SCS Unit Hydrograph

Venkatesh Merwade, Lyles School of Civil Engineering, Purdue University

SCS Dimensionless Unit Hydrograph

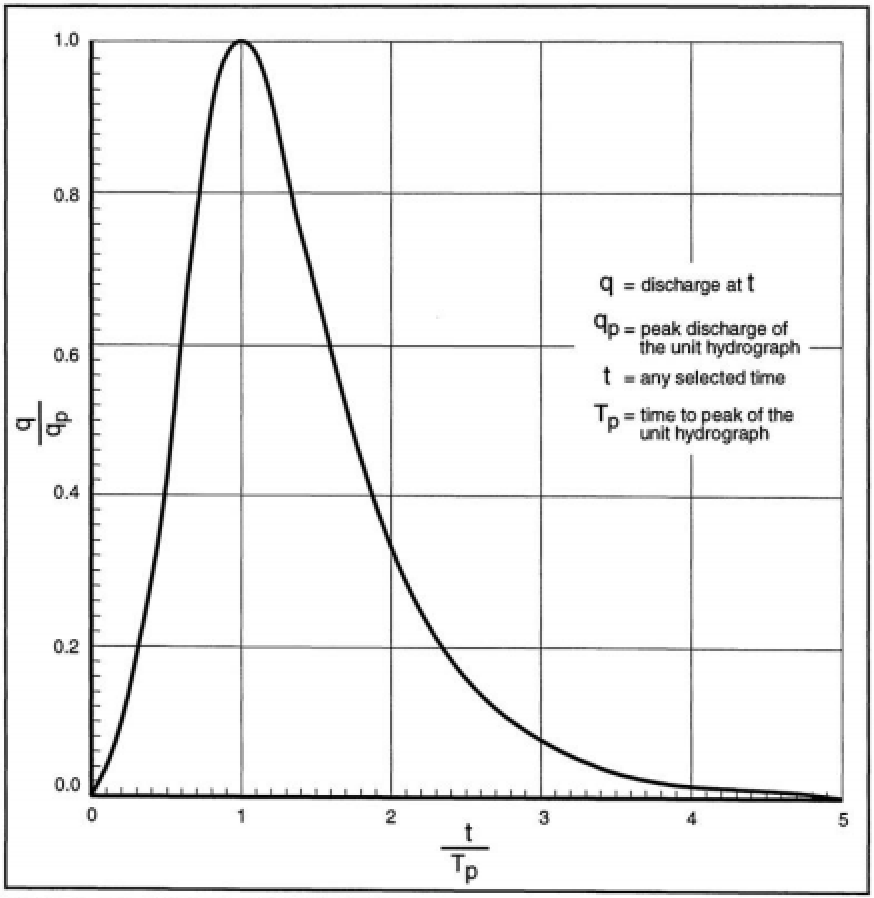


Figure 9. Dimensionless unit hydrograph.

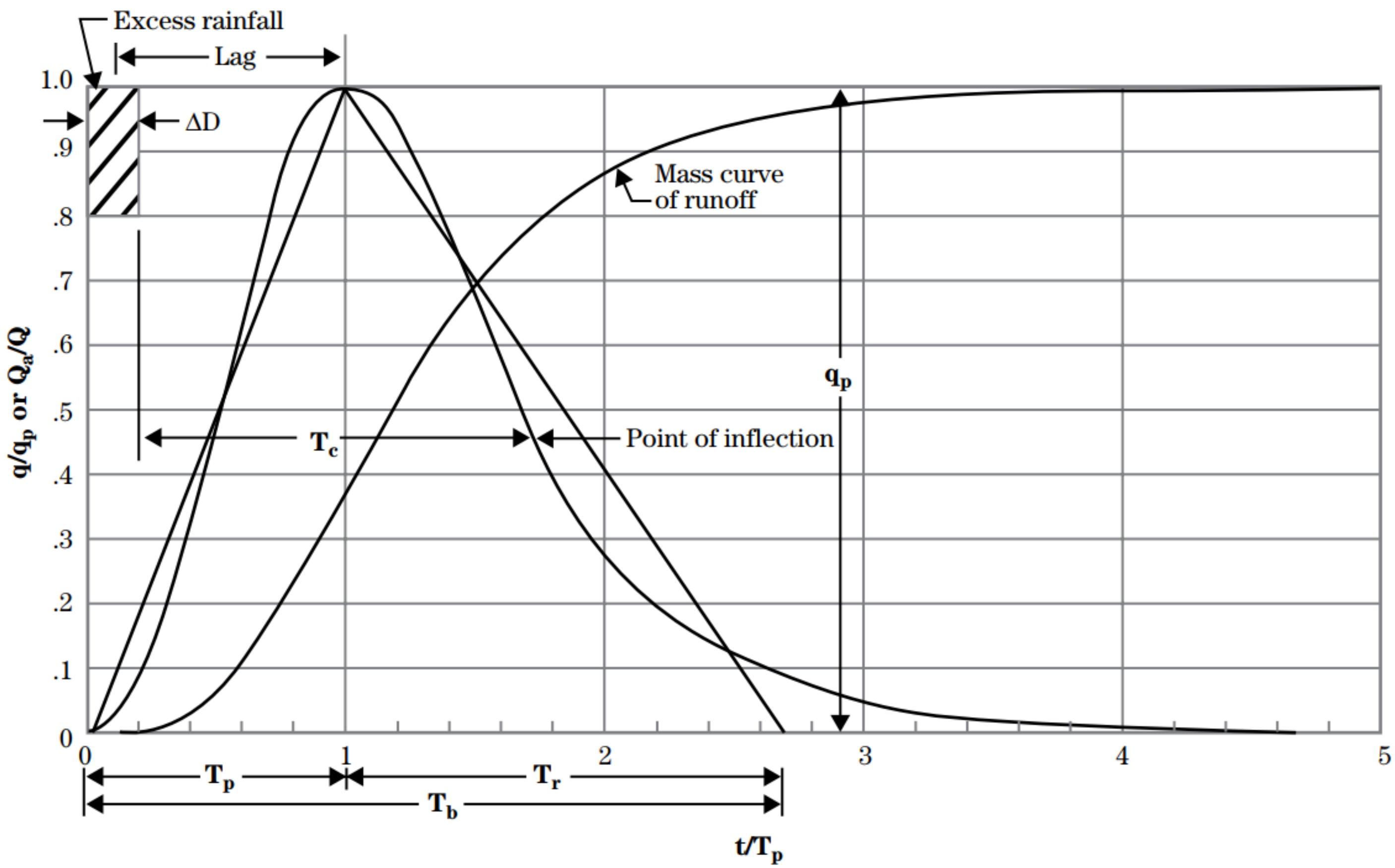
"Victor Mockus worked out the NRCS unit hydrograph methodology based upon many natural unit hydrographs from small watersheds in widely varying locations. NRCS has taken an average unit hydrograph from many small agricultural watersheds in the Midwest and has made it dimensionless" – USDA Module 107, Hydrograph Development

Ratios for dimensionless unit hydrograph and mass curve.

Time Ratios (t/t_p)	Discharge Ratios (q/q_p)	Mass Curve Ratios (Q_a/Q)
0.0	0.000	0.000
0.1	0.030	0.001
0.2	0.100	0.006
0.3	0.190	0.012
0.4	0.310	0.035
0.5	0.470	0.065
0.6	0.660	0.107
0.7	0.820	0.163
0.8	0.930	0.228
0.9	0.990	0.300
1.0	1.000	0.375
1.1	0.990	0.450
1.2	0.930	0.522
1.3	0.860	0.589
1.4	0.780	0.650
1.5	0.680	0.700

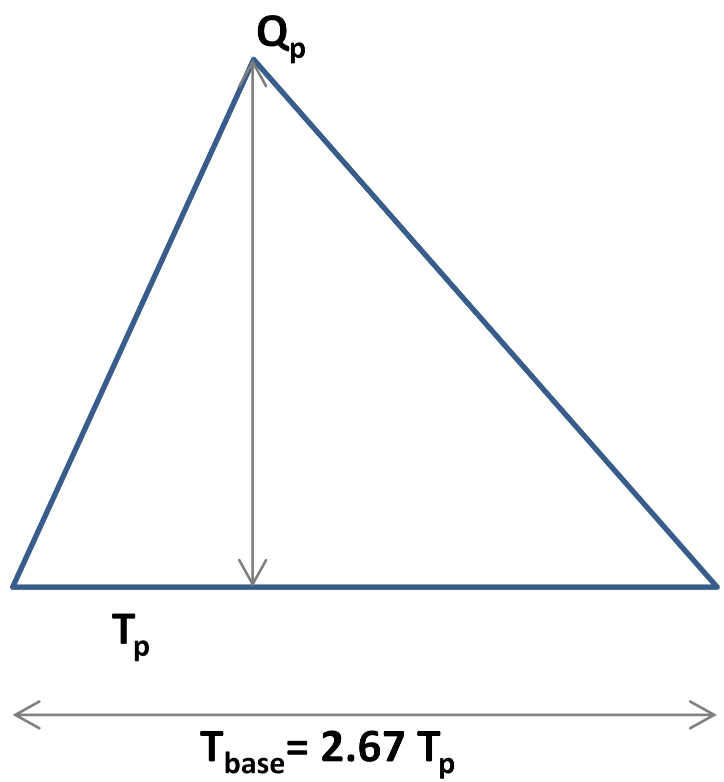
Time Ratios (t/t_p)	Discharge Ratios (q/q_p)	Mass Curve Ratios (Q_a/Q)
1.6	0.560	0.751
1.7	0.460	0.790
1.8	0.390	0.822
1.9	0.330	0.849
2.0	0.280	0.871
2.2	0.207	0.908
2.4	0.147	0.934
2.6	0.107	0.953
2.8	0.077	0.967
3.0	0.055	0.977
3.2	0.040	0.984
3.4	0.029	0.989
3.6	0.021	0.993
3.8	0.015	0.995
4.0	0.011	0.997
4.5	0.005	0.999
5.0	0.000	1.000

Figure 16A–1 Dimensionless curvilinear unit hydrograph and equivalent triangular hydrograph



Source: USDA NRCS Part 630 Hydrology National Engineering Handbook

Finding Qp for SCS Triangular UH



For UH, the area of triangle = unit depth of water

$$\frac{1}{2}(2.67\,T_p)(Q_p) = 1 \text{ inch}$$

For US units, Qp is in cfs, Tp is in hours and the depth is in inch. The depth is converted to volume by multiplying it with Area in square miles

$$\frac{1}{2}(2.67\,T_p * 60 * 60)(Q_p) = (\frac{1}{12}) * A\,(5280*5280)$$

After simplifying the above expression, you get the following

$$Q_p = \frac{483.4 * A}{T_p}$$

If you do the same analysis using SI units, you get the SI version of Qp.

Q_p for US and SI Units

When watershed area (A) is in square miles, Qp is in cfs using the following expression. Tp is in hours

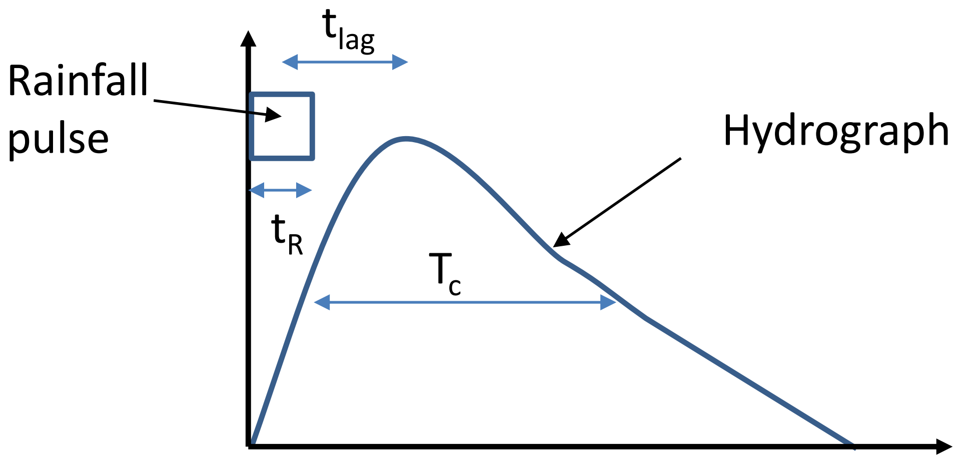
$$Q_p = \frac{483.4 * A}{T_p}$$

When watershed area (A) is in square kilometers, Qp is in m3/s using the following expression. Tp is in hours

$$Q_p = \frac{2.08 * A}{T_p}$$

Finding Tp

T_p is time to discharge peak, which is also equal to rainfall duration/2 plus the lag time as shown in the figure below. T_c is time of concentration



$$\mathbf{T_p} = \frac{t_R}{2} + t_{lag}$$

$$t_{lag} = 0.6T_c$$

Expression for T_c

$$T_c = \frac{l^{0.8}(S+1)^{0.7}}{1140Y^{0.5}}$$

- T_c is time of concentration(hr)
- ℓ is maximum flow length (ft)
- Y is average watershed slope (%)
- S is maximum potential retention (inch)
- S = (1000/CN) – 10
- CN is curve number