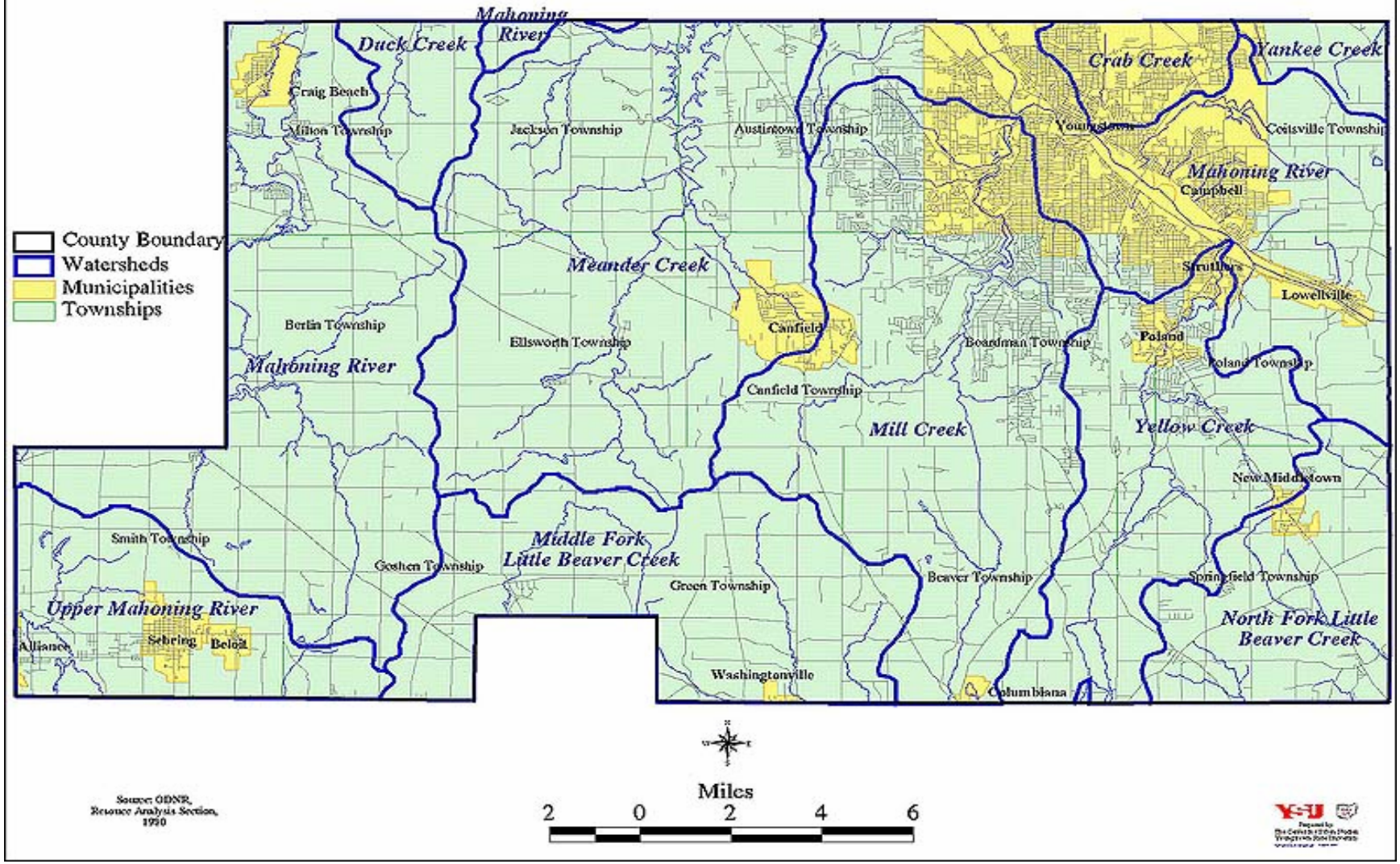
Major Watersheds
Mahoning County, Ohio



Form LD-34
(Revised July 1999)

STORM SEWER COMPUTATION SHEET

Calculated by.....Date.....

Checked by.....Date.....

Just Full Capacity .....Yr. Frequency

Hydraulic Gradient .....Yr. Frequency

Interstate Sag .....Yr. Frequency

Project.....

Sheet.....of.....

Manning's "n" for ..... Year Design Frequency.....

Manning's "n" for ..... Year H.G. Frequency.....

MH CB or I	Station	Side	Drainage Area In Acres		Time of Concentration In Minutes		Rainfall in Inches/Hour		Runoff Coef.	Column 7 x Column 4		Discharge in cfs (Col.6 x Col.8)		Size of Pipe in Inches	Length of Pipe in Feet	Slope of Pipe in Ft./Ft.	Inlet F/L of Pipe	Outlet F/L of Pipe	Mean Velocity in Ft./Sec.	Just Full Capacity (.....Year Q)	Friction Slope in Ft./Ft.	Head Loss in Feet	Elevation of Hyd. Gradient (for 25 year Q)	Grate or Cover Elev.	Cover Elev (21) minus H.G. Elev. (20)
No.			ΔA	ΣA	Δt	Σt	i...	i...	C	ΔCA	ΣCA	Q...	Q...	Ø	L	S_o	Elev.	Elev.	V_m	cfs	S_f	H	Elev.	Elev.	

Worksheet 2: Runoff curve number and runoff

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Figure 2-3	CN [1/] Figure 2-4	Area ☐ acres ☐ mi² ☐ %	Product of CN x area

[1/] Use only one CN source per line

Totals ➡ ☐ ☐

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = _____ = _____ ; Use CN ➡ ☐

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr			
Rainfall, P (24-hour)	in			
Runoff, Q	in			

(Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)

Worksheet 3: Time of Concentration (T_c) or travel time (T_t)

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to Tc only)

	Segment ID		
1. Surface description (table 3-1)			
2. Manning's roughness coefficient, n (table 3-1)			
3. Flow length, L (total L † 300 ft) ..... ft			
4. Two-year 24-hour rainfall, P_2 ..... in			
5. Land slope, s ..... ft/ft			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t ..... hr		+	=

Shallow concentrated flow

	Segment ID		
7. Surface description (paved or unpaved)			
8. Flow length, L .....ft			
9. Watercourse slope, s ..... ft/ft			
10. Average velocity, V (figure 3-1) ..... ft/s			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t ..... hr		+	=

Channel flow

	Segment ID		
12. Cross sectional flow area, a ..... ft^2			
13. Wetted perimeter, p_w ..... ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ..... ft			
15 Channel slope, s ..... ft/ft			
16. Manning's roughness coefficient, n			
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V .....ft/s			
18. Flow length, L ..... ft			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t ..... hr		+	=
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... Hr			

Worksheet 4: Graphical Peak Discharge method

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Data

Drainage area ..... A_m = _____ mi^2 (acres/640)

Runoff curve number .....CN = _____ (From worksheet 2)

Time of concentration ..... T_c = _____ hr (From worksheet 3)

Rainfall distribution ..... = _____ (I, IA, II III)

Pond and swamp areas sprea
throughout watershed ..... = _____ percent of A_m (_____ acres or mi^2 covered)

	Storm #1	Storm #2	Storm #3
2. Frequency ..... yr			
3. Rainfall, P (24-hour) ..... in			
4. Initial abstraction, I_a ..... in (Use CN with table 4-1)			
5. Compute I_a / P			
6. Unit peak discharge, q_u ..... csm/in (Use T_c and I_a / P with exhibit 4– _____)			
7. Runoff, Q ..... in (From worksheet 2) Figure 2-6			
8. Pond and swamp adjustment factor, F_p ..... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)			
9. Peak discharge, q_p ..... ft^3/s			

(Where $q_p = q_u A_m Q F_p$)

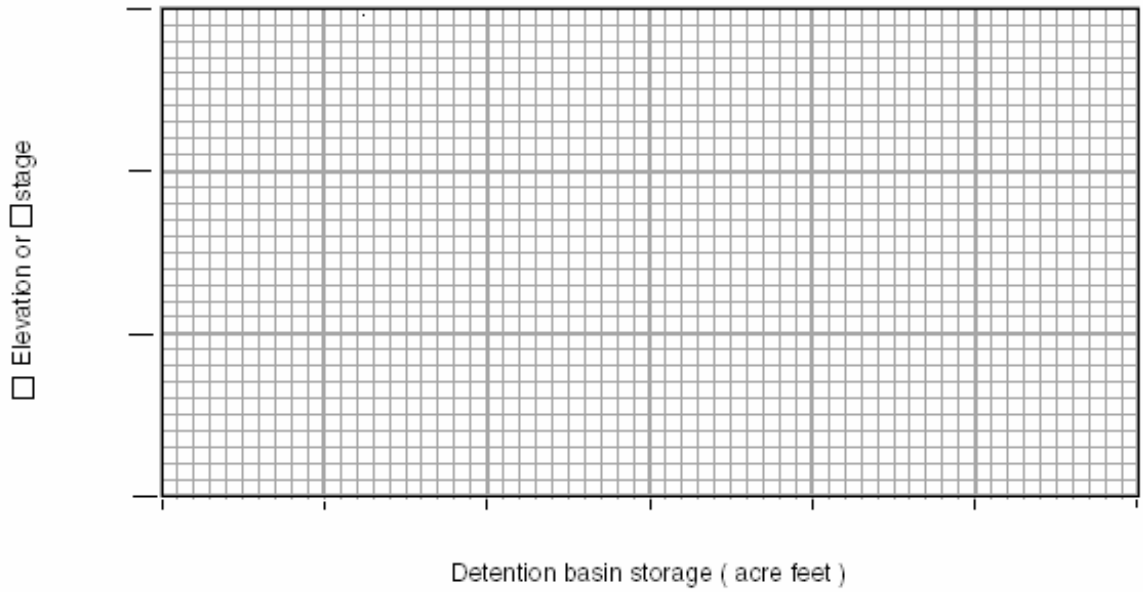
SMALL DETENTION POND DESIGN SPREADSHEET

T	ΔT	I	Q__y	i__y	V_T	T_E	D	* Storage Required
Min.	$T - T_{cr}$ Min	IN. = CFS Hr. Ac.	__ x I C.F.S.	I = ___ In./Hr.	__i_y T Cu. Ft.	V_T - ΔT 30 Q__y	__T_E Cu. Ft.	$V_T - D$ Cu. Ft.
10								
15								
20								
30								
40								
50								
60								
70								
80								
90								
100								
110								
120								

Worksheet 6a: Detention basin storage, peak outflow discharge (q_o) known

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed



1. Data:
   Drainage area ..... A_m = _____ mi²
   Rainfall distribution type (I, IA, II, III) = _____

	1st Stage	2nd Stage
2. Frequency ..... yr		
3. Peak inflow discharge q_i ..... ft³/s (from worksheet 4 or 5b)		
4. Peak outflow discharge q_u ..... ft³/s 1/		
5. Compute $\frac{q_o}{q_i}$		
6. $\frac{V_s}{V_r}$ ..... (Use $\frac{q_o}{q_i}$ with figure 6-1)		
7. Runoff, Q ..... in (From worksheet 2)		
8. Runoff volume V_r..... ac ft ($V_r = QA_m$ 53.33)		
9. Storage volume, V_s ..... ac-ft ($V_s = V_r (\frac{V_s}{V_r})$)		
10. Maximum storage E_{max} (from plot)		

1/ 2nd stage q_o includes 1st stage q_o.

STAGE-STORAGE WORKSHEET

PROJECT: _____ SHEET _____ of _____

COUNTY: _____ COMPUTED BY: _____ DATE: _____

DESCRIPTION: _____

ATTACH COPY OF TOPO: SCALE – 1”=_____ *ft.*

1	2	3	4	5	6	7	8
ELEV.	AREA (in^2)	AREA (ft^2)	AVG. AREA (ft^2)	INTERVAL	VOL. (ft^3)	TOTAL VOLUME (ft^3)	($ac.\ ft.$)

CULVERT DESIGN WORKSHEET

PROJECT: _____

STATION: _____

SHEET _____ OF _____

CULVERT DESIGN FORM

DESIGNER / DATE: _____ / _____

REVIEWER / DATE: _____ / _____

HYDROLOGICAL DATA

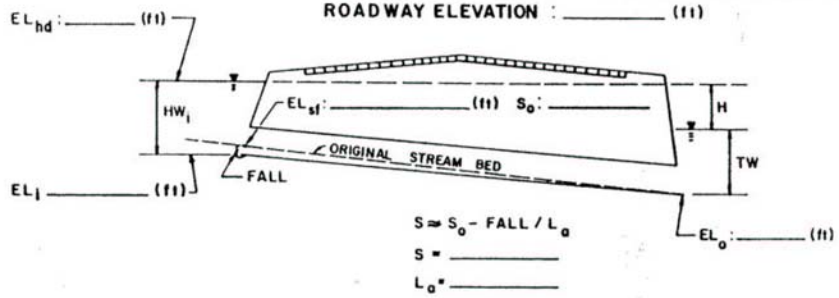
SEE ADD'L SHTS.

- ☐ METHOD: _____
- ☐ DRAINAGE AREA: _____ ☐ STREAM SLOPE: _____
- ☐ CHANNEL SHAPE: _____
- ☐ ROUTING: _____ ☐ OTHER: _____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)

ROADWAY ELEVATION: _____ (ft)



$S = S_o - FALL / L_a$

$S =$ _____

$L_a =$ _____

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_1/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

- a. APPROXIMATE
- f. CULVERT FACE
- hd. DESIGN HEADWATER
- hi. HEADWATER IN INLET CONTROL
- ho HEADWATER IN OUTLET CONTROL
- i. INLET CONTROL SECTION
- o. OUTLET
- sf. STREAMBED AT CULVERT FACE
- tw. TAILWATER

COMMENTS / DISCUSSION:

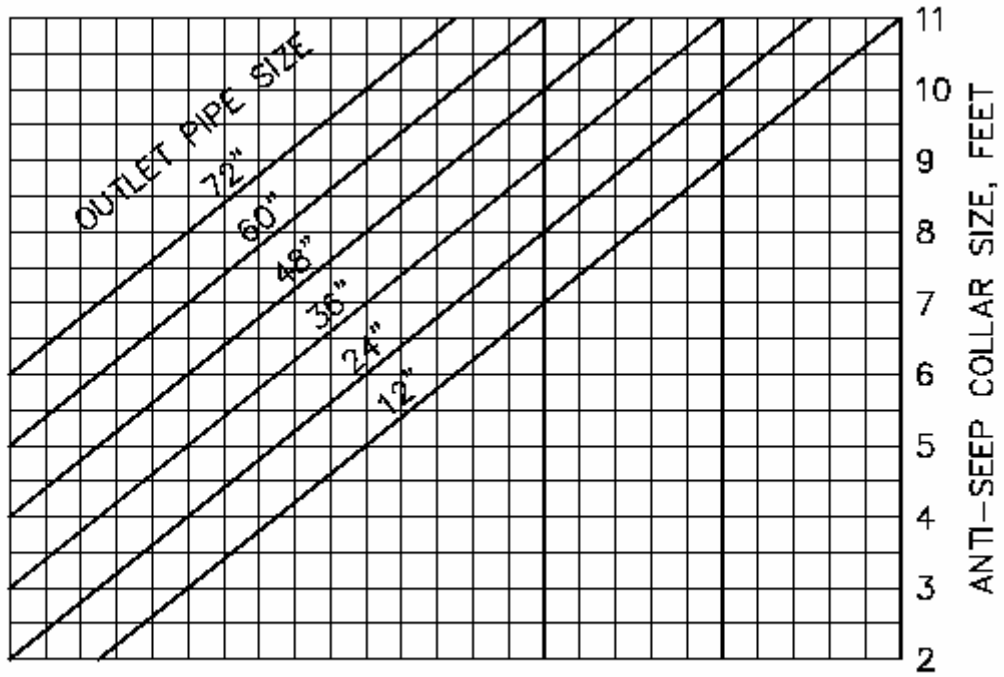
CULVERT BARREL SELECTED:

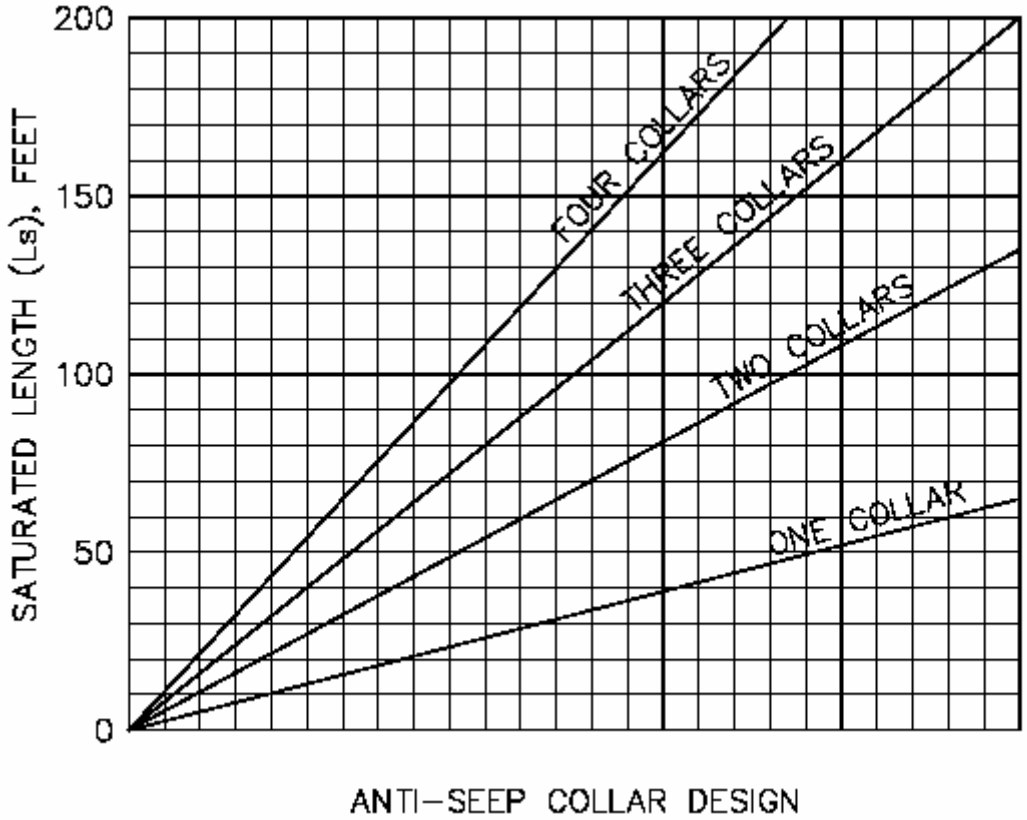
SIZE: _____

SHAPE: _____

MATERIAL: _____ n _____

ENTRANCE: _____


OUTLET PIPE SIZE
72"
60"
48"
36"
24"
12"
11
10
9
8
7
6
5
4
3
2
ANTI-SEEP COLLAR SIZE, FEET


200
150
100
50
0
SATURATED LENGTH (Ls), FEET
FOUR COLLARS
THREE COLLARS
TWO COLLARS
ONE COLLAR
ANTI-SEEP COLLAR DESIGN