43-03

Carmen Johnson

Fac/Perm/Co ID #	Date	Doc ID#
43-03	7/18/13	DIN

EROSION & SEDIMENT CONTROL

CALCULATIONS

FOR:

HARNETT COUNTY

ANDERSON CREEK LANDFILL

CLOSURE

McKIM & CREED

PROJECT NO. 304/91978.00

SEPTEMBER 1993

McKIM&CREED

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CALCULATION

PROJECT ANDERSON CREEK LANDFILL
CLIENT HARNETT CO.
SUBJECT CLOSURE

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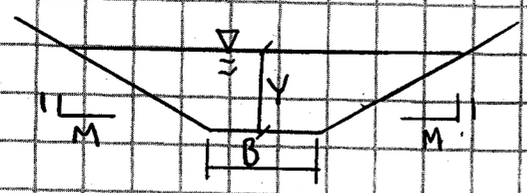
REMARKS

DESIGN CRITERIA & ASSUMPTIONS

CHANNEL CALCULATIONS:



$W = B + 2MY$

$A = BY + MY^2$

$W_p = B + 2Y\sqrt{1+M^2}$

$R = A / W_p$

$Q = 1.486/n \, A R^{0.67} S^{0.5}$

$V = 1.486/n \, R^{0.67} S^{0.5}$

W = TOP WIDTH (FT.)
A = CROSS SECTIONAL AREA (SF)
W_p = WETTED PERIMETER
R = HYDRAULIC RADIUS
Q = FLOW (CFS)
V = VELOCITY (FPS)
n = ROUGHNESS COEFFICENT

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REMARKS

DESIGN ASSUMPTIONS

OPEN CHANNEL FLOW CRITERIA

VELOCITY	STABILIZATION CONDITION
0 - 2.5 FPS	NORMAL SEEDING
2.5 - 4.5 FPS	ADD JUTE NET WITH STRAW
4.5 FPS +	ARMORIZE

(4.5 FPS = MAX. VELOCITY FOR GRASS LINED CHANNELS W/ 0 STONE)

USE MANNING'S FORMULA: $Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

$V = \frac{1.486}{n} R^{2/3} S^{1/2}$

MAXIMUM ALLOWABLE SHEAR STRESS

LINER	SHEAR STRESS
NET W/ STRAW	1.45
FS-2 FILTER STONE	0.80
CLASS "A" RIP RAP	2.50
CLASS "B" RIP RAP	3.80

MANNING'S ROUGHNESS COEFFICENT ("n")

	0 - 0.5 FT	0.5 - 1 FT	1.0 - 2.0 FT
NET W/ STRAW	0.065	0.033	0.033
FS-2	0.045	0.034	0.034
CLASS "A" RIP RAP	0.106	0.054	0.044
CLASS "B" RIP RAP	0.215	0.068	0.062

GRASS LINED CHANNEL HAS A RETARDANCE CLASS "C" (PG. 8.05.8)

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DRAINAGE AREA

CALCULATIONS

CALCULATION

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CLIENT HARNETT CO.
SUBJECT EVALUATION OF DRAINAGE STRS.

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REMARKS

SLOPE DRAIN SYSTEM (CULVERT) CHECK

DRAINAGE AREA (A)

AREA = 157,945 ft^2 = 3.63 acres
C = 0.35 (ASSUME FOR ALL GRASS)
ΣCA = 1.27

ΔH = 311 − 284 = 27' L = 750'
$T_c = \left(L^3/\Delta H\right)^{0.385} \div 128 = 4.59$ min.
$i_{10} = 7.8 \frac{in}{hr.}$

$Q_{10} = \Sigma CAI = (1.27)(7.8) = \underline{\underline{9.91 \text{ cfs}}}$

DRAINAGE AREA (B) (INCLUDES DRAINAGE AREA (A))

AREA = 157,945 + 142,135 = 300,080 ft^2 = 6.89 ac.
C = 0.35
ΣCA = 2.41

ΔH = 311 − 278 = 33' L = 920'
$T_c = \left(920^3/33\right)^{0.385} \div 128 = 5.39$ min.
$i_{10} = 7.6 \frac{in}{hr.}$

$Q_{10} = (2.41)(7.6) = \underline{\underline{18.31 \text{ cfs}}}$

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SUBJECT EVALUATION OF DRAINAGE STRS.

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REMARKS

DRAINAGE AREA (C)

AREA = 125,240 ft^2 = 2.88 acres
C = 0.35
ΣCA = 1.01

ΔH = 297 − 237 = 60' L = 730'
$T_c = \left(\frac{730^3}{60}\right)^{0.385} \div 120 = 3.28$ min.
i_{10} = 7.8 in/hr.

$Q_{10} = (1.01)(7.8) = \underline{\underline{7.88 \text{ cfs}}}$

DRAINAGE AREA (D)

AREA = 247,535 ft^2 = 5.68 acres
C = 0.35
ΣCA = 1.99

ΔH = 311 − 290 = 21' L = 1050'
$T_c = \left(\frac{1050^3}{21}\right)^{0.385} \div 120 = 7.5$ min.
$i_{10} = 6.9 \frac{in}{hr}$

$Q_{10} = (1.99)(6.9) = \underline{\underline{13.73 \text{ cfs}}}$

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SUBJECT EVALUATION OF DRAINAGE STRUCTURES

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REMARKS

DRAINAGE AREA (E)

AREA = 84165 ft^2 = 1.93 acres
C = 0.35
ΣCA = 0.68

ΔH = 298 - 280 = 18'' L = 470'

$T_c = \left(\frac{470'}{18}\right)^{0.385} \div 12.8 = 3.14$ minutes

i_{10} = 7.8 in/hr

$Q_{10} = \Sigma CA I = 0.68(7.8) = \underline{\underline{5.30 \text{ cfs}}}$

DRAINAGE AREA (F)

AREA = 60295 ft^2 = 1.38 acres
C = 0.35
ΣCA = 0.48

ΔH = 340 - 315 = 25' L = 400'

$T_c = \left(\frac{400'}{25}\right)^{0.385} \div 12.8 = 2.3$ minutes

i_{10} = 7.8 in/hr

$Q_{10} = \Sigma CA I = (0.48)(7.8) = \underline{\underline{3.75 \text{ cfs}}}$

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CALCULATION

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SUBJECT EVALUATION OF DRAINAGE STRUCTURES

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REMARKS

DRAINAGE AREA (G)

AREA = 110 825 ft^2 = 2.55 acres
C = 0.35
ΣCA = 0.89

ΔH = 336 − 311 = 25' L = 1200'

$T_c = \left(\frac{1200'}{25}\right)^{0.385} \div 128 = 8.15$ minutes

$i_{10} = 6.8 \frac{in}{hr}$

$Q = \Sigma CA\,I = (0.89)(6.8) = \underline{6.05 \text{ cfs}}$

DRAINAGE AREA (H) (INCLUDES (G))

AREA = 110,825 + 53,320 = 164,145 ft^2 = 3.77 acres
C = 0.35
ΣCA = 1.32

ΔH = 336 − 293 = 43' L = 1650'

$T_c = \left(\frac{1650'}{43}\right)^{0.385} \div 128 = 9.55$ minutes

$i_{10} = 6.5 \frac{in}{hr}$

$Q = \Sigma CA\,I = (1.32)(6.5) = \underline{8.58 \text{ cfs}}$

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CALCULATION

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REMARKS

DRAINAGE AREA (I)

AREA = 74,555 ft^2 = 1.71 acres
C = 0.35
ΣCA = 0.60

ΔH = 323 − 314 = 9 FT L = 450'
$T_c = \left(\frac{450'}{9}\right)^{0.385} \div 128 = 3.89$ min.
$i_{10} = 7.8 \frac{in}{hr.}$

$Q = \Sigma CA\,I = (0.60)(7.8) = \underline{4.68}$ cfs

DRAINAGE AREA (J) (INCLUDES (I))

AREA = 74,555 + 79,050 = 153,605 ft^2 = 3.53 acres
C = 0.35
ΣCA = 1.24

ΔH = 323 − 295 = 28 FT L = 500' (CONS.)
$T_c = \left(\frac{500'}{28}\right)^{0.385} \div 128 = 2.84$ minutes
$i_{10} = 7.8 \frac{in}{hr.}$

$Q = \Sigma CA\,I = (1.24)(7.8) = \underline{9.67}$ cfs

DRAINAGE AREA (K) (INCLUDES (G), (H), (I) & (J))

AREA = 164,145 + 153,605 + 32,000 = 349,750 ft^2
= 8.03 acres
C = 0.35
ΣCA = 2.81

ΔH = 336 − 288 = 48' L = 1800'
$T_c = \left(\frac{1800'}{48}\right)^{0.385} \div 128 = 10.12$ minutes
$i_{10} = 6.2 \frac{in}{hr.}$
$Q = \Sigma CA\,I = (2.81)(6.2) = \underline{17.42}$ cfs

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REMARKS

DRAINAGE AREA (L) (INCLUDES (G), (H), (I), (J), (K))

AREA = 349,750 + 7130 = 8.19 acres

C = 0.35

$\Sigma CA = (0.35)(8.19) = 2.87$

$\Delta H = 336 - 284 = 52'$ $L = 1900'$

$T_c = \left(\frac{1900^3}{52}\right)^{0.385} \div 128 = 10.45$ min

$i_{10} = 6.2 \frac{in}{hr}$

$Q = (2.87)(6.2) = \underline{17.79 \text{ cfs}}$

DRAINAGE AREA (M)

AREA = 74,440 ft^2 = 1.71 acres

C = 0.35

$\Sigma CA = 0.60$

$\Delta H = 311 - 290 = 21'$ $L = 700'$

$T_c = \left(\frac{700^3}{21}\right)^{0.385} \div 128 = 4.68$ minutes

$i_{10} = 7.8 \frac{in}{hr}$

$Q = (0.60)(7.8) = \underline{4.68 \text{ cfs}}$

DRAINAGE AREA (N) (INCLUDES (M))

AREA = 74,440 + 126,480 = 200,920 ft^2 = 4.61 acres

C = 0.35

$\Sigma CA = (0.35)(4.61) = 1.61$

$\Delta H = 311 - 276 = 35'$ $L = 880'$

$T_c = \left(\frac{880^3}{35}\right)^{0.385} \div 128 = 5.0$ minutes

$i_{10} = 7.8 \frac{in}{hr}$

$Q = \Sigma CA\, I = (1.61)(7.8) = \underline{12.56 \text{ cfs}}$

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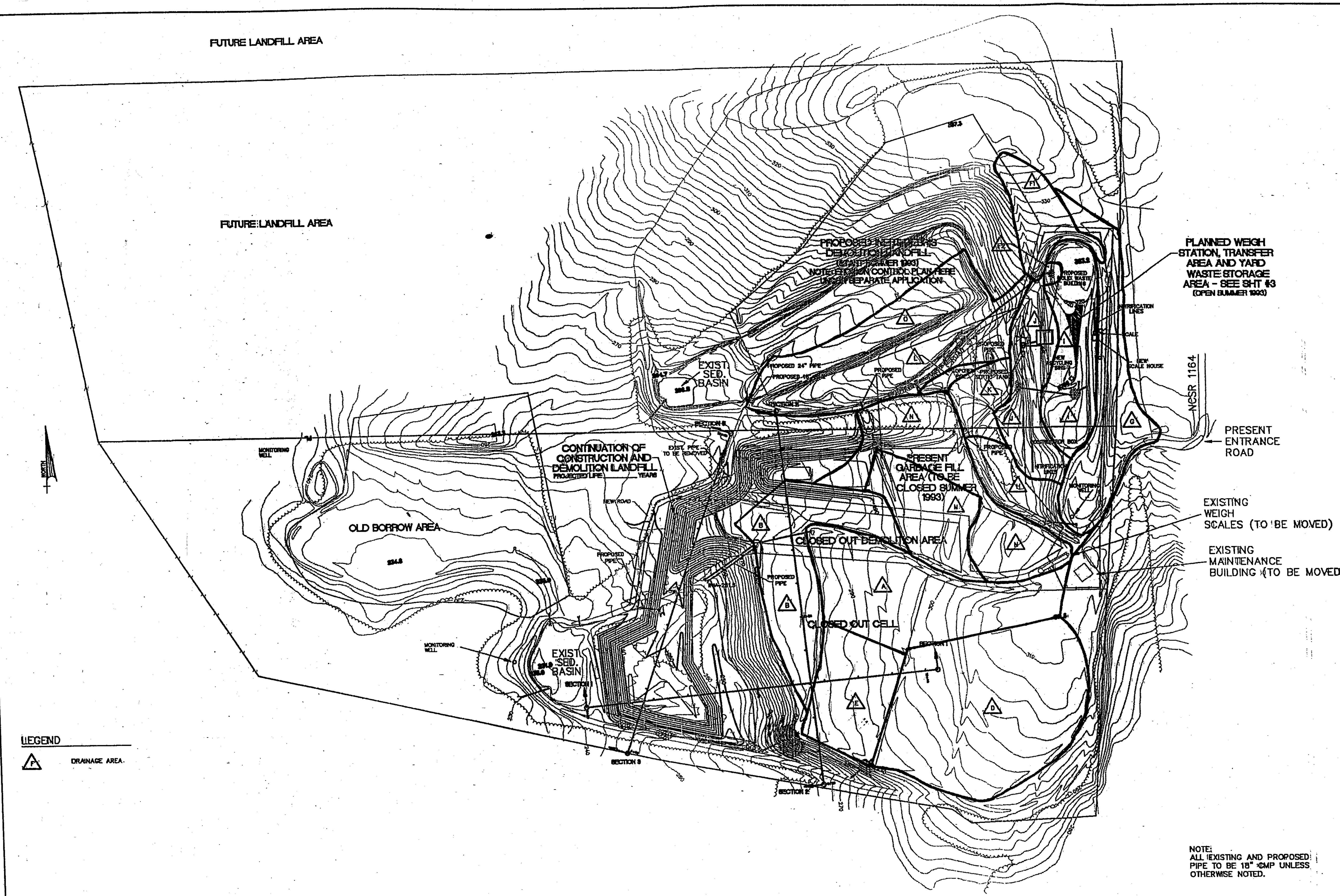

LEGEND

DRAINAGE AREA.

NOTE:
ALL EXISTING AND PROPOSED PIPE TO BE 18" CMP UNLESS OTHERWISE NOTED.

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ANDERSON CREEK LANDFILL

CLOSURE AND EROSION CONTROL PLAN

SHEET NO. 1

CALCULATION

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REMARKS

DRAINAGE AREA (D) (INCLUDES (F) THROUGH (N))

AREA = 60295 (F) + 356880 (G THRU L) + 200920 (M, N) + 191425

= 809,520 ft² = 18.58 acres

C = 0.35

$\Sigma CA = (18.58)(0.35) = 6.50$

$\Delta H = 340 - 266 = 74'$ (USE MAIN TRIBUTARY)

$L = 1350'$

$T_c = \left(\frac{1350^3}{74}\right)^{0.385} \div 120 = 6.15$ minutes

$i_{10} = 7.1 \frac{in}{hr}$

$Q = \Sigma CAI = 6.50(7.1) = \underline{\underline{46.15 \text{ cfs}}}$

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OUTLET

PROTECTION CALCULATIONS

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REMARKS

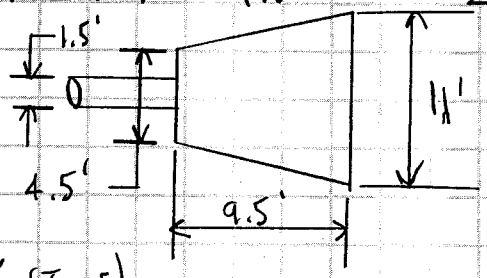
HEADWATER ANALYSIS & OUTLET STONE SIZING

- USE PIPE DIA = 18" & CMP FOR ALL PIPES
- USE TYPE 3 INLET CONTROL

PIPE #1 (DRAINAGE AREA "A")

$Q = 9.91$ cfs $D_o = 18"$ $\frac{HW}{D} = 1.7$ $HW = 2.55 > 2$

$\therefore L_a = 9.5^{FT}$
$W = 1.5 + 9.5 = 11^{FT}$



$d_{50} = 0.3^{FT} = 3.6"$
(USE CLASS "A" STONE)

PIPE #2 (DRAINAGE AREA "B")

$Q = 18.31$ cfs $D_o = 18"$ $\frac{HW}{D} = 4.5'$ $HW = 6.75'$
FOR 2 PIPES: $Q = 9.15$ cfs ; $HW = 2.27$ (from Printout)
$\therefore L_a = 16'$
$W = 16 + 1.5 = 17.5'$

$d_{50} = 0.6^{FT} = 7.2"$ (USE CLASS "B" STONE)

FOR 2 PIPES: $Q = 9.16$ cfs $D_o = 18"$ $\frac{HW}{D} = 1.51$ $HW = 2.27$
$\therefore L_a = 9.5'$ $W = 1.5 + 9.5 = 11'$
$d_{50} = 0.3' = 3.6"$ (USE CLASS "A" STONE @ BOTH PIPES)

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REMARKS

PIPE #3 (DRAINAGE AREA "C")

$Q = 7.88$ cfs $D_o = 18''$ $\frac{HW}{D} = 2.90$ $HW = 1.99$

$\therefore L_a = 9.5$ FT.

$W = 1.5 + 9.5 = 11^{FT}$

$d_{50} = 0.3^{FT.} = 3.6''$ USE CLASS "A" STONE

PIPE #4 (DRAINAGE AREA "D")

$Q = 13.73$ cfs $D_o = 18''$ $\frac{HW}{D} = 2.8$ $HW = 4.20 > 2.0$

$\therefore L_a = 12$ FT.

$W = 1.5 + 12 = 13.5^{FT}$

$d_{50} = 0.4^{FT} = 4.8''$ USE CLASS "B" STONE

PIPE #5 (DRAINAGE AREA "E")

$Q = 5.30$ cfs $D_o = 18''$ $\frac{HW}{D} = 0.95$ $HW = 1.43 < 2.0$

$\therefore L_a = 9.5^{FT}$

$W = 1.5 + 9.5 = 11^{FT}$

$d_{50} = 0.3^{FT} = 3.6''$ USE CLASS "A" STONE

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REMARKS

PIPE #6 (DRAINAGE AREA "F")

$Q = 3.75$ cfs $D_o = 18''$ $\frac{HW}{D} = 0.75$ $HW = 1.13' < 2$

$\therefore L_a = 9.5$ FT
$W = 9.5 + 1.5 = 11$ FT

$d_{50} = 0.3$ FT $= 3.6''$ USE CLASS "A" STONE

PIPE #7 (DRAINAGE AREA "G")

$Q = 6.05$ cfs $D_o = 18''$ $\frac{HW}{D} = 1.05$ $HW = 1.58'$

$\therefore L_a = 9.5$ FT
$W = 9.5 + 1.5 = 11$ FT

$d_{50} = 0.3$ FT $= 3.6''$ USE CLASS "A" STONE

PIPE #8 (DRAINAGE AREA "H")

$Q = 8.58$ cfs $D_o = 18''$ $\frac{HW}{D} = 1.46$ $HW = 2.19 > 2$

$\therefore L_a = 9.5$ FT
$W = 9.5 + 1.5 = 11$ FT

$d_{50} = 0.3$ FT $= 3.6''$ USE CLASS "A" STONE

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REMARKS

PIPE #9 (DRAINAGE AREA "I")

$Q = 4.68$ cfs $D_o = 18''$ $\frac{HW}{D} = 0.88$ $HW = 1.32 < 2$

$\therefore L_a = 9.5'$ $W = 11'$ $d_{50} = 3.6''$ (USE CLASS "A" STONE)

PIPE #10 (DRAINAGE AREA "J")

$Q = 9.67$ cfs $D_o = 18''$ $\frac{HW}{D} = 1.6$ $HW = 2.4 > 2$

$\therefore L_a = 9.5'$ $W = 11'$ $d_{50} = 3.6''$ (USE CLASS "A" STONE)

PIPE #11 (DRAINAGE AREA "K")

$Q = 17.42$ cfs $D_o = 18''$ $\frac{HW}{D} = 4.0$ $HW = 6.0$ **

FOR 2 PIPES: $Q = 8.7$ cfs $HW = 2.15'$ (FROM PRINTOUT)

$L_a = 15'$ $W = 15 + 1.5 = 16.5'$

$d_{50} = 0.4' = 4.8''$ (USE CLASS "B" STONE)

PIPE #12 (DRAINAGE AREA "L")

$Q = 17.79$ cfs $D_o = 18''$ $\frac{HW}{D} = 4.1$ $HW = 6.15$

FOR 2 PIPES: $Q = 8.9$ cfs; $HW = 2.18'$ (FROM PRINTOUT)

$L_a = 15'$ $W = 16.5'$ $d_{50} = 4.8''$ (USE CLASS "B" STONE)

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REMARKS

PIPE #13 (DRAINAGE AREA (M))

$Q = 4.68$ cfs $D_o = 18''$ $\frac{HW}{D} = 0.88$ $HW = 1.32 < 2$

$\therefore L_a = 9.5'$ $W = 11'$ $d_o = 3.6''$ (USE CLASS "A" STONE)

PIPE #14 (DRAINAGE AREA (N))

$Q = 12.56$ cfs $D_o = 18''$ $\frac{HW}{D} = 2.4$ $HW = 3.6 > 2$

$\therefore L_a = 12'$ $W = 12 + 1.5 = 13.5$ FT

$d_{50} = 0.4$ FT $= 4.8''$ (USE CLASS "B" STONE)

PIPE #15 (DRAINAGE AREA (O))

2-18": $Q = 12.2$ cfs $D_o = 18''$ $\frac{HW}{D} = 2.30$ $HW = 3.45$

$L_a = 11.5'$ $W = 11.5 + 1.5 = 13'$ $d_{50} = 0.38' = 4.6''$ (USE CLASS "B" STONE)

1-24": $Q = 21.7$ cfs $D_o = 24''$ $\frac{HW}{D} = 1.85$ $HW = 3.71'$

$L_a = 14'$ $W = 14 + 2 = 16'$ $d_{50} = 0.42' = 5.1''$ (USE CLASS "B" STONE)

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DRAINAGE DITCH

STABILITY

CALCULATIONS

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REMARKS

Ⓐ CHECK SLOPE STABILITY FOR DITCHES → DRAINAGE AREA Ⓐ

① DRAINAGE DITCH (A1) : AT PIPE ENTRANCE

AREA = 42,000 ft^2 = 0.96 acres C = 0.35 (For all calcs)

$\Sigma CA = 0.34$

$\Delta H = 298 - 284 = 14'$ $L = 570'$

$T_c = \left(\frac{570^3}{14}\right)^{0.385} \div 128 = 4.3$ min. $i_{10} = 7.8$ in/hr.

$Q = \Sigma CAI = (0.34)(7.8) = \underline{2.65 \text{ cfs}}$

SLOPE = $\frac{2'}{260'}$ = 0.77% Bottom Width = 0

SIDESLOPES (H/V) : USE 3:1 CONS

n = .030 (Malcolm - Elements of Urban Stormwater Design

FROM CALCS: $V = 2.0 \frac{ft}{sec} < 2.5 \frac{ft}{sec}$; $D = 0.66'$; LWS = 3.98'

GRASS LINED (OK)

② DRAINAGE DITCH (A2) AT PIPE ENTRANCE

AREA = 3.63 - 0.96 = 2.67 acres $\Sigma CA = 0.93$

$\Delta H = 311 - 284 = 27'$ $L = 750'$ $T_c = 4.59$ min.

$i_{10} = 7.8$ in/hr. $Q = (0.93)(7.8) = \underline{7.25 \text{ cfs}}$

SLOPE = $2'/30'$ = 6.67% Bottom Width = 2' ; 3:1 SIDESLOPES

FROM CALCS: $V = 5.55 \frac{ft}{sec}$; $D = 0.41'$; LWS = 4.44'

(USE RIP RAP)

$T = (62.4)(0.41)(.0667) = 1.71$

USE CLASS "A" RIP RAP

CHECK DEPTH W/ RIP RAP

MAX. $D = 2.5/62.4(.0667) = 0.60'$

USING n = .054 & Q = 7.25 cfs ; S = .0667 ; 3:1)

FROM CALC: DEPTH = 0.55 < 0.60' ∴ OK

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CALCULATION

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REMARKS

(A) SLOPE STABILITY → DRAINAGE AREA (A) [Cont'd]

(J) DRAINAGE DITCH (A3) 100' FROM PIPE ENTRANCE

AREA = 40300 ft^2 = 0.93 acres $\Sigma CA = 0.33$

$\Delta H = 311 - 289 = 22'$ $L = 650'$ ∴ $T_c = 4.22$ minutes

$i_{10} = 7.8$ in/hr. $Q = (0.33)(7.8) = \underline{2.57 \text{ cfs}}$

SLOPE = $\frac{2'}{50'}$ = 4.00% Bottom Width = 2' ; 3:1

FROM CALCS: $V = 3.42 \frac{ft}{sec}$; $D = 0.27'$; LWS = 3.60'
(USE LINER)

$T = 62.4(0.27')(0.04) = 0.67 < 1.45$ (USE STRAW W/NET)

MAX. D = $1.45 / 62.4(0.04) = 0.58'$

USING n = .065 (CONS.) DEPTH = 0.40' < 0.58 ∴ OK
and $V = 1.98 \frac{ft}{sec}$; LWS = 4.42'

CHECKING STABILITY

$V = 1.98$ fps $R = A/P = 0.89 / 4.49 = 0.20$ $VR = 0.38$

USING CURVE "C" n = 0.16

∴ $V = 1.03$ ft/sec ; D = 0.64' ✓OK
< 4.5

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REMARKS

(A) DRAINAGE AREA (A) [Con'td]

(4) DRAINAGE DITCH (A3) 300' FROM PIPE ENTRANCE

AREA = 29915 ft^2 = 0.69 acres $\Sigma CA = 0.24$

$\Delta H = 311 - 296 = 15'$ $L = 450'$ $T_c = 3.2$ min $i_{10} = 7.8$ in/hr.

$Q = (0.24)(7.8) = \underline{\underline{1.87 \text{ cfs}}}$ $n = .03$

SLOPE $= \frac{2'}{50'} = 4.00\%$ Bot. Width = 2' 3:1

FROM CALCS: $V = 3.10 \frac{ft}{sec}$ $D = 0.23'$ LWS = 3.35'

(USE LINER)

$T = 62.4(0.23)(0.04) = 0.58 < 1.45$ (USE STRAW W/NET)

MAX $D = 1.45/62.4(0.04) = 0.58'$

USING $n = .065$; DEPTH = 0.34' < 0.58'

$V = 1.81 \frac{ft}{sec}$; LWS = 4.05'

CHECKING STABILITY

$V = 1.81 \frac{ft}{sec}$ $R = A/P = 0.69/4.11 = 0.17$

$VR = 0.31$

USING CURVE "C"; $n = 0.19$

$\therefore V = \underset{<4.5}{0.84} \text{ ft/sec}$; $D = 0.59'$

→ USE STRAW W/ NET FOR REMAINDER OF DITCH (A3)

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REMARKS

(A) DRAINAGE AREA (A) [Cont'd]

(5) DRAINAGE DITCH (A4) 100' FROM PIPE ENTRANCE

AREA = 74,710 ft² = 1.72 acres ΣCA = 0.60
ΔH = 311 − 289 = 22' L = 800' T_c = 5.36 minutes
i_{10} = 7.6 in/hr. Q = (0.60)(7.6) = 4.56 cfs

SLOPE = 2'/60' = 3.33% Bottom Width = 0' USE 3:1

FROM CALCS: V = 3.98 ft/sec D = 0.62' LWS = 3.70'
(USE LINER)
T = (62.4)(0.62')(0.033) = 1.29 < 1.45
(USE STRAW W/ NET)

MAX. D = 1.45/62.4 (.033) = 0.70'
USING n = .033 DEPTH = 0.64' ≈ 0.62 ∴ OK
V = 3.71 ft/sec LWS = 3.84'

CHECKING STABILITY
V = 3.71 ft/sec R = A/P = 1.23/4.05 = 0.30
VR = 1.11
W/ CURVE "C"; n = 0.19
∴ V = 1.00 ft/sec D = 1.23'

CHECK W/ 4:1 SLOPES
V = 0.94 ft/sec D = 1.10'
< 4.5
(PER CONTOURS; DEPTH SHOULD BE O.K.)

USE STRAW W/ NET FOR REMAINDER OF DITCH (A4)

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REMARKS

(B) SLOPE STABILITY → DRAINAGE AREA (B)

(1) DRAINAGE DITCH (B1) AT PIPE ENTRANCE

AREA = 66,495 ft^2 = 1.53 acres $\Sigma CA = 0.54$

$\Delta H = 284 - 278 = 6'$ $L = 500'$ $T_c = 5.13$ minutes $n = .033$

$i_{10} = 7.8$ in/hr $Q = (0.54)(7.8) = \underline{4.21 \text{ cfs}}$

SLOPE $= \frac{2'}{100'} = 2\%$ Bottom Width = 0' USE 3:1

FROM CALCS: $V = 3.23 \frac{ft}{sec}$ $D = 0.66'$ LWS = 3.96'
(USE LINER)

$T = (62.4)(0.66)(0.02) = 0.82 < 1.45$
(USE STRAW W/ NET)

MAX. $D = 1.45 / 62.4(.02) = 1.16'$

USING $n = .033$ DEPTH = 0.68' < 1.16' ∴ OK
$V = 3.00 \frac{ft}{sec}$. LWS = 4.10

CHECKING STABILITY

$V = 3.00 \frac{ft}{sec}$. $R = A/P = 1.39/4.32 = 0.32$
$VR = 0.96$

W/ CURVE "C" $n = 0.085$

∴ $V = 1.48 \frac{ft}{sec}$. $D = 0.98'$
< 4.5

(PER CONTOURS; DEPTH SHOULD BE O.K.)

USE STRAW W/ NET FOR REMAINDER OF DITCH (B1)

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REMARKS

(B) DRAINAGE AREA (B) [Cont'd]

(2) DRAINAGE DITCH (B2) AT PIPE ENTRANCE

AREA = 68,665 ft^2 = 1.73 acres $\Sigma CA = 0.61$

$\Delta H = 294 - 278 = 16'$ $L = 450'$ $t_c = 3.12$ minutes

$i_{10} = 7.8 \frac{in}{hr.}$ $Q = (0.61)(7.8) = \underline{4.76 \text{ cfs}}$

SLOPE = $\frac{1'}{100'}$ = 1% Bottom Width = 0 USE 3:1

FROM CALCS: $V = 2.56 \frac{ft}{sec.}$ $D = 0.79'$ LWS = 4.72'
(USE LINER)

$T = (62.4)(0.79)(0.01) = 0.49 < 1.45$
(USE STRAW W/ NET)

MAX. $D = 1.45 / (62.4)(.01) = 2.32$

USING $n = .033$ DEPTH = $0.82' < 2.32'$

$V = 2.39 \frac{ft}{sec.}$ LWS = 4.89'

CHECKING STABILITY

$V = 2.39 \frac{ft}{sec.}$ $R = A/P = 2.01/5.16 = 0.39$

$VR = 0.93$

W/ CURVE "C" $n = 0.085$

$\therefore V = 1.17 \frac{ft}{sec.}$ $D = 1.46'$ (TRY TO KEEP $D \pm 1'$)
< 4.5

✓ CHECK W/ 3:1 SLOPES & 2' BOTTOM WIDTH

$V = 1.16 \frac{ft}{sec}$ $D = 0.88$ (O.K.)
< 4.5

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REMARKS

(D) SLOPE STABILITY → DRAINAGE AREA (D)

(1) DRAINAGE DITCH (D1) AT PIPE ENTRANCE

AREA = 195,300 ft² = 4.48 ac. ΣCA = 1.57

ΔH = 311 − 290 = 21' L = 1050' T_c = 7.5 mins

i_{10} = 6.9 in/hr. Q = (1.57)(6.9) = 10.83 cfs (n = .03)

SLOPE = 2'/70' = 2.86% Bottom Width = 2' USE 3:1

FROM CALC: V = 4.57 ft/sec, D = 0.62' LWS = 5.70'
(USE RIP RAP)

T = (62.4)(0.62)(.0286) = 1.11 < 2.50
USE CLASS "A" RIP RAP

CHECK DEPTH OF RIP RAP

MAX. D = 2.5/62.4 (.0286) = 1.40

USING n = .054 & Q = 10.83 cfs; S = 2.86%; 3:1)

FROM CALC, DEPTH = 0.82' < 1.40' ∴ OK

V = 2.97 ft/sec < 4.5 ft/sec

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REMARKS

(17) DRAINAGE AREA (D) [Cont'd]

(2) DRAINAGE DITCH (D2) 200' FROM PIPE ENTRANCE

AREA = 157,635 ft^2 = 3.62 acres $\Sigma CA = 1.27$

$\Delta H = 311 - 294 = 17'$ $L = 850'$ $T_c = 6.35$ minutes

$i_{10} = 7.0 \frac{in}{hr.}$ $Q = (1.27)(7.0) = \underline{8.89 \text{ cfs}}$

SLOPE = $\frac{2'}{100'} = 2\%$ Bottom Width = 2' 3:1

FROM CALCS: $V = 3.80 \frac{ft}{sec.}$ $D = 0.61'$ LWS = 5.66'
(USE LINER)

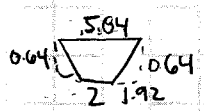
$T = (62.4)(0.61')(0.02) = 0.76 < 1.45$
(USE STRAW W/ NET)

MAX. D = $1.45 / (62.4)(0.02) = 1.16$

USING $n = 0.033$ DEPTH = 0.64' < 1.16'

$V = 3.54 \frac{ft}{sec.}$ LWS = 5.84'

CHECKING STABILITY



$V = 3.54 \frac{ft}{sec.}$ $R = A/P =$

$= 2.51 / 6.05 = 0.42$

$VR = 1.47$

W/ CURVE "C" $n = 0.068$

$\therefore V = 2.08 \frac{ft}{sec} < 4.5$ $D = 0.91'$ O.K.

USE STRAW W/ NET 200' FROM PIPE ENTRANCE

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(D) DRAINAGE AREA (D) [(Cont'd)]

(3) DRAINAGE DITCH (D2) 450' FROM PIPE ENTRANCE

AREA = 43,425 Ft^2 = 0.99 acre $\Sigma CA = 0.35$

$\Delta H = 311 - 299 = 12'$ $L = 600'$ $T_c = 4.85$ min.

$i_{10} = 7.8 \frac{in}{hr.}$ $Q = (0.35)(7.8) = \underline{\underline{2.73 \text{ cfs}}}$

SLOPE = $\frac{2'}{100'} = 2\%$ Bottom Width = 2' 3:1

FROM CALCS: $V = 2.73 \frac{ft}{sec.}$ $D = 0.33'$ LWS = 4.00'
(USE LINER)

$T = (62.4)(0.33')(.02) = 0.41' < 1.45$ (USE STRAW W/NET)

MAX. $D = 1.45 / 62.4(.02) = 1.16'$

USING $n = .065$ DEPTH = 0.50' < 1.16'

$V = 1.57 \frac{ft}{sec}$ LWS = 4.99' (5.0')

CHECKING STABILITY: $V = 1.57 \frac{ft}{sec}$

$R = A/P = \frac{1.75}{5.16}$

$= 0.34$ $VR = 0.53$

W/ CURVE "C" $n = 0.13$

$\therefore V = 0.95 \frac{ft}{sec.}$ $D = 0.70$ O.K.

USE STRAW W/ NET 450' FROM PIPE ENTRANCE IN DITCH (D2)

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REMARKS

(D) DRAINAGE AREA (D) [Cont'd]

(4) DRAINAGE DITCH (D2) 680' FROM PIPE ENTRANCE

AREA = 22,475 ft^2 = 0.52 acres $\Sigma CA = 0.18$

$H = 311 - 303 = 8'$ $L = 400'$ $T_c = 3.56$ min

$i_{10} = 7.8 \frac{in}{hr}$ $Q = (0.18)(7.8) = \underline{1.40 \text{ cfs}}$

SLOPE $= \frac{2'}{80'} = 2.5\%$ Bottom Width = 2' 3:1

FROM CALCS: $V = \underline{2.42 \frac{ft}{sec}}$ $D = 0.22'$ LWS = 3.31'

GRASS LINED O.K.

(USE GRASS LINED FROM THIS POINT UP; STRAW W/ NET BELOW)

(5) DRAINAGE DITCH (D3) 450' FROM PIPE ENTRANCE AT JCT.

AREA = 81,065 ft^2 = 1.86 ac. $\Sigma CA = 0.65$

$H = 311 - 299 = 12'$ $L = 600'$ $t_c = 4.85$ min.

$i_{10} = 7.8 \frac{in}{hr}$ $Q = (0.65)(7.8) = \underline{5.08 \text{ cfs}}$

SLOPE $= \frac{2'}{100'} = 2\%$ Bottom Width = 2' 3:1

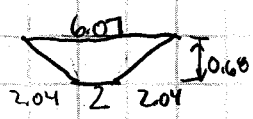
FROM CALCS: $V = 3.26 \frac{ft}{sec}$ $D = 0.46'$ LWS = 4.77'

USE LINER: $T = 62.4(0.46)(.02) = 0.57 < 1.45$ (USE STRAW W/ NET)

MAX. D = 1.16

USING $n = .065$; DEPTH = 0.68'

$V = 1.86 \frac{ft}{sec}$ LWS = 6.07'



CHECKING STABILITY: $V = 1.86 \frac{ft}{sec}$ $R = A/P = \frac{2.74}{6.30} = 0.44$

$VR = 0.82$

W/ CURVE "C" $n = 0.093$

$\therefore V = 1.43 \frac{ft}{sec} < 4.5$ $D = 0.81'$ $\therefore$ OK

USE STRAW W/ NET FOR ALL OF DRAINAGE DITCH (D3)

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REMARKS

(D) DRAINAGE AREA (D) [Cont'd]

(6) DRAINAGE DITCH (D4) 250' FROM PIPE ENTRANCE @ JCT.

AREA = 15,500 ft^2 = 0.36 acres $\Sigma CA = 0.13$

$H = 304 - 294 = 10'$ $L = 250'$ $t_c = 1.89$ min

$i_{10} = 7.8 \frac{in}{hr.}$ $Q = (0.13)(7.8) = \underline{1.01 \text{ cfs}}$

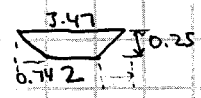
SLOPE = $\frac{2'}{50'} = 4\%$ BOTTOM WIDTH = 2' 3:1

FROM CALCS: $V = 2.56 \frac{ft}{sec.}$ $D = 0.16'$ LWS = 2.96'
(USE LINER)

$T = (62.4)(0.16')(.04) = 0.40' < 1.45$ (USE STRAW W/ NET)

MAX $D = 1.45/62.4(.04) = 0.58'$

USING $n = .065$: DEPTH = 0.25' < 0.58'
$V = 1.51 \frac{ft}{sec}$ LWS = 3.47'



CHECKING STABILITY

$V = 1.51 \frac{ft}{sec.}$ $R = A/P = \frac{0.68}{3.56} = 0.19$
$VR = 0.29$

W/ CURVE "C" $n = 0.20$

$\therefore V = 0.68 \frac{ft}{sec} < 4.5$ $D = 0.45'$ $\therefore$ OK

USE STRAW W/ NET IN DITCH (D4)

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REMARKS

(D) DRAINAGE AREA (D) [Cont'd]

(7) DRAINAGE DITCH (D5) AT PIPE ENTRANCE

AREA = 52,700 ft^2 = 1.21 acres $\Sigma CA = 0.42$

$\Delta H = 310 - 290 = 20'$ $L = 600'$ $T_c = 3.99$ min

$i_{10} = 7.8$ in/hr. $Q = (0.42)(7.8) = \underline{\underline{3.28 \text{ cfs}}}$

SLOPE = $\frac{2'}{50'} = 4\%$ Bottom Width = 2' USE 3:1

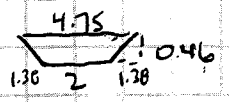
FROM CALCS: $V = 3.68 \frac{ft}{sec}$ $D = 0.31'$ LWS = 3.83'
(USE LINER)

$T = (62.4)(0.31)(.04) = 0.77 < 1.45$ (USE STRAW W/ NET)

MAX. $D = 1.45/(62.4)(.04) = 0.58$

USING $n = .065$; DEPTH = 0.46' < 0.58'
$V = 2.12 \frac{ft}{sec}$ LWS = 4.75'

CHECKING STABILITY



$V = 2.12 \frac{ft}{sec}$ $R = A/P = 1.55/4.90 = 0.32$
$VR = 0.68$

W/ CURVE "C" $n = 0.11$

$\therefore V = 1.45 \frac{ft}{sec} < 4.5$ $D = 0.60'$ $\therefore$ OK

USE STRAW W/ NET IN DITCH (D5)

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(E) SLOPE STABILITY → DRAINAGE AREA (E)

(1) DRAINAGE DITCH (E1) AT PIPE ENTRANCE

AREA = 14,880 ft² = 0.34 acres ΣCA = 0.12
ΔH = 295 − 280 = 15' L = 240' t_c = 1.55 min
i_{10} = 7.8 in/hr Q = (0.12)(7.8) = 0.94 cfs

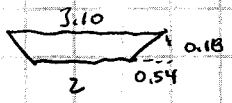
SLOPE = 2'/20' = 10% Bottom Width = 2' USE 3:1

FROM CALC: V = 3.39 ft/sec D = 0.12' LWS = 2.71'
(USE LINER)
T = 62.4 (0.12)(.10) = 0.75 < 1.45
USE STRAW W/ NET

MAX. D = 1.45/(62.4)(0.10) = 0.23'

USING n = .065; DEPTH = 0.18' < 0.23'
V = 2.02 ft/sec LWS = 3.10'

CHECKING STABILITY



V = 2.02 ft/sec R = A/P = 0.46/3.14 = 0.15
VR = 0.30

W/ CURVE "C" n = 0.19

∴ V = 0.96 ft/sec < 4.5 D = 0.33' ∴ OK

USE STRAW W/ NET IN DITCH (E1)

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(E) DRAINAGE AREA (E) (Cont'd)

(2) DRAINAGE DITCH (E2) AT PIPE ENTRANCE

AREA = 1.93 − 0.34 = 1.59 acres ΣCA = 0.56
ΔH = 298 − 280 = 18' L = 470' T_c = 3.14 minutes
i_{10} = 7.8 "/hr. Q = (0.56)(7.8) = 4.37 cfs

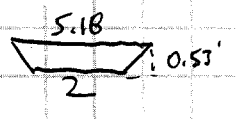
SLOPE = 2'/50' = 4% Bottom Width = 2' 3:1

FROM CALCS: V = 4.00 ft/sec D = 0.36' LWS = 4.14'
(USE LINER)
T = (62.4)(0.36)(.04) = 0.90 < 1.45
USE STRAW W/ NET

MAX. D = 1.45/62.4(.04) = 0.58'

USING n = .065 DEPTH = 0.53' < 0.58'
V = 2.36 ft/sec. LWS = 5.18'

CHECKING STABILITY



V = 2.30 ft/sec. R = A/P = 1.90/5.35 = 0.36
VR = 0.83
W/ CURVE "C" n = .092

∴ V = 1.78 ft/sec. < 4.5 D = 0.63' ∴ OK

USE STRAW W/ NET IN DITCH (E2)

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REMARKS

(E) SLOPE STABILITY → DRAINAGE AREA (E)

(1) DRAINAGE DITCH (F1) BEFORE PIPE ENTRANCE

AREA = 16,430 ft^2 = 0.38 ac. $\Sigma CA = 0.13$

$\Delta H = 341 - 316 = 25'$ $L = 350'$ $t_c = 1.96$ min

$i_{10} = 7.8 \frac{in}{hr}$ $Q = (0.13)(7.8) = \underline{1.01 \text{ cfs}}$ n=.03

SLOPE = $\frac{2'}{30'}$ = 6.67% Bottom Width = 0 3:1

FROM CALCS: V = 3.55 $\frac{ft}{sec}$. D = 0.31' LWS = 1.85'

USE LINER

$T = 62.4(.0667)(0.31) = 1.29 < 1.45$

USE STRAW W/ NET

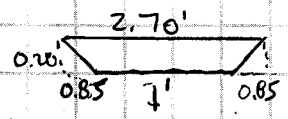
MAX. D = $1.45 / (62.4)(.0667) = 0.35'$

USING n = .065 DEPTH = 0.41' > 0.35'

USE BOTTOM WIDTH = 1' DEPTH = 0.28' < 0.35 ∴ OK

V = 1.93 $\frac{ft}{sec}$ LWS = 2.70'

CHECKING STABILITY



V = 1.93 $\frac{ft}{sec}$ $R = A/P = 0.52/2.79 = 0.19$

VR = 0.37

W/ CURVE "C" n = 0.17

∴ V = 0.95 $\frac{ft}{sec}$ < 4.5 D = 0.45' ∴ OK

USE STRAW W/ NET IN DITCH (F1)

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(F) DRAINAGE AREA (F) (Cont'd)

(2) DRAINAGE DITCH (F2) BEFORE PIPE ENTRANCE

AREA = 22,165 ft^2 = 0.51 ac. $\Sigma CA = 0.18$

$\Delta H = 340 - 316 = 24'$ $L = 200'$ $t_c = 1.05$ min

$i_{10} = 7.8 \frac{in}{hr.}$ $Q = (0.18)(7.8) = \underline{\underline{1.40 \text{ cfs}}}$

SLOPE = $\frac{2'}{30'}$ = 6.67% Bottom Width = 1' 3:1

FROM CALCS: $V = 3.70 \frac{ft}{sec.}$ $D = 0.23'$ LWS = 2.35'
(USE LINER)

$T = (62.4)(0.23)(.0667) = 0.96 < 1.45$
USE STRAW W/ NET

MAX. $D = 1.45 / (62.4)(.0667) = 0.35'$

USING $n = .065$ DEPTH = 0.33' < 0.35', ∴ OK
$V = 2.11 \frac{ft}{sec.}$ LWS = 3.00'

CHECKING STABILITY

$V = 2.11 \frac{ft}{sec.}$ $R = A/P = 0.66/3.11 = 0.21$
$VR = 0.44$

W/ CURVE "C" $n = 0.14$

∴ $V = 1.20 \frac{ft}{sec.} < 4.5$ $D = 0.48'$ ∴ OK

USE STRAW W/ NET IN DITCH (F2)

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(F) DRAINAGE AREA (F) (Cont'd)

(3) DRAINAGE DITCH (F3) BEFORE PIPE ENTRANCE

AREA = 9,610 ft^2 = 0.22 ac. $\Sigma CA = 0.08$

$\Delta H = 324 - 315 = 9'$ $L = 300'$ $t_c = 2.44$ min

$i_{10} = 7.8 \frac{in}{hr}$ $Q = (0.08)(7.8) = \underline{\underline{0.63 \text{ cfs}}}$

SLOPE = $\frac{2'}{50'} = 4\%$ Bottom Width = 1' 3:1

FROM CALCS: $V = 2.46 \frac{ft}{sec}$ $D = 0.17'$ LWS = 2.02'

(CLOSE USE LINER)

$T = (62.4)(0.17')(.04) = 0.42 < 1.45$

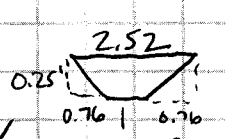
USE STRAW W/ NET

MAX. $D = 1.45 / (62.4)(.04) = 0.58'$

USING $n = .065'$ DEPTH = $0.25' < 0.58'$

$V = 1.41 \frac{ft}{sec}$ LWS = 2.52'

CHECKING STABILITY



$V = 1.41 \frac{ft}{sec}$ $R = A/P = 0.44/2.60 = 0.17$

$VR = 0.24$

W/ CURVE "C" $n = 0.25$

$V = 0.53 \frac{ft}{sec} < 4.5$ $D = 0.49'$ ∴ OK

USE STRAW W/ NET IN DITCH (F3)
AND IN REMAINING DITCH OF DRAINAGE DITCH AREA (F)

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CALCULATION

PROJECT AND. CREEK CLOSE OUT
CLIENT
SUBJECT DITCH CHECKS

PROJ. NO. 0009-1978.00
DATE 8/13/93
DES. BY TJE
CHK. BY

REMARKS

(G) SLOPE STABILITY → DRAINAGE AREA (G)

(D) DRAINAGE DITCH (G1) 70' FROM PIPE ENTRANCE

AREA = 76,105 ft^2 = 1.75 ac. $\Sigma CA = 0.61$

$\Delta H = 336 - 311 = 25'$ L = 1100' t_c = 7.37 minutes

$i_{10} = 6.9 \frac{in}{hr}$ Q = (0.61)(6.9) = 4.21 cfs

SLOPE = $\frac{2'}{100'}$ = 2% Bottom Width = 1' USE 3:1

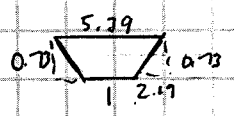
FROM CALCS: V = 3.20 $\frac{ft}{sec}$ D = 0.52' LWS = 4.10'
(USE LINER)

T = (62.4)(0.52')(.02) = 0.65 < 1.45
USE STRAW W/ NET

MAX. D = 1.45 / (62.4)(.02) = 1.16'

USING n = .065 DEPTH = 0.73'
V = 1.80 $\frac{ft}{sec}$ LWS = 5.39'

CHECKING STABILITY



V = 1.80 $\frac{ft}{sec}$ R = A/P = 2.33/5.62
= 0.41 VR = 0.74

W/ CURVE "C" n = 0.10

∴ V = 1.31 $\frac{ft}{sec}$ < 4.5 D = 0.88' ∴ OK

USE STRAW W/ NET IN DITCH (G1)

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CALCULATION

PROJECT AND. CREEK CLOSE OUT
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REMARKS

(6) DRAINAGE AREA (6) (Cont'd)

(2) DRAINAGE DITCH (62) 70' FROM PIPE ENTRANCE

AREA = 14570 ft^2 = 0.33 ac. $\Sigma CA = 0.12$

$\Delta H = 325 - 311 = 14'$ $L = 300'$ $t_c = 2.05$ minutes

$i_{10} = 7.8 \frac{in}{hr}$ $Q = (0.12)(7.8) = \underline{\underline{0.94 \text{ cfs}}}$

SLOPE = $\frac{2'}{50'} = 4\%$ Bottom Width = 1' 3:1

FROM CALCS: $V = 2.76 \frac{ft}{sec}$ $D = 0.21'$ LWS = 2.26'
(USE LINER)

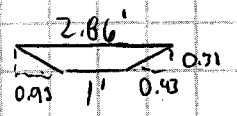
$T = (62.4)(0.21')(.04) = 0.52 < 1.45$

USE STRAW W/ NET

MAX. $D = 1.45/(62.4)(.04) = 0.58'$

USING $n = .065$ DEPTH = 0.31' < 0.58
$V = 1.57 \frac{ft}{sec}$ LWS = 2.86'

CHECKING STABILITY



$V = 1.57 \frac{ft}{sec}$ $R = A/P = 0.60/2.96 = 0.20$
$VR = 0.31$

W/ CURVE "C" $n = 0.19$

$\therefore V = 0.71 \frac{ft}{sec} < 4.5$ $D = 0.52'$ $\therefore$ OK

USE STRAW W/ NET IN DITCH (62)

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CALCULATION

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REMARKS

G DRAINAGE AREA G (Cont'd)

3 DRAINAGE DITCH G3 AT PIPE ENTRANCE (INCLS AREA FROM DITCH G1 AND G2)

AREA = 76,105 + 14,570 + 4805 = 95,480 ft^2 = 2.19 ac

$\Delta H = 336 - 308 = 28'$ $L = 1200'$ $t_c = 7.80$ min

$i_{10} = 6.8 \frac{in}{hr}$ $Q = (0.77)(6.8) = 5.24$ cfs

SLOPE = $\frac{2'}{120'}$ = 1.67% Bottom Width = 2' 3:1

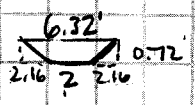
FROM CALCS: $V = 3.08 \frac{ft}{sec}$ $D = 0.49'$ LWS = 4.94'
(USE LINER)

$T = (62.4)(0.49')(.0167) = 0.51 < 1.45$
USE STRAW W/ NET

MAX. D = $1.45 / (62.4)(.0167) = 1.39'$

USING n = 0.065 DEPTH = 0.72' < 1.39'
$V = 1.75 \frac{ft}{sec}$ LWS = 6.32'

CHECKING STABILITY



$V = 1.75 \frac{ft}{sec}$ $R = A/P = 3.05/6.56 = 0.46$
VR = 0.81

W/ CURVE "C" n = .094

$\therefore V = 1.34 \frac{ft}{sec} < 4.5$ $D = 0.86' < 1$ $\therefore$ OK

USE STRAW W/ NET IN DITCH G3
(USE SAME IN DITCH G4)

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CALCULATION

PROJECT ANDERSON CREEK LANDFILL
CLIENT
SUBJECT DITCH CHECKS

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REMARKS

DRAINAGE AREA (6) (Cont'd)

(4) DRAINAGE DITCH (G1) ≈ 650' FROM PIPE ENTRANCE

AREA = 29,450 ft^2 = 0.68 ac $\Sigma CA = 0.24$

$\Delta H = 336 - 317 = 19'$ $L = 600'$ $t_c = 4.07$ min

$i_{10} = 7.8 \frac{in}{hr.}$ $Q = (0.24)(7.8) = \underline{\underline{1.87 \text{ cfs}}}$

SLOPE = $\frac{2'}{70'} = 2.86\%$ Bottom Width = 1' 3:1

FROM CALCS: $V = 2.95 \frac{ft}{sec}$ $D = 0.32'$ LWS = 2.93'

(USE LINER)

$T = (62.4)(0.32')(.0286) = 0.57 < 1.45$

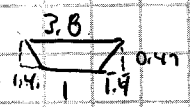
USE STRAW W/ NET

MAX $D = 1.45/(62.4)(.0286) = 0.81'$

USING $n = .065$; DEPTH = 0.47'

$V = 1.67 \frac{ft}{sec.}$ LWS = 3.80'

CHECKING STABILITY



$V = 1.67 \frac{ft}{sec.}$ $R = A/P = \frac{1.13}{3.95} = 0.29$

$VR = 0.48$

W/ CURVE "C" $n = 0.14$

$\therefore V = 0.94 \frac{ft}{sec} < 4.5$ $D = 0.66'$

USE STRAW W/ NET HERE

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CALCULATION

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REMARKS

(H) SLOPE STABILITY → DRAINAGE AREA (H)

(1) DRAINAGE DITCH (H1) AT PIPE ENTRANCE
(INCLUDES DRAINAGE AREA (G))

AREA = 3.77 acres $\Sigma CA = 1.32$
$\Delta H = 336 - 293 = 43'$ $L = 1650'$ $T_c = 9.55$ min.
$i_{10} = 6.5 \frac{in}{hr}$ $Q = (1.32)(6.5) = 8.58$ cfs

SLOPE $= \frac{2'}{100'} = 2\%$ (AVG.) Bottom Width = 1' 3:1

FROM CALCS: $V = 3.84 \frac{ft}{sec}$ $D = 0.71'$ LWS = 5.27'

CHECK 200' UPSTREAM

AREA = 3.77 − 0.48 = 3.29 ac. $\Sigma CA = 1.15$
$\Delta H = 336 - 297 = 39'$ $L = 1450'$ $T_c = 8.54$ min.
$i_{10} = 6.8 \frac{in}{hr}$ $Q = (1.15)(6.8) = 7.82$ cfs

SLOPE $= \frac{2'}{30'} = 6.67\%$ Bot. Width = 1' 3:1
FROM CALCS: $V = 5.86 \frac{ft}{sec}$ $D = 0.52'$ LWS = 4.12'
$> 4.5 \frac{ft}{sec}$

USE RIP-RAP FOR ALL OF DRAINAGE DITCH (H1)

USING $D = 0.71'$ (AT PIPE): $T = (62.4)(0.71)(.02) = 0.89 < 2.50$
$T = (62.4)(0.52)(.0667) = 2.16 < 2.50$
USE CLASS "A" RIP RAP

CHECKING DEPTH W/ RIP RAP

MAX. $D = 2.5/62.4(.02) = 2.00$
USING $n = .054$ & $Q = 8.58$ cfs; $S = 2\%$; 3:1
FROM CALC DEPTH = 0.92' < 2.00' ∴ OK
MAX. $D = 2.5/62.4(.0667) = 0.60'$
USING $n = .054$; $Q = 7.82$ cfs; $S = 6.67\%$, 3:1, 1' BOTTOM
FROM CALC. DEPTH = 0.68' > 0.60'

** W/ 2' BOTTOM: DEPTH = 0.57' < 0.60 ∴ OK

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CALCULATION

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REMARKS

(I) SLOPE STABILITY → DRAINAGE AREA (I)

(1) DRAINAGE DITCH (II) AT PIPE ENTRANCE

AREA = 1.71 acres $\Sigma CA = 0.60$

$\Delta H = 323 - 316 = 7$ FT $L = 400'$ $T_c = 3.74$ minutes

$i_{10} = 7.8 \frac{in}{hr.}$ $Q = (0.60)(7.8) = \underline{4.68 \text{ cfs}}$

SLOPE $= \frac{2'}{150'} = 1.33\%$ Bottom Width = 1' 3:1

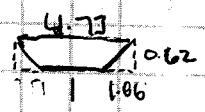
FROM CALCS: $V = 2.83 \frac{ft}{sec}$ $D = 0.60'$ LWS = 4.57'
(USE LINER)

$T = (62.4)(0.60')(.0133) = 0.50 < 1.45$
USE STRAW W/ NET

MAX. $D = 1.45/(62.4)(.0133) = 1.75'$

USING $n = .033$ DEPTH = 0.62' < 1.75'
$V = 2.63 \frac{ft}{sec}$ LWS = 4.73'

CHECKING STABILITY



$V = 2.63 \frac{ft}{sec}$ $R = A/P = 1.78/4.92 = 0.36$
$VR = 0.95$

W/ CURVE "C" $n = 0.086$

$\therefore V = 1.29 \frac{ft}{sec} < 4.5$ $D = 0.95' < 1$

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CALCULATION

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REMARKS

(J) SLOPE STABILITY → DRAINAGE AREA (J)

(1) DRAINAGE DITCH (J1) AT PIPE ENTRANCE
(INCLUDES DRAINAGE AREA (I))

AREA = 1.71 + 1.20 = 2.91 acres ∴ ΣCA = 1.02
ΔH = 323 − 295 = 28' L = 700' t_c = 4.19 min.
i_{10} = 7.8 in/hr. Q = (1.02)(7.8) = 7.96 cfs

SLOPE = 2'/20' = 10% Bottom Width = 1' 3:1

FROM CALCS: V = 6.85 ft/sec. D = 0.48' LWS = 3.87'
(USE RIP RAP)
T = (62.4)(0.10)(0.48') = 3.00 < 3.80
USE CLASS "B" RIP RAP

CHECK DEPTH W/ RIP RAP ("B")
MAX. D = 3.8/62.4(.10) = 0.61'
USING n = .215 & Q = 7.96 cfs; S = 10%; 3:1
FROM CALC; DEPTH = 0.14' > 0.61' ∴ OK

CHECK W/ n = .068 D = 0.69' > 0.61'
CHECK W/ n = .068; 6:1 SLOPES
FROM CALC; DEPTH = 0.57' < 0.61'
V = 3.20 ft/sec ∴ OK

USE CLASS "B" RIP RAP HERE

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CALCULATION

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REMARKS

(J) DRAINAGE AREA (J) (Cont'd)

(2) DRAINAGE DITCH (J2) 100' FROM BOTTOM PIPE ENTRANCE; JUST ABOVE PIPE DRAINING AREA (I)

AREA = 42,935 ft^2 = 0.99 acres $\Sigma CA = 0.35$
$\Delta H = 319 - 301 = 18'$ $L = 300'$ $t_c = 1.86$ minutes
$i_{10} = 7.8 \frac{in}{hr}$ $Q = (0.35)(7.8) = \underline{\underline{2.73 \text{ cfs}}}$

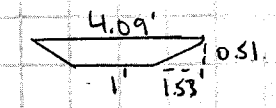
SLOPE = $\frac{2'}{50'} = 4\%$ Bottom Width = 1' 3:1

FROM CALCS: V = 3.69 $\frac{ft}{sec}$ D = 0.36' LWS = 3.14'
(USE LINER)
$T = (62.4)(0.36')(.04) = 0.90 < 1.45$
USE STRAW W/ NET

MAX. D = $1.45 / (62.4)(.04) = 0.58'$

USING n = .065 DEPTH = 0.51' < 0.58'
V = 2.08 $\frac{ft}{sec}$ LWS = 4.09'

CHECKING STABILITY



V = 2.08 $\frac{ft}{sec}$ $R = A/P = 1.30 / 4.23 = 0.31$
VR = 0.65

W/ CURVE "C" n = 0.12

∴ V = 1.32 $\frac{ft}{sec}$ < 4.5 D = 0.68' ∴ OK

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CALCULATION

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REMARKS

(J) DRAINAGE AREA (J) (Cont'd)

(3) DRAINAGE DITCH (J3)

AREA = 26,815 ft^2 = 0.62 ac. $\Sigma CA = 0.22$

$\Delta H = 317 - 295 = 22'$ $L = 300'$ $t_c = 1.73$ minutes

$i_{10} = 7.8 \frac{in}{hr.}$ $Q = (0.22)(7.8) = \underline{\underline{1.72 \text{ cfs}}}$

SLOPE = $\frac{2'}{30'}$ = 6.67% Bottom Width = 1' 3:1

FROM CALCS: $V = 3.92 \frac{ft}{sec.}$ $D = 0.25'$ LWS = 2.50'
(USE LINER)

$T = (62.4)(0.25')(.0667) = 1.04 < 1.45$
USE STRAW W/ NET

MAX. $D = 1.45/(62.4)(.0667) = 0.35'$

USING $n = .065$ DEPTH = 0.37' > 0.35

TRY. 1.5' BOTTOM WIDTH
$n = .065$ DEPTH = 0.32' < 0.35'
$V = 2.18 \frac{ft}{sec}$ LWS = 3.43'

CHECKING STABILITY

$V = 2.18 \frac{ft}{sec.}$ $R = A/P = 0.79/3.52 = 0.22$
$VR = 0.48$

W/ CURVE "C" $n = 0.14$

$\therefore V = 1.25 \frac{ft}{sec.} < 4.5$ $D = 0.47'$ $\therefore$ OK

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REMARKS

(K) SLOPE STABILITY → DRAINAGE AREA (K)

(I) DRAINAGE DITCH (K1) JUST ABOVE PIPE ENTRANCE
(INCLUDES DRAINAGE AREAS (G) AND (H))

AREA = 3.77 (G & H) + 0.14 = 3.93 acres $\Sigma CA = 1.38$
$\Delta H = 336 - 288 = 48'$ $L = 1800'$ $t_c = 10.12$ min
$i_{10} = 6.2 \frac{in}{hr}$ $Q = (1.38)(6.2) = 8.56$ cfs (use 8.8)

SLOPE $= \frac{2'}{70'} = 2.86\%$ Bottom Width = 1' 3:1

FROM CALCS: $V = 4.42 \frac{ft}{sec}$ $D = 0.67'$ LWS = 5.00'
(USE RIP-RAP; CLOSE TO $4.5 \frac{ft}{sec}$)

$\tau = (62.4)(0.67')(.0286) = 1.20 < 2.50$
USE CLASS "A" RIP RAP

CHECK DEPTH OF RIP RAP
MAX. $D = 2.5/62.4(.0286) = 1.40'$
USING $n = .054$, $Q = 8.8$ cfs, $S = 2.86\%$, 3:1 etc
FROM CALC, DEPTH $= 0.86' < 1.40$ ∴ OK

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REMARKS

(K) DRAINAGE AREA (K) (Cont'd)

(2) DRAINAGE DITCH (K2) AT PIPE ENTRANCE
(INCLUDE DRAINAGE AREAS (I) AND (J))

AREA = 3.53 (I & J) + 0.60 = 4.13 acres $\Sigma CA = 1.45$
$\Delta H = 323 - 288 = 35'$ $L = 850'$ $t_c = 4.81$ min
$I_{10} = 7.8 \frac{in}{hr.}$ $Q = (7.8)(1.45) = \underline{\underline{11.31 \text{ cfs}}}$

SLOPE $= \frac{4'}{120'} = 3.33\%$ (AVG.) Bot. Width = 1' 3:1

FROM CALCS: V = 4.98 ft/sec D = 0.72' LWS = 5.31'
(USE RIP RAP)

$T = (62.4)(0.72')(.0333) = 1.50 < 2.50$
USE CLASS "A" RIP RAP

CHECK DEPTH OF RIP RAP
MAX. $D = 2.5/62.4(.0333) = 1.20'$
USING $n = .054$, $Q = 11.31$ cfs, $S = 3.33\%$, 3:1 etc.
DEPTH = 0.93' < 1.20' ∴ OK

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REMARKS

(L) SLOPE STABILITY → DRAINAGE AREA (L) →

(1) DRAINAGE DITCH (L1) AT PIPE ENTRANCE →
(INCLUDES DRAINAGE AREAS (G), (H), (I), (J), (K))

AREA = 8.19 acres $\Sigma CA = 2.87$
$\Delta H = 336' - 284' = 52'$ $T_c = 10.45$ min
$i_{10} = 6.2 \frac{in}{hr}$ $Q = (2.87)(6.2) = \underline{17.79 \text{ cfs}}$

SLOPE $= \frac{2'}{70'} = 2.86\%$ Bottom Width = 1' 3:1

FROM CALCS: $V = 5.28 \frac{ft}{sec}$ $D = 0.91'$ LWS = 6.44'
(USE RIP RAP)

$T = (62.4)(0.91')(.0286) = 1.62 < 2.50$
USE CLASS "A" RIP RAP

CHECK DEPTH OF RIP RAP
MAX. $D = 2.5/62.4(.0286) = 1.40'$
USING $n = .054$, $Q = 17.79$ cfs, $S = 2.86\%$, 3:1
FROM CALC, DEPTH = $1.16' < 1.40'$

CHECK $n = .044$; DEPTH = $1.07' < 1.40'$ ∴ OK

DEPTH CHECKS O.K. WITH EXISTING TOPOGRAPHY ALSO

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REMARKS

(M) SLOPE STABILITY → DRAINAGE AREA (M)

① AT PIPE ENTRANCE (M1)

AREA = 1.71 acres $\Sigma CA = 0.60$

$\Delta H = 311 - 288 = 23'$ $L = 700$ $t_c = 4.51$ minutes

$i_{10} = 7.8 \frac{in}{hr.}$ $Q = (7.8)(0.60) = \underline{4.68 \text{ cfs}}$

SLOPE $= \frac{2'}{80'} = 2.50\%$ Bot. Width = 2' 3:1

FROM CALCS: $V = 3.45 \frac{ft}{sec}$ $D = 0.42'$ LWS = 4.50'

(USE LINER)

$T = (62.4)(0.42')(.025) = 0.66 < 1.45$

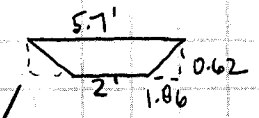
USE STRAW W/ NET

MAX. $D = 1.45 / (62.4)(.025) = 0.93'$

USING $n = .065$ DEPTH = 0.62' < 0.93'

$V = 1.97 \frac{ft}{sec}$ LWS = 5.70'

CHECKING STABILITY



$V = 1.97 \frac{ft}{sec}$ $R = A/P = 2.39 / 5.92$

$= 0.40$

$VR = 0.79$

W/ CURVE "C" $n = .096$

$\therefore V = 1.48 \frac{ft}{sec} < 4.5$ $D = 0.75'$ ∴ OK

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REMARKS

(M) DRAINAGE AREA (M) (Cont'd)

(2) IN DITCH 250' FROM PIPE ENTRANCE (M1)

AREA = 14,105 ft^2 = 0.32 ac. $\Sigma CA = 0.11$

$\Delta H = 311 - 296 = 15'$ $L = 450'$ $t_c = 3.19$ min

$i_{10} = 7.8 \frac{in}{hr.}$ $Q = (7.8)(0.11) = \underline{\underline{0.86 \text{ cfs}}}$

SLOPE = $\frac{2'}{40'} = 5\%$ Bot. Width = 2' 3:1

FROM CALCS: $V = 2.61 \frac{ft}{sec}$ $D = 0.14'$ LWS = 2.82'
(USE LINER)

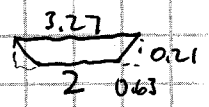
$T = (62.4)(.05)(0.14') = 0.44' < 1.45$

USE STRAW W/ NET

MAX. $D = 1.45/(62.4)(.05) = 0.46'$

USING $n = .065$; DEPTH = $0.21' < 0.46'$
$V = 1.55 \frac{ft}{sec}$ LWS = 3.27'

CHECKING STABILITY



$V = 1.55 \frac{ft}{sec}$ $R = A/P$
$= 0.55/3.33 = 0.17$
$VR = 0.26$

W/ CURVE "C" $n = 0.22$

$\therefore V = 0.66 \frac{ft}{sec} < 4.5$ $D = 0.41'$ $\therefore$ OK

USE STRAW W/ NET FOR ENTIRE DITCH HERE

McKIM&CREED

CALCULATION

PROJECT AND CREEK CLOSE OUT
CLIENT
SUBJECT DITCH CHECKS

PROJ. NO. 0009-1978.00
DATE 8/14/93
DES. BY TJE
CHK. BY

REMARKS

(N) SLOPE STABILITY → DRAINAGE AREA (N)

NO DITCHES SHOWN

(O) SLOPE STABILITY → DRAINAGE AREA (O)

(1) AT MAIN PIPE ENTRANCE, DRAINAGE DITCH (01)
(INCLUDES DRAINAGE AREAS (F) THROUGH (N) AND PART OF (O) = 1.68 ac.)

AREA = 15.87 acres $\Sigma CA = 5.55$

$\Delta H = 340 - 266 = 74'$ $L = 1350'$ (USED MAIN TRIBUTARY)

$T_c = 6.15$ minutes $i_{10} = 7.1 \frac{in}{hr.}$

$Q = (5.55)(7.1) = \underline{\underline{39.41 \text{ cfs}}}$

SLOPE $= \frac{2'}{60'} = 3.33\%$ Bot. Width = 1' 3:1

FROM CALCS: $V = 6.83 \frac{ft}{sec}$ $D = 1.23'$ LWS = 8.38'
(USE RIP RAP)

$T = (62.4)(1.23)(.0333) = 2.56 > 2.50$
USE CLASS "B" RIP RAP

CHECK DEPTH OF RIP RAP

MAX. $D = 3.8 / 62.4(.0333) = 1.83'$
USING $n = .062$; $Q = 39.41$ cfs, $S = 3.33\%$; 3:1 etc.
FROM CALC, DEPTH = 1.66' < 1.83' ∴ OK

USE CLASS "B" RIP RAP UP TO EXIT OF NEW PIPE APPROX 300' FROM MAIN PIPE ENTRANCE
(DEPTH CHECKS OUT w/ EXIST. TOPOGRAPHY)

McKIM&CREED

CALCULATION

PROJECT AND. CREEK CLOSE OUT
CLIENT
SUBJECT DITCH CHECKS

PROJ. NO. 0009-1978.00
DATE 8/14/93
DES. BY TJE
CHK. BY

REMARKS

O DRAINAGE AREA O (Cont'd)

(2) 350' FROM MAIN PIPE ENTRANCE, DRAINAGE DITCH (O1), JUST ABOVE PROPOSED PIPE LOCATION
(INCLUDES DRAINAGE AREAS (F) THROUGH (L), PART OF (Q)

DRAINAGE AREAS (F) THROUGH (L) = 9.57 acres
DRAINAGE AREA (O) = 49,755 ft^2 = 1.14 acres
TOTAL = 10.71 acres

$\Sigma CA = 3.75$ $\Delta H = 340 - 275 = 65'$ $L = 1000'$
$t_c = 4.56$ minutes $i_{10} = 7.8$ in/hr. $Q = 29.25$ cfs

SLOPE = $\frac{2'}{50'}$ = 4% Bottom Width = 1' 3:1

FROM CALCS: V = 6.78 ft/sec D = 1.04' LWS = 7.26'
(USE RIP RAP)
$T = (62.4)(1.04')(.04) = 2.60 > 2.50$
USE CLASS "B" RIP RAP

CHECK DEPTH OF RIP RAP

MAX. $D = 3.8 / 62.4(.04) = 1.52'$
USING $n = .062$; $Q = 29.25$ cfs, $S = 4\%$, 3:1 etc.
FROM CALC; DEPTH = 1.41' < 1.52' ∴ OK

USE CLASS "B" RIP RAP UP TO EXIT OF UPFLOW PIPE 170' FROM PROPOSED PIPE
(DEPTH CHECKS OUT W/ EXIST. TOPOGRAPHY)

McKIM&CREED

CALCULATION

PROJECT: AND CREEK CLOSE OUT
CLIENT:
SUBJECT: DITCH CHECKS

PROJ. NO. 0009-1978.00
DATE 8/14/93
DES. BY TJE
CHK. BY

REMARKS

(O) DRAINAGE AREA (O) (Cont'd)

(3) 520' FROM MAIN PIPE ENTRANCE, ABOVE CROSSING PIPE IN DRAINAGE DITCH (D2)
(INCLUDES DRAINAGE AREA (F) AND PART OF (O))

AREA = 1.38 + 0.76 = 2.14 acres $\Sigma CA = 0.75$
$\Delta H = 340 - 282 = 58'$ $L = 830'$ $t_c = 3.85$ min.
$i_{10} = 7.8 \frac{in}{hr}$ $Q = 5.85$ cfs

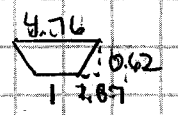
SLOPE $= \frac{2'}{100'} = 2\%$ (AVG) Bottom Width = 1' 3:1

FROM CALCS: $V = 3.48 \frac{ft}{sec}$ $D = 0.60'$ LWS = 4.60'
(USE LINER)
$T = (62.4)(.02)(0.60') = 0.75 < 1.45$
USE STRAW W/ NET

MAX. $D = 1.45 / (62.4)(.02) = 1.16'$

USING $n = .033$ DEPTH = 0.63' < 1.16'
$V = 3.24 \frac{ft}{sec}$ LWS = 4.76'

CHECKING STABILITY



$V = 3.24 \frac{ft}{sec}$ $R = A/P = 1.79 / 4.94$
$= 0.36$
$VR = 1.17$

W/ CURVE "C" $n = .078$
$\therefore V = 1.71 \frac{ft}{sec} < 4.5$ $D = 0.92'$ $\therefore$ OK
USE STRAW W/ NET W/ STONE AT OUTLET OF PIPE DRAINING AREA (F)

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CALCULATION

PROJECT AND CREEK CLOSE OUT
CLIENT
SUBJECT DITCH CHECKS

PROJ. NO. 0009-1978.00
DATE 8/16/93
DES. BY TJE
CHK. BY

REMARKS

(R) SLOPE STABILITY → DRAINAGE AREA (R)

(1) JUST ABOVE SEDIMENT POND (DITCH (R1))

AREA = 209,560 ft^2 = 4.81 acres $\Sigma CA = 1.68$
$\Delta H = 336 - 259 = 77'$ $L = 1100'$ $t_c = 4.78$ minutes
$i_{10} = 7.8 \frac{in}{hr}$ $Q = (1.68)(7.8) = \underline{\underline{13.10 \text{ cfs}}}$

SLOPE = $\frac{2'}{20'} = 10\%$ Bottom Width = 0' 3:1

FROM CALCS: $V = 7.83 \frac{ft}{sec}$; $D = 0.75'$, LWS = 4.48'
(USE RIP RAP)
$T = (62.4)(.10)(0.75') = 4.68 < 5.00$ 0.67
USE CLASS II RIP RAP

CHECK DEPTH OF RIP RAP

MAX. $D = 5.0/(62.4)(.10) = 0.80'$
USING $n = 0.084$; $Q = 13.10$ cfs; $S = 10\%$; 3:1 etc.
FROM CALC; DEPTH = 1.09 > 0.80

TRY 1.5' WIDE DITCH AND 5:1 (AFTER OTHER TRIALS)
WITH $n = .084$; $V = 3.22 \frac{ft}{sec}$; $D = 0.76'$; LWS = 9.14
DEPTH = 0.76 < 0.80

USE CLASS II RIP RAP

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CALCULATION

PROJECT ANA CREEK CLOSE OUT
CLIENT
SUBJECT DITCH CHECKS

PROJ. NO. 0009-1978.00
DATE 8/16/93
DES. BY TJE
CHK. BY

REMARKS

SLOPE STABILITY → DRAINAGE AREA (R) (Cont'd)

(2) 50' ABOVE SEDIMENT POND (DITCH (R2))

AREA = 151,590 ft² = 3.48 ac $\Sigma CA = 1.22$
$\Delta H = 336 - 262 = 74'$ $L = 1050'$ $t_c = 4.60$ minutes
$i_{10} = 7.8 \frac{in}{hr}$ $Q = (1.22)(7.8) = \underline{\underline{9.52 \text{ cfs}}}$

SLOPE = $\frac{2'}{20'} = 10\%$ Bottom Width = 1' 3:1

FROM CALCS: $V = 7.17 \frac{ft}{sec}$ $D = 0.52'$ LWS = 4.11'
(USE RIP RAP)
$T = (62.4)(0.10)(0.52') = 3.24' < 3.80$
USE CLASS "B" RIP RAP

CHECK DEPTH OF RIP RAP

MAX. $D = 3.8/(62.4)(0.10) = 0.61'$
USING $n = 0.068$; $Q = 9.52$ cfs, $S = 10\%$ 3:1
FROM CALC, DEPTH = 0.75' > 0.61'

TRY 1.5' WIDE DITCH AND 5:1 (AFTER OTHER TRIALS)
WITH $n = .068$; $V = 3.48 \frac{ft}{sec}$ $D = 0.61' \approx 0.61$ ft
LWS = 7.55'

USE CLASS "B" RIP RAP FOR ALL OF DITCH (R2) ABOVE 50' OF SEDIMENT POND

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CALCULATION

PROJECT ANO CREEK CLOSE OUT
CLIENT
SUBJECT DITCH CHECKS

PROJ. NO. 0009-1978.00
DATE 8/17/93
DES. BY TJE
CHK. BY

REMARKS

DRAINAGE AREA (R) (Cont'd)

(3) JUST ABOVE SEDIMENT POND (DITCH (R3))
(INCLUDES DRAINAGE AREA (P))

AREA = 24,800 + 342,085 = 366,885 ft^2 = 8.42 acres
(P)
ΣCA = 2.95

ΔH = 308 − 258 = 50' L = 1500' t_c = 8.07 min
i_{10} = 6.7 in/hr. Q = (2.95)(6.7) = 19.77 cfs

SLOPE = 2'/40' = 5% Bottom Width = 1' 3:1

FROM CALCS: V = 6.68 ft/sec. D = 0.84' LWS = 6.04'
(USE RIP RAP)
T = (62.4)(0.84')(.05) = 2.62 (USE CLASS "B")

CHECK DEPTH OF RIP RAP

MAX. D = 7.8/(62.4)(.05) = 1.22'
USING n = .068; Q = 19.77 cfs; S = 5%; 3:1 etc
FROM CALC; D = 1.19' < 1.22

USING n = .062; D = 1.15' < 1.22' ∴ OK

∴ USE CLASS "B" RIP RAP
(FROM PIPE TO POND)

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CULVERT/HEADWATER

ANALYSIS

50

(A)

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 17, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	160.0
Culvert Slope (feet per foot).....	0.0375

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
9.9	1.21	2.55	0.92	1.11	1.21	1.11	7.05

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B
(2 PIPES)

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 19, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	176.0
Culvert Slope (feet per foot).....	0.1705

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
9.1	1.17	2.27	-23.52	0.65	1.17	0.65	12.47

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PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 17, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	24.0
Culvert Slope (feet per foot).....	0.0417

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
7.9	1.09	1.99	1.21	0.91	1.09	0.91	7.05

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D

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 17, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	70.0
Culvert Slope (feet per foot).....	0.2714

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
13.7	1.37	4.09	-12.10	0.72	1.37	0.72	16.45

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PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 17, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	116.0
Culvert Slope (feet per foot).....	0.2241

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
5.3	1.00	1.41	-23.59	0.45	0.89	0.45	11.95

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F1

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 17, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	40.0
Culvert Slope (feet per foot).....	0.0500

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
3.8	1.00	1.14	-0.60	0.56	0.74	0.56	6.27

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PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 17, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	226.0
Culvert Slope (feet per foot).....	0.1283

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
3.8	1.00	1.13	-26.79	0.44	0.74	0.44	8.80

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PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 17, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	80.0
Culvert Slope (feet per foot).....	0.0500

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
6.0	1.00	1.59	-1.60	0.73	0.95	0.73	7.10

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5B
H

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 17, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	20.0
Culvert Slope (feet per foot).....	0.0500

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
8.6	1.13	2.13	1.32	0.90	1.13	0.90	7.79

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PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 17, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	160.0
Culvert Slope (feet per foot).....	0.0750

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
4.7	1.00	1.33	-9.59	0.56	0.83	0.56	7.72

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J

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 17, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	22.0
Culvert Slope (feet per foot).....	0.0614

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
9.7	1.20	2.46	1.33	0.91	1.20	0.91	8.60

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K 61
(2 PIPES)

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 19, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	20.0
Culvert Slope (feet per foot).....	0.0445

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
8.7	1.14	2.15	1.46	0.95	1.14	0.95	7.39

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(2 PIPES)

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 19, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	36.0
Culvert Slope (feet per foot).....	0.2222

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
8.9	1.15	2.18	-5.21	0.60	1.15	0.60	13.60

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M

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 17, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	100.0
Culvert Slope (feet per foot).....	0.1200

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
4.7	1.00	1.32	-10.00	0.50	0.83	0.50	9.13

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PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 17, 1993

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	30.0
Culvert Slope (feet per foot).....	0.0667

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
12.6	1.34	3.60	2.05	1.07	1.34	1.07	9.29

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0
(3 PIPES)
2-18"
1-24"

65

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 24, 1993

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	1.50
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	26.0
Culvert Slope (feet per foot).....	0.0770

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
12.2	1.32	3.45	1.72	0.99	1.32	0.99	9.84

==========

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0
2-18"
1-24"
66

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE
August 24, 1993

==========

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Culvert Diameter (feet).....	2.00
FHWA Chart Number (1,2 or 3).....	2
Scale Number on Chart (Type of Culvert Entrance).....	3
Manning's Roughness Coefficient (n-value).....	0.0240
Entrance Loss Coefficient of Culvert Opening.....	0.50
Culvert Length (feet).....	26.0
Culvert Slope (feet per foot).....	0.0770

==========

PROGRAM RESULTS:

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
21.7	1.66	3.71	1.75	1.16	1.66	1.16	11.49

==========

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CONSTRUCTION & DEMOLITION

LANDFILL AREA CALCULATIONS

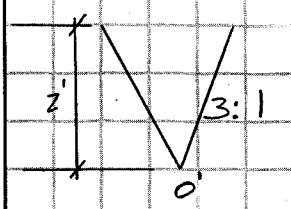
CALCULATION

PROJECT ANDERSON CREEK LANDFILL
CLIENT HARNETT COUNTY
SUBJECT CHANNEL ANALYSIS
C&D LANDFILL

PROJ. NO. 0009-1978.00
DATE 8-26-93
DES. BY AWB
CHK. BY TJE

REMARKS

CHANNEL A



$S_o = 0.8\%$
$C = 0.35$
$I = 7.8$ IN/HR
$A = 11.5$ ACRES

$Q = CIA$
$Q = (0.35)(7.8)(11.5)$
$Q = 31.4$ CFS

$Q_{10} = 31.4$ CFS
$D_{10} = 1.8'$
$V_{10} = 3.7$ FPS

$T_D = (S_2)(D_2)(62.4)$
$T_D = 0.89$

LINER MAT'L	T_D
TACKED MULCH	0.35
JUTE NET	0.45
STRAW W/NET	1.45
RIPRAP	DESIGN

∴ USE STRAW W/NET FOR ENTIRE CHANNEL

McKIM&CREED

CALCULATION

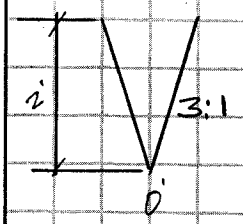
PROJECT ANDERSON CREEK LANDFILL
CLIENT HARNETT COUNTY
SUBJECT CHANNEL ANALYSIS
C & P LANDFILL

PROJ. NO. 0009-1978.00
DATE 8-26-93
DES. BY AJB
CHK. BY TJE

6B

REMARKS

CHANNEL B



$S_o = 2.8\%$
$C = 0.35$
$I = 7.8$ IN/HR
$A = 2.41$ ACRES

$Q = CIA$
$Q = (0.35)(7.8)(2.41)$
$Q = 6.6$ CFS

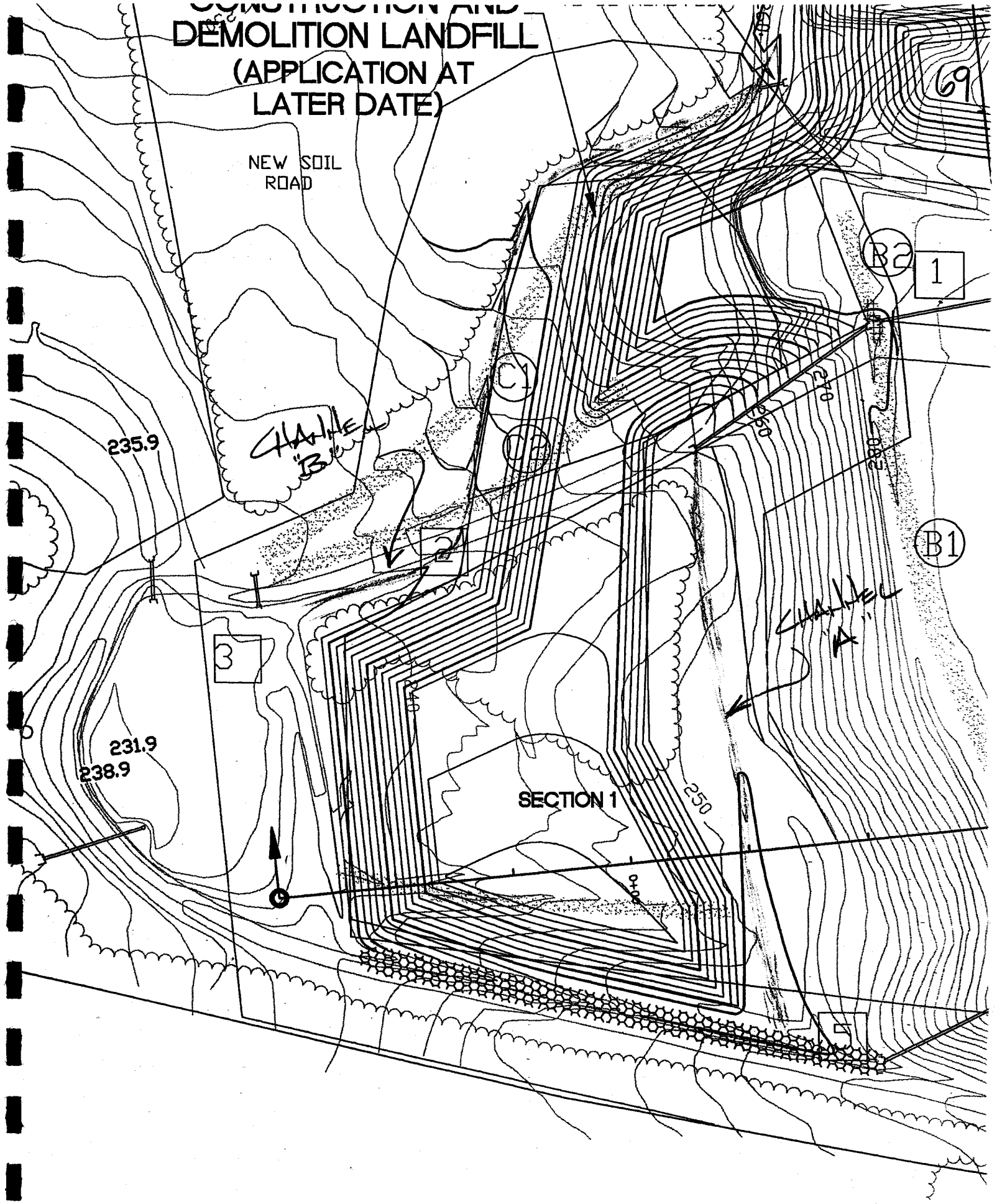
$Q_{10} = 6.6$ CFS
$D_{10} = 0.8'$
$V_{10} = 3.7$ FPS

$T_D = (S_2)(D_2)(62.4)$
$T_D = 1.4$

LINER MAT'L	T_D
TACKED MULCH	0.35
JUTE NET	0.45
STRAW W/NET	1.45
RIPRAP	DESIGN

∴ USE STRAW W/NET FOR ENTIRE CHANNEL

McKIM&CREED


CONSTRUCTION AND
DEMOLITION LANDFILL
(APPLICATION AT
LATER DATE)
NEW SOIL
ROAD
69
B2
1
C1
C2
235.9
CHANNEL
"B"
2
B1
CHANNEL
"A"
3
231.9
238.9
SECTION 1
250
240
230
5

CALCULATION

PROJECT ANDERSON CRK. C&D LANDFILL (CLOSURE) PROJ. NO. 0009-1976.00

CLIENT HARNETT DATE 9/16/93

SUBJECT DESIGN LIFE CALCULATION DES. BY TJE

CHK. BY

REMARKS

FROM COMPUTER CALCULATION: 41,500 CY

IT WAS PREVIOUS ASSUMED THAT 2,290 CY OF C&D AND INERT MATERIAL WILL BE ACCUMULATED IN 1993 (SEE SITE APPLICATION - JUNE 1993)

→ ASSUME THAT 25% OF THE ABOVE MATERIAL IS C&D (75% INERT DEBRIS)

2,290 CY (0.25) = 572.5 CY

ASSUME INCREASE OF 1% PER YR.

TRY 40 YEARS

$572.5 (1.01)^{40} = 852$ CY (AFTER 50 YRS)

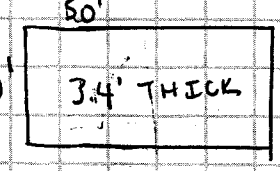
712 CY PER YR. AVERAGE

59 CY PER MONTH AVERAGE

ASSUME LANDFILL IS COVERED ONCE A MONTH USING 1' COVER ON TOP, 2' COVER ON SIDESLOPES, AND 0.5' FACE COVER

∴ 59 CY = 1,593 CF STRIP PER MONTH

∴ (10' x 50' x 3.2') STRIP PER MONTH USED



∴ COVER = (54')(3.7')(1') + 2(10')(3.7')(2') + 1(0.5')(10')(50') = 597 CF/MONTH

22.11 CY/MONTH

≅ 265 CY/YR.

TOTAL AVG. PER YR = 712 + 265 = 977 CY/YR.

977 x = 41,500

x = 42.5 YEARS

McKIM&CREED

DESIGN CHARTS, CURVES AND TABLES

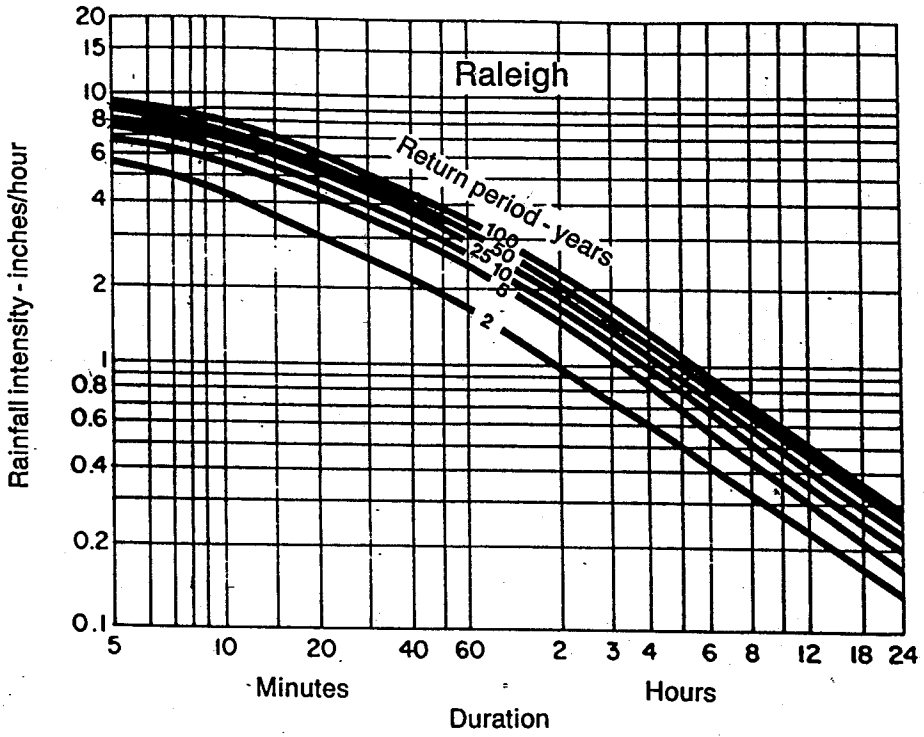


Figure 8.03e Rainfall intensity duration curves—Raleigh.

8.03.6

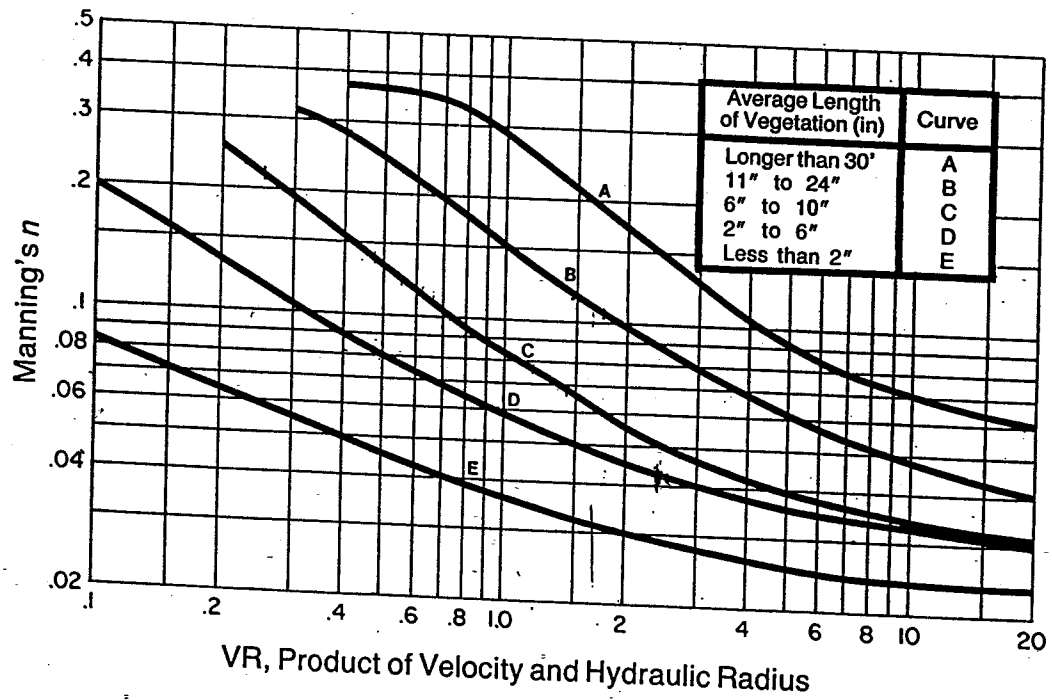


Figure 8.05c Manning's *n* related to velocity, hydraulic radius, and vegetal retardance.

Table 8.05e
Manning's Roughness Coefficients for Temporary Lining Materials

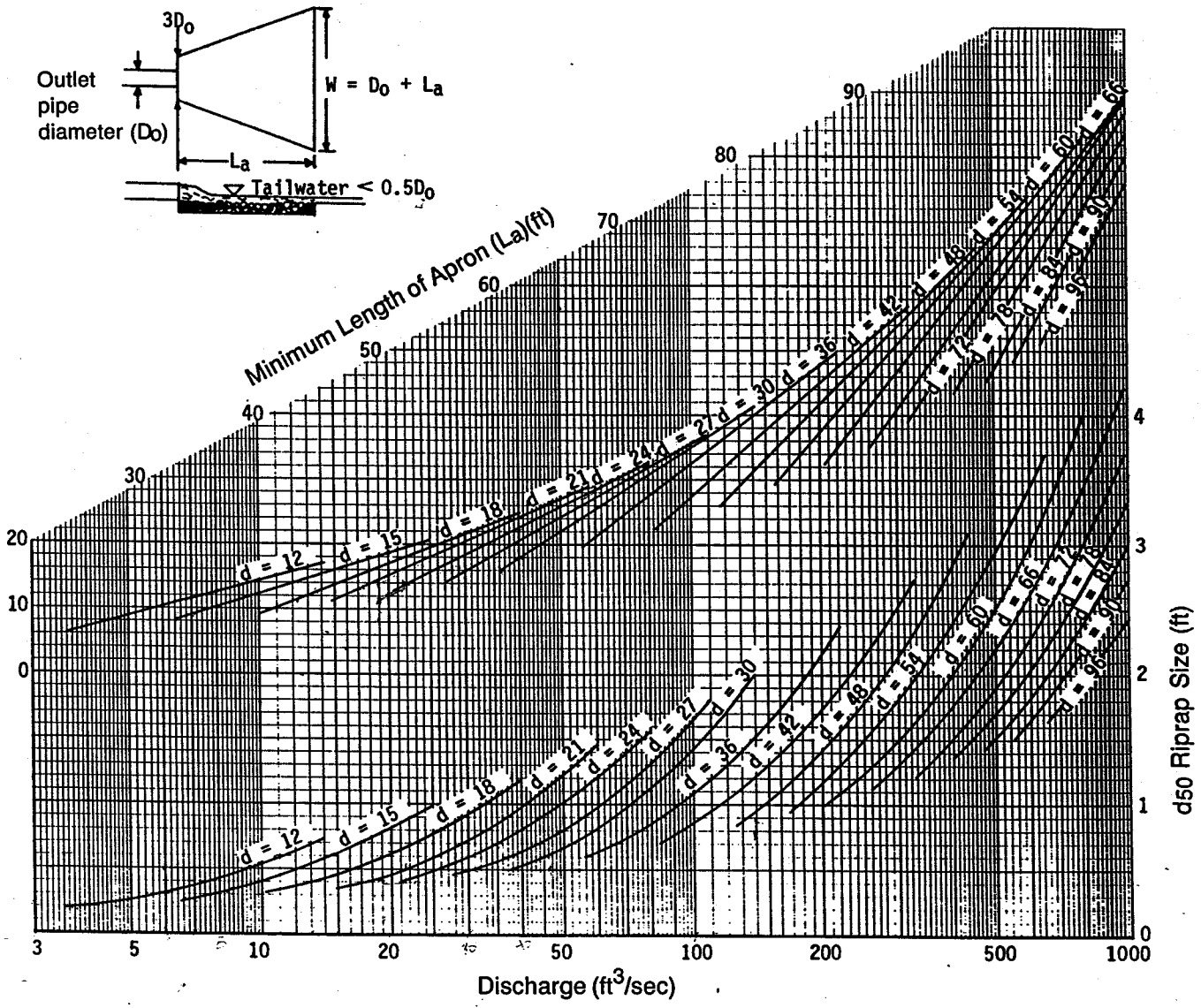
Lining Type	*n* value for Depth Ranges 0-0.5 ft	0.5-2.0 ft	>2.0 ft
Woven Paper Net	0.016	0.015	0.015
Jute Net	0.028	0.022	0.019
Fiberglass Roving	0.028	0.021	0.019
Straw with Net	0.065	0.033	0.025
Curled Wood Mat	0.066	0.035	0.028
Synthetic Mat	0.036	0.025	0.021

Table 8.05f
Manning's Roughness Coefficient for Riprap and Gravel

Material	d_{50} (inches)	*n* value for Depth Ranges 0-0.5 ft	0.5-1.0 ft	1.0-2.0 ft	> 2.0 ft
Gravel	1	0.033	0.028	0.026	0.025
	2	0.045	0.034	0.034	0.031
Riprap	6	0.106	0.054	0.044	0.041
	9	0.215	0.068	0.062	0.047
	12	0.797	0.084	0.060	0.053
	15	—	0.104	0.068	0.059
	18	—	0.127	0.076	0.064
	21	—	0.158	0.085	0.070
	24	—	0.199	0.095	0.076

Table 8.05g
Permissible Shear Stresses for Riprap and Temporary Liners

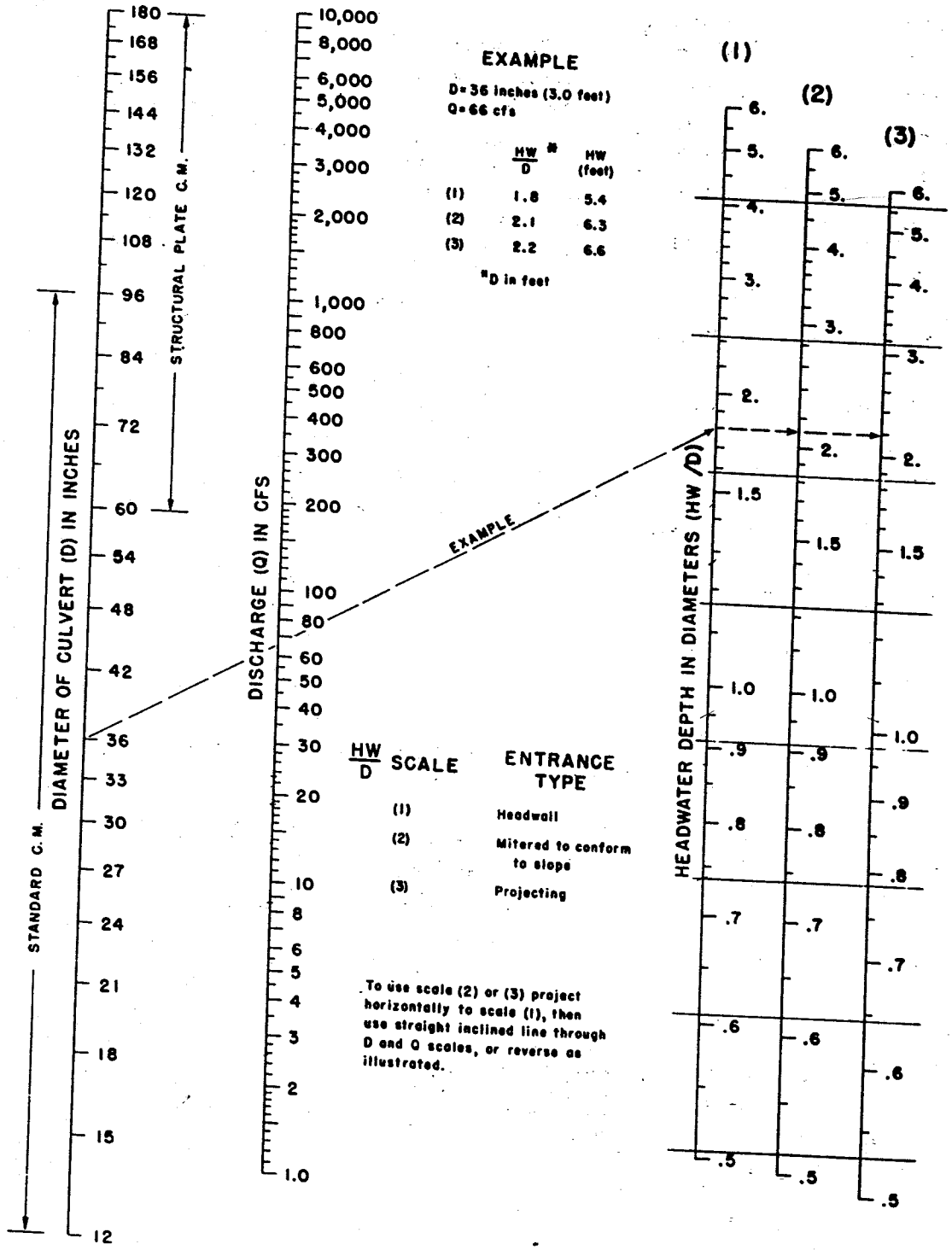
Lining Category	Lining Type	Permissible Unit Shear Stress, T_d (lb/ft^2)
Temporary	Woven Paper Net	0.15
	Jute Net	0.45
	Fiberglass Roving:	
	Single	0.60
	Double	0.85
	Straw with Net	1.45
	Curled Wood mat	1.55
	Synthetic Mat	2.00
	d_{50} Stone Size (inches)	
Gravel Riprap	1	0.40
	2	0.80
Rock Riprap	6	2.50
	9	3.80
	12	5.00
	15	6.30
	18	7.50
	21	8.80
	24	10.00



Curves may not be extrapolated.

Figure 8.06a Design of outlet protection protection from a round pipe flowing full, minimum tailwater condition (T_w < 0.5 diameter).

Exhibit 12



BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
HIGHWAY BUILDING
P. O. BOX 25201
RALEIGH NORTH CAROLINA 27611

SUBJECT Minimum Guidelines PROJECT 75
Coefficient for Rip Rap / Stone COUN
PREPARED BY DNJ DATE 11/1/99 STATION
CHECKED BY DATE STR NO. SHEET OF

	Material	d50 (in)(ft)	N value for depth ranges 0-0.5 (ft)	0.5-1.0 (ft)	1.0-2.0 (ft)	>2.0 (ft)
Stone	Class A	4 .33	0.076	0.044	0.039	0.036
Stone	Class B	8 .67	0.179	0.063	0.056	0.045
Rip Rap	Class I	10 .83	0.469	0.073	0.061	0.049
Rip Rap	Class II	12 1.0	0.797	0.084	0.060	0.053
		Tau Permissible Unit Shear Stress				
	Class A	1.65				
	Class B	3.37				
	Class I	4.20				
	Class II	5.00				

McKIM & CREED ENGINEERS, PA

243 NORTH FRONT ST.
WILMINGTON, NC 28401
919/343-1048 FAX 919/251-8282

SUITE 117, BUILDING I
5625 DILLARD ROAD
CARY, NC 27511
919/233-8091 FAX 919/233-8031

310 E. JOHNSTON STREET
P.O. BOX 1749
SMITHFIELD, NC 27577
919/934-7154 FAX 919/828-0501

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ARCHITECTS
PLANNERS

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