CE 374 K – Hydrology

Introduction to HEC - HMS

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Hydrologic Engineering Center

- **U.S. Army Corps of Engineers** (USACE) **Hydrologic Engineering Center** (HEC)
  - Formed 1964 to institutionalize the technical expertise in hydrologic engineering
  - L. Roy Beard founding Director (Professor Emeritus, Dept. of Civil Engr., UT Austin)
  - Development well-known family of HEC software
    - HEC-1 (watershed hydrology, now HEC-HMS)
    - HEC-2 (river hydraulics, now HEC-RAS)
    - HEC-3 (reservoir analysis, now HEC-ResSim)

HEC-Hydrologic Modeling System (HEC-HMS)

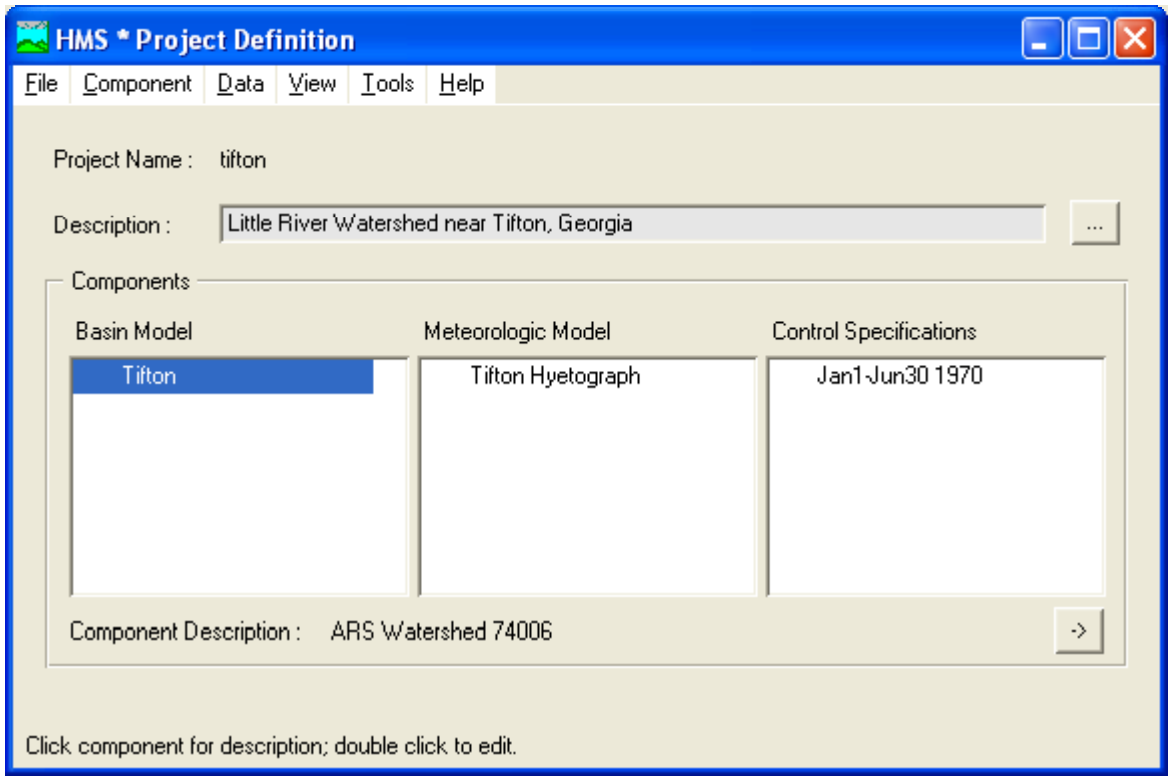
- Simulation of runoff hydrographs resulting from design storms and other precipitation events
- Primary function
  - quantifying rainfall losses into the soil (computing rainfall excess)
  - converting excess rainfall to runoff
  - routing flows
- Obtaining
  - Program: http://www.hec.usace.army.mil/
  - Data: http://www.ce.utexas.edu/prof/mckinney/ce374k/Homework/waller.zip

Start the Program

Components:

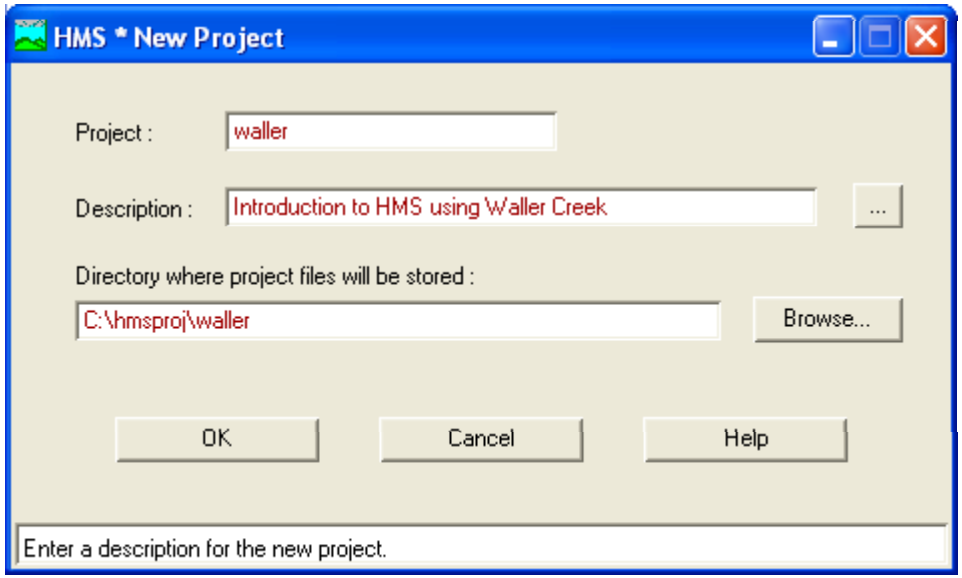
- Basin Model
- Meteorologic Model
- Control Specifications

Project Definition Screen



Import Waller Creek Model

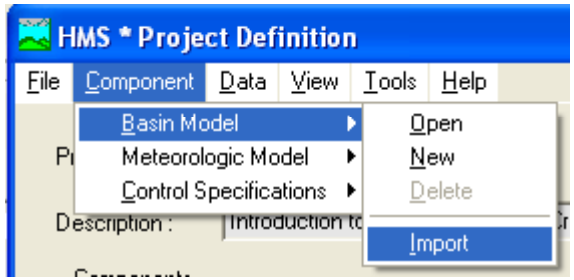
File/New Project



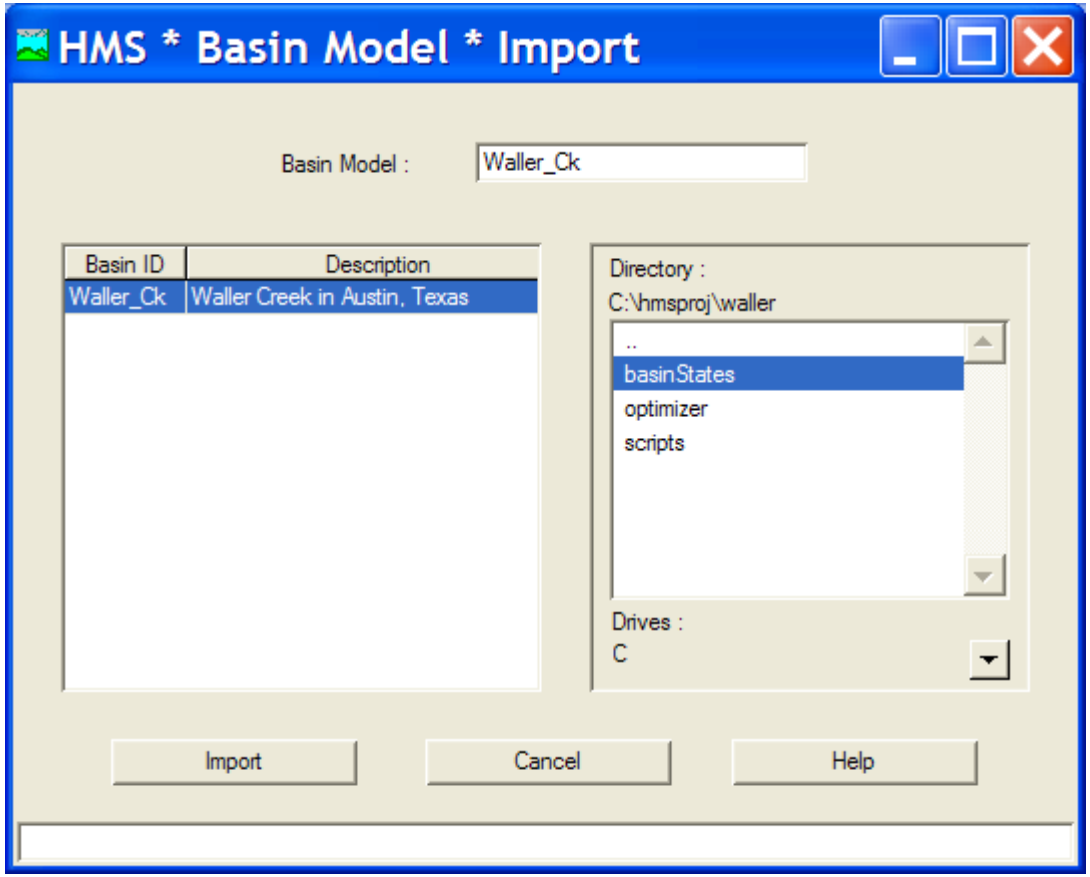
Creates: C:\hmsproj\waller

Copy:
Waller_Ck.basin and
Hms.map
to C:\hmsproj\waller

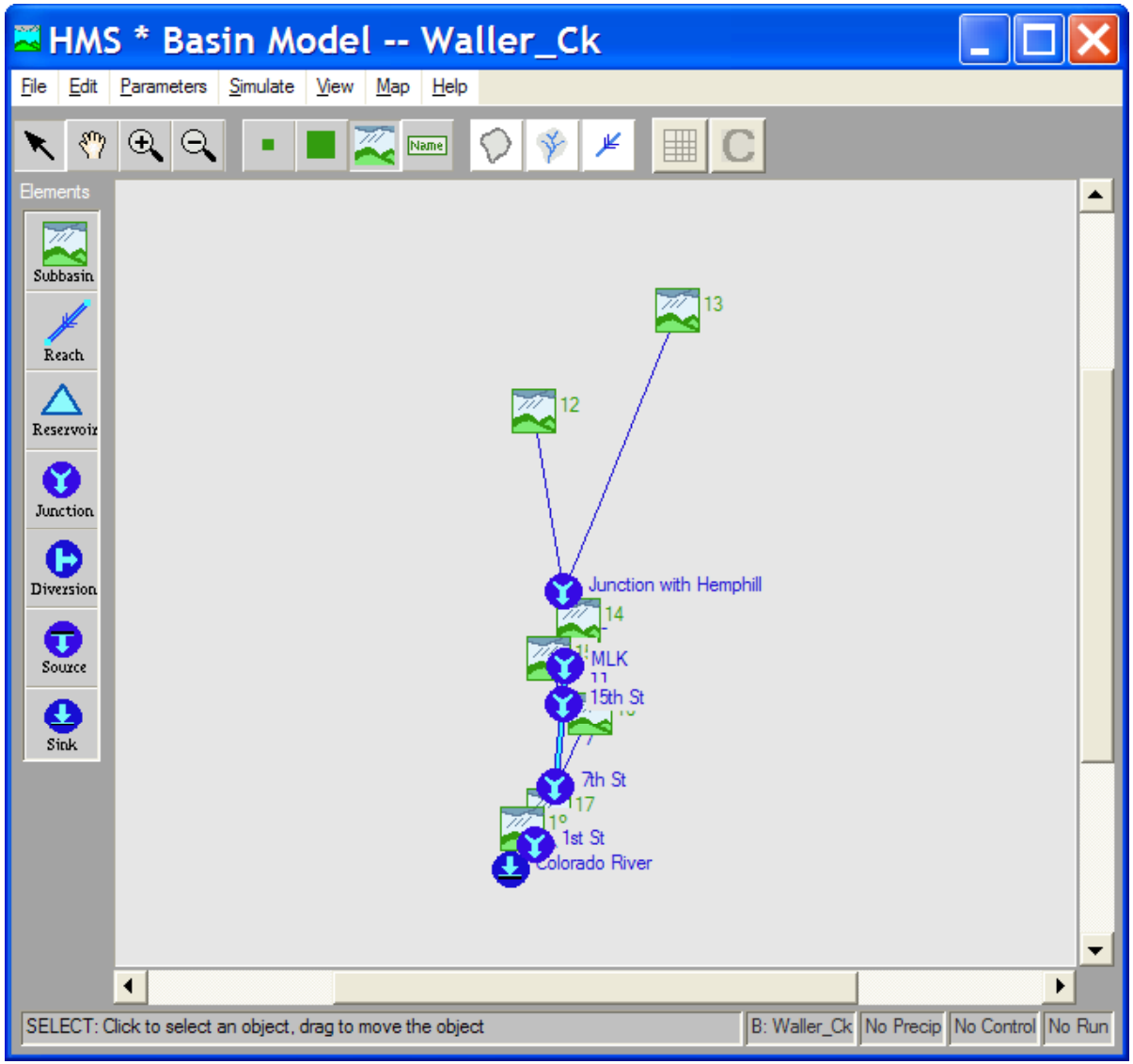
Import Basin Model



Component/Basin Model/Import:
Import basin model file Waller_Ck.basin

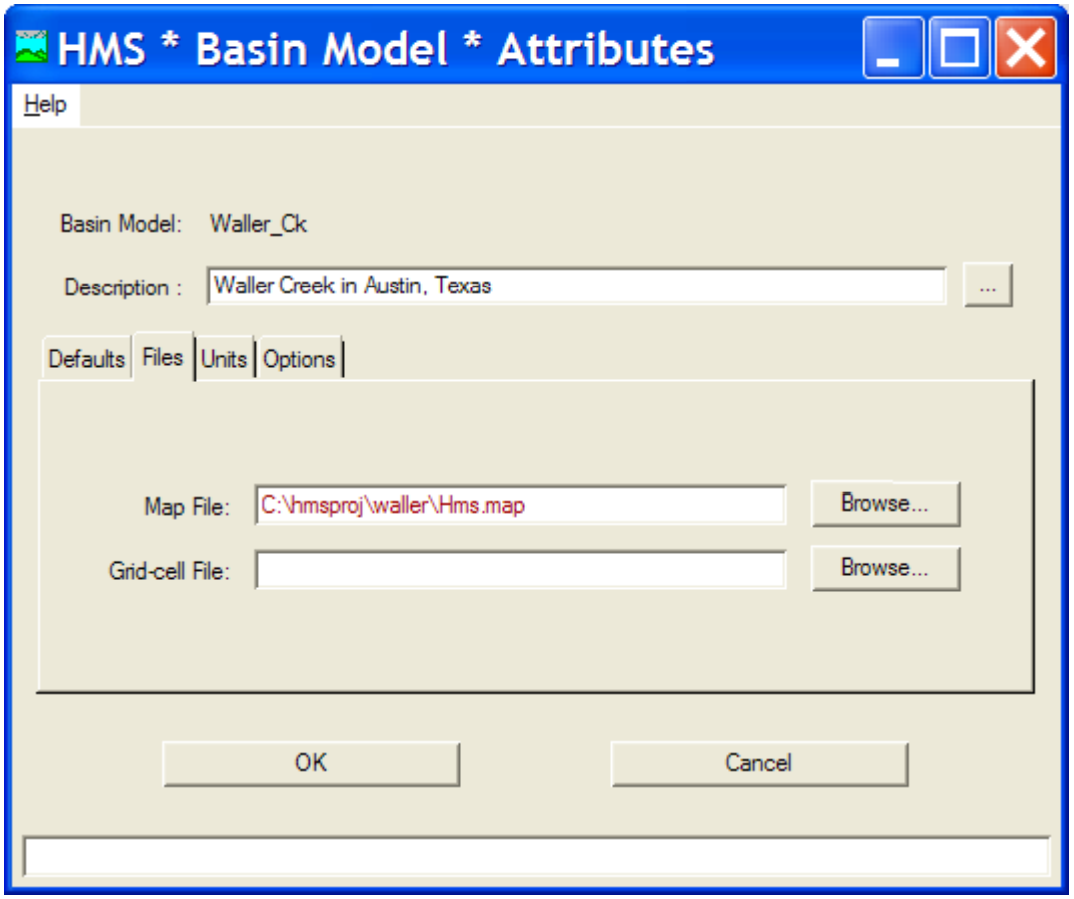


Basin Model

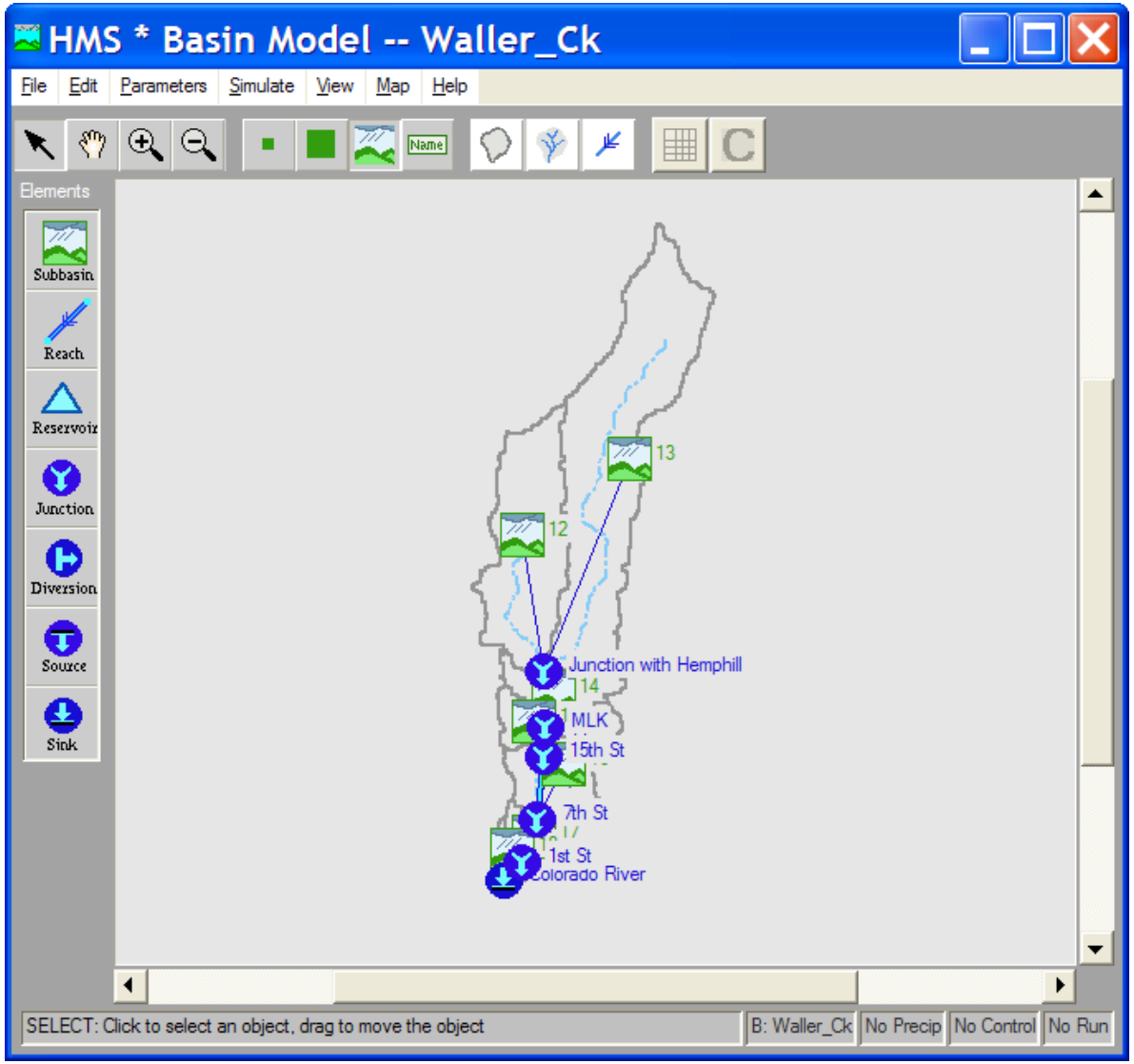

HMS * Basin Model -- Waller_Ck
File
Edit
Parameters
Simulate
View
Map
Help
Name
Elements
Subbasin
Reach
Reservoir
Junction
Diversion
Source
Sink
13
12
Junction with Hemphill
14
MLK
15th St
7th St
17
1st St
Colorado River
SELECT: Click to select an object, drag to move the object
B: Waller_Ck
No Precip
No Control
No Run

Basin Map

File/Basin Model Attributes
Files tab



Basin Model With Map



Hydrologic Elements

- **Subbasin** - Outflow calculated from precipitation by subtracting losses, transforming excess precipitation and adding baseflow

- **River Reach** - Inflow from other elements, Outflow computed from flow routing methods

- **Reservoir** - Outflow computed from storage - outflow relations and level water surface assumption

- **Junction** - combine flows from upstream reaches and subbasins

- **Diversion** - Two outlets, main and diverted

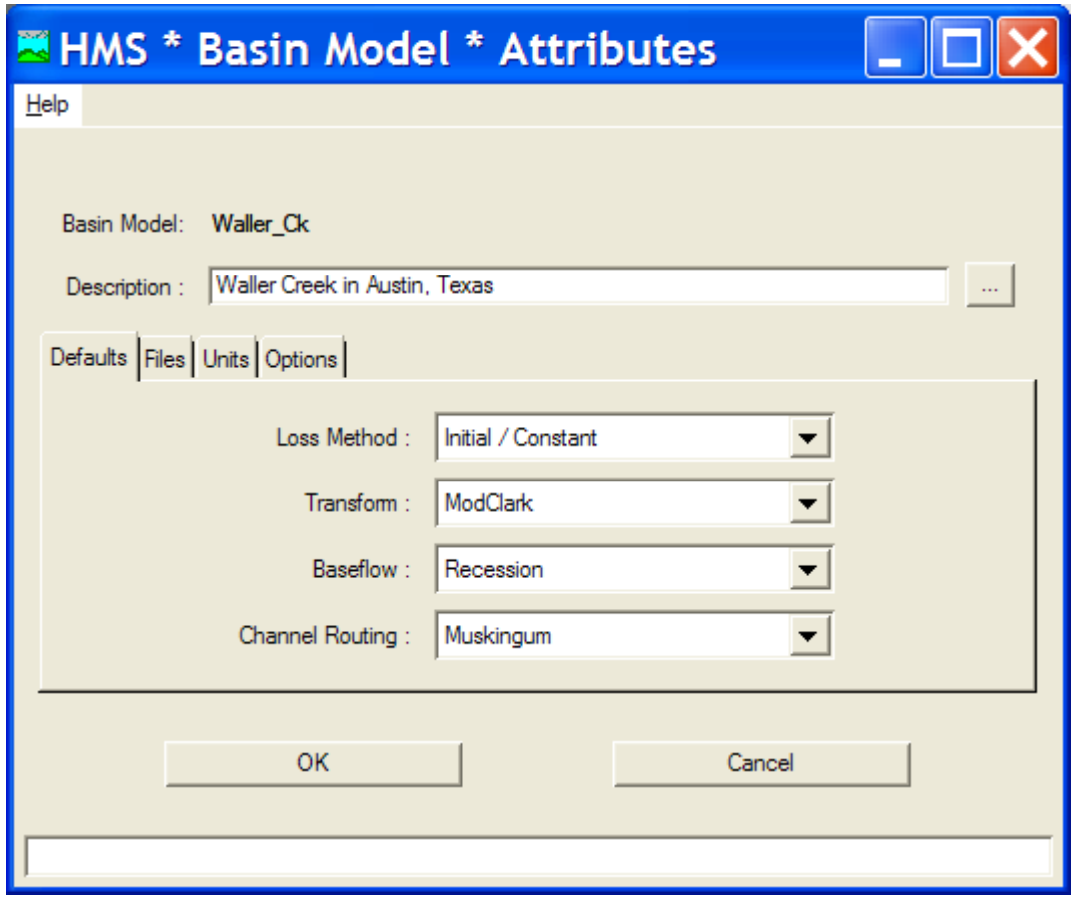
- **Source** - inflow from outside the modeled region

- **Sink** - outflow leaving the modeled region

Basin Model Attributes

- **Basin Model window**
  - **File/Basin Model Attributes**

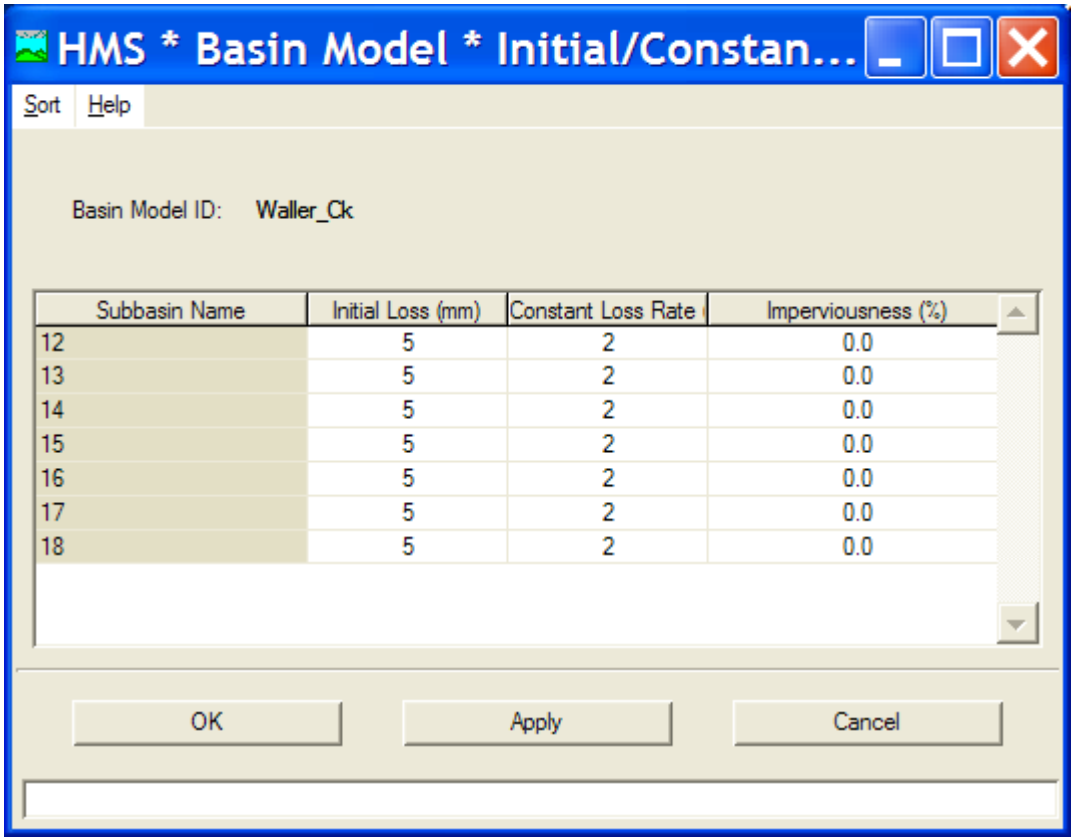
- Loss Rates
  - rainfall losses absorbed by the ground
- Transform
  - how to convert excess rainfall to direct runoff
- Baseflow
- Routing
  - routing a hydrograph through a river reach



Basin Model Parameters

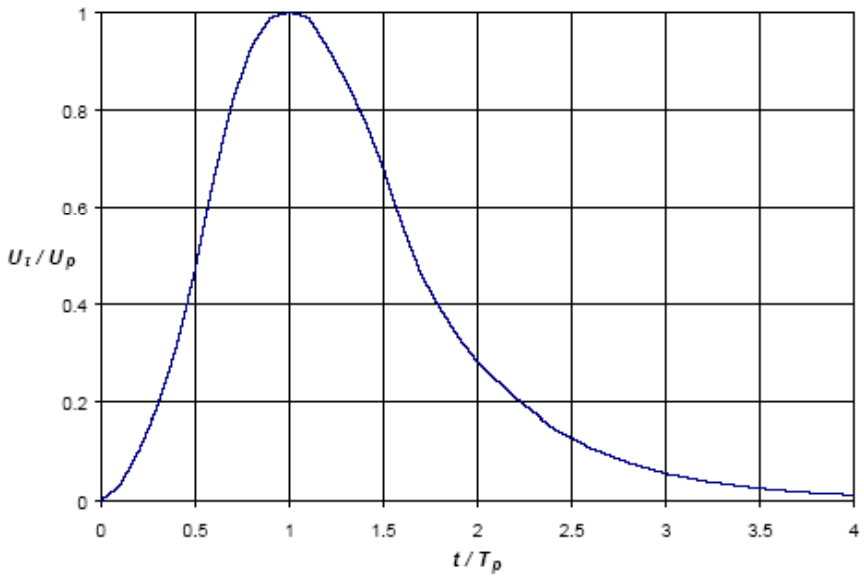
- **Basin Model Screen**
  - **Parameters/Loss Rate/Initial Constant**

- Enter values
  - initial loss
  - constant loss rate
  - % imperviousness



SCS Dimensionless Hydrograph

- SCS developed a parametric UH model based on averages of UHs from a large number of small agricultural watersheds in the US.
  - A – watershed area
  - C – conversion factor for unit system
  - T_p- time to peak
  - Δt – excess precip duration
  - t_{lag} - basin lag, time between center of rainfall excess and UH peak

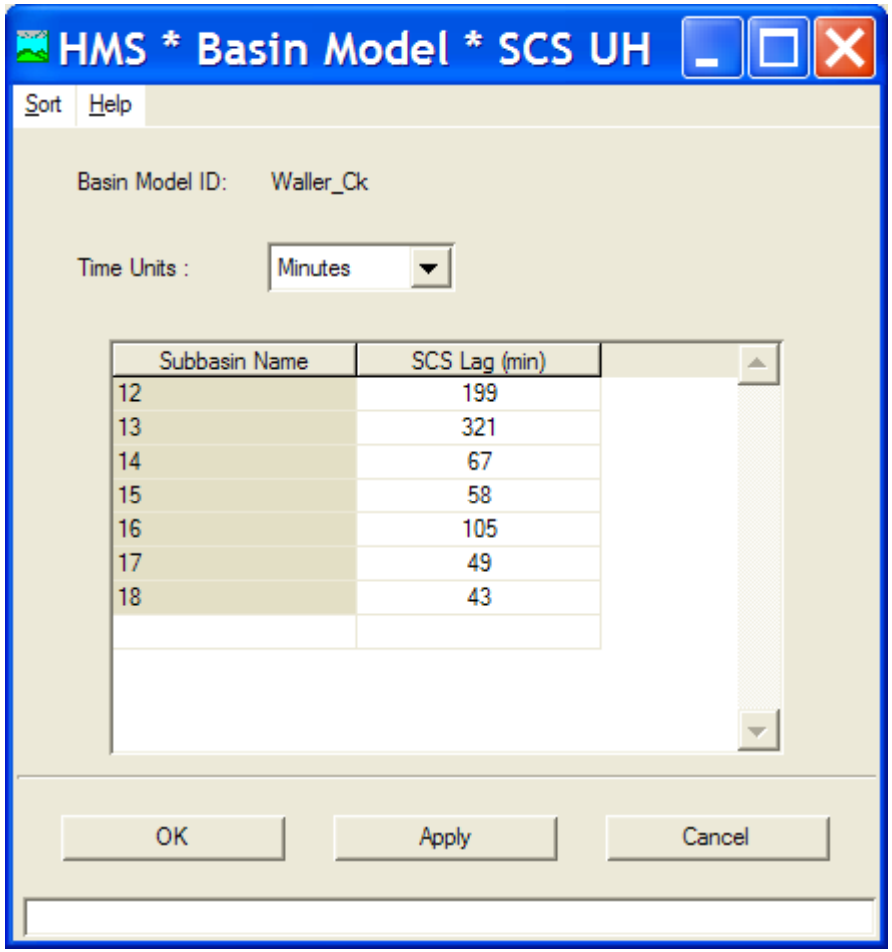


Given ER hyetograph and time lag, then solve for time of UH peak, then UH peak

$$U_p = C\frac{A}{T_p} \qquad T_p = \frac{\Delta t}{2} + t_{lag}$$

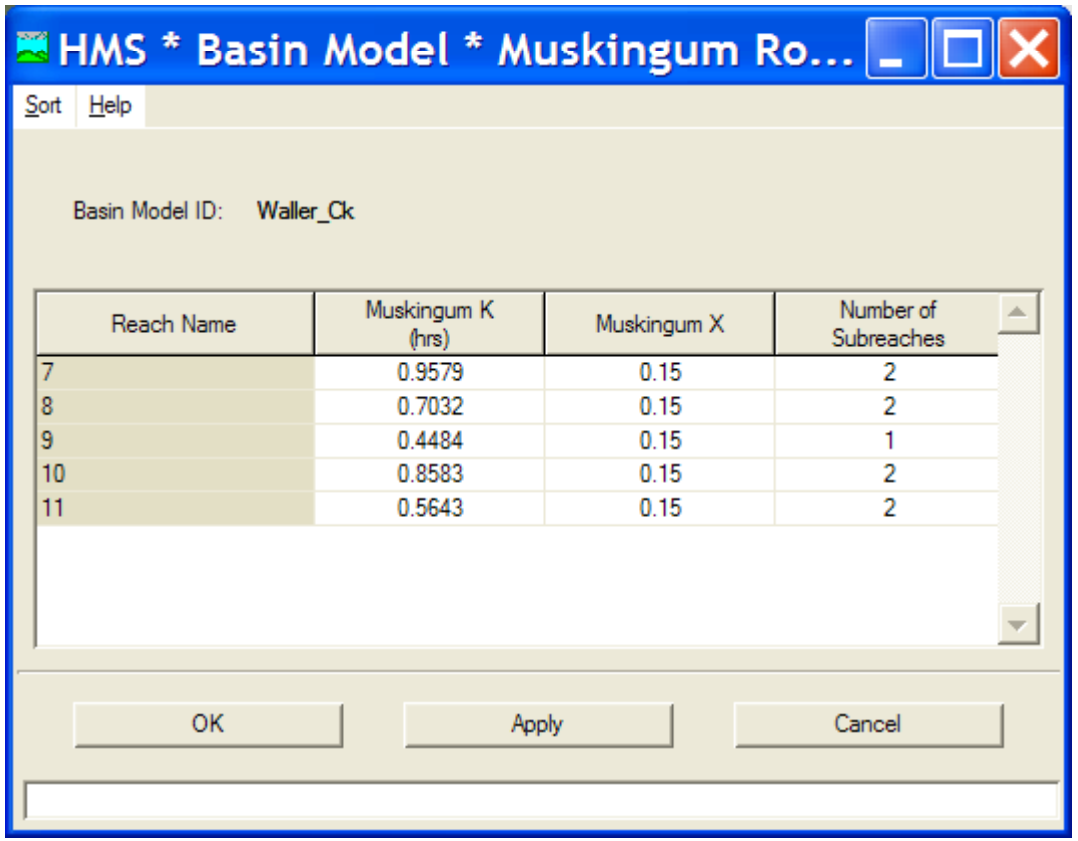
Transform Method

- Basin Model Screen
  - Parameters/Transform/ SCS UH



Reach Routing Method

- Basin Model Screen
  - Parameters/Reach/ Muskingum



Meteorological Model

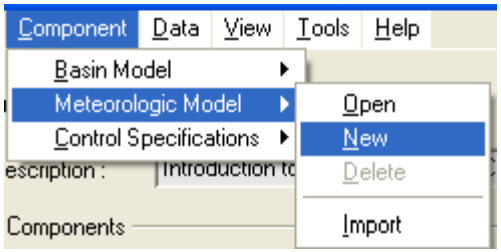
- Precipitation and evapotranspiration data necessary to simulate a watershed
- Precipitation depth expected as function of return period and the storm duration

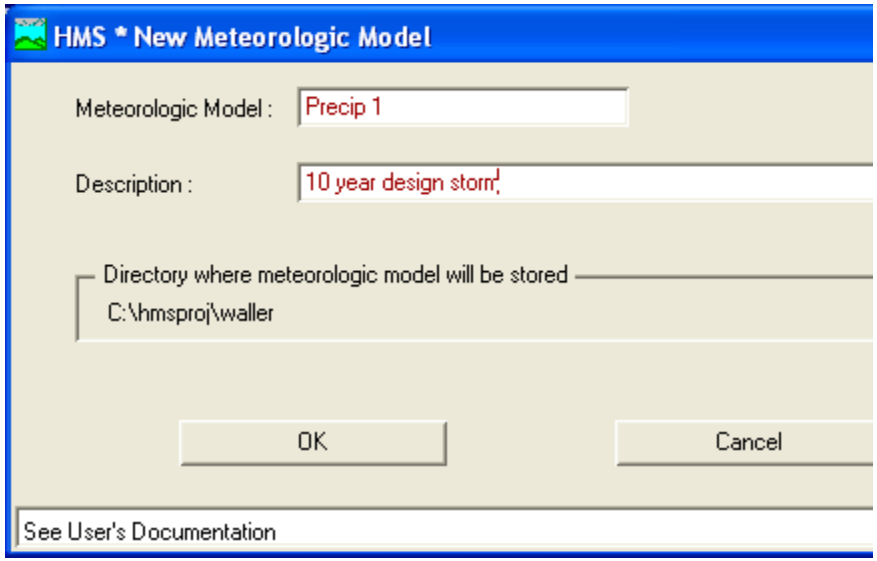
Design Precipitation Depths for Travis County, Texas (in.)

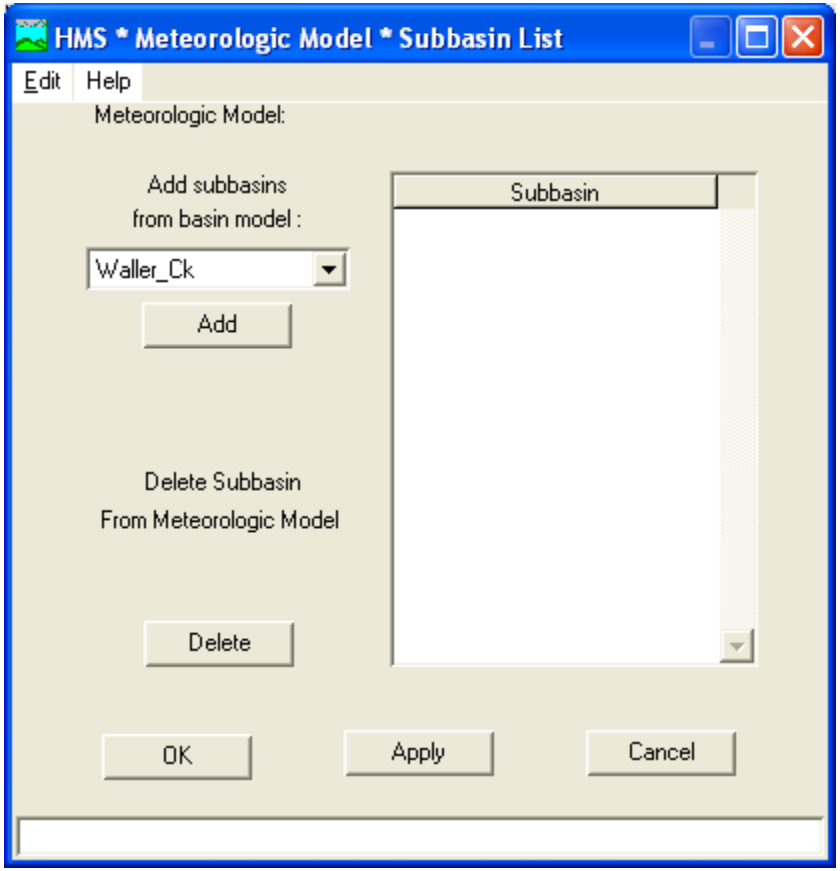
Duration (min)	Return Period (yr)					
	2	**5**	**10**	**25**	**50**	**100**
5	0.60	0.75	0.85	0.98	1.07	1.24
15	1.15	1.47	1.66	1.93	2.12	2.43
60	1.94	2.55	2.91	3.41	3.80	4.31
120	2.35	3.13	3.57	4.21	4.74	5.35
180	2.60	3.47	3.98	4.71	5.34	6.02
360	3.05	4.11	4.75	5.65	6.45	7.28
720	2.54	4.87	5.57	6.71	7.75	8.69
1440	4.06	5.67	6.52	7.94	9.26	10.39

Meteorological Model

Component/ Meteorologic Model/New

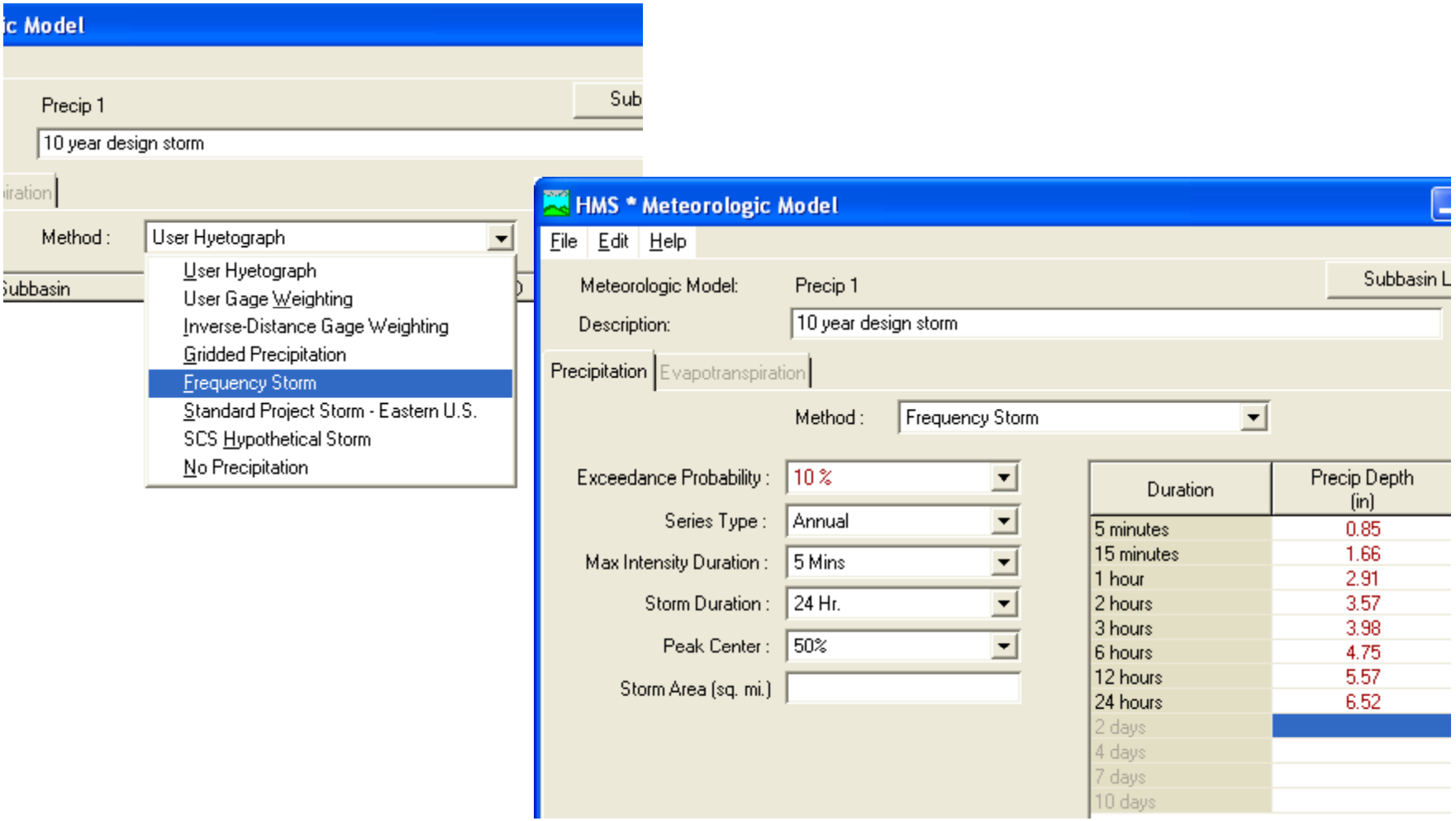






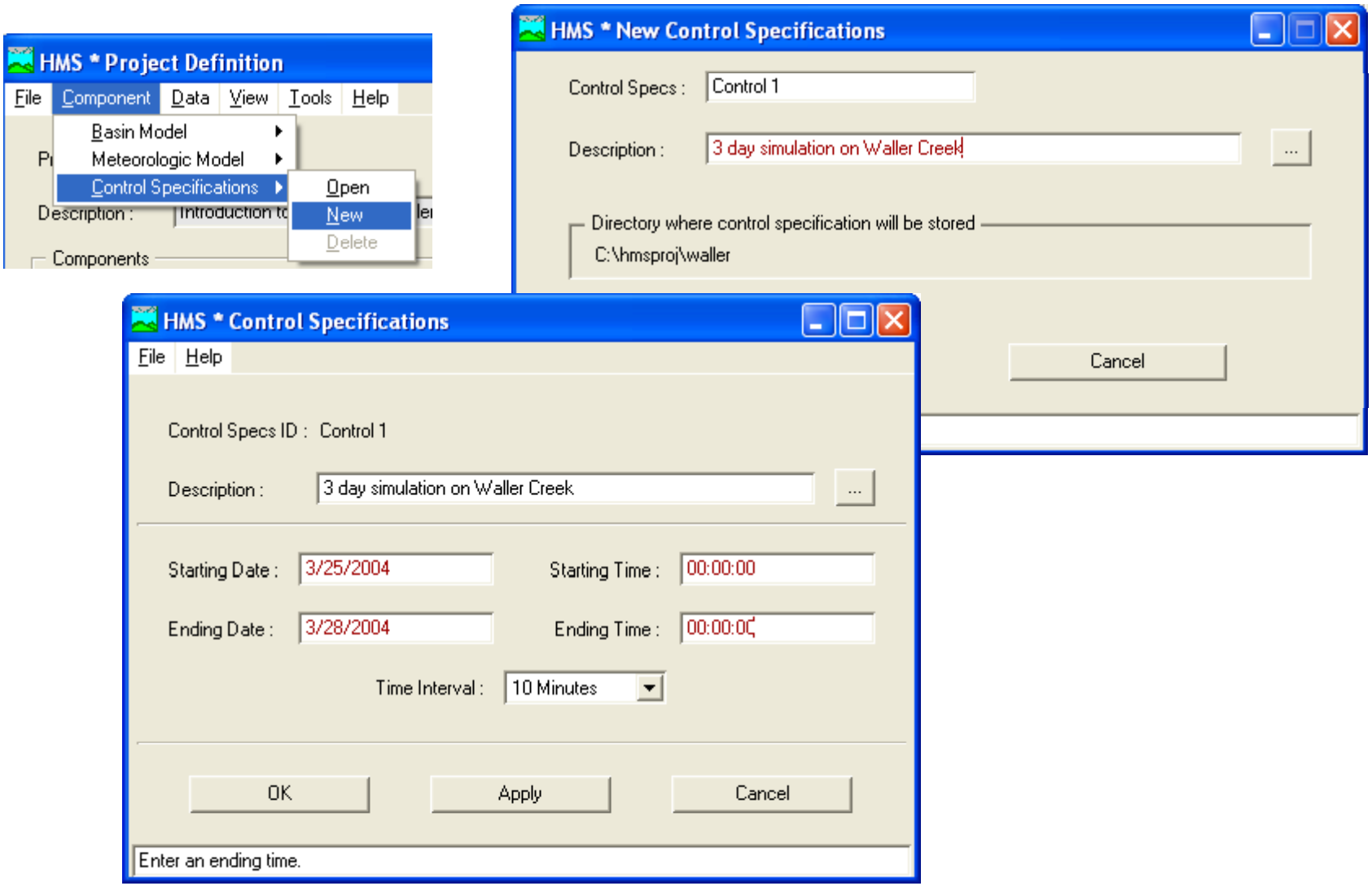
Meteorological Model

Method: Frequency Storm

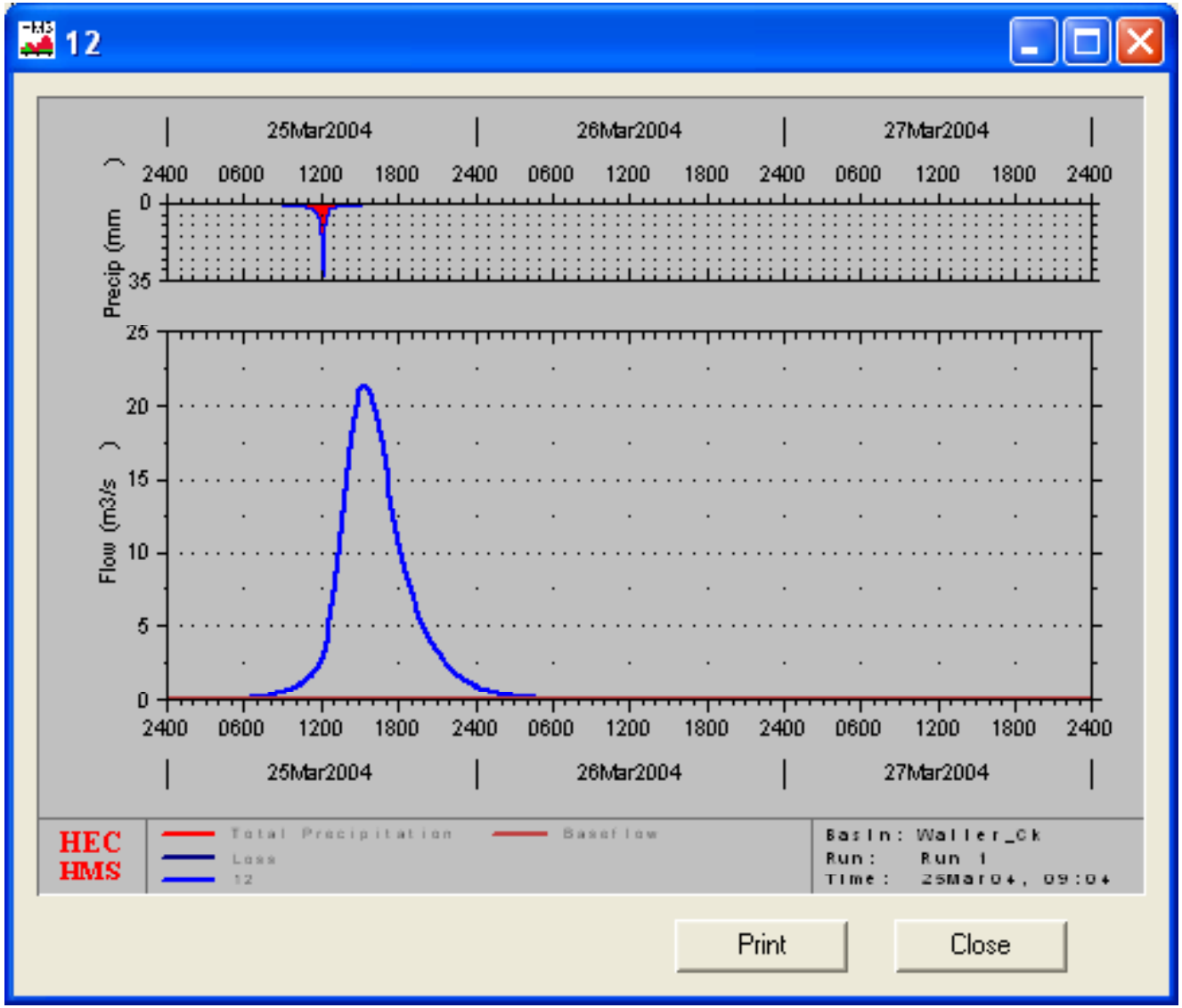


Control Specifications

Component/ Control Specifications/New



Run it!


12
25Mar2004
26Mar2004
27Mar2004
2400 0600 1200 1800 2400 0600 1200 1800 2400 0600 1200 1800 2400
Precip (mm)
0
35
Flow (m3/s)
25
20
15
10
5
0
HEC
HMS
Total Precipitation
Baseflow
Loss
12
Basin: Waller_Ck
Run: Run 1
Time: 25Mar04, 09:04
Print
Close