EPIC soil file (*filename*.SOL)

File format: different formats are used to read the EPIC soil file.

Line 1: space delimited, 2 fields (string)

Line 2 – 3: fixed format; 10 fields of 8 characters each (floating with 2 decimal digits) per line

Line 4 – 47: fixed format; 15 fields of 8 characters each (floating with 2 decimal digits) per line

Data for each soil is maintained in a separate soil file named *filename*.SOL. This file must be listed in the EPIC soil list file SOIL___.DAT (or user-defined name) with a unique reference number, which corresponds to the variable INPS in the run file EPICRUN.DAT. Elements included in the EPIC soil file are listed below.

Soil file – Line 1

Line – Field	Variable name	Description
L1 – F1	SOLS	Soil series name
L1 – F2	SOLO	Soil order This information can be used to drive the estimation of soil carbon losses if soil horizon is B or C, and if SOLO is one of the following: • Alfisols • Mollisols • Ultisols

Soil file – Line 2

Line - Field	Variable name	Description
L2 – F1	SALB	Soil albedo *(cols. 1-8)* Ratio of the amount of solar radiation reflected by the soil to the amount incident upon it, often expressed as a fraction. The value for albedo should be reported when the soil is at or near field capacity. *(Range: 0 to 1).*

Line - Field	Variable name	Description
L2 – F2	HSG	Soil hydrologic group *(cols. 9-16)* The U.S. Natural Resource Conservation Service (NRCS) classifies soils into four hydrologic groups based on infiltration characteristics of the soils. NRCS Soil Survey Staff (1996) defines a hydrologic group as a group of soils having similar runoff potential under similar storm and cover conditions. Soil properties that influence runoff potential are those that impact the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to seasonally high-water table, saturated hydraulic conductivity, and depth to a very slowly permeable layer. The definitions for the different classes are: A Soils having high infiltration rates when thoroughly wetted, consisting chiefly of sand or gravel that are deep and well to excessively drained. These soils have high rate of water transmission (low runoff potential) B Soils having moderate infiltration rates when thoroughly wetted, chiefly moderately deep to deep, moderately well to well drained, with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. C Soils having slow infiltration rates when thoroughly wetted, chiefly with a layer that impedes the downward movement of water or of moderately fine to fine texture and a slow infiltration rate. These soils have a slow rate of water transmission (high runoff potential). D Soils having very slow infiltration rates when thoroughly wetted, chiefly clay soils with a high swelling potential; soils with a high permanent water table; soils with a clay pan or clay layer at or near the surface; and shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission. See table 8 below for hydrologic group rating criteria. Accepted values are 1 for hydrologic group A 2 for hydrologic group B 3 for hydrologic group C 4 for hydrologic group D
L2 – F3	FFC	Initial soil water content *(cols. 17-24)* Soil water content at the beginning of the simulation as a fraction of field capacity. Set at zero if unknown. *(Range: 0 to 1)*

Line - Field	Variable name	Description
L2 – F4	`WTMN`	Minimum depth to water table *(cols. 25-32)* This is the depth in meters from the soil surface to the water table when the water table is at its highest level. With the depth set at zero, the model automatically sets the depth deep enough to remove any effects (default at 50 m). Fluctuation of water table is simulated as a function of groundwater storage. Set to 0 if unknown. *(Range: 0 to 100 meters)*
L2 – F5	`WTMX`	Maximum depth to water table *(cols. 33-40)* This is the depth in meters from the soil surface to the water table when the water table is at its lowest level. Set to 0 if unknown. *(Range: 0 to 100 meters)*
L2 – F6	`WTBL`	Initial water table height *(cols. 41-48)* This is the depth in meters from the soil surface to the current water level at which the model will begin the simulation. Throughout the simulation the water level will fluctuate up and down between WTMN and WTMX. This depth must be greater than or equal to WTMN and less than or equal to WTMX. Set to 0 if unknown. WTMN, WTMX, and WTBL are very important when the field contains a water table that is near the surface. Default settings assume the water table is deep enough not to affect plant growth; however, if the water table is within several feet of the surface, it can provide an extra supply of water that ordinarily would not be accounted for in the model. *(Range: 0 to 100 meters)*
L2 – F7	`GWST`	Groundwater storage *(cols. 49-56)* The amount of groundwater storage in millimeters available at the beginning of the simulation. Set to 0 if unknown. *(Range: 0 to 200 mm)*

Line - Field	Variable name	Description
L2 – F8	`GWMX`	Maximum groundwater storage *(cols. 57-64)* The maximum amount of groundwater storage available in millimeters. Set to 0 if unknown. *(Range: 10 to 500 mm)*
L2 – F9	`RFT0`	Groundwater residence time *(cols: 65-72)* The length of time water spends in the groundwater portion of the hydrologic cycle in days. Set to zero if unknown. *(Range: 1 to 365 days)*
L2 – F10	`RFPK`	Ratio between return flow and return flow + deep percolation *(cols. 73-80)* Set to 0 if unknown. *(Range: 0.01 to 0.99)*

Table 8. Hydrologic Grouping Criteria.

Criteria*	Hydrologic Soil Groups			
	A	B	C	D
Final constant infiltration rate (mm hr^{-1})	7.6-11.4	3.8-7.6	1.3-3.8	0-1.3
Mean permeability: surface layer (mm hr^{-1})	> 254.0	84.0-254.0	8.4-84.0	< 8.4
Mean permeability: most restrictive layer below the surface layer to a depth of 1.0 m (mm hr^{-1})	> 254.0	84.0-254.0	8.4-84.0	< 8.4
Shrink-swell potential: most restrictive layer**	Low	Low	Moderate	High, Very High
Depth to bedrock or cemented pan (mm)	> 1016	> 508	> 508	< 508
DUAL HYDROLOGIC GROUPS	A/D	B/D	C/D	
Mean depth to water table (m)	< 0.61	< 0.61	< 0.61	

* These criteria are guidelines only. They are based on the theory that the minimum permeability occurs within the uppermost 50 cm. If the minimum permeability occurs between a depth of 50 to 100 cm, then the Hydrologic Soil Group is increased one group. For example, C to B. If the minimum permeability occurs below a depth of 100 cm, the Hydrologic Soil Group is based on the permeability above 100 cm, using the rules previously given.

** Shrink-swell potential is assigned to a profile using the following guidelines:

Low: All soils with sand, loamy sand, sandy loam, loam or silt loam horizons that are at least 50 cm thick from the surface without a clay horizon within 100 cm of the surface.

Medium: All soils with clay loam horizons within 50 cm of the surface or soils with clay horizons from 50 to 100 cm beneath the surface.

High: All soils with clay horizons within 50 cm of the surface. Lower the shrink-swell potential one class when kaolinite clay is dominant.

Soil file – Line 3

Line - Field	Variable name	Description
L3 – F1	TSLA	Number of soil layers after splitting *(cols. 1-8)* It sets the number of soil layers created by the model when splitting the original soil layers. No splitting occurs if TSLA is set to zero. *(Range: 3 to 15).*

Line - Field	Variable name	Description
L3 – F2	XIDP	Soil weathering code *(cols. 9-16)* The soil weathering code is used to provide information for estimating the phosphorus sorption ratio. If no weathering information is available or if the soil contains $CaCO_3$, XIDP is left at 0. Accepted values are: 0 for calcareous and non-calcareous soils without weathering information 1 for non $CaCO_3$ slightly weathered 2 for non $CaCO_3$ moderately weathered 3 for non $CaCO_3$ highly weathered 4 Input Phosphorus sorption ratio (PSP) or active + stable mineral P (kg/ha)
L3 – F3	RTN0	Number of years of cultivation when simulation begins *(cols. 17-24)* This parameter affects the partitioning of nitrogen and carbon into the passive and slow humus pools. The number of years of cultivation before the simulation starts is used to estimate the fraction of the organic N pool that is mineralizable. Mineralization is more rapid from soil recently in sod. Also, increasing the number of years the field has been in cultivation increases the amount of C and N in the passive pool. This means it will take longer for the carbon and nitrogen to become available. *(Range: 0 to 300 years)*
L3 – F4	XIDK	Soil grouping *(cols. 25-32)* Accepted values are: 1 = Kaolinitic soil group 2 = Mixed soil group 3 = Smectitic soil group
L3 – F5	ZQT	Minimum thickness of maximum layer in meters *(cols. 33-40)* The model splits layers with thickness greater than ZQT. This splitting scheme produces thinner layers near the soil surface throughout the simulation period. Since most activity (tillage, root growth, microbial activity, rainfall/runoff interaction, etc.) occurs relatively near the soil surface, concentrating computational effort in that zone by using thin layers is very desirable. As soil layers are eroded and lost from the system, layer splitting continues until the number of layers equals TSLA. When the thickest soil layer reaches ZQT, no further splitting occurs. Instead, the number of soil layers is reduced until only

Line - Field	Variable name	Description
L3 – F5 (cont.)	`ZQT` `(cont.)`	two layers remain. At that time, the simulation stops. The simulation will also stop if the user-specified, minimum soil-profile thickness (ZF) is reached. If ZQT and ZF are not inputted, the model sets both of them to 0.1 m. Refer to TSLA, ZF and ZTK for further information. Set to 0 if unknown. *(Range: 0.01 to 0.25 meters)*
L3 – F6	`ZF`	Minimum profile thickness *(cols. 41-48)* This is the minimum thickness (in meters) of the profile that is allowed. If the profile is eroded to this thickness, the simulation will stop. If ZF is not inputted, the model sets it to 0.1 m. Refer to TSLA, ZQT, and ZTK for further information. *(Range: 0.05 to 0.25 meters)*
L3 – F7	`ZTK`	Minimum layer thickness for beginning simulation layer *(cols. 49-56)* The model splits the first layer with thickness greater than ZTK (in meters); if none exists the thickest layer is split. This is only done once to make certain there are no extremely thick layers even at lower depths. Refer to TSLA, ZQT and ZF for further information. *(Range: 0.05 to 0.25 mm)*
L3 – F8	`FBM`	Fraction of organic carbon in biomass pool *(cols. 57-64)* Set to 0 if unknown and the model will assign the default value of 0.04. *(Range: 0.03 to 0.05)*
L3 – F9	`FHP`	Fraction of carbon in passive pool *(cols. 65-72)* Set to 0 if unknown and the model will calculate its value as a function of RTN0. *(Range: 0.3 to 0.7)*
L3 – F10	`XCC`	NOT USER INPUT *(cols. 73-80)* This is a code written automatically by the model when a .SOT file is created. XCC is equal to 0 for regular soil files. XCC is equal to 1 for model generated SOT files.

Soil file – Line number > 3

Starting from line 4, rows are assigned to variables while columns are assigned to soil layers. Up to 15 soil layers can be input. As reported at the beginning of this section, the format used from line 4 on is fixed with 15 fields of 8 characters each (floating with 2 decimal digits) per line.

Line number	Variable	Description
4	Z	Depth to bottom of layer Depth from the soil surface to the bottom of the layer (meters) *(Range: 0.01 to 10.0)*
5	BD	Moist bulk density (Mg m^{-3}) The soil bulk density represents the ratio of the mass of solid particles to the total volume of the soil. Usually, BD values fall between 1.1 and 1.9 Mg m^{-3}. *(Range: 0.5 to 2.5)*
6	U	Soil water content at wilting point (fraction) The wilting point is the soil water content at 1500 KPa or -15 Bars. The value of U must be lower than the value of FC. Set to 0 if unknown. *(Range: 0.01 to 0.5)*
7	FC	Soil water content at field capacity (fraction) The field capacity is the soil water content at 33 KPa or -0.33 bar. The value of FC must be greater than U and cannot be greater than 1. *(Range: 0.1 to 0.9)*
8	SAN	Sand content (%) Fraction of soil particles which have a diameter between 2.0 and 0.05 mm. *(Range: 1 to 99)*
9	SIL	Silt content (%) Fraction of soil particles which have a diameter between 0.05 and 0.002 mm. *(Range: 1 to 99)*

Line number	Variable	Description
10	WON	Initial organic nitrogen concentration (g N Mg^{-1} or ppm) Users may define the concentration of organic nitrogen (dry weight basis) contained in humic substances for all soil layers at the beginning of the simulation. If the user does not specify initial nitrogen concentrations, EPIC will initialize levels of organic nitrogen. Set to 0 if unknown. *(Range: 100 to 5000)*
11	PH	Soil pH It is the pH of a solution in equilibrium with the soil. It is determined by means of a glass, quinhydrone, or other suitable electrode or indicator at a specified soil-solution ratio in a specified solution, usually distilled water, 0.01 M $CaCl_2$ or 1 M KCl. *(Range: 3 to 9)*
12	SMB	Sum of bases (cmol kg^{-1}) The sum of bases (Ca^{++}, K^{+}, etc.) on the cation exchange complex. Set to 0 if unknown. *(Range: 0 to 150)*
13	WOC	Organic carbon concentration (%) It is the concentration of organic carbon present in the soil. Set to 0 if unknown. *(Range: 0.1 to 10)*
14	CAC	Calcium carbonate content (%) It is the carbon carbonate content of the soil. A compound, $CaCO_3$ is found in nature as calcite and argonite and in plant ashes, bones, and shells. $CaCO_3$ is found in calcareous soils. It is also used as a liming agent to increase the pH of a soil. Set to 0 if unknown. *(Range: 0 to 99)*

Line number	Variable	Description
15	CEC	Cation exchange capacity (cmol kg^{-1}) The cation exchange capacity of a soil is the quantity of positive ions necessary to neutralize the negative charge of a unit quantity of soil, under a given set of conditions. Set to 0 if unknown. *(Range: 0 to 150)*
16	ROK	Coarse fragment content (%) The percent (in volume) of the sample which has a particle diameter > 2 mm, i.e. the percent of the sample which does not pass through a 2 mm sieve. Set to 0 if unknown. *(Range: 0 to 99)*
17	CNDS	Initial soluble nitrogen concentration (g Mg^{-1}) Users may define the concentration of nitrate (dry weight basis) for all soil layers at the beginning of the simulation. Set to 0 if unknown. *(Range: 0.01 to 500)*
18	PKRZ	Initial soluble phosphorus concentration (g Mg^{-1}) Users may define the concentration of solution P (dry weight basis) for all soil layers at the beginning of the simulation. Set to 0 if unknown. *(Range: 0 to 20)*
19	RSD	Crop residue (Mg ha^{-1}) The amount of biomass in each soil layer at the beginning of the simulation. Set to 0 if unknown. *(Range: 0 to 20)*

Line number	Variable	Description
20	BDD	Dry bulk density (Mg m^{-3}) Density of the soil after oven drying. Set to 0 if unknown (BD value will be assigned to BDD). *(Range: 0 to 2.0)*
21	PSP	Phosphorus sorption ratio (fraction) The fraction of phosphorus adsorbed on soil particle surfaces Set to 0 if unknown. The model will estimate PSP according to the soil weathering code (XIDP) and using CAC, PKRZ, BSA, PH, and/or CLA depending on XIDP. *(Range: 0 to 0.9)*
22	SATC	Saturated conductivity (mm h^{-1}) Rate at which water passes through the soil layer, when saturated. The saturated hydraulic conductivity relates soil water flow rate (flux density) to the hydraulic gradient and is a measure of the ease of water movement through the soil. The saturated conductivity is the reciprocal of the resistance of the soil matrix to water flow. Set to 0 if unknown. *(Range: 0.00001 to 100)*
23	HCL	Lateral hydraulic conductivity (mm h^{-1}) Set to 0 if unknown. *(Range: 0.00001 to 10)*
24	WP	Initial organic phosphorus concentration (g Mg^{-1}) Users may define the concentration of organic phosphorus (dry weight basis) contained in humic substances for all soil layers at the beginning of the simulation. Set to 0 if unknown. *(Range: 50 to 1000)*

Line number	Variable	Description
25	EXCK	Exchangeable potassium concentration (g Mg^{-1}) The amount of potassium on the surface of soil particles that can be readily replaced with a salt solution. Set to 0 if unknown. *(Range: 0 to 200)*
26	ECND	Electrical conductivity (mmho cm^{-1}) Conductivity of electricity through water or an extract of soil. Commonly used to estimate the soluble salt content in solution. For a conversion to commonly used units, 1 mmho cm^{-1} is equal to 1 dS m^{-1}. Set to 0 if unknown. *(Range: 0 to 50)*
27	STFR	Fraction of water storage interacting with nitrogen leaching It is the fraction of soil porosity that interacts with percolating water as nitrogen leaching occurs. Set to 0 if unknown. *(Range: 0.05 to 1.0)*
28	ST	Initial soil water storage (fraction, m/m) Fraction of field capacity initially available at the start of the simulation. Set to 0 if unknown (the value of FC will be used) *(Range: 0.001 to 1.0)*
29	CPRV	Fraction inflow partitioned to vertical crack or pipe flow NOT USED It is the fraction of water flowing through the soil profile partitioned to flow in vertical cracks or pipes. Set to 0 if unknown. *(Range: 0.0 to 0.05)*
30	CPRH	Fraction inflow partitioned to horizontal crack or pipe flow NOT USED It is the fraction of water flowing through the soil profile partitioned to flow in horizontal cracks or pipes. Set to 0 if unknown. *(Range: 0.0 to 0.05)*

Line number	Variable	Description
31	`WLS`	Structural litter (kg ha^{-1}) One of the two litter components that contains all the lignin from plant residues and roots. The structural litter component has a fixed C/N ratio. Set to 0 if unknown. *(Range: 0.0 to 10000)*
32	`WLM`	Metabolic litter (kg ha^{-1}) One of the two litter components is made up of readily decomposable and water-soluble organic matter. Set to 0 if unknown. *(Range: 0.0 to 10000)*
33	`WLSL`	Lignin content of structural litter (kg ha^{-1}) Lignin is a complex polymer that binds to cellulose fibers and gives strength to the cell walls of plants. It is very resistant to decomposition. Set to 0 if unknown. *(Range: 0.0 to 10000)*
34	`WLSC`	Carbon content of structural litter (kg ha^{-1}) Carbon makes up almost half of the elemental composition of the dry matter in plants and is a common constituent of all organic matter. It is also present in the atmosphere in the form of CO_2. Set to 0 if unknown. *(Range: 0.0 to 10000)*
35	`WLMC`	Carbon content of metabolic litter (kg ha^{-1}) See WLSC and WLM for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*

Line number	Variable	Description
36	`WLSLC`	Carbon content of lignin of structural litter (kg ha^{-1}) See WLSC, WLSL and WLS for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*
37	`WLSLNC`	Nitrogen content of lignin of structural litter (kg ha^{-1}) The amount of nitrogen found in the lignin portion of the structural litter. See WLSL and WLS for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*
38	`WBMC`	Carbon content of biomass organic pool (kg ha^{-1}) The carbon content of the fresh soil organic matter. Set to 0 if unknown. *(Range: 0.0 to 10000)*
39	`WHSC`	Carbon content of slow humus pool (kg ha^{-1}) Slow humus is a conceptual component of soil organic matter that decomposes at rates intermediate between the microbial and passive humus components. Set to 0 if unknown. *(Range: 0.0 to 10000)*
40	`WHPC`	Carbon content of passive humus pool (kg ha^{-1}) Passive humus is a conceptual component composed of old or stable soil organic matter. Set to 0 if unknown. *(Range: 0.0 to 10000)*
41	`WLSN`	Nitrogen content of structural litter (kg ha^{-1}) See WLS for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*

Line number	Variable	Description
42	`WLMN`	Nitrogen content of metabolic litter (kg ha^{-1}) See WLM for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*
43	`WBMN`	Nitrogen content of biomass pool (kg ha^{-1}) The nitrogen content of the fresh soil organic matter. Set to 0 if unknown. *(Range: 0.0 to 10000)*
44	`WHSN`	Carbon content of slow humus pool (kg ha^{-1}) See WHSC for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*
45	`WHPN`	Carbon content of passive humus pool (kg ha^{-1}) See WHPC for more information. Set to 0 if unknown. *(Range: 0.0 to 10000)*
46	`FE26`	Iron content (%) It can be used in the estimation of carbon losses if the soil order (SOLO) is Ultisols and if soil horizon (ASHZ) is B or C. Set to 0 if unknown. *(Range: 0.1 to 50.0)*
47	`SULF`	Sulfur content (%) Set to 0 if unknown. *(Range: 0.01 to 0.06)*
48	`ASHZ`	Soil horizon The format for this variable is a string with 8 characters (e.g., •••••••A – seven spaces and one letter).

Line number	Variable	Description
48 (cont.)	**ASHZ** **(cont.)**	Accepted values are • A • B • C This information drives the estimation of soil carbon losses. If ASHZ is equal to B or C, the approach used in the estimation is driven by the soil order (SOLO). Set to A if unknown.
49	**CGO2**	O_2 concentration in gas phase (g m^{-3} of soil air) This information is used when the new O2 ratio method is selected for the oxygen-depth function (IOX = 2 in the EPIC control file) or when the Izaurralde denitrification approach is selected (IDN > 2 in the EPIC control file). Set to 0 if unknown. *(Range: 110 to 275)* for more information see (R. C. Izaurralde et al., 2017)
50	**CGCO2**	CO_2 concentration in gas phase (g m^{-3} of soil air) This information is used when the Izaurralde denitrification approach is selected (IDN > 2 in the EPIC control file). Set to 0 if unknown. *(Range: 0.2 to 1.2)* for more information see (R. C. Izaurralde et al., 2017)
51	**CGN2O**	N_2O concentration in gas phase (g m^{-3} of soil air) This information is used when the Izaurralde denitrification approach is selected (IDN > 2 in the EPIC control file). Set to 0 if unknown. *(Range: 0.004 to 0.01)* for more information see (R. C. Izaurralde et al., 2017)