



DESIGN AND CONSTRUCTION OF CIVIL, STRUCTURES AND TRACK WORKS, INVOLVING FORMATION IN EMBANKMENT /CUTTING, BALLAST ON FORMATION, TRACK WORKS, BRIDGES, STRUCTURES, BUILDINGS, YARDS & INTEGRATION WITH INDIAN RAILWAY'S EXISTING RAILWAY SYSTEM AND TESTING & COMMISSIONING ON DESIGN-BUILD LUMP SUM BASIS OF KHURJA-PILKHANI SECTION (APPROXIMATELY 222 ROUTE KM OF SINGLE LINE) OF EASTERN DEDICATED FREIGHT CORRIDOR

CIVIL, STRUCTURES AND TRACK WORKS

CONTRACT PACKAGE NO: 303

ICB No.: **HQ/EN/EC/D-B/Khurja-Pilkhani Section**

PART-4 – REFERENCE DOCUMENT

HYDRAULIC DATA – VOLUME 4

KHURJA TO PILKHANI

From Km. 1367.0 (ALJN-GZB) to Km 187.5 (SRE-UMB)

HYDRAULIC DATA

(MEERUT DETOUR)

PART. 2/3

**EMPLOYER: DEDICATED FREIGHT CORRIDOR CORPORATION OF INDIA LTD
(A GOVERNMENT OF INDIA ENTERPRISE)
MINISTRY OF RAILWAYS**

COUNTRY: INDIA

**KHURJA - PILKHANI SECTION
HYDRAULIC DATA
MEERUT DETOUR**

Sr. No.	Bridge No	DFCC Chainage	Page No.	
			From	To
Major Bridges				
1	D/MTC 1	1171.946	1	7
2	D/MTC 217	49280	8	12
3	D/MTC 224	51670	13	17
4	D/MTC 269	63570	18	22
Minor Bridges				
5	D/MTC 6	2873.03	23	26
6	D/MTC 10	3604.419	27	30
7	D/MTC 12	3995.123	31	35
8	D/MTC 14	4257.061	36	39
9	D/MTC 15	4323.982	40	44
10	D/MTC 17	4498.818	45	48
11	D/MTC 18	4651.973	49	52
12	D/MTC 21	5340	53	56
13	D/MTC 23	5556.909	57	60
14	D/MTC 24	5817.992	61	64
15	D/MTC 26	6211.971	65	68
16	D/MTC 28	6725.689	69	72
17	D/MTC 29	6954.869	73	76
18	D/MTC 31	7283.887	77	80
19	D/MTC 33	7602.662	81	84
20	D/MTC 34	7965.91	85	88
21	D/MTC 36	8369.13	89	92
22	D/MTC 39	8865.075	93	96
23	D/MTC 42	9131.184	97	100
24	D/MTC 43	9435.503	101	104
25	D/MTC 45	9546.632	105	108
26	D/MTC 47	9739.747	109	112
27	D/MTC 48	10025.156	113	116
28	D/MTC 50	10261.507	117	120
29	D/MTC 52	10514.831	121	124
30	D/MTC 53	10724.863	125	128
31	D/MTC 54	10893.89	129	132
32	D/MTC 56	11041.13	133	136
33	D/MTC 59	12466.912	137	140
34	D/MTC 61	12787.231	141	144
35	D/MTC 63	12940.793	145	148
36	D/MTC 65	13143.877	149	152
37	D/MTC 66	13466.235	153	156
38	D/MTC 68	13705.712	157	160
39	D/MTC 71	14222.685	161	164
40	D/MTC 73	14643.552	165	168
41	D/MTC 74	14795.972	169	172
42	D/MTC 76	14826.857	173	176
43	D/MTC 77	15045.318	177	180
44	D/MTC 79	15388.241	181	184
45	D/MTC 80	15638.878	185	188
46	D/MTC 82	16021.318	189	192
47	D/MTC 84	16207.735	193	196
48	D/MTC 86	16578.027	197	200
49	D/MTC 87	16815.826	201	204
50	D/MTC 91	17606.459	205	208
51	D/MTC 94	18380.027	209	212
52	D/MTC 95	18450.591	213	216
53	D/MTC 97	18503.593	217	220
54	D/MTC 98	18657.508	221	224
55	D/MTC 99	18854.471	225	228
56	D/MTC 100	19005.492	229	232
57	D/MTC 102	19475	233	236
58	D/MTC 103	19585	237	240
59	D/MTC 105	19960	241	244
60	D/MTC 106	20242	245	248
61	D/MTC 108	20422	249	252
62	D/MTC 109	20622.5	253	256
63	D/MTC 110	20715.5	257	260
64	D/MTC 112	20939.5	261	264
65	D/MTC 113	21180	265	268
66	D/MTC 114	21355	269	272
67	D/MTC 116	21721	273	276
68	D/MTC 118	22411	277	280
69	D/MTC 119	22650	281	284
70	D/MTC 122	23360	285	288
71	D/MTC 123	23588	289	292
72	D/MTC 125	23956	293	296

73	D/MTC 126	24322	297	300
74	D/MTC 127	24418	301	304
75	D/MTC 128	24776	305	308
76	D/MTC 129	24915	309	312
77	D/MTC 132	25916	313	316
78	D/MTC 133	26262	317	320
79	D/MTC 135	26534.5	321	324
80	D/MTC 137	26895.5	325	328
81	D/MTC 140	27512.5	329	332
82	D/MTC 142	27836.5	333	336
83	D/MTC 143	28292.53	337	340
84	D/MTC 145	28677	341	344
85	D/MTC 148	29665	345	348
86	D/MTC 149A	29928.43	349	352
87	D/MTC 151	30310	353	356
88	D/MTC 153	30553	357	360
89	D/MTC 154	30770	361	364
90	D/MTC 156	31490	365	368
91	D/MTC 158	32000	369	372
92	D/MTC 159	32093	373	376
93	D/MTC 161	32402	377	380
94	D/MTC 164	33830	381	384
95	D/MTC 165	34110	385	388
96	D/MTC 169	34832	389	392
97	D/MTC 172	35778	393	396
98	D/MTC 173	36038	397	400
99	D/MTC 175	36581	401	404
100	D/MTC 179	37910	405	408
101	D/MTC 187A	41004.57	409	412
102	D/MTC 187	40805	413	416
103	D/MTC 191	42228	417	420
104	D/MTC 192	42464	421	424
105	D/MTC 193	42660	425	428
106	D/MTC 194	43186	429	432
107	D/MTC 196	43427	433	436
108	D/MTC 201	45570	437	440
109	D/MTC 203	45950	441	444
110	D/MTC 204	46178	445	448
111	D/MTC 205	46267.54	449	452
112	D/MTC 208	46840	453	456
113	D/MTC 210	47696	457	460
114	D/MTC 213	48274.92	461	464
115	D/MTC 219A	50661	465	468
116	D/MTC 221	50830	469	472
117	D/MTC 222	51000	473	476
118	D/MTC 225	52283	477	480
119	D/MTC 226	52424	481	484
120	D/MTC 228	52640	485	488
121	D/MTC 229	52761	489	492
122	D/MTC 230A	53000	493	496
123	D/MTC 234	54193	497	500
124	D/MTC 238	55926	501	504
125	D/MTC 240	56600	505	508
126	D/MTC 242	57235	509	512
127	D/MTC 243	57377.79	513	516
128	D/MTC 247A	58701.07	517	520
129	D/MTC 250	59437	521	524
130	D/MTC 252	60283	525	528
131	D/MTC 254	60435	529	532
132	D/MTC 256	61030	533	536
133	D/MTC 259	61814	537	540
134	D/MTC 260	62071.52	541	544
135	D/MTC 261	62163	545	548
136	D/MTC 262	62286	549	552
137	D/MTC 264	62549	553	556
138	D/MTC 265	62760	557	560
139	D/MTC 266	62956	561	564
140	D/MTC 267	63148	565	568
141	D/MTC 271	63944.22	569	572
142	D/MTC 275	64440	573	576
143	D/MTC 276	65026	577	580
144	D/MTC 277	65136	581	584
145	D/MTC 279	65550	585	588
146	D/MTC 280	65676	589	592
147	D/MTC 283	65987	593	596
148	D/MTC 285	66194	597	600
149	D/MTC 287	66541.18	601	604
150	D/MTC 288	66622.77	605	608
151	D/MTC 289	66769	609	612

MAJOR BRIDGES

D/MTC Br. NO. 1 CH 1/171.946

I. Physiographic Parameters:

1	Catchment area	A	=	244.15257	sq.km
2	Length of Longest stream from source to bridge site (L)	L	=	48.721	km
3	Bed Level	BL	=	204.65	m
4	Level at the farthest point:	FL	=	222.25	m
5	Height of the farthest point along the point of interest along river	H	=	17.61	m
6	Observed HFL		=	208.124	m
7	Soil		=	Red soil/ clayey loam	
8	Sub zone		=	1(e)	
9	Proposed formation level		=	216.293	m

II. Calculation of Equivalent Stream Slope (S)

$$\text{Equivalent slope (S)} = \frac{\sum L_i \times (D_{i-1} + D_i)}{L^2}$$

S. No.	Distance (Km)	Reduced level (m)	Segment length (Li)	Height above Datum (Di)	Di-1+Di	Li x (Di-1+Di)
1	0.000	204.650	0.00	0.000	0.000	0
2	5.000	206.000	5.000	1.350	1.350	6.75
3	10.000	210.000	5.000	5.350	6.700	33.5
4	15.000	212.000	5.000	7.350	12.700	63.50
5	20.000	214.000	5.000	9.350	16.700	83.50
6	25.000	217.000	5.000	12.350	21.700	108.50
7	30.000	218.000	5.000	13.350	25.700	128.50
8	35.000	219.000	5.000	14.350	27.700	138.50
9	40.000	219.500	5.000	14.850	29.200	146.00
10	45.000	221.000	5.000	16.350	31.200	156.00
11	48.721	223.000	3.721	18.350	34.700	129.1187
	48.721					993.8687

$$\text{Equivalent Slope (S)} = \frac{\sum L_i \times (D_{i-1} + D_i)}{L^2} = 0.41869389 \text{ m/km}$$

III Calculation of Synthetic Unit Hydrograph Parameters

(i)	Ratio of L/sqrt S	L/sqrt S	=	75.29530216
(ii)	Peak Discharge of Unit Hydrograph per catchment area	q_p	=	$2.030/(L/\text{sqrt } S)^{0.649}$
			=	0.122877873 cumec/sq.km
(xi)	Peak Discharge of Unit Hydrograph	Q_p	=	$q_p \times A$
			=	30.00094813 cumec
(iii)	Time from center of unit excess rainfall duration t peak of unit hydrograph Round this value to nearer 0.5 value	t_p	=	$1.858/q_p^{1.038}$
			=	16.4 hrs.
			=	17 hrs.
(iv)	Width of the 50% Discharge Ordinate of Unit Hydrograph	W_{50}	=	$2.217/q_p^{0.990}$
			=	17.6679738 hrs.
(v)	Width of the 75% Discharge Ordinate of Unit Hydrograph	W_{75}	=	$1.477/q_p^{0.876}$
			=	9.27 hrs.
(vi)	Width of rising side Discharge Ordinate of 50% Unit Hydrograph	W_{R50}	=	$0.812/q_p^{0.907}$
			=	5.437551689 hrs.
(vii)	Width of rising side Discharge Ordinate of 75% Unit Hydrograph	W_{R75}	=	$0.606/q_p^{0.791}$
			=	3.181990953 hrs.
(viii)	Base width of the Unit Hydrograph	T_B	=	$7.744 \times t_p^{0.779}$
			=	70.38580047 hrs.
			=	71 hrs.

(ix) Unit Duration of Unit Hydrograph

$$T_r = 2.0 \text{ hrs.}$$

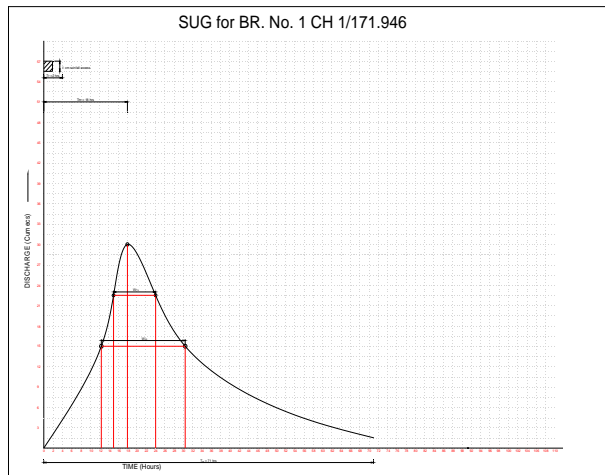
(x) Time to start of rise to the peak of Unit Hydrograph

$$T_m = t_p + t_r/2$$

$$= 18 \text{ hrs.}$$

46

The Plotted papers were joined to draw synthetic unit hydrograph



The summation of Discharge Ordinates of Unit Hydrograph of 1hr interval
Theoretically equal to

$$Q = (A \times d) / (0.36 \times t_r)$$

where

A = Catchment area

d = 1.0cm Depth

t_r = 1.0 hrs.

$$Q = 339.10 \text{ m}^3/\text{s}$$

Theoretical Discharge

Revise the ordinates of Hydrograph equal to theoretical Discharge

IV. Estimation of Design Storm

Refer Flood Estimation Report for 1e sub zone

(a) Design Storm Duration

The Design Storm Duration

$$T_D = 1.1 \times t_p$$

$$T_D = 18.7 \text{ hrs.}$$

$$= 19.0 \text{ hrs.}$$

(b) Estimation of point rainfall and Areal Rainfall for Storm Duration

R₅₀ 24 hour point rainfall (Refer Plate 9 of FER-Subzone-1(e)) = 280 mm

Conversion factor (Refer Fig. 10 of FER- Subzone- 1(e)) = 0.94

R₅₀ 19 hour point rainfall = 263.2 mm

Areal Reduction Factor for 244.152568 Sq. km catchment area = 0.90

R₅₀ hour Areal rainfall = 236.88 mm

This 50 year design storm hour areal rainfall has been split in to 1-hour rainfall increments using time distribution coefficients given in Table-A-2 or fig- 12b of F.E.R-1(e)

Duration (hr)	Coefficient	Storm Rainfall (mm)	Rainfall Increment (mm)	Loss Rate/Hr (mm/hr)	2 hrs Effective Hourly Rainfall (cm)
2	0.39	92.38	92.38	3.0	8.63832
4	0.57	135.0216	42.64	3.0	3.66384
6	0.68	161.0784	26.06	3.0	2.00568
8	0.74	175.2912	14.21	3.0	0.82128
10	0.79	187.1352	11.84	3.0	0.5844
12	0.84	198.9792	11.84	3.0	0.5844
14	0.88	208.4544	9.48	3.0	0.34752
16	0.90	213.192	4.74	3.0	-0.12624
18	0.93	220.2984	7.11	3.0	0.11064
20	0.95	225.036	4.74	3.0	-0.12624
22	0.98	232.1424	7.11	3.0	0.11064
24	1.0	236.88	4.74	3.0	-0.12624

Base Flow for the Catchment area = 0.045XA = 10.98686556 m³/s

V. Estimation of Peak Discharge

For estimation of peak discharge, effective rainfall increments were arranged against ordinates

in descending order. Sum of product of U.G ordinates and gives total direct surface runoff and base flow gives total Peak Discharge

Time (hours)	S.U.G Ordinates (m ³ /s)	2-hr Ef. Rainfall (cm)	Direct Runoff (m ³ /s)
18	30.00	8.63832	259.1582383
20	28.70	3.66384	105.152208
16	26.75	2.00568	53.65194
22	26.65	0.82128	21.887112
24	22.50	0.5844	13.149
14	18.30	0.5844	10.69452
12	14.80	0.34752	5.143296
TOTAL			468.8363143

$$\text{Peak Discharge} = \text{Direct surface runoff} + \text{base flow} = 479.8232 \text{ m}^3/\text{s}$$

VIII Water way Calculation

1	Design discharge ass per synthetic Unit Hydrograph method	Q	=	479.82318	m ³ /s
2	Velocity (Calculated from equivalent slope)	V	=	1.6	m/s
3	Required area of water way	A	=	299.88949	m ²
4	Proposed linear water way		=	45	m
5	Required Depth of water way		=	6.6642108	m
	Area of water way/ Proposed Linear water way		=	208.12	m
6	Observed HFL		=	212.31	m
	Designed HFL		=		

7	Required Vertical Clearance	=	1.0 m
	Provide Vertical Clearance	=	1.5 m
9	Minimum Free board Required	=	1.0 m
	Free board provided	=	0.8 m
10	formation level	=	216.293 m

Min. Formation Required =	B.L	+	Ht of water	+ Vertical Clearance
=	204.65		+6.664	+1.500
=	212.809			m

Provided Formation level is OK

Velocity for MTC 1 Ch 1/171.946

b	=	45	HFL	bed level
depth	=	3.479	208.124	204.65
A	=	156.555		
P	=	51.958		
R	=	3.01310674		
RL of farthest point	=	222.25		
RL of point of interest	=	204.645		
Difference	=	17.605		
Length of Stream	=	48721		
slope	=	0.000361343	2767.452	
n	=	0.025		
v	=	1.58621817		m/s
v	=	1.60		m/s

ESTIMATION OF DESIGN DISCHARGE FOR MTC BR. NO.217 CH NO. 49/280.000

Velocity for MTC BR NO 217 Ch 49/290

Catchment Area	1.45683	sq.km
Length of longest stream (L) (km)	2.328	
Height of furthest point (m)	226	
Height of point of intersection (m)	223.977	
Height Difference (H) (m)	2.023	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	224.9885	
Observed H.F.L	226.432	
Proposed Formation Level	230.185	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR MTC BR. NO.217 CH NO. 49/280.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

1.880437055 hr
 1.880437055 hr *60
 112.8262233 Min

ESTIMATION OF DESIGN DISCHARGE FOR MTC BR. NO.217 CH NO. 49/280.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	49.9883789	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR MTC BR. NO.217 CH NO. 49/280.000

4 **Design Flood Discharge =**

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 14.87581167 \text{ cum/sec}$$

5 **Checking for adequacy of Waterway Provided**

a Discharge = 14.87581167 cum/sec

b Avg. Waterway Required = Q/V (V=1.58)
9.415070677 Sq.m

c Proposed opening 1X18.3

d Height of water = Avg. Waterway/total width
0.514484736 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
223.977		0.514484736		+0.7500

225.2415 m

Proposed Formation Level	230.185	m
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Provided formation Level is O.K.

Velocity for MTC BR NO 217 Ch 49/290

b	=	18.3	HFL	bed level
depth	=	2.624	226.601	223.977
A	=	48.0192		
P	=	23.548		
R	=	2.039205		
RL of farthest point	=	226		
RL of point of interest	=	223.977		
Difference	=	2.023		
Length of Stream	=	2328		
slope	=	0.000869	1150.766	
n	=	0.03		
v	=	1.580129		m/s

ESTIMATION OF DESIGN DISCHARGE FOR MTC BR. NO.224 CH NO. 51/670.000

Catchment Area	10.466596	sq.km
Length of longest stream (L) (km)	5.492	
Height of furthest point (m)	231	
Height of point of intersection (m)	224.864	
Height Difference (H) (m)	6.136	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	227.932	
Observed H.F.L	226.998	
Proposed Formation Level	230.77	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR MTC BR. NO.224 CH NO. 51/670.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

3.117458286 hr
 3.117458286 hr *60
 187.0474972 Min

ESTIMATION OF DESIGN DISCHARGE FOR MTC BR. NO.224 CH NO. 51/670.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	30.15276914	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR MTC BR. NO.224 CH NO. 51/670.000

4 **Design Flood Discharge =**

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 64.46669502 \text{ cum/sec}$$

5 **Checking for adequacy of Waterway Provided**

a Discharge = **64.46669502 cum/sec**

b Avg. Waterway Required = Q/V (V=1.55)
41.59141614 Sq.m

c Proposed opening 1X12.2

d Height of water = Avg. Waterway/total width
3.409132471 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
224.864		3.409132471		+0.7500

229.0231 m

Proposed Formation Level	230.77	m
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Provided formation Level is O.K.

Velocity for MTC BR NO 224 Ch 51/670

b	=	12.2	HFL	bed level
depth	=	2.260	227.124	224.864
A	=	27.572		
P	=	16.72		
R	=	1.649043		
RL of farthest point	=	231		
RL of point of interest	=	224.864		
Difference	=	6.136		
Length of Stream	=	5492		
slope	=	0.001117	895.0456	
n	=	0.03		
v	=	1.555169		m/s

ESTIMATION OF DESIGN DISCHARGE FOR MTC BR. NO.269 CH NO. 63/570.000

Catchment Area	23.628714	sq.km
Length of longest stream (L) (km)	14.415	
Height of furthest point (m)	237	
Height of point of intersection	228.732	
Height Difference (H) (m)	8.268	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	232.866	
Observed H.F.L	231.112	
Proposed Formation Level	234.888	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR MTC BR. NO.269 CH NO. 63/570.000

2 Run off coefficient

Description of the catchment

Formula for C

a	Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b	Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c	Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d	Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e	Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.

Duration of Rainfall

	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

7.636071705 hr

7.636071705 hr *60

458.1643023 Min

ESTIMATION OF DESIGN DISCHARGE FOR MTC BR. NO.269 CH NO. 63/570.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	12.30999441	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR MTC BR. NO.269 CH NO. 63/570.000

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 59.41562688 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **59.41562688 cum/sec**

b Avg. Waterway Required = Q/V (V=1.21)
49.10382387 Sq.m

c Proposed opening 1X18.3

d Height of water = Avg. Waterway/total width
2.683269064 m

Min. Formation Required

B.L + Ht of water + free Board

228.732 2.683269064 +0.7500

232.1653 m

Proposed Formation Level 234.888 m

Provided formation Level is O.K.

Velocity for MTC 269 Ch 63/570

b	=	18.3	HFL	bed level
depth	=	2.380	231.112	228.732
A	=	43.554		
P	=	23.06		
R	=	1.888725065		
RL of farthest point	=	237.000		
RL of point of interest	=	228.732		
Difference	=	8.268		
Length of Stream	=	14415		
slope	=	0.000573569	1743.469	
n	=	0.03		
v	=	1.219787425		m/s

MINOR BRIDGES

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.6 CH NO.2/873.030

Catchment Area	0.080171503	sq.km
Length of longest stream (L) (km)	0.3530309	
Height of furthest point (m)	209.242	
Height of point of intersection (m)	209.034	
Height Difference (H) (m)	0.208	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	209.138	
Observed H.F.L	209.636	
Proposed Formation Level	214.810	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.6 CH NO.2/873.030

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.6 CH NO.2/873.030

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.585132626 hr

0.585132626 hr *60

35.10795758 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.6 CH NO.2/873.030

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.6 CH NO.2/873.030

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
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b	1h Ratio =	=	0.370	From Fig. 10
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c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$
		=	1.27027027

d				
i	R-50 (24)	=	200	mm

ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.
		=	74 mm

iii	R-50 (tc)	=	K x R-50 (1)
		=	1h Ratio x74
		=	94 mm

iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$
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	I	=	160.6473401 mm/hr
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ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.6 CH NO.2/873.030

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.6 CH NO.2/873.030

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.630851321 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 2.630851321 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)

$$1.503343612 \text{ Sq.m}$$

c Proposed opening 1X1.2x1.2

d Height of water = Avg. Waterway/total width

$$1.252786344 \text{ m}$$

Min. Formation Required

B.L + Ht of water + free Board

$$209.138 + 1.252786344 + 0.5000$$

$$210.891 \text{ m}$$

Proposed Formation Level 214.81 m

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.10 CH NO.3/604.419

Catchment Area	0.022317151	sq.km
Length of longest stream (L) (km)	0.1841722	
Height of furthest point (m)	209.675	
Height of point of intersection (m)	209.375	
Height Difference (H) (m)	0.300	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	209.525	
Observed H.F.L	210.023	
Proposed Formation Level	215.467	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.10 CH NO.3/604.419

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = $\frac{\text{Areal Reduction factor}}{\text{Area \& duration rainfall from table below}}$

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.262966294 \text{ hr}$$

$$= 0.262966294 \text{ hr} * 60$$

$$= 15.77797763 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.10 CH NO.3/604.419

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	357.4602608	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.10 CH NO.3/604.419

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.629555875 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.629555875 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.931174786 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.775978988 m

Min. Formation Required

B.L + Ht of water + free Board

$$209.525 + 0.775978988 + 0.5000$$

210.8010 m

Proposed Formation
Level

$$215.467 \text{ m}$$

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR NO 12 CH NO.3/995.123

Catchment Area	0.037434337	sq.km
Length of longest stream (L) (km)	0.2281309	
Height of furthest point (m)	210.072	
Height of point of intersection (m)	209.888	
Height Difference (H) (m)	0.184	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	209.980	
Observed H.F.L	210.559	
Proposed Formation Level	215.898	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR NO 12 CH NO.3/995.123

2 Run off coefficient

Description of the catchment

Formula for C

a	Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b	Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c	Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d	Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e	Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

Duration of Rainfall

	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.388470826 hr

0.388470826 hr *60

ESTIMATION OF DESIGN DISCHARGE FOR BR NO 12 CH NO.3/995.123
23.30824955 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR NO 12 CH NO.3/995.123

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	241.9744129	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR NO 12 CH NO.3/995.123

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.850300803 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.850300803** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
1.057314745 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.881095621 m

Min. Formation Required	B.L	+	Ht of water	+	free Board
	209.98		0.881095621		+1.4880
	212.349		m		
Proposed Formation Level	215.898		m		

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 14 CH NO.4/255.061

Catchment Area	0.041327689	sq.km
Length of longest stream (L) (km)	0.2232957	
Height of furthest point (m)	210.185	
Height of point of intersection (m)	209.905	
Height Difference (H) (m)	0.28	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	210.045	
Observed H.F.L	210.598	
Proposed Formation Level	216.186	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 14 CH NO.4/255.061

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop /	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.328716612 hr
 0.328716612 hr *60
 19.7229967 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 14 CH NO.4/255.061

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74 mm	
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	285.9606015 mm/hr	

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 14 CH NO.4/255.061

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.414071121 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.414071121** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
1.379469212 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.149557676 m

Min. Formation Required	B.L	+	Ht of water	+	free Board
	210.045		1.149557676		+0.5000
	211.6946 m				

Proposed Formation Level	216.186	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.15 CH NO.4/323.982

Catchment Area	0.016495905	sq.km
Length of longest stream (L) (km)	0.1613351	
Height of furthest point (m)	210.598	
Height of point of intersection (m)	210.446	
Height Difference (H) (m)	0.152	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	210.522	
Observed H.F.L	211.130	
Proposed Formation Level	216.261	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.15 CH NO.4/323.982

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.289910093 hr

0.289910093 hr *60

17.39460557 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.15 CH NO.4/323.982

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.15 CH NO.4/323.982

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74 mm	
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	324.238453 mm/hr	

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.15 CH NO.4/323.982

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.092555236 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.092555236 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.624317277 Sq.m

c Proposed opening 1x.1.2x1.2

d Height of water = Avg. Waterway/total width
0.520264398 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
210.522		0.520264398		+0.5000

211.5423 m

Proposed Formation Level	216.261	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR Br. NO. 17 CH NO.4/498.818

Catchment Area	0.019578487	sq.km
Length of longest stream (L) (km)	0.1543176	
Height of furthest point (m)	210.412	
Height of point of intersection (m)	210.26	
Height Difference (H) (m)	0.152	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	210.336	
Observed H.F.L	210.952	
Proposed Formation Level	216.321	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR Br. NO. 17 CH NO.4/498.818

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.276868765 hr
 0.276868765 hr *60
 16.61212591 Min

ESTIMATION OF DESIGN DISCHARGE FOR Br. NO. 17 CH NO.4/498.818

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F) ^ 0.2$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F) ^ 0.2$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 ,
Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	339.5110314	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR Br. NO. 17 CH NO.4/498.818

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.357799859 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.357799859 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.775885634 Sq.m

c Proposed opening 1x.1.2x1.2

d Height of water = Avg. Waterway/total width
0.646571361 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
210.336		0.646571361		+0.5000
211.4826 m				

Proposed Formation Level	216.321	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.18 CH NO. 4/651.973

Catchment Area	0.0584682	sq.km
Length of longest stream (L) (km)	0.2935374	
Height of furthest point (m)	210.724	
Height of point of intersection (m)	210.408	
Height Difference (H) (m)	0.316	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	210.566	
Observed H.F.L	211.865	
Proposed Formation Level	216.138	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.18 CH NO. 4/651.973

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.418446192 hr
 0.418446192 hr *60
 25.10677153 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.18 CH NO. 4/651.973

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	224.6405912	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.18 CH NO. 4/651.973

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.682938389 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.682938389 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.533107651 Sq.m

c Proposed opening 1x3.0x3.0

d Height of water = Avg. Waterway/total width
0.511035884 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
210.566		0.511035884		+0.5000
211.5770 m				

Proposed Formation Level	216.138	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 21 CH NO.5/340.000

Catchment Area	0.017579806	sq.km
Length of longest stream (L) (km)	0.1499745	
Height of furthest point (m)	210.016	
Height of point of intersection (m)	209.856	
Height Difference (H) (m)	0.16	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	209.936	
Observed H.F.L	210.480	
Proposed Formation Level	215.717	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 21 CH NO.5/340.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	C = 0.249(R x F) ^ 0.2
b Alluvium/silty/coastal area	C = 0.332(R x F) ^ 0.2
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	C = 0.415(R x F) ^ 0.2
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	C = 0.456(R x F) ^ 0.2
e Hilly soil / plateau/barren	C = 0.498(R x F) ^ 0.2

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.264092847 hr

0.264092847 hr *60

15.84557082 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 21 CH NO.5/340.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	355.9354259	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 21 CH NO.5/340.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{1.278168294 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.278168294 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.730381883 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.608651569 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
209.936		0.608651569		+0.5000

211.0447 m

Proposed Formation Level	215.717	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.23 CH NO.5/556.909

Catchment Area	0.023400279	sq.km
Length of longest stream (L) (km)	0.1769311	
Height of furthest point (m)	209.934	
Height of point of intersection (m)	209.654	
Height Difference (H) (m)	0.28	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	209.794	
Observed H.F.L	210.291	
Proposed Formation Level	215.924	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.23 CH NO.5/556.909

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.258349606 hr

0.258349606 hr *60

15.50097634 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.23 CH NO.5/556.909

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	363.8480491	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.23 CH NO.5/556.909

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.739177173 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.739177173 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.993815527 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.828179606 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
209.794		0.828179606		+0.5000

211.1222 m

Proposed Formation Level	215.924	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.24 CH NO.5/817.992

Catchment Area	0.03547614	sq.km
Length of longest stream (L) (km)	0.2243942	
Height of furthest point (m)	209.934	
Height of point of intersection (m)	209.478	
Height Difference (H) (m)	0.456	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	209.706	
Observed H.F.L	209.938	
Proposed Formation Level	215.726	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.24 CH NO.5/817.992

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.279224913 \text{ hr}$$

$$= 0.279224913 \text{ hr} * 60$$

$$= 16.75349475 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.24 CH NO.5/817.992

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	336.6461794	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.24 CH NO.5/817.992

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.439567238 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.439567238 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.394038422 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.161698685 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
209.706		1.161698685		+0.5000
211.3677 m				

Proposed Formation Level	215.726	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.26 CH NO.6/211.971

Catchment Area	0.020416105	sq.km
Length of longest stream (L) (km)	0.1602586	
Height of furthest point (m)	209.885	
Height of point of intersection (m)	209.485	
Height Difference (H) (m)	0.400	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	209.685	
Observed H.F.L	210.095	
Proposed Formation Level	215.666	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.26 CH NO.6/211.971

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.2061956 hr

0.2061956 hr *60

12.37173602 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.26 CH NO.6/211.971

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	455.8778161	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.26 CH NO.6/211.971

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.901183762 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.901183762** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
1.086390721 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.905325601 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
209.685		0.905325601		+0.5000
211.0903 m				

Proposed Formation Level	215.666	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.28 CH NO.6/725.689

Catchment Area	0.015934374	sq.km
Length of longest stream (L) (km)	0.1473642	
Height of furthest point (m)	210.005	
Height of point of intersection (m)	209.737	
Height Difference (H) (m)	0.268	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	209.871	
Observed H.F.L	210.417	
Proposed Formation Level	216.173	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.28 CH NO.6/725.689

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.217059704 hr

0.217059704 hr *60

13.02358224 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.28 CH NO.6/725.689

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a tc h Ratio = 0.470 From Fig. 10

b 1h Ratio = 0.370 From Fig. 10

c Coefficient K = $\frac{tc\ h\ Ratio}{1h\ Ratio}$
= 1.27027027

d
i R-50 (24) = 200 mm

ii R-50 (1) = R-50 (24) x 1 h to 24 h Rainfall Ratio.
= 74 mm

iii R-50 (tc) = K x R-50 (1)
= 1h Ratio x74
= 94 mm

iv Int. of rainfall (I) = $\frac{R-50\ (tc)}{tc}$

I = 433.0605739 mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.28 CH NO.6/725.689

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.409569172 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.409569172 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.805468098 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.671223415 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
209.871		0.671223415		+0.5000
211.0422 m				

Proposed Formation Level	216.173	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.29 CH NO.6/954.869

Catchment Area	0.018897357	sq.km
Length of longest stream (L) (km)	0.1555555	
Height of furthest point (m)	210.114	
Height of point of intersection (m)	209.833	
Height Difference (H) (m)	0.281	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	209.9735	
Observed H.F.L	210.497	
Proposed Formation Level	215.946	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.29 CH NO.6/954.869

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop /	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

Areal Reduction
factor depending
F = upon catchment Area
& duration rainfall
from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.225838343 hr
 0.225838343 hr *60
 13.55030058 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.29 CH NO.6/954.869

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	416.2269291	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.29 CH NO.6/954.869

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.606697024 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.606697024** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.918112585 Sq.m

c Proposed opening 1X1.2X1.2

d Height of water = Avg. Waterway/total width
0.765093821 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
209.9735		0.765093821		+0.5000

211.2386 m

Proposed Formation Level	215.946	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.31 CH NO. 7/283.887

Catchment Area	0.081496383	sq.km
Length of longest stream (L) (km)	0.3689531	
Height of furthest point (m)	211.125	
Height of point of intersection (m)	210.801	
Height Difference (H) (m)	0.324	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	210.963	
Observed H.F.L	211.354	
Proposed Formation Level	216.253	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.31 CH NO. 7/283.887

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.525626347 hr
 0.525626347 hr *60
 31.53758081 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.31 CH NO. 7/283.887

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	178.8342624	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.31 CH NO. 7/283.887

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.977088905 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.977088905 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.70119366 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.417661383 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
210.963		1.417661383		+0.5000
212.8807 m				

Proposed Formation Level	216.253	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 33 CH NO.7/602.662

Catchment Area	0.027305707	sq.km
Length of longest stream (L) (km)	0.1943835	
Height of furthest point (m)	211.116	
Height of point of intersection (m)	210.815	
Height Difference (H) (m)	0.301	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	210.9655	
Observed H.F.L	212.375	
Proposed Formation Level	216.593	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 33 CH NO.7/602.662

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.277751898 hr

0.277751898 hr *60

16.66511389 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 33 CH NO.7/602.662

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x 74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	338.4315306	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 33 CH NO.7/602.662

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.887673965 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.887673965 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.078670837 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.359556946 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
210.9655		0.359556946		+0.5000
211.8251 m				

Proposed Formation Level	216.593 m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.34 CH NO.7/965.910

Catchment Area	0.034104475	sq.km
Length of longest stream (L) (km)	0.2194749	
Height of furthest point (m)	211.18	
Height of point of intersection (m)	210.682	
Height Difference (H) (m)	0.498	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	210.931	
Observed H.F.L	211.312	
Proposed Formation Level	215.920	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.34 CH NO.7/965.910

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.264721495 \text{ hr}$$

$$= 0.264721495 \text{ hr} * 60$$

$$= 15.88328969 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.34 CH NO.7/965.910

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	355.0901676	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.34 CH NO.7/965.910

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.473732623 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.473732623 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.413561499 Sq.m

c Proposed opening 1X1.2X1.2

d Height of water = Avg. Waterway/total width
1.177967915 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
210.931		1.177967915		+0.5000

212.6090 m

Proposed Formation Level	215.92	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 36 CH NO.8/369.130

Catchment Area	0.051139759	sq.km
Length of longest stream (L) (km)	0.2685849	
Height of furthest point (m)	211.381	
Height of point of intersection (m)	211.194	
Height Difference (H) (m)	0.187	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	211.2875	
Observed H.F.L	211.834	
Proposed Formation Level	216.776	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 36 CH NO.8/369.130

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.457418888 hr

0.457418888 hr *60

27.44513331 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 36 CH NO.8/369.130

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	205.5009147	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 36 CH NO.8/369.130

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 2.146718903 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **2.146718903 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.226696516 Sq.m

c Proposed opening 1X1.2X1.2

d Height of water = Avg. Waterway/total width
1.022247096 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
211.2875		1.022247096		+0.5000
212.8097 m				

Proposed Formation Level	216.776	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 39 CH NO.8/865.075

Catchment Area	0.03627566	sq.km
Length of longest stream (L) (km)	0.2204152	
Height of furthest point (m)	211.900	
Height of point of intersection (m)	211.717	
Height Difference (H) (m)	0.183	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	211.809	
Observed H.F.L	212.372	
Proposed Formation Level	218.036	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 39 CH NO.8/865.075

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.375585977 hr

0.375585977 hr *60

22.53515859 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 39 CH NO.8/865.075

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	250.275585	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 39 CH NO.8/865.075

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.854541474 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.854541474 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
1.059737985 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.883114988 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
211.8085		0.883114988		+0.5000
213.1916 m				

Proposed Formation Level	218.036	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 42 CH NO.9/131.184

Catchment Area	0.013003926	sq.km
Length of longest stream (L) (km)	0.1355796	
Height of furthest point (m)	212.538	
Height of point of intersection (m)	212.322	
Height Difference (H) (m)	0.216	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	212.43	
Observed H.F.L	212.997	
Proposed Formation Level	218.319	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 42 CH NO.9/131.184

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = $\frac{\text{Areal Reduction factor}}{\text{Area \& duration rainfall from table below}}$

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.21450361 \text{ hr}$$

$$= 0.21450361 \text{ hr} * 60$$

$$= 12.87021662 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 42 CH NO.9/131.184

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	438.2210623	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 42 CH NO.9/131.184

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.164046883 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.164046883** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.665169648 Sq.m

c Proposed opening 1X1.2X1.2

d Height of water = Avg. Waterway/total width
0.55430804 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
212.43		0.55430804		+0.5000
213.4843 m				

Proposed Formation Level	218.319	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.43 CH NO.9/438.503

Catchment Area	0.020041683	sq.km
Length of longest stream (L) (km)	0.173293	
Height of furthest point (m)	213.5	
Height of point of intersection (m)	213.072	
Height Difference (H) (m)	0.428	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	213.286	
Observed H.F.L	213.685	
Proposed Formation Level	218.254	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.43 CH NO.9/438.503

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.21841892 hr

0.21841892 hr *60

13.10513521 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.43 CH NO.9/438.503

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	430.3656476	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.43 CH NO.9/438.503

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.761872728 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.761872728 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
1.006784416 Sq.m

c Proposed opening 1X1.2X1.2

d Height of water = Avg. Waterway/total width
0.838987013 m

Min. Formation Required	B.L	+	Ht of water	+	free Board
	213.286		0.838987013		+0.5000
	214.6250 m				

Proposed Formation Level	218.254	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.45 CH NO.9/546.632

Catchment Area	0.026551451	sq.km
Length of longest stream (L) (km)	0.1944828	
Height of furthest point (m)	213.900	
Height of point of intersection (m)	213.404	
Height Difference (H) (m)	0.496	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	213.652	
Observed H.F.L	214.034	
Proposed Formation Level	218.231	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.45 CH NO.9/546.632

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$0.233911117 \text{ hr}$$

$$0.233911117 \text{ hr} * 60$$

$$14.03466699 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.45 CH NO.9/546.632

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	401.8620465	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.45 CH NO.9/546.632

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.179555766 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.179555766 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.245460438 Sq.m

c Proposed opening 1X1.2X1.2

d Height of water = Avg. Waterway/total width
1.037883698 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
213.652		1.037883698		+0.5000
215.1899 m				

Proposed Formation Level	218.231	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.47 CH NO.9/736.747

Catchment Area	0.04603642	sq.km
Length of longest stream (L) (km)	0.2585559	
Height of furthest point (m)	212.537	
Height of point of intersection (m)	212.141	
Height Difference (H) (m)	0.396	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	212.339	
Observed H.F.L	212.756	
Proposed Formation Level	218.191	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.47 CH NO.9/736.747

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.339460322 hr

0.339460322 hr *60

20.36761933 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.47 CH NO.9/736.747

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	276.9101243 mm/hr	

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.47 CH NO.9/736.747

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 2.604012828 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **2.604012828 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.488007331 Sq.m

c Proposed opening 1X1.2X1.2

d Height of water = Avg. Waterway/total width
1.240006109 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
212.339		1.240006109		+0.5000
214.0790 m				

Proposed Formation Level	218.191	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.48 CH NO.10/028.156

Catchment Area	0.130886157	sq.km
Length of longest stream (L) (km)	0.3896163	
Height of furthest point (m)	212.988	
Height of point of intersection (m)	212.547	
Height Difference (H) (m)	0.441	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	212.7675	
Observed H.F.L	213.194	
Proposed Formation Level	218.130	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.48 CH NO.10/028.156

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.500009325 hr

0.500009325 hr *60

30.00055948 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.48 CH NO.10/028.156

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74 mm	
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	187.996494 mm/hr	

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.48 CH NO.10/028.156

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 5.026274578 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **5.026274578 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
2.872156902 Sq.m

c Proposed opening 1X1.2X1.2

d Height of water = Avg. Waterway/total width
2.393464085 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
212.7675		2.393464085		+0.5000

215.6610 m

Proposed Formation Level	218.13	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.50 CH NO.10/261.507

Catchment Area	0.047096336	sq.km
Length of longest stream (L) (km)	0.2582648	
Height of furthest point (m)	212.221	
Height of point of intersection (m)	212.009	
Height Difference (H) (m)	0.212	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	212.115	
Observed H.F.L	212.624	
Proposed Formation Level	218.080	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.50 CH NO.10/261.507

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.420631341 hr

0.420631341 hr *60

25.23788048 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.50 CH NO.10/261.507

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	223.4735997	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.50 CH NO.10/261.507

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 2.149889245 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **2.149889245 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.22850814 Sq.m

c Proposed opening 1X1.2X1.2

d Height of water = Avg. Waterway/total width
1.023756783 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
212.115		1.023756783		+0.5000
213.6388 m				

Proposed Formation Level	218.08	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.52 CH NO. 10/511.831

Catchment Area	0.109995701	sq.km
Length of longest stream (L) (km)	0.3911888	
Height of furthest point (m)	212.745	
Height of point of intersection (m)	212.326	
Height Difference (H) (m)	0.419	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	212.5355	
Observed H.F.L	212.854	
Proposed Formation Level	218.028	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.52 CH NO. 10/511.831

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.511041417 hr
 0.511041417 hr *60
 30.66248502 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.52 CH NO. 10/511.831

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F) ^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F) ^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	183.9381249	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.52 CH NO. 10/511.831

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 4.132855386 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **4.132855386 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
2.361631649 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.968026374 m

Min. Formation Required

B.L + Ht of water + free Board

$$212.5355 + 1.968026374 + 0.5000$$

215.0035 m

Proposed Formation Level

$$218.028 \text{ m}$$

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.53 CH NO.10/724.863

Catchment Area	0.030321502	sq.km
Length of longest stream (L) (km)	0.2101067	
Height of furthest point (m)	212.4	
Height of point of intersection (m)	212.196	
Height Difference (H) (m)	0.204	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	212.298	
Observed H.F.L	212.846	
Proposed Formation Level	217.983	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.53 CH NO.10/724.863

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = $\frac{\text{Areal Reduction factor depending upon catchment Area \& duration rainfall from table below}}{\text{Area \& duration rainfall from table below}}$

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.344272942 hr

0.344272942 hr *60

20.6563765 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.53 CH NO.10/724.863

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	273.0391751	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.53 CH NO.10/724.863

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.691135521 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.691135521** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.966363155 Sq.m

c Proposed opening 1X1.2X1.2

d Height of water = Avg. Waterway/total width
0.805302629 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
212.298		0.805302629		+0.5000
213.6033 m				

Proposed Formation Level	217.983	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.54 CH NO.10/893.890

Catchment Area	0.033065656	sq.km
Length of longest stream (L) (km)	0.2184116	
Height of furthest point (m)	212.200	
Height of point of intersection (m)	211.849	
Height Difference (H) (m)	0.351	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	212.025	
Observed H.F.L	212.547	
Proposed Formation Level	217.947	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.54 CH NO.10/893.890

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.297179874 hr

0.297179874 hr *60

17.83079246 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.54 CH NO.10/893.890

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	316.3067493	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.54 CH NO.10/893.890

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.136428397 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.136428397 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.220816227 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.017346856 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
212.0245		1.017346856		+0.5000
213.5418 m				

Proposed Formation Level	217.947	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.56 CH NO.11/041.130

Catchment Area	0.128697702	sq.km
Length of longest stream (L) (km)	0.2261303	
Height of furthest point (m)	212.008	
Height of point of intersection (m)	211.809	
Height Difference (H) (m)	0.199	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	211.9085	
Observed H.F.L	212.447	
Proposed Formation Level	217.916	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.56 CH NO.11/041.130

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.374676974 hr

0.374676974 hr *60

22.48061844 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.56 CH NO.11/041.130

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F) ^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F) ^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	250.8827778	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.56 CH NO.11/041.130

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 6.595449268 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **6.595449268 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
3.768828153 Sq.m

c Proposed opening 1X1.2X1.2

d Height of water = Avg. Waterway/total width
3.140690127 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
211.9085		3.140690127		+0.5000

215.5492 m

Proposed Formation Level	217.916	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.59 CH NO.12/466.912

Catchment Area	0.048822923	sq.km
Length of longest stream (L) (km)	0.2616647	
Height of furthest point (m)	211.073	
Height of point of intersection (m)	210.741	
Height Difference (H) (m)	0.332	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	210.907	
Observed H.F.L	211.412	
Proposed Formation Level	218.909	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.59 CH NO.12/466.912

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.365236001 \text{ hr}$$

$$= 0.365236001 \text{ hr} * 60$$

$$= 21.91416005 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.59 CH NO.12/466.912

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	257.3678383	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.59 CH NO.12/466.912

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.566733594 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.566733594 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.466704911 Sq.m

c Proposed opening 1X1.2X1.2

d Height of water = Avg. Waterway/total width
1.222254092 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
210.907		1.222254092		+0.5000
212.6293 m				

Proposed Formation Level	218.909	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.61 CH NO.12/787.231

Catchment Area	0.067185423	sq.km
Length of longest stream (L) (km)	0.3164508	
Height of furthest point (m)	211.400	
Height of point of intersection (m)	211.175	
Height Difference (H) (m)	0.225	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	211.288	
Observed H.F.L	211.869	
Proposed Formation Level	220.505	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.61 CH NO.12/787.231

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.508526918 hr

0.508526918 hr *60

30.51161505 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.61 CH NO.12/787.231

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	184.8476389	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.61 CH NO.12/787.231

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.536831975 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.536831975 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.449618271 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.208015226 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
211.2875		1.208015226		+0.5000
212.9955 m				

Proposed Formation Level	220.505	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.63 CH NO.12/940.793

Catchment Area	0.044378887	sq.km
Length of longest stream (L) (km)	0.2670972	
Height of furthest point (m)	211.606	
Height of point of intersection (m)	211.407	
Height Difference (H) (m)	0.199	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	211.5065	
Observed H.F.L	212.021	
Proposed Formation Level	221.268	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.63 CH NO.12/940.793

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = $\frac{\text{Areal Reduction factor}}{\text{Area \& duration rainfall from table below}}$

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.445141875 hr
 0.445141875 hr *60
 26.70851249 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.63 CH NO.12/940.793

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	211.1686303	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.63 CH NO.12/940.793

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.914293613 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.914293613** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
1.093882065 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.911568387 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
211.5065		0.911568387		+0.5000
212.9181 m				

Proposed Formation Level	221.268	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.65 CH NO.13/141.877

Catchment Area	0.022352063	sq.km
Length of longest stream (L) (km)	0.1705931	
Height of furthest point (m)	212.686	
Height of point of intersection (m)	212.369	
Height Difference (H) (m)	0.317	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	212.5275	
Observed H.F.L	213.002	
Proposed Formation Level	222.191	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.65 CH NO.13/141.877

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.238349731 hr

0.238349731 hr *60

14.30098389 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.65 CH NO.13/141.877

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	394.3784599	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.65 CH NO.13/141.877

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.800667525 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.800667525 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.028952871 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.857460726 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
212.5275		0.857460726		+0.5000
213.8850 m				

Proposed Formation Level	222.191	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.66 CH NO.13/466.235

Catchment Area	0.039256283	sq.km
Length of longest stream (L) (km)	0.2605966	
Height of furthest point (m)	211.756	
Height of point of intersection (m)	211.555	
Height Difference (H) (m)	0.201	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	211.6555	
Observed H.F.L	212.215	
Proposed Formation Level	224.775	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.66 CH NO.13/466.235

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.432439156 hr

0.432439156 hr *60

25.94634938 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.66 CH NO.13/466.235

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x 74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	217.3716201	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.66 CH NO.13/466.235

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 1.743069718 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **1.743069718 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.996039839 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.830033199 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
211.6555		0.830033199		+0.5000
212.9855 m				

Proposed Formation Level	224.775	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.68 CH NO.13/705.712

Catchment Area	0.022416078	sq.km
Length of longest stream (L) (km)	0.1891217	
Height of furthest point (m)	213.324	
Height of point of intersection (m)	213.072	
Height Difference (H) (m)	0.252	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	213.198	
Observed H.F.L	213.767	
Proposed Formation Level	224.775	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.68 CH NO.13/705.712

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.287041125 \text{ hr}$$

$$= 0.287041125 \text{ hr} * 60$$

$$= 17.22246753 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.68 CH NO.13/705.712

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	327.4792065	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.68 CH NO.13/705.712

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 1.499498738 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **1.499498738 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.856856422 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.714047018 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
213.198		0.714047018		+0.5000
214.4120 m				

Proposed Formation Level	224.775	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.71 CH NO.14/222.685

Catchment Area	0.044478279	sq.km
Length of longest stream (L) (km)	0.2626405	
Height of furthest point (m)	213.112	
Height of point of intersection (m)	212.630	
Height Difference (H) (m)	0.482	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	212.564	
Observed H.F.L	212.871	
Proposed Formation Level	224.909	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.71 CH NO.14/222.685

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.322394874 hr

0.322394874 hr *60

19.34369243 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.71 CH NO.14/222.685

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	291.5679114	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.71 CH NO.14/222.685

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.649051753 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.649051753 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.513743859 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.261453216 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
212.564		1.261453216		+0.5000
214.3255 m				

Proposed Formation Level	224.909	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.73 CH NO.14/643.552

Catchment Area	0.041673013	sq.km
Length of longest stream (L) (km)	0.2469997	
Height of furthest point (m)	213.546	
Height of point of intersection (m)	213.343	
Height Difference (H) (m)	0.203	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	213.445	
Observed H.F.L	213.968	
Proposed Formation Level	222.835	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.73 CH NO.14/643.552

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.407713102 hr

0.407713102 hr *60

24.4627861 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.73 CH NO.14/643.552

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F) ^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F) ^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	230.5542785	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.73 CH NO.14/643.552

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.962595655 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.962595655 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.121483231 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.934569359 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
213.4445		0.934569359		+0.5000
214.8791 m				

Proposed Formation Level	222.835	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR.NO.74 CH NO.14/795.972

Catchment Area	0.012721838	sq.km
Length of longest stream (L) (km)	0.1311771	
Height of furthest point (m)	213.786	
Height of point of intersection (m)	213.495	
Height Difference (H) (m)	0.291	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	213.6405	
Observed H.F.L	214.130	
Proposed Formation Level	222.081	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR.NO.74 CH NO.14/795.972

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.187042361 hr

0.187042361 hr *60

11.22254164 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR.NO.74 CH NO.14/795.972

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	502.559953	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR.NO.74 CH NO.14/795.972

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{1.305991844 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.305991844 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.746281053 Sq.m

c Proposed opening 1x.1.2x1.2

d Height of water = Avg. Waterway/total width
0.621900878 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
213.6405		0.621900878		+0.5000
214.7624 m				

Proposed Formation Level	222.081	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.76 CH No. 14/826.857

Catchment Area	0.114739733	sq.km
Length of longest stream (L) (km)	0.4096841	
Height of furthest point (m)	213.845	
Height of point of intersection (m)	213.548	
Height Difference (H) (m)	0.297	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	213.6965	
Observed H.F.L	214.124	
Proposed Formation Level	221.928	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.76 CH No. 14/826.857

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.603648121 hr
 0.603648121 hr *60
 36.21888725 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.76 CH No. 14/826.857

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	155.7198586	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.76 CH No. 14/826.857

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 3.64972866 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **3.64972866 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
2.085559234 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.737966028 m

Min. Formation Required

B.L + Ht of water + free Board

$$213.6965 + 1.737966028 + 0.5000$$

215.9345 m

Proposed Formation Level

$$221.928 \text{ m}$$

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.77 CH NO.15/045.318

Catchment Area	0.036970285	sq.km
Length of longest stream (L) (km)	0.2314817	
Height of furthest point (m)	215.998	
Height of point of intersection (m)	215.593	
Height Difference (H) (m)	0.405	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	215.796	
Observed H.F.L	216.220	
Proposed Formation Level	220.846	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.77 CH NO.15/045.318

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.300401961 hr

0.300401961 hr *60

18.02411766 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.77 CH NO.15/045.318

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	312.9140692	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.77 CH NO.15/045.318

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 2.363092012 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **2.363092012 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.350338293 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.125281911 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
215.7955		1.125281911		+0.5000
217.4208 m				

Proposed Formation Level	220.846	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.79 CH NO.15/388.241

Catchment Area	0.0641676	sq.km
Length of longest stream (L) (km)	0.3066532	
Height of furthest point (m)	213.794	
Height of point of intersection (m)	213.458	
Height Difference (H) (m)	0.336	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	213.626	
Observed H.F.L	215.058	
Proposed Formation Level	219.995	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.79 CH NO.15/388.241

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon
catchment Area &
duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.428640411 hr

0.428640411 hr *60

25.71842467 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.79 CH NO.15/388.241

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a tc h Ratio = 0.470 From Fig. 10

b 1h Ratio = 0.370 From Fig. 10

c Coefficient K = $\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$
= 1.27027027

d
i R-50 (24) = 200 mm

ii R-50 (1) = R-50 (24) x 1 h to 24 h Rainfall Ratio.
= 74 mm

iii R-50 (tc) = K x R-50 (1)
= 1h Ratio x74
= 94 mm

iv Int. of rainfall (I) = $\frac{R-50 (tc)}{tc}$

I = 219.2980353 mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.79 CH NO.15/388.241

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.874440185 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.874440185 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.642537249 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.547512416 m

Min. Formation Required

$$\text{B.L} + \text{Ht of water} + \text{free Board}$$

$$213.626 + 0.547512416 + 0.5000$$

$$214.6735 \text{ m}$$

Proposed Formation Level 219.995 m

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.80 CH NO.15/641.878

Catchment Area	0.065333457	sq.km
Length of longest stream (L) (km)	0.2988064	
Height of furthest point (m)	214.223	
Height of point of intersection (m)	213.747	
Height Difference (H) (m)	0.476	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	213.985	
Observed H.F.L	214.392	
Proposed Formation Level	219.645	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.80 CH NO.15/641.878

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.370044661 \text{ hr}$$

$$= 0.370044661 \text{ hr} * 60$$

$$= 22.20267967 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.80 CH NO.15/641.878

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	254.0233919	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.80 CH NO.15/641.878

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{3.390096722 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **3.390096722 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.937198127 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.614331772 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
213.985		1.614331772		+0.5000
216.0993 m				

Proposed Formation Level	219.645	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.82 CH NO.16/021.318

Catchment Area	0.008204368	sq.km
Length of longest stream (L) (km)	0.1167799	
Height of furthest point (m)	214.324	
Height of point of intersection (m)	214.041	
Height Difference (H) (m)	0.283	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.1825	
Observed H.F.L	214.698	
Proposed Formation Level	219.836	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.82 CH NO.16/021.318

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.167440172 \text{ hr}$$

$$= 0.167440172 \text{ hr} * 60$$

$$= 10.04641034 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.82 CH NO.16/021.318

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	561.3945489	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.82 CH NO.16/021.318

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{0.940840622 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **0.940840622 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.537623213 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.448019344 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.1825		0.448019344		+0.5000
215.1305 m				

Proposed Formation Level	219.836	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.84 CH NO.16/207.735

Catchment Area	0.033311628	sq.km
Length of longest stream (L) (km)	0.2251378	
Height of furthest point (m)	214.106	
Height of point of intersection (m)	213.883	
Height Difference (H) (m)	0.223	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	213.9945	
Observed H.F.L	214.553	
Proposed Formation Level	219.940	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.84 CH NO.16/207.735

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.358607142 hr

0.358607142 hr *60

21.51642853 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.84 CH NO.16/207.735

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	262.1252869 mm/hr	

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.84 CH NO.16/207.735

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 1.783641307 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **1.783641307 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.019223604 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.849353004 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
213.9945		0.849353004		+0.5000

215.3439 m

Proposed Formation Level	219.94	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.86 CH NO.16/578.027

Catchment Area	0.048216773	sq.km
Length of longest stream (L) (km)	0.2461046	
Height of furthest point (m)	214.825	
Height of point of intersection (m)	214.354	
Height Difference (H) (m)	0.471	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.5895	
Observed H.F.L	214.964	
Proposed Formation Level	220.128	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.86 CH NO.16/578.027

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.303820245 hr

0.303820245 hr *60

18.22921467 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.86 CH NO.16/578.027

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F) ^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F) ^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	309.393471	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.86 CH NO.16/578.027

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{3.047277668 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = $\mathbf{3.047277668 \text{ cum/sec}}$

b Avg. Waterway Required = $Q/V \quad (V=1.75)$
 1.741301524 Sq.m

c Proposed opening $1 \times 1.2 \times 1.2$

d Height of water = Avg. Waterway/total width
 1.451084604 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.5895		1.451084604		+0.5000
216.5406 m				

Proposed Formation Level	220.128	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.87 CH NO.16/815.826

Catchment Area	0.061568436	sq.km
Length of longest stream (L) (km)	0.3207726	
Height of furthest point (m)	214.500	
Height of point of intersection (m)	214.330	
Height Difference (H) (m)	0.17	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.415	
Observed H.F.L	214.961	
Proposed Formation Level	220.006	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.87 CH NO.16/815.826

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.568079727 \text{ hr}$$

$$= 0.568079727 \text{ hr} * 60$$

$$= 34.0847836 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.87 CH NO.16/815.826

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	165.4697318	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.87 CH NO.16/815.826

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 2.081035209 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **2.081035209 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.189162977 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.990969147 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.415		0.990969147		+0.5000
215.9060 m				

Proposed Formation Level	220.006	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.91 CH NO.17/606.459

Catchment Area	0.017363226	sq.km
Length of longest stream (L) (km)	0.1835321	
Height of furthest point (m)	214.386	
Height of point of intersection (m)	214.141	
Height Difference (H) (m)	0.245	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.2635	
Observed H.F.L	214.790	
Proposed Formation Level	220.103	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.91 CH NO.17/606.459

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.280982748 hr

0.280982748 hr *60

16.8589649 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.91 CH NO.17/606.459

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	334.5401117	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.91 CH NO.17/606.459

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.186537225 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.186537225 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.678021272 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.565017726 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.2635		0.565017726		+0.5000
215.3285 m				

Proposed Formation Level	220.103	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR.NO.94 CH NO.18/380.027

Catchment Area	0.01490329	sq.km
Length of longest stream (L) (km)	0.1453783	
Height of furthest point (m)	213.878	
Height of point of intersection (m)	213.524	
Height Difference (H) (m)	0.354	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	213.701	
Observed H.F.L	214.132	
Proposed Formation Level	219.300	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR.NO.94 CH NO.18/380.027

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.194437911 \text{ hr}$$

$$= 0.194437911 \text{ hr} * 60$$

$$= 11.66627465 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR.NO.94 CH NO.18/380.027

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	483.4448158	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR.NO.94 CH NO.18/380.027

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.47174244 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.47174244 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.84099568 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.700829734 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
213.701		0.700829734		+0.5000

214.9018 m

Proposed Formation Level	219.3	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.95 CH NO. 18/450.591

Catchment Area	0.019829422	sq.km
Length of longest stream (L) (km)	0.16586943	
Height of furthest point (m)	213.995	
Height of point of intersection (m)	213.721	
Height Difference (H) (m)	0.274	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	213.858	
Observed H.F.L	214.324	
Proposed Formation Level	219.349	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.95 CH NO. 18/450.591

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.243463707 \text{ hr}$$

$$= 0.243463707 \text{ hr} * 60$$

$$= 14.60782242 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.95 CH NO. 18/450.591

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	386.0945073	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.95 CH NO. 18/450.591

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.563890786 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.563890786 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.893651877 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.744709898 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
213.858		0.744709898		+0.5000

215.1027 m

Proposed Formation Level	219.349	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.97 CH NO. 18/503.591

Catchment Area	0.024280483	sq.km
Length of longest stream (L) (km)	0.1932534	
Height of furthest point (m)	214.024	
Height of point of intersection (m)	213.793	
Height Difference (H) (m)	0.231	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	213.9085	
Observed H.F.L	214.348	
Proposed Formation Level	219.452	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.97 CH NO. 18/503.591

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.302479161 \text{ hr}$$

$$= 0.302479161 \text{ hr} * 60$$

$$= 18.14874969 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.97 CH NO. 18/503.591

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	310.7652096	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.97 CH NO. 18/503.591

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.541318734 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.541318734 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.880753563 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.733961302 m

Min. Formation Required

B.L + Ht of water + free Board

$$213.9085 + 0.733961302 + 0.5000$$

215.1425 m

Proposed Formation Level 219.452 m

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.98 CH NO.18/657.508

Catchment Area	0.023285025	sq.km
Length of longest stream (L) (km)	0.2013286	
Height of furthest point (m)	214.509	
Height of point of intersection (m)	214.069	
Height Difference (H) (m)	0.44	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.289	
Observed H.F.L	214.711	
Proposed Formation Level	219.749	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.98 CH NO.18/657.508

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.252668436 \text{ hr}$$

$$= 0.252668436 \text{ hr} * 60$$

$$= 15.16010615 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.98 CH NO.18/657.508

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x 74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	372.0290574	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.98 CH NO.18/657.508

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.769523418 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.769523418 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.011156239 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.842630199 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.289		0.842630199		+0.5000
215.6316 m				

Proposed Formation Level	219.749	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.99 CH NO.18/854.471

Catchment Area	0.022778919	sq.km
Length of longest stream (L) (km)	0.1897549	
Height of furthest point (m)	214.107	
Height of point of intersection (m)	213.894	
Height Difference (H) (m)	0.213	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.0005	
Observed H.F.L	214.579	
Proposed Formation Level	219.864	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.99 CH NO.18/854.471

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.305238135 \text{ hr}$$

$$= 0.305238135 \text{ hr} * 60$$

$$= 18.31428809 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.99 CH NO.18/854.471

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	307.9562783	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.99 CH NO.18/854.471

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.432929826 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.432929826 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.818817044 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.682347536 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.0005		0.682347536		+0.5000

215.1828 m

Proposed Formation Level	219.864	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.100 CH NO.19/005.492

Catchment Area	0.04738431	sq.km
Length of longest stream (L) (km)	0.2685288	
Height of furthest point (m)	214.456	
Height of point of intersection (m)	214.149	
Height Difference (H) (m)	0.307	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.3025	
Observed H.F.L	214.654	
Proposed Formation Level	219.932	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.100 CH NO.19/005.492

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.385427601 hr

0.385427601 hr *60

23.12565607 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.100 CH NO.19/005.492

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	243.8849727	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.100 CH NO.19/005.492

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.360599685 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.360599685 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.348914105 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.124095088 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.3025		1.124095088		+0.5000

215.9266 m

Proposed Formation Level	219.932	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.102 CH NO.19/473.000

Catchment Area	0.0146905010	sq.km
Length of longest stream (L) (km)	0.1589033	
Height of furthest point (m)	214.107	
Height of point of intersection (m)	213.951	
Height Difference (H) (m)	0.156	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.029	
Observed H.F.L	214.551	
Proposed Formation Level	220.121	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.102 CH NO.19/473.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.282842445 hr

0.282842445 hr *60

16.97054667 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.102 CH NO.19/473.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	332.340502	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.102 CH NO.19/473.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{0.997292656 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **0.997292656 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.569881518 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.474901265 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.029		0.474901265		+0.5000
215.0039 m				

Proposed Formation Level	220.121	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.103 CH NO.19/585.000

Catchment Area	0.014399411	sq.km
Length of longest stream (L) (km)	0.1583552	
Height of furthest point (m)	213.834	
Height of point of intersection (m)	213.501	
Height Difference (H) (m)	0.333	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	213.6675	
Observed H.F.L	214.111	
Proposed Formation Level	220.166	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.103 CH NO.19/585.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.216958265 hr

0.216958265 hr *60

13.01749593 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.103 CH NO.19/585.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	433.2630509	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.103 CH NO.19/585.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{1.274380483 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = $\mathbf{1.274380483 \text{ cum/sec}}$

b Avg. Waterway Required = Q/V (V=1.75)
 0.728217419 Sq.m

c Proposed opening $1 \times 1.2 \times 1.2$

d Height of water = Avg. Waterway/total width
 0.606847849 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
213.6675		0.606847849		+0.5000
214.7743 m				

Proposed Formation Level	220.166	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.105 CH NO.19/958.000

Catchment Area	0.040297626	sq.km
Length of longest stream (L) (km)	0.226507	
Height of furthest point (m)	214.328	
Height of point of intersection (m)	214.153	
Height Difference (H) (m)	0.175	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.2405	
Observed H.F.L	214.803	
Proposed Formation Level	220.316	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.105 CH NO.19/958.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.392338889 \text{ hr}$$

$$= 0.392338889 \text{ hr} \times 60$$

$$= 23.54033336 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.105 CH NO.19/958.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	239.5887906	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.105 CH NO.19/958.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.972189745 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.972189745 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.126965569 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.939137974 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.2405		0.939137974		+0.5000
215.6796 m				

Proposed Formation Level	220.316	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.106 CH NO.20/242.000

Catchment Area	0.02184171	sq.km
Length of longest stream (L) (km)	0.1701525	
Height of furthest point (m)	214.328	
Height of point of intersection (m)	213.870	
Height Difference (H) (m)	0.458	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.099	
Observed H.F.L	214.57	
Proposed Formation Level	220.43	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.106 CH NO.20/242.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.209372234 hr

0.209372234 hr *60

12.56233402 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.106 CH NO.20/242.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	448.9611558	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.106 CH NO.20/242.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.003079269 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.003079269 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.144616725 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.953847271 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.099		0.953847271		+0.5000
215.5528 m				

Proposed Formation Level	220.43	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.108 CH NO.20/420.000

Catchment Area	0.028514373	sq.km
Length of longest stream (L) (km)	0.2192234	
Height of furthest point (m)	214.9	
Height of point of intersection (m)	214.59	
Height Difference (H) (m)	0.31	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.745	
Observed H.F.L	215.27	
Proposed Formation Level	220.494	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.108 CH NO.20/420.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.311385343 hr

0.311385343 hr *60

18.68312059 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.108 CH NO.20/420.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F) ^ 0.2$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F) ^ 0.2$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	301.8767648	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.108 CH NO.20/420.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.758313284 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.758313284 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.004750448 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.83729204 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.745		0.83729204		+0.5000
216.0823 m				

Proposed Formation Level	220.494	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.109 CH NO.20/622.500

Catchment Area	0.01400796	sq.km
Length of longest stream (L) (km)	0.1485443	
Height of furthest point (m)	214.9	
Height of point of intersection (m)	214.406	
Height Difference (H) (m)	0.494	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.653	
Observed H.F.L	215.051	
Proposed Formation Level	220.582	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.109 CH NO.20/622.500

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.17722915 hr

0.17722915 hr *60

10.63374898 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.109 CH NO.20/622.500

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	530.3867911	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.109 CH NO.20/622.500

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.517645498 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.517645498** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.867225999 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.722688333 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.653		0.722688333		+0.5000
215.8757 m				

Proposed Formation Level	220.582	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.110 CH NO.20/715.500

Catchment Area	0.015904106	sq.km
Length of longest stream (L) (km)	0.1602344	
Height of furthest point (m)	214.900	
Height of point of intersection (m)	214.462	
Height Difference (H) (m)	0.438	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.681	
Observed H.F.L	215.122	
Proposed Formation Level	220.620	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.110 CH NO.20/715.500

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.199808354 hr

0.199808354 hr *60

11.98850123 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.110 CH NO.20/715.500

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	470.4508003	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.110 CH NO.20/715.500

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.528361955 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.528361955 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.873349688 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.727791407 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.681		0.727791407		+0.5000
215.9088 m				

Proposed Formation Level	220.62	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.112 CH NO.20/937.500

Catchment Area	0.030525156	sq.km
Length of longest stream (L) (km)	0.2251519	
Height of furthest point (m)	214.987	
Height of point of intersection (m)	214.725	
Height Difference (H) (m)	0.262	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.856	
Observed H.F.L	215.38	
Proposed Formation Level	220.709	

703

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.112 CH NO.20/937.500

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.339233175 \text{ hr}$$

$$= 0.339233175 \text{ hr} * 60$$

$$= 20.35399051 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.112 CH NO.20/937.500

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x 74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	277.0955404	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.112 CH NO.20/937.500

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{1.727786887 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = $\mathbf{1.727786887 \text{ cum/sec}}$

b Avg. Waterway Required = Q/V (V=1.75)
 0.987306792 Sq.m

c Proposed opening $1 \times 1.2 \times 1.2$

d Height of water = Avg. Waterway/total width
 0.82275566 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.856		0.82275566		+0.5000
216.1788 m				

Proposed Formation Level	220.709	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR NO.113 CH NO.21/180.000

Catchment Area	0.016929468	sq.km
Length of longest stream (L) (km)	0.1545836	
Height of furthest point (m)	215.168	
Height of point of intersection (m)	214.968	
Height Difference (H) (m)	0.2	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	215.068	
Observed H.F.L	216.568	
Proposed Formation Level	220.807	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR NO.113 CH NO.21/180.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.252306703 hr

0.252306703 hr *60

15.13840217 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR NO.113 CH NO.21/180.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	372.5624367	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR NO.113 CH NO.21/180.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.288383424 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.288383424** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.7362191 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.245406367 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
215.068		0.245406367		+0.5000
215.8134 m				

Proposed Formation Level	220.807	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.114 CH NO.21/355.000

Catchment Area	0.051396229	sq.km
Length of longest stream (L) (km)	0.2682873	
Height of furthest point (m)	215.124	
Height of point of intersection (m)	214.816	
Height Difference (H) (m)	0.308	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.970	
Observed H.F.L	215.446	
Proposed Formation Level	221.490	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.114 CH NO.21/355.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.384637056 hr

0.384637056 hr *60

23.07822335 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.114 CH NO.21/355.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	244.3862301	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.114 CH NO.21/355.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.565728685 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.565728685 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.466130677 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.221775564 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.97		1.221775564		+0.5000

216.6918 m

Proposed Formation Level	221.49	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.116 CH NO.21/721.000

Catchment Area	0.019164911	sq.km
Length of longest stream (L) (km)	0.1656467	
Height of furthest point (m)	215.27	
Height of point of intersection (m)	215.073	
Height Difference (H) (m)	0.197	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	215.172	
Observed H.F.L	215.773	
Proposed Formation Level	222.610	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.116 CH NO.21/721.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.272435274 \text{ hr}$$

$$= 0.272435274 \text{ hr} * 60$$

$$= 16.34611644 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.116 CH NO.21/721.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	345.0360837	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.116 CH NO.21/721.000

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 1.350747172 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **1.350747172 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.771855527 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.643212939 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
215.1715		0.643212939		+0.5000
216.3147 m				

Proposed Formation Level	222.61	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.118 CH NO.22/411.000

Catchment Area	0.009665113	sq.km
Length of longest stream (L) (km)	0.1195033	
Height of furthest point (m)	216.124	
Height of point of intersection (m)	215.741	
Height Difference (H) (m)	0.383	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	215.933	
Observed H.F.L	216.375	
Proposed Formation Level	221.561	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.118 CH NO.22/411.000

2 Run off coefficient

Description of the catchment

Formula for C

a	Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b	Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c	Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d	Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e	Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

Duration of Rainfall

	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.154484395 \text{ hr}$$

$$= 0.154484395 \text{ hr} * 60$$

$$= 9.269063726 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.118 CH NO.22/411.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	608.4756958	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.118 CH NO.22/411.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.20130395 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.20130395 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.6864594 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.5720495 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
215.9325		0.5720495		+0.5000

217.0045 m

Proposed Formation Level	221.561	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.119 CH NO.22/650.000

Catchment Area	0.029096326	sq.km
Length of longest stream (L) (km)	0.2137412	
Height of furthest point (m)	212.935	
Height of point of intersection (m)	212.513	
Height Difference (H) (m)	0.422	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	212.724	
Observed H.F.L	213.194	
Proposed Formation Level	221.345	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.119 CH NO.22/650.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.272710297 hr

0.272710297 hr *60

16.36261782 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.119 CH NO.22/650.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	344.6881216	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.119 CH NO.22/650.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.048647385 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.048647385 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.170655648 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.975546374 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
212.724		0.975546374		+0.5000
214.1995 m				

Proposed Formation Level	221.345	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.122 CH NO.23/360.000

Catchment Area	0.010743702	sq.km
Length of longest stream (L) (km)	0.1183312	
Height of furthest point (m)	215.736	
Height of point of intersection (m)	215.536	
Height Difference (H) (m)	0.2	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	215.636	
Observed H.F.L	217.111	
Proposed Formation Level	221.407	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.122 CH NO.23/360.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.191338513 hr
 0.191338513 hr *60
 11.48031078 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.122 CH NO.23/360.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	491.2758989	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.122 CH NO.23/360.000

4 Design Flood Discharge =

$$\begin{aligned} Q-50 &= 0.278 \text{ C I A} \\ Q-50 &= \mathbf{1.078157378 \text{ cum/sec}} \end{aligned}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.078157378 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.61608993 Sq.m

Proposed opening = 1x3x3

d Height of water = Avg. Waterway/total width
0.20536331 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
215.636		0.20536331		+0.5000

216.3414 m

Proposed Formation Level	221.407	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.123 CH NO.23/588.000

Catchment Area	0.012765894	sq.km
Length of longest stream (L) (km)	0.1294508	
Height of furthest point (m)	215.876	
Height of point of intersection (m)	215.464	
Height Difference (H) (m)	0.412	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	215.67	
Observed H.F.L	216.076	
Proposed Formation Level	221.298	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.123 CH NO.23/588.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.163639772 hr

0.163639772 hr *60

9.818386304 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.123 CH NO.23/588.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	574.4324806	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.123 CH NO.23/588.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.497935 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.497935 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.855962857 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.713302381 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
215.67		0.713302381		+0.5000
216.8833 m				

Proposed Formation Level	221.298	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.125 CH NO.23/956.000

Catchment Area	0.020129349	sq.km
Length of longest stream (L) (km)	0.1926347	
Height of furthest point (m)	215.107	
Height of point of intersection (m)	214.918	
Height Difference (H) (m)	0.189	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	215.0125	
Observed H.F.L	215.591	
Proposed Formation Level	220.761	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.125 CH NO.23/956.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.323088059 hr
 0.323088059 hr *60
 19.38528352 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.125 CH NO.23/956.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	290.942353	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.125 CH NO.23/956.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.19629814 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.19629814 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.683598937 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.569665781 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
215.0125		0.569665781		+0.5000
216.0822 m				

Proposed Formation Level	220.761	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.126 CH NO.24/322.000

Catchment Area	0.012827832	sq.km
Length of longest stream (L) (km)	0.2217801	
Height of furthest point (m)	214.85	
Height of point of intersection (m)	214.617	
Height Difference (H) (m)	0.233	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	214.7335	
Observed H.F.L	215.217	
Proposed Formation Level	222.228	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.126 CH NO.24/322.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.347769966 hr

0.347769966 hr *60

20.86619793 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.126 CH NO.24/322.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	270.2936116	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.126 CH NO.24/322.000

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 0.708258476 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **0.708258476 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.404719129 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.337265941 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
214.7335		0.337265941		+0.5000
215.5708 m				

Proposed Formation Level	222.228	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.127 CH NO.24/418.000

Catchment Area	0.011131134	sq.km
Length of longest stream (L) (km)	0.139902	
Height of furthest point (m)	216.198	
Height of point of intersection (m)	215.996	
Height Difference (H) (m)	0.202	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	216.097	
Observed H.F.L	216.627	
Proposed Formation Level	222.276	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.127 CH NO.24/418.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.226767879 hr

0.226767879 hr *60

13.60607274 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.127 CH NO.24/418.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	414.5207886	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.127 CH NO.24/418.000

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 0.94251543 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **0.94251543 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.538580246 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.448816872 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
216.097		0.448816872		+0.5000
217.0458 m				

Proposed Formation Level	222.276	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.128 CH NO.24/776.000

Catchment Area	0.015919304	sq.km
Length of longest stream (L) (km)	0.1491035	
Height of furthest point (m)	216.265	
Height of point of intersection (m)	215.902	
Height Difference (H) (m)	0.363	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	216.0835	
Observed H.F.L	216.452	
Proposed Formation Level	221.339	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.128 CH NO.24/776.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.197875546 hr

0.197875546 hr *60

11.87253277 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.128 CH NO.24/776.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	475.046067	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.128 CH NO.24/776.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.544765442 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.544765442 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.88272311 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.735602592 m

Min. Formation Required

B.L + Ht of water + free Board

216.0835 0.735602592 +0.5000

217.3191 m

Proposed Formation
Level

221.339 m

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.129 24/915.000

Catchment Area	0.015453467	sq.km
Length of longest stream (L) (km)	0.1534982	
Height of furthest point (m)	216.014	
Height of point of intersection (m)	215.777	
Height Difference (H) (m)	0.237	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	215.8955	
Observed H.F.L	216.327	
Proposed Formation Level	221.819	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.129 24/915.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.236226558 hr

0.236226558 hr *60

14.1735935 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.129 24/915.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	397.9230813	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.129 24/915.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.256110373 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.256110373 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.717777356 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.598147797 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
215.8955		0.598147797		+0.5000
216.9936 m				

Proposed Formation Level	221.819	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.132 CH NO.25/916.000

Catchment Area	0.02004774	sq.km
Length of longest stream (L) (km)	0.193032	
Height of furthest point (m)	217.200	
Height of point of intersection (m)	216.884	
Height Difference (H) (m)	0.316	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	217.042	
Observed H.F.L	217.562	
Proposed Formation Level	225.452	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.132 CH NO.25/916.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.271165412 hr

0.271165412 hr *60

16.26992471 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.132 CH NO.25/916.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	346.6518808	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.132 CH NO.25/916.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.419586055 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.419586055 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.811192031 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.675993359 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
217.042		0.675993359		+0.5000
218.2180 m				

Proposed Formation Level	225.452	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.133 CH NO.26/262.000

Catchment Area	0.024575705	sq.km
Length of longest stream (L) (km)	0.1950912	
Height of furthest point (m)	216.486	
Height of point of intersection (m)	216.185	
Height Difference (H) (m)	0.301	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	216.3355	
Observed H.F.L	216.582	
Proposed Formation Level	227.363	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.133 CH NO.26/262.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.27879858 hr

0.27879858 hr *60

16.72791482 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.133 CH NO.26/262.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	337.1609708	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.133 CH NO.26/262.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.6925676 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.6925676 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.967181486 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.805984572 m

Min. Formation Required

B.L + Ht of water + free Board

$$216.3355 + 0.805984572 + 0.5000$$

$$217.6415 \text{ m}$$

Proposed Formation Level

$$227.363 \text{ m}$$

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.135 CH NO.26/532.500

Catchment Area	0.0254649	sq.km
Length of longest stream (L) (km)	0.196083	
Height of furthest point (m)	216.887	
Height of point of intersection (m)	216.400	
Height Difference (H) (m)	0.487	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	216.6435	
Observed H.F.L	217.047	
Proposed Formation Level	228.530	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.135 CH NO.26/532.500

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon
catchment Area &
duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.237398434 hr

0.237398434 hr *60

14.24390602 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.135 CH NO.26/532.500

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a tc h Ratio = 0.470 From Fig. 10

b 1h Ratio = 0.370 From Fig. 10

c Coefficient K = $\frac{tc\ h\ Ratio}{1h\ Ratio}$
= 1.27027027

d
i R-50 (24) = 200 mm

ii R-50 (1) = R-50 (24) x 1 h to 24 h Rainfall Ratio.
= 74 mm

iii R-50 (tc) = K x R-50 (1)
= 1h Ratio x74
= 94 mm

iv Int. of rainfall (I) = $\frac{R-50\ (tc)}{tc}$

I = 395.9588045 mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.135 CH NO.26/532.500

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.059656144 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.059656144** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
1.176946368 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.98078864 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
216.6435		0.98078864		+0.5000
218.1243 m				

Proposed Formation Level	228.53	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.137 CH NO.26/893.500

Catchment Area	0.0377094	sq.km
Length of longest stream (L) (km)	0.2290994	
Height of furthest point (m)	217.237	
Height of point of intersection (m)	216.763	
Height Difference (H) (m)	0.474	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	217.000	
Observed H.F.L	217.407	
Proposed Formation Level	230.383	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.137 CH NO.26/893.500

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.281501856 hr

0.281501856 hr *60

16.89011135 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.137 CH NO.26/893.500

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	333.9231983	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.137 CH NO.26/893.500

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.572165779 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.572165779 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.469809017 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.224840847 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
217		1.224840847		+0.5000
218.7248 m				

Proposed Formation Level	230.383	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.140 CH NO.27/512.500

Catchment Area	0.01903721	sq.km
Length of longest stream (L) (km)	0.1677308	
Height of furthest point (m)	218.300	
Height of point of intersection (m)	217.965	
Height Difference (H) (m)	0.335	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	218.133	
Observed H.F.L	218.597	
Proposed Formation Level	228.820	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.140 CH NO.27/512.500

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.22979142 hr

0.22979142 hr *60

13.78748519 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.140 CH NO.27/512.500

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	409.0666225	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.140 CH NO.27/512.500

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.590743246 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.590743246 cum/sec**

b Avg. Waterway Required = Q/V ($V=1.75$)
0.908996141 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.757496784 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
218.1325		0.757496784		+0.5000
219.3900 m				

Proposed Formation Level	228.82	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.142 CH NO.27/834.500

Catchment Area	0.03692975	sq.km
Length of longest stream (L) (km)	0.2471928	
Height of furthest point (m)	218.236	
Height of point of intersection (m)	217.899	
Height Difference (H) (m)	0.337	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	218.068	
Observed H.F.L	218.550	
Proposed Formation Level	227.260	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.142 CH NO.27/834.500

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.342578225 hr

0.342578225 hr *60

20.55469349 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.142 CH NO.27/834.500

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	274.3898858	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.142 CH NO.27/834.500

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.069889726 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.069889726 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.182794129 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.985661774 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
218.0675		0.985661774		+0.5000
219.5532 m				

Proposed Formation Level	227.260	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.143 CH NO.28/292.530

Catchment Area	0.030012401	sq.km
Length of longest stream (L) (km)	0.2023394	
Height of furthest point (m)	218.421	
Height of point of intersection (m)	218.028	
Height Difference (H) (m)	0.393	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	218.2245	
Observed H.F.L	219.586	
Proposed Formation Level	225.128	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.143 CH NO.28/292.530

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.264075338 \text{ hr}$$

$$= 0.264075338 \text{ hr} * 60$$

$$= 15.84452027 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.143 CH NO.28/292.530

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	355.9590259	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.143 CH NO.28/292.530

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.182244926 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.182244926 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.246997101 Sq.m

c Proposed opening 1x3.0x3.0

d Height of water = Avg. Waterway/total width
0.4156657 m

Min. Formation Required

B.L + Ht of water + free Board

$$218.2245 + 0.4156657 + 0.5000$$

$$219.1402 \text{ m}$$

Proposed Formation Level

$$225.128 \text{ m}$$

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.145 CH NO.28/677.000

Catchment Area	0.02099757	sq.km
Length of longest stream (L) (km)	0.1820952	
Height of furthest point (m)	218.102	
Height of point of intersection (m)	217.848	
Height Difference (H) (m)	0.254	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	217.975	
Observed H.F.L	218.448	
Proposed Formation Level	224.055	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.145 CH NO.28/677.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.275258864 hr

0.275258864 hr *60

16.51553184 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.145 CH NO.28/677.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	341.4967229	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.145 CH NO.28/677.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.464732508 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.464732508 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.836990005 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.697491671 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
217.975		0.697491671		+0.5000
219.1725 m				

Proposed Formation Level	224.055	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.148 CH NO.29/667.000

Catchment Area	0.02835413	sq.km
Length of longest stream (L) (km)	0.196665	
Height of furthest point (m)	218.534	
Height of point of intersection (m)	218.271	
Height Difference (H) (m)	0.263	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	218.403	
Observed H.F.L	218.933	
Proposed Formation Level	223.732	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.148 CH NO.29/667.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.294525425 hr

0.294525425 hr *60

17.67152548 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.148 CH NO.29/667.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x 74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	319.157506	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.148 CH NO.29/667.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.848519904 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.848519904** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
1.056297088 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.880247573 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
218.4025		0.880247573		+0.5000
219.7827 m				

Proposed Formation Level	223.732	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.149 A CH NO.29/928.430

Catchment Area	0.055516244	sq.km
Length of longest stream (L) (km)	0.2873235	
Height of furthest point (m)	218.376	
Height of point of intersection (m)	218.078	
Height Difference (H) (m)	0.298	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	218.227	
Observed H.F.L	218.624	
Proposed Formation Level	223.930	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.149 A CH NO.29/928.430

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.417647155 \text{ hr}$$

$$= 0.417647155 \text{ hr} * 60$$

$$= 25.05882929 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.149 A CH NO.29/928.430

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	225.0703708	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.149 A CH NO.29/928.430

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 2.552355367 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **2.552355367 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.458488781 Sq.m

c Proposed opening 1X1.2x1.2

d Height of water = Avg. Waterway/total width
1.215407317 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
218.227		1.215407317		+0.5000
219.942 m				

Proposed Formation Level 223.93 m

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.151 CH NO.30/312.000

Catchment Area	0.02970666	sq.km
Length of longest stream (L) (km)	0.2329059	
Height of furthest point (m)	218.639	
Height of point of intersection (m)	218.387	
Height Difference (H) (m)	0.252	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	218.513	
Observed H.F.L	219.010	
Proposed Formation Level	224.220	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.151 CH NO.30/312.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.356080852 hr

0.356080852 hr *60

21.36485114 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.151 CH NO.30/312.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	263.9849893	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.151 CH NO.30/312.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.601901473 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.601901473 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.91537227 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.762810225 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
218.513		0.762810225		+0.5000
219.7758 m				

Proposed Formation Level	224.22	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.153 CH NO.30/553.000

Catchment Area	0.02422757	sq.km
Length of longest stream (L) (km)	0.1923206	
Height of furthest point (m)	219.122	
Height of point of intersection (m)	218.745	
Height Difference (H) (m)	0.377	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	218.9335	
Observed H.F.L	220.325	
Proposed Formation Level	224.395	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.153 CH NO.30/553.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.254172724 \text{ hr}$$

$$= 0.254172724 \text{ hr} * 60$$

$$= 15.25036341 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.153 CH NO.30/553.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	369.8272524	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.153 CH NO.30/553.000

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 1.830254614 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **1.830254614 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.045859779 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.348619926 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
218.9335		0.348619926		+0.5000
219.7821 m				

Proposed Formation Level	224.395	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.154 CH NO.30/772.000

Catchment Area	0.0192139	sq.km
Length of longest stream (L) (km)	0.1636257	
Height of furthest point (m)	219.556	
Height of point of intersection (m)	219.133	
Height Difference (H) (m)	0.423	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	219.3445	
Observed H.F.L	219.797	
Proposed Formation Level	224.568	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.154 CH NO.30/772.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.206656416 hr

0.206656416 hr *60

12.39938498 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.154 CH NO.30/772.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	454.8612701	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.154 CH NO.30/772.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.785242545 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.785242545 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.020138597 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.850115497 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
219.3445		0.850115497		+0.5000
220.6946 m				

Proposed Formation Level	224.568	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR NO. 156 CH NO.31/490.000

Catchment Area	0.04359643	sq.km
Length of longest stream (L) (km)	0.2665623	
Height of furthest point (m)	219.5	
Height of point of intersection (m)	219.082	
Height Difference (H) (m)	0.418	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	219.291	
Observed H.F.L	220.605	
Proposed Formation Level	225.112	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR NO. 156 CH NO.31/490.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = $\frac{\text{Areal Reduction factor}}{\text{depending upon catchment Area}}$
& duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.343871248 hr

0.343871248 hr *60

20.6322749 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR NO. 156 CH NO.31/490.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	273.3581259	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR NO. 156 CH NO.31/490.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.434364791 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.434364791 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.391065595 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.463688532 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
219.291		0.463688532		+0.5000
220.2547 m				

Proposed Formation Level	225.112 m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 158 CH NO.32/000.000

Catchment Area	0.02504643	sq.km
Length of longest stream (L) (km)	0.1863354	
Height of furthest point (m)	219.5	
Height of point of intersection (m)	219.028	
Height Difference (H) (m)	0.472	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	219.264	
Observed H.F.L	220.539	
Proposed Formation Level	225.501	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 158 CH NO.32/000.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.227638502 hr
 0.227638502 hr *60
 13.6583101 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 158 CH NO.32/000.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	412.9354187 mm/hr	

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 158 CH NO.32/000.000

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 2.112665352 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **2.112665352 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.207237344 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.402412448 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
219.264		0.402412448		+0.5000
220.1664 m				

Proposed Formation Level	225.501	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 159 CH NO.32/093.000

Catchment Area	0.01903721	sq.km
Length of longest stream (L) (km)	0.1677308	
Height of furthest point (m)	219.100	
Height of point of intersection (m)	218.85	
Height Difference (H) (m)	0.25	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	218.975	
Observed H.F.L	220.45	
Proposed Formation Level	225.565	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 159 CH NO.32/093.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.254205512 \text{ hr}$$

$$= 0.254205512 \text{ hr} * 60$$

$$= 15.25233075 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 159 CH NO.32/093.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	369.77955	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 159 CH NO.32/093.000

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 1.437967043 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **1.437967043 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.821695453 Sq.m

c Proposed opening 1x3x3

d Height of water = Avg. Waterway/total width
0.273898484 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
218.975		0.273898484		+0.5000
219.7489 m				

Proposed Formation Level	225.565	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 161 CH NO.32/402.000

Catchment Area	0.01223263	sq.km
Length of longest stream (L) (km)	0.1472122	
Height of furthest point (m)	219.6	
Height of point of intersection (m)	219.210	
Height Difference (H) (m)	0.39	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	219.405	
Observed H.F.L	220.759	
Proposed Formation Level	224.063	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 161 CH NO.32/402.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon
catchment Area &
duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.190504196 hr

0.190504196 hr *60

11.43025178 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 161 CH NO.32/402.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a tc h Ratio = 0.470 From Fig. 10

b 1h Ratio = 0.370 From Fig. 10

c Coefficient K = $\frac{tc\ h\ Ratio}{1h\ Ratio}$
= 1.27027027

d
i R-50 (24) = 200 mm

ii R-50 (1) = R-50 (24) x 1 h to 24 h Rainfall Ratio.
= 74 mm

iii R-50 (tc) = K x R-50 (1)
= 1h Ratio x74
= 94 mm

iv Int. of rainfall (I) = $\frac{R-50\ (tc)}{tc}$

I = 493.4274508 mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO 161 CH NO.32/402.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.232951204 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.232951204 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.704543545 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.234847848 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
219.405		0.234847848		+0.5000

220.1398 m

Proposed Formation Level	224.063	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.164 CH NO.33/830.000

Catchment Area	0.104288249	sq.km
Length of longest stream (L) (km)	0.4837609	
Height of furthest point (m)	219.945	
Height of point of intersection (m)	219.641	
Height Difference (H) (m)	0.304	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	219.793	
Observed H.F.L	221.125	
Proposed Formation Level	227.636	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.164 CH NO.33/830.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.711215895 hr

0.711215895 hr *60

42.67295368 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.164 CH NO.33/830.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	132.1680248	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.164 CH NO.33/830.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.815558256 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.815558256 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.608890432 Sq.m

c Proposed opening 1x3.0x3.0

d Height of water = Avg. Waterway/total width
0.536296811 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
219.793		0.536296811		+0.5000

220.8293 m

Proposed Formation Level	227.636	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.165 CH NO.34/110.000

Catchment Area	0.048915411	sq.km
Length of longest stream (L) (km)	0.2478694	
Height of furthest point (m)	219.845	
Height of point of intersection (m)	219.582	
Height Difference (H) (m)	0.263	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	219.7135	
Observed H.F.L	220.015	
Proposed Formation Level	228.994	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.165 CH NO.34/110.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.374227746 \text{ hr}$$

$$= 0.374227746 \text{ hr} * 60$$

$$= 22.45366479 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.165 CH NO.34/110.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	251.1839405	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.165 CH NO.34/110.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.509806955 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.509806955 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.434175403 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.195146169 m

Min. Formation Required

B.L + Ht of water + free Board

$$219.7135 + 1.195146169 + 0.5000$$

$$221.4086 \text{ m}$$

Proposed Formation Level

$$228.994 \text{ m}$$

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.169 CH NO.34/830.000

Catchment Area	0.044525891	sq.km
Length of longest stream (L) (km)	0.2474328	
Height of furthest point (m)	222.014	
Height of point of intersection (m)	221.743	
Height Difference (H) (m)	0.271	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	221.8785	
Observed H.F.L	222.215	
Proposed Formation Level	231.939	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.169 CH NO.34/830.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.369703761 \text{ hr}$$

$$= 0.369703761 \text{ hr} * 60$$

$$= 22.18222567 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.169 CH NO.34/830.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	254.2576243	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.169 CH NO.34/830.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.312540492 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.312540492 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.32145171 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.101209758 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
221.8785		1.101209758		+0.5000

223.4797 m

Proposed Formation Level	231.939	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 172 CH NO.35/778.000

Catchment Area	0.02716391	sq.km
Length of longest stream (L) (km)	0.1875218	
Height of furthest point (m)	222.126	
Height of point of intersection (m)	221.783	
Height Difference (H) (m)	0.343	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	221.9545	
Observed H.F.L	223.354	
Proposed Formation Level	231.308	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 172 CH NO.35/778.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.255818591 hr

0.255818591 hr *60

15.34911549 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 172 CH NO.35/778.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	367.4478835	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 172 CH NO.35/778.000

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 2.03887582 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **2.03887582 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.165071897 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.388357299 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
221.9545		0.388357299		+0.5000
222.8429 m				

Proposed Formation Level	231.308	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 173 CH NO.36/038.000

Catchment Area	0.006657063	sq.km
Length of longest stream (L) (km)	0.3267429	
Height of furthest point (m)	221.212	
Height of point of intersection (m)	220.926	
Height Difference (H) (m)	0.286	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	221.069	
Observed H.F.L	222.507	
Proposed Formation Level	230.011	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 173 CH NO.36/038.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.483901639 \text{ hr}$$

$$= 0.483901639 \text{ hr} \times 60$$

$$= 29.03409836 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 173 CH NO.36/038.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	194.2543533	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 173 CH NO.36/038.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{0.264153378 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **0.264153378 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.150944788 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.050314929 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
221.069		0.050314929		+0.5000
221.6193 m				

Proposed Formation Level	230.011	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.175 CH NO.36/581.000

Catchment Area	0.04100551	sq.km
Length of longest stream (L) (km)	0.2642207	
Height of furthest point (m)	221.578	
Height of point of intersection (m)	221.218	
Height Difference (H) (m)	0.36	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	221.398	
Observed H.F.L	221.756	
Proposed Formation Level	227.794	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.175 CH NO.36/581.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.35876603 hr

0.35876603 hr *60

21.52596183 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.175 CH NO.36/581.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	262.0091983	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.175 CH NO.36/581.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.194630943 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.194630943 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.254074825 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.045062354 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
221.398		1.045062354		+0.5000
222.9431 m				

Proposed Formation Level	227.794	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.179 CH NO.37/910.000

Catchment Area	0.03579948	sq.km
Length of longest stream (L) (km)	0.2129033	
Height of furthest point (m)	221.145	
Height of point of intersection (m)	220.892	
Height Difference (H) (m)	0.253	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	221.0185	
Observed H.F.L	221.465	
Proposed Formation Level	226.699	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.179 CH NO.37/910.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.324035205 hr

0.324035205 hr *60

19.4421123 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.179 CH NO.37/910.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	290.0919361	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.179 CH NO.37/910.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.121363623 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.121363623 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.212207784 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.010173154 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
221.0185		1.010173154		+0.5000
222.5287 m				

Proposed Formation Level	226.699	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 187A CH NO. 41/004.570

Catchment Area	0.10367096	sq.km
Length of longest stream (L) (km)	0.3998792	
Height of furthest point (m)	220.805	
Height of point of intersection (m)	220.517	
Height Difference (H) (m)	0.288	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	220.661	
Observed H.F.L	221.105	
Proposed Formation Level	226.698	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 187A CH NO. 41/004.570

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.59498486 hr
 0.59498486 hr *60
 35.6990916 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 187A CH NO. 41/004.570

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

$$\begin{aligned}
 R &= 20 \text{ cm} \\
 F &= 0.87 \\
 C &= 0.415(R \times F)^{0.2} \\
 C &= \mathbf{0.734781048}
 \end{aligned}$$

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

$$\begin{aligned}
 \text{a} \quad \text{tc h Ratio} &= 0.470 \quad \text{From Fig. 10} \\
 \text{b} \quad \text{1h Ratio} &= 0.370 \quad \text{From Fig. 10} \\
 \text{c} \quad \text{Coefficient K} &= \frac{\text{tc h Ratio}}{\text{1h Ratio}} \\
 &= 1.27027027 \\
 \text{d} & \\
 \text{i} \quad \text{R-50 (24)} &= 200 \text{ mm} \\
 \text{ii} \quad \text{R-50 (1)} &= \text{R-50 (24) x 1 h to 24 h Rainfall Ratio.} \\
 &= 74 \text{ mm} \\
 \text{iii} \quad \text{R-50 (tc)} &= \text{K x R-50 (1)} \\
 &= \text{1h Ratio} \times 74 \\
 &= 94 \text{ mm} \\
 \text{iv} \quad \text{Int. of rainfall (I)} &= \frac{\text{R-50 (tc)}}{\text{tc}} \\
 \mathbf{I} &= \mathbf{157.9872133 \text{ mm/hr}}
 \end{aligned}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 187A CH NO. 41/004.570

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 3.345659978 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **3.345659978** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
1.911805702 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.593171418 m

Min. Formation Required	B.L	+	Ht of water	+	free Board
	220.661		1.593171418		+0.5000
	222.7542 m				

Proposed Formation Level	226.698	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 187 CH NO.40/805.000

Catchment Area	0.021947387	sq.km
Length of longest stream (L) (km)	0.1846465	
Height of furthest point (m)	222.9	
Height of point of intersection (m)	222.551	
Height Difference (H) (m)	0.349	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	222.7255	
Observed H.F.L	224.146	
Proposed Formation Level	228.408	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 187 CH NO.40/805.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.250258159 hr

0.250258159 hr *60

15.01548954 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 187 CH NO.40/805.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a tc h Ratio = 0.470 From Fig. 10

b 1h Ratio = 0.370 From Fig. 10

c Coefficient K = $\frac{tc\ h\ Ratio}{1h\ Ratio}$
= 1.27027027

d
i R-50 (24) = 200 mm

ii R-50 (1) = R-50 (24) x 1 h to 24 h Rainfall Ratio.
= 74 mm

iii R-50 (tc) = K x R-50 (1)
= 1h Ratio x74
= 94 mm

iv Int. of rainfall (I) = $\frac{R-50\ (tc)}{tc}$

I = 375.6121293 mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 187 CH NO.40/805.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.683934389 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.683934389 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.962248222 Sq.m

c Proposed opening 1x3.0x3.0

d Height of water = Avg. Waterway/total width
0.320749407 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
222.7255		0.320749407		+0.5000
223.5462 m				

Proposed Formation Level	228.408	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 191 CH NO.42/228.000

Catchment Area	0.02210582	sq.km
Length of longest stream (L) (km)	0.1769713	
Height of furthest point (m)	224.5	
Height of point of intersection (m)	224.156	
Height Difference (H) (m)	0.344	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	224.328	
Observed H.F.L	224.756	
Proposed Formation Level	229.98	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 191 CH NO.42/228.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.240694839 hr

0.240694839 hr *60

14.44169033 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 191 CH NO.42/228.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	390.5360017	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 191 CH NO.42/228.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.76347963 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.76347963 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.007702645 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.839752205 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
224.328		0.839752205		+0.5000
225.6678 m				

Proposed Formation Level	229.98	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 192 CH NO.42/464.000

Catchment Area	0.02261951	sq.km
Length of longest stream (L) (km)	0.1785654	
Height of furthest point (m)	224.221	
Height of point of intersection (m)	223.843	
Height Difference (H) (m)	0.378	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	224.032	
Observed H.F.L	224.543	
Proposed Formation Level	229.612	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 192 CH NO.42/464.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.235166549 hr

0.235166549 hr *60

14.10999293 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 192 CH NO.42/464.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74 mm	
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	399.7167133 mm/hr	

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 192 CH NO.42/464.000

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 1.846878147 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **1.846878147 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.055358941 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.879465784 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
224.032		0.879465784		+0.5000
225.4115 m				

Proposed Formation Level	229.612	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 193 CH NO.42/660.000

Catchment Area	0.02249869	sq.km
Length of longest stream (L) (km)	0.184076	
Height of furthest point (m)	224.221	
Height of point of intersection (m)	223.805	
Height Difference (H) (m)	0.416	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	224.013	
Observed H.F.L	224.442	
Proposed Formation Level	229.727	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 193 CH NO.42/660.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.234792852 \text{ hr}$$

$$= 0.234792852 \text{ hr} * 60$$

$$= 14.08757109 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 193 CH NO.42/660.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	400.3529042	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 193 CH NO.42/660.000

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 1.839937019 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **1.839937019 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.051392582 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.876160485 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
224.013		0.876160485		+0.5000
225.3892 m				

Proposed Formation Level	229.727	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.194 CH NO.43/186.000

Catchment Area	0.065826784	sq.km
Length of longest stream (L) (km)	0.3178257	
Height of furthest point (m)	224.451	
Height of point of intersection (m)	224.101	
Height Difference (H) (m)	0.35	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	224.276	
Observed H.F.L	224.654	
Proposed Formation Level	230.061	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.194 CH NO.43/186.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.438593461 hr

0.438593461 hr *60

26.31560765 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.194 CH NO.43/186.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	214.3214808	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.194 CH NO.43/186.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.881848072 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.881848072 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.646770327 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.372308606 m

Min. Formation Required

B.L + Ht of water + free Board

$$224.276 + 1.372308606 + 0.5000$$

226.1483 m

Proposed Formation
Level

$$230.061 \text{ m}$$

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.196 CH NO.43/427.000

Catchment Area	0.034139742	sq.km
Length of longest stream (L) (km)	0.2778034	
Height of furthest point (m)	223.789	
Height of point of intersection (m)	223.455	
Height Difference (H) (m)	0.334	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	223.622	
Observed H.F.L	224.897	
Proposed Formation Level	229.347	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.196 CH NO.43/427.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.387771459 hr

0.387771459 hr *60

23.26628751 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.196 CH NO.43/427.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F) ^ 0.2$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F) ^ 0.2$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	242.4108271	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.196 CH NO.43/427.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.690499281 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.690499281 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.965999589 Sq.m

c Proposed opening 1x3.0x3.0

d Height of water = Avg. Waterway/total width
0.321999863 m

Min. Formation Required

B.L + Ht of water + free Board

$$223.622 + 0.321999863 + 0.5000$$

224.4440 m

Proposed Formation Level 229.347 m

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 201 CH NO.45/570.000

Catchment Area	0.01761461	sq.km
Length of longest stream (L) (km)	0.1661738	
Height of furthest point (m)	225.6	
Height of point of intersection (m)	225.111	
Height Difference (H) (m)	0.489	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	225.3555	
Observed H.F.L	225.724	
Proposed Formation Level	229.733	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 201 CH NO.45/570.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	C = 0.249(R x F) ^ 0.2
b Alluvium/silty/coastal area	C = 0.332(R x F) ^ 0.2
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	C = 0.415(R x F) ^ 0.2
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	C = 0.456(R x F) ^ 0.2
e Hilly soil / plateau/barren	C = 0.498(R x F) ^ 0.2

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.199742593 hr

0.199742593 hr *60

11.9845556 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 201 CH NO.45/570.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	470.6056852	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 201 CH NO.45/570.000

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 1.693296239 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **1.693296239 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.967597851 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.806331542 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
225.3555		0.806331542		+0.5000
226.6618 m				

Proposed Formation Level	229.733	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 203 CH NO.45/950.000

Catchment Area	0.02917281	sq.km
Length of longest stream (L) (km)	0.2172193	
Height of furthest point (m)	226.127	
Height of point of intersection (m)	225.994	
Height Difference (H) (m)	0.133	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	226.0605	
Observed H.F.L	227.566	
Proposed Formation Level	231.631	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 203 CH NO.45/950.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.413010448 \text{ hr}$$

$$= 0.413010448 \text{ hr} * 60$$

$$= 24.78062687 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 203 CH NO.45/950.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	227.597148	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 203 CH NO.45/950.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.356275202 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.356275202** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.775014401 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.258338134 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
226.0605		0.258338134		+0.5000
226.8188 m				

Proposed Formation Level	231.631	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 204 CH NO.46/178.000

Catchment Area	0.01645342	sq.km
Length of longest stream (L) (km)	0.164062	
Height of furthest point (m)	226.8	
Height of point of intersection (m)	226.400	
Height Difference (H) (m)	0.4	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	226.6	
Observed H.F.L	227.983	
Proposed Formation Level	232.771	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 204 CH NO.46/178.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.211262583 hr

0.211262583 hr *60

12.67575496 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 204 CH NO.46/178.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	444.9439122	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 204 CH NO.46/178.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.49542348 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.49542348 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.854527703 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.284842568 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
226.6		0.284842568		+0.5000
227.3848 m				

Proposed Formation Level	232.771	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.205 CH NO.46/267.540

Catchment Area	0.027630475	sq.km
Length of longest stream (L) (km)	0.210444	
Height of furthest point (m)	226.898	
Height of point of intersection (m)	226.551	
Height Difference (H) (m)	0.347	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	226.7245	
Observed H.F.L	230.048	
Proposed Formation Level	233.221	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.205 CH NO.46/267.540

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.287099647 hr

0.287099647 hr *60

17.22597882 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.205 CH NO.46/267.540

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	327.4124542	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.205 CH NO.46/267.540

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.847933287 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.847933287 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.055961878 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.879968232 m

Min. Formation Required

$$\text{B.L.} + \text{Ht of water} + \text{free Board}$$

$$226.7245 + 0.879968232 + 0.5000$$

$$\mathbf{228.1045 \text{ m}}$$

Proposed Formation Level 233.221 m

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 208 CH NO.46/840.000

Catchment Area	0.032088315	sq.km
Length of longest stream (L) (km)	0.2139011	
Height of furthest point (m)	225.9	
Height of point of intersection (m)	225.528	
Height Difference (H) (m)	0.372	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	225.714	
Observed H.F.L	227.039	
Proposed Formation Level	231.516	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 208 CH NO.46/840.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.285057951 hr

0.285057951 hr *60

17.10347707 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 208 CH NO.46/840.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74 mm	
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	329.7575094 mm/hr	

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 208 CH NO.46/840.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.161445809 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.161445809 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.235111891 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.411703964 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
225.714		0.411703964		+0.5000
226.6257 m				

Proposed Formation Level	231.516	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.210 CH NO.47/696.000

Catchment Area	0.045981365	sq.km
Length of longest stream (L) (km)	0.2657758	
Height of furthest point (m)	225.786	
Height of point of intersection (m)	225.349	
Height Difference (H) (m)	0.437	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	225.5675	
Observed H.F.L	225.896	
Proposed Formation Level	231.468	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.210 CH NO.47/696.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.337603841 hr

0.337603841 hr *60

20.25623043 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.210 CH NO.47/696.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	278.4328515	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.210 CH NO.47/696.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.61520102 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.61520102 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.494400583 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.245333819 m

Min. Formation Required

B.L + Ht of water + free Board

$$225.5675 + 1.245333819 + 0.5000$$

227.3128 m

Proposed Formation
Level

$$231.468 \text{ m}$$

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.213 CH NO.48/274.920

Catchment Area	0.02667352	sq.km
Length of longest stream (L) (km)	0.1998239	
Height of furthest point (m)	226.214	
Height of point of intersection (m)	225.886	
Height Difference (H) (m)	0.328	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	226.05	
Observed H.F.L	226.354	
Proposed Formation Level	232.584	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.213 CH NO.48/274.920

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.277455677 hr

0.277455677 hr *60

16.64734061 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.213 CH NO.48/274.920

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	338.7928519	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.213 CH NO.48/274.920

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.84593886 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.84593886 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.054822206 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.879018505 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
226.05		0.879018505		+0.5000
227.4290 m				

Proposed Formation Level	232.584	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 219A CH NO. 50/661.000

Catchment Area	0.184161572	sq.km
Length of longest stream (L) (km)	0.5260873	
Height of furthest point (m)	224.650	
Height of point of intersection (m)	224.305	
Height Difference (H) (m)	0.345	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	224.478	
Observed H.F.L	224.925	
Proposed Formation Level	230.108	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 219A CH NO. 50/661.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop /	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.742586849 hr

0.742586849 hr *60

44.55521093 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 219A CH NO. 50/661.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	126.5845202	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 219A CH NO. 50/661.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 4.761922866 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **4.761922866** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
2.72109878 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
2.267582317 m

Min. Formation Required	B.L	+	Ht of water	+	free Board
	224.4775		2.267582317		+0.5000
	227.2451 m				

Proposed Formation Level	230.108	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 221 CH NO.50/830.000

Catchment Area	0.016689097	sq.km
Length of longest stream (L) (km)	0.1673432	
Height of furthest point (m)	224.925	
Height of point of intersection (m)	224.485	
Height Difference (H) (m)	0.44	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	224.705	
Observed H.F.L	226.028	
Proposed Formation Level	230.160	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 221 CH NO.50/830.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.20866191 hr

0.20866191 hr *60

12.5197146 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 221 CH NO.50/830.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a tc h Ratio = 0.470 From Fig. 10

b 1h Ratio = 0.370 From Fig. 10

c Coefficient K = $\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$
= 1.27027027

d
i R-50 (24) = 200 mm

ii R-50 (1) = R-50 (24) x 1 h to 24 h Rainfall Ratio.
= 74 mm

iii R-50 (tc) = K x R-50 (1)
= 1h Ratio x 74
= 94 mm

iv Int. of rainfall (I) = $\frac{R-50 (tc)}{tc}$

I = 450.4895023 mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 221 CH NO.50/830.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.53574909 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.53574909 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.877570909 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.292523636 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
224.705		0.292523636		+0.5000
225.4975 m				

Proposed Formation Level	230.16	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.222 CH NO.51/000.000

Catchment Area	0.053231474	sq.km
Length of longest stream (L) (km)	0.2850599	
Height of furthest point (m)	224.987	
Height of point of intersection (m)	224.623	
Height Difference (H) (m)	0.364	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	224.805	
Observed H.F.L	225.124	
Proposed Formation Level	230.321	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.222 CH NO.51/000.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.386615192 hr

0.386615192 hr *60

23.19691152 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.222 CH NO.51/000.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	243.1358155	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.222 CH NO.51/000.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.643748708 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.643748708 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.510713547 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.258927956 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
224.805		1.258927956		+0.5000

226.5639 m

Proposed Formation Level	230.321	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.225 CH NO.52/283.000

Catchment Area	0.028845871	sq.km
Length of longest stream (L) (km)	0.2157319	
Height of furthest point (m)	225.312	
Height of point of intersection (m)	224.964	
Height Difference (H) (m)	0.348	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	225.138	
Observed H.F.L	225.879	
Proposed Formation Level	231.740	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.225 CH NO.52/283.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.294277144 hr

0.294277144 hr *60

17.65662863 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.225 CH NO.52/283.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	319.4267784	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.225 CH NO.52/283.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.882165106 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.882165106 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.075522918 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.896269098 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
225.138		0.896269098		+0.5000

226.5343 m

Proposed Formation Level	231.74	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 226 CH NO.52/424.000

Catchment Area	0.01731637	sq.km
Length of longest stream (L) (km)	0.1738439	
Height of furthest point (m)	225.731	
Height of point of intersection (m)	225.393	
Height Difference (H) (m)	0.338	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	225.562	
Observed H.F.L	226.937	
Proposed Formation Level	231.267	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 226 CH NO.52/424.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = $\frac{\text{Areal Reduction factor}}{\text{Area \& duration rainfall from table below}}$

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.237732619 \text{ hr}$$

$$= 0.237732619 \text{ hr} * 60$$

$$= 14.26395717 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 226 CH NO.52/424.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	395.4021968	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 226 CH NO.52/424.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.398616595 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.398616595** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.799209483 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.266403161 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
225.562		0.266403161		+0.5000
226.3284 m				

Proposed Formation Level	231.267	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 228 CH NO.52/640.000

Catchment Area	0.032582246	sq.km
Length of longest stream (L) (km)	0.2267704	
Height of furthest point (m)	226.225	
Height of point of intersection (m)	226.035	
Height Difference (H) (m)	0.190	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	226.13	
Observed H.F.L	227.598	
Proposed Formation Level	231.842	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 228 CH NO.52/640.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.381822834 hr
 0.381822834 hr *60
 22.90937003 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 228 CH NO.52/640.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	246.1874767	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 228 CH NO.52/640.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.638512359 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.638512359 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.936292777 Sq.m

c Proposed opening 1x3.0x3.0

d Height of water = Avg. Waterway/total width
0.312097592 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
226.13		0.312097592		+0.5000
226.9421 m				

Proposed Formation Level	231.842	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 229 CH NO.52/761.000

Catchment Area	0.01355729	sq.km
Length of longest stream (L) (km)	0.1435957	
Height of furthest point (m)	226.8	
Height of point of intersection (m)	226.368	
Height Difference (H) (m)	0.432	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	226.584	
Observed H.F.L	227.935	
Proposed Formation Level	232.219	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 229 CH NO.52/761.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.179225373 \text{ hr}$$

$$= 0.179225373 \text{ hr} * 60$$

$$= 10.75352237 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 229 CH NO.52/761.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F) ^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F) ^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a tc h Ratio = 0.470 From Fig. 10

b 1h Ratio = 0.370 From Fig. 10

c Coefficient K = $\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$
= 1.27027027

d
i R-50 (24) = 200 mm

ii R-50 (1) = R-50 (24) x 1 h to 24 h Rainfall Ratio.
= 74 mm

iii R-50 (tc) = K x R-50 (1)
= 1h Ratio x74
= 94 mm

iv Int. of rainfall (I) = $\frac{R-50 (tc)}{tc}$

I = 524.4793105 mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 229 CH NO.52/761.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.452459359 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.452459359 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.829976776 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.276658925 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
226.584		0.276658925		+0.5000
227.3607 m				

Proposed Formation Level	232.219	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR NO. 230A CH NO.53/000.000

Catchment Area	0.071422957	sq.km
Length of longest stream (L) (km)	0.3309775	
Height of furthest point (m)	227.480	
Height of point of intersection (m)	227.099	
Height Difference (H) (m)	0.381	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	227.290	
Observed H.F.L	227.710	
Proposed Formation Level	232.880	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR NO. 230A CH NO.53/000.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.444193604 hr
 0.444193604 hr *60
 26.65161626 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR NO. 230A CH NO.53/000.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	211.6194359	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR NO. 230A CH NO.53/000.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 3.087422897 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **3.087422897 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.764241656 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.47020138 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
227.2895		1.47020138		+1.4880
230.248		m		

Proposed Formation Level	232.88	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.234 CH NO.54/193.000

Catchment Area	0.041502605	sq.km
Length of longest stream (L) (km)	0.2628992	
Height of furthest point (m)	225.602	
Height of point of intersection (m)	225.228	
Height Difference (H) (m)	0.374	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	225.415	
Observed H.F.L	225.879	
Proposed Formation Level	231.615	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.234 CH NO.54/193.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.352242039 \text{ hr}$$

$$= 0.352242039 \text{ hr} * 60$$

$$= 21.13452232 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.234 CH NO.54/193.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	266.8619576	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.234 CH NO.54/193.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.262375905 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.262375905 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.292786232 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.07732186 m

Min. Formation Required

B.L + Ht of water + free Board

$$225.415 + 1.07732186 + 0.5000$$

$$226.9923 \text{ m}$$

Proposed Formation Level

$$231.615 \text{ m}$$

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 238 CH NO.55/926.000

Catchment Area	0.01000731	sq.km
Length of longest stream (L) (km)	0.1232293	
Height of furthest point (m)	226.1	
Height of point of intersection (m)	225.650	
Height Difference (H) (m)	0.45	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	225.875	
Observed H.F.L	227.172	
Proposed Formation Level	231.196	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 238 CH NO.55/926.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	C = 0.249(R x F) ^ 0.2
b Alluvium/silty/coastal area	C = 0.332(R x F) ^ 0.2
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	C = 0.415(R x F) ^ 0.2
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	C = 0.456(R x F) ^ 0.2
e Hilly soil / plateau/barren	C = 0.498(R x F) ^ 0.2

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.150844908 hr

0.150844908 hr *60

9.050694461 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 238 CH NO.55/926.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	623.1566013	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 238 CH NO.55/926.000

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 1.273847079 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **1.273847079 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.727912617 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.242637539 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
225.875		0.242637539		+0.5000
226.6176 m				

Proposed Formation Level	231.196	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 240 CH NO.56/600.000

Catchment Area	0.007410621	sq.km
Length of longest stream (L) (km)	0.1043524	
Height of furthest point (m)	228.821	
Height of point of intersection (m)	228.373	
Height Difference (H) (m)	0.448	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	228.597	
Observed H.F.L	229.897	
Proposed Formation Level	231.937	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 240 CH NO.56/600.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.1271918 hr

0.1271918 hr *60

7.631507983 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 240 CH NO.56/600.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	739.0413549	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 240 CH NO.56/600.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.118732066 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.118732066 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.639275466 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.213091822 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
228.597		0.213091822		+0.5000
229.3101 m				

Proposed Formation Level	231.937	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 242 CH NO.57/235.000

Catchment Area	0.01326128	sq.km
Length of longest stream (L) (km)	0.136142	
Height of furthest point (m)	228.542	
Height of point of intersection (m)	228.091	
Height Difference (H) (m)	0.451	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	228.3165	
Observed H.F.L	229.616	
Proposed Formation Level	234.849	

Using Improved Rational Formula

$$Q_{-50} = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 242 CH NO.57/235.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.167105577 hr
 0.167105577 hr *60
 10.02633461 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 242 CH NO.57/235.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a tc h Ratio = 0.470 From Fig. 10

b 1h Ratio = 0.370 From Fig. 10

c Coefficient K = $\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$
= 1.27027027

d
i R-50 (24) = 200 mm

ii R-50 (1) = R-50 (24) x 1 h to 24 h Rainfall Ratio.
= 74 mm

iii R-50 (tc) = K x R-50 (1)
= 1h Ratio x74
= 94 mm

iv Int. of rainfall (I) = $\frac{R-50 (tc)}{tc}$

I = 562.5186292 mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 242 CH NO.57/235.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.523789922 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.523789922 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.870737098 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.290245699 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
228.3165		0.290245699		+0.5000
229.1067 m				

Proposed Formation Level	234.849	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.243 CH NO.57/377.790

Catchment Area	0.046044367	sq.km
Length of longest stream (L) (km)	0.2650605	
Height of furthest point (m)	228.584	
Height of point of intersection (m)	228.212	
Height Difference (H) (m)	0.372	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	228.398	
Observed H.F.L	229.876	
Proposed Formation Level	235.557	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.243 CH NO.57/377.790

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.355897366 hr

0.355897366 hr *60

21.35384197 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.243 CH NO.57/377.790

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	264.1210892	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.243 CH NO.57/377.790

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{2.484175811 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.484175811 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.419529035 Sq.m

c Proposed opening 1x3.0x3.0

d Height of water = Avg. Waterway/total width
0.473176345 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
228.398		0.473176345		+0.5000

229.3712 m

Proposed Formation Level	235.557	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.247A CH NO. 58/701.070

Catchment Area	0.022317151	sq.km
Length of longest stream (L) (km)	0.1841722	
Height of furthest point (m)	227.214	
Height of point of intersection (m)	226.991	
Height Difference (H) (m)	0.223	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	227.1025	
Observed H.F.L	227.587	
Proposed Formation Level	233.656	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.247A CH NO. 58/701.070

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.291300843 hr

0.291300843 hr *60

17.47805056 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.247A CH NO. 58/701.070

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	322.6904501	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.247A CH NO. 58/701.070

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.471050565 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.471050565 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.840600323 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.700500269 m

Min. Formation Required

B.L. + Ht of water + free Board

227.1025 0.700500269 +0.5000

228.3030 m

Proposed Formation
Level

233.656 m

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 250 CH NO.59/437.000

Catchment Area	0.01699309	sq.km
Length of longest stream (L) (km)	0.1576062	
Height of furthest point (m)	227.9	
Height of point of intersection (m)	227.422	
Height Difference (H) (m)	0.478	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	227.661	
Observed H.F.L	228.984	
Proposed Formation Level	233.335	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 250 CH NO.59/437.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.190583693 hr

0.190583693 hr *60

11.43502161 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 250 CH NO.59/437.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F) ^ 0.2$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F) ^ 0.2$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	493.2216304	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 250 CH NO.59/437.000

4 Design Flood Discharge =

Q-50 = 0.278 x C x I x A

Q-50 = 1.712053037 cum/sec

5 Checking for adequacy of Waterway Provided

a Discharge = **1.712053037 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.978316021 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.32610534 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
227.661		0.32610534		+0.5000
228.4871 m				

Proposed Formation Level	233.335	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 252 CH NO.60/283.000

Catchment Area	0.030518439	sq.km
Length of longest stream (L) (km)	0.2245441	
Height of furthest point (m)	227.315	
Height of point of intersection (m)	227.104	
Height Difference (H) (m)	0.211	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	227.2095	
Observed H.F.L	227.726	
Proposed Formation Level	233.96	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 252 CH NO.60/283.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.364518655 \text{ hr}$$

$$= 0.364518655 \text{ hr} \times 60$$

$$= 21.87111929 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 252 CH NO.60/283.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	257.8743194	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 252 CH NO.60/283.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.607582073 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.607582073 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.918618327 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.765515273 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
227.2095		0.765515273		+0.5000

228.4750 m

Proposed Formation Level	233.96	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 254 CH NO.60/435.000

Catchment Area	0.01722946	sq.km
Length of longest stream (L) (km)	0.1730409	
Height of furthest point (m)	229.5	
Height of point of intersection (m)	229.027	
Height Difference (H) (m)	0.473	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	229.2635	
Observed H.F.L	229.646	
Proposed Formation Level	234.073	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 254 CH NO.60/435.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	C = 0.249(R x F) ^ 0.2
b Alluvium/silty/coastal area	C = 0.332(R x F) ^ 0.2
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	C = 0.415(R x F) ^ 0.2
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	C = 0.456(R x F) ^ 0.2
e Hilly soil / plateau/barren	C = 0.498(R x F) ^ 0.2

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.210696285 hr

0.210696285 hr *60

12.64177711 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 254 CH NO.60/435.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	446.1398071	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 254 CH NO.60/435.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{1.57016533 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = $\mathbf{1.57016533 \text{ cum/sec}}$

b Avg. Waterway Required = Q/V (V=1.75)
 0.897237331 Sq.m

c Proposed opening $1 \times 1.2 \times 1.2$

d Height of water = Avg. Waterway/total width
 0.747697776 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
229.2635		0.747697776		+0.5000
230.5112 m				

Proposed Formation Level	234.073	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 256 CH NO.61/028.000

Catchment Area	0.01068646	sq.km
Length of longest stream (L) (km)	0.1462453	
Height of furthest point (m)	228.699	
Height of point of intersection (m)	228.361	
Height Difference (H) (m)	0.338	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	228.53	
Observed H.F.L	228.993	
Proposed Formation Level	234.511	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 256 CH NO.61/028.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon
catchment Area & duration
rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.19878496 hr

0.19878496 hr *60

11.92709761 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 256 CH NO.61/028.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74 mm	
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	472.8727963 mm/hr	

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 256 CH NO.61/028.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.032240601 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.032240601** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.589851772 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.491543143 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
228.53		0.491543143		+0.5000
229.5215 m				

Proposed Formation Level	234.511	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.259 CH NO.61/814.000

Catchment Area	0.069027999	sq.km
Length of longest stream (L) (km)	0.3259082	
Height of furthest point (m)	230.987	
Height of point of intersection (m)	230.667	
Height Difference (H) (m)	0.32	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	230.827	
Observed H.F.L	231.124	
Proposed Formation Level	235.091	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.259 CH NO.61/814.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.464276691 hr

0.464276691 hr *60

27.85660144 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.259 CH NO.61/814.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	202.4654735	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.259 CH NO.61/814.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.85482177 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.85482177 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.631326725 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.359438938 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
230.827		1.359438938		+0.5000

232.6864 m

Proposed Formation Level	235.091	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.260 CH NO.62/071.520

Catchment Area	0.024252064	sq.km
Length of longest stream (L) (km)	0.1941089	
Height of furthest point (m)	231.189	
Height of point of intersection (m)	230.878	
Height Difference (H) (m)	0.311	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	231.0335	
Observed H.F.L	231.359	
Proposed Formation Level	235.886	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.260 CH NO.62/071.520

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.274236151 \text{ hr}$$

$$= 0.274236151 \text{ hr} * 60$$

$$= 16.45416907 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.260 CH NO.62/071.520

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	342.7702716	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.260 CH NO.62/071.520

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.698066118 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.698066118 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.970323496 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.808602914 m

Min. Formation Required

B.L + Ht of water + free Board

$$231.0335 + 0.808602914 + 0.5000$$

232.3421 m

Proposed Formation Level

$$235.886 \text{ m}$$

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 261 CH NO.62/163.000

Catchment Area	0.01035893	sq.km
Length of longest stream (L) (km)	0.1252729	
Height of furthest point (m)	230.673	
Height of point of intersection (m)	230.37	
Height Difference (H) (m)	0.303	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	230.5215	
Observed H.F.L	231.052	
Proposed Formation Level	236.203	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 261 CH NO.62/163.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon
catchment Area &
duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.175867028 hr

0.175867028 hr *60

10.55202167 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 261 CH NO.62/163.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74 mm	
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	534.4947326 mm/hr	

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 261 CH NO.62/163.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.130996003 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.130996003 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.646283431 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.538569525 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
230.5215		0.538569525		+0.5000
231.5601 m				

Proposed Formation Level	236.203	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 262 CH NO.62/286.000

Catchment Area	0.01448903	sq.km
Length of longest stream (L) (km)	0.1402169	
Height of furthest point (m)	230.752	
Height of point of intersection (m)	230.277	
Height Difference (H) (m)	0.475	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	230.5145	
Observed H.F.L	231.849	
Proposed Formation Level	236.072	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A =

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 262 CH NO.62/286.000

2 Run off coefficient

Description of the catchment

Formula for C

a	Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b	Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c	Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d	Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e	Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

Duration of Rainfall

	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.169230672 \text{ hr}$$

$$= 0.169230672 \text{ hr} * 60$$

$$= 10.15384031 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 262 CH NO.62/286.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x 74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	555.4548651	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 262 CH NO.62/286.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.64395842 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.64395842 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.939404812 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.313134937 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
230.5145		0.313134937		+0.5000
231.3276 m				

Proposed Formation Level	236.072	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.264 CH NO.62/549.000

Catchment Area	0.057009913	sq.km
Length of longest stream (L) (km)	0.2748567	
Height of furthest point (m)	228.312	
Height of point of intersection (m)	227.943	
Height Difference (H) (m)	0.369	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	228.1275	
Observed H.F.L	228.547	
Proposed Formation Level	234.746	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.264 CH NO.62/549.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.370553529 hr

0.370553529 hr *60

22.23321171 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.264 CH NO.62/549.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	253.6745511	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.264 CH NO.62/549.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.954132843 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.954132843 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.68807591 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.406729925 m

Min. Formation Required

$$\text{B.L.} + \text{Ht of water} + \text{free Board}$$

$$228.1275 + 1.406729925 + 0.5000$$

$$\mathbf{230.0342 \text{ m}}$$

Proposed Formation Level 234.746 m

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.265 CH NO.62/760.000

Catchment Area	0.029676972	sq.km
Length of longest stream (L) (km)	0.2174104	
Height of furthest point (m)	228.124	
Height of point of intersection (m)	227.79	
Height Difference (H) (m)	0.334	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	227.957	
Observed H.F.L	228.389	
Proposed Formation Level	233.998	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.265 CH NO.62/760.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.300879497 hr

0.300879497 hr *60

18.05276985 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.265 CH NO.62/760.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	312.4174322	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.265 CH NO.62/760.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.893902371 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.893902371 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.082229926 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.901858272 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
227.957		0.901858272		+0.5000

229.3589 m

Proposed Formation Level	233.998	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 266 CH NO.62/956.000

Catchment Area	0.01450152	sq.km
Length of longest stream (L) (km)	0.1491424	
Height of furthest point (m)	228.002	
Height of point of intersection (m)	227.595	
Height Difference (H) (m)	0.407	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	227.7985	
Observed H.F.L	228.238	
Proposed Formation Level	233.604	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 266 CH NO.62/956.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.190268588 hr

0.190268588 hr *60

11.41611529 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 266 CH NO.62/956.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	494.0384584	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 266 CH NO.62/956.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.463447092 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.463447092 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.836255481 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.696879568 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
227.7985		0.696879568		+0.5000
228.9954 m				

Proposed Formation Level	233.604	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 267 CH NO.63/148.000

Catchment Area	0.01294123	sq.km
Length of longest stream (L) (km)	0.1382845	
Height of furthest point (m)	227.854	
Height of point of intersection (m)	227.394	
Height Difference (H) (m)	0.46	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	227.624	
Observed H.F.L	228.081	
Proposed Formation Level	233.211	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 267 CH NO.63/148.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop /	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor depending upon catchment Area & duration rainfall from table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.168674381 hr

0.168674381 hr *60

10.12046285 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 267 CH NO.63/148.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74 mm	
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	557.286765 mm/hr	

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 267 CH NO.63/148.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.473184115 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.473184115 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.841819494 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.701516245 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
227.624		0.701516245		+0.5000

228.8255 m

Proposed Formation Level	233.211	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.271 CH NO.63/944.220

Catchment Area	0.017144295	sq.km
Length of longest stream (L) (km)	0.1657994	
Height of furthest point (m)	230.125	
Height of point of intersection (m)	229.853	
Height Difference (H) (m)	0.272	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	229.989	
Observed H.F.L	230.359	
Proposed Formation Level	236.442	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.271 CH NO.63/944.220

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.24397318 hr
 0.24397318 hr *60
 14.63839077 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.271 CH NO.63/944.220

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	385.2882525	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.271 CH NO.63/944.220

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.349298821 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.349298821 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.771027897 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.642523248 m

Min. Formation Required

B.L + Ht of water + free Board

$$229.989 + 0.642523248 + 0.5000$$

231.1315 m

Proposed Formation Level

$$236.442 \text{ m}$$

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 275 CH NO.64/438.000

Catchment Area	0.010329038	sq.km
Length of longest stream (L) (km)	0.1300037	
Height of furthest point (m)	230.6	
Height of point of intersection (m)	230.201	
Height Difference (H) (m)	0.399	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	230.4005	
Observed H.F.L	230.813	
Proposed Formation Level	237.197	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 275 CH NO.64/438.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.166191388 hr

0.166191388 hr *60

9.971483252 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 275 CH NO.64/438.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F) ^ 0.2$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F) ^ 0.2$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	565.6129442	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 275 CH NO.64/438.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.193388753 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.193388753 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.68193643 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.568280358 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
230.4005		0.568280358		+0.5000
231.4688 m				

Proposed Formation Level	237.197	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 276 CH NO.65/026.000

Catchment Area	0.011346197	sq.km
Length of longest stream (L) (km)	0.1354721	
Height of furthest point (m)	231.003	
Height of point of intersection (m)	230.554	
Height Difference (H) (m)	0.449	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	230.7785	
Observed H.F.L	232.130	
Proposed Formation Level	236.015	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 276 CH NO.65/026.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.

	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.166509732 hr

0.166509732 hr *60

9.990583891 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 276 CH NO.65/026.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	564.5315691	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 276 CH NO.65/026.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.308402243 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.308402243** cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.747658424 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.249219475 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
230.7785		0.249219475		+0.5000
231.5277 m				

Proposed Formation Level	236.015	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.277 CH No. 65/136.000

Catchment Area	0.097136298	sq.km
Length of longest stream (L) (km)	0.3762661	
Height of furthest point (m)	231.435	
Height of point of intersection (m)	231.037	
Height Difference (H) (m)	0.398	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	231.236	
Observed H.F.L	231.587	
Proposed Formation Level	236.620	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.277 CH No. 65/136.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.499663655 hr

0.499663655 hr *60

29.97981929 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.277 CH No. 65/136.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F) ^ 0.2$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F) ^ 0.2$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	188.1265509	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.277 CH No. 65/136.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 3.732797095 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **3.732797095 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
2.133026911 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.777522426 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
231.236		1.777522426		+0.5000

233.5135 m

Proposed Formation Level	236.62	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 279 CH NO.65/550.000

Catchment Area	0.01264769	sq.km
Length of longest stream (L) (km)	0.1362174	
Height of furthest point (m)	231.443	
Height of point of intersection (m)	231.119	
Height Difference (H) (m)	0.324	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	231.281	
Observed H.F.L	232.702	
Proposed Formation Level	237.418	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 279 CH NO.65/550.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.187409973 hr

0.187409973 hr *60

11.24459839 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 279 CH NO.65/550.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F)^{0.2}$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	501.5741606	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 279 CH NO.65/550.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.295833221 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.295833221 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.740476126 Sq.m

c Proposed opening 1X3X3

d Height of water = Avg. Waterway/total width
0.246825375 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
231.281		0.246825375		+0.5000
232.0278 m				

Proposed Formation Level	237.418	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.280 CH NO.65/676.000

Catchment Area	0.059217998	sq.km
Length of longest stream (L) (km)	0.2933031	
Height of furthest point (m)	231.498	
Height of point of intersection (m)	231.191	
Height Difference (H) (m)	0.307	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	231.3445	
Observed H.F.L	231.754	
Proposed Formation Level	237.477	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.280 CH NO.65/676.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

$$= 0.422289221 \text{ hr}$$

$$= 0.422289221 \text{ hr} * 60$$

$$= 25.33735328 \text{ Min}$$

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.280 CH NO.65/676.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	222.5962569	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.280 CH NO.65/676.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 2.692615369 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **2.692615369 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.538637354 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
1.282197795 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
231.3445		1.282197795		+0.5000
233.1267 m				

Proposed Formation Level	237.477	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 283 CH NO.65/987.000

Catchment Area	0.01275174	sq.km
Length of longest stream (L) (km)	0.1332567	
Height of furthest point (m)	230.769	
Height of point of intersection (m)	230.513	
Height Difference (H) (m)	0.256	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	230.641	
Observed H.F.L	231.185	
Proposed Formation Level	237.349	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 283 CH NO.65/987.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment Area
& duration rainfall from table
below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the cacthment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.198705726 hr

0.198705726 hr *60

11.92234358 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 283 CH NO.65/987.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F) ^ 0.2$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F) ^ 0.2$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \text{ h Ratio}}{1h \text{ Ratio}}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	473.0613542	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 283 CH NO.65/987.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.232223997 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = 1.232223997 cum/sec

b Avg. Waterway Required = Q/V (V=1.75)
0.704127998 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.586773332 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
230.641		0.586773332		+0.5000
231.7278 m				

Proposed Formation Level	237.349	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.285 CH NO.66/194.000

Catchment Area	0.021560964	sq.km
Length of longest stream (L) (km)	0.1775258	
Height of furthest point (m)	233.487	
Height of point of intersection (m)	233.091	
Height Difference (H) (m)	0.396	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	233.289	
Observed H.F.L	233.595	
Proposed Formation Level	237.060	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.285 CH NO.66/194.000

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.230028046 hr

0.230028046 hr *60

13.80168278 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.285 CH NO.66/194.000

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	408.6458216	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.285 CH NO.66/194.000

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.799774024 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.799774024 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
1.028442299 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.857035249 m

Min. Formation Required

B.L + Ht of water + free Board

$$233.289 + 0.857035249 + 0.5000$$

234.6460 m

Proposed Formation Level

$$237.06 \text{ m}$$

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.287 CH NO.66/541.180

Catchment Area	0.02024649	sq.km
Length of longest stream (L) (km)	0.1686477	
Height of furthest point (m)	231.741	
Height of point of intersection (m)	231.379	
Height Difference (H) (m)	0.362	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	231.56	
Observed H.F.L	231.895	
Proposed Formation Level	236.631	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.287 CH NO.66/541.180

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.22499366 hr
 0.22499366 hr *60
 13.49961961 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.287 CH NO.66/541.180

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F)^{0.2}$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	417.78955	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.287 CH NO.66/541.180

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.727865999 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.727865999 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.987351999 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.822793333 m

Min. Formation Required

B.L + Ht of water + free Board

$$231.56 + 0.822793333 + 0.5000$$

232.8828 m

Proposed Formation
Level

$$236.631 \text{ m}$$

Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.288 CH NO.66/622.770

Catchment Area	0.020699251	sq.km
Length of longest stream (L) (km)	0.1749333	
Height of furthest point (m)	230.598	
Height of point of intersection (m)	230.25	
Height Difference (H) (m)	0.348	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	230.424	
Observed H.F.L	230.845	
Proposed Formation Level	236.163	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.288 CH NO.66/622.770

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the calculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.236879887 hr

0.236879887 hr *60

14.21279321 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.288 CH NO.66/622.770

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas , $C = 0.415 (R \times F) ^ 0.2$

R	=	20	cm
F	=	0.87	
C	=	$0.415(R \times F) ^ 0.2$	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 " .

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc \ h \ Ratio}{1h \ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio	x74
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50 (tc)}{tc}$	
	I	=	396.8255865	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO.288 CH NO.66/622.770

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = 1.677865097 \text{ cum/sec}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **1.677865097 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.958780055 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.798983379 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
230.424		0.798983379		+0.5000

231.7230 m

Proposed Formation Level	236.163	m
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Provided formation Level is O.K.

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 289 CH NO.66/769.00

Catchment Area	0.008551422	sq.km
Length of longest stream (L) (km)	0.1287213000	
Height of furthest point (m)	231.657	
Height of point of intersection (m)	231.444	
Height Difference (H) (m)	0.213	
Nature of soil	Red soil/clayey loam	
Avg.Bed Level	231.5505	
Observed H.F.L	232.121	
Proposed Formation Level	235.492	

Using Improved Rational Formula

$$Q-50 = 0.278 \times C \times I \times A$$

Where

Q-50 = 50 Years Design Flood Discharge

C = Runoff Coefficient

I = 50 Years Rainfall Intensity lasting for t_c hour duration where t_c = time of concentration

A = Catchment Area

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 289 CH NO.66/769.00

2 Run off coefficient

Description of the catchment	Formula for C
a Sandy Soil / Sandy Laom/ arid Areas	$C = 0.249(R \times F)^{0.2}$
b Alluvium/silty/coastal area	$C = 0.332(R \times F)^{0.2}$
c Red soil /Clayey loam/ gray or brown alluvium/ cultivated plains / tall crop / wooded areas	$C = 0.415(R \times F)^{0.2}$
d Black Cotton/ clayey soil/lightly covered/ lightly wooded/Plain & Barren / sub mountaine &	$C = 0.456(R \times F)^{0.2}$
e Hilly soil / plateau/barren	$C = 0.498(R \times F)^{0.2}$

Where

R = 50 Year 24 hour point rainfall (cm)

F = Areal Reduction factor
depending upon catchment
Area & duration rainfall from
table below

Catchment Area in Sq. Km.	Duration of Rainfall		
	< 30 Min	30 to 60 min	60 To 100 min
< 2.5 Sq. Km	0.72	0.81	0.88
2.5 to 5.0 Sq. Km	0.71	0.8	0.87
5 to 13.0 Sq. Km	0.7	0.79	0.86
13.0 to 25.0 Sq. Km	0.68	0.78	0.85

Note:- Rainfall Duration shall be equal to the caculated tc for the catchment

for estimating the time of concentration(tc) as per bhatnagar formula

$$tc = [L^3 / H]^{0.345}$$

0.204266533 hr

0.204266533 hr *60

12.25599201 Min

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 289 CH NO.66/769.00

Nature of Soil is , Red soil /Clayey loam/gray or brown alluvium/cultivated plains /tall crop /wooded areas ,C = 0.415 (R x F) ^ 0.2

R	=	20	cm
F	=	0.87	
C	=	0.415(R x F) ^ 0.2	
C	=	0.734781048	

But as per Annexure 5.1.1.(a) 1. (Khosla), of "Flood Estimation Methods For Catchments Less Than 25 SqKm in Area", Bridges & Floods wing Report No. RBF - 16 , Coeff. Assumed for calculation is " 0.10 ".

3 Calculation of Intensity of Rainfall (I)

a	tc h Ratio	=	0.470	From Fig. 10
b	1h Ratio =	=	0.370	From Fig. 10
c	Coefficient K	=	$\frac{tc\ h\ Ratio}{1h\ Ratio}$	
		=	1.27027027	
d				
i	R-50 (24)	=	200	mm
ii	R-50 (1)	=	R-50 (24) x 1 h to 24 h Rainfall Ratio.	
		=	74	mm
iii	R-50 (tc)	=	K x R-50 (1)	
		=	1h Ratio x74	
		=	94	mm
iv	Int. of rainfall (I)	=	$\frac{R-50\ (tc)}{tc}$	
	I	=	460.1830678	mm/hr

ESTIMATION OF DESIGN DISCHARGE FOR BR. NO. 289 CH NO.66/769.00

4 Design Flood Discharge =

$$Q-50 = 0.278 \times C \times I \times A$$

$$Q-50 = \mathbf{0.803843892 \text{ cum/sec}}$$

5 Checking for adequacy of Waterway Provided

a Discharge = **0.803843892 cum/sec**

b Avg. Waterway Required = Q/V (V=1.75)
0.459339367 Sq.m

c Proposed opening 1x1.2x1.2

d Height of water = Avg. Waterway/total width
0.382782806 m

Min. Formation Required

B.L	+	Ht of water	+	free Board
231.5505		0.382782806		+0.5000
232.4333 m				

Proposed Formation Level	235.492	m
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Provided formation Level is O.K.