APPENDIX P-1

Runoff Curve Numbers
Source: NRCS (SCS) TR-55

Runoff Curve Numbers for Urban Areas					
Cover Description		**Curve Numbers for Hydrologic Soil Groups**			
Cover Type and Hydrologic Condition	***Average % Impervious Area***	***A***	***B***	***C***	***D***
Fully Developed Urban Areas (Vegetation Established)					
Open Space (lawns, parks, golf courses, etc)					
Poor Condition (grass cover < 50%)		68	79	86	89
Fair Condition (grass cover 50% to 75%)		49	69	79	84
Good Condition (grass cover > 75%)		39	61	74	80
Impervious Areas					
Paved Parking Lots, Roofs, Driveways, etc.		98	98	98	98
Streets and Roads					
Paved: Curbed and Storm Sewers		98	98	98	98
Paved: Open Ditches		83	89	92	93
Gravel		76	85	89	91
Dirt		72	82	87	89
Western Desert Urban Areas					
Natural Desert Landscaping (pervious area only)		63	77	85	88
Artificial Desert Landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban Districts					
Commercial and Business	85%	89	92	94	95
Industrial	72%	81	88	91	93
Residential Districts by Average Lot Size					
1/8 Acre	65%	77	85	90	92
1/4 Acre	38%	61	75	83	87
1/3 Acre	30%	57	72	81	86
1/2 Acre	25%	54	70	80	85
1 Acre	20%	51	68	79	84
2 Acres	12%	46	65	77	82

APPENDIX P-1 (Cont'd.)

Runoff Curve Numbers
Source: NRCS (SCS) TR-55

Runoff Curve Numbers for Cultivated Agricultural Lands						
Cover Description			**Curve Numbers for Hydrologic Soil Groups**			
Cover Type	***Treatment***	***Hydrologic Condition***	***A***	***B***	***C***	***D***
Fallow	Bare Soil	--	77	86	91	94
	Crop Residue Cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row Crops	Straight Row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & Terraced (C & T)	Poor	66	74	80	82
		Good	62	71	78	81
	C & T + CR	Poor	65	73	79	81
		Good	61	70	77	80
Small Grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C & T	Poor	61	72	79	82
		Good	59	70	78	81
	C & T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close Seeded or Broadcast Legumes Or Rotation Meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C & T	Poor	63	73	80	83
		Good	51	67	76	80

APPENDIX P-1 (Cont'd.)

RUNOFF CURVE NUMBERS
Source: NRCS (SCS) TR-55

Runoff Curve Numbers for Other Agricultural Lands					
Cover Description		**Curve Numbers for Hydrologic Soil Groups**			
Cover Type	***Hydrologic Condition***	***A***	***B***	***C***	***D***
Pasture, Grassland, or Range - Continuous Forage for Grazing	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow - Continuous Grass, Protected from Grazing and Generally Mowed for Hay	--	30	58	71	78
Brush - Brush, Weed, Grass Mixture with Brush the Major Element	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30	48	65	73
Woods - Grass Combination (Orchard or Tree Farm)	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30	55	70	77
Farmsteads - Buildings, Lanes, Driveways, and Surrounding Lots	--	59	74	82	86

APPENDIX P-1 (Cont'd.)

Runoff Curve Numbers
Source: NRCS (SCS) TR-55

Runoff Curve Numbers For Cultivated Agricultural Lands					
Cover Description		**Curve Numbers for Hydrologic Soil Groups**			
Cover Type	***Hydrologic Condition***	***A***	***B***	***C***	***D***
Herbaceous - Mixture of Grass, Weeds, and Low-Growing Brush, With Brush the Minor Element	Poor	--	80	87	93
	Fair	--	71	81	89
	Good	--	62	74	85
Oak-Aspen - Mountain Brush Mixture of Oak Brush, Aspen, Mountain Mahogany, Bitter Brush, Maple, and Other Brush	Poor	--	66	74	79
	Fair	--	48	57	63
	Good	--	30	41	48
Pinyon-Juniper - Pinyon, Juniper, or Both; Grass Understory	Poor	--	75	85	89
	Fair	--	58	73	80
	Good	--	41	61	71
Sagebrush With Grass Understory	Poor	--	67	80	85
	Fair	--	51	63	70
	Good	--	35	47	55
Desert Shrub - Major Plants Include Saltbrush, Greasewood, Creosotebush, Blackbrush, Bursage, Palo Verde, Mesquite, and Cactus	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

APPENDIX P-2

Runoff Coefficients For The Rational Method

Source: Rawls, W.J., S.L. Long, and R.H. McCuen, 1981. Comparison of Urban Flood Frequency Procedures. Preliminary Draft Report prepared for the Soil Conservation Service, Beltsville, Maryland.

Land Use	A			B			C			D		
	0-2%	2-6%	6+%	0-2%	2-6%	6+%	0-2%	2-6%	6+%	0-2%	2-6%	6+%
Cultivated	0.08[a]	0.13	0.16	0.11	0.15	0.21	0.14	0.19	0.26	0.18	0.23	0.31
Land	0.14[b]	0.08	0.22	0.16	0.21	0.28	0.20	0.25	0.34	0.24	0.29	0.41
Pasture	0.12	0.20	0.30	0.18	0.28	0.37	0.24	0.34	0.44	0.30	0.40	0.50
	0.15	0.25	0.37	0.23	0.34	0.45	0.30	0.42	0.52	0.37	0.50	0.62
Meadow	0.10	0.16	0.25	0.14	0.22	0.30	0.20	0.28	0.36	0.24	0.30	0.40
	0.14	0.22	0.30	0.20	0.28	0.37	0.26	0.35	0.44	0.30	0.40	0.50
Forest	0.05	0.08	0.11	0.08	0.11	0.14	0.10	0.13	0.16	0.12	0.16	0.20
	0.08	0.11	0.14	0.10	0.14	0.18	0.12	0.16	0.20	0.15	0.20	0.25
Residential	0.25	0.28	0.31	0.27	0.30	0.35	0.30	0.33	0.38	0.33	0.36	0.42
1/8 Acre	0.33	0.37	0.40	0.35	0.39	0.44	0.38	0.42	0.49	0.41	0.45	0.54
1/4 Acre	0.22	0.26	0.29	0.24	0.29	0.33	0.27	0.31	0.36	0.30	0.34	0.40
	0.30	0.34	0.37	0.33	0.37	0.42	0.36	0.40	0.47	0.38	0.42	0.52
1/3 Acre	0.19	0.23	0.26	0.22	0.26	0.30	0.25	0.29	0.34	0.28	0.32	0.39
	0.28	0.32	0.35	0.30	0.35	0.39	0.33	0.38	0.45	0.36	0.40	0.50
1/2 Acre	0.16	0.20	0.24	0.19	0.23	0.28	0.22	0.27	0.32	0.26	0.30	0.37
	0.25	0.29	0.32	0.28	0.32	0.36	0.31	0.35	0.42	0.34	0.38	0.48
1 Acre	0.14	0.19	0.22	0.17	0.21	0.26	0.20	0.25	0.31	0.24	0.29	0.35
	0.22	0.26	0.29	0.24	0.28	0.34	0.28	0.32	0.40	0.31	0.35	0.46
Industrial	0.67	0.68	0.68	0.68	0.68	0.69	0.68	0.69	0.69	0.69	0.69	0.70
	0.85	0.85	0.86	0.85	0.86	0.86	0.86	0.86	0.87	0.86	0.86	0.88
Commercial	0.71	0.71	0.72	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.89	0.89	0.90
Streets	0.70	0.71	0.72	0.71	0.72	0.74	0.72	0.73	0.76	0.73	0.75	0.78
	0.76	0.77	0.79	0.80	0.82	0.84	0.84	0.85	0.89	0.89	0.91	0.95
Open Space	0.05	0.10	0.14	0.08	0.13	0.19	0.12	0.17	0.24	0.16	0.21	0.28
	0.11	0.16	0.20	0.14	0.19	0.26	0.18	0.23	0.32	0.22	0.27	0.39
Parking or	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87
Impervious	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97

a = Runoff coefficients for storm recurrence intervals less than 25 years
b = Runoff coefficients for storm recurrence intervals of 25 years or more

APPENDIX P-3

DESIGN STORM RAINFALL AMOUNT (INCHES)

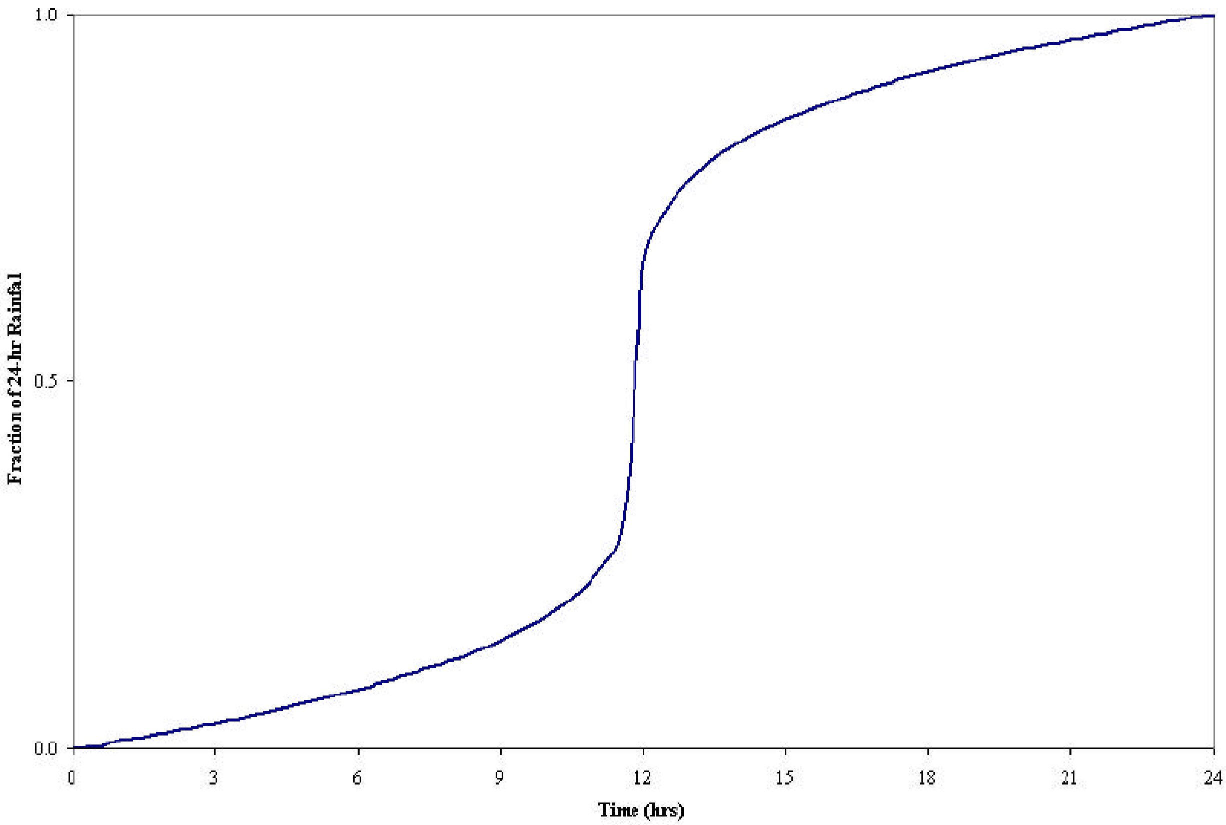
The design storm rainfall amount chosen for design shall be obtained from the PENNDOT Region III Storm Intensity-Duration-Frequency Curve according to Appendix P-5.

Source: NRCS (SCS) TR-55

Design Storm Frequency (years)	24 Hours Rainfall Amount (inches)
1	2.4
2	2.8
5	3.7
10	4.4
25	4.9
50	5.5
100	6.0

APPENDIX P-4

NRCS (SCS) Type II Rainfall Distribution



APPENDIX P-5

PENN DOT Storm Intensity-Duration-Frequency Curve Region 3

Source: "Field Manual of Pennsylvania Department of Transportation"
STORM INTENSITY-DURATION-FREQUENCY CHARTS
P D T - I D F" May 1986

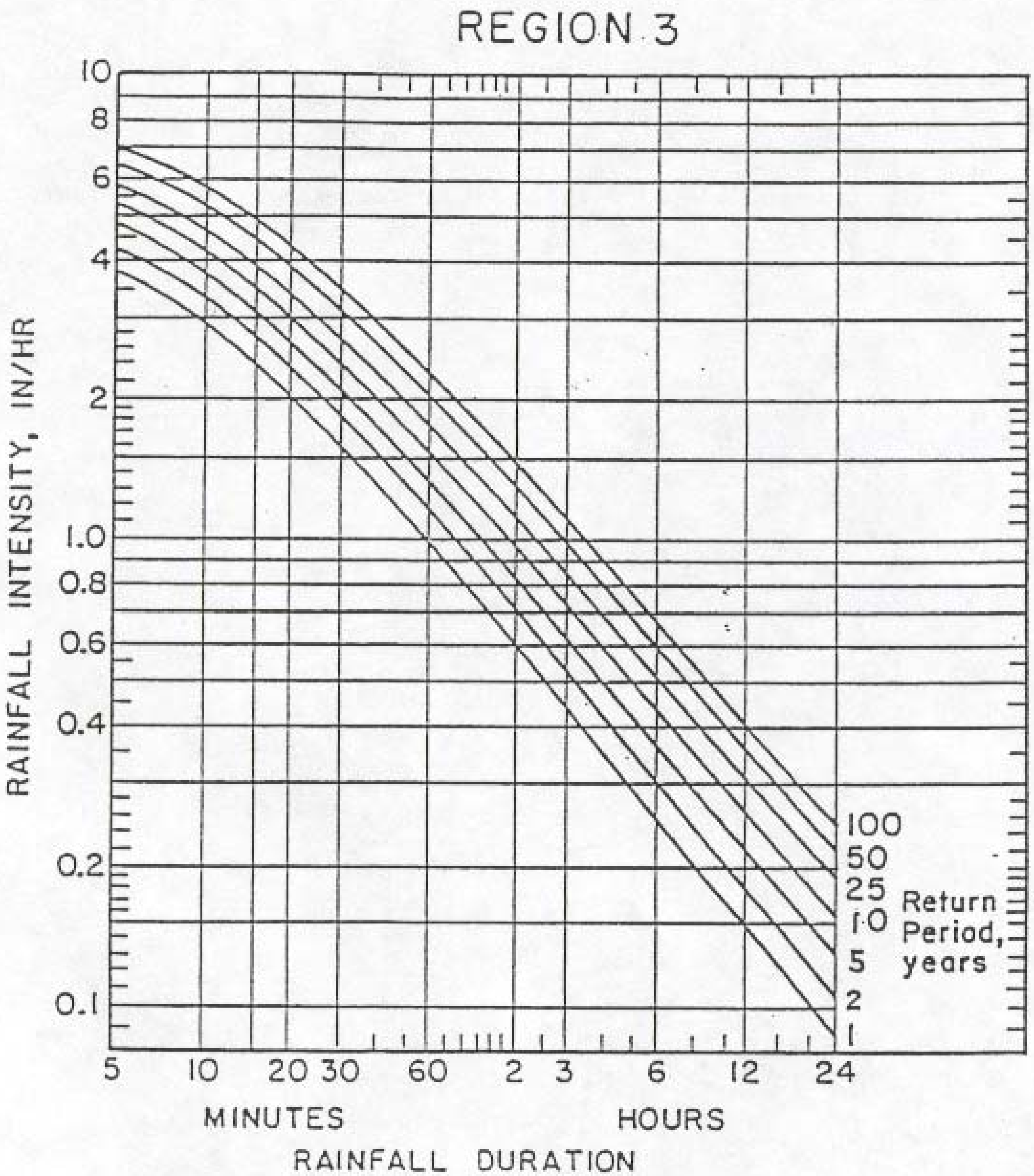


Figure 4 . Storm intensity-duration-frequency curves for Region 3.

APPENDIX P-6

Manning Roughness Coefficients

Roughness Coefficients (Manning's "n") For Overland/Sheet Flow
(From U.S. Army Corps of Engineers & NRCS TR-55)

Surface Description	**n**
Dense Growth	0.4 - 0.5
Pasture	0.3 - 0.4
Lawns	0.2 - 0.3
Bluegrass Sod	0.2 - 0.5
Short Grass Prairie	0.1 - 0.2
Sparse Vegetation	0.05 - 0.13
Bare Clay - Loam Soil (eroded)	0.01 - 0.03
Concrete/Asphalt - very shallow depths	
(less than 1/4 inch)	0.10 - 0.15
- small depths	
(1/4 inch to several inches)	0.05 - 0.10
Fallow (no residue)	0.05
Cultivated Soils	
Residue Cover Less Than or = 20%	0.06
Residue Cover Greater Than 20%	0.17
Grass	
Dense Grasses	0.24
Bermuda Grass	0.41
Range (natural)	0.13
Woods (Light Underbrush)	0.40

APPENDIX P-7

Release Rate Percentage Procedures

All controls designed to meet the release rate requirements shall meet the specified watershed release rate for the 2-, 10-, 25-, and 100-year return period storm. To utilize the Release Rate for a particular site in one of the delineated Release Rate Percentage areas, the applicant shall follow the following general sequence of actions.

1. Compute the pre-development and post-development runoff for the specific site using an approved method for the 2-, 10-, 25-, and 100-year storms, using **no stormwater management techniques**. If the post-development peak rate is less than or equal to the pre-development rate and time of peak of post and pre-development rates are identical, the requirements of Act 167 and the Plan have been met. If the post-development runoff rate exceeds the pre-development rate, proceed to Step 2.

2. Apply on-site stormwater management techniques to increase infiltration and reduce impervious surfaces. Recompute the post-development runoff rate for the 2-, 10-, 25-, and 100 year storms; and if the resulting post-development rate is less than or equal to the pre-development rate multiplied by the applicable release rate, the requirements of the Act 167 Plan have been meet. Otherwise, stormwater detention or retention will be required and the applicant should proceed to Step 3.

3. Multiply the assigned release rate percentage for the area times the pre-development peak runoff rate to determine the allowable total peak runoff rate from the development. Design the necessary detention/retention facilities to meet the allowable peak runoff rate standard.

APPENDIX P-8

Method for Computing Peak Discharge for Water Quality Storm

(Adapted from Claytor and Schueler, 1996)

The peak rate of discharge is needed for the sizing of off-line diversion structures and to design grass channels. Conventional SCS methods underestimate the volume and rate of runoff for rainfall events less than 2 inches. This discrepancy in estimating runoff and discharge rates can lead to situations where a significant amount of runoff by-passes the filtering treatment practice due to an inadequately sized diversion structure or leads to the design of undersized grass channels.

The following procedure can be used to estimate peak discharges for small storm events. It relies on the volume of runoff computed using the Small Storm Hydrology Method (Pitt, 1994) and utilizes the NRCS, TR-55 Graphical Peak Discharge Method (USDA, 1986).

Using the WQv methodology, a corresponding Curve Number (CN) is computed utilizing the following equation:

$$CN = \frac{1000}{[10+5P+10Q_a - 10\,(Q_a^2 + 1.25\,Q_a P)^{1/2}]}$$

Where: P = rainfall, in inches (use 1.2" for the Water Quality Storm)
Q_a = runoff volume, in inches (equal to P x R_v)

Note: The above equation is derived from the SCS Runoff Curve Number method described in detail in NEH-4, Hydrology (SCS 1985) and SCS TR-55 Chapter 2: Estimating Runoff. The CN can also be obtained graphically using Figure 1 of this Appendix from TR-55.

Once a CN is computed the time of concentration (t_c) is computed (based on the methods identified in TR-55, Chapter 3: "Time of Concentration and Travel Time").

Using the computed CN, t_c and drainage area (A), in acres; the peak discharge (Q_p) for the Water Quality Storm is computed (based upon the procedures identified in TR-55, Chapter 4: "Graphical Peak Discharge Method"). Use Rainfall distribution type II.

- Read initial abstraction (I_a), compute I_a/P
- Read the unit peak discharge (q_u) from Exhibit 4-II for appropriate t_c
- Using the runoff volume (Q_a), compute the peak discharge (Q_p); $\mathbf{Q_p = q_u \times A \times Q_a}$

Where: Q_p = the peak discharge, in cfs
q_u = the unit peak discharge, in cfs/mi^2/inch
A = drainage area, in square miles
Q_a = runoff volume, in watershed inches

Example Calculation of Peak Discharge for Water Quality Storm

Using a 3.0 acre small shopping center having a 1.0 acre flat roof, 1.6 acres of parking, and 0.4 acres of open space, and using P = 1.2"; the weighted volumetric runoff coefficient (R_v) is:

R_v =0.05+0.009(I); I = 2.6 acres/3.0 acres = 0.867 (86.7%)
=0.05+0.009(86.7%)
=0.83

The runoff volume, Q_a is:

$$Q_a = P \times R_v = 1.2'' \times 0.83 = 1.0 \text{ watershed inches}$$

and WQ_v is:

$$WQ_v = \frac{[(1.2'')(1.0)(3.0 \text{ acres})]}{12} \times \frac{43{,}560 \text{ ft}^2}{\text{acre}} = 13{,}016 \text{ ft}^3$$

Using Q_a = 1.0 watershed inches and P = 1.2"; CN for the water quality storm is:

$$CN = \frac{1000}{[10 + (5)(1.2'') + (10)(1.0) - 10((1.0)^2 + 1.25(1.0)(1.2''))^{1/2}]} = 98$$

Using: t_c = 10 minutes (0.17 hour);
$I_a = (200/CN)-2=0.041$;
$I_a/P = (0.041/1.2'') = 0.049$; (Use $I_a/P = 0.10$, *Ref: TR-55 Limitations*)
q_u = 850 csm/in. (from TR-55 Exhibit 4-II); and
A = 3.0 acres x 1/640 mi^2 per acre = 0.0047 mi^2
Q_p = (850 csm/in.)(0.0047 mi^2)(1.0") = 4.0 cfs

For computing runoff volume and peak rate for storms larger than the Water Quality Storm (i.e. 2-, 10-, 25-, and 100-year storms) use the published CN's from TR-55 and follow the prescribed procedure in TR-55.

In some cases the Rational Formula may be used to compute peak discharges associated with Water Quality Storm. The designer must have available reliable intensity, duration, frequency (IDF) tables or curves for the storm and region of interest. This information may not be available for many locations and therefore the TR-55 method described above is recommended.

APPENDIX P-9

Acceptable Stormwater Best Management Practices (BMP's)

BMP Group 1 - Stormwater Ponds

Stormwater Ponds - Practices that have a combination of permanent pool, extended detention or shallow wetland equivalent to the entire WQ_v include:

- Micropool Extended Detention
- Wet Pond
- Wet Extended Detention Pond
- Multiple Pond System
- Pocket Pond

BMP Group 2 - Stormwater Wetlands

Stormwater Wetlands - Practices that include significant shallow wetland areas to treat stormwater runoff but often may also incorporate small permanent pools and/or extended detention storage to achieve the full WQ_v include:

- Shallow Wetland
- Extended Detention Shallow Wetland
- Pond/Wetland System
- Pocket Wetland

BMP Group 3 - Infiltration Practices

Infiltration Practices - Practices that capture and temporarily store the WQ_v before allowing it to infiltrate into the soil over a two-day period include:

- Infiltration Trench
- Infiltration Basin

BMP Group 4 - Filtering Practices

Filtering Practices - Practices that capture and temporarily store the WQ_v and pass it through a filter bed of sand, organic matter, soil or other media are considered to be filtering practices. Filtered runoff may be collected and returned to the conveyance system. Design variants include:

- Surface Sand Filter
- Underground Sand Filter
- Perimeter Sand Filter
- Organic Filter
- Pocket Sand Filter
- Bioretention*

  * May also be used for infiltration

BMP Group 5 - Open Channel Practices

Open Channel Practices - Vegetated open channels that are explicitly designed to capture and treat the full WQ_v within dry or wet cells formed by checkdams or other means include:

- Dry Swale
- Wet Swale

BMP Group 6 - Non-Structural BMP's

Non-structural BMP's - These are increasingly recognized as a critical feature of stormwater BMP plans, particularly with respect to site design. In most cases, non-structural BMP's shall be combined with structural BMP's to meet all stormwater requirements. The key benefit of non-structural BMP's is that they can reduce the generation of stormwater from the site; thereby reducing the size and cost of structural BMP's. In addition, they can provide partial removal of many pollutants. The non-structural BMP's have been classified into seven broad categories. To promote grater use of non-structural BMP's, a series of credits and incentives are provided for developments that use these progressive site-planning techniques in Appendix O of this Ordinance.

- Natural Area Conservation
- Disconnection of Rooftop Runoff
- Disconnection of Non-Rooftop Impervious Area
- Sheet Flow to Buffers
- Grass Channel
- Environmentally Sensitive Development

There are numerous sources of information available related to BMP's. This brief list has been provided for your convenience:

United States Environmental Protection Agency - www.epa.gov
PA Department of Environmental Protection - www.dep.state.pa.us
The Center for Watershed Protection - www.cwp.org
The Pennsylvania Handbook of Best Management Practices for Developing Areas*
2000 Maryland Stormwater Design Manual*
New York Stormwater Management Design Manual*

* - Available for review at the Union County Planning Office.

APPENDIX P-10

Computation Of The Channel Protection Storage Volume (Cp_v)

The following procedure shall be used to design the channel protection storage volume (Cp_v). 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).

- Compute the time of concentration (*tc*) and the one-year post-development runoff depth (*Qa*) in inches.

  $$Qa = \frac{(2.4 - Ia)^2}{(2.4 - Ia) + S}$$ where S = (1000/CN) - 10, Ia = (200/CN)-2

- Compute the ratio *Ia/2.4* where 2.4 is the one-year rainfall depth (Source: NRCS (SCS) TR-55.

- With *tc* and *Ia/P*, find the unit peak factor (*qu*) from Figure 1 and compute the one year post-development peak discharge *qi = quAQa* where A is the drainage in square miles.

- **If *qi* ≤ 2.0 cfs, Cp_v is not required**. Provide for water quality (WQv) and groundwater recharge (Re_v) as necessary.

- With *qu*, find the ratio of outflow to inflow (*qo/qi*) for T = 12 or 24 hours from Figure 2.

- Compute the peak outflow discharge *qo = (qo/qi)xqi*

- With *qo/qi*, compute the ratio of storage to runoff volume (*Vs/Vr*).

  - $Vs/Vr = 0.683 - 1.43(qo/qi) + 1.64(qo/qi)^2 - 0.804(qo/qi)^3$

- Compute the extended detention storage volume Vs = (Vs/Vr)xVr (note: Vr = Qa);

- Convert Vs to acre-feet by (Vs/12)xA, where Vs is in inches and A is in acres.

- Compute the required orifice area (*Ao*) for extended detention design:

  - $$Ao = \frac{qo}{C(2gho)^{0.5}} = \frac{qo}{4.18(ho)^{0.5}}$$

- Where ho is the maximum storage depth associated with Vs.

- Determine the required maximum orifice diameter (*do*) $do = (4Ao/\pi)^{0.5}$

- A *do* of less than 3.0 inches is subject to local jurisdictional approval, and is not recommended unless an internal control for orifice protection is used.

Figure 1 SCS Graphical Method of Determining Peak Discharge (qu) in csm/in
For 24-Hour Type II Storm Distribution

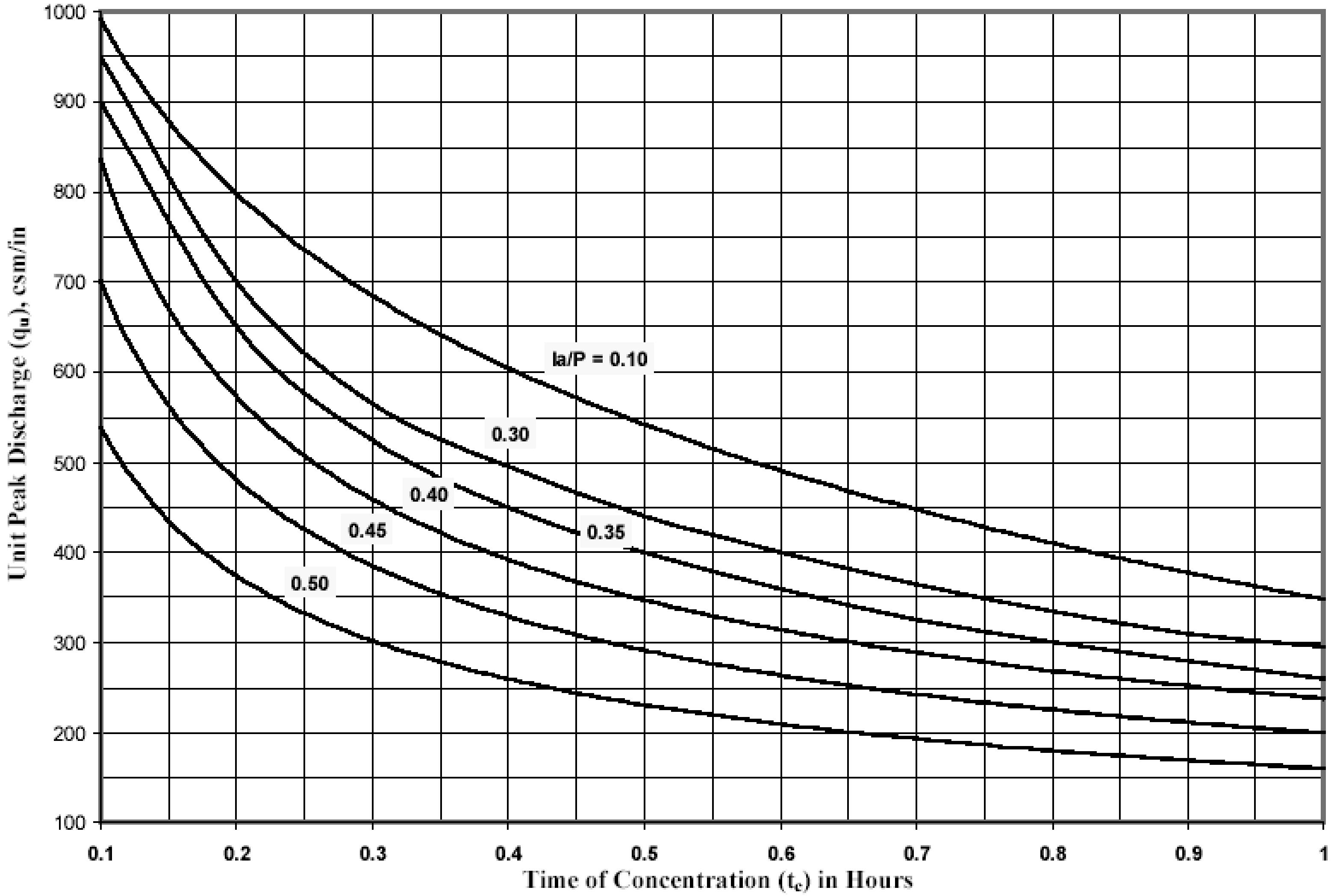
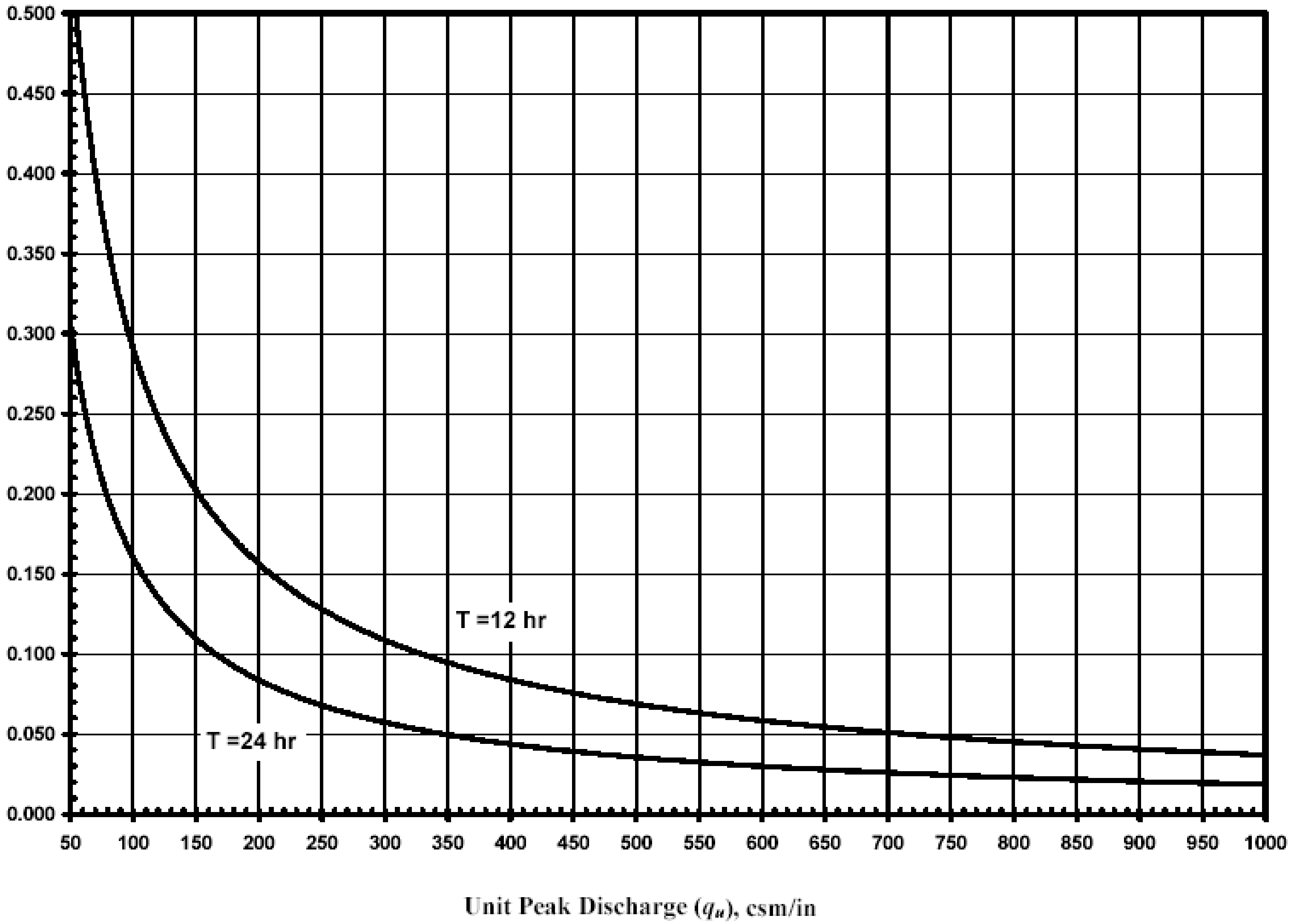
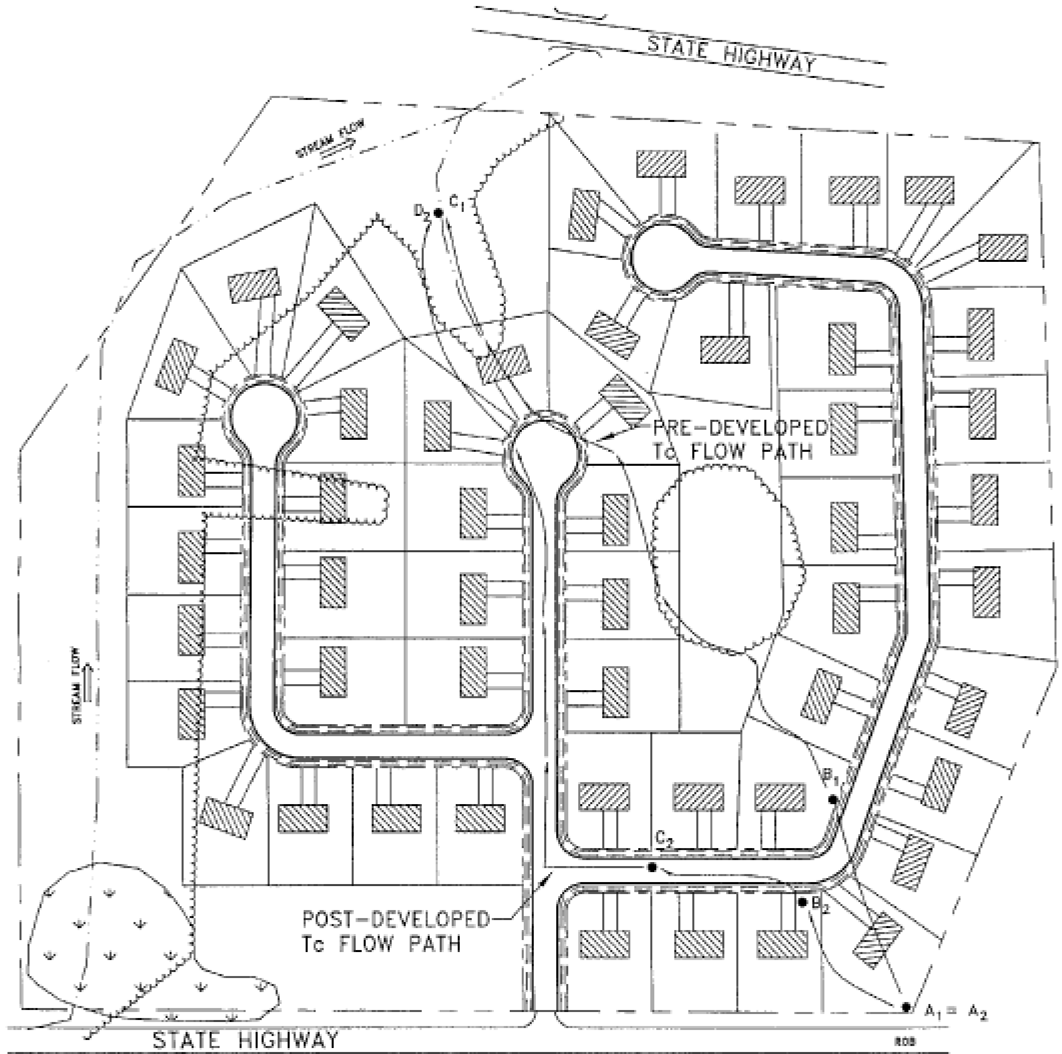


Figure 2 Detention Time Versus Discharge Ratios (qo/qi)



Design Example: The Meadows



BASE DATA	Hydrologic Data		
Location: Anywhere, PA Site Area = Total Drainage Area (A) = 38.0 ac Measured Impervious Area = 13.8 ac; I=13.8/38 =36.3% Soils Types: 60% "B", 40% "C" Zoning: Residential (½ ac lots)		Pre	Post
	CN	63	78
	tc	0.35 hr	0.19 hr

Step 1 Compute Water Quality Volume (WQ_v)

$$WQ_v = \frac{(P)(R_v)(A)}{12}$$

Step 1a. Compute Volumetric Runoff Coefficient (R_v)

R_v = 0.05 + (0.009) (I); I = 13.8 ac/38.0 ac = 36.3%
=0.05 + (0.009) (36.3) = 0.38

Step 1.b Compute WQ_v

$$WQ_v = [(1.2")(R_v)(A)] / 12$$
$$= [1.2")(0.38)(38.0ac)] / 12$$
$$= 1.44 \text{ ac-ft}$$

Check Minimum: [(0.2")(38.0 ac)] 12 = 0.63 ac-ft < 1.44 ac-ft
Therefore use WQ_v = 1.44 ac-ft

Step 2 Compute Recharge Volume (Re_v)

$Re_v = \frac{(S)(R_v)(A)}{12}$ (percent volume method)

or

$Re_v = (S)(Ai)$ (percent area method)

Step 2a. Determine Soil Specific Recharge Factor (*S*) Based on Hydrologic Soil Group

HSG	Soil Specific Recharge Factor (*S*)
A	0.40
B	0.27
C	0.14
D	0.07

Assume imperviousness is located proportionally (60/40) in B and C soils and compute a composite S:

S = (0.27)(0.60) + (0.14)(0.40) = 0.218; Use 0.218 or 21.8% of site imperviousness

Step 2b. Compute Recharge Using Percent Volume Method

$$Re_v = [(S)(R_v)(A)]/12$$
$$= [(0.218)(0.38)(38 \text{ ac})]/12$$
$$= 0.26 \text{ ac-ft}$$

or

For "B" soils =[(0.27)(.38)(38 ac)]/12 × 60%= 0.19 ac-ft
For "C" soils =[(0.14)(.38)(38 ac)]/12 × 40% = 0.07 ac-ft

Add recharge requirement for both soils for a total volume of 0.26 ac-ft

Step 2c. Compute Recharge Using Percent Area Method

$$Re_v = (S)(Ai)$$
$$= (0.218)(13.8 \text{ ac})$$
$$= 3.01 \text{ ac}$$

or

For "B" soils = (0.27)(13.8 ac)(60%) = 2.24 ac
For "C" soils = (0.14)(13.8 ac)(40%) = 0.77 ac

Added together = 3.01 acres of the total site impervious area needs to be treated by non-structural practices.

The Re_v requirement may be met by: a) treating 0.26 ac-ft using structural methods, b) treating 3.01 acres using non-structural methods, or c) a combination of both (e.g., 0.13 ac-ft structurally and 1.51 acres non-structurally).

Step 3. Compute Channel Protection Volume

Step 3a. Select Cp_v Sizing Rule

For channel protection, provide 12 or 24 hours of extended detention time (*T*) for the one-year design storm event.

Given that our stream is not a stocked or reproducing trout stream, we will use a *T* of 24 hours for the one-year design storm event.

Step 3b. Develop site hydrologic and TR-55 Input Parameters

Condition	**CN**	**tc**	**Runoff (Qa) 1-year storm**	**Q 1-year**
		hours	inches	cfs
pre-developed	63	0.35	0.2	4.62
developed	78	0.19	0.8	35.0

Step 3c. Utilize MDE Method to Compute Storage Volume

Initial abstraction (*Ia*) for CN of 78 is 0.564: (TR-55) [Ia = (200/CN) - 2]

Ia/P = (0.564)/2.4” = 0.235
tc = 0.19 hours

Figure P.1 (Appendix P-8), qu = 740 csm/in

Knowing *qu* and *T* (extended detention time) find *qo/qi* from Appendix F, Figure F.2, “Detention Time Versus Discharge Ratios.”

Peak outflow discharge/peak inflow discharge (qo/qi) = 0.024

With *qo/qi,* compute *Vs/Vr* for a Type II rainfall distribution,

$Vs/Vr = 0.683 - 1.43(qo/qi)+1.64(qo/qi)\ 2 - 0.804(qo/qi)^3$ (Appendix F)
$Vs/Vr = 0.65$

Therefore, Vs = 0.65(0.8.)(1/12)(38 ac) = 1.65 ac-ft

Step 3d. Define the Cp_v Release Rate

qi is known (35.0 cfs), therefore,
$qo = (qo/qi)\ qi$ = .024 (35.0) = .84 cfs

Step 4. Compute Overbank and Extreme Event Requirements

Compute assuming a release rate of 75%

Step 4a. Compute Pre-Development Runoff Peak Flow

Because CNs have already been determined use TR-55, however other appropriate methods may be used.

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

Where P = 24-hr rainfall (in.)

Union County 24 hour Rainfall for Various Frequencies (in.)					
2yr	5yr	10yr	25yr	50yr	100yr
2.8	3.7	4.4	4.9	5.5	6.0

S = (1000/CN) – 10

Note: this is not the Soil Specific Recharge Factor used in the Re_v calculation

CN = curve number see step 3b

Summary of Pre-Development Peak Flows (cfs)					
2yr	5yr	10yr	25yr	50yr	100yr
15.2	30.4	49.4	53.2	68.4	83.6

Step 4b. Compute post-development runoff peak flow

Summary of Post-Development Peak Flows (cfs)					
2yr	5yr	10yr	25yr	50yr	100yr
38.0	64.6	95.0	91.0	117.8	136.8

Step 4c. Because post-development flows are greater than pre development flows multiply the pre-development flows by the release rate to determine allowable post-development runoff peak flows

Allowable Post-Development Peak Flows (cfs) @ 75% Release Rate					
2yr	5yr	10yr	25yr	50yr	100yr
11.4	15.2	37.1	39.9	51.3	62.7

Note: These allowable outflows may be met through the use of both structural BMPs and non-structural BMPs or a combination of both.