0.0 and SNO_{100}. Consequently if SNO_{100} is set to a very small value, the impact of the areal depletion curve on snow melt will be minimal. As the value for SNO_{100} increases, the influence of the areal depletion curve will assume more importance in snow melt processes. If no value for SNOCOVMX is entered, the model will set SNOCOVMX = 1.00. Required in watersheds where snowfall is significant.
SNO50COV	Fraction of snow volume represented by SNOCOVMX that corresponds to 50% snow cover. SWAT assumes a nonlinear relationship between snow water and snow cover. SNO50COV can vary between 0.01 and 0.99. Example areal depletion curves for various fractions of SNO_{100} at 50% coverage are shown in the following figures. If no value for SNO50COV is entered, the model will set SNO50COV = 0.50, i.e. 50% of SNOCOVMX. Required in watersheds where snowfall is significant.

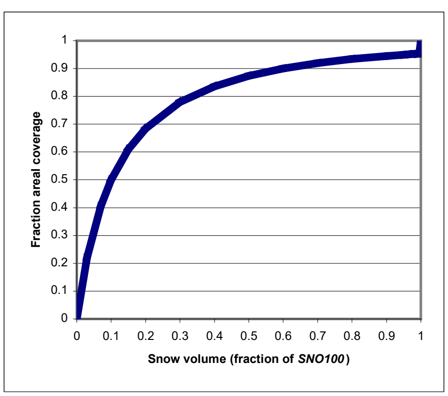

Figure 4-1: 10% SNO_{100} = 50% coverage

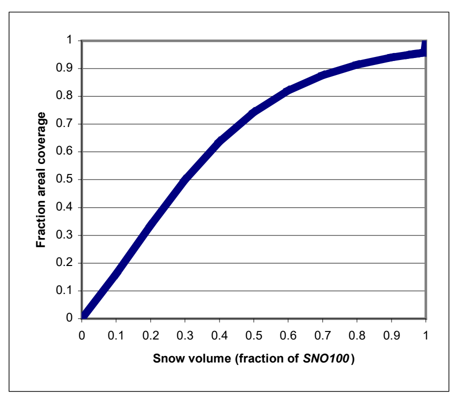

Figure 4-2: 30% SNO_{100} = 50% coverage

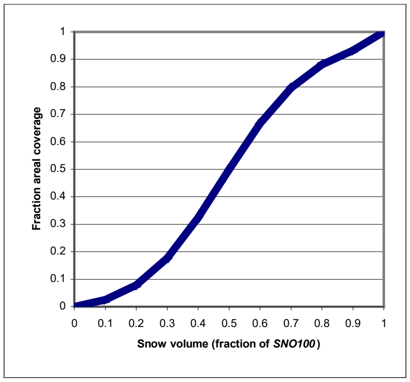

Figure 4-3: 50% SNO_{100} = 50% coverage

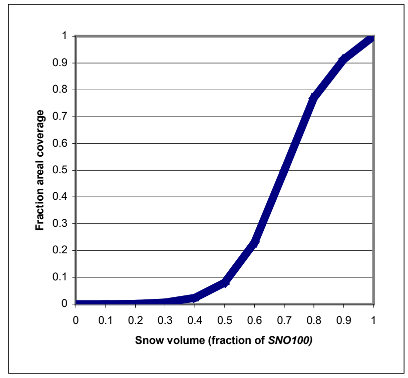

Figure 4-4: 70% SNO_{100} = 50% coverage

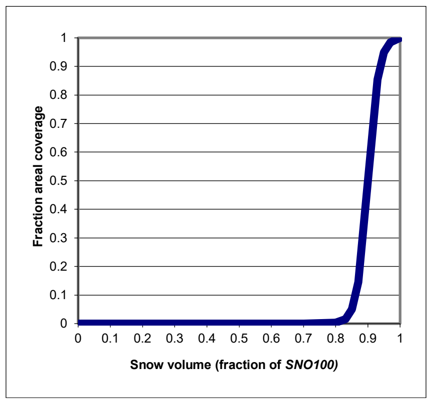

Figure 4-5: 90% SNO_{100} = 50% coverage

Variable name	Definition
IPET	Potential evapotranspiration (PET) method. There are four options for potential ET calculations: 0 Priestley-Taylor method 1 Penman/Monteith method 2 Hargreaves method 3 read in potential ET values Numerous methods exist to calculate potential evapotranspiration. Three of the most popular or widely-used are included in SWAT. However, if a method other than Priestley-Taylor, Penman/Monteith, or Hargreaves is recommended for the area in which the watershed is located, the user can calculate daily PET values with the recommended method and import them into SWAT. A discussion of Priestley-Taylor, Penman-Monteith and Hargreaves PET methods is found in Chapter 2:2 of the theoretical documentation. Required.

Variable name	Definition
PETFILE	Name of potential evapotranspiration input file (**.pet**). This file is described in Chapter 11. Required only if IPET = 3.
ESCO	Soil evaporation compensation factor. This coefficient has been incorporated to allow the user to modify the depth distribution used to meet the soil evaporative demand to account for the effect of capillary action, crusting and cracks. ESCO must be between 0.01 and 1.0. As the value for ESCO is reduced, the model is able to extract more of the evaporative demand from lower levels. The change in depth distribution resulting from different values of *esco* are graphed in Figure 4-6.

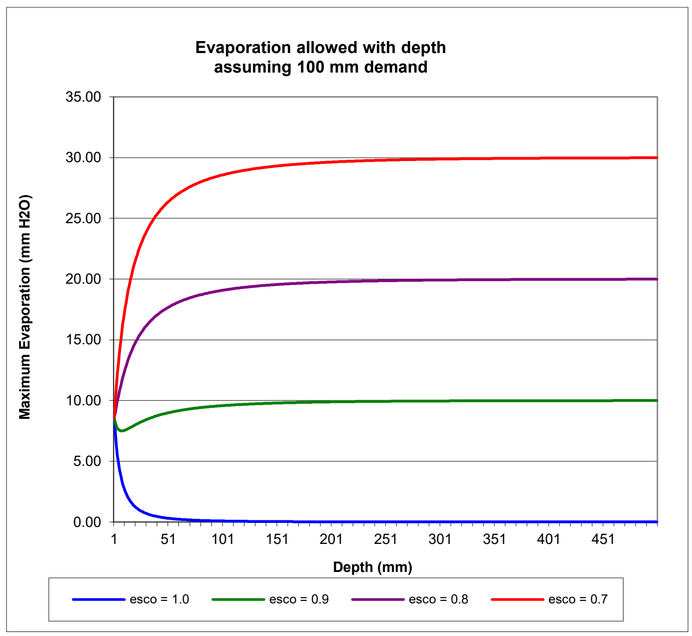

Figure 4-6: Soil evaporative demand distribution with depth

If no value for ESCO is entered, the model will set ESCO = 0.95. The value for ESCO may be set at the watershed or HRU level (ESCO in .hru file, see Chapter 19).

Required.

Variable name	Definition
EPCO	Plant uptake compensation factor. The amount of water uptake that occurs on a given day is a function of the amount of water required by the plant for transpiration, E_t, and the amount of water available in the soil, *SW*. If upper layers in the soil profile do not contain enough water to meet the potential water uptake, users may allow lower layers to compensate. The plant uptake compensation factor can range from 0.01 to 1.00. As *epco* approaches 1.0, the model allows more of the water uptake demand to be met by lower layers in the soil. As *epco* approaches 0.0, the model allows less variation from the original depth distribution to take place. If no value for EPCO is entered, the model will set EPCO = 1.0. The value for EPCO may be set at the watershed or HRU level (EPCO in .hru file, see Chapter 19). Required.
EVLAI	Leaf area index at which no evaporation occurs from water surface. EVLAI is used in HRUs where a plant is growing in a ponded environment (e.g. rice). Currently, this is simulated only in HRUs defined as depressional areas/potholes. Evaporation from the water surface is allowed until the leaf area of the plant reaches the value specified for EVLAI. Chapter 8:1 in the Theoretical Documentation provides more detail on the use of this parameter. EVLAI should be set between 0.0 and 10.0. If no value for EVLAI is entered, the model will set EVLAI = 3.0. Required if depressional areas/potholes are modeled in the watershed.

Variable name	Definition
FFCB	Initial soil water storage expressed as a fraction of field capacity water content. All soils in the watershed will be initialized to the same fraction. FFCB should be between 0.0 and 1.0. If FFCB is not set to a value, the model will calculate it as a function of average annual precipitation. The default method is to allow the model to calculate FFCB (set FFCB = 0.0). We recommend using a 1 year equilibration period for the model where the watershed simulation is set to start 1 year prior to the period of interest. This allows the model to get the water cycling properly before any comparisons between measured and simulated data are made. When an equilibration period is incorporated, the value for FFCB is not going to impact model results. Required.

SURFACE RUNOFF

Variable name	Definition
IEVENT	Rainfall/runoff/routing option: 0 daily rainfall/curve number runoff/daily routing 1 sub-daily rainfall/Green & Ampt infiltration/sub-daily routing Option 0 is the default option. Required.

Variable name	Definition
ICN	Daily curve number calculation method: 0 calculate daily CN value as a function of soil moisture 1 calculate daily CN value as a function of plant evapotranspiration 2 use traditional SWAT method which bases CN on soil moisture but retention is adjusted for mildly-sloped tiled-drained watersheds Option 0 was the only method used to calculate the daily CN value in versions of SWAT prior to SWAT2012. Calculation of the daily CN value as a function of plant evapotranspiration was added because the soil moisture method was predicting too much runoff in shallow soils. By calculating daily CN as a function of plant evapotranspiration, the value is less dependent on soil storage and more dependent on antecedent climate. Required.
CNCOEF	Plant ET curve number coefficient. ET weighting coefficient used to calculate the retention coefficient for daily curve number calculations dependent on plant evapotranspiration. This value can vary between 0.5 and 2.0. If no value is entered for CNCOEF, the model will set CNCOEF = 1.0. Required if ICN = 1.
ICRK	Crack flow code. There are two options: 0 do not model crack flow in soil 1 model crack flow in soil Crack, or bypass, flow is a newer feature in SWAT and has been tested on a limited basis in simulations of some areas in Texas. This type of flow should be modeled only on soils classified as Vertisols. The default option is to model the watershed without crack flow. Required.

Variable name	Definition
SURLAG	Surface runoff lag coefficient. In large subbasins with a time of concentration greater than 1 day, only a portion of the surface runoff will reach the main channel on the day it is generated. SWAT incorporates a surface runoff storage feature to lag a portion of the surface runoff release to the main channel. SURLAG controls the fraction of the total available water that will be allowed to enter the reach on any one day. Figure 4-7 plots the fraction of total available water entering the reach at different values for *surlag* and t_{conc}. Note that for a given time of concentration, as *surlag* decreases in value more water is held in storage. The delay in release of surface runoff will smooth the streamflow hydrograph simulated in the reach. If no value for SURLAG is entered, the model will set SURLAG = 4.0. Required.

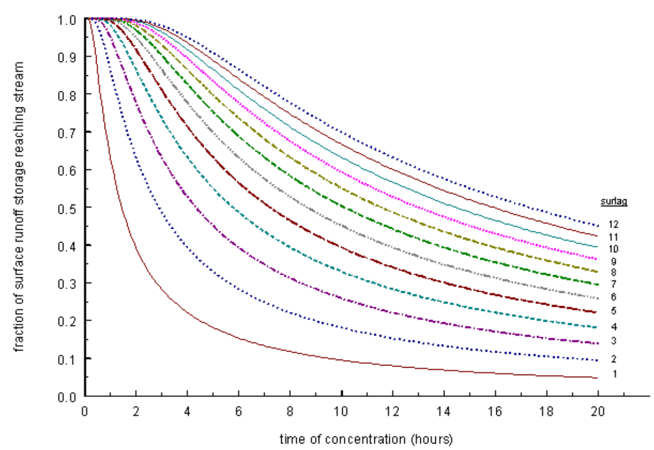

Figure 4-7: Influence of *surlag* and t_{conc} on fraction of surface runoff released.

Variable name	Definition
ISED_DET	Code governing calculation of daily maximum half-hour rainfall value: 0 generate daily value using triangular distribution 1 use monthly maximum half-hour rainfall value for all days in month The user has the option of using the monthly maximum half-hour rainfall for all days in the month. The randomness of the triangular distribution used to generated daily values causes the maximum half-hour rainfall value to jump around. For small plots or microwatersheds in particular, the variability of the triangular distribution is unrealistic. Required.
ADJ_PKR	Peak rate adjustment factor for sediment routing in the *subbasin (tributary channels)*. Sediment routing is a function of peak flow rate and mean daily flow. Because SWAT originally could not directly calculate the sub-daily hydrograph due to the use of precipitation summarized on a daily basis, this variable was incorporated to allow adjustment for the effect of the peak flow rate on sediment routing. This factor is used in the MUSLE equation and impacts the amount of erosion generated in the HRUs. If no value for ADJ_PKR is entered, the model will set ADJ_PKR=1.0. Required.
TB_ADJ	*New variable in testing.* *Adjustment factor for subdaily unit hydrograph basetime.*

NUTRIENT CYCLING

Variable name	Definition
RCN	Concentration of nitrogen in rainfall (mg N/L). If no value for RCN is entered, the model will set RCN = 1.0. Required.

Variable name	Definition
CMN	Rate factor for humus mineralization of active organic nutrients (N and P). Chapters 3:1 and 3:2 of the Theoretical Documentation describe the use of this parameter in the mineralization calculations. If no value for CMN is specified, the model will set CMN = 0.0003. Required.
CDN	Denitrification exponential rate coefficient. This coefficient allows the user to control the rate of denitrification. Acceptable values for CDN range from 0.0 to 3.0. If no value for CDN is specified, the model will set CDN = 1.4. Required.

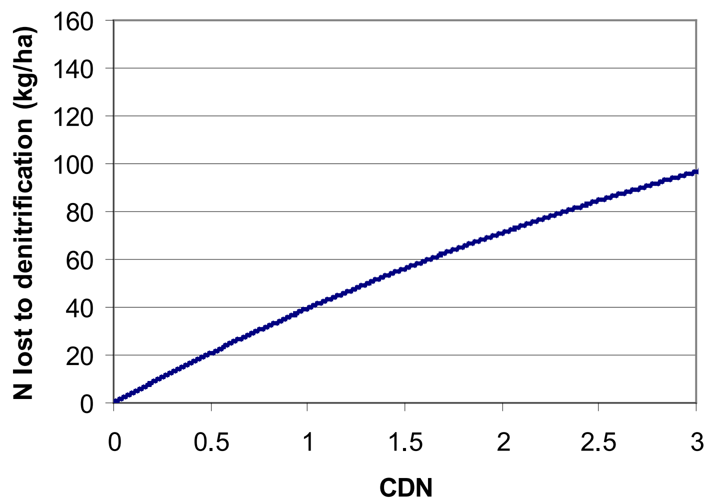

Fig 4-8: Impact of CDN value on amount of nitrogen lost to denitrification assuming initial nitrate content in layer is 200 kg/ha, temperature of layer is 10 °C, and organic carbon content of layer is 2%.

Variable name	Definition
SDNCO	Denitrification threshold water content. Fraction of field capacity water content above which denitrification takes place. Denitrification is the bacterial reduction of nitrate, NO_3^-, to N_2 or N_2O gases under anaerobic (reduced) conditions. Because SWAT does not track the redox status of the soil layers, the presence of anaerobic conditions in a soil layer is defined by this variable. If the soil water content calculated as fraction of field capacity is ≥ SDNCO, then anaerobic conditions are assumed to be present and denitrification is modeled. If the soil water content calculated as a fraction of field capacity is < SDNCO, then aerobic conditions are assumed to be present and denitrification is not modeled. If no value for SDNCO is specified, the model will set SDNCO = 1.10. Required.
N_UPDIS	Nitrogen uptake distribution parameter. Root density is greatest near the surface, and plant nitrogen uptake in the upper portion of the soil will be greater than in the lower portion. The depth distribution of nitrogen uptake is controlled by β_n, the nitrogen uptake distribution parameter. The importance of the nitrogen uptake distribution parameter lies in its control over the maximum amount of nitrate removed from the upper layers. Because the top 10 mm of the soil profile interacts with surface runoff, the nitrogen uptake distribution parameter will influence the amount of nitrate available for transport in surface runoff. The model allows lower layers in the root zone to fully compensate for lack of nitrate in the upper layers, so there should not be significant changes in nitrogen stress with variation in the value used for β_n. If no value for N_UPDIS is entered, the model will set N_UPDIS = 20.0. Figure 4-9 illustrates nitrogen uptake as a function of depth for four different uptake distribution parameter values. Required.

Variable name	Definition
N_UPDIS, cont.	

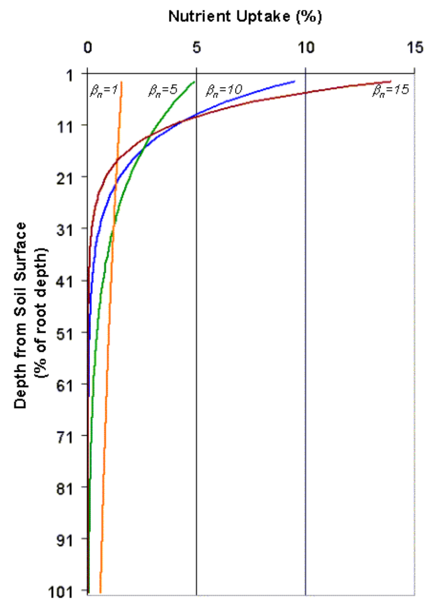

Figure 4-9: Depth distribution of nitrogen uptake

P_UPDIS	Phosphorus uptake distribution parameter. This parameter controls plant uptake of phosphorus from the different soil horizons in the same way that UBN controls nitrogen uptake. The illustration of nitrogen uptake as a function of depth for four different uptake distribution parameter values in Figure 4-9 is valid for phosphorus uptake as well. Phosphorus removed from the soil by plants is taken from the solution phosphorus pool. The importance of the phosphorus uptake distribution parameter lies in its control over the maximum amount of solution P removed from the upper layers. Because the top 10 mm of the soil profile interacts with surface runoff, the phosphorus uptake distribution parameter will influence the amount of labile phosphorus available for transport in surface runoff. The model allows lower layers in the root zone to fully compensate for lack of solution P in the upper layers, so there should not be significant changes in phosphorus stress with variation in the value used for β_p.

Variable name	Definition
P_UPDIS, cont.	If no value for P_UPDIS is entered, the model will set P_UPDIS = 20.0. Required.
NPERCO	Nitrate percolation coefficient. NPERCO controls the amount of nitrate removed from the surface layer in runoff relative to the amount removed via percolation. The value of NPERCO can range from 0.01 to 1.0. As NPERCO → 0.0, the concentration of nitrate in the runoff approaches 0. As NPERCO → 1.0, surface runoff has the same concentration of nitrate as the percolate. If no value for NPERCO is entered, the model will set NPERCO = 0.20. Required.
PPERCO	Phosphorus percolation coefficient (10 m^3/Mg). The phosphorus percolation coefficient is the ratio of the solution phosphorus concentration in the surface 10 mm of soil to the concentration of phosphorus in percolate. The value of PPERCO can range from 10.0 to 17.5 If no value for PPERCO is entered, the model will set PPERCO = 10.0. Required.
PHOSKD	Phosphorus soil partitioning coefficient (m3/Mg). The phosphorus soil partitioning coefficient is the ratio of the soluble phosphorus concentration in the surface 10 mm of soil to the concentration of soluble phosphorus in surface runoff. The primary mechanism of phosphorus movement in the soil is by diffusion. Diffusion is the migration of ions over small distances (1-2 mm) in the soil solution in response to a concentration gradient. Due to the low mobility of solution phosphorus, surface runoff will only partially interact with the solution P stored in the top 10 mm of soil. If no value for PHOSKD is entered, the model will set PHOSKD = 175.0. Required.

Variable name	Definition
PSP	Phosphorus availability index. Many studies have shown that after an application of soluble P fertilizer, solution P concentration decreases rapidly with time due to reaction with the soil. This initial "fast" reaction is followed by a much slower decrease in solution P that may continue for several years (Barrow and Shaw, 1975; Munns and Fox, 1976; Rajan and Fox, 1972; Sharpley, 1982). In order to account for the initial rapid decrease in solution P, SWAT assumes a rapid equilibrium exists between solution P and an "active" mineral pool. The subsequent slow reaction is simulated by the slow equilibrium assumed to exist between the "active" and "stable" mineral pools. The algorithms governing movement of inorganic phosphorus between these three pools are taken from Jones et al. (1984). Equilibration between the solution and active mineral pool is governed by the phosphorus availability index. This index specifies the fraction of fertilizer P which is in solution after an incubation period, i.e. after the rapid reaction period. A number of methods have been developed to measure the phosphorus availability index. Jones et al. (1984) recommends a method outlined by Sharpley et al. (1984) in which various amounts of phosphorus are added in solution to the soil as K_2HPO_4. The soil is wetted to field capacity and then dried slowly at 25°C. When dry, the soil is rewetted with deionized water. The soil is exposed to several wetting and drying cycles over a 6-month incubation period. At the end of the incubation period, solution phosphorus is determined by extraction with anion exchange resin. The P availability index is then calculated: $$pai = \frac{P_{solution,f} - P_{solution,i}}{fert_{minP}}$$ where *pai* is the phosphorus availability index, $P_{solution,f}$ is the amount of phosphorus in solution after fertilization and incubation, $P_{solution,i}$ is the amount of phosphorus in solution before fertilization, and $fert_{minP}$ is the amount of soluble P fertilizer added to the sample. If no value for PSP is entered, the model will set PSP = 0.40. Required.

Variable name	Definition
RSDCO	Residue decomposition coefficient. The fraction of residue which will decompose in a day assuming optimal moisture, temperature, C:N ratio and C:P ratio. If no value for RSDCO is entered, the model will set RSDCO = 0.05. Required.

PESTICIDE CYCLING

Variable name	Definition
PERCOP	Pesticide percolation coefficient. PERCOP controls the amount of pesticide removed from the surface layer in runoff and lateral flow relative to the amount removed via percolation. The value of PERCOP can range from 0.01 to 1.0. As PERCOP → 0.0, the concentration of pesticide in the runoff and lateral flow approaches 0. As PERCOP → 1.0, surface runoff and lateral flow has the same concentration of pesticide as the percolate. If no value for PERCOP is entered, the model will set PERCOP = 0.50. Required if pesticide transport is of interest.

ALGAE/CBOD/DISSOLVED OXYGEN

Variable name	Definition
ISUBWQ	Subbasin water quality code. The algorithms used to calculate loadings of algae, organic carbonaceous biological oxygen demand and dissolved oxygen to the stream network (see Chapter 4:4 in Theoretical Documentation) were derived from results of limited studies and are still in the testing phase. ISUBWQ allows the user to choose to apply or not apply the algorithms. 0 do not calculate algae/CBOD loadings and set dissolved oxygen to saturated oxygen concentration 1 calculate algae/CBOD/dissolved oxygen loadings using algorithms documented in Theoretical Documentation The default option is ISUBWQ=0. Required.

BACTERIA

Variable name	Definition
WDPQ	Die-off factor for persistent bacteria in soil solution at 20°C. (1/day) SWAT allows two different bacteria types to be modeled in a given simulation. In the input/output files these two types are referred to as 'persistent' and 'less persistent'. These terms are purely descriptive and are used solely to differentiate between the two types. The bacteria input variables in the .bsn file govern the actual persistence of the two bacteria types. The user may choose to model no, one, or two types of bacteria. Required if bacteria processes are of interest.
WGPQ	Growth factor for persistent bacteria in soil solution at 20°C. (1/day) Required if bacteria processes are of interest.
WDLPQ	Die-off factor for less persistent bacteria in soil solution at 20°C. (1/day) Required if bacteria processes are of interest.
WGLPQ	Growth factor for less persistent bacteria in soil solution at 20°C. (1/day) Required if bacteria processes are of interest.
WDPS	Die-off factor for persistent bacteria adsorbed to soil particles at 20°C. (1/day) Required if bacteria processes are of interest.
WGPS	Growth factor for persistent bacteria adsorbed to soil particles at 20°C. (1/day) Required if bacteria processes are of interest.
WDLPS	Die-off factor for less persistent bacteria adsorbed to soil particles at 20°C. (1/day) Required if bacteria processes are of interest.
WGLPS	Growth factor for less persistent bacteria adsorbed to soil particles at 20°C. (1/day) Required if bacteria processes are of interest.

Variable name	Definition
WDPF	Die-off factor for persistent bacteria on foliage at 20°C. (1/day) Required if bacteria processes are of interest.
WGPF	Growth factor for persistent bacteria on foliage at 20°C. (1/day) Required if bacteria processes are of interest.
WDLPF	Die-off factor for less persistent bacteria on foliage at 20°C. (1/day) Required if bacteria processes are of interest.
WGLPF	Growth factor for less persistent bacteria on foliage at 20°C. (1/day) Required if bacteria processes are of interest.
BACT_SWF	Fraction of manure applied to land areas that has active colony forming units. If no value for BACT_SWF is specified, the model will set BACT_SWF = 0.15. Required if bacteria processes are of interest.
WOF_P	Wash-off fraction for persistent bacteria. Fraction of persistent bacteria on foliage that washes off during a rainfall event. Required if bacteria processes are of interest.
WOF_LP	Wash-off fraction for less persistent bacteria. Fraction of less persistent bacteria on foliage that washes off during a rainfall event. Required if bacteria processes are of interest.

Variable name	Definition
BACTKDQ	Bacteria soil partitioning coefficient (m^3/Mg). The bacteria soil partitioning coefficient is the ratio of the solution bacteria concentration in the surface 10 mm of soil to the concentration of solution bacteria in surface runoff. Due to the low mobility of bacteria, surface runoff will only partially interact with the solution bacteria stored in the top 10 mm of soil. If no value for BACTKDQ is entered, the model will set BACTKDQ = 175.0. Required if bacteria processes are of interest.
BACTMIX	Bacteria percolation coefficient (10 m^3/Mg). The bacteria percolation coefficient is the ratio of the solution bacteria concentration in the surface 10 mm of soil to the concentration of bacteria in percolate. The value of BACTMIX can range from 7.0 to 20.0. If no value for BACTMIX is entered, the model will set BACTMIX = 10.0. Required if bacteria processes are of interest.
THBACT	Temperature adjustment factor for bacteria die-off/growth. If no value for THBACT is entered, the model will set THBACT = 1.07. Required if bacteria processes are of interest.
BACTMINLP	Minimum daily bacteria loss for less persistent bacteria (# cfu/m^2). This is the minimum daily bacteria loss from each of the different bacteria pools. Also, when bacteria levels fall below BACTMIN the model considers the remaining bacteria in the soil to be insignificant and zeros out, i.e. kills, the remaining bacteria. If no value for BACTMIN is entered, the model will set BACTMIN = 0.0.

BACTMINP	Minimum daily bacteria loss for persistent bacteria (# cfu/m^2). This is the minimum daily bacteria loss from each of the different bacteria pools. Also, when bacteria levels fall below BACTMIN the model considers the remaining bacteria in the soil to be insignificant and zeros out, i.e. kills, the remaining bacteria. If no value for BACTMIN is entered, the model will set BACTMIN = 0.0.
WDLPRCH	Die-off factor for less persistent bacteria in streams (moving water) at 20°C. (1/day) Required if bacteria processes are of interest.
WDPRCH	Die-off factor for persistent bacteria in streams (moving water) at 20°C. (1/day) Required if bacteria processes are of interest.
WDLPRES	Die-off factor for less persistent bacteria in water bodies (still water) at 20°C. (1/day) Required if bacteria processes are of interest.
WDPRES	Die-off factor for persistent bacteria in water bodies (still water) at 20°C. (1/day) Required if bacteria processes are of interest.

4.3 MODELING OPTIONS: REACHES

Variable name	Definition
IRTE	Channel water routing method: 0 variable storage method 1 Muskingum method The user must be careful to define MSK_CO1, MSK_CO2 and MSK_X when the Muskingum method is chosen. The default option is IRTE=0. Required.

Variable name	Definition
MSK_CO1	Calibration coefficient used to control impact of the storage time constant (K_m) for normal flow (where normal flow is when river is at bankfull depth) upon the K_m value calculated for the reach. Required only if IRTE = 1.
MSK_CO2	Calibration coefficient used to control impact of the storage time constant (K_m) for low flow (where low flow is when river is at 0.1 bankfull depth) upon the K_m value calculated for the reach. Required only if IRTE = 1.
MSK_X	MSK_X is a weighting factor that controls the relative importance of inflow and outflow in determining the storage in a reach. The weighting factor has a lower limit of 0.0 and an upper limit of 0.5. This factor is a function of the wedge storage. For reservoir-type storage, there is no wedge and X = 0.0. For a full-wedge, X = 0.5. For rivers, X will fall between 0.0 and 0.3 with a mean value near 0.2. If no value for MSK_X is entered, the model will set MSK_X = 0.2. Required only if IRTE = 1.
TRNSRCH	Fraction of transmission losses from main channel that enter deep aquifer. The remainder if the transmission losses enter bank storage. In arid watersheds, transmission losses from the main channel network may be permanently lost due to transmission to aquifers that do not contribute flow back to the stream network. This variable allows the user to specify the fraction of transmission losses from the channel network that is permanently lost. TRNSRCH varies between 0.00 and 1.00. The default value for TRNSRCH is 0.00. Required.

Variable name	Definition
EVRCH	Reach evaporation adjustment factor. The evaporation coefficient is a calibration parameter for the user and is allowed to vary between 0.0 and 1.0. This coefficient was created to allow reach evaporation to be dampened in arid regions. The original equation tends to overestimate evaporation in these areas. If no value for EVRCH is entered, the model will set EVRCH = 1.00. Required.
IDEG	Channel degradation code. There are two options: 0 channel dimensions are not updated as a result of degradation (the dimensions remain constant for the entire simulation) 1 channel dimensions are updated as a result of degradation Traditionally, channel dimensions remain fixed, or constant, throughout the simulation. The change in channel dimensions with time is a new feature in SWAT that is still in the testing phase. The recommended option is to keep the channel dimensions constant. Required.
PRF	Peak rate adjustment factor for sediment routing in the main channel. Sediment routing is a function of peak flow rate and mean daily flow. Because SWAT originally could not directly calculate the sub-daily hydrograph, this variable was incorporated to allow adjustment for the effect of the peak flow rate on sediment routing. This variable impacts channel degradation. If no value for PRF is entered, the model will set PRF = 1.0. Required.

Variable name	Definition
SPCON	Linear parameter for calculating the maximum amount of sediment that can be reentrained during channel sediment routing. The maximum amount of sediment that can be transported from a reach segment is calculated $conc_{sed,ch,mx} = c_{sp} \cdot v_{ch,pk}^{spexp}$ where concsed,ch,mx is the maximum concentration of sediment that can be transported by the water (ton/m3 or kg/L), csp is a coefficient defined by the user, vch,pk is the peak channel velocity (m/s), and spexp is an exponent defined by the user. SPCON should be between 0.0001 and 0.01. If no value for SPCON is entered, the model will set SPCON = 0.0001. Required.
SPEXP	Exponent parameter for calculating sediment reentrained in channel sediment routing The maximum amount of sediment that can be transported from a reach segment is calculated $conc_{sed,ch,mx} = c_{sp} \cdot v_{ch,pk}^{spexp}$ where concsed,ch,mx is the maximum concentration of sediment that can be transported by the water (ton/m3 or kg/L), csp is a coefficient defined by the user, vch,pk is the peak channel velocity (m/s), and spexp is an exponent defined by the user. The exponent, spexp, normally varies between 1.0 and 2.0 and was set at 1.5 in the original Bagnold stream power equation (Arnold et al., 1995). If no value for SPEXP is entered, the model will set SPEXP = 1.0. Required.

Variable name	Definition
IWQ	In-stream water quality code. The variable identifies whether in-stream transformation of nutrients using the QUAL2E algorithms and in-stream transformation of pesticides is allowed to occur. 0 do not model in-stream nutrient and pesticide transformations 1 model in-stream nutrient and pesticide transformations The default option is IWQ=0. Required.
WWQFILE	Name of watershed water quality input file (**.wwq**). This file is described in Chapter 26. Required.
IRTPEST	Identification number of pesticide to be routed through the watershed channel network. This is the pesticide ID number from the pesticide database. While more than one type of pesticide may be applied to the HRUs, the model will monitor the movement of only one pesticide through the channel network. Required only if pesticide transport processes are of interest.

DEPIMP_BSN
Depth to impervious layer for modeling perched water tables (mm).

This variable is included for convenience. A value for DEPIMP_BSN can be defined that will be used to set the value of DEP_IMP (.hru) for every HRU in the watershed. If the user sets a value for DEPIMP_BSN and also sets values for DEP_IMP in some HRUs, the customized values for DEP_IMP will not be overwritten by the basin level value (DEPIMP_BSN).

For watersheds where there are no perched water tables, DEPIMP_BSN should be set to 0. For watersheds where perched water tables occur in only a portion of the watershed, DEPIM_BSN should be set to 0 and the DEP_IMP variable (.hru) should be used to set the depth to the impervious layer for those areas that have perched water tables.

See DEP_IMP (.hru) for more information.

Optional.

DDRAIN_BSN
Depth to the sub-surface drain (mm)

Optional.

TDRAIN_BSN
Time to drain soil to field capacity (hours).

Optional.

GDRAIN_BSN
Drain tile lag time (hours).

Optional.

CNFROZ_BSN
Parameter for frozen soil adjustment on infiltration/runoff.

If no value for CNFROZ_BSN is entered, the model will set CNFROZ_BSN = 0.000862.

Optional.

DORM_HR
Time threshold used to define dormancy (hours). The maximum day length minus DORM_HR is equal to when dormancy occurs.

Optional.

SMXCO
Adjustment factor for maximum curve number S factor. Coefficient curve number method that uses antecedent climate.

Optional.

FIXCO
Nitrogen fixation coefficient. (0.0 – 1.0)

1.0 = fixes 100% of nitrogen demand. 0.0 = fixes none of nitrogen demand.

NFIXMX	Maximum daily-n fixation (kg/ha). (1.0 – 20.0)
ANION_EXCL_BSN	Fraction of porosity from which anions are excluded. (.01 – 1.00)
CH_ONCO_BSN	Channel organic nitrogen concentration in basin (ppm). (0.0 – 100.0)
CH_OPCO_BSN	Channel organic phosphorus concentration in basin (ppm). (0.0 – 100)
HLIFE_NGW_BSN	Half-life of nitrogen in groundwater (days) (0.0 – 500.0)
RCN_SUB_BSN	Concentration of nitrate in precipitation (ppm). (0.0 – 2.0)
BC1_BSN	Rate constant for biological oxidation of NH3 (1/day). (0.10 – 1.0)
BC2_BSN	Rate constant for biological oxidation NO2 to NO3 (1/day) (0.2 – 2.0)
BC3_BSN	Rate constant for hydrolosis of organic nitrogen to ammonia (1/day). (0.02 – 0.40)
BC4_BSN	Rate constant for decay of organic phosphorus to dissolved phosphorus (1/day) (0.01 – 0.70)
DECR_MIN	Minimum daily residue decay (fraction 0.0 – 0.05)
ICFAC	ICFAC = 0 for C-factor calculation using Cmin. ICFAC = 1 for new C-factor calculation. (0-1)
RSD_COVCO	Residue cover factor for computing fraction of cover. (0.1 – 0.5)
VCRIT	Critical velocity
CSWAT	Code for new carbon routines: 0 = original routines 1 = new carbon routines
RES_STLR_CO	Reservoir sediment settling coefficient (0.09 – 0.27)
SOL_P_MODEL	Code 0 = use new soil phosphorus routines 1 = use original soil phosphorus subroutines
IABSTR	Initial abstraction on impervious cover (mm)
BFLO_DIST	Baseflow distribution factor during the day for subdaily runs. 0 = baseflow evenly distributed to each time step during the day 0.5 = even weights between even distribution and rainfall pattern 1= profile of baseflow in a day follows rainfall pattern
IUH	Unit hydrograph method: 1 = triangular UH 2 = gamma function UH

UHALPHA	Alpha coefficient for gamma function unit hydrograph. Required if iuh = 2 is selected
TLU	A temporary string variable)no default or min/max values)
LU_NODRAIN	Land use typed in urban.dat that do not make runoff to urban BMPs

4.4 SUBDAILY EROSION

Variable name	Definition
EROS_SPL	Splash erosion coefficient (0.9 – 3.1)
RILL_MULT	Rill erosion coefficient – multiplier to USLE_K for soil susceptible to rill erosion (0.5-2.0)
EROS_EXPO	Exponential coefficient for overland flow – (1.5-3.0)
SUBD_CHSED	Instream sediment model, 0=Bagnold model, 1=Brownlie model, 2=Yang model
C_FACTOR	Scaling parameter for cover and management factor for overland flow erosion (0.03/0.001/0.45)
CH_D50	Median particle diameter of main channel (mm) (50/10/100)
SIG_G	Geometric standard deviation of particle size (1.57/1.0/5.0)

4.5 SUBBASIN DRAINAGE

Variable name	Definition
DRAIN_CO_BSN	Daily drainage coefficient (mm day^{-1}). Range (10-51 mm day^{-1})
LATKSATF_BSN	Multiplication factor to determine lateral ksat (conk(j1,j)) from SWAT ksat input value (sol_k(j1,j)) for HRU Range (0.01 - 4.00)
PC_BSN	Pump capacity (mm h^{-1}) Default value = 1.042 mm h^{-1} or 22 mm day^{-1}
RE_BSN	Effective radius of drains (mm) Range (3.0 – 40.0 mm)
SDRAIN_BSN	Distance between two drain tubes or tiles (mm) Range (7600 – 30000 mm)
ITDRN	Tile drainage equations flag/code Tile drainage routines flag/code: 1 = DRAINMOD tile equations (Subroutine DRAINS) 1 simulate tile flow using subroutine drains(wt_shall) 0 simulate tile flow using subroutine origtile(wt_shall,d)
IWTDN	water table depth algorithms flag/code 1 simulate wt_shall using subroutine new water table depth routine 0 simulate wt_shall using subroutine original water table depth routine
SOL_P_MODEL	Soil phosphorus model 0 = original soil phosphorus model 1 = new soil phosphorus model
IABSTR	Initial abstraction on impervious cover (mm)
IATMODEP	Atmospheric deposition values 0=read in average annual values 1=read in monthly values
R2ADJ	Curve number retention parameter adjustment for low gradient, non-draining soils (dimensionless) (0-3)

The basin input file is a free format file. The variables may be placed in any position the user wishes on the line. Values for variables classified as integers *should not* include a decimal while values for variables classified as reals *must* contain a decimal. A blank space denotes the end of an input value and the beginning of the next value if there is another on the line.

Variable name	**Line #**	**Format**	**F90 Format**
TITLE	1	character	a80
Comment line	2	character	a80
Comment line	3	character	a80
SFTMP	4	real	free
SMTMP	5	real	free
SMFMX	6	real	free
SMFMN	7	real	free
TIMP	8	real	free
SNOCOVMX	9	real	free
SNO50COV	10	real	free
IPET	11	integer	free
PETFILE	12	character	a13 (space 1-13)
ESCO	13	real	free
EPCO	14	real	free
EVLAI	15	real	free
FFCB	16	real	free
Comment line	17	character	a80
IEVENT	18	integer	free
ICRK	19	integer	free
SURLAG	20	real	free
ADJ_PKR	21	real	free
PRF	22	real	free

Variable name	Line #	Format	F90 Format
SPCON	23	real	free
SPEXP	24	real	free
Comment line	25	character	a80
RCN	26	real	free
CMN	27	real	free
N_UPDIS	28	real	free
P_UPDIS	29	real	free
NPERCO	30	real	free
PPERCO	31	real	free
PHOSKD	32	real	free
PSP	33	real	free
RSDCO	34	real	free
Comment line	35	character	a80
PERCOP	36	real	free
Comment line	37	character	a80
ISUBWQ	38	integer	free
Comment line	39	character	a80
WDPQ	40	real	free
WGPQ	41	real	free
WDLPQ	42	real	free
WGLPQ	43	real	free
WDPS	44	real	free
WGPS	45	real	free
WDLPS	46	real	free
WGLPS	47	real	free
BACTKDQ	48	real	free
THBACT	49	real	free
WOF_P	50	real	free
WOF_LP	51	real	free
WDPF	52	real	free
WGPF	53	real	free
WDLPF	54	real	free
WGLPF	55	real	free

Variable name	Line #	Format	F90 Format
ISED_DET	56	integer	free
Comment line	57	character	a80
IRTE	58	integer	free
MSK_CO1	59	real	free
MSK_CO2	60	real	free
MSK_X	61	real	free
IDEG	62	integer	free
IWQ	63	integer	free
WWQFILE	64	character	a13 (space 1-13)
TRNSRCH	65	real	free
EVRCH	66	real	free
IRTPEST	67	integer	free
ICN	68	real	free
CNCOEF	69	real	free
CDN	70	real	free
SDNCO	71	real	free
BACT_SWF	72	real	free
BACTMX	73	real	free
BACTMINLP	74	real	free
BACTMINP	75	real	free
WDLPRCH	76	real	free
QWDPRCH	77	real	free
WDLPRES	78	real	free
WDPRES	79	real	free
TB_ADJ	80	real	free
DEPIMP_BSN	81	real	free
DDRAIN_BSN	82	real	free
TDRAIN_BSN	83	real	free
GDRAIN_BSN	84	real	free
CN_FROZ	85	real	free
DORM_HR	86	real	free
SMXCO	87	real	free
FIXCO	88	real	free
NFIXMX	89	real	free
ANION_EXCL_BSN	90	real	free
Variable name	**Line #**	**Format**	**F90 Format**

CH_OPCO_BSN	92	real	free
CH_ONCO_BSN	91	real	free
HLIFE_NGW_BSN	93	real	free
RCN_SUB_BSN	94	real	free
BC1_BSN	95	real	free
BC2_BSN	96	real	free
BC3_BSN	97	real	free
BC4_BSN	98	real	free
DECR_MIN	99	real	free
ICFAC	100	real	free
RSD_COVCO	101	real	free
VCRIT	102	real	free
CSWAT	103	integer	free
RES_STLR_CO	104	real	free
SOL_P_MODEL	105	integer	free
IABSTR	106	real	free
BFLO_DIST	107	real	free
IUH	108	integer	free
UHALPHA	109	real	free
title	110	character	free
TLU/ LU_NODRAIN	111	real	free
title	112	character	free
EROS_SPL	113	real	free
RILL_MULT	114	real	free
EROS_EXPO	115	real	free
SUB_CHSED	116	integer	free
C_FACTOR	117	real	free
CH_D50	118	real	free
SIG_G	119	real	free
RE_BSN	120	real	free
SDRAIN_BSN	121	real	free
DRAIN_CO_BSN	122	real	free
PC_BSN	123	real	free
LATKSATF_BSN	124	real	free
ITDRN	125	integer	free
Variable name	**Line #**	**Format**	**F90 Format**

IWTDN	126	integer	free
SOL_P_MODEL	127	integer	free
IABSTR	128	real	free
IATMODEP	129	integer	free
R2ADJ	130	real	free

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