CHAPTER 25

SWAT INPUT DATA: .RTE

In order to simulate the physical processes affecting the flow of water and transport of sediment in the channel network of the watershed, SWAT requires information on the physical characteristics of the main channel within each subbasin. The main channel input file (.rte) summarizes the physical characteristics of the channel which affect water flow and transport of sediment, nutrients and pesticides.

Following is a brief description of the variables in the main channel input file. They are listed in the order they appear within the file.

Variable name	Definition
TITLE	The first line of the .rte file is reserved for user comments. The comments may take up to 80 spaces. The title line is not processed by the model and may be left blank. Optional.
CH_W(2)	Average width of main channel at top of bank (m). Required.
CH_D	Depth of main channel from top of bank to bottom (m). Required.
CH_S(2)	Average slope of main channel along the channel length (m/m). Required.
CH_L(2)	Length of main channel (km). Required.
CH_N(2)	Manning's "n" value for the main channel. Required.

Table 25-1: Values of Manning's roughness coefficient, *n*, for channel flow (Chow, 1959).[1]

Characteristics of Channel	Median	Range
Excavated or dredged		
Earth, straight and uniform	0.025	0.016-0.033
Earth, winding and sluggish	0.035	0.023-0.050
Not maintained, weeds and brush	0.075	0.040-0.140
Natural streams		
Few trees, stones or brush	0.050	0.025-0.065
Heavy timber and brush	0.100	0.050-0.150

[1] Chow (1959) has a very extensive list of Manning's roughness coefficients. These values represent only a small portion of those he lists in his book.

Variable name	Definition
CH_K(2)	Effective hydraulic conductivity in main channel alluvium (mm/hr).

Required.

Streams may be categorized by their relationship to the groundwater system. A stream located in a discharge area that receives groundwater flow is a gaining or effluent stream (Figure 25-1a). This type of stream is characterized by an increase in discharge downstream. A stream located in a recharge area is a losing or influent stream. This type of stream is characterized by a decrease in discharge downstream. A losing stream may be connected to (Figure 25-1b) or perched above (Figure 25-1c) the groundwater flow area. A stream that simultaneously receives and loses groundwater is a flow-through stream (Figure 25-1d).

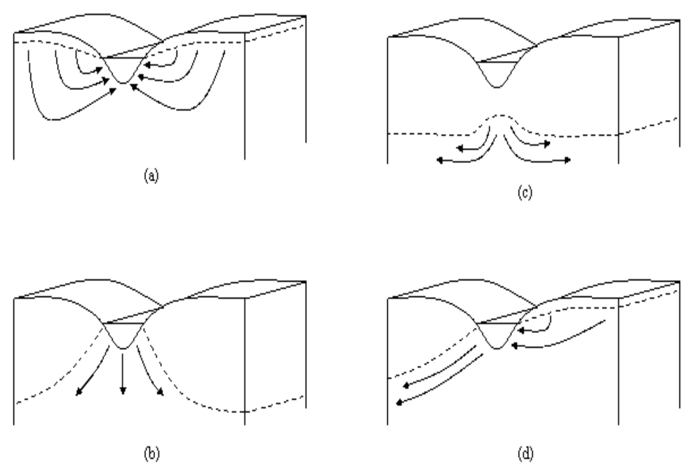

Figure 25-1: Stream-groundwater relationships: a) gaining stream receiving water from groundwater flow; b) losing stream connected to groundwater system; c) losing stream perched above groundwater system; and d) flow-through stream (After Dingman, 1994).

Typical values for K_{ch} for various alluvium materials are given in Table 25-2. For perennial streams with continuous groundwater contribution, the effective conductivity will be zero.

Variable name	Definition

CH_K(2), cont.

Table 25-2: Example hydraulic conductivity values for various bed materials (from Lane, 1983).

Bed material group	Bed material characteristics	Hydraulic conductivity
1 Very high loss rate	Very clean gravel and large sand	> 127 mm/hr
2 High loss rate	Clean sand and gravel, field conditions	51-127 mm/hr
3 Moderately high loss rate	Sand and gravel mixture with low silt-clay content	25-76 mm/hr
4 Moderate loss rate	Sand and gravel mixture with high silt-clay content	6-25 mm/hr
5 Insignificant to low loss rate	Consolidated bed material; high silt-clay content	0.025-2.5 mm/hr

CH_COV1

If CH_EQ is 0 the

CH_COV1 - Channel erodibility factor.

0 = non-erosive channel

1 = no resistance to erosion

The channel erodibility factor is conceptually similar to the soil erodibility factor used in the USLE equation. Channel erodibility is a function of properties of the bed or bank materials.

If CH_EQN ≠ 0:
Channel bank vegetation coefficient for critical shear stress (Julian and Torres, 2006)

Bank Vegetation	CH_COV1
None	1.00
Grassy	1.97
Sparse trees	5.40
Dense trees	19.20

Required.

Variable name	Definition
CH_COV2	If CH_EQ is 0 the Channel cover factor. 0 = channel is completely protected from erosion by cover 1 = no vegetative cover on channel The channel cover factor, C_{CH}, is defined as the ratio of degradation from a channel with a specified vegetative cover to the corresponding degradation from a channel with no vegetative cover. The vegetation affects degradation by reducing the stream velocity, and consequently its erosive power, near the bed surface. If CH_EQN ≠ 0: Channel bed vegetation coefficient for critical shear stress (Julian and Torres, 2006)

Bed Vegetation	CH_COV2
None	1.00
Grassy	1.97
Sparse trees	5.40
Dense trees	19.20

Variable name	Definition
	Required.
CH_WDR	Channel width-depth ratio (m/m). While sediment transport calculations have traditionally been made with the same channel dimensions throughout a simulation, SWAT will model channel downcutting and widening. When channel downcutting and widening is simulated, channel dimensions are allowed to change during the simulation period. Required only if channel degradation is being modeled (IDEG = 1 in .bsn).

Variable name	Definition
ALPHA_BNK	Baseflow alpha factor for bank storage (days). Bank storage contributes flow to the main channel or reach within the subbasin. Bank flow is simulated with a recession curve similar to that used for groundwater.The baseflow alpha factor, or recession constant, characterizes the bank storage recession curve. This constant will be some number less than 1.0, and will be large (approach one) for flat recessions and small (approach zero) for steep recessions. If no value is entered for ALPHA_BNK, the variable will be set to the same value as ALPHA_BF from the groundwater (.gw) file. Required.
ICANAL	Code for irrigation canal. 0 = no irrigation canal 1 = irrigation canal (restricts outflow)
CH_ONCO	Organic nitrogen concentration in the channel (ppm) (0.0 – 100.0)
CH_OPCO	Organic phosphorus concentration in the channel (ppm) (0.0 – 100.0)
CH_SIDE	Change in horizontal distance per unit vertical distance(0.0 – 5.0) 0 = for vertical channel bank 1 = for channel bank with gentle side slope
CH_BNK_BD	Bulk density of channel bank sediment (g/cc) (1.1 – 1.9). If the bulk density is not given, the model assumes a default value of 1.4 g/cc for bank sediments assuming silt type material.
CH_BED_BD	Bulk density of channel bed sediment (g/cc) (1.1 – 1.9). If the bulk density is not given, the model assumes a default value of 1.5 g/cc for bed sediments assuming sand type material.

Variable name	Definition
CH_BNK_KD	Erodibility of channel bank sediment by jet test (cm^3/N-s) Channel erodibility can be measured with a submerged vertical jet device. The basic premise of the test is that erosion of a vegetated or bare channel and local scour beneath an impinging jet are the result of hydraulic stresses, boundary geometry, and the properties of the material being eroded. Hanson (1990) developed a method for determining the erodibility coefficient of channels *in situ* with the submerged vertical jet. Allen et al. (1999) utilized this method to determine channel erodibility factors for thirty sites in Texas. A submerged, vertical jet of water directed perpendicularly at the channel bed causes erosion of the bed material in the vicinity of the jet impact area (Figure 25-2). Important variables in the erosion process are: the volume of material removed during a jetting event, elevation of the jet above the ground surface, diameter of the jet nozzle, jet velocity, time, mass density of the fluid and coefficient of erodibility.

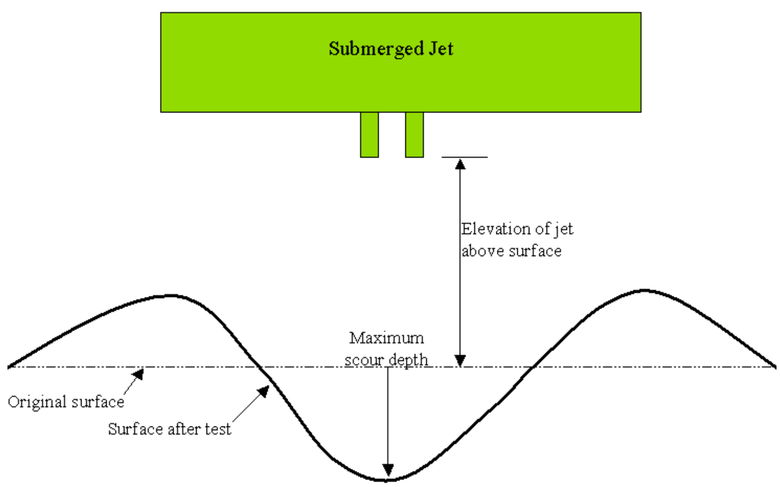

Figure 25-2: Simplified cross-section of submerged jet test (After Allen etal, 1999)

Variable name	Definition
CH_BNK_KD, Cont.	Hanson (1991) defined a jet index, J_i, to relate erodibility to scour created by the submerged jet. The jet index is a function of the depth of scour beneath the jet per unit time and the jet velocity. The jet index is determined by a least squares fit following the procedures outlined in ASTM standard D 5852-95. Once the jet index is determined, the channel erodibility coefficient is calculated: $K_{d,bank} = 0.003 \cdot \exp[385 \cdot J_i]$ where $K_{d,bank}$ is the channel erodibility coefficient (cm^3/N-s) and J_i is the jet index. In general, values for channel erodibility are an order of magnitude smaller than values for soil erodibility. CH_BNK_KD could range between 0.001 to 3.75 cm^3/N-s, from soils with low erodibility to high erodibility. If no value is entered, K_d is calculated from critical shear stress as: $k_d = 0.2 \cdot \tau_c^{-0.5}$
CH_BED_KD	Similar to CH_BNK_KD but calculated for channel bed (0.001 to 3.75 cm^3/N-s) Optional
CH_BNK_D50	D50 Median particle size diameter of channel bank sediment (μm). If no value is given, the model assumes 50 μm (silt size sediment) for bank. (1 to 10000 μm)
CH_BED_D50	D50 Median particle size diameter of channel bed sediment (μm). If no value is given, the model assumes 500 μm (sand size sediment) for bed. (1 to 10000 μm)
CH_BNK_TC	$T_{c,bank}$: Critical shear stress of channel bank (N/m^2) Critical Stress can also be calculated from Jet test. However if critical stress value is not available, then it is estimated based on silt and clay percentage of bank sediments using this regression relationship developed by Julian and Torres (2006): $\tau_{c,bnk} = \begin{pmatrix} 0.1 + 0.1779 \cdot SC + 0.0028 \cdot SC_{bnk}^{2} \\ - 2.34 \times 10^{-5} \cdot SC_{bnk}^{3} \end{pmatrix} \cdot CH\_COV1$ where SC_{bnk} is calculated based on the D50 particle size from Table 7:2-3 Critial Stress range between 0.0 to 400 N/m^2 for bed material with low resistance to high resistance for erosion.

Variable name	Definition
CH_BED_TC	$T_{c,bed}$: Critical shear stress of channel bed (N/m^2) Critical Stress can also be calculated from Jet test. However if critical stress value is not available, then it is estimated based on silt and clay percentage of bed sediments using this regression relationship developed by Julian and Torres (2006): $\tau_{c,bnk} = \begin{pmatrix} 0.1 + 0.1779 \cdot SC + 0.0028 \cdot SC_{bed}{}^2 \\ -2.34 \times 10^{-5} \cdot SC_{bed}{}^3 \end{pmatrix} \cdot CH\_COV2$ where SC_{bed} is calculated based on the D50 particle size from Table 7:2-3 Critial Stress range between 0.0 to 400 N/m^2 for bed material with low resistance to high resistance for erosion.
CH_ERODMO	CH_ERODMO is set to a value between 0.0 and 1.0. A value of 0.0 indicates a non-erosive channel while a value of 1.0 indicates no resistance to erosion.
CH_EQN	Sediment routing methods: Model used for Channel Erosion 0 – Simplified Bagnold Equation (Default) All codes below routing by particle size 1 – Simplified Bagnold Equation 2 – Kodatie model 3 – Molinas and Wu model 4 – Yang sand and gravel model

The main channel 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. The format of the main channel input file is:

Variable name	**Line #**	**Format**	**F90 Format**
TITLE	1	character	a80
CH_W(2)	2	real	free
CH_D	3	real	free
CH_S(2)	4	real	free
CH_L(2)	5	real	free
CH_N(2)	6	real	free
CH_K(2)	7	real	free
CH_COV1	8	real	free
CH_COV2	9	real	free
CH_WDR	10	real	free
ALPHA_BNK	11	real	free
ICANAL	12	integer	free
CH_ONCO	13	real	free
CH_OPCO	14	real	free
CH_SIDE	15	real	free
CH_BNK_BD	16	real	free
CH_BED_BD	17	real	free
CH_BNK_KD	18	real	free
CH_BED_KD	19	real	free
CH_BNK_D50	20	real	free
CH_BED_D50	21	real	free
CH_BNK_TC	22	real	free
CH_BED_TC	23	real	free

Variable name	Line #	Format	F90 Format
CH_ERODMO(1)	24	real	f6.2
CH_ERODMO(2)	24	real	f6.2
CH_ERODMO(3)	24	real	f6.2
CH_ERODMO(4)	24	real	f6.2
CH_ERODMO(5)	24	real	f6.2
CH_ERODMO(6)	24	real	f6.2
CH_ERODMO(7)	24	real	f6.2
CH_ERODMO(8)	24	real	f6.2
CH_ERODMO(9)	24	real	f6.2
CH_ERODMO(10)	24	real	f6.2
CH_ERODMO(11)	24	real	f6.2
CH_ERODMO(12)	24	real	f6.2
CH_EQN	25	integer	free

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