Appendix D.11

Method for Computing the Channel Protection Storage Volume ($C_{pv}$)
Appendix D.11................ Method for Computing the Channel Protection Storage Volume (Cpv)

The following procedure shall be used to design the channel protection storage volume (Cpv). The method is based on the Design Procedures for Stormwater Management Extended Detention Structures (MDE, 1987) and utilizes the NRCS, TR-55 Graphical Peak Discharge Method (USDA, 1986).

1. Compute the time of concentration ($t_c$) and the one-year post-development runoff depth ($Q_a$) in inches.
2. Compute the initial abstraction ($I_a$) [$I_a = \frac{200}{CN} - 2$] and the ratio $\frac{I_a}{P}$ where $P$ is the one-year rainfall depth (see Table 2-2).
3. With $t_c$ and $I_a/P$, find the unit peak factor ($q_u$) from Figure D.11.1 and compute the one year post-development peak discharge $q_i = q_u A Q_a$ where $A$ is the drainage in square miles.
4. If $q_i \leq 2.0$ cfs, Cpv is not required. Provide for water quality (WQv) and groundwater recharge (Rev) as necessary.
5. With $q_u$, find the ratio of outflow to inflow ($q_o/q_i$) for $T = 24$ hours from Figure D.11.2 (use $T = 12$ hours in USE III/IV waters).
6. Compute the peak outflow discharge $q_o = \frac{q_o}{q_i} \times q_i$.
7. With $q_o/q_i$, compute the ratio of storage to runoff volume ($V_s/V_r$).
   $$\frac{V_s}{V_r} = 0.683 - 1.43\left(\frac{q_o}{q_i}\right) + 1.64\left(\frac{q_o}{q_i}\right)^2 - 0.804\left(\frac{q_o}{q_i}\right)^3$$
8. Compute the extended detention storage volume $V_s = \left(\frac{V_s}{V_r}\right) \times V_r$ (note: $V_r = Q_a$);
   Convert $V_s$ to acre-feet by $\frac{V_s}{12} \times A$, where $V_s$ is in inches and $A$ is in acres.
9. Compute the required orifice area ($A_o$) for extended detention design:
   $$A_o = \frac{q_o}{C \sqrt{2gh_o}} = \frac{q_o}{4.81 \sqrt{h_o}}$$
   where $h_o$ is the maximum storage depth associated with $V_s$.
10. Determine the required maximum orifice diameter ($d_o$) $d_o = \sqrt{\frac{4A_o}{\pi}}$.
    A $d_o$ of less than 3.0” is subject to local jurisdictional approval, and is not recommended unless an internal control for orifice protection is used (App. D.8).
Figure D.11.1

SCS Graphical Method of Determining Peak Discharge ($q_u$) in csm/in for 24-Hour Type II Storm Distribution

Time of Concentration ($t_c$) in Hours

Unit Peak Discharge ($q_u$), csm/in

Ia/P = 0.10

0.45
0.50
0.40
0.30
0.35

100 200 300 400 500 600 700 800 900 1000

0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
Figure D.11.2  Detention Time Versus Discharge Ratios ($q_o/q_i$)