

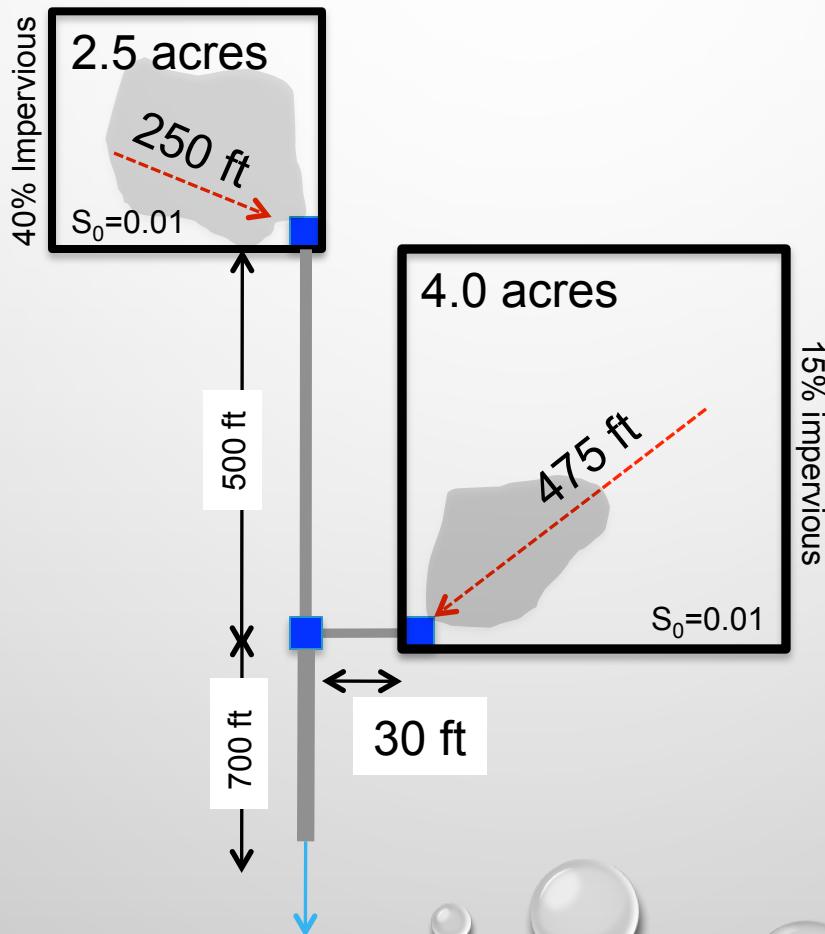
CE 3372 WATER SYSTEMS DESIGN

LECTURE 19: SWMM HYDROLOGY

SWMM AS HYDROLOGIC MODEL

- SUB-CATCHMENTS
 - INFILTRATION MODEL (RUNOFF GENERATION)
- RAINGAGES
 - TIME-SERIES OF RAINFALL (HYETOGRAPH)

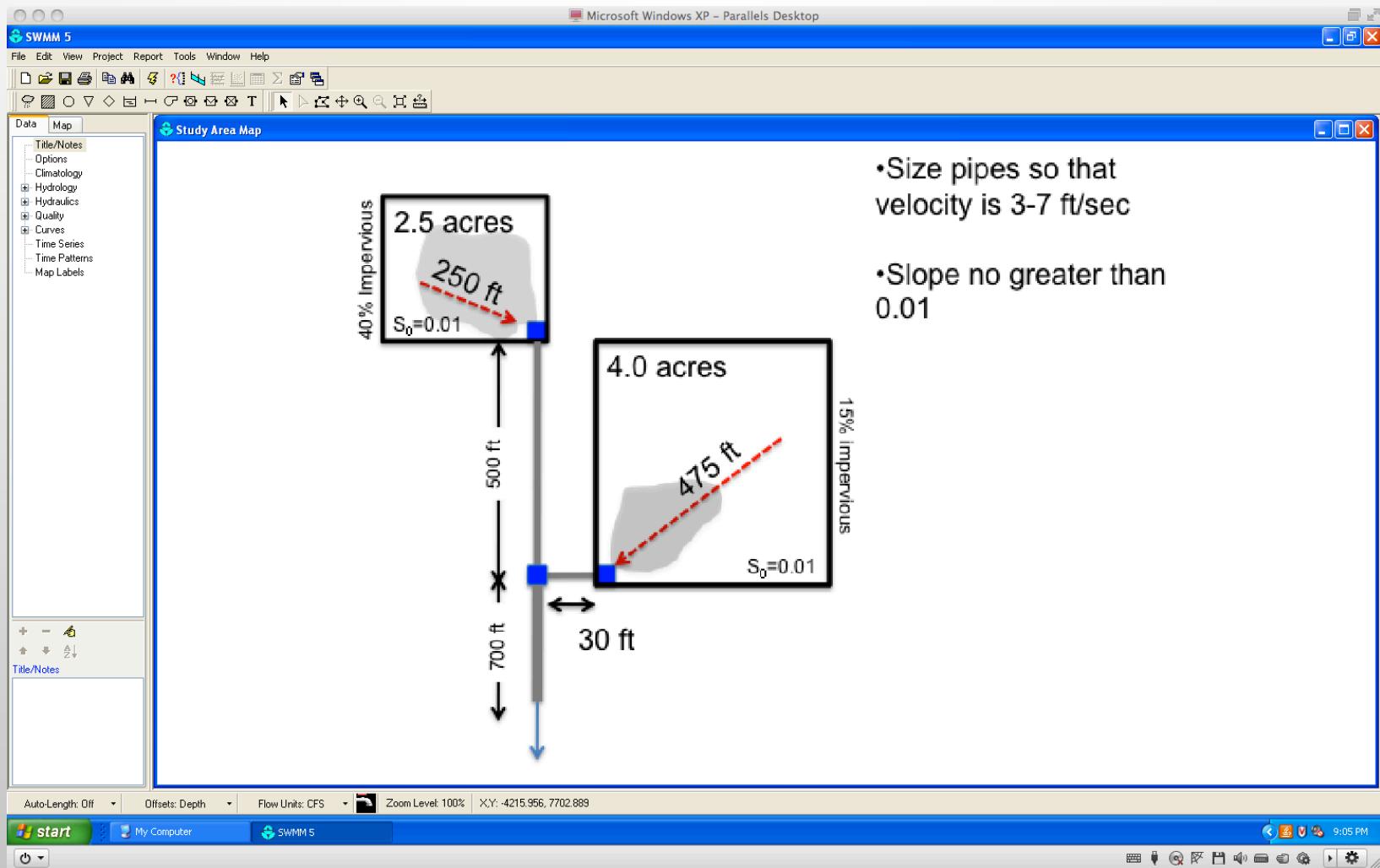
SWMM AS HYDROLOGIC MODEL



- Size pipes so that velocity is 3-7 ft/sec
- Slope no greater than 0.01

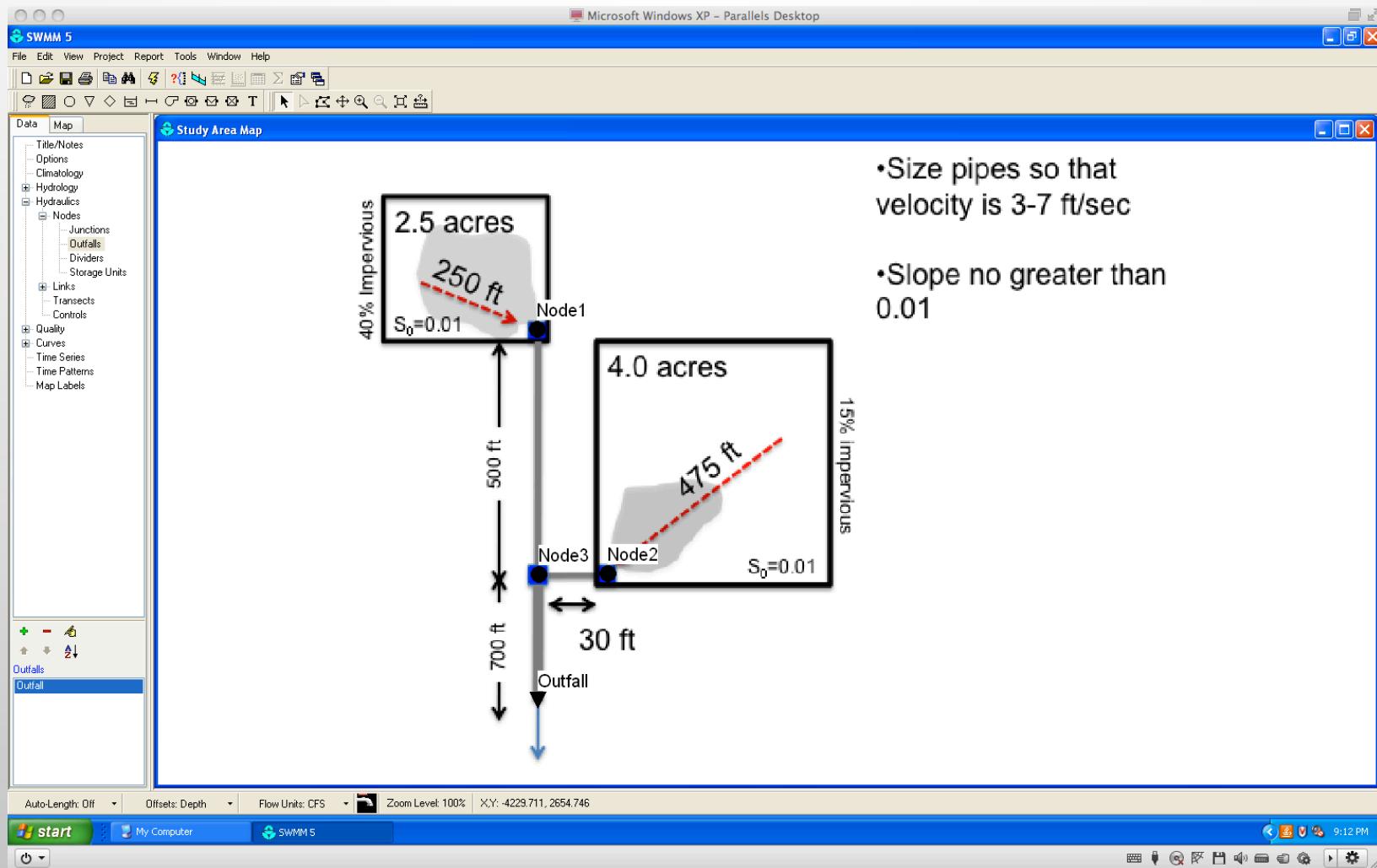
SWMM AS HYDROLOGIC MODEL

- LOAD THE PICTURE INTO SWMM



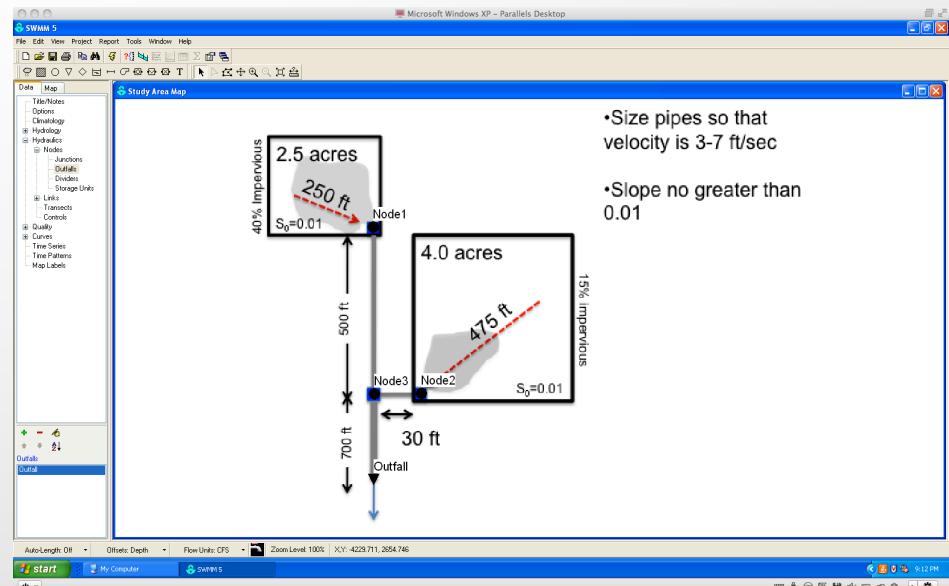
SWMM AS HYDROLOGIC MODEL

- 3 NODES + OUTFALL



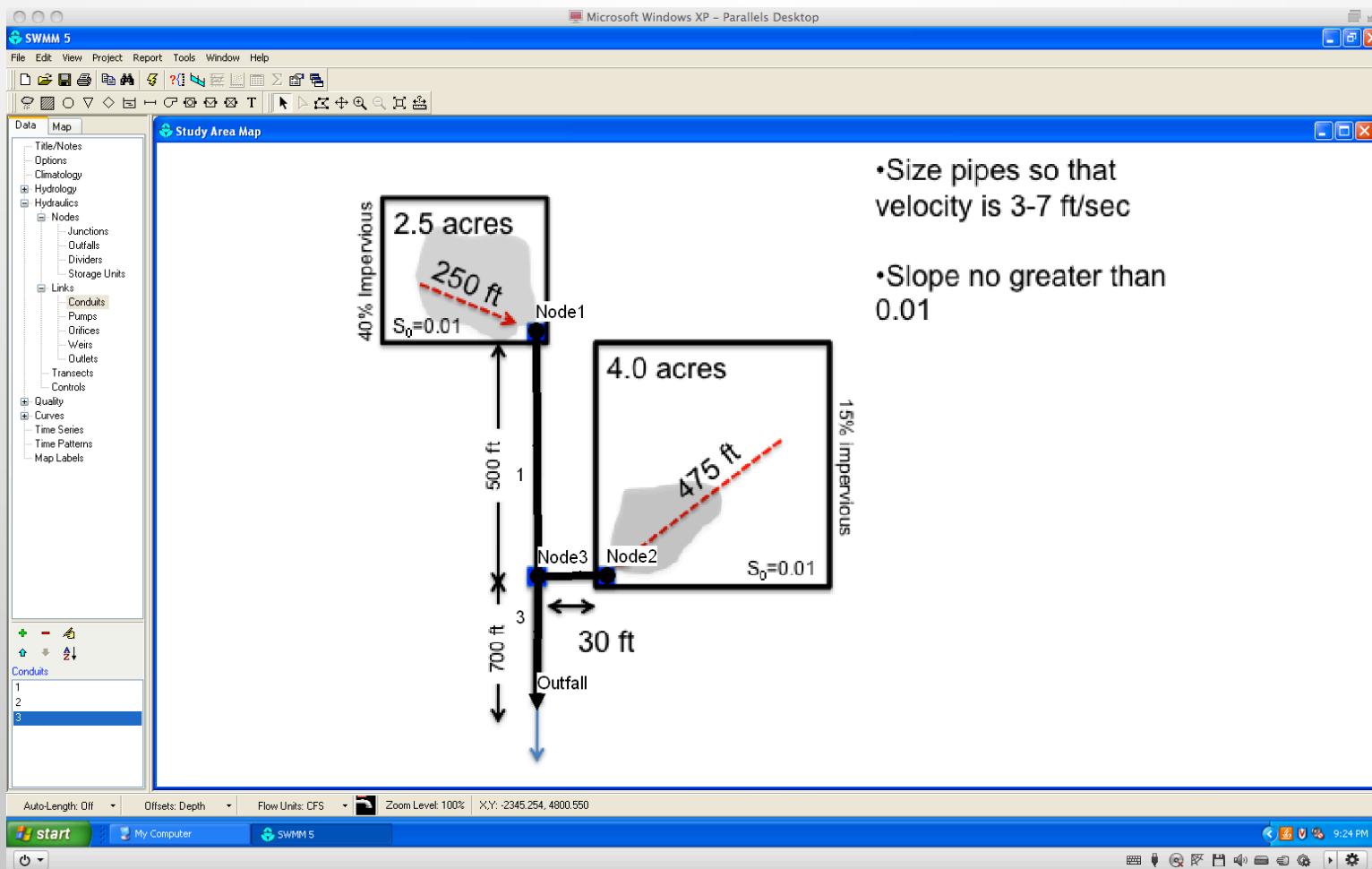
SWMM AS HYDROLOGIC MODEL

- INVERT ELEVATIONS
 - (EXAMPLE, THESE WOULD BE DESIGN VALUES, EXCEPT FOR OUTFALL, ADJUST TO GET VELOCITY)
 - OUTFALL = 0
 - NODE 3 = $700 * (0.01) = 7 \text{ FT}$
 - OFFSET OF 2 FT
 - NODE 2 = $7 + 2 + 0.01(30) = 9.3$
 - NODE 1 = $7 + 2 + 0.01(500) = 14$



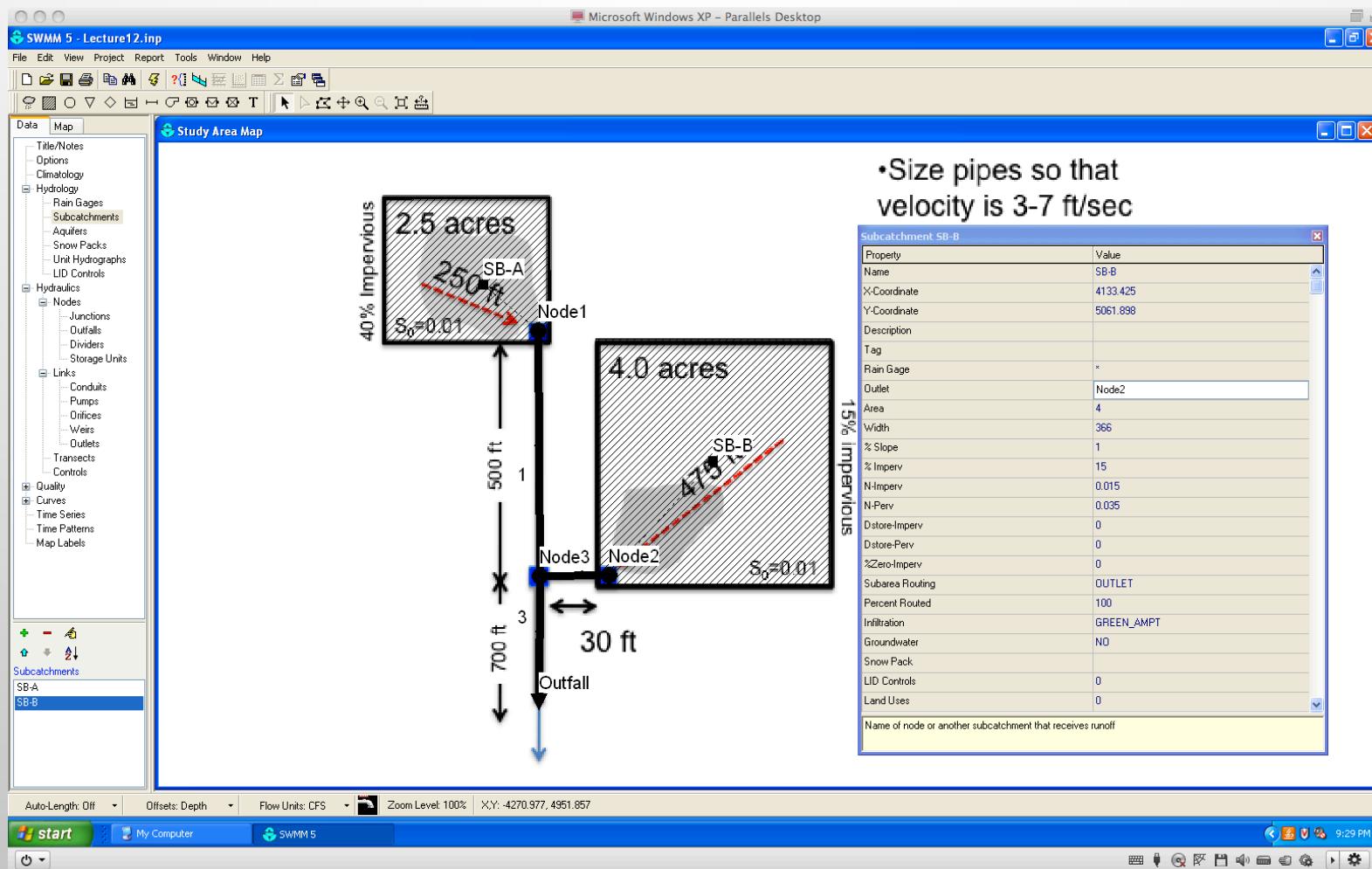
SWMM AS HYDROLOGIC MODEL

- 3 PIPES, 24" DIAMETER, CONCRETE (N=0.013)



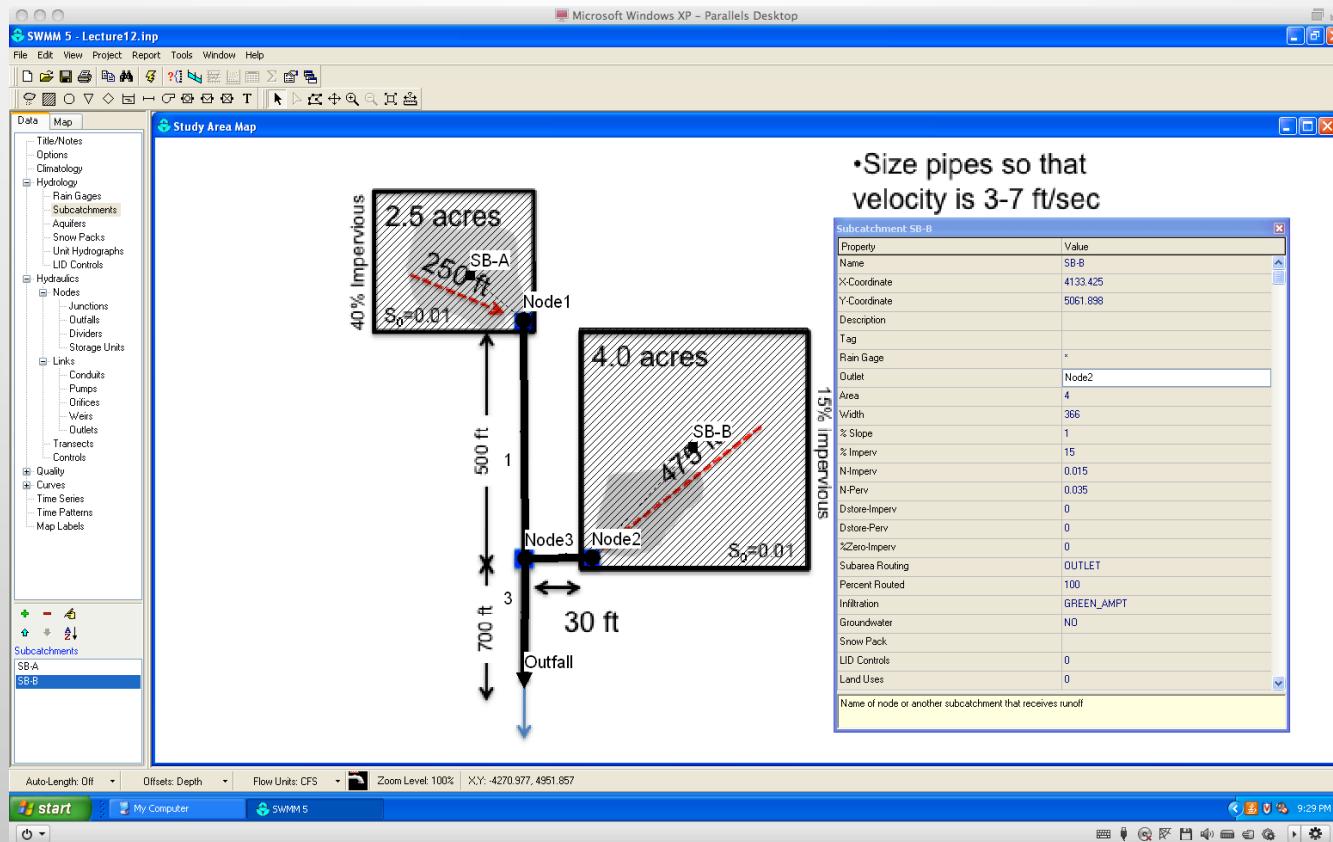
SWMM AS HYDROLOGIC MODEL

- 2 SUB-CATCHMENTS



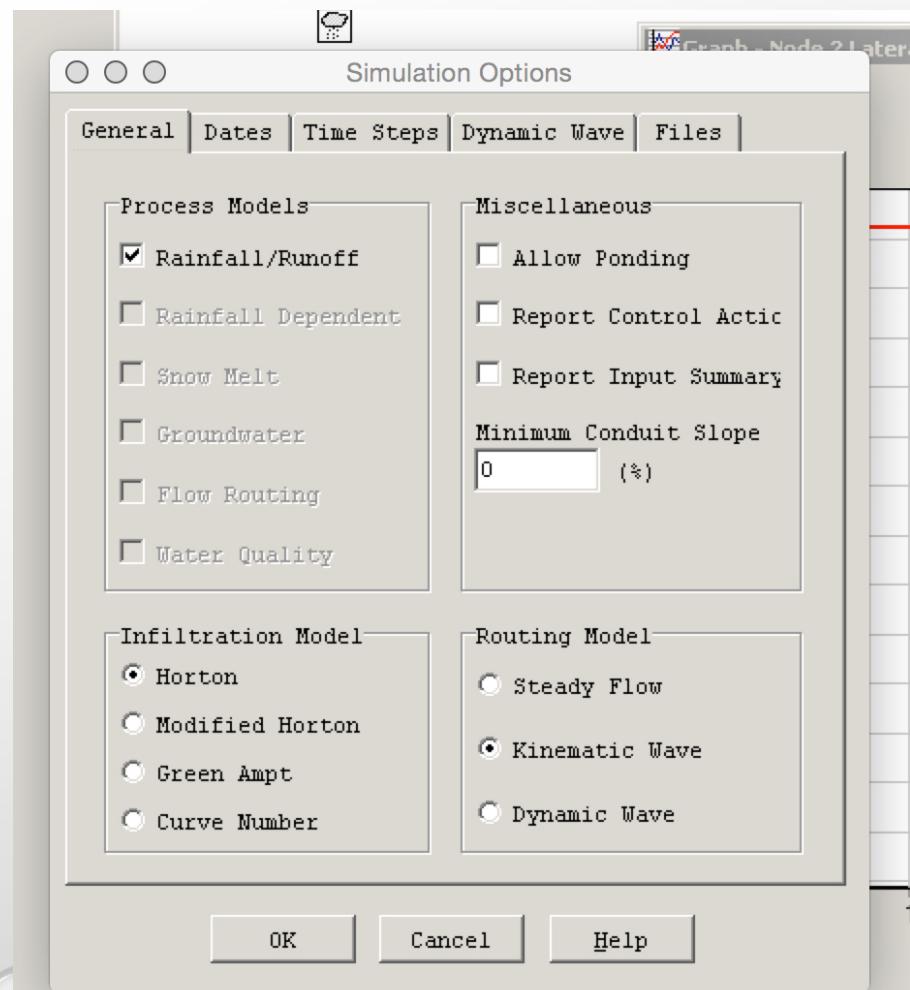
SWMM AS HYDROLOGIC MODEL

- CHOOSE A RUNOFF GENERATION MECHANISM!
 - FOR THIS SCALE RATIONAL IS LOGICAL, BUT NOT PART OF SWMM – NEED A HACK!



HACKING RATIONAL METHOD IN SWMM

- RUNOFF GENERATION
 - NO EXPLICIT RATIONAL METHOD FOR RUNOFF GENERATION
 - HORTON, GREEN-AMPT, AND CN.



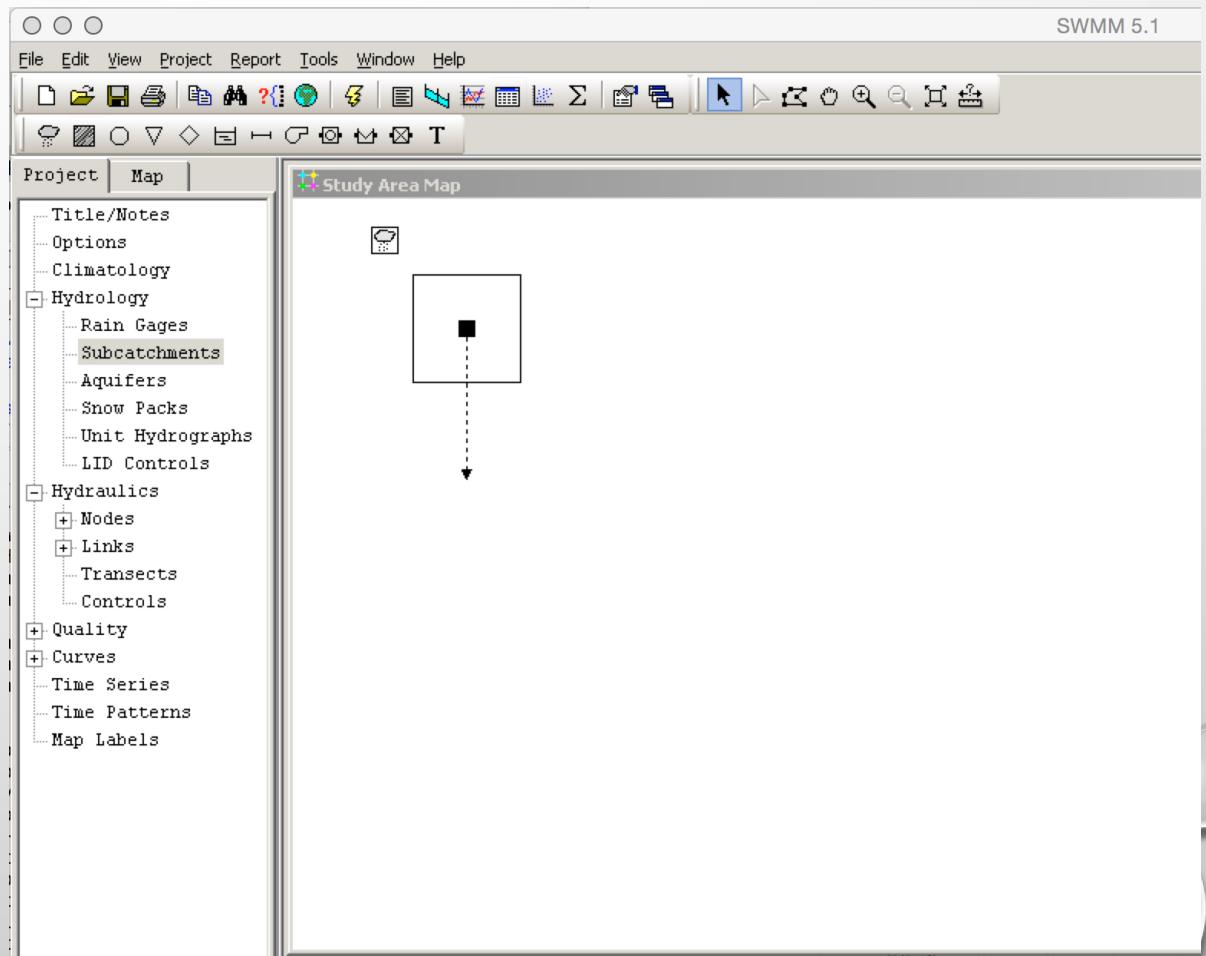
HACKING RATIONAL METHOD IN SWMM

- SUPPOSE WE WANT TO SIMULATE A 10.9 ACRE DRAINAGE AREA, WITH TC =49 MINUTES, AND C=0.32 AND APPLIED RAIN DEPTH IS 0.87 INCHES.
 - $I = 0.87\text{INCHES}/49\text{MIN} \times 60\text{ MIN/HR} = 1.06 \text{ IN/HR}$
 - $QP = (0.32)(1.06)(10.9) = 3.7 \text{ CFS}$

HACKING RATIONAL METHOD IN SWMM

- EQUIVALENT SWMM MODEL:

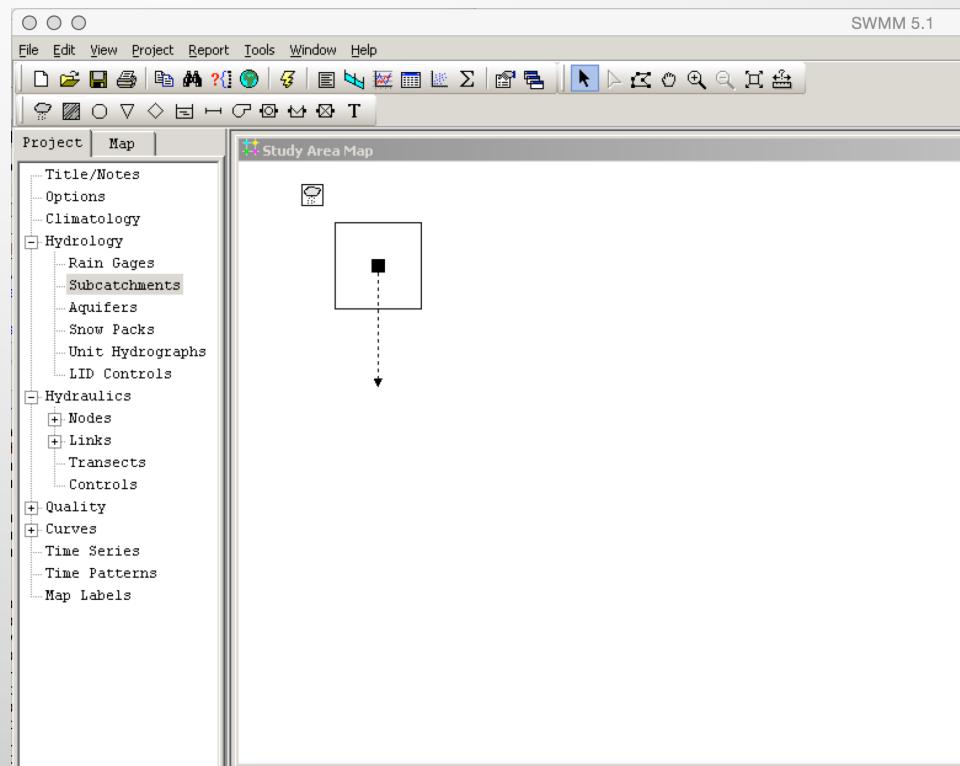
- RAINGAGE
- CATCHMENT
- OUTLET



HACKING A RATIONAL METHOD IN SWMM

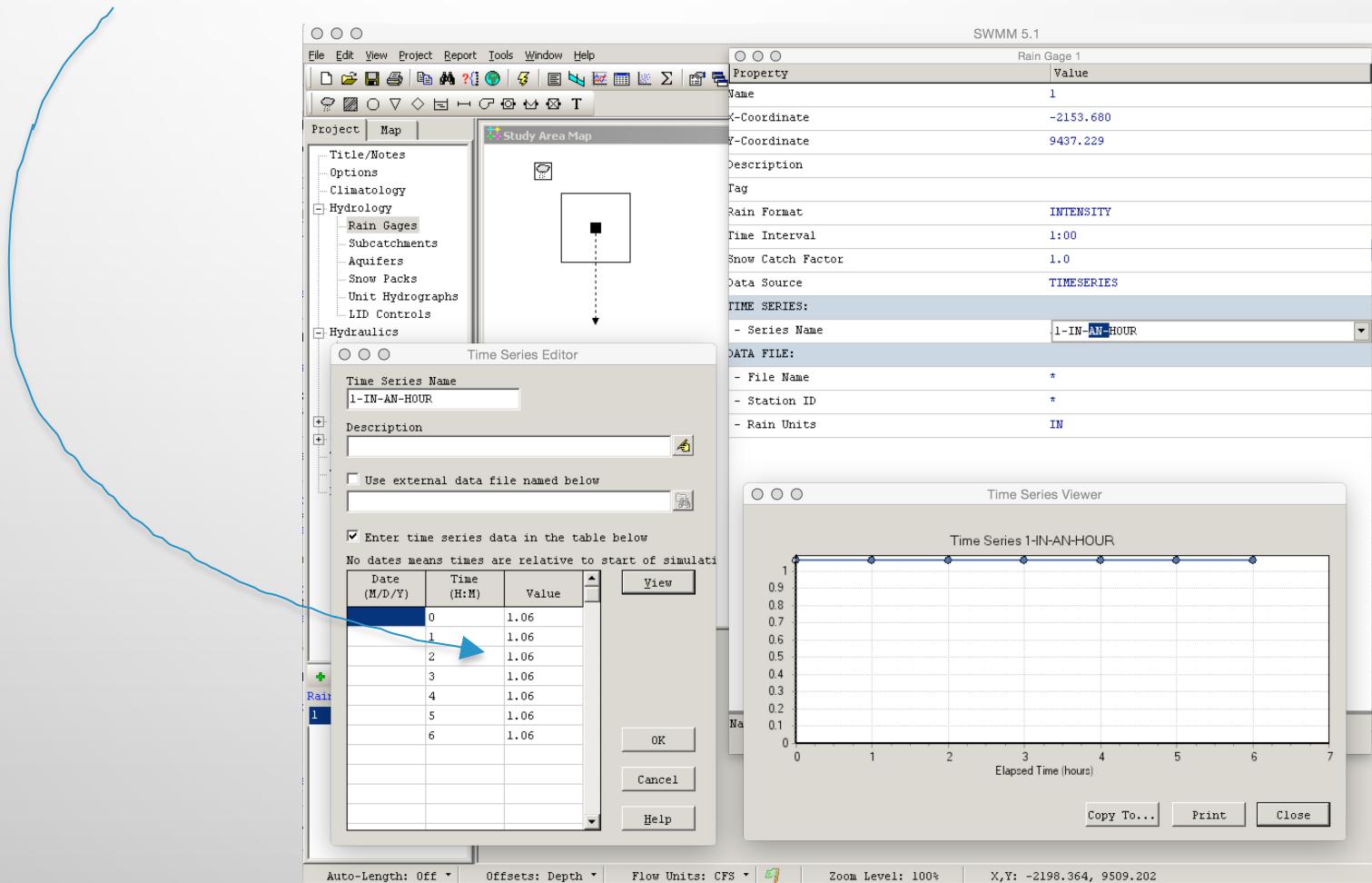
- EQUIVALENT SWMM MODEL:

- RAINGAGE → CONSTANT INTENSITY OF 1.06 IN.HR
- CATCHMENT → AREA = 10.9 ACRES
- OUTLET



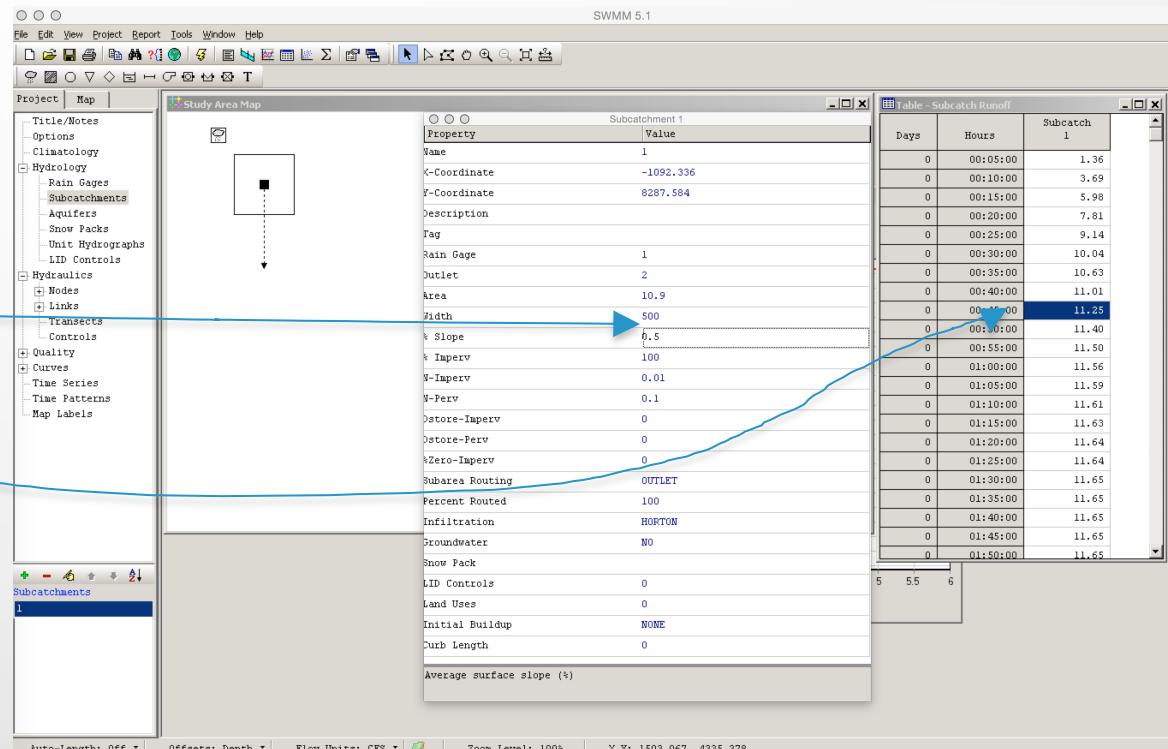
HACKING A RATIONAL METHOD IN SWMM

- RAINGAGE → CONSTANT INTENSITY OF 1.06 IN/HR



HACKING RATIONAL METHOD IN SWMM

- CATCHMENT → SET SIZE, SET TO 100% IMPERVIOUS
 - RUN TO ADJUST WIDTH & SLOPE
 - ARRIVAL TIME OF QP AT 50 MINUTES
 - QP = 11.65 CFS (C=1)



HACKING A RATIONAL METHOD IN SWMM

- CATCHMENT → SET SIZE, SET TO 100% IMPERVIOUS
 - WIDTH = 1500
 - ARRIVAL TIME OF QP AT 50 MINUTES
 - QP = 11.65 CFS (C=1)

The screenshot shows the SWMM software interface. On the left is a 'Subcatchment 1' properties table with various parameters like Name, X-Y coordinates, Description, Rain Gage, and Width. The 'Width' field is highlighted with a blue arrow pointing to it. On the right is a 'Table - Subcatch Runoff' showing runoff volume over time, with a blue arrow pointing to the first data row.

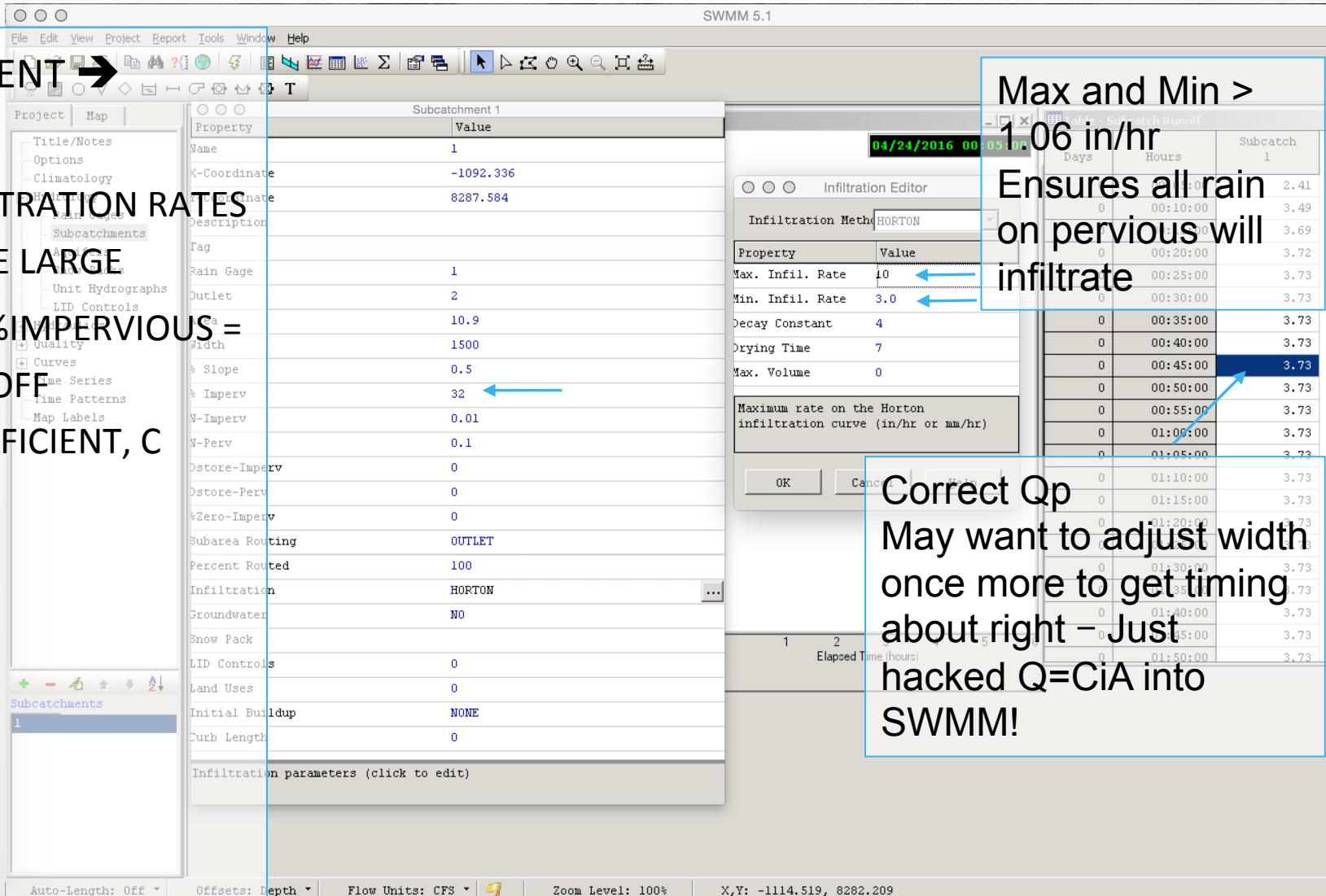
Subcatchment 1			MM 5.1
Property	Value		
Name	1		
X-Coordinate	-1092.336		
Y-Coordinate	8287.584		
Description			
Rag			
Rain Gage	1		
Outlet	2		
Area	10.9		
Width	1500		
% Slope	0.5		
% Imperv	100		
%-Imperv	0.01		
%-Perv	0.1		
Qstore-Imperv	0		
Qstore-Perv	0		
%Zero-Imperv	0		
Subarea Routing	OUTLET		
Percent Routed	100		
Infiltration	HORTON		
Groundwater	NO		
Snow Pack			
LID Controls	0		
Land Uses	0		
Initial Buildup	NONE		
Curb Length	0		
Width of overland flow path (ft)			

Table - Subcatch Runoff		
Days	Hours	Subcatch 1
0	00:05:00	3.53
0	00:10:00	7.60
0	00:15:00	9.89
0	00:20:00	10.93
0	00:25:00	11.36
0	00:30:00	11.54
0	00:35:00	11.61
0	00:40:00	11.63
0	00:45:00	11.64
0	00:50:00	11.65
0	00:55:00	11.65
0	01:00:00	11.65
0	01:05:00	11.65
0	01:10:00	11.65
0	01:15:00	11.65
0	01:20:00	11.65
0	01:25:00	11.65
0	01:30:00	11.65
0	01:35:00	11.65
0	01:40:00	11.65
0	01:45:00	11.65
0	01:50:00	11.65

Elapsed Time (hours)

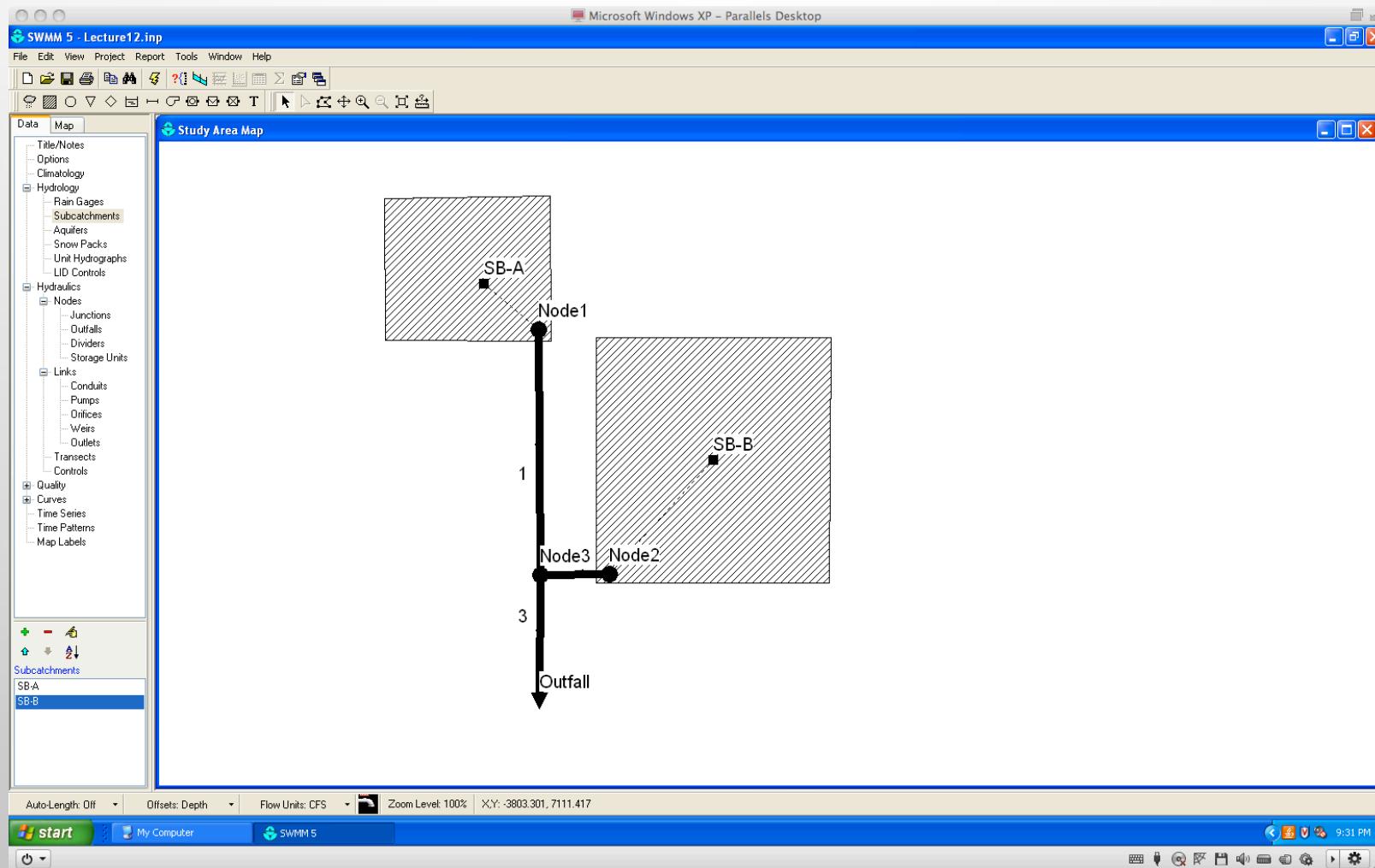
HACKING A RATIONAL METHOD IN SWMM

- CATCHMENT →
ADJUST
 - INFILTRATION RATES
TO BE LARGE
 - SET %IMPERVIOUS =
RUNOFF
COEFFICIENT, C



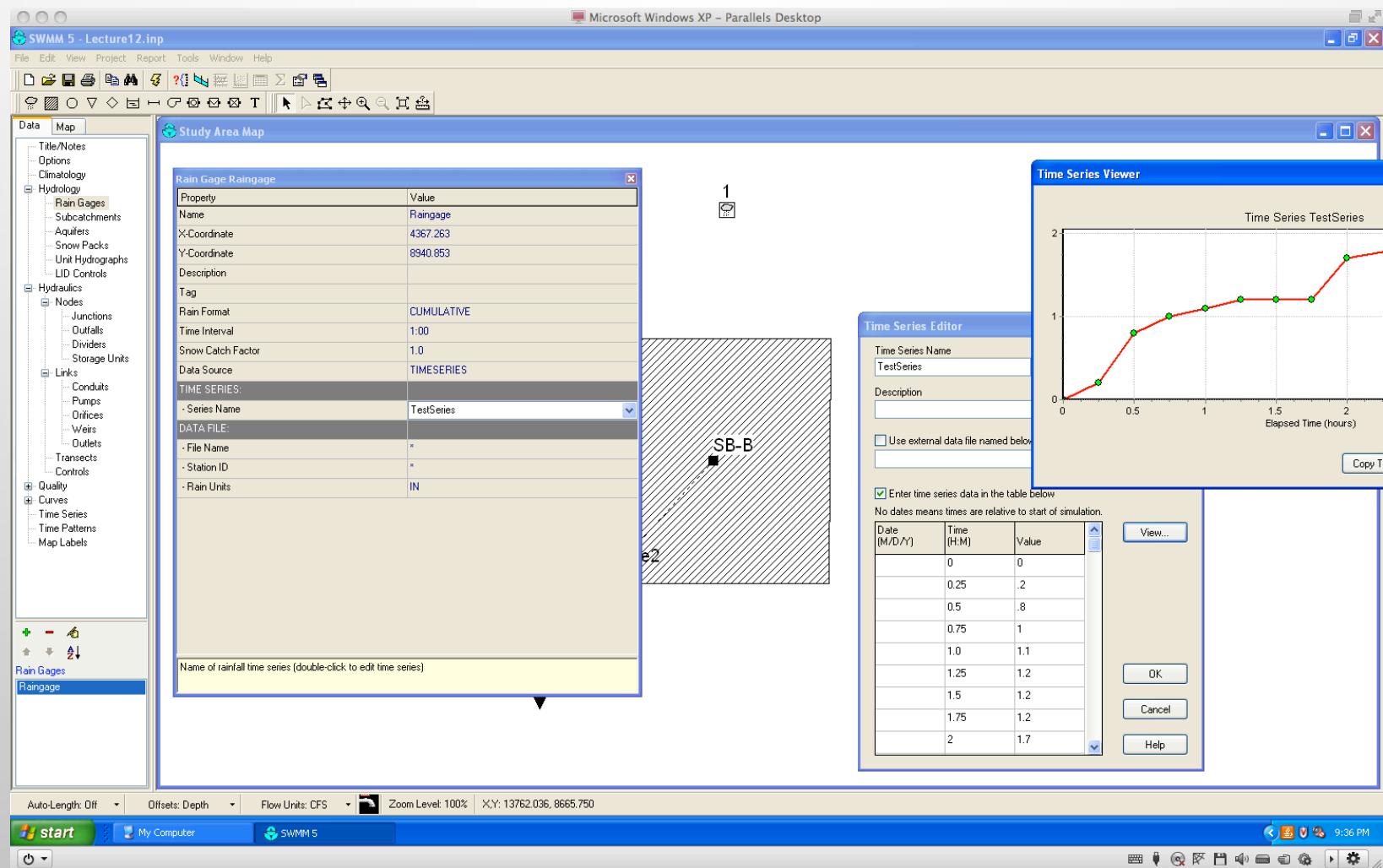
SWMM AS HYDROLOGIC MODEL

- SUPPRESS BACKGROUND, CHECK LAYOUT



SWMM AS HYDROLOGIC MODEL

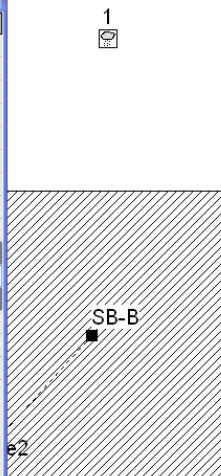
- INSERT A RAINGAGE



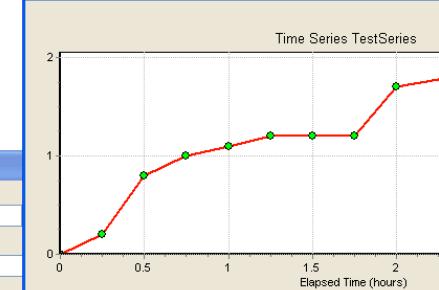
Rain Gage Raingage

Property	Value
Name	Raingage
X-Coordinate	4367.263
Y-Coordinate	8940.853
Description	
Tag	
Rain Format	CUMULATIVE
Time Interval	1:00
Snow Catch Factor	1.0
Data Source	TIMESERIES
TIME SERIES:	
- Series Name	TestSeries
DATA FILE:	
- File Name	*
- Station ID	*
- Rain Units	IN

Name of rainfall time series (double-click to edit time series)



Time Series Viewer



Enter time series data in the table below.

No dates means times are relative to start of simulation.

Date (M/D/Y)	Time (H:M)	Value
	0	0
	0.25	.2
	0.5	.8
	0.75	1
	1.0	1.1
	1.25	1.2
	1.5	1.2
	1.75	1.2
	2	1.7

View...

OK

Cancel

Help

start

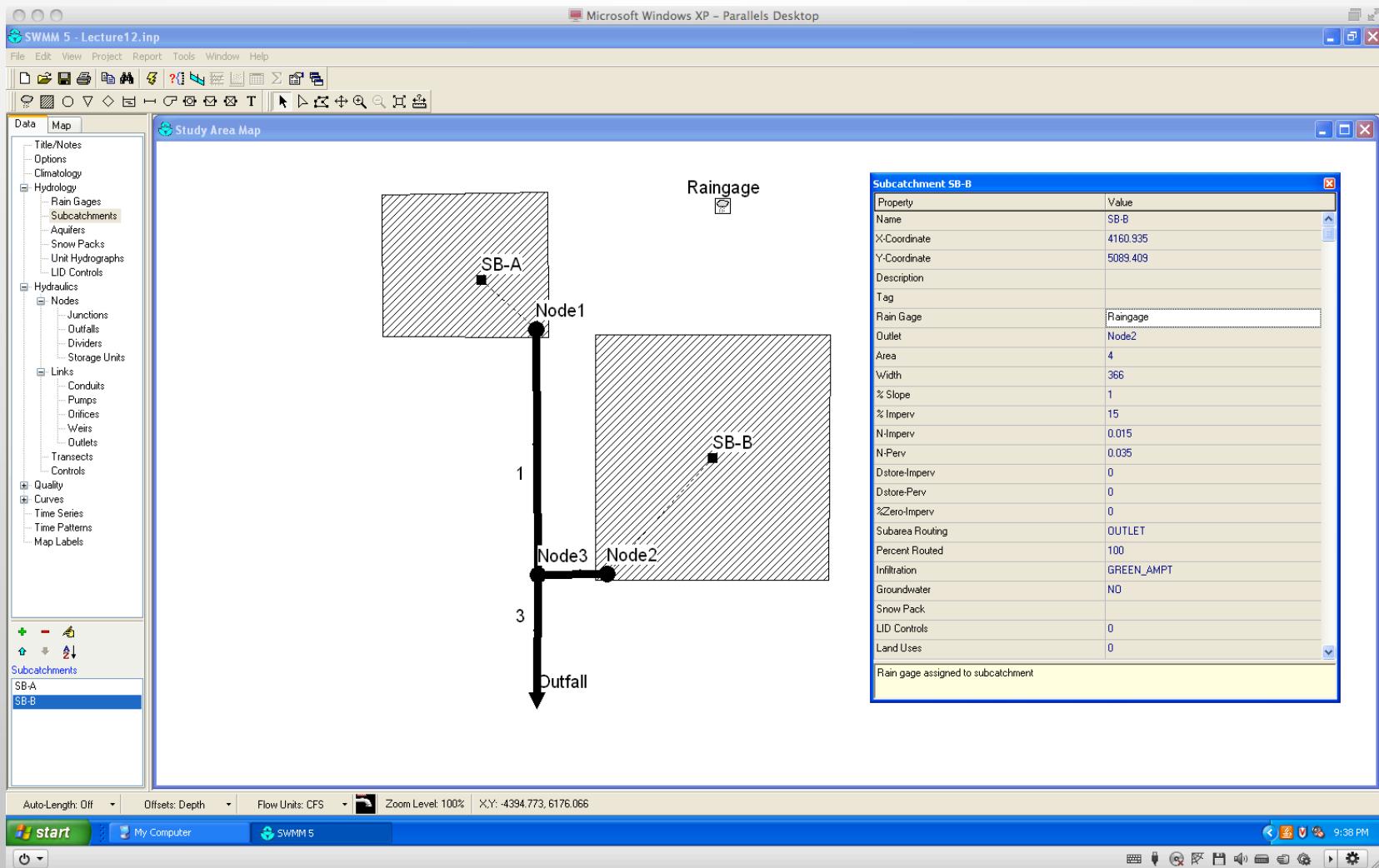
My Computer

SWMM 5

9:36 PM

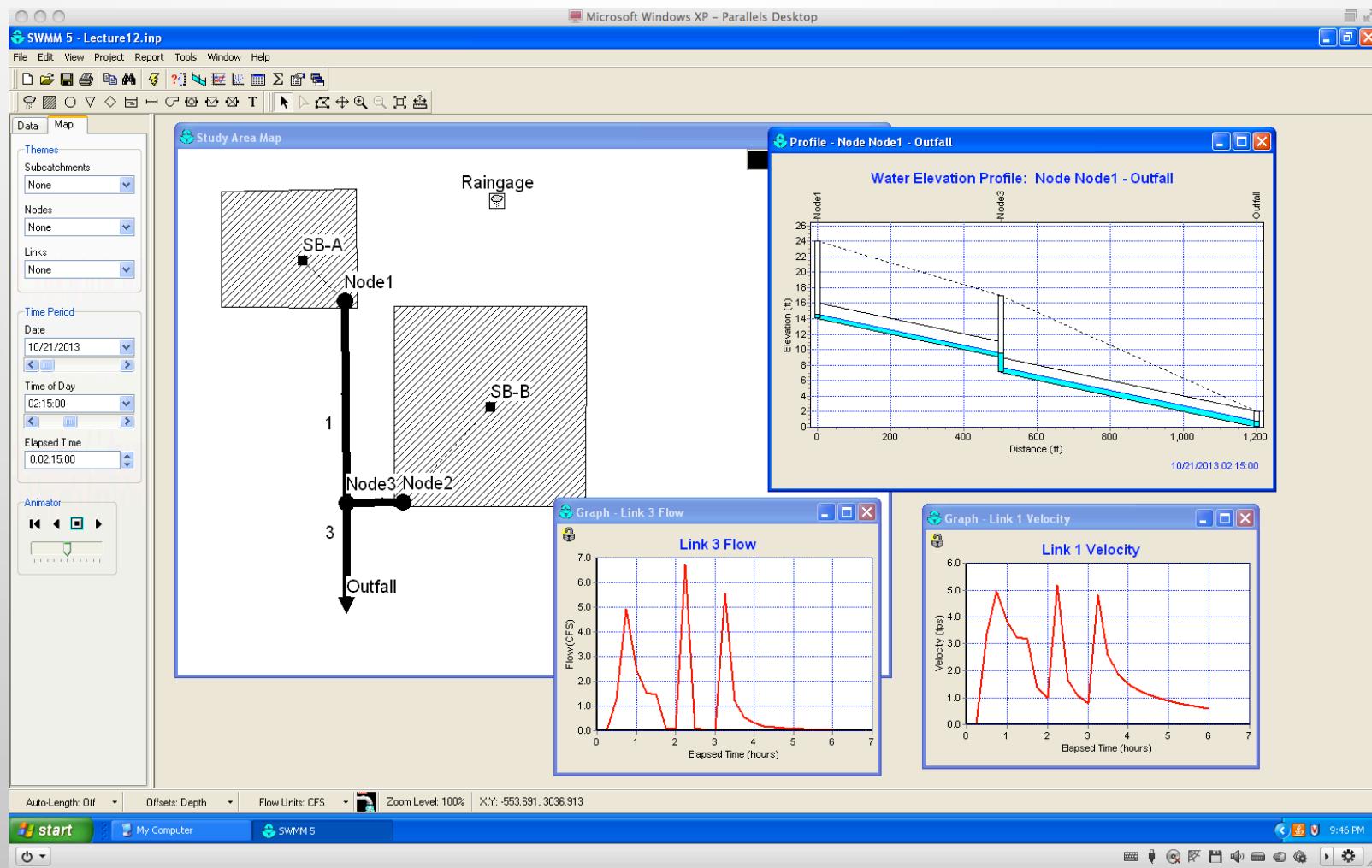
SWMM AS HYDROLOGIC MODEL

- APPLY THE RAINGAGE TO THE SUB-CATCMENTS



SWMM AS HYDROLOGIC MODEL

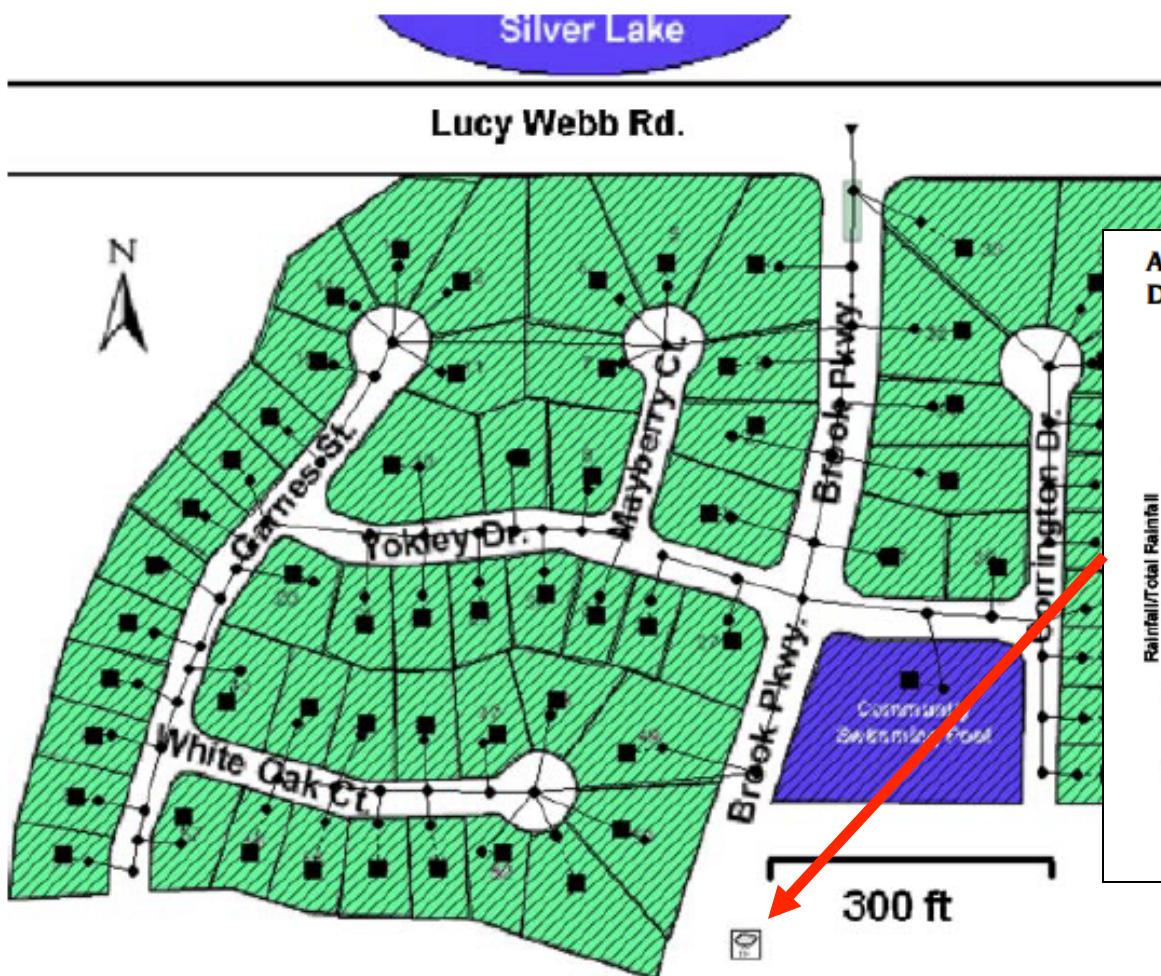
- SET THE TIME WINDOW, AND RUN THE MODEL



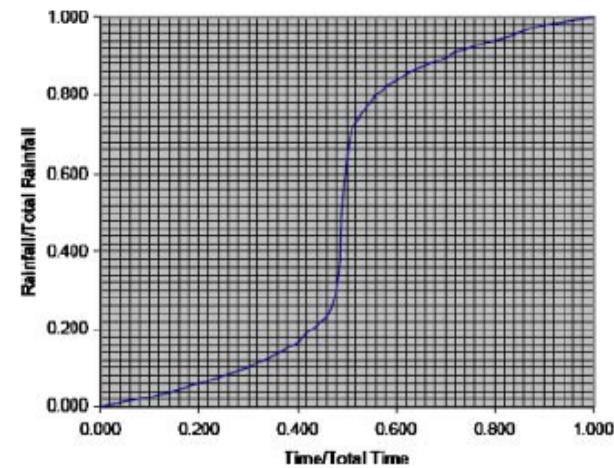
SWMM AS HYDROLOGIC MODEL

- FOR LARGER SCALE (LOTS OF SMALL CATCHMENTS) THERE WILL BE A DESIRE TO USE SCS STORMS OR EVEN HISTORICAL EVENTS TO EVALUATE THE DESIGN.
- THE NEXT EXAMPLE ILLUSTRATES HOW TO USE HEC-HMS AS A TOOL TO GENERATE RAINFALL FOR USE IN SWMM.

SWMM AS HYDROLOGIC MODEL



APPENDIX 4: SCS TYPE II STORM DISTRIBUTION



SWMM AS HYDROLOGIC MODEL

- ASSIGN A STORM TO A RAINGAGE

- SUPPOSE INSTRUCTED TO USE SCS-TYPE II STORM AND PARAMETERIZE FOR SAN ANTONIO, TEXAS
- SCS STORMS ARE BUILT-IN TO HEC-HMS, SO TAKE ADVANTAGE OF THAT TO GENERATE A RAINFALL TIME SERIES FOR SWMM

SWMM AS HYDROLOGIC MODEL

- HOW TO GENERATE SCS TYPE STORMS
 - SELECT ANNUAL EXCEEDANCE PROBABILITY (AEP) OR ANNUAL RECURRENCE INTERVAL (ARI)
 - LOOK UP 24 HOUR DEPTH FOR THE ARI AND LOCATION
 - GENERATE 24 HOUR STORM USING SCS TABULATIONS OR HEC-HMS
 - PUT THE TIME SERIES INTO SWMM AND RUN THE HYDRAULICS

SWMM AS HYDROLOGIC MODEL

- HOW TO GENERATE SCS TYPE STORMS
 - SELECT ANNUAL EXCEEDANCE PROBABILITY (AEP) OR ANNUAL RECURRENCE INTERVAL (ARI)
 - GIVEN IN THE PROJECT STATEMENT, A 10% CHANCE AEP OR 10-YEAR ARI (SAME PROBABILITY) IS SPECIFIED.

SWMM AS HYDROLOGIC MODEL

- HOW TO GENERATE SCS TYPE STORMS
 - LOOK UP 24 HOUR STORM DEPTH FOR THE AEP/ARI AND LOCATION

The image shows the front cover of a scientific report. At the top is the USGS logo with the tagline "science for a changing world". Below it, text reads "In cooperation with the Texas Department of Transportation". The main title is "Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas". Below the title is a photograph of a bridge over a river or stream flowing through a green landscape. At the bottom, the report number "Scientific Investigations Report 2004-5041" and the subtitle "(TxDOT Implementation Report 5-1301-01-1)" are printed, along with the "U.S. Department of the Interior U.S. Geological Survey" logo.

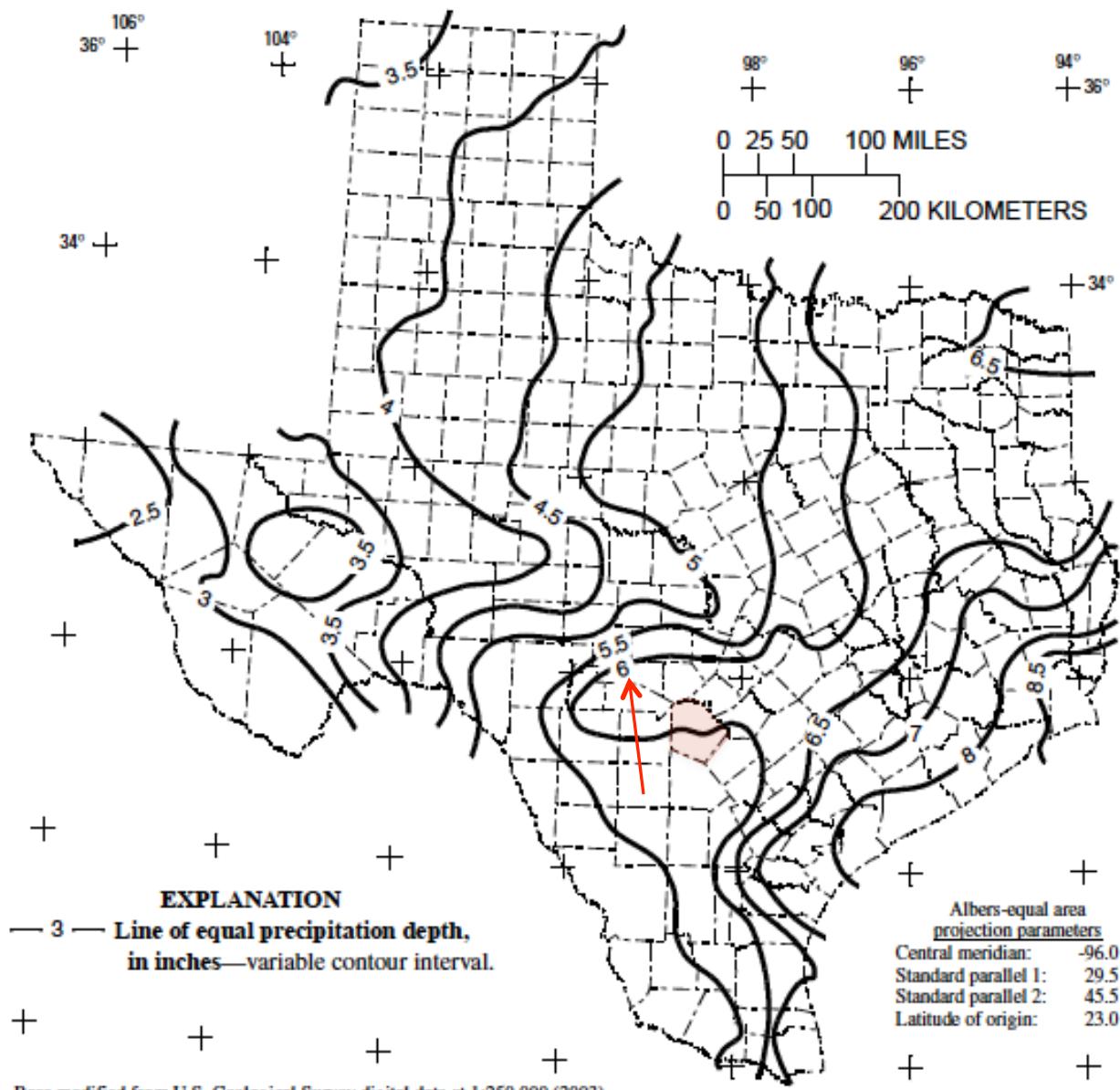


Figure 35. Depth of precipitation for 10-year storm for 1-day duration in Texas.

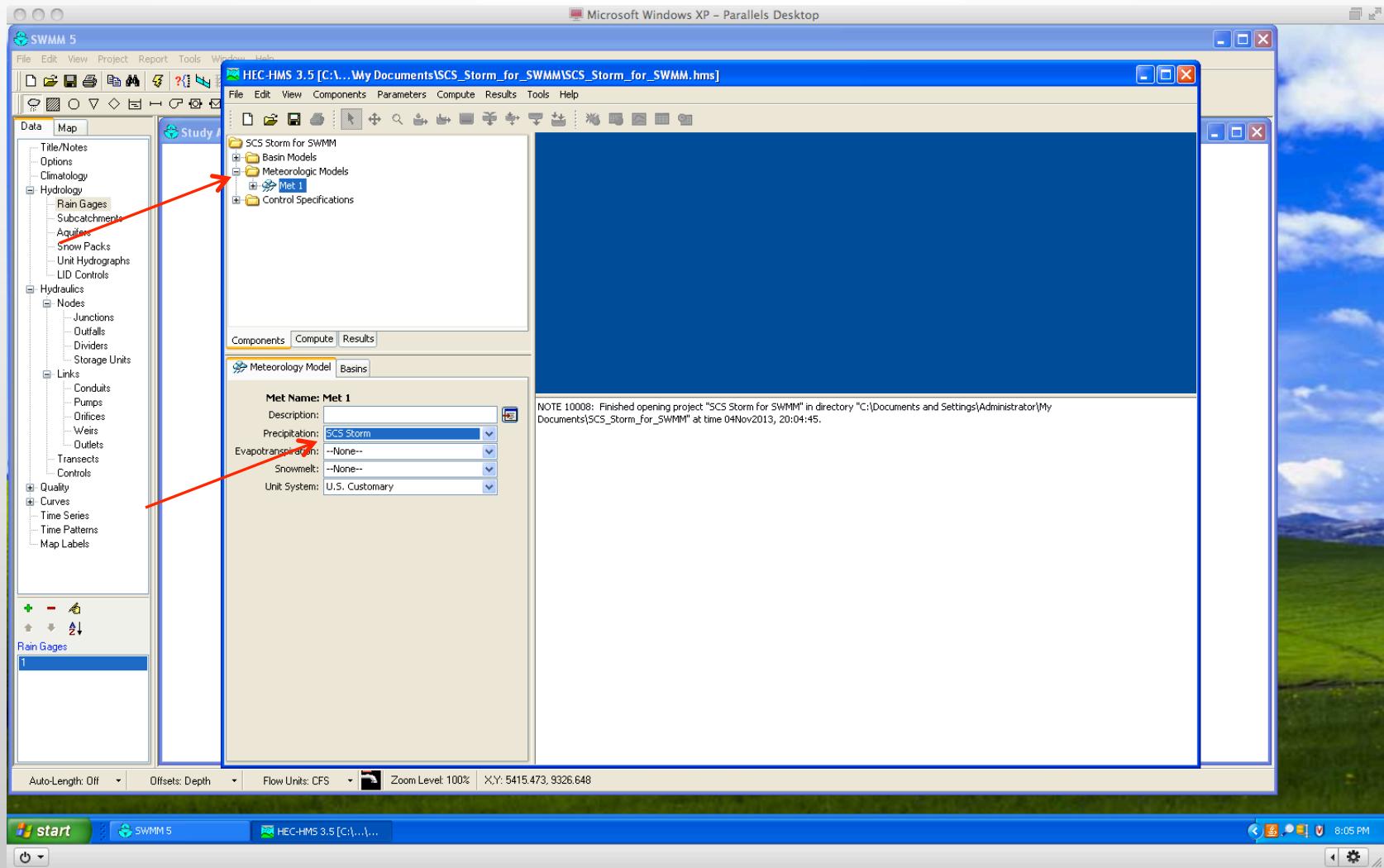
SWMM AS HYDROLOGIC MODEL

- HOW TO GENERATE SCS TYPE STORMS
 - SELECT ANNUAL EXCEEDANCE PROBABILITY (AEP) OR ANNUAL RECURRENCE INTERVAL (ARI)
 - LOOK UP 24 HOUR DEPTH FOR THE ARI AND LOCATION
 - 6 INCHES FOR BEXAR COUNTY, TX

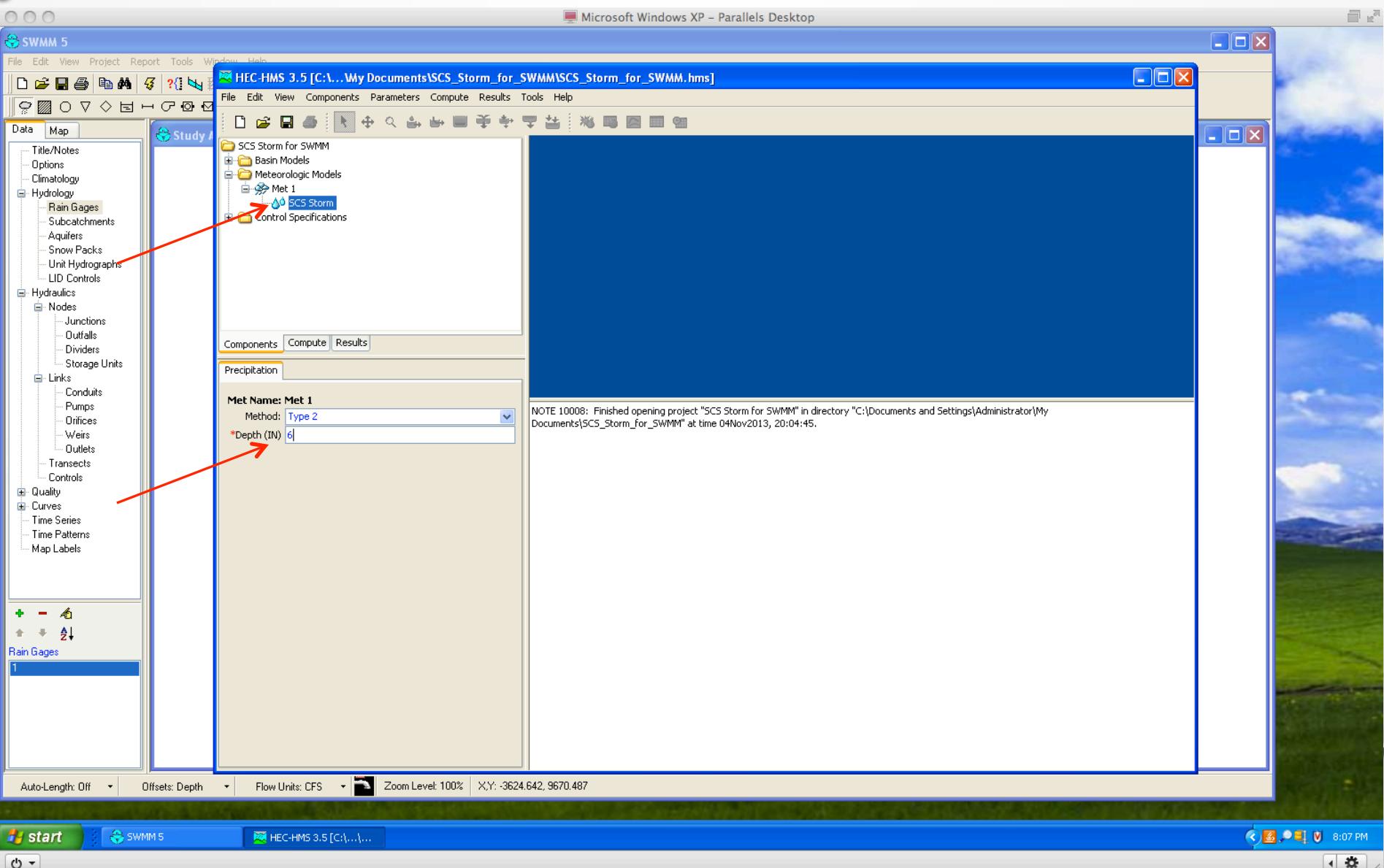
SWMM AS HYDROLOGIC MODEL

- HOW TO GENERATE SCS TYPE STORMS
 - GENERATE 24 HOUR STORM USING SCS TABULATIONS OR HEC-HMS
 - GET THE SWMM MODEL BUILT
 - OPEN HMS AND GENERATE A SCS STORM FROM THE METEROLOGICAL MODEL

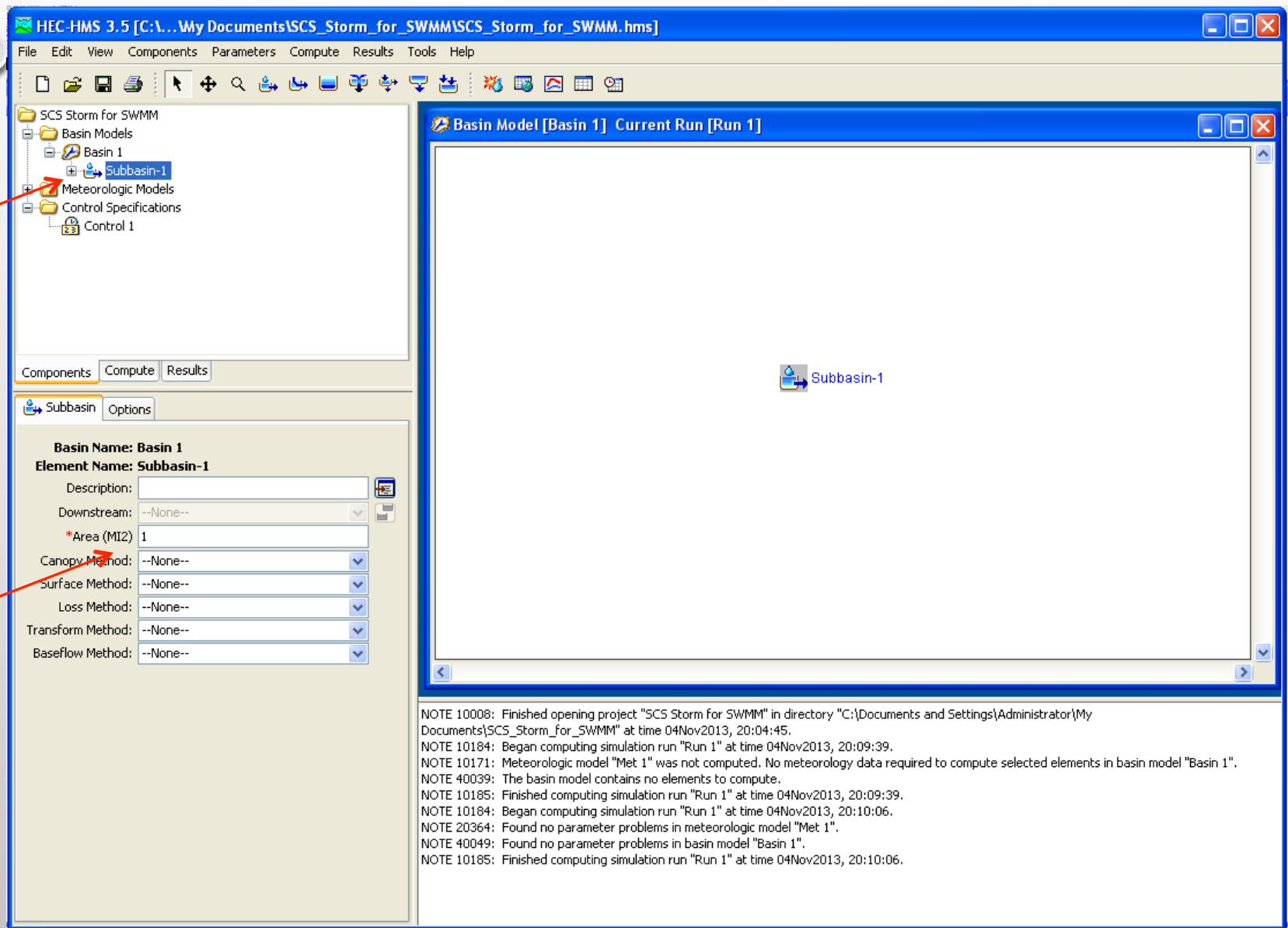
BUILD A MINIMAL HEC MODEL



BUILD A MINIMAL HEC MODEL



BUILD A MINIMAL HEC MODEL



RUN THE HEC MODEL

SWMM\SCS_Storm_for_SWMM.hms]

Tools Help

+ - +

Time-Series Results for Subbasin "Subbasin-1"

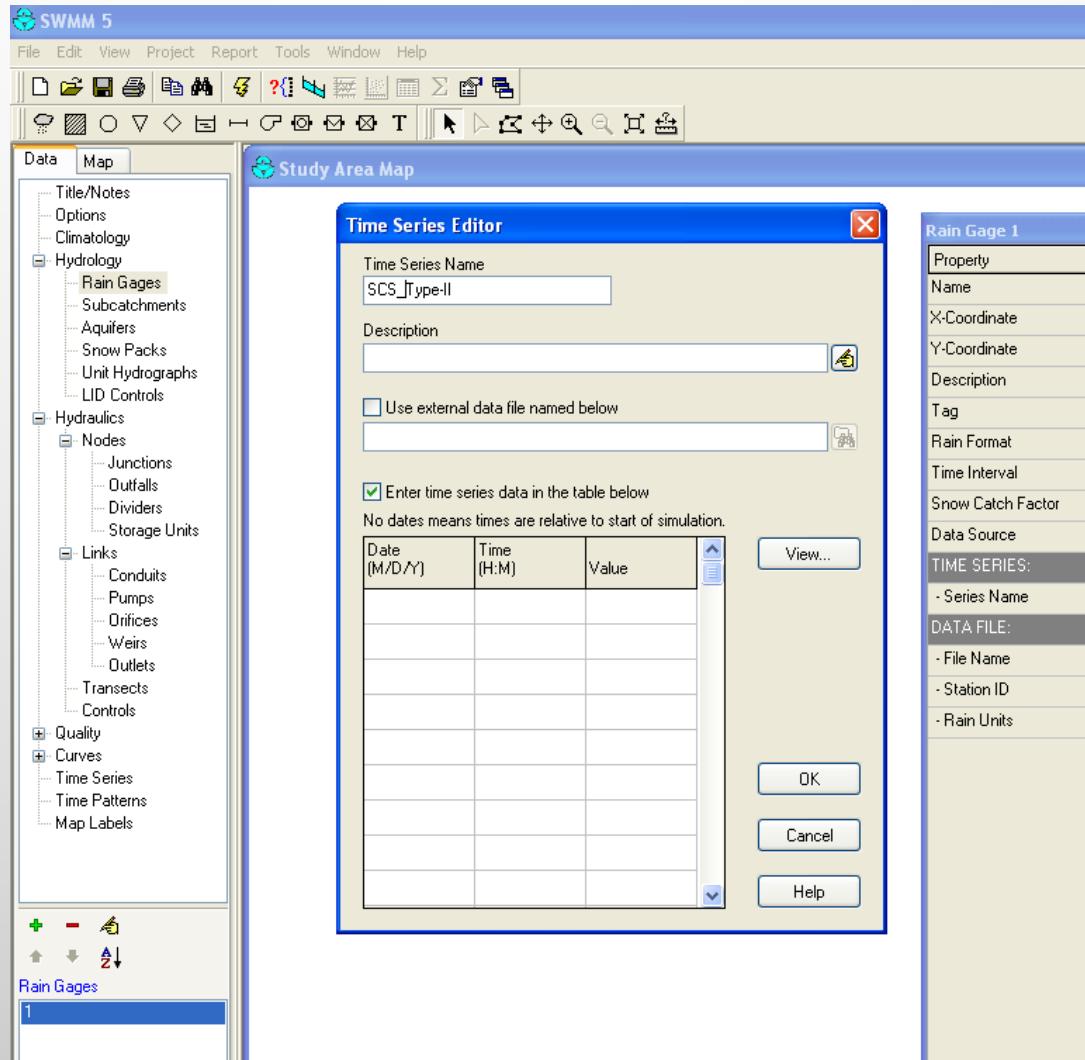
Project: SCS Storm for SWMM
Simulation Run: Run 1 Subbasin: Subbasin-1
Start of Run: 03 Nov 2013, 00:00 Basin Model: Basin 1
End of Run: 04 Nov 2013, 01:00 Meteorologic Model: Met 1
Compute Time: 04 Nov 2013, 20:10:06 Control Specifications: Control 1

Date	Time	Precip (IN)	Loss (IN)	Excess (IN)	Dir...	Base...	Total... (CFS)
03Nov2013	00:00				0.0	0.0	0.0
03Nov2013	01:00	0.06	0.00	0.06	40.7	0.0	40.7
03Nov2013	02:00	0.07	0.00	0.07	44.5	0.0	44.5
03Nov2013	03:00	0.08	0.00	0.08	48.4	0.0	48.4
03Nov2013	04:00	0.08	0.00	0.08	52.3	0.0	52.3
03Nov2013	05:00	0.09	0.00	0.09	58.1	0.0	58.1
03Nov2013	06:00	0.10	0.00	0.10	65.8	0.0	65.8
03Nov2013	07:00	0.11	0.00	0.11	73.6	0.0	73.6
03Nov2013	08:00	0.13	0.00	0.13	81.3	0.0	81.3
03Nov2013	09:00	0.16	0.00	0.16	104.5	0.0	104.5
03Nov2013	10:00	0.20	0.00	0.20	131.6	0.0	131.6
03Nov2013	11:00	0.32	0.00	0.32	209.1	0.0	209.1
03Nov2013	12:00	2.57	0.00	2.57	1657.2	0.0	1657.2
03Nov2013	13:00	0.65	0.00	0.65	422.0	0.0	422.0
03Nov2013	14:00	0.29	0.00	0.29	185.9	0.0	185.9
03Nov2013	15:00	0.20	0.00	0.20	129.7	0.0	129.7
03Nov2013	16:00	0.16	0.00	0.16	102.6	0.0	102.6
03Nov2013	17:00	0.13	0.00	0.13	84.4	0.0	84.4
03Nov2013	18:00	0.12	0.00	0.12	74.3	0.0	74.3
03Nov2013	19:00	0.10	0.00	0.10	64.7	0.0	64.7
03Nov2013	20:00	0.09	0.00	0.09	55.4	0.0	55.4
03Nov2013	21:00	0.08	0.00	0.08	49.2	0.0	49.2
03Nov2013	22:00	0.07	0.00	0.07	47.6	0.0	47.6
03Nov2013	23:00	0.07	0.00	0.07	45.3	0.0	45.3
04Nov2013	00:00	0.07	0.00	0.07	43.8	0.0	43.8
04Nov2013	01:00	0.00	0.00	0.00	0.0	0.0	0.0

SWMM AS HYDROLOGIC MODEL

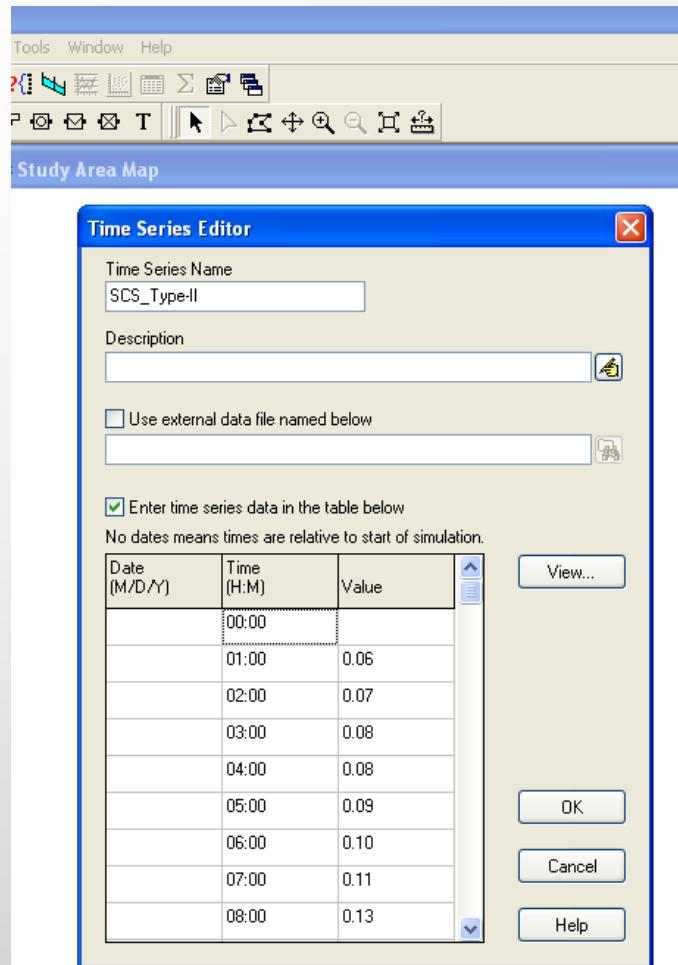
- NOW HAVE SCS TYPE II IN HEC-HMS, ONLY AFTER THE TWO COLUMNS IN THE TIME SERIES
- NOW GO TO THE SWMM MODEL AND BUILD A RAINGAGE TO ACCEPT THE TIME SERIES

SWMM RAINGAGE



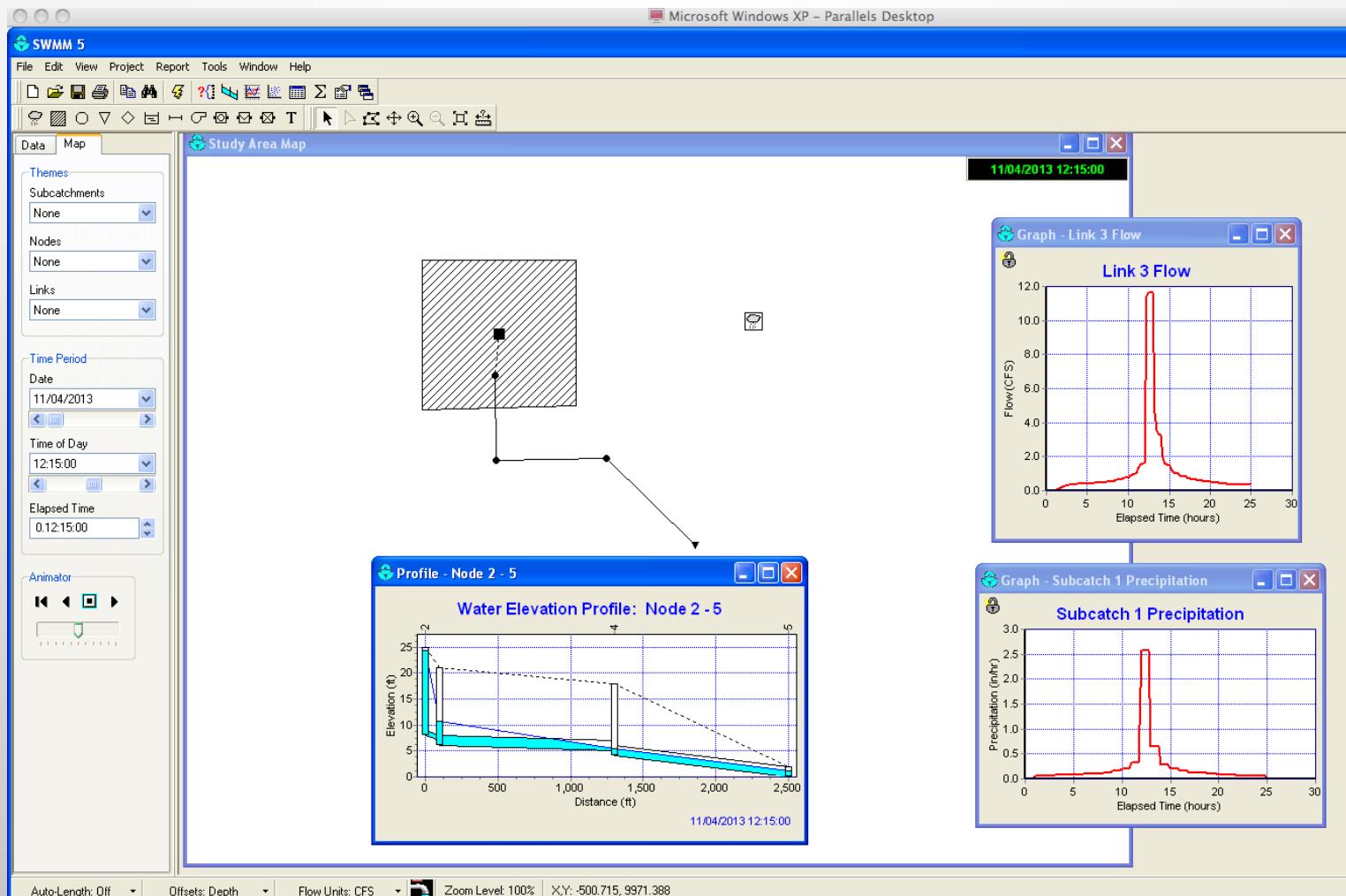
SWMM AS HYDROLOGIC MODEL

- NOW COPY-PASTE FROM HMS TO SWMM THE TWO COLUMNS
 - EDIT TO FIX THE FIRST VALUE
 - EDIT TO FIX THE 24TH AND 25TH HOURS
 - SET THE TIME WINDOW
 - RUN SWMM



SWMM AS HYDROLOGIC MODEL

- DONE! INTERPRET RESULTS



SWMM AS HYDROLOGIC MODEL

- SHOWED HOW TO USE HMS TO GENERATE SWMM INPUT.
- SWMM IS ALSO HANDY FOR GENERATING HMS INPUT
 - THE TIME ARITHMETIC IS MORE DEMANDING!

NEXT TIME

- CONDUITS IN SWMM
 - INVERT ELEVATIONS AND OFFSETS
 - DUAL DRAINAGE SYSTEMS