Appendix F:
Sample Calculations

EXAMPLE STORMWATER DETENTION DESIGN CALCULATIONS

A = 20.10 acre site, Weighted "C" = 0.50, Q_{all}=0.20 cfs/acre

Required Water Quality Volume = V_{wq} = 1"/12"(43,560)(C)(A)
V_{wq} = 3,630(0.50)(20.10) = 36,482 C.F.

Required Channel Protection Volume = V_{cp} = 1.3"/12"(43,560)(C)(A)
V_{cp} = 4,719(0.50)(20.10) = 47,426 C.F.
To be Infiltrated

Required Forebay Volume = V_{wq} When Downstream Infiltration is Proposed
(or 15% of V_{wq} With Upstream Infiltration)
= 36, 482 C.F. Forebay Volume to be Discharged
To Detention Basin at Same Rate as the Extended Detention Volume
(Previous Required Forebay Volume = 5,427 C.F.)
Because of the proposed downstream infiltration design, the forebay size must increase, however the additional forebay storage is credited toward the 100 Yr. Storm storage requirement.

Required Extended Detention Volume
(For Channel Protection Rate Control) = V_{ED} = 1.9"/12(43,560)(C)(A)
V_{ED} = 6,897(0.50)((20.10) = 69,315 C.F.
To Be Discharged Over 48 Hours
(Previous Required Bankfull Volume = 51,858 C.F.)
Although the extended detention volume is larger than the current bankfull volume, the required 100 Yr. Storm storage volume may decrease after the infiltration credit is applied.

Extended Detention Volume
Discharge Rate = VED /(48 hr)(60 min)(60 sec)
69,315/172,800 = 0.40 cfs
To Be Used for Both Forebay & Detention Basin Outlet
Outlet Control Design
(Previous Required Min. Bankfull Discharge Rate = 0.36 cfs)

100 Year Storm Inlet Rate = $Q_{100in} = (C)(A)(30.2033x100^{0.2203}/ (T_c+9.1747)^{0.8069})$

$Q_{100in} = (0.50)(20.10)(83.3018/(21.0+9.1747)^{0.8069})$

$Q_{100in} = 53.57$ cfs

Note: $T_c = 21.0$ min From Storm Sewer Design

100 Year Storm Allowable Outlet Rate = Q_{100all} = Lesser of Restricted Rate for Drain Or Variable Release Rate (Q_{vrr})

$Q_{100all} = 0.20$ cfs/acre x 20.10 acres = 4.02 cfs

Required 100 Yr. Storm Detention Volume

Storage Curve Factor = $R = 0.206 – (0.15)(LN(Q_{all}/Q_{100in}))$

$R = 0.206 – (0.15)(LN(4.02/53.57))$

$R = 0.594$

100 Year Storm Volume In = $V_{100in} = 18,985(C)(A)$

$V_{100in} = 190,799$ C.F.

Required 100 Year Storm Storage Volume Above Outlet = $V_{100det} = (V_{100in})(R)$ – Vcp Credit

$= 190,799(0.594) – 47,426$

$= 113,335 – 47,426 =$ 65,909 C.F.

(Previous 100 Yr. Storm Storage Volume = 108,540 C.F.)

The total 100 Yr. Storm Storage Volume requirement decreased due to the credit for the required infiltration.

Since 65,909 c.f. Is Less Than the Required Extended Detention Volume of 69,315 C.F., the Minimum Required 100 Yr. Storm Storage Volume Is the Extended Detention Volume of 69,315 C.F.

Design Calculations For Infiltration of Channel Protection Volume

For Loamy Sand (Type B) Soils with a 2"/hr In-Situ Infiltration Rate:

Max. Total Water Storage Depth = 2.0"/hr x 72 hr = 144" or 12 ft.
Max. Surface Water Storage Depth = 2.0"/hr x 24 hr = 48" or 4 ft.
Infiltration Depth During Storm = 2.0"/hr x 6 hr = 12" or 1 ft.
Potential Soil Storage Depth = 2.0"/hr x 48 hr = 96" or 8 ft.
Potential Soil Storage Depth EQV = 96"/0.25 porosity = 24" or 2 ft.

- Since the potential soil storage is relatively expensive & the soils are permeable, the most economical storage to meet the infiltration requirement will be surface water storage located in the bottom of the detention basin. However, it should again be noted that upstream infiltration would reduce the required forebay size.

The Detention Basin Bottom Infiltration Area Required
(Below the basin outlet elevation)
= 47,426 C.F./ (4 ft. Surface + 1 ft. Infiltration) Depth
= 9,485 S.F. Required

For Sandy Loam (Type B) Soils with a 1"/hr In-Situ Infiltration Rate:

Max. Total Water Storage Depth = 1.0"/hr x 72 hr = 72" or 6 ft.
Max. Surface Water Storage Depth = 1.0"/hr x 24 hr = 24" or 2 ft.
Infiltration Depth During Storm = 1.0"/hr x 6 hr = 6" or 0.5 ft.
Potential Soil Storage Depth = 1.0"/hr x 48 hr = 48" or 4 ft.
Potential Soil Storage Depth EQV = 48"/0.25 porosity = 12" or 1 ft.

- Since the potential soil storage is relatively expensive & the soils are reasonably permeable, the most economical storage to meet the infiltration requirement will still be surface water storage located in the bottom of the detention basin.

The Detention Basin Bottom Infiltration Area Required
(Below the basin outlet elevation)
= 47,426 C.F./ (2 ft. Surface + 0.5 ft. Infiltration) Depth
= 18,970 S.F. Required

Design Calculations for Infiltration of Channel Protection Volume (continued)

For Loamy (Type C) Soils with a 0.50"/hr In-Situ Infiltration Rate:

Max. Total Water Storage Depth = 0.50"/hr x 72 hr = 36" or 3.0 ft.
Max. Surface Water Storage Depth = 0.5"/hr x 24 hr = 12" or 1.0 ft.
Infiltration Depth During Storm = 0.5"/hr x 6 hr = 3" or 0.25 ft.
Potential Soil Storage Depth = 0.5"/hr x 48 hr = 24" or 2.0 ft.
Potential Soil Storage Depth EQV = 24"/0.25 porosity = 6" or 0.5 ft.

- Since the soil permeability is relatively low, a combination of surface water storage & soil storage will be utilized in the bottom of the detention basin to meet the infiltration requirement.

The Detention Basin Bottom Infiltration Area Required
(Below the basin outlet elevation)
= 47,426 C.F./ (1 ft. Surface + 0.25 ft. Infiltration + 0.5 ft. Soil) Depth
= 27,101 S.F. Required

For Loamy Clay (Type C) Soils with a 0.25"/hr In-Situ Infiltration Rate:

Max. Total Water Storage Depth = 0.25"/hr x 72 hr = 18" or 1.5 ft.
Max. Surface Water Storage Depth = 0.25"/hr x 24 hr = 6" or 0.50 ft.
Infiltration Depth During Storm = 0.25"/hr x 6 hr = 1.5" or 0.125 ft.
Potential Soil Storage Depth = 0.25"/hr x 48 hr = 12" or 1.0 ft.
Potential Soil Storage Depth EQV = 12"/0.25 porosity = 3" or 0.25 ft.

- Since the soil permeability is low, a combination of surface water storage & soil storage will be utilized in the bottom of the detention basin to meet the infiltration requirement.

The Detention Basin Bottom Infiltration Area Required
(Below the basin outlet elevation)
= 47,426 C.F./ (0.5 ft. Surface + 0.125 ft. Infiltration + 0.25 ft. Soil) Depth
= 54,201 S.F. Required