Texas A&M University Hydrologic Modeling Inventory
Model Description Form
Response requested by: May 25, 2007

Name of Model:
Storm Water Management Model (SWMM)

Model Type:
SWMM is a physically-based, distributed, unsteady, continuous urban stormwater runoff quantity and quality model.

Model Objective(s):
- **to design and size drainage system components, including detention facilities;**
- **to generate non-point source pollutant loadings for TMDL studies;**
- **to evaluate BMP and LID stormwater controls to meet sustainability goals;**
- **to alleviate combined and sanitary sewer overflows;**
- **to control flooding of urban areas and natural channel systems.**

Agency and Office:
U.S. Environmental Protection Agency, National Risk Management Research Laboratory, Cincinnati, Ohio.

Technical Contact and Address:
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Model Structure or Mathematical Basis:
Hydrology:

Spatial Representation	**User-defined subcatchment areas**
Rainfall	**User supplied**
Interception/Evaporation	**User supplied**
Infiltration	**Horton Curve** **Green-Ampt method** **SCS Curve**
Overland Flow	**Nonlinear reservoir model**
Groundwater	**Localized two-zone flux model**
Snowmelt	**Heat balance/degree day model**

Hydraulics:

Drainage Elements	**Nodes (Junction, Storage, Outfall)**
	Links (Conduits, Pumps, Regulators)
Conduit Shapes	**20 common shapes**
	irregular open channels
	custom closed conduits
Flow Routing	**Steady Flow**
	Kinematic Wave (nonlinear form)
	Dynamic Wave (semi-implicit)

Water Quality:

Pollutant Buildup	**Power, exponential or saturation function of time**
Pollutant Washoff	**Rate proportional to runoff and buildup or can use an EMC**
BMP Removal	**User-assigned percent reduction**
Non-Runoff Loads	**User-defined, sanitary DWF, RDII inflow**
Drainage System Routing	**CSTR model**
Drainage System Treatment	**User-defined functions**

Model Parameters:

Subcatchments: surface roughness, flow path length.

Infiltration: Horton: max/min rates and decay constant; Green-Ampt: hydraulic conductivity and suction head; Curve Number: NRCS (SCS) Curve number; All: time for saturated soil to fully drain.

Conduits: Manning's roughness.

Water Quality: buildup/washoff function coefficients.

Spatial Scale Employed in the Model:

A study area can be divided into any number of individual subcatchments, each of which drains to a single point. Study areas can range in size from single lots up to hundreds of acres.

Temporal Scale Employed in the Model:

SWMM uses hourly or more frequent rainfall data as input and can be run for single events or in continuous fashion for any number of years.

Input Data Requirements:

Hydrology: Hourly or more frequent rainfall data; daily evaporation rates; subcatchment area, percent imperviousness, depression storage, and slope.

Hydraulics: Conduit shape, size, length, and slope; storage unit shape and size; weir/orifice type and dimensions; pump curve data.

Water Quality: Street sweeping frequency and effectiveness; BMP removal efficiency; treatment unit removal efficiency.

Computer Requirements:

Operating System: Windows 98/NT/ME/2000/XP/Vista;

Hardware Requirements: equivalent of an Intel 486 or higher CPU;

Memory Requirements: minimum of 256 MB RAM;

Disk Storage Requirements: minimum of 4 Mbytes.

Model Output:

SWMM produces time series output for the following variables:

Subcatchments: rainfall, runoff flow, pollutant washoff quality, snow depth, GW water table elevation, GW flow rate.

Drainage System Nodes: water depth, lateral inflow, flooding rate, pollutant concentration.

Drainage System Links: flow rate, flow depth, flow velocity, pollutant concentration.

Additional tables summarize such quantities as total rainfall, infiltration, evaporation, and runoff for each subcatchment; average and maximum water depth at each drainage system node; total and maximum flooding at each node; maximum flow, velocity and depth in each link.

Parameter Estimation / Model Calibration:

The SWMM Users and Reference Manuals provide guidelines and tables for estimating model parameters, most of which are physically-based. No formal calibration tools are included. However, SWMM's graphical user interface facilitates comparing computed values against measured values through its time series plotting feature.

Model Testing and Verification:

The latest version of SWMM, 5.0, has undergone quality assurance testing to verify its compatibility with earlier versions of the program (see Storm Water Management Model Quality Assurance Report, EPA/600/R-06/097, U.S. Environmental Protection Agency, Cincinnati, OH, September 2006). SWMM has been in constant use for over 30 years and has been field tested numerous times.

Model Sensitivity:

Runoff volumes are most sensitive to values assigned to percent imperviousness and infiltration parameters (e.g., hydraulic conductivity for Green-Ampt infiltration). Peak runoff rates are sensitive to flow path length and slope. The accuracy and stability of flow routing results are sensitive to the time step used. SWMM's dynamic wave routing method can use an internally computed variable time step to reduce the sensitivity to the user's initially assigned time step.

Model Reliability:

A properly calibrated SWMM model should be able to produce highly accurate runoff hydrographs and drainage system flow rates. Minimum reliability levels of ±10% for event volumes and ±20% for peak flows are routinely achievable. Water quality estimates are less reliable, and are highly dependent on the amount of measured data available for calibration.

Model Application / Case Studies:

There have been literally thousands of applications made with SWMM during its lifetime. Most of these are documented in consultant reports and are not available to the public. The 15-volume set of proceedings from the Annual Conferences on Stormwater and Urban Water Systems Modeling contain a number papers related to applications and case studies using SWMM (see

http://www.computationalhydraulics.com).

Documentation:

Storm Water Management Model User's Manual, EPA/600/R-05/040, U.S. Environmental Protection Agency, Cincinnati, OH (June 2007);

Storm Water Management Model Reference Manual (in preparation);

Storm Water Management Model Applications Manual (in preparation).

Other Comments:

SWMM 5.0 runs under a Windows graphical user interface. The interface allows users to draw a schematic representation of a catchment area and its drainage system elements against a backdrop map image of the study area, edit the properties of individual components by pointing and clicking on them, and view analysis results in several different formats, such as time series plots, hydraulic grade line profile plots, and tabular listings. A statistical analysis tool summarizes the results of long-term simulations with frequency plots and histograms.

The latest version of SWMM can be downloaded from http://www.epa.gov/ednnrmrl/models/swmm.