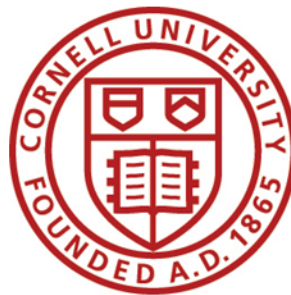# SWAT-WB
User Manual

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SWAT-WB is a modified version of the Soil & Water Assessment Tool, which was developed with the explicit goal of accurately modeling surface runoff generation without using the USDA-NRCS Curve Number (CN) method. Instead of using the CN method, a physically based soil water balance (WB is short for water balance) is used for every day of simulation. This results in a version of SWAT which models runoff generated strictly from saturation-excess processes; no surface runoff will be generated with SWAT-WB until the soil becomes sufficiently saturated. Therefore, this version of SWAT is intended for use in watersheds where either the user wishes to model runoff without relying upon the CN, or in watersheds where saturation-excess is the predominant mechanism for runoff generation.

This model was designed to replace the CN-based SWAT 2005, and can be used by making a few simple adjustments to any preexisting SWAT2005 project; detailed descriptions of these adjustments are provided below.

1. <u>Create a SWAT project</u>

Before SWAT-WB can be used, a standard SWAT project must be created. There are multiple ways to accomplish this step, the simplest of which is to use a GIS interface. Users can download extensions for both ArcGIS and for MapWindow (a free, open source GIS) which will create the files necessary to run SWAT and SWAT-WB. If the user is not comfortable with using GIS, a more labor intensive process can be followed to develop the necessary text input files (as described in the *SWAT Input/Output File Documentation* available from the official SWAT website).

During the project development stage, follow all steps as outlined in the official SWAT manual, up to and including the writing (and editing, if so desired) of the input files.

> *When soils data is added and reclassified during the HRU Analysis portion, make a point of recording each soil type's name that is assigned by SWAT. These recorded soil names will be used in a later step.*

After the input files are written, expand the *SWAT Simulation* menu and select the *Run SWAT* button (Figure 1).
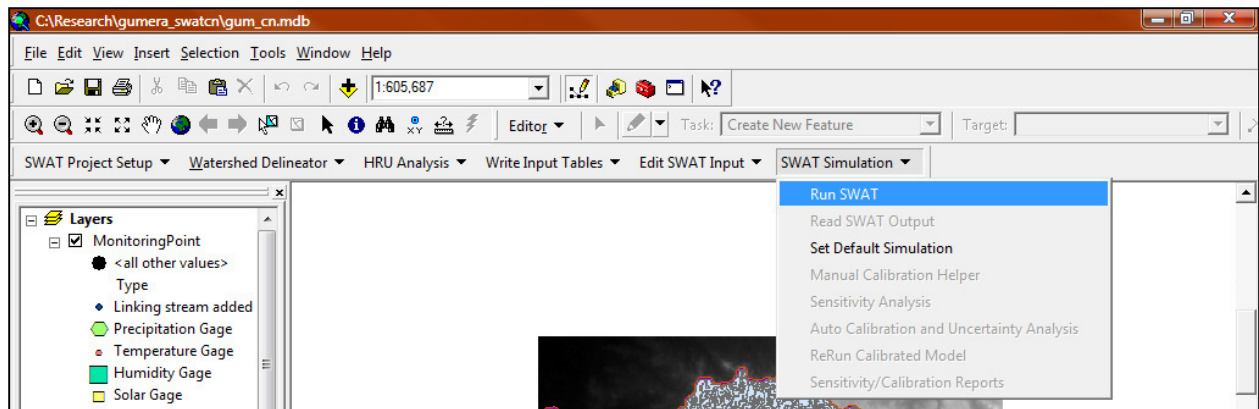
Figure 1. After all input files are written in the GIS interface, select the Run SWAT button.

In the *Setup and Run SWAT Model Simulation* window, set the final parameters for the model run and click the *Setup SWAT Run* button (Figure 2), which will create one final input file called *file.cio*. At this point, the project setup is complete (Figure 3) and if the user were to click the *Run SWAT* button, the simulation would be run using SWAT2005. However, if the user wants to use SWAT-WB, a few modifications must first be made to the project outside of the GIS interface.
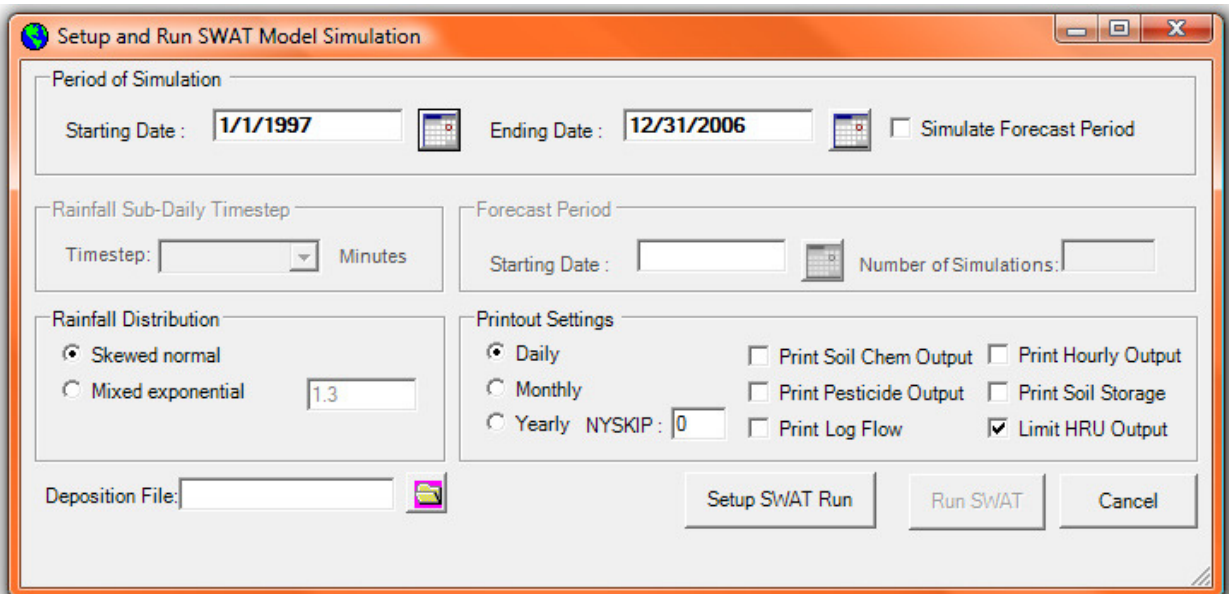

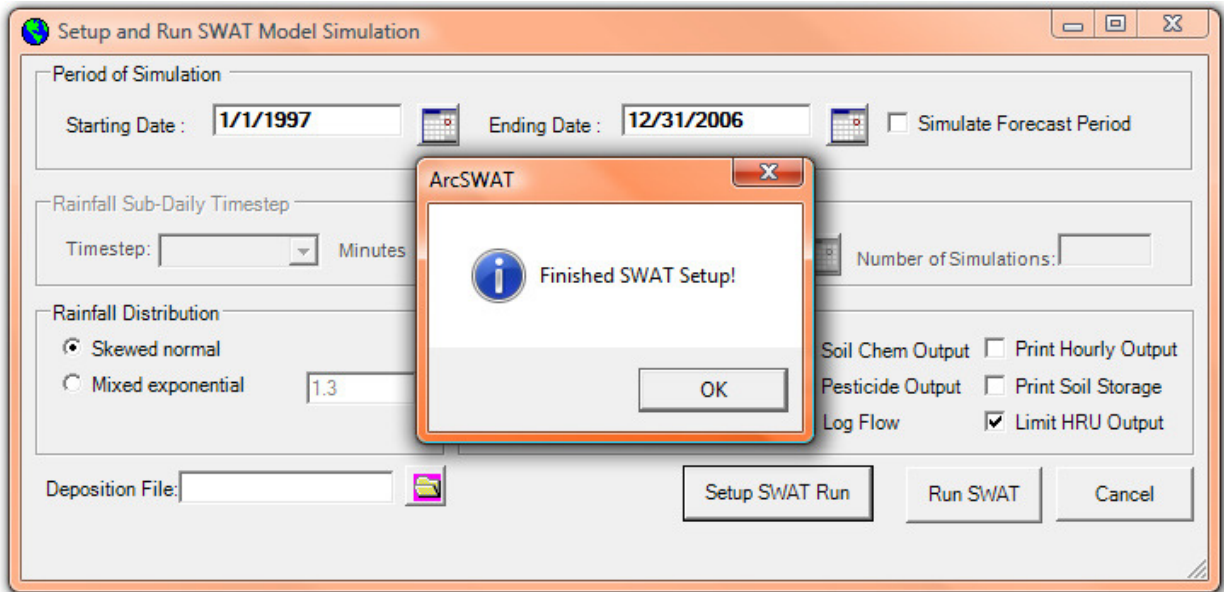**Figure 2. Set final parameters and click Setup SWAT Run.**

Figure 3. After clicking *Setup SWAT Run,* the project is ready to be modified for use with SWAT-WB.

2. Add files to the project folder

After the project setup is complete, copies of two files must be placed in the project folder which is the location on the user's computer where all of the text input files were saved (Figure 4). The folder name is *TxtInOut* and is located at: *…\projectdirectory\Scenarios\Default*, where *projectdirectory* is the name of the folder created in the first step of the SWAT GIS interface.
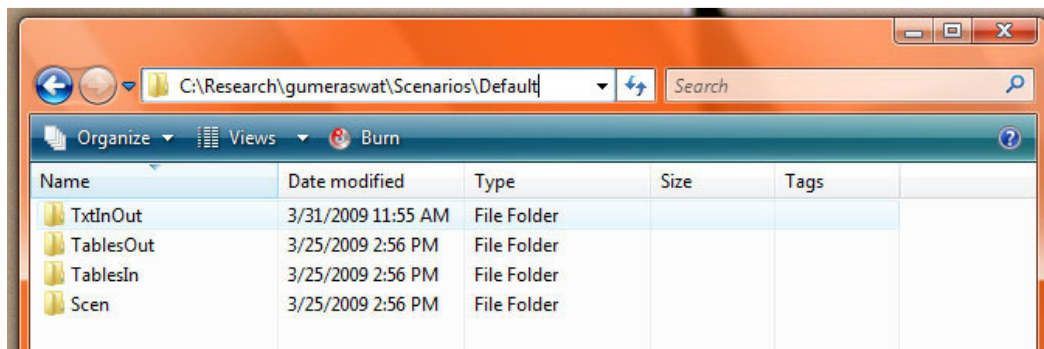

Figure 4. Location of the TxtInOut folder containing all text input files. In the above figure,
***C:\Research\gumeraswat* will be replaced by the location of the specific project directory created during the project setup.**

Before files are copied to the *TxtInOut* folder and the project is modified to work with SWAT-WB, the user may want to copy the entire *TxtInOut* folder and save it in a different location on their computer. All modifications to the text files should be done to the *TxtInOut* copy, rather than the original folder. This will ensure that the files developed with the GIS interface remain unchanged;

the user can then redo these steps, or revert to the default SWAT2005 program, at anytime without having to start over at the beginning of the GIS interface.
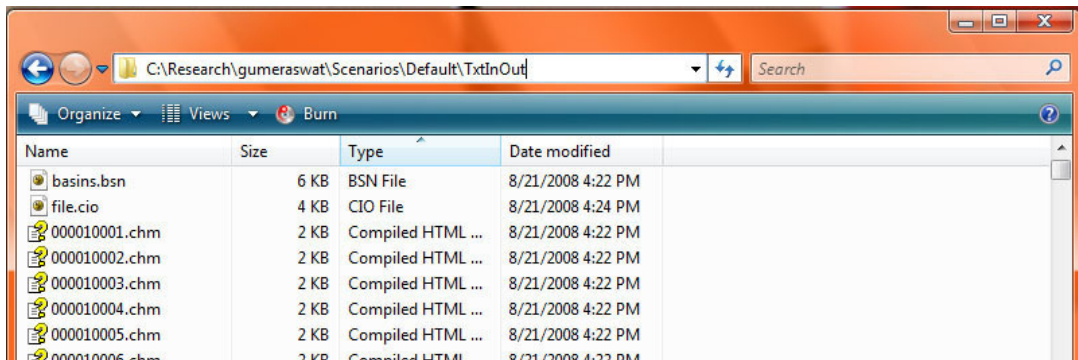

Figure 5. The *TxtInOut* folder containing the input files developed during the project setup stage.

Once the *TxtInOut* folder has been located and copied to a new location, two files need to be added to this folder. *Soilname.bee* and *swatwb.exe* files were downloaded from the SWAT-WB website and are located in the same *swatwb.zip* file that contains this manual. These two files need to be placed in the *TxtInOut* folder.
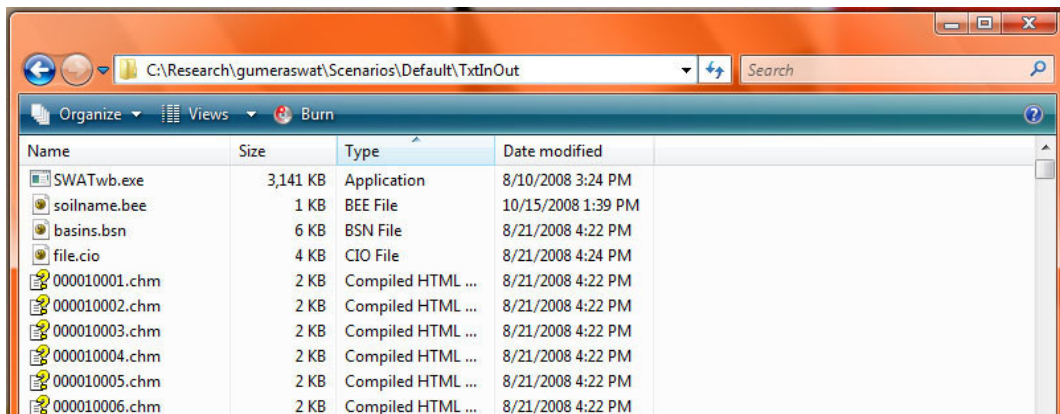

Figure 6. The *TxtInOut* folder containing the files needed to run SWAT-WB.

3. Create new *.bee* files

Once the original *soilname.bee* file has been added to the *TxtInOut* folder, it should be used as a template to create a similar *.bee* file for each soil present in the watershed (i.e. if the watershed being modeled has five soil types used in the HRU definition process, than five separate *.bee* files need to be created). Replace the 'soilname' in each file's name with the SWAT-assigned name (these were recorded during the first step) for each soil type in the watershed (i.e. a soil named Hudson, will have a file named *Hudson.bee*).

These .*bee* files contain a single variable, *EDC*, which ranges from 0.000 to 1.000. For lower *EDC* values, less water will infiltrate the soil profile during a rain event, resulting in more surface runoff.

> *A full discussion of the EDC variable is provided in the Theoretical Documentation and should be consulted when choosing EDC values for each soil type.*

When changing the value of this variable, be sure to adhere to the formatting of the original .*bee* files; change only the number value in the file and do not change the character spacing of this value (it should occupy spaces 12-16 on the second line). If an *EDC* value of 1.000 is chosen, SWAT-WB will use the saturation-deficit of the entire soil profile to calculate the maximum volume of rain able to infiltrate.

4. Run SWAT-WB

Once all input files have been created and the .*bee* files have been created for each soil type, there are two ways to run SWAT-WB. The simplest is to double click *swatwb.exe* in the *TxtInOut* folder. This will result in a command window opening which will show the progress of the model simulations. Once the model is done running, this window will close automatically.

The second way to run SWAT-WB doesn't automatically close the command window and is therefore more useful if the model is not running correctly. To run SWAT-WB this way, the executable should be run from a command prompt. To open a command prompt window first open the *Start Menu* from Windows taskbar. Navigate to *All Programs*, then to *Accessories* and click on *Command Prompt* (Figure 7a), or navigate to *Run*, type *cmd* and hit OK (Figure 7b).
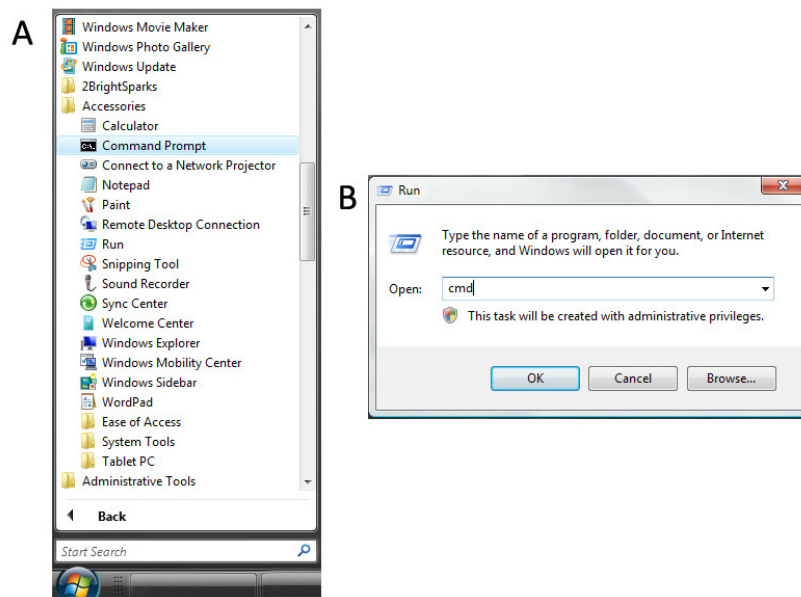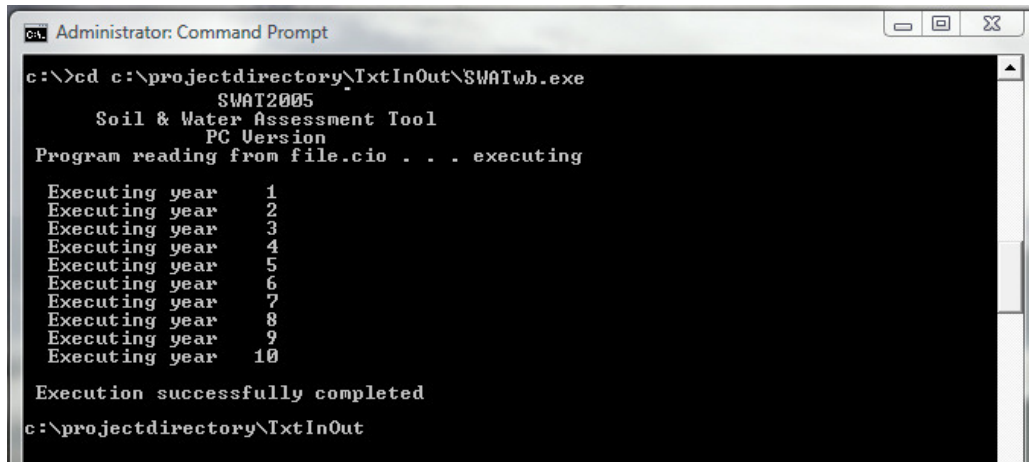

Figure 7. Accessing Windows Command Prompt either from Start Menu>All Programs>Accessories (A) or from the Run tool (B).

In *Command Prompt*, change the working directory to the *TxtInOut* folder in which *soilname.bee* and *swatwb.exe* files have been saved. To accomplish this, type *cd* (for 'change directory') followed by a space and then the entire file path for the *swatwb.exe* file located in the *TxtInOut* folder (Figure 8). Hit enter and SWAT-WB will begin to run.

Figure 8. Navigating to project directory with Command Prompt and running SWAT-WB.

5. <u>Read SWAT-WB output</u>

After SWAT-WB has been successfully executed, the output files are ready to be viewed. Since SWAT-WB was run from *Command Prompt*, rather than from the GIS interface, the output must be viewed using a text editor (and input into a spreadsheet) rather than using the GIS interface. The official *SWAT Input/Output File Documention* should be reviewed for a complete description of all output files.

6. <u>Calibrating SWAT-WB</u>

Once the initial model run has been completed, it is important to calibrate the model. There are many processes which can be followed to accomplish this; here we will discuss a few methods that we have found can be easily implemented with SWAT-WB.

Dynamically Dimensioned Search (DDS) Algorithm

DDS is an autocalibration routine developed by Dr. Bryan Tolson (University of Waterloo) and Dr. Christine Shoemaker (Cornell University), primarily for use in watershed models. This algorithm is used outside of the GIS interface and can be downloaded in various formats. The MATLAB version of DDS has been successfully used to autocalibrate two different SWAT-WB models. DDS and papers describing it can be found from Dr. Tolson's website: www.civil.uwaterloo.ca/btolson/software.htm.

PARASOL

PARASOL is an autocalibration algorithm included in the SWAT program and available for use within the GIS interface.   Using PARASOL requires the user to rename *swatwb.exe* to *swat2005.exe* and replacing the original *swat2005.exe* file found in the default SWAT installation folder (normally found in C:\Program Files\). At this point the GIS interface will run SWAT-WB rather than the original SWAT program, and the included autocalibration routine, PARASOL, can then be used. However, the autocalibration files created by the interface must be altered to insure that *EDC* is a calibration parameter rather than the Curve Number.

Manual Calibration

Another option, if the user is not comfortable with either MATLAB or with altering files used by PARASOL, is manual calibration.

This concludes the instructions for how to use SWAT-WB. If any problems arise throughout the process listed above, first determine if it is a problem with the default SWAT files, or if it is from SWAT-WB. If it is the former, please refer to either the official SWAT help documentation or the online User Forums. If the problem is determined to be from SWAT-WB please contact someone from the Soil and Water Lab via the contact information provided on the SWAT-WB website.