Santa Barbara Urban Hydrograph
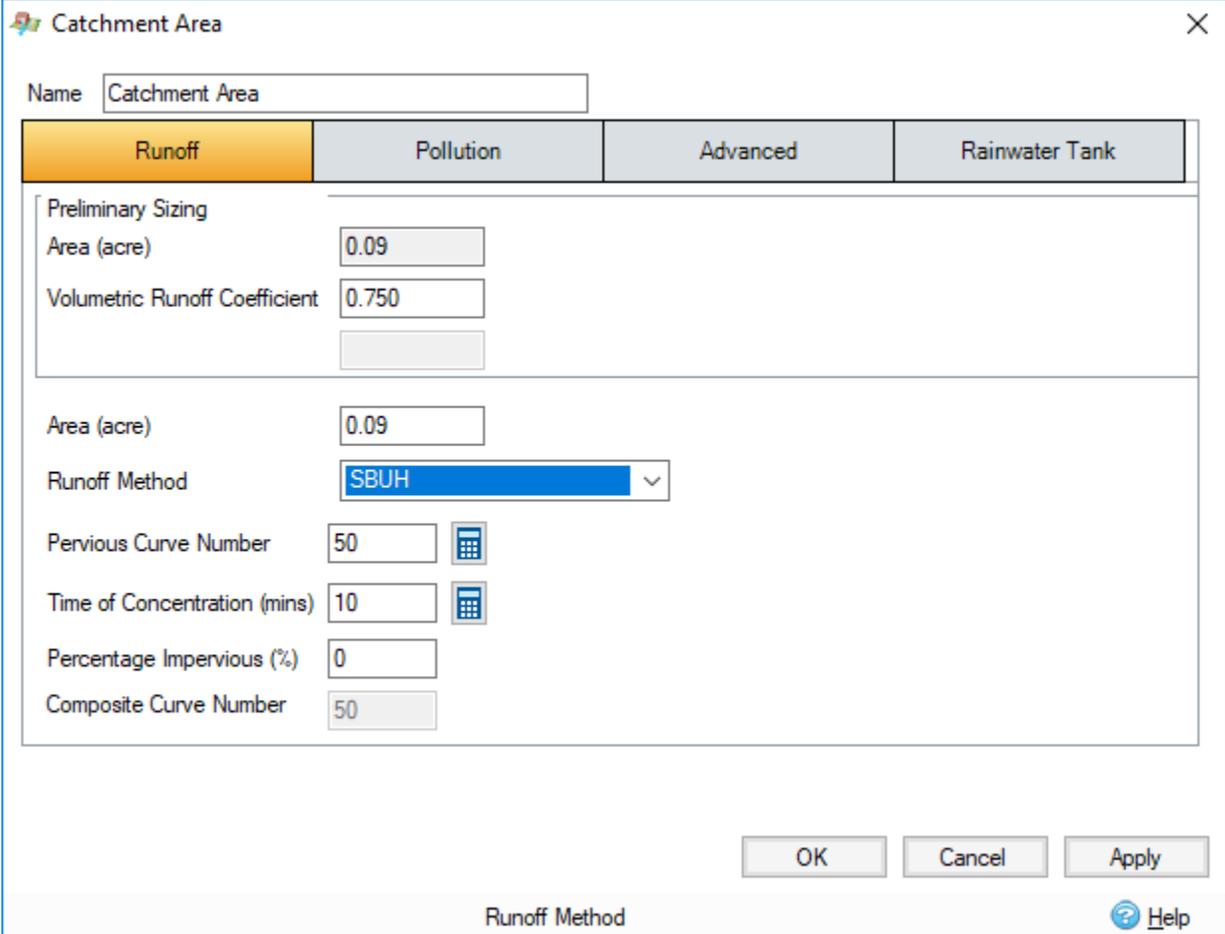
The **Santa Barbara Urban Hydrograph** method is described in this document from the Washington State Department of Ecology (section 2.3.3), with the input attributes described below.

> ⚠ This method may not be available for your region. For more information, refer to the Regionalisation topic.

Pervious Curve Number - The runoff curve number for the pervious fraction of the Catchment, as described in National Engineering Handbook - Section 4 (NEH-4) Chapter 9. Typical values vary from 20 for areas with high infiltration and interception capacities to 98 for impervious areas. It is a dimensionless number depending on hydrologic soil group, cover type, treatment, hydrological condition, and antecedent moisture conditions. This number has a valid range from 0 to 100 with typical values from 60 to 90 and 98 for impervious surfaces.

> ⓘ **Pervious and Impervious Curve Numbers**
>
> The Pervious CN characterises the fraction of the Catchment that is not impervious (area derived from the Percentage Impervious value). The impervious fraction of the Catchment is assigned a default CN of 98.

For ease of use the Curve Number Calculator can be accessed using the button to the right of the field. This provides a quick and easy way to select the appropriate curve number.

Time of Concentration - The time of concentration as described in NEH-4 Chapter 15 (in mins) is defined in two ways; the time for runoff to travel from the furthermost point of the watershed to the point in question, and the time from the end of excess rainfall to the point of inflection on the trailing limb of the unit hydrograph. Tc can be estimated from several formula such as Kinematic-wave. For a constant excess rainfall can be described as:

$$Tc = C(n^{0.6} L^{0.6}/i^{0.4} S^{0.3})$$

in which **L** is the distance from the upper end of the plane to the point of interest (usually the inlet) **n** is the Manning resistance coefficient, **i** is the excess rainfall rate, **S** is the dimensionless slope of the surface, and **C** is a constant that depends on units of the other variables. For **tc** in minutes, **i** in inches/hr and **L** in feet **C** equals 0.938. For **tc** in minutes **i** in mm/hr and **L** in meters **C** equals 6.99.

Another formula for determining tc is the lag equation

Tc = L/0.6 where **L= I^0.8(S+1)^0.7/1900Y^0.5**

    Tc = time of concentration in hours

    L = lag time in hours

    I = hydraulic length of the watershed in feet

    Y = Average land slope in percent

    S = Potential maximum retention in inches

    CN = weighted Curve Number

For ease the Time Of Concentration Calculator can be accessed using the button to the right of the field. This allows a set of popular methods to be sued to determine the Time of Concentration.

Percent Impervious - Pervious portion of the Inflows area.

Composite Curve Number - The weighted CN used by the simulation. It is calculated as follows:

CN = (PIMP / 100 * 98) + ((1 – (PIMP / 100)) * PACN)

where:

    PIMP = Percent Impervious

    PACN = Pervious Area Curve Number

The **Santa Barbara Urban Hydrograph** method, like the SCS method, is based on the curve number (CN) approach, and also uses SCS equations for computing soil absorption and precipitation excess. Incremental runoff depths are converted into instantaneous hydrographs which are then routed through an imaginary reservoir with a time delay equal to the basin time of concentration.

The SBUH method was developed by the Santa Barbara County Flood Control and Water Conservation District, California. The SBUH method directly computes a runoff hydrograph without going through an intermediate process (unit hydrograph) as the SCS UH method does.

The SBUH method uses two steps to synthesize the runoff hydrograph.

Step one – computing the instantaneous hydrograph, and step two – computing the runoff hydrograph.

The instantaneous hydrograph, I(t), in cfs, at each step, dt, is computed as follows:

I(t) = 60.5 R(t) A/dt

where:

    R(t) = total runoff depth (both impervious and pervious runoffs) at time increment dt, in inches (also known as precipitation excess)

    A = area in acres

    dt = time interval in minutes*

> ⓘ   *A maximum time interval of 10 minutes should be used for all design storms of 24-hour duration. A maximum time interval of 60 minutes should be used for the 100-year, 7 day design storm.

Step two – The runoff hydrograph, Q(t), is then obtained by routing the instantaneous hydrograph I(t), through an imaginary reservoir with a time delay equal to the time of concentration, Tc, of the drainage basin. The following equation estimates the routed flow, Q(t):

Q(t +1) = Q(t) + w[I(t) +I(t +1) – 2Q(t)]

where:

    w = dt/(2T + dt)

    dt = time interval in minutes*