LECTURE 8-B
INTRODUCTION TO SWMM

CEEN 4800/6965 - Special Topics
Geographic Information Systems and Hydrologic & Hydraulic Modeling
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OUTLINE

- **Download instructions**
- **Description**
- **Capabilities**
- **Applications**
- **User interface**
- **Input data**
- **Output results**
- **Tutorial**
- **Exercise**

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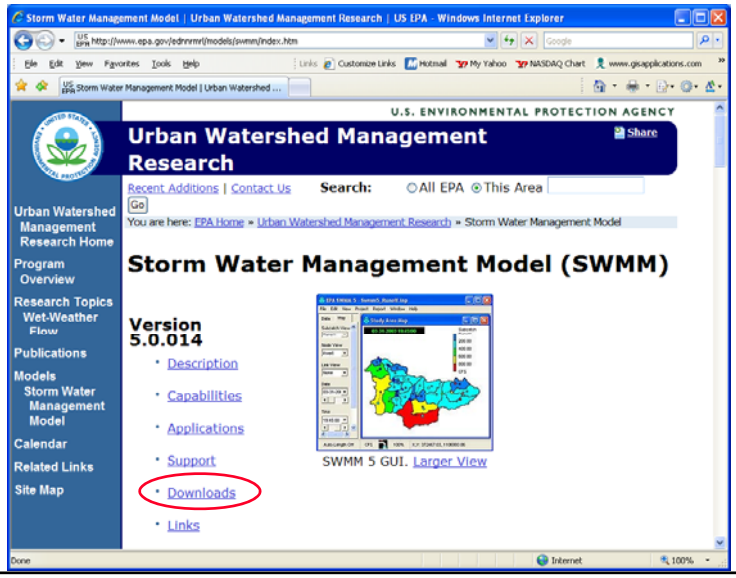
EPA SWMM WEB SITE

http://www.epa.gov/ednnrmrl/models/swmm/index.htm



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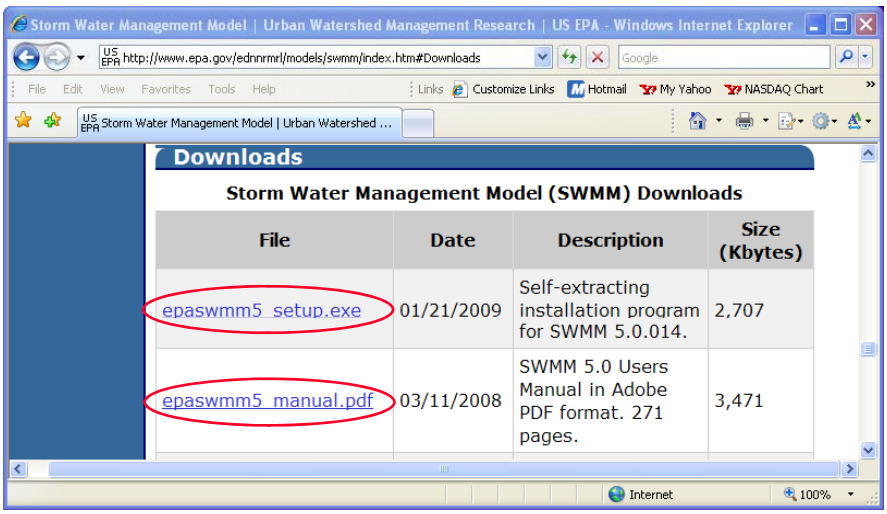
SWMM DOWNLOAD

http://www.epa.gov/ednnrmrl/models/swmm/index.htm#Downloads



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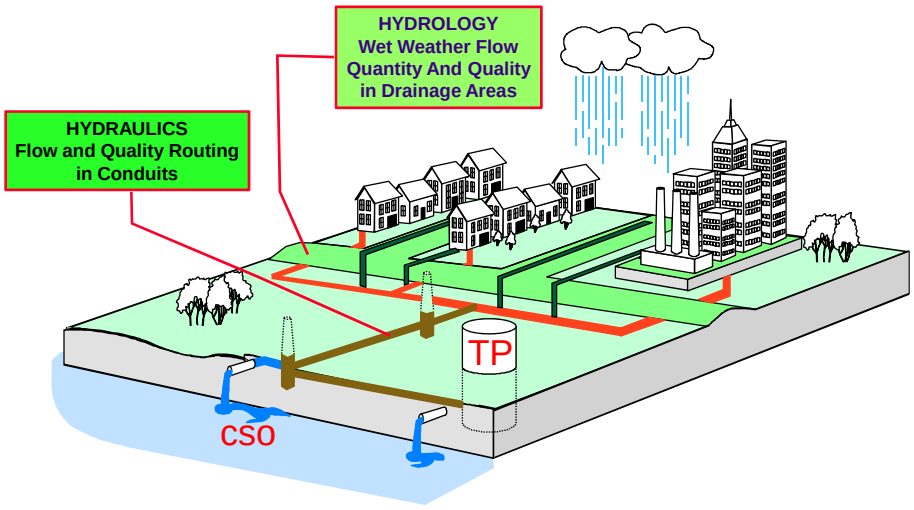
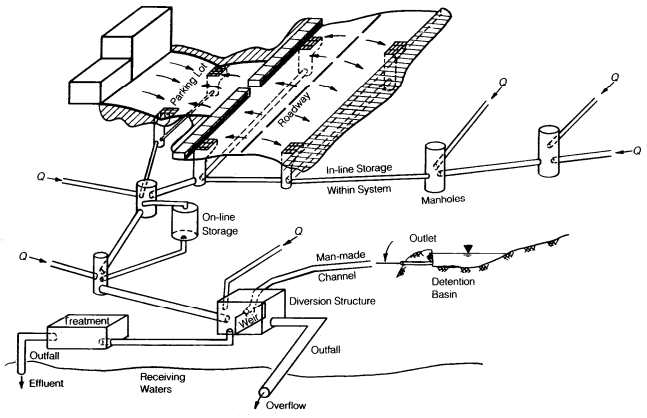
WHAT IS SWMM?

- A hydrologic and hydraulic (H&H) and water quality model
- Models sanitary, combined, and storm sewers and their drainage areas



WHAT IS SWMM?

SWMM is a dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas (sewersheds).



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HYDROLOGIC MODELING FEATURES

- Spatially and time varying rainfall
- Evaporation of standing surface water
- Snow accumulation and melting
- Interception from depression storage
- Infiltration into soil layers
- Nonlinear routing of overland flow

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HYDRAULIC MODELING FEATURES

- Models drainage networks of any size
- Accommodates various conduit shapes as well as irregular natural channels
- Models pumps, regulators, storage basins
- Allows external inflows, For example:
  - Rainfall Dependent Inflow and Infiltration (RDII)
  - Dry Weather Flow (DWF) or sanitary flow
- Models various flow regimes, such as backwater, surcharging, reverse flow, and surface ponding

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WATER QUALITY MODELING FEATURES

- Pollutant buildup over different land uses
- Pollutant washoff during runoff events
- Reduction in buildup from street cleaning
- Reduction in washoff from Best Management Practices (BMPs)
- Water quality routing through the drainage network
- User-defined treatment functions

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TYPICAL APPLICATIONS OF SWMM

- Design and sizing of drainage system components including detention facilities
- Control of combined and sanitary sewer overflows
- Generating non-point source (NPS) pollutant loadings for wasteload allocation studies
- Evaluating BMPs for sustainability goals
- Flood plain mapping of natural channel systems

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LIMITATIONS OF SWMM

- Not applicable to large-scale, non-urban watersheds
- Not applicable to forested areas or irrigated cropland
- Not suitable with highly aggregated (e.g., daily) rainfall data
- It's an analysis tool, not an *automated* design tool

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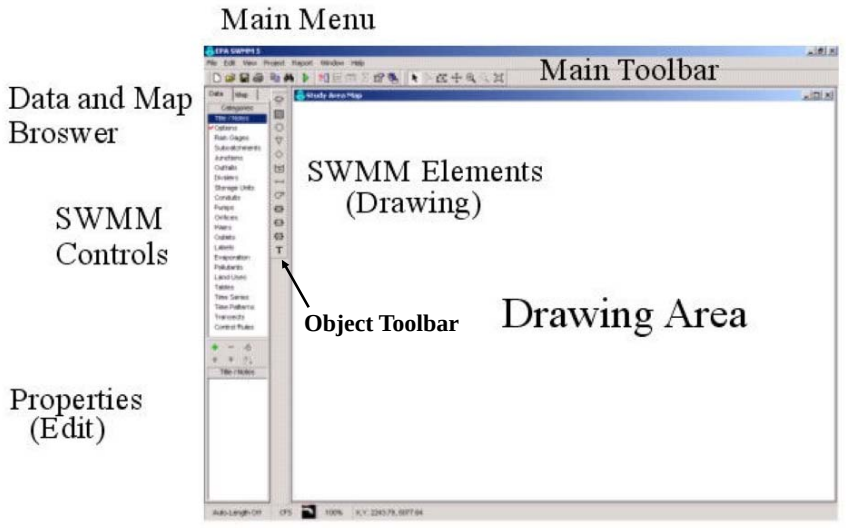
USER INTERFACE



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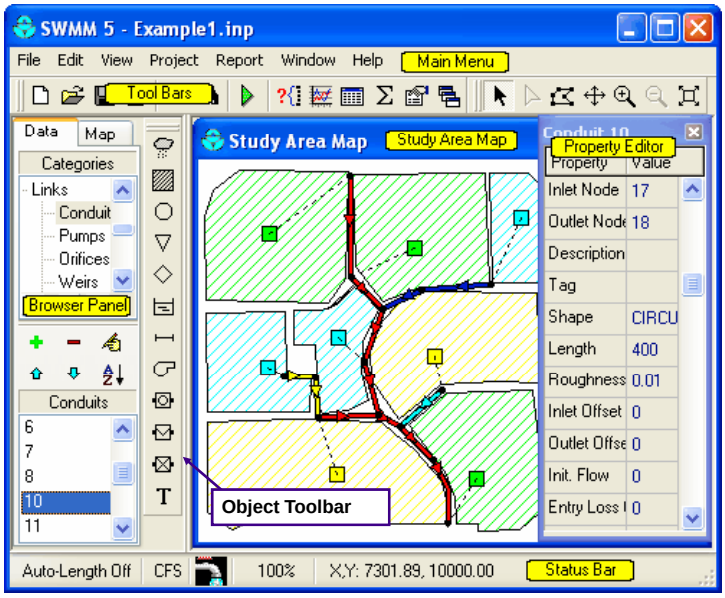
USER INTERFACE (DATA BROWSER)



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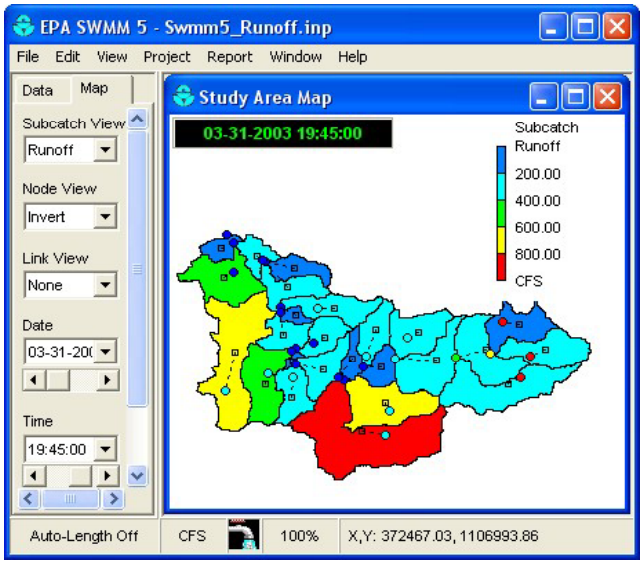
USER INTERFACE (MAP BROWSER)



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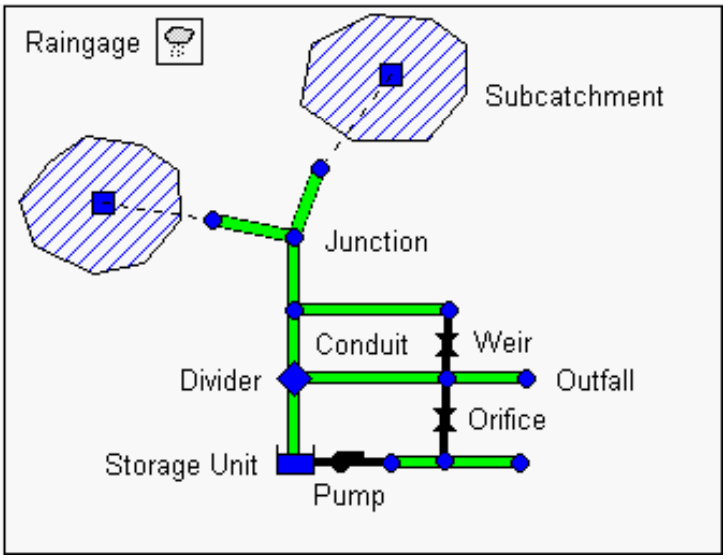
SWMM'S VISUAL OBJECTS



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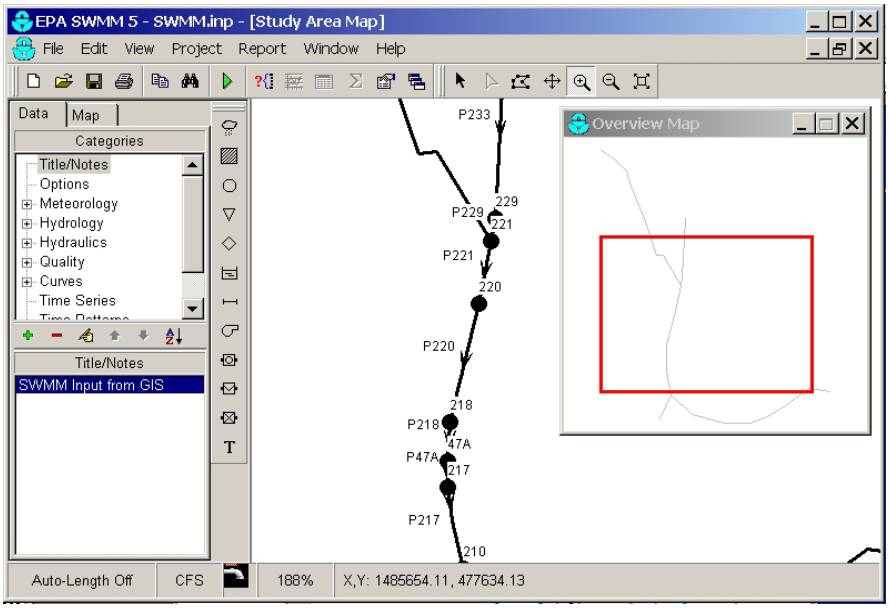
SWMM NETWORK (JUNCTIONS AND CONDUITS)



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INPUT DATA - HYDROLOGIC

- Precipitation
- Channel Characteristics
- Watershed characteristics
  - Imperviousness
  - Slope
  - Roughness
  - Width (a shape factor)
  - Depression Storage
  - Infiltration Parameters
    - Infiltration parameters for either the Horton or Green-Ampt equations for up to 100 subcatchments.

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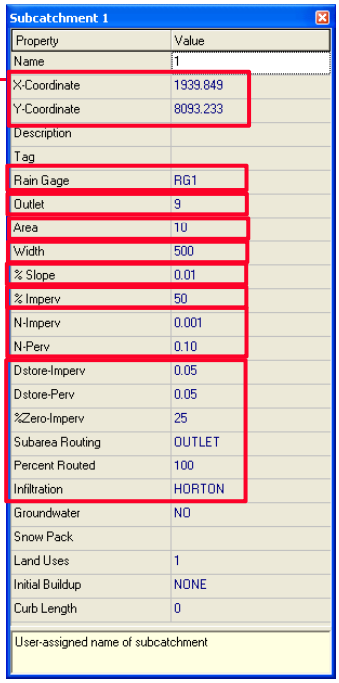
SWMM INPUT: SUBCATCHMENTS

- Coordinates (can import from GIS)
- Rain gauge (rainfall hyetograph)
- Outlet
- Area
- Width
- Slope (%)
- Percent imperviousness
- Roughness
- Infiltration parameters



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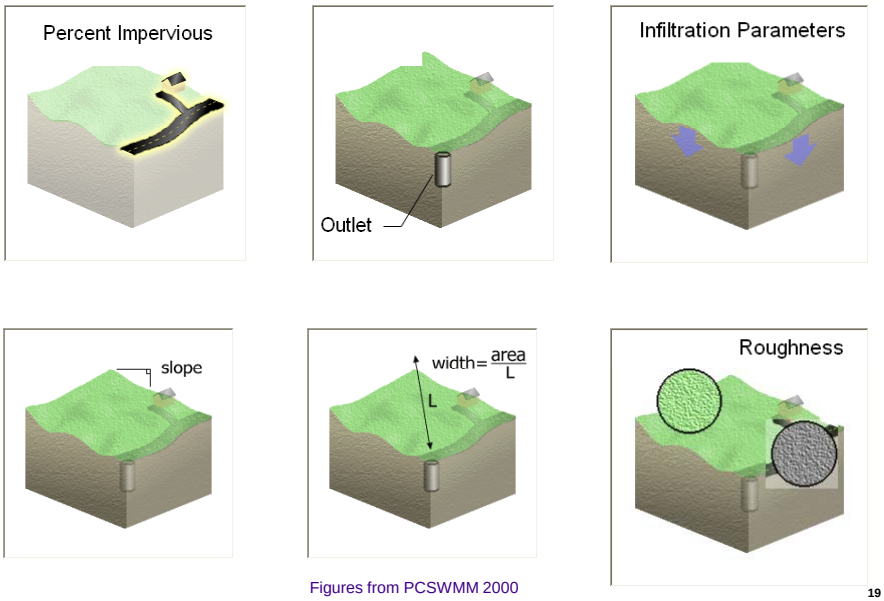
KEY SUBCATCHMENT PROPERTIES



Figures from PCSWMM 2000

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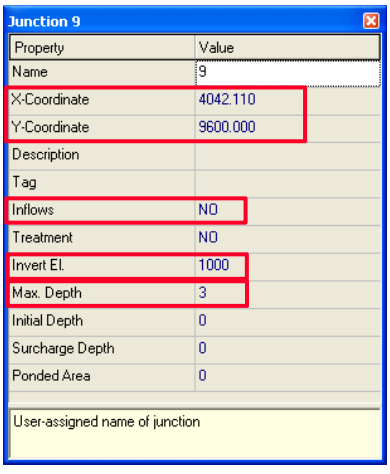
SWMM INPUT: NODES

- Nodes (manholes)
  - Coordinates (can import from GIS)
  - Inflow (cfs)
  - Invert (bottom) elevation
  - Maximum depth



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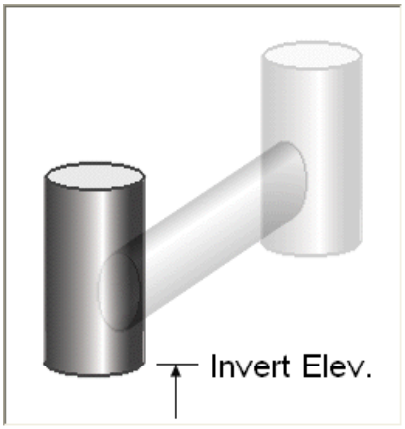
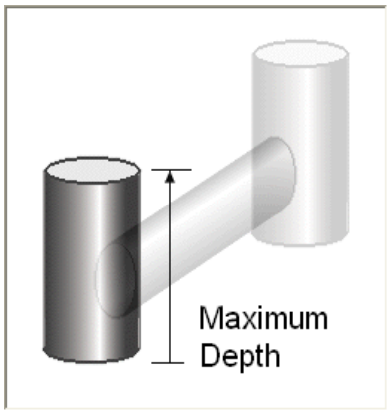
KEY NODE PROPERTIES





Figures from PCSWMM 2000

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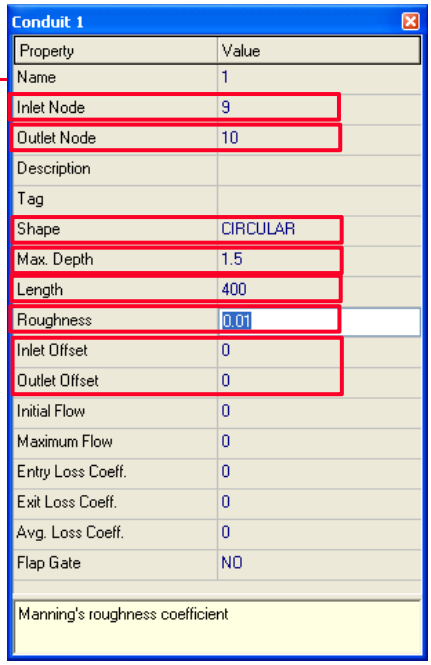
SWMM INPUT: CONDUITS

- Inlet node
- Outlet node
- Shape (e.g., circular)
- Maximum depth
  - Diameter for circular pipes
- Length
- Roughness (Manning's coefficient)
- Offset



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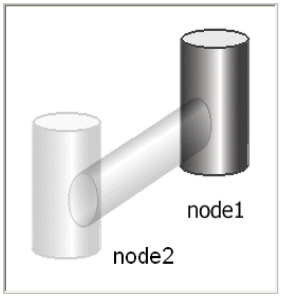
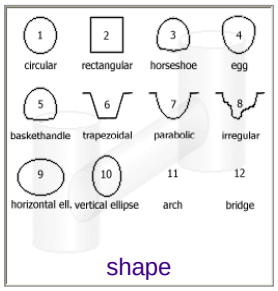
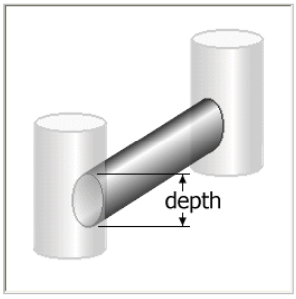
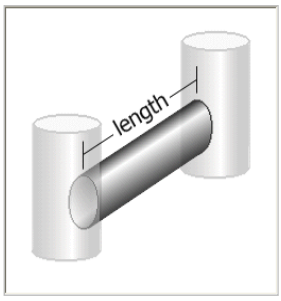
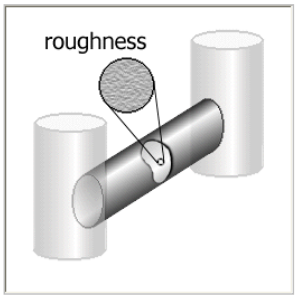
KEY CONDUIT PROPERTIES

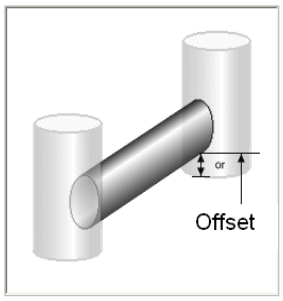












Figures from PCSWMM 2000

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ROUGHNESS TABLES

EPA SWMM Help

Manning's Roughness n for Closed Conduits

Conduit Material	Manning n
Asbestos-cement pipe	0.011 - 0.015
Brick	0.013 - 0.017
Cast iron pipe	
- Cement-lined & seal coated	0.011 - 0.015
Concrete (monolithic)	
- Smooth forms	0.012 - 0.014
- Rough forms	0.015 - 0.017
Concrete pipe	0.011 - 0.015
Corrugated-metal pipe (1/2-in. x 2-2/3-in. corrugations)	
- Plain	0.022 - 0.026
- Paved invert	0.018 - 0.022
- Spun asphalt lined	0.011 - 0.015
Plastic pipe (smooth)	0.011 - 0.015
Vitrified clay	
- Pipes	0.011 - 0.015
- Liner plates	0.013 - 0.017

Source: ASCE (1982). *Gravity Sanitary Sewer Design and Construction*, ASCE Manual of Practice No. 60, New York, NY.

EPA SWMM Help

Manning's Roughness n for Open Channels

Channel Type	Manning n
Lined Channels	
- Asphalt	0.013 - 0.017
- Brick	0.012 - 0.018
- Concrete	0.011 - 0.020
- Rubble or riprap	0.020 - 0.035
- Vegetal	0.030 - 0.40
Excavated or dredged	
- Earth, straight and uniform	0.020 - 0.030
- Earth, winding, fairly uniform	0.025 - 0.040
- Rock	0.030 - 0.045
- Unmaintained	0.050 - 0.140
Natural channels (minor streams, top width at flood stage < 100 ft)	
- Fairly regular section	0.030 - 0.070
- Irregular section with pools	0.040 - 0.100

Source: ASCE (1982). *Gravity Sanitary Sewer Design and Construction*, ASCE Manual of Practice No. 60, New York, NY.

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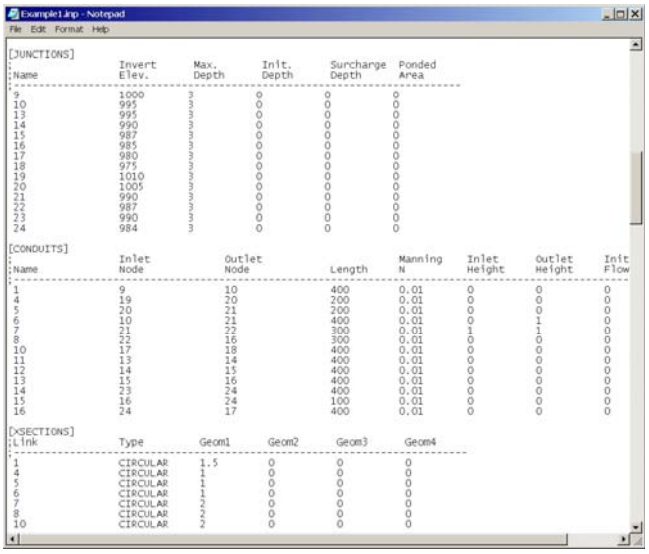
SWMM INPUT FILE (*.INP)

Like EPANET input file



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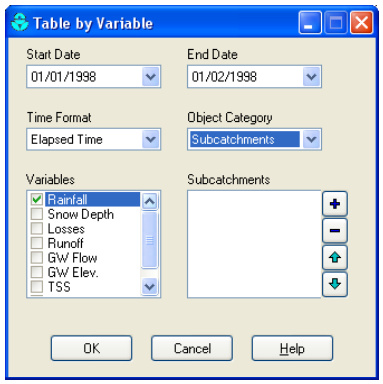
SWMM OUTPUT

- **Subcatchments**
  - **rainfall rate (in/hr or mm/hr)**
  - **snow depth (inches or millimeters)**
  - **losses (infiltration + evaporation in in/hr or mm/hr)**
  - **runoff flow (flow units)**
  - **groundwater flow into the drainage network (flow units)**
  - **groundwater elevation (ft or m)**
  - **washoff concentration of each pollutant (mass/liter)**



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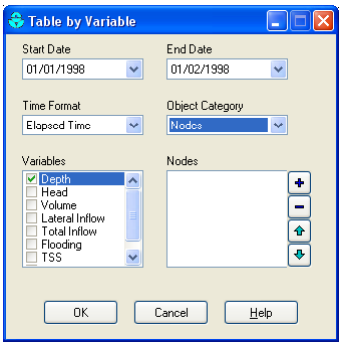
SWMM OUTPUT

- Nodes (manholes)
  - water depth (ft or m above the node invert elevation)
  - hydraulic head (ft or m, absolute elevation per vertical datum)
  - stored water volume (including ponded water, ft^3 or m^3)
  - lateral inflow (runoff + all other external inflows, in flow units)
  - total inflow (lateral inflow + upstream inflows, in flow units)
  - surface flooding (flow lost from the system when the water depth exceeds the defined maximum node depth, flow units)
  - concentration of each pollutant after any treatment (mass/liter)



Support\Manhole overflow Youtube.avi

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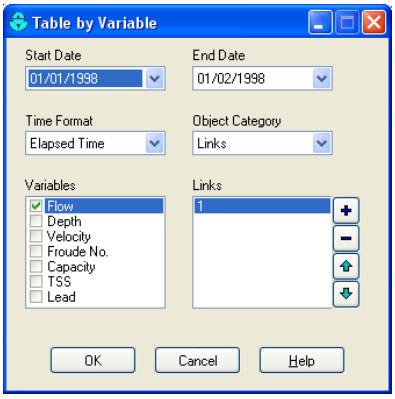
SWMM OUTPUT

- Links (pipes)
  - Flow rate (flow units)
  - Average water depth (ft or m)
  - Flow velocity (ft/sec or m/sec)
  - Froude number (dimensionless)
  - Capacity (ratio of depth to full depth)
  - Concentration of each pollutant (mass/liter)
    - Total suspended solids (TSS)
    - Lead
    - etc.



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SWMM OUTPUT

Tabular output

Table - Link 1602

Days	Hours	Flow (CFS)
0	00:15:00	5.59
0	00:30:00	42.46
0	00:45:00	70.17
0	01:00:00	70.27
0	01:15:00	70.31
0	01:30:00	70.35
0	01:45:00	70.36
0	02:00:00	70.36
0	02:15:00	70.36
0	02:30:00	70.35
0	02:45:00	70.35
0	03:00:00	70.33
0	03:15:00	50.30
0	03:30:00	36.09
0	03:45:00	21.16
0	04:00:00	11.92
0	04:15:00	6.12
0	04:30:00	3.36
0	04:45:00	2.03
0	05:00:00	1.37
0	05:15:00	0.97
0	05:30:00	0.71
0	05:45:00	0.54
0	06:00:00	0.44
0	06:15:00	0.38

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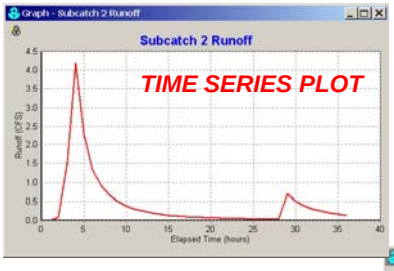
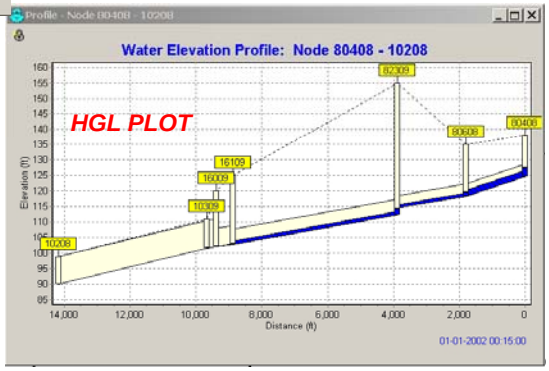
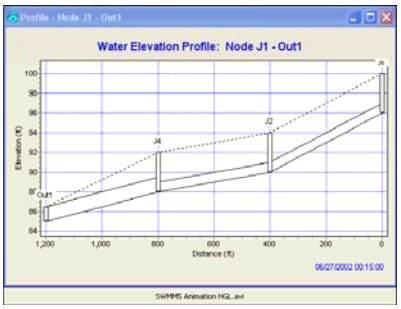
GRAPHICAL OUTPUT





ANIMATED OUTPUT

PLAN AND HGL ANIMATION



..\..\..\..\2008\YSUGIS08\Lectures\11-SWMM\Support\SWMM5 Animation Plan and HGL.avi

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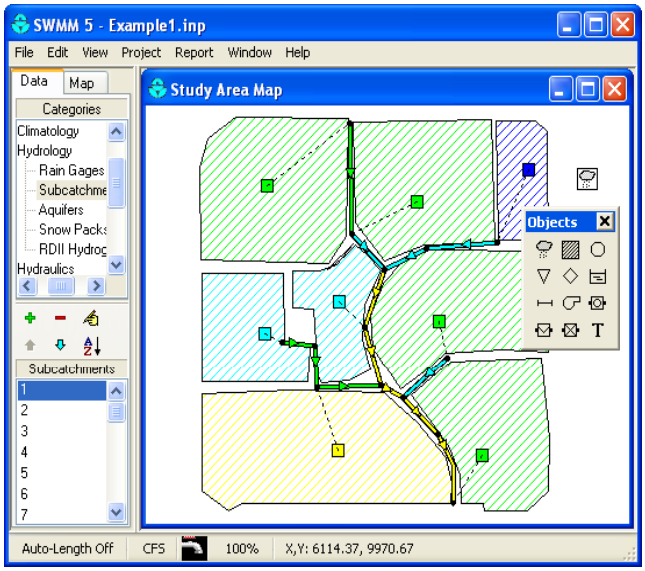
STEPS IN RUNNING SWMM 5

- **Draw drainage system objects**



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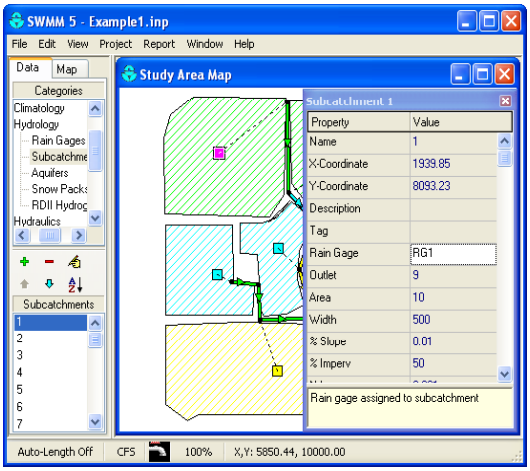
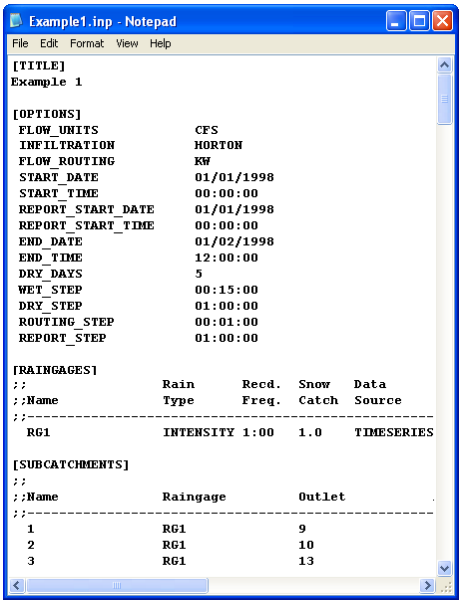
STEPS IN RUNNING SWMM 5

- Draw drainage system objects
- **Edit their properties**



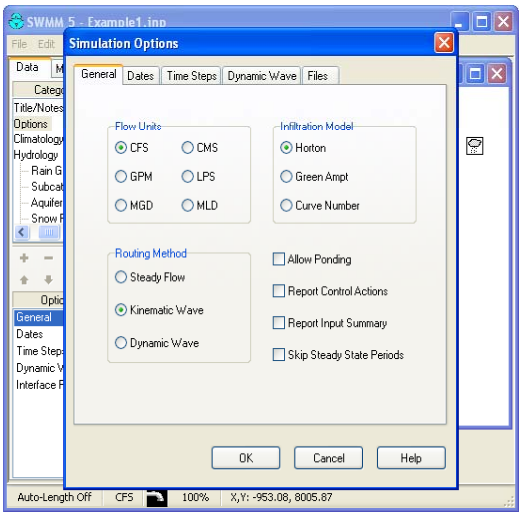
STEPS IN RUNNING SWMM 5

- Draw drainage system objects
- Edit their properties
- **Alternatively, create and edit a SWMM 5 input file using the format described in the Users Manual.**



STEPS IN RUNNING SWMM 5

- Draw drainage system objects
- Edit their properties
- **Set analysis options**



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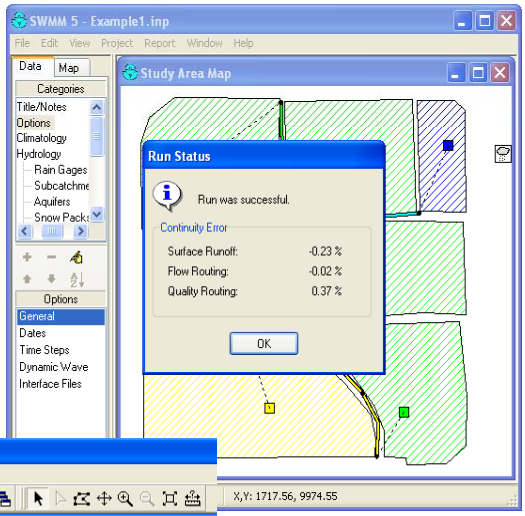
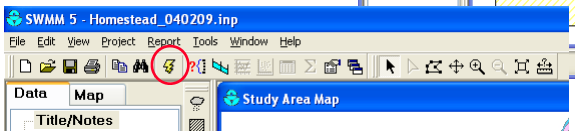
STEPS IN RUNNING SWMM 5

- Draw drainage system objects
- Edit their properties
- Set analysis options
- **Run a simulation (using the run button)**





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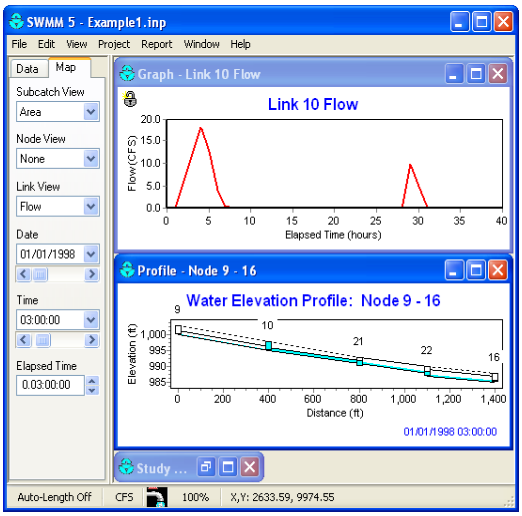
STEPS IN RUNNING SWMM 5

- Draw drainage system objects
- Edit their properties
- Set analysis options
- Run a simulation
- **View a variety of ad hoc reports**



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SWMM EXAMPLES

- **SWMM5 comes with three examples to help one become familiar with the program.**
- **The example input files are installed in the "Examples" folder of the SWMM5 installation directory**
  - **C:\Program Files\EPA SWMM 5.0\Examples**
- **Each example consists of a .INP file which holds the model data and a .TXT file which includes suggestions on running it.**
- **Examples include:**
  - **EXAMPLE1.INP models runoff quantity and quality from a small watershed and its routing through a network of storm sewers. It can be run in either single event mode or in continuous mode using the companion rainfall file.**
  - **EXAMPLE2.INP is Example 1 of the 1988 EXTRAN Users Manual. It illustrates how SWMM5 can graphically compare its results to observed data stored in a text file.**
  - **EXAMPLE3.INP illustrates the use of the rule-based controls feature in SWMM5 for simulating real-time control.**

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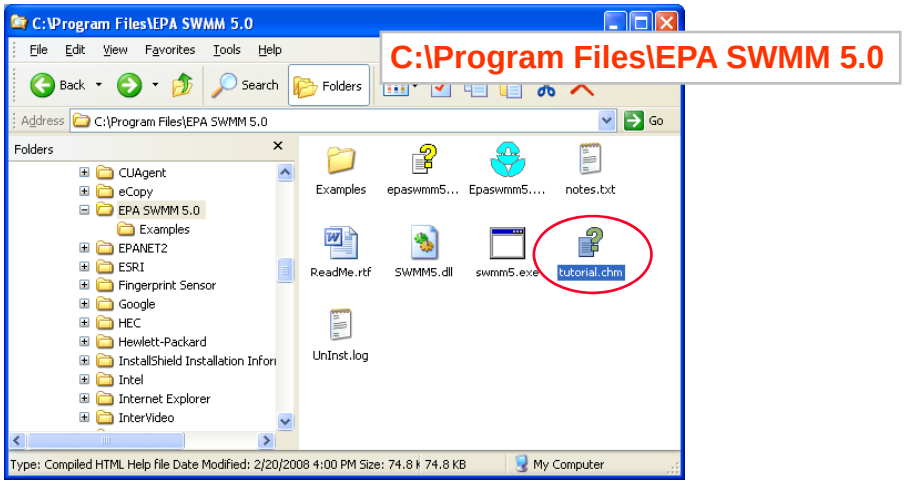
SWMM TUTORIAL

1. Open tutorial.chm file from C:\Program Files\EPA SWMM 5.0, or
2. Open Chapter 2 (Quick Start Tutorial) of the Users Manual, or
3. Select Tutorial from SWMM Help menu



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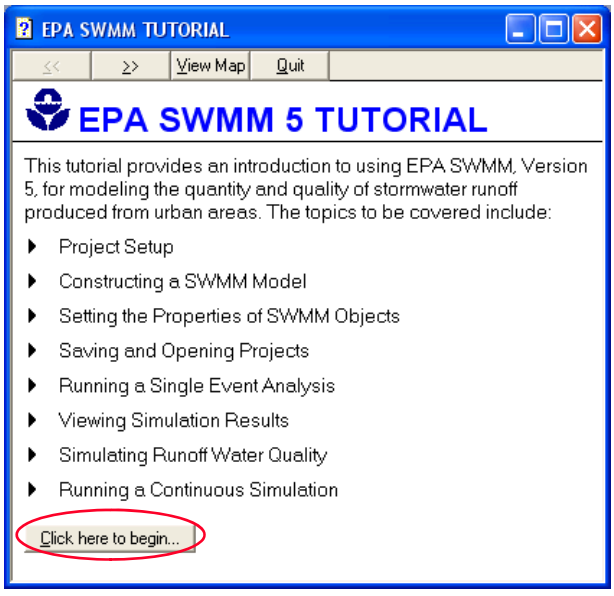
SWMM TUTORIAL



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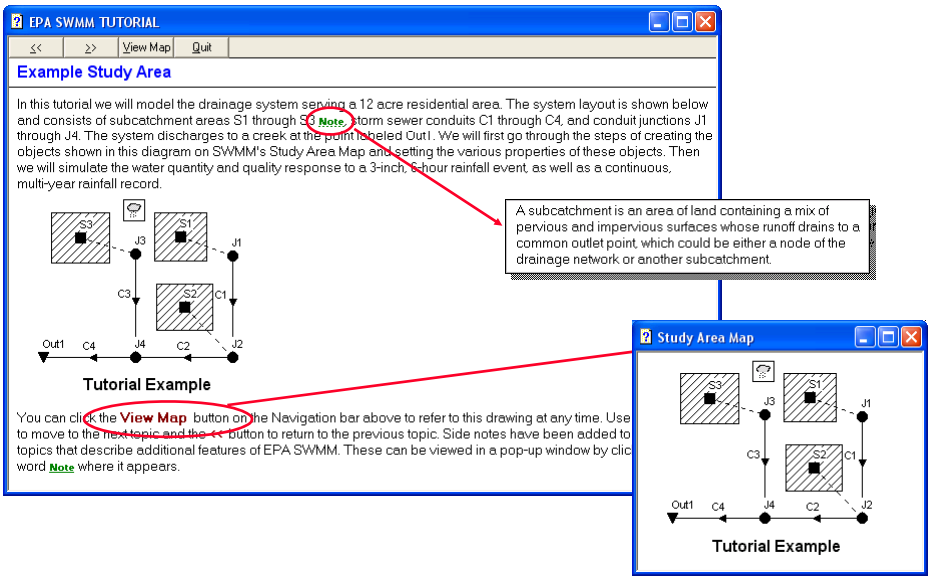
SWMM TUTORIAL



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LAB EXERCISE: SWMM TUTORIAL

- Download and print the exercise from the Course Web site
  - SWMM Exercise (SWMMExercise.pdf)
- Same as the above tutorial example up to "Viewing a Profile Plot" step (about 75% of the tutorial).

This exercise is the initial part of the tutorial example included with SWMM 5 up to "Viewing a Profile Plot" step of the tutorial. Thus, you can also do this exercise by following the steps in the tutorial which can be accessed using one of the following methods:

- Select Tutorial from SWMM Help menu
- Open Tutorial.hlp file from C:\Program Files\EPA SWMM 5.0, or
- Open Chapter 2 (Quick Start Tutorial) of the Users Manual

Several steps (depending on available time) will be done by students in the class on the projector. Remaining steps should be completed as homework. After completing the following exercise steps, submit the following items as homework:

- Screenshot of Figure 2-12. Example of viewing color-coded results on the Study Area Map
- Screenshot of Figure 2-15. Time Series plot of results from initial simulation run
- Screenshot of Figure 2-17. Example of a Profile plot

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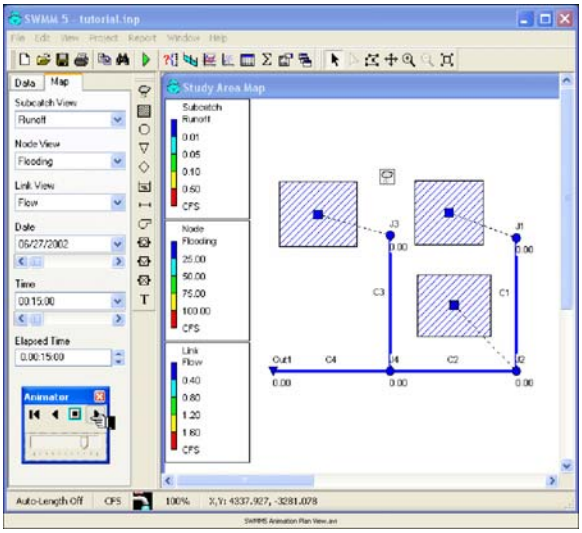
SWMM EXERCISE



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