Time of Concentration (TR-55) Program

This program will calculate a time of concentration for different flow segments. Namely, “sheet flow,” “shallow concentrated flow” and “channel flow.” A total time of concentration is a summation of these flow segments as laid out in the USDA/NRCS TR-55:

Computation of travel time and time of concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600V} \qquad \text{[eq. 3-1]}$$

where:

T_t = travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversion factor from seconds to hours.

Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments:

$$T_c = T_{t_1} + T_{t_2} + \ldots T_{t_m} \qquad \text{[eq. 3-2]}$$

where:

T_c = time of concentration (hr)
m = number of flow segments

Typically any given situation for evaluation has a stretch of sheet flow followed by shallow concentrated flow and/or channel flow. Further definitions and limitations are laid out in TR-55 and will not be discussed in detail in this readme.

Sheet flow is calculated as so:

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

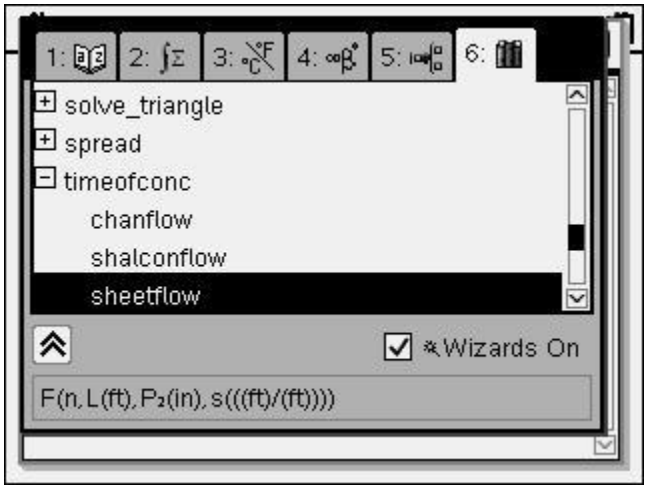
$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \qquad \text{[eq. 3-3]}$$

where:

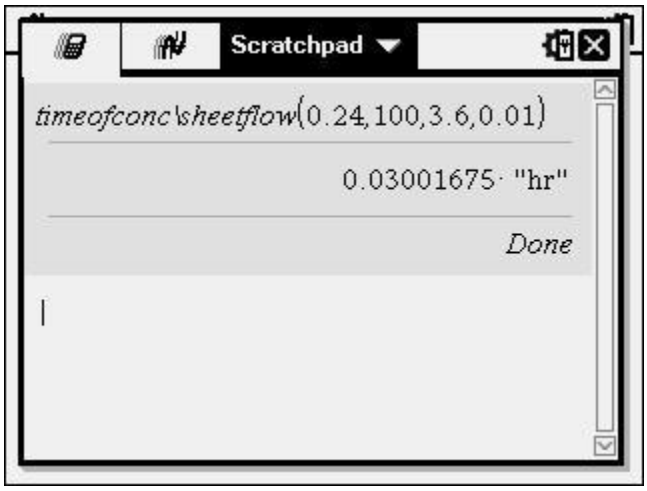
T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

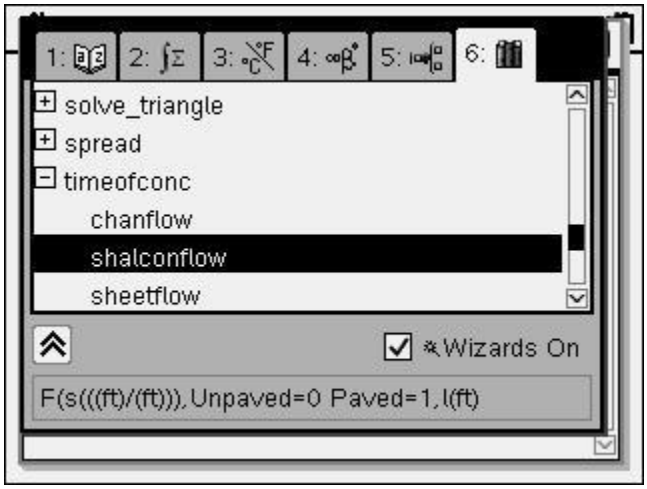
To use this function open the public library select "timeofconc" and then "sheetflow:



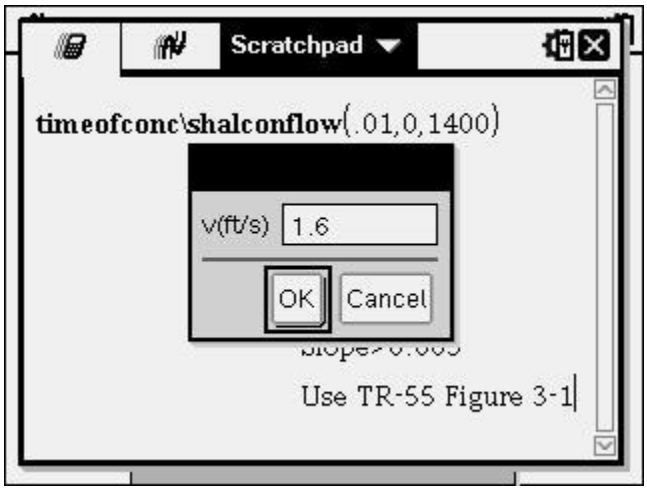
The wizard will indicate the necessary values (n, L, P_2, s) and their associated units. Comments in the program can be consulted in addition by opening the document. As per the sheet flow example found in TR-55 the time of concentration can be calculated as so:



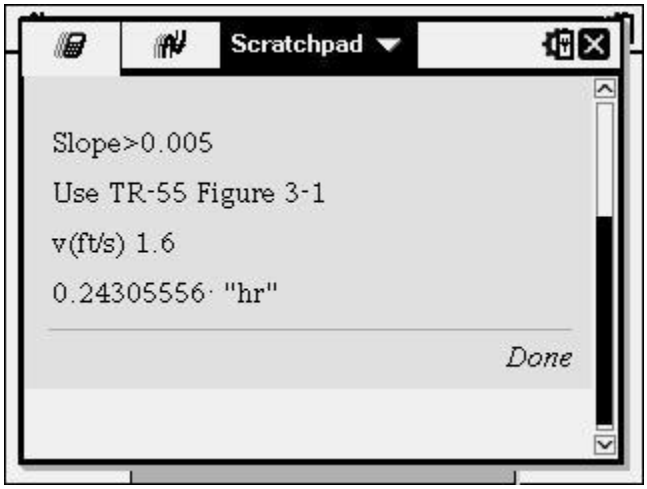
The next flow segment to consider is shallow concentrated flow. Similarly it can be accessed as such:



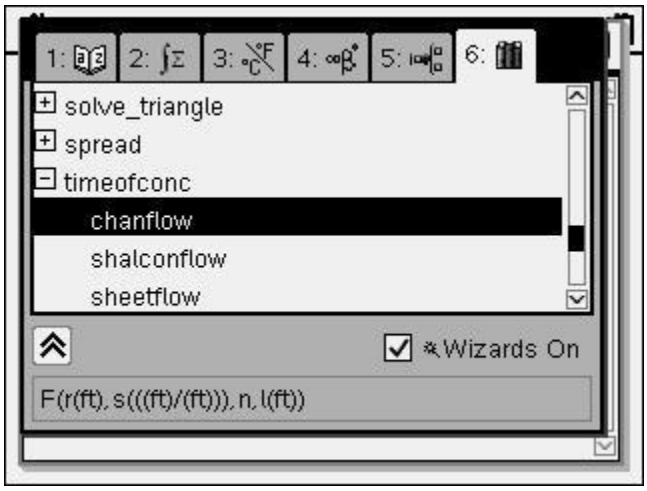
For this program there are 3 inputs need (s, pavement type, L). The units are indicated in the wizard and additional comments can be reviewed by opening up the timeofconc document. In this case you input s and L as you would in other cases, but as for the surface you simply input “0” for unpaved and “1” to indicate paved. As before following the TR-55 example found in the manual here is how that scenario would be solved:



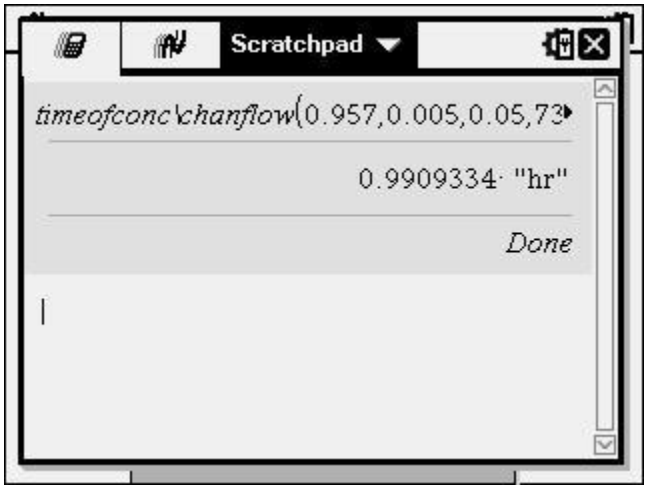
As for this flow segment it should be noted that if the slope is less than 0.005 ft/ft there is an implicit equation that is used. However, if the slope is greater, which it is in many cases, the TR-55 Figure 3-1 must be consulted. The program will remind you of this and require and input of that velocity given by the chart. Afterwards you will receive the time of concentration for this segment:



Finally channel flow or open channel flow may be considered as well. Once again the program can be accessed in the public library and the wizard will prompt the variables needed:



In this case (r, s, n, l) will be required and the units are indicated respectively. Just as the other segments the TR-55 example will be used and is calculated as such:



Now that you have all your relevant flow segments times of concentration calculated you simply sum them up to find the total time a drop would take to traverse the entire basin in question.

Please may sure after downloading to place the ".tns" in the "MyLib" folder in the root directory of your calculator. Also please refresh you library by going to your calculator, selecting "6: Refresh Libraries". If you think I have made a mistake, please let me know.

Thank You

Brian