U. S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

UNDERGROUND OUTLET DESIGN SHEET

COUNTY _____ NO. T-3 LANDOWNER Example Problem (FIELD NO. 1)

REQUIRED STORAGE (For 24 Hr. Removal Time)

( ) Drainage Area = 5.7 Ac. (2) Runoff Curve No. 80 (3) 10 Yr-24 Hr. Storm = 6.6 in.

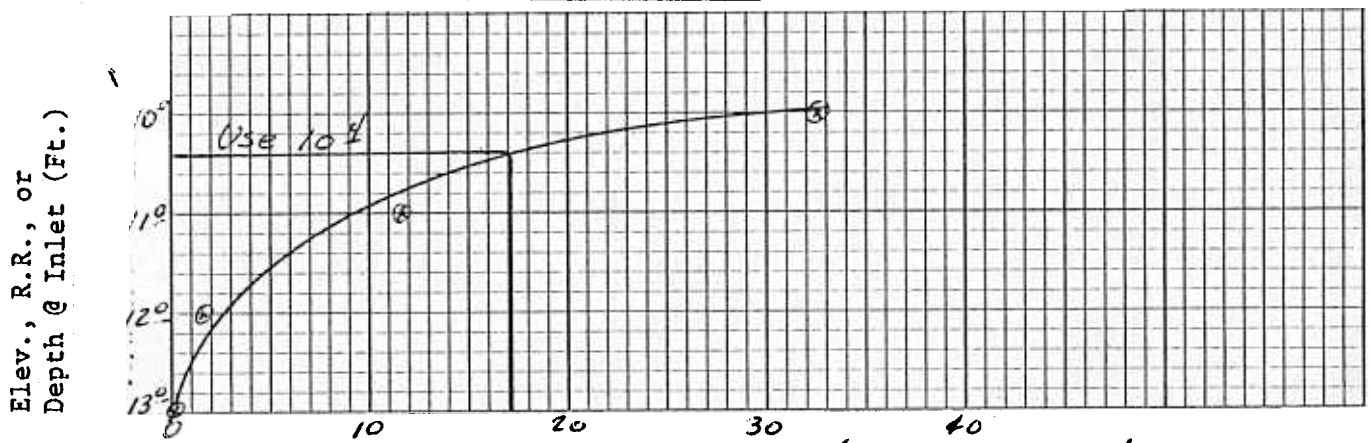
(4) Runoff (10 Yr-24 Hr. event) = 4.4 in. (5) Volume Runoff = (1)(4) = (5.7)(4.4) = 25.1 Ac.

(6) Discharge Coefficient 0.61 1/ (7) Sediment Storage=.03(Design Life Yrs.)(1)=.03(10 Yr.)(5.7 Ac.) = 1.31 Ac.

(8) Total Storage Required = (6)(5) + (7) = (.61)(25.1) + (1.31) = 17.02 Ac.-in.

STAGE STORAGE

Stage	Area Ac.	Storage (Ac.In.) Incri.	Accum.
13°			0
12°			1.6
11°			11.8
10°			32.8



(9) Design Elev. = 10.4 ft.
(9a) Design Depth @ Inlet 2.6 ft.

(10) Settled Const. Height = (9a) + 0.5 = (2.6) + .5 = 3.1 ft.
Fill Elevation or Rod Reading 9.2

1/ DISCHARGE COEFFICIENT

Removal Time (Hrs.)	Routing Coef.
6	0.36
12	0.47
18	0.53
24	0.61
30	0.65
36	0.65
48	0.72

Area Computations

Emaple using: storage = $\Sigma \frac{D_0^2}{S_0} + \frac{D_1^2}{S_1} + \frac{D_2^2}{S_2} + \dots \frac{D_n^2}{S_n}) .01377$

storage @ 12° = $\left(\frac{.8^2}{.007} + \frac{.5}{.009} + 0\right) .01377 =$ 1.6 ac. in

storage @ 11° = $\left(\frac{1.8^2}{.007} + \frac{(1.5)^2}{.009} + \frac{.9^2}{.009} + \frac{.7^2}{.009} + 0\right) .01377 =$ 11.8

Storage @ 10° = $\left(\frac{2.8^2}{.007} + \frac{2.5^2}{.009} + \frac{1.9^2}{.009} + \frac{1.7^2}{.009} + \frac{.9^2}{.011} + \frac{.6^2}{.012} + \frac{.7^2}{.012} + \frac{.6^2}{.012} + \frac{.6^2}{.012}\right) .01377 = 32.8$

HYDRAULICS

Terrace No. T-3

Sheet ___ of ___

(11) Removal Time = 24 Hrs. (12) Design Discharge $1.25 \frac{(5)}{(11)} = \frac{(1.25)(25.1)}{(24)}$ = 1.31 cfs or Ac-Ft/Hr.

Orifice Design

(13) Design Orifice Head = (9a) + 1.0 + (2.6) + 1.0 = 3.6 (14) Q = (12) 1.31 (15) Orifice Size 5 1/4 in Dia. (Exhibit 3)

(16) Actual Discharge = 1.4 ≥ (13) (Exhibit 3)

Offset Line (17) Length = 50 ft, n = .015

w/orifice

(18) Hp = 1.0 ft (19) Q = (16) 1.4 (20) Dia. = 10 in. (Exhibit 6)

w/o orifice

(21) Hp = (9) - WS Elev. @ Outlet = ft

(22) Q des. = (12) = cfs, (23) Dia. = in. (Exhibit 6) (24) Actual Q = ≥(13) (Exhibit 6)

Vertical Inlet

(25) Min. Area Opening sq in./ft for; Q = (16) or (26) = (1.4) (27) Ho = (9a) = 2.6 (28) Area = (sq in./ft) = 22 sq. in (Exhibit 4)

(29) Min. Number of 1' holes/ft = (24)/.7854 22/.7854 = 28 (30) Min. Dia. Inlet = (Select larger of a.,b., or c.) = 10"

a. Dia. = (20) or (23) = 10

b. Dia. = (15)+2" ____ +2 = 8

c. Q from (16) or (24) 1.4, depth from (9a) 2.6

Dia = 6 (Exhibit 5)

Design By: _____

Approved By: _____

U. S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

UNDERGROUND OUTLET DESIGN SHEET

COUNTY NO. T-4 LANDOWNER Example Problem (FIELD NO. 1)

REQUIRED STORAGE (For 25 Hr. Removal Time)

(1) Drainage Area = 28.4 Ac. (2) Runoff Curve No. = 80 (3) 10 Yr-24 Hr. Storm = 6.6 in.

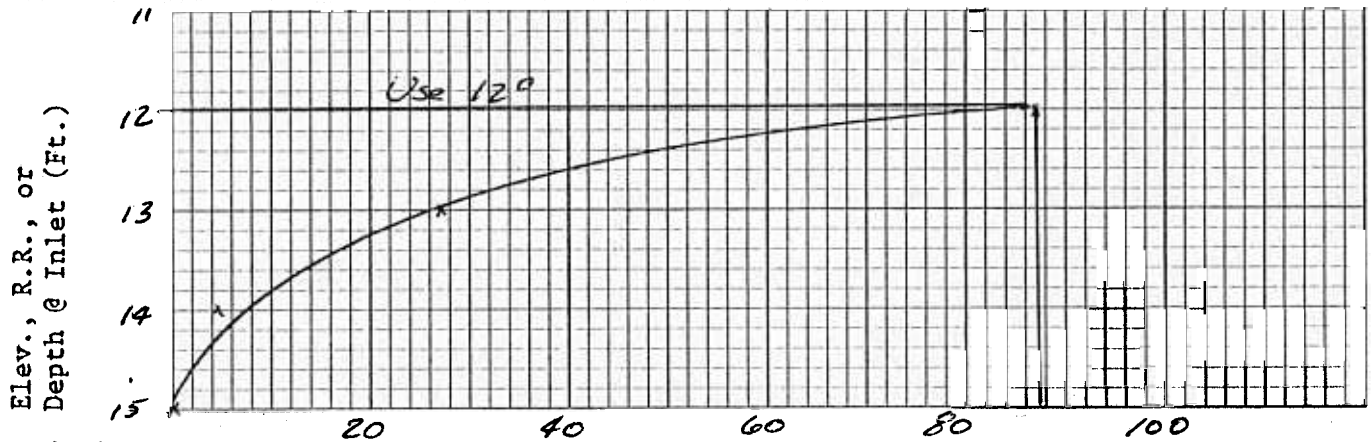
(4) Runoff (10 Yr-24 Hr. event) = 4.4 in (5) Volume Runoff = (1)(4) = (28.4)(4.4) 125 Ac.

(6) Discharge Coefficient .61 1/ (7) Sediment Storage=.03(Design Life Yrs.)(1)=.03(10 Yr.)(28.4 Ac.) = 8.5

(8) Total Storage Required = (6)(5) + (7) = (.61)(125) + (8.5) = 84.8 Ac.-in.

STAGE STORAGE

Elev. or Rod Reading	Area Ac.	Storage (Ac.In.) Incri.	Accum.
15°	0		
14°	.74	4.44	4.44
13°	3.13	23.2	27.6
12°	6.72	59.1	86.7
11°	9.43	96.9	183.6
10°			



(9) Design Elev. = 12° ft.
(9a) Design Depth @ Inlet 3° ft.

(10) Settled Const. Height = (9a) + 0.5 = (3°) + .5 = 3.5 ft.
Fill Elevation or Rod Reading 11.5

1/ DISCHARGE COEFFICIENT

Removal Time (Hrs.)	Routing Coef.
6	0.36
12	0.47
18	0.53
24	0.61
30	0.65
36	0.65
48	0.72

Area Computations

D.A. = (9.15)(.92) = 8.4 Ac + 20 Ac (outside water) = 28.4 Ac

Area 14° = (.8)(.92) = .74 $\frac{(.74)(12)}{2} = 4.44$

Area 13° = (3.4)(.92) = 3.13 $\left(\frac{.74+3.13}{2}\right)(12) = 23.2$

Area 12° = (7.3)(.92) = 59.1 $\left(\frac{3.13+6.72}{2}\right)12 = 59.1$

Area 11° = (10.25)(.92) = 9.43 Ac $\left(\frac{6.72+9.43}{2}\right)12 = 183.6$

Planimeter from Grid Map

HYDRAULICS Terrace No. T-4 Sheet ___

(11) Removal Time = 24 Hrs. (12) Design Discharge = 1.25 $\frac{(5)}{(11)}$ = $\frac{(1.25)(25)}{(24)}$ = 6.5 cfs or Ac-Ft/Hr.

Orifice Design

(13) Design Orifice Head = (9a) + 1.0 + (3.0) + 1.0 = 4.0 (14) Q = (12) 6.5 (15) Orifice Size 11 1/8 in Dia. (Exhibit 3)

(16) Actual Discharge = 6.5 ≥ (1 2/3) (Exhibit 3)

$d = \sqrt{\frac{(38.1)(6.5)}{\sqrt{4.0}}}$ = 11.127 use 11 1/8

Offset Line (17) Length = ___ ft, n = ___

w/orifice

(18) Hp = 1.0 ft (19) Q = (16) ___ (20) Dia. = ___ in. (Exhibit 6)

w/o orifice

(21) Hp = (9) - WS Elev. @ Outlet = ___ ft

(22) Q des. = (12) = ___ cfs, (23) Dia. = ___ in. (Exhibit 6) (24) Actual Q = ___ ≥ (1 2/3) (Exhibit 6)

Vertical Inlet

(25) Min. Area Opening sq in./ft for; Q = (16) or (26) = (6.5). (27) Ho = (9a) = 3.0 (28) Area = sq in./ft = 82 sq in (Exhibit 4)

(29) Min. Number of 1' holes/ft = (24)/.7854 = 82/.7854 = 104 (30) Min. Dia. Inlet = (Select larger of a.,b., or c.) = 15"

a. Dia. = (20) or (23) = —

b. Dia. = (15)+2" 11 1/8 +2 = 13 1/8 use 15"

c. Q from (16) or (24) 6.5, depth from (9a) 3.0

Dia = 12 (Exhibit 5)

Design By: ___

Approved By: ___

U. S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

UNDERGROUND OUTLET DESIGN SHEET

COUNTY _____ NO. T-5 LANDOWNER Example Problem (FIELD NO. 1)

REQUIRED STORAGE (For 24 Hr. Removal Time)

(1) Drainage Area = 5.5 Ac. (2) Runoff Curve No. = 80 (3) 10 Yr-24 Hr. Storm = 6.6 in.

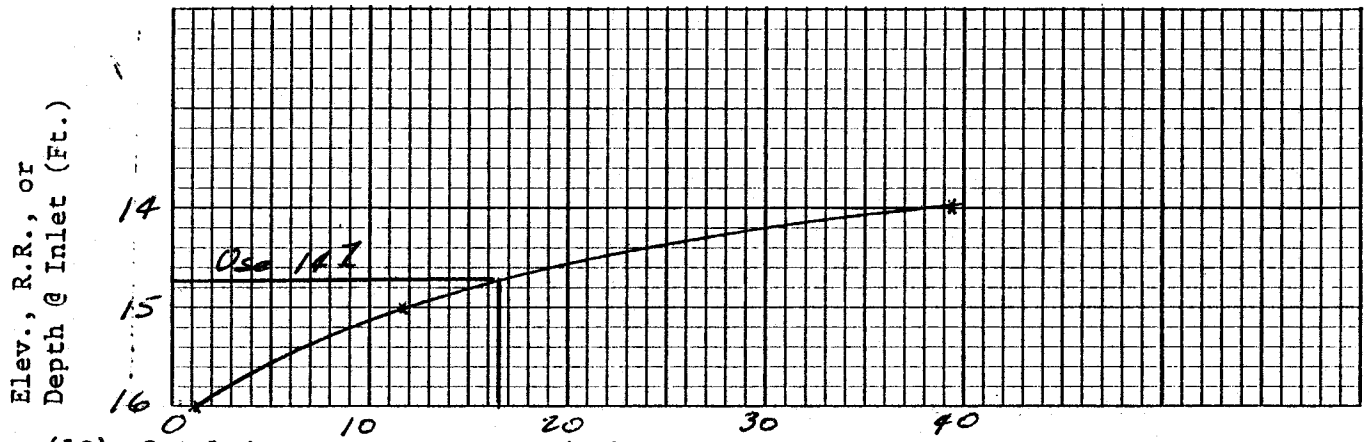
(4) Runoff (10 Yr-24 Hr. event) = 4.4 in. (5) Volume Runoff = (1)(4) = (5.5)(4.4) = 24.2 Ac.-in

(6) Discharge Coefficient .61 1/ (7) Sediment Storage=.03(Design Life Yrs.)(1)=.03(10 Yr.)(5.5 Ac.) = 1.7 Ac.-in

(8) Total Storage Required = (6)(5) + (7) = (.61)(24.2) + (1.7) = 16.5 Ac.-in.

STAGE STORAGE

Elev. or Rod Reading	Area Ac.	Storage (Ac.In.) Incri.	Accum.
16.3	–		
16.0	.2	1.2	1.2
15.0	1.56	10.56	11.76
14.0	3.13	28.14	39.3
13.0			



(9) Design Elev. = 14.7 ft.
(9a) Design Depth @ Inlet 1.6 ft.

(10) Settled Const. Height = (9a) + 0.5 = (1.6) + .5 = 2.1 ft.
Fill Elevation or Rod Reading 14.2

1/ DISCHARGE COEFFICIENT

Removal Time (Hrs.)	Routing Coef.
6	0.36
12	0.47
18	0.53
24	0.61
30	0.65
36	0.65
48	0.72

Area Computations

D.A. = (5.95)(.92) = 5.46 Ac use 5.5

Area 16° = (.2)(.92) ≈ .2 Ac

Area 15° = (1.7)(.92) = 1.56

14 = (3.4)(.92) = 3.13

$\frac{(.2)}{2}12 = 1.2$

$\left(\frac{1.56 + .2}{2}\right)12 = 10.56$

$\left(\frac{1.56 + 3.13}{2}\right)12 = 28.14$

HYDRAULICS Terrace No. T-5 Sheet ____

(11) Removal Time = 24 Hrs. (12) Design Discharge = 1.25 $\frac{(5)}{(11)}$ = $\frac{(1.25)(242)}{(24)}$ = 1.26 cfs or Ac-Ft/Hr.

Orifice Design

(13) Design Orifice Head = (9a) + 1.0 = (1.6) + 1.0 = 2.6 (14) Q = (12) 1.26 (15) Orifice Size 5½ in Dia. (Exhibit 3)

(16) Actual Discharge = 1.3 ≥ (13) (Exhibit 3)

Offset Line (17) Length = _____ ft, n = _____ Not used

w/orifice

(18) Hp = 1.0 ft (19) Q = (16) _____ (20) Dia. = _____ in. (Exhibit 6)

w/o orifice

(21) Hp = (9) - WS Elev. @ Outlet = _____ ft

(22) Q des. = (12) = _____ cfs, (23) Dia. = _____ in. (Exhibit 6) (24) Actual Q = _____ ≥ (13) (Exhibit 6)

Vertical Inlet

(25) Min. Area Opening sq in./ft for; Q = (16) or (26) = (1.3). (27) Ho = (9a) = 1.6 (28) Area = sq in./ft 43 (Exhibit 4)

(29) Min. Number of 1' holes/ft = (24)/.7854 = 55 (30) Min. Dia. Inlet = (Select larger of a.,b., or c.) = 8"

a. Dia. = (20) or (23) = _____

b. Dia. = (15)+2" 5½ +2 = 7½

c. Q from (16) or (24) 1.3, depth from (9a) 1.6

Dia = 6 (Exhibit 5)

Design By: _____

Approved By: _____

U. S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

UNDERGROUND OUTLET DESIGN SHEET

COUNTY _____ NO. T-6 LANDOWNER Example Problem (FIELD NO. 1)

REQUIRED STORAGE (For 24 Hr. Removal Time)

(1) Drainage Area = 4.1 Ac. (2) Runoff Curve No. = 80 (3) 10 Yr-24 Hr. Storm = 6.6 in.

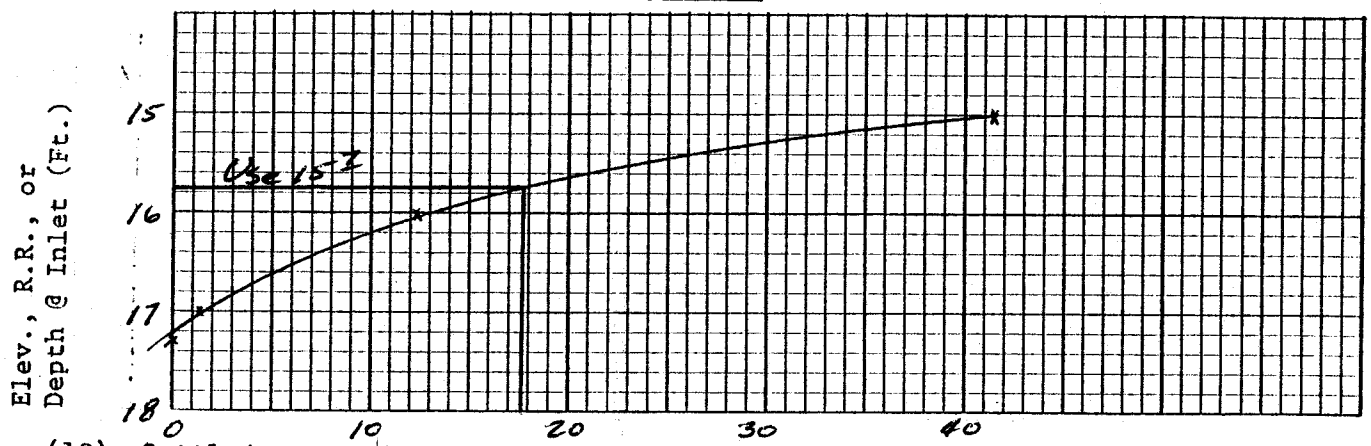
(4) Runoff (10 Yr-24 Hr. event) = 4.4 in. (5) Volume Runoff = (1)(4) = (4.1)(4.4) = 27.1 Ac.-in

(6) Discharge Coefficient .61 1/ (7) Sediment Storage=.03(Design Life Yrs.)(1)=.03(10 Yr.)(4.1 Ac.) = 1.23 Ac.-in.

(8) Total Storage Required = (6)(5) + (7) = (.61)(27.1) + (1.23) = 17.73 Ac.-in.

STAGE STORAGE

Elev. or Rod Reading	Area Ac.	Storage (Ac.In.) Incri.	Accum.
17.3	0		
17.0	.24	1.44	1.44
16.0	1.58	10.92	12.36
15.0	3.27	29.1	41.46



(9) Design Elev. = 15.7 ft.
(9a) Design Depth @ Inlet 1.6 ft.

(10) Settled Const. Height = (9a) + 0.5 = (1.6) + .5 = 2.1 ft.
Fill Elevation or Rod Reading 15.2

1/ DISCHARGE COEFFICIENT

Removal Time (Hrs.)	Routing Coef.
6	0.36
12	0.47
18	0.53
24	0.61
30	0.65
36	0.65
48	0.72

Area Computations

Area 17° = $\frac{(160)(120)}{2\ (43560)}$ = .24 Ac. $\frac{(.24)}{2}12$ = 1.44 Ac. in

Area 16° = (1.72)(.92) = 1.58 Ac. $\left[\frac{(1.58)+(.24)}{2}\right]12$ = 10.92 Ac. in

Area 15° = (3.55)(.92) = 3.27 Ac $\left[\frac{1.58+3.27}{2}\right]12$ = 29.1 Ac. in

HYDRAULICS Terrace No._____ Sheet____

(11) Removal Time = 24 Hrs. (12) Design Discharge = 1.25 $\frac{(5)}{(11)}$ = $\frac{(1.25)(27.1)}{(24)}$ = 1.41 cfs or Ac-Ft/Hr.

Orifice Design

(13) Design Orifice Head = (9a) + 1.0 + (1.6) + 1.0 = 2.6 (14) Q = (12) 1.41 (15) Orifice Size 5 3/4 in Dia. (Exhibit 3)

(16) Actual Discharge = 1.4 ≥ (13) (Exhibit 3)

Offset Line (17) Length = _____ft, n = _____ not used

w/orifice

(18) Hp = 1.0 ft (19) Q = (16) _____ (20) Dia. = _____ in. (Exhibit 6)

w/o orifice

(21) Hp = (9) - WS Elev. @ Outlet = _____ft

(22) Q des. = (12) = _____cfs, (23) Dia. = _____ in. (Exhibit 6) (24) Actual Q = _____ ≥ (13) (Exhibit 6)

Vertical Inlet

(25) Min. Area Opening sq in./ft for; Q = (16) or (26) = (1.4). (27) Ho = (9a) = 1.6 (28) Area = sq in./ft 46 sq. in (Exhibit 4)

(29) Min. Number of 1' holes/ft = (24)/.7854 = 59 (30) Min. Dia. Inlet = (Select larger of a.,b., or c.) = 8"

a. Dia. = (20) or (23) = —

b. Dia. = (15)+2" 5 3/4 +2 = 7 3/4

c. Q from (16) or (24) 1.4, depth from (9a) 1.6

Dia = 6 (Exhibit 5)

Design By:_____

Approved By:_____