E&S Worksheets
7 sheets

January ,2022

Runoff Coefficient worksheet see p 111

1) Lookup type B Soil, 4% slope, Pasture — Read 0.28

2) Lookup type B Soil, 8% slope, Forest — Read ______

3) Lookup Type C Soil, 1% slope, Industrial — Read ______

With Mixed land uses, use:

$$C_W = \frac{(C_1 X A_1) + (C_2 X A_2) + (C_3 X A_3) + \ldots(C_n X A_n)}{A_{(total)}}$$

4) 4 acres Type "A", Cultivated, @ 1% + 8 acres type "B" Woods @ 8%

C_W = ((.08x4) + (.14x8))/(4+8) = (.32+1.12)/12 = 1.44/12 = 0.12

5) 6 acres type B residential (¼ acre lot) @ 4% + 2 acres type B streets@3%
   ((____X 6) + (____X 2)) / (6+2)

6) 22.6 acres type "C" open space @2% + 14.6 acres industrial type C @1.8%

7) 3.5 acres woods @ 8 % + 6.5 acres meadow @ 3 % , both type "C"

Time of concentration Tc Worksheet

$T_{c\,(\text{sheet flow})} = \left[\frac{2Ln}{3s^{.5}}\right]^{.4673}$ (P 112)

L	Type	n	s	Tc, Minutes
150	Smooth pavement	.02	0.02	3.4
150	Grass, average	.4	.02	
150	Grass, dense		.02	
100	Average grass		.02	
100	Dense Grass		.04	13.6

$T_{c(\text{shallow})}$ = use figure 5.1 , page 113 (P 113)

L	Slope , s	Type	V (fps)	t = L/V (sec)	t (min)
300	3%	Asphalt	3.5	85 sec.	1.4 min
300	3%	Short grass	1.3		
300	.04	Fallow			
150	2%	Short grass			
450	8%	Forest			10.7 min

$T_{c(\text{open channel})}$

Use Manning's Equation (P 123)

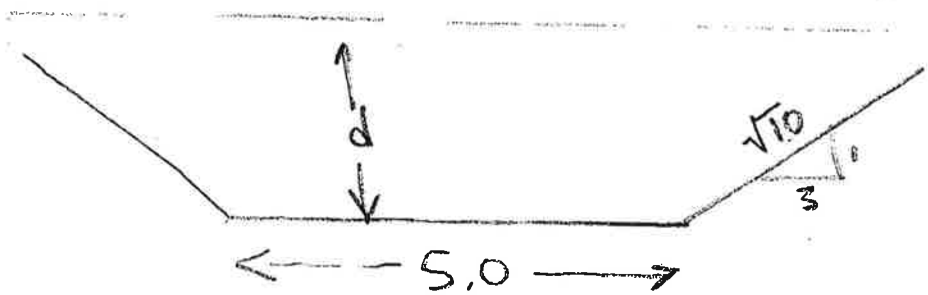
$V = (1.486/n)\,R^{.667}\,s^{.5}$ (fps)

$Tc = L/V$ (sec)

$Q = VA$ (cfs)

B	D	Z	A	WP	R	n	s	V	L	T	Q
2	1	2	4	6.47	.61	.04	.02	3.78	100	26.2sec	15.25
4	1.5	2	10.5			.04	.02		200		
6	3	3				.03	.04		1000		
5	5	3		36.62		.04	.02		500		1026

TYPICAL MANNINGS PRACTICE SHEET



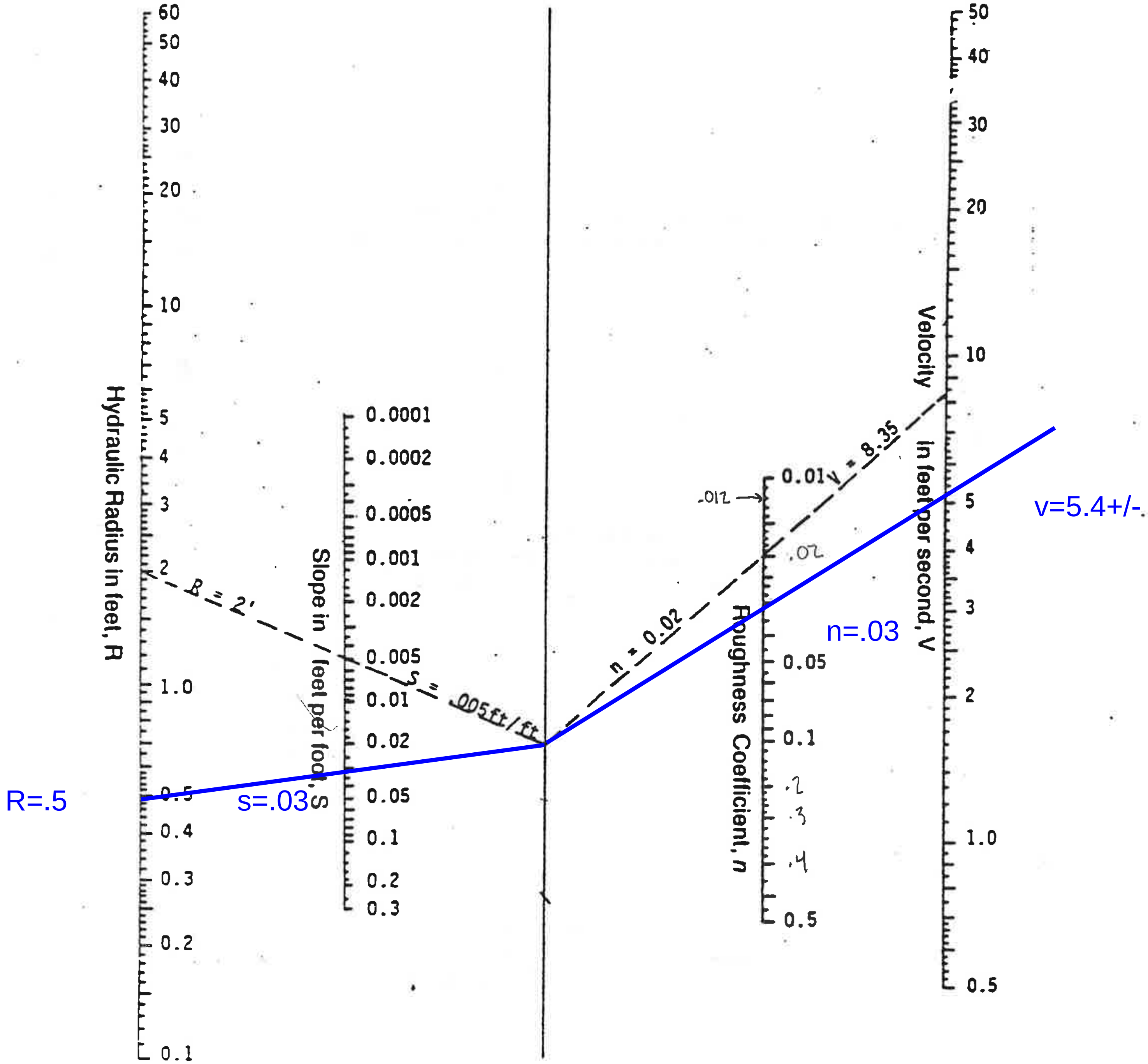
$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

$$Q = VA$$

n = 0.04
s = 0.02

D= (FT)	A= (SQFT)	WP= (FT)	Hyd.R= (FT)	V (fps)	Q (cfs)
1	8	11.32	0.71	4.17	33.35
1.1	9.13	11.96	0.76	4.39	40.08
1.5	14.25	14.49	0.98	5.2	74.05
1.9	20.33	17.02	1.19	5.91	120.25
2	22	17.65	1.25	6.08	133.85
2.1	23.73	18.28	1.3	6.25	148.33
2.15	24.62	18.6	1.32	6.33	155.89
2.2	25.52	18.91	1.35	6.41	163.68
2.4	29.28	20.18	1.45	6.73	197.11
2.5	31.25	20.81	1.5	6.89	215.23
2.6	33.28	21.44	1.55	7.04	234.31
3	42	23.97	1.75	7.63	320.56
4	68	30.3	2.24	9	612.08
5	100	36.62	2.73	10.26	1025.69

FIGURE 4.4 Nomograph for Solution of Manning's Equation



Ex R = 2 s = .005 n = .02 V = 8.35

4

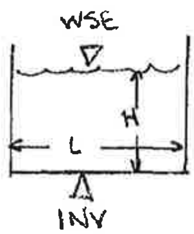
WEIR AND ORIFICE FLOW

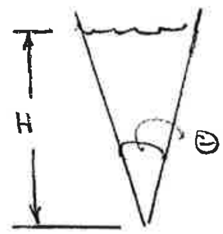
Standard Equation for Weirs

$$Q= C*L*H^{1.5}$$

$$H=(Q/(L*C))^{2/3}$$

$$H = \left(\frac{Q}{CL}\right)^{2/3}$$





$$Q = 2.5\tan\left(\frac{\theta}{2}\right)H^{2.5}$$

V NOTCH TYPE

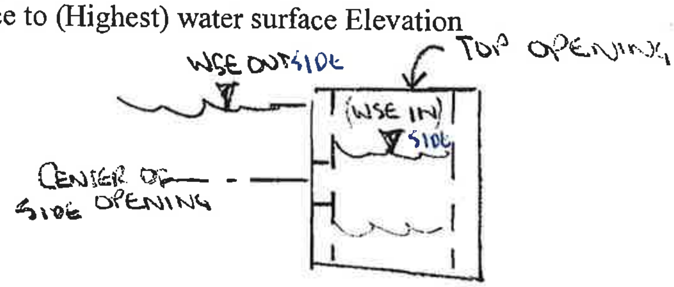
Q= Discharge in cfs
C≈3.0 unless otherwise specified use 3.0
L = Bottom Width in feet
H= Water depth above invert(feet)

Ex. 10'X2' Wier H=2 Q=85
Ex. 10X4' Wier H=4 Q=__240__
Ex. Given Q= 240,L=10 , determine H __4__

Standard Equation for Orifice

$$Q=CA_o(2gh)^{0.5}$$

C ≈0.6 unless otherwises specified use 0.6
A_o = Cross sectional Area of orifice
g = acceleration due to gravity 32.2 fps/s
h = head distance from center of orifice to (Highest) water surface Elevation



Ex. 10'x2' Side Invert = 100, WSE = 102 (h=1) Q=96

Ex. 10'x2' Top Invert = 100, WSE = 101.5 (h=1.5) Q=118

-------- UNIVERSAL SOIL LOSS EQUATION (USDA) --------------------

A= R x K x LS x C x P (tons/acre)
A= Soil loss in tons / acre
R= Rainfall Factor
K= Soil Erodibility Factor
LS = Length/Slope Factor
C= Cover
P = Practice
Sample problem :
Values are published in USDA and Canadian publications
Given 5 acre site in York County, PA soils are loamy sand
Woods for 6 months -Stripped and graded for 1 month
Mulched and seeded 2 months- Last 3 months site is well established lawn

months	R	K	LS	C	P	A, tons/month	X Acreage
6	100	.17	.68	.084	1	.97	4.85
1	17	.24	.68	1	1.3	3.6	18
2	33	.17	.68	.03	1.2	.14	.7
3	50	.17	.68	.003	1	.017	.085
total							23.36

Note exceptionally high value during stripping and grading- keep this period SHORT

Note well established lawn contributes less soil runoff than native woods!

SHEAR $\tau_d = 62.4$ d x s p 129
Sample problem:
62.4 X 1.2 x .01 = 0.75 find values >0.75 on Table 6 see Vigitative "C" or rip-rap R-3
Discussion then compute critical slope (p.31)
$S_c = 14.56n^2D_m/R^{1.33}$
Using example from p 14 with a depth of 1.2', A= 5.28, R= .716, v=2.97, T=4.4, S_o=.01
Dm=Area of Channel / Top Width = 5.28/4.4 = 1.2

S_c=14.56*.04^2*1.2/.716$^{1.33}$= .043

Test for 0.7Sc =.028 Test for 1.3Sc=.056

Freeboard calc not required, but let's do it anyway:

F= 0.025*v*3D = 0.025*2.97*3*1.2=.26 feet

Channel is described as 2 feet deep- our flow depth is only 1.2 feet deep, we're OK!

Del Val PSLS Review 4/21/21

		A	WP	R
PIPE FULL		$\frac{\pi D^2}{4}$	πD	$\frac{D}{4}$
PIPE ½ FULL		$\frac{\pi D^2}{8}$	$\frac{\pi D}{2}$	$\frac{D}{4}$

MANNINGS $V = \frac{1.486}{n} R^{.666} S^{.5}$

GIVEN 24" PIPE FLOWING FULL

$n = 0.03$ CALCULATE V @ S = 2%, 3%, 4%

2% $V = \left(\frac{1.486}{.03} \times \left(\frac{2}{4}\right)^{.666} \right) \times (.02)^{.5}$

$49.5 \times .630 \times .1414 =$

$(31.22) \times .1414 =$

3% $V = 31.22 \times (.03)^{.5} =$ ... fps

4% $V = 31.22 \times (.04)^{.5} = 6.24$ fps

Q=VA
FULL A= 3.14 SQ FT
1/2 A = 1.57
Qfull=16.96 cfs
Qhalf=8.45 cfs
(3%)

Designed by: CK Checked by: