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ABQ10

CALCULATION COVER SHEET

WESTON
MANAGERS DESIGNERS/CONSULTANTS

Project:	**INEEL V-Tank Remediation Project**				**Number of Sheets:** 1 of 33
Site:	Test Area North, Idaho Falls, Idaho				
Calculation Number:	ABQ10-CE006		**Work Order Number:**	12393.002.001	
Subject:	**Storm Water Hydrology**				
Rev #:	**Date:**	**Revision:**	**Calculated by:**	**Checked:**	**Approved:**
RAA	5/15/01	90%	Chris Ehrsam	Berg Keshian	B. Keshian
RAB	6/27/01	90% Polish	D. Brennecke	B. Keshian	B. Keshian
RAC	9/27/01	Draft Final	D. Brennecke	B. Keshian	9-28-01

Problem Statement:

Determine on-site storm water volumes that must be retained and size off-site storm water run-on control features.

Method of Solution:

Urban Hydrology for Small Watersheds, TR-55
Haestad Methods – Flowmaster Software

Assumptions:

Soil type is the same throughout the site
Soil Hydrological Group is B
Storm water runoff in the HIC/Drum Filling Area will be contain within its boundary by a berm.
Storm water runoff in the Liquid Waste Storage Area will be contain within its' boundary by a berm.
The existing system carrying Storm water runoff from Basins 1 and 2 have the capacity to accept the flows.

Sources of Formulas and References:

INEEL/BBWI Drawings
Urban Hydrology for Small Watersheds, TR-55
NOAA Atlas 2, Volume V, Isopluvials of 2yr./24 hr. Precipitation
Site Photographs
Information gathered from Site Visit
Survey provided by INEEL

Calculation:

See Attachments

Discussion:

Six Basins were used to develop the storm water analysis for this site (see attached Basin Map). A 2yr/24hr storm was used to calculate the storm water volume and flow rate for each basin. All storm water will be kept on site. Offsite flows are diverted by the proposed V-ditches and discharge into existing systems. The new 21" corrugated metal pipe culvert replacing the 8" and 15" pipe culverts crossing the site exceeds the capacity of the existing culverts.

Storm water runoff from roof 616 will be captured in rain gutters and discharged offsite.

Summary:

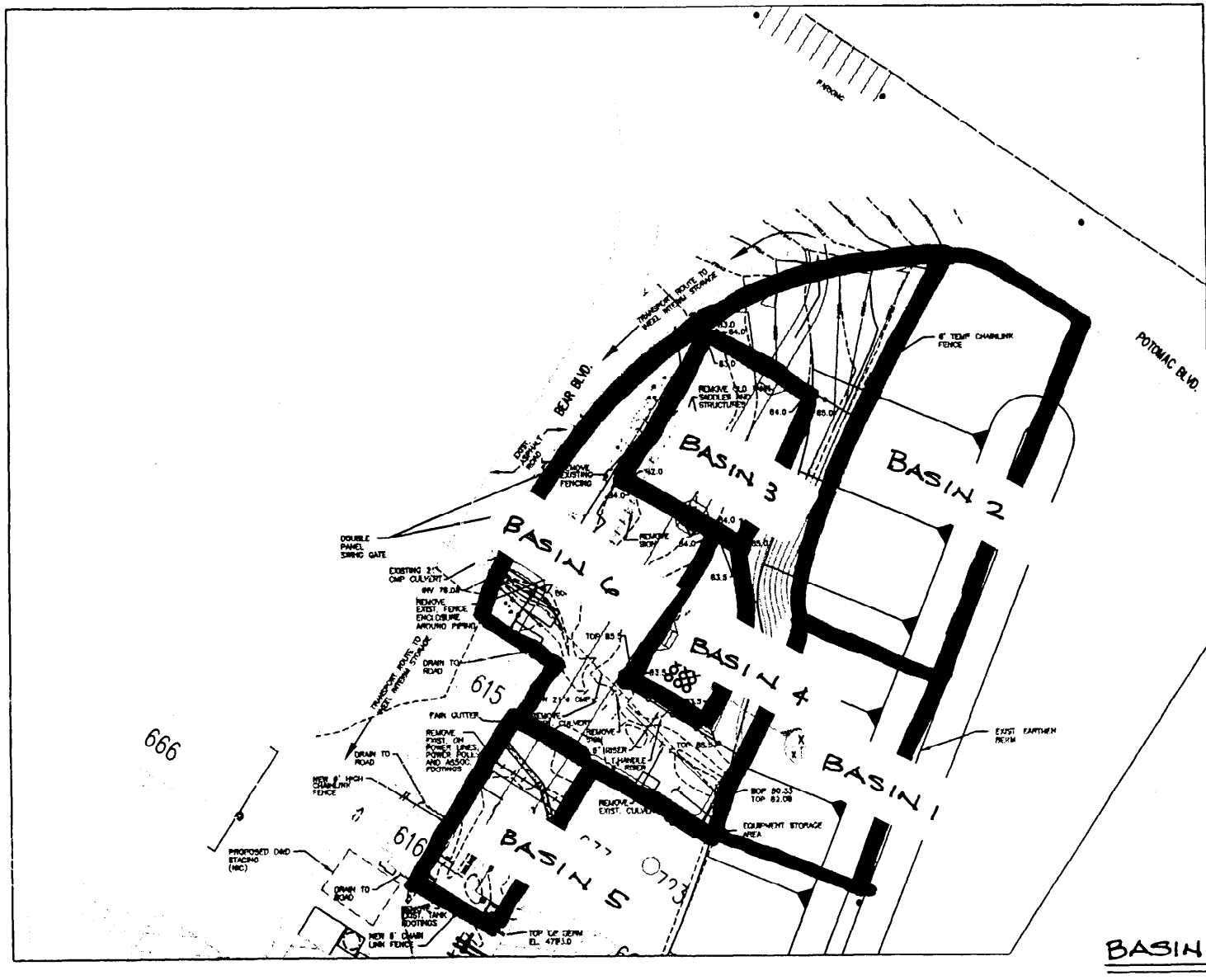
Basin Number	Peak Discharge (CFS)	Storm water Volume (CF)
1	0.027	116.2
2	0.043	185.8
3	0.123	299.7
4	0.065	200
5	0.06	149
6	0.280	694

V-Ditch at East Boundary:
A one-foot deep v-ditch installed at 1% grade will adequately handle peak discharge rates for Basins 1 and 2.

21" CMP:
Pipe can handle 7.0 cfs at 0.67% grade. Pipe can handle a drainage area of 5 acres if a 100-year 24-hour storm occurred. Pipe can handle a drainage area of 75 acres if a 2-year 24-hour storm occurred. Mapping was not available to determine actual size of drainage area but field inspection indicates that drainage area is less than 5 acres; therefore, 21" CMP should be more than adequate.

CONSTRUCTION NOTES:

1. OVERHEAD STEAM/CONDENSATION AND POWER LINES AND SUPPORT STRUCTURES ARE TO BE REMOVED BY BBWI PRIOR TO START OF WORK.
2. ONE FOOT (1') OF COVER IS REQUIRED OVER NEW 21" CMP CULVERT.
3. PLACE JERSEY BARRIERS AROUND 8" RISER AND T-HANDLE 8" RISER.



BASIN MAP

SCALE 1" = 30'

Revisions						
Rev. No.:	Date:	Description:	Drawn By:	Checked By:	Project A/E:	Approvals

		Date
Designed by:	S. Edens	8/01/01
Drawn by:	J. M. M.	8/01/01
Checked by:	S. Brewster	8/01/01
Project Manager:	S. Hanna	8/01/01
Client Approval:		

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V-TANK REMEDIATION PROJECT
IDAHO FALLS, IDAHO

GRADING AND SURFACE DEMOLITION PLAN

DRAWING NO.: ARG 8001-RAA-C02

PROJECT NO.: 12302.002.001

SHEET 4 of 14

2 of 22

Worksheet 2: Runoff curve number and runoff

Project	By	Date
Ineel- V. tanks Remediation	C. Ehrsam	5/25/01
Location	**Checked**	**Date**
Idaho Falls, Idaho		

Check one: ☐ Present ☑ Developed BASIN 1

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN[1/] Table 2-2	CN[1/] Figure 2-3	CN[1/] Figure 2-4	Area ☑ acres ☐ mi² ☐ %	Product of CN x area
B	gravel, natural grass	79			.291	22.99

[1/] Use only one CN source per line

Totals ➡ .291 | 22.99

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{22.99}{.291} = 79$; **Use CN** ➡ 79

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	2		
Rainfall, P (24-hour)	in	1.1	SEE Pg 24/32	
Runoff, Q (Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)	in	0.1001		

$S = \frac{1000}{CN} - 10 = 2.66$

$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} = 0.100$

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

Project	By	Date
Inel - V. tanks	C. Ehrsam	5/28/01
Location	**Checked**	**Date**
Idaho Falls, Idaho		

Check one: ☐ Present ☑ Developed

Check one: ☑ T_c ☐ T_t through subarea

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

Sheet flow (Manning's formula)

	Segment ID	1		
1. Surface description (table 3-1)		grave/bare soil		
2. Manning's roughness coefficient, n (table 3-1)		.011		
3. Flow length, L (total L † 300 ft) ft		100		
4. Two-year 24-hour rainfall, P_2 in		1.1		
5. Land slope, s ft/ft		.1313		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t hr		.0162	+	= .0162

min. = .10 hr = .10

Shallow concentrated flow

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

Channel flow

	Segment ID			
12. Cross sectional flow area, a ft^2				
13. Wetted perimeter, p_w ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft				
15 Channel slope, s ft/ft				
16. Manning's roughness coefficient, n				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ft/s				
18. Flow length, L ft				
19. $T_t = \frac{L}{3600\ V}$ Compute T_t hr			+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) Hr .10

Worksheet 4: Graphical Peak Discharge method

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☑ Developed

1. Data

Drainage area ..... A_m = 0.0005 mi^2 (acres/640)

Runoff curve number ..... CN = 79 (From worksheet 2)

Time of concentration ..... T_c = .10 hr (From worksheet 3)

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

Pond and swamp areas sprea throughout watershed ..... = 0 percent of A_m (_____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	2		
3. Rainfall, P (24-hour)	in	1.1		
4. Initial abstraction, I_a (Use CN with table 4-1)	in	0.532		
5. Compute I_a/P		.5		
6. Unit peak discharge, q_u (Use T_c and I_a/P with exhibit 4– 11)	csm/in	545		
7. Runoff, Q (From worksheet 2) Figure 2-6	in	.10		
8. Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)		0		
9. Peak discharge, q_p	ft^3/s	.027		

(Where $q_p = q_u A_m Q F_p$)

V_r = Q * Am * 53.33 = 0.0027 AC·FT
116.15 CF

Worksheet 2: Runoff curve number and runoff

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed Basin 2

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN[1/] Table 2-2	CN[1/] Figure 2-3	CN[1/] Figure 2-4	Area ☑ acres ☐ mi² ☐ %	Product of CN x area
B	gravel, sand, < 50% grass	79			.5052	39.91

[1/] Use only one CN source per line

Totals ➡ .505 | 39.91

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{39.91}{.505} = .79$; Use CN ➡ 79

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	2		
Rainfall, P (24-hour)	in	1.1	SEE Pg 24/32	
Runoff, Q	in	0.10		

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

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

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subarea

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

Sheet flow (Applies to first 300 ft)

Segment ID	1	
1. Surface description (table 3-1)	gravel/sand	
2. Manning's roughness coefficient, n (table 3-1)	.011	
3. Flow length, L (total L † 300 ft) ft	95	
4. Two-year 24-hour rainfall, P_2 in	1.1	
5. Land slope, s ft/ft	.1313	
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t hr	.016 +	= .016

MIN. T = 0.10

Shallow concentrated flow

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

Channel flow

Segment ID		
12. Cross sectional flow area, a ft^2		
13. Wetted perimeter, p_w ft		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft		
15 Channel slope, s ft/ft		
16. Manning's roughness coefficient, n		
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ft/s		
18. Flow length, L ft		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t hr	+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) Hr .10

Worksheet 4: Graphical Peak Discharge method

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Data

Drainage area ..... A_m = 0.0008 mi^2 (acres/640)

Runoff curve number ..... CN = 79 (From worksheet 2)

Time of concentration ..... T_c = .10 hr (From worksheet 3)

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

Pond and swamp areas sprea throughout watershed ..... = 0 percent of A_m (_____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	2		
3. Rainfall, P (24-hour)	in	1.1		
4. Initial abstraction, I_a (Use CN with table 4-1)	in	0.532		
5. Compute I_a/P		.50		
6. Unit peak discharge, q_u (Use T_c and I_a/P with exhibit 4– _____)	csm/in	550		
7. Runoff, Q (From worksheet 2) Figure 2-6	in	.10		
8. Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)		0		
9. Peak discharge, q_p	ft^3/s	.0434		

(Where $q_p = q_u A_m Q F_p$)

V_r = 185.8 CF

Worksheet 2: Runoff curve number and runoff

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed BASIN 3

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN[1/] Table 2-2	CN[1/] Figure 2-3	CN[1/] Figure 2-4	Area ☑ acres ☐ mi² ☐ %	Product of CN x area
B	Newly graded	91			.1687	15.35
	Totals ➡					

[1/] Use only one CN source per line

CN(weighted) = $\frac{\text{total product}}{\text{total area}}$ = _____ = _____ ; Use CN ➡ 91

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	2		
Rainfall, P (24-hour)	in	1.1	SEE Pg 24/32	
Runoff, Q	in	.43		

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

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

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subarea

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

Sheet flow (Applicable to T_c only)

Segment ID		
1. Surface description (table 3-1)	Flat	
2. Manning's roughness coefficient, n (table 3-1)	.011	
3. Flow length, L (total L † 300 ft) ft	0	
4. Two-year 24-hour rainfall, P_2 in	1.1	
5. Land slope, s ft/ft	0	
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t hr	0 +	= 0

T = .10

Shallow concentrated flow

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

Channel flow

Segment ID		
12. Cross sectional flow area, a ft^2		
13. Wetted perimeter, p_w ft		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft		
15 Channel slope, s ft/ft		
16. Manning's roughness coefficient, n		
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ft/s		
18. Flow length, L ft		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t hr	+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) Hr .10

MIN.

Worksheet 4: Graphical Peak Discharge method

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Data

Drainage area ..... A_m = .0003 mi^2 (acres/640)

Runoff curve number ..... CN = 91 (From worksheet 2)

Time of concentration ..... T_c = .10 hr (From worksheet 3)

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

Pond and swamp areas sprea throughout watershed ..... = 0 percent of A_m (_____ acres or mi^2 covered)

	Storm #1	Storm #2	Storm #3
2. Frequency ..... yr	2		
3. Rainfall, P (24-hour) ..... in	1.1		
4. Initial abstraction, I_a ..... in (Use CN with table 4-1)	0.198		
5. Compute I_a/P	.225		
6. Unit peak discharge, q_u ..... csm/in (Use T_c and I_a/P with exhibit 4– II)	950		
7. Runoff, Q ..... in (From worksheet 2) Figure 2-6	.43		
8. Pond and swamp adjustment factor, F_p ..... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)	0		
9. Peak discharge, q_p ..... ft^3/s	.1226		

(Where $q_p = q_u A_m Q F_p$)

V_r = Q * Am * 53.33 = .0069 AC. FT

299.7 CF

Worksheet 2: Runoff curve number and runoff

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed BASIN 4

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN[1/] Table 2-2	CN[1/] Figure 2-3	CN[1/] Figure 2-4	Area ☑ acres ☐ mi² ☐ %	Product of CN x area
B	Newly graded areas	91			.1018	9.26

[1/] Use only one CN source per line

Totals ➡ .102 | 9.26

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{9.26}{.102} = 91$; Use CN ➡ 91

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	2		
Rainfall, P (24-hour)	in	1.1	SEE Pg 24/32	
Runoff, Q	in	0.4304		

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

S = 0.99

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

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☑ Developed

Check one: ☑ T_c ☐ T_t through subarea

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

Sheet flow (Segment ID 1)

	Segment ID		
1. Surface description (table 3-1)	graded, flat		
2. Manning's roughness coefficient, n (table 3-1)	0.011		
3. Flow length, L (total L † 300 ft) ft	0		
4. Two-year 24-hour rainfall, P_2 in	1.1		
5. Land slope, s ft/ft	0		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t hr	0	+	= 0

Min. T_c = 0.10

Shallow concentrated flow

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

Channel flow

	Segment ID		
12. Cross sectional flow area, a ft^2			
13. Wetted perimeter, p_w ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft			
15 Channel slope, s ft/ft			
16. Manning's roughness coefficient, n			
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ft/s			
18. Flow length, L ft			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) Hr .10

Worksheet 4: Graphical Peak Discharge method

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Data

Drainage area ..... A_m = .0002 mi^2 (acres/640)

Runoff curve number ..... CN = 91 (From worksheet 2)

Time of concentration ..... T_c = .10 hr (From worksheet 3)

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

Pond and swamp areas sprea throughout watershed ..... = 0 percent of A_m (_____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	2		
3. Rainfall, P (24-hour)	in	1.1		
4. Initial abstraction, I_a (Use CN with table 4-1)	in	0.198		
5. Compute I_a/P		.225		
6. Unit peak discharge, q_u (Use T_c and I_a/P with exhibit 4– _____)	csm/in	950		
7. Runoff, Q (From worksheet 2) Figure 2-6	in	.43		
8. Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)		0		
9. Peak discharge, q_p	ft^3/s	.065		

(Where $q_p = q_u A_m Q F_p$)

10. Volume of Runoff V_r =

$V_r = Q \cdot A_m \cdot 53.33 = 0.0043$ AC-FT

$V_r = 200$ CF

Worksheet 2: Runoff curve number and runoff

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed BASIN 5

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN[1/] Table 2-2	CN[1/] Figure 2-3	CN[1/] Figure 2-4	Area ☑ acres ☐ mi² ☐ %	Product of CN x area
B	graded	91			.098	8.92
B	gravel / sand	79			.048	3.79
					Totals ➡ .146	12.71

[1/] Use only one CN source per line

CN(weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{12.71}{.146} = 87.05$; Use CN ➡ 87

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	2		
Rainfall, P (24-hour)	in	1.1	SEE Pg 24/32	
Runoff, Q	in	.331		

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

S = 1.4943

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

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subarea

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

Sheet flow (over land flow)

Segment ID			
1. Surface description (table 3-1) ..... gravel	gravel		
2. Manning's roughness coefficient, n (table 3-1)	.011		
3. Flow length, L (total L † 300 ft) ..... ft	25		
4. Two-year 24-hour rainfall, P_2 ..... in	1.1		
5. Land slope, s ..... ft/ft	.02		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t ..... hr	.0114	+	= .0114

min t_c = 0.10

Shallow concentrated flow

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

Channel flow

Segment ID			
12. Cross sectional flow area, a ..... ft^2			
13. Wetted perimeter, p_w ..... ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ..... ft			
15 Channel slope, s ..... ft/ft			
16. Manning's roughness coefficient, n			
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ..... ft/s			
18. Flow length, L ..... ft			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t ..... hr		+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... Hr 0.10

Worksheet 4: Graphical Peak Discharge method

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☑ Developed

1. Data

Drainage area ..... A_m = .000223 mi^2 (acres/640)

Runoff curve number ..... CN = 87 (From worksheet 2)

Time of concentration ..... T_c = 0.10 hr (From worksheet 3)

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

Pond and swamp areas sprea throughout watershed ..... = 0 percent of A_m (_____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	2		
3. Rainfall, P (24-hour)	in	1.1		
4. Initial abstraction, I_a (Use CN with table 4-1)	in	.299		
5. Compute I_a/P		.30		
6. Unit peak discharge, q_u (Use T_c and I_a/P with exhibit 4– _____)	csm/in	940		
7. Runoff, Q (From worksheet 2) Figure 2-6	in	.281		
8. Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)		0		
9. Peak discharge, q_p	ft^3/s	.06		

(Where $q_p = q_u A_m Q F_p$)

Volume of Runoff V_r

$V_r = Q. * A_m * 53.33 = .0034$ Ac. FT

$= 149$ CF

Worksheet 2: Runoff curve number and runoff

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☑ Developed BASIN 6

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN[1/] Table 2-2	CN[1/] Figure 2-3	CN[1/] Figure 2-4	Area ☑ acres ☐ mi² ☐ %	Product of CN x area
B	Newly graded	86			.683	58.757
	Paved (3055)	98			.071	6.738

[1/] Use only one CN source per line

Totals ➡ .754 | 65.677

$$CN(weighted) = \frac{total\ product}{total\ area} = \frac{65.677}{.754} = 87.105;$$ **Use CN** ➡ 87

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	2		
Rainfall, P (24-hour)	in	1.1	SEE Pg 24/32	
Runoff, Q (Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)	in	0.28		

S = 1.4943

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

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subarea

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

Sheet flow

Segment ID	1	2
1. Surface description (table 3-1) ....gravel	graded	graded
2. Manning's roughness coefficient, n (table 3-1)	.011	.011
3. Flow length, L (total L † 300 ft) ft	120	170'
4. Two-year 24-hour rainfall, P_2 in	1.1	1.1
5. Land slope, s ft/ft	.05	0.0118
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t hr	.028 +	.0651 = .093

$t_{c\,min}$ 0.10

Shallow concentrated flow

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

Channel flow

Segment ID		
12. Cross sectional flow area, a ft^2		
13. Wetted perimeter, p_w ft		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft		
15 Channel slope, s ft/ft		
16. Manning's roughness coefficient, n		
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ft/s		
18. Flow length, L ft		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t hr	+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) Hr 0.10

Worksheet 4: Graphical Peak Discharge method

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Data

Drainage area ..... A_m = .001067 mi^2 (acres/640)

Runoff curve number ..... CN = 87 (From worksheet 2)

Time of concentration ..... T_c = 1.10 hr (From worksheet 3)

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

Pond and swamp areas sprea throughout watershed ..... = 0 percent of A_m (_____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	2		
3. Rainfall, P (24-hour)	in	1.1		
4. Initial abstraction, I_a (Use CN with table 4-1)	in	.299		
5. Compute I_a/P		.300		
6. Unit peak discharge, q_u (Use T_c and I_a/P with exhibit 4–II)	csm/in	950		
7. Runoff, Q (From worksheet 2) Figure 2-6	in	0.23		
8. Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)		0		
9. Peak discharge, q_p	ft^3/s	.28		

(Where $q_p = q_u A_m Q F_p$)

Volume of Runoff V_r = 0.015933 AC.FT

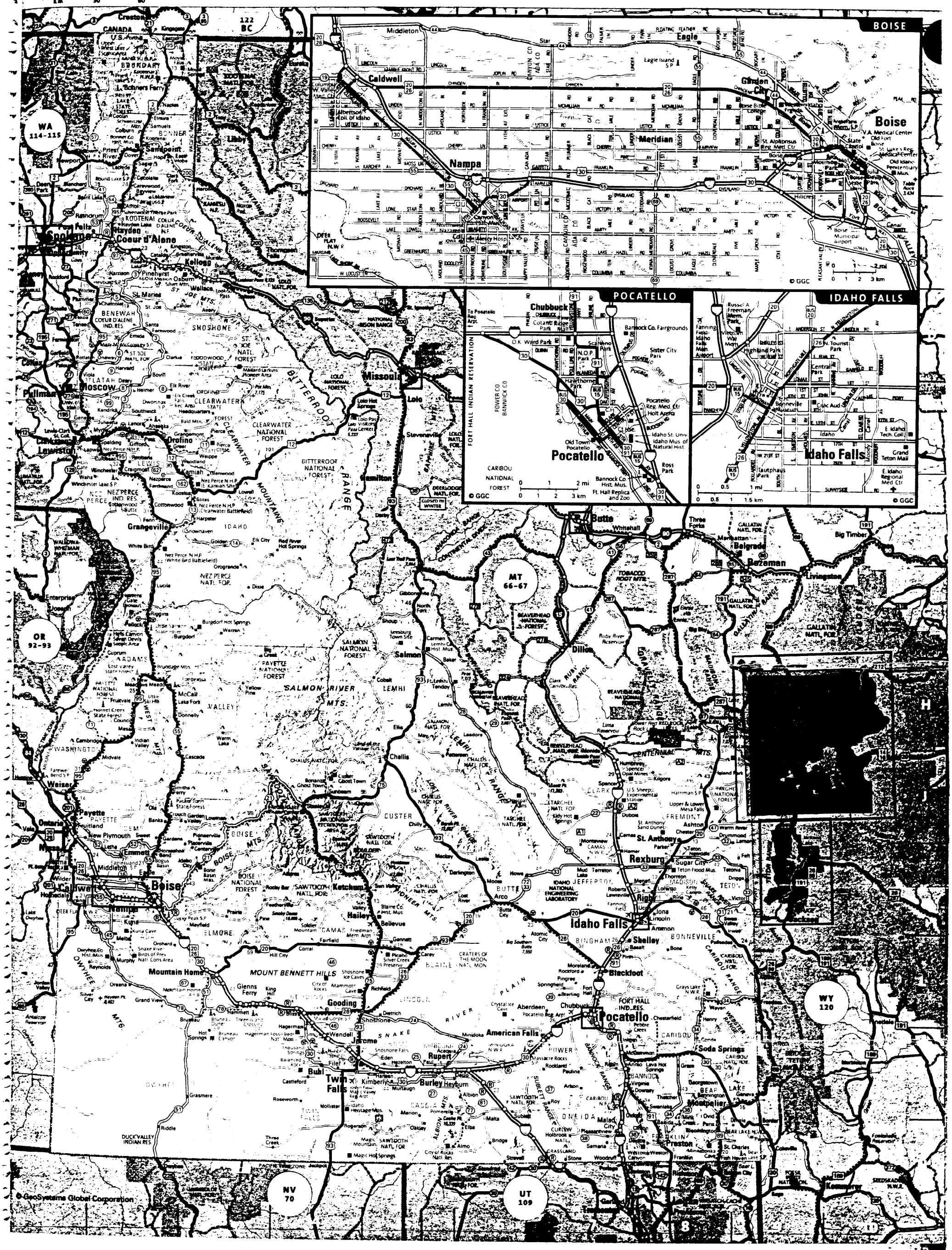
V_r = Q * Am * 53.32 = 0.015933 AC.FT
694 CF

TOURISM:
800.847.4843
208.334.2470

ROAD CONDITIONS:
208.336.6600 (WINTER)
208.376.8028 (BOISE)

208.772.1200 (COEUR D'ALENE)
208.239.3300 (POCATELLO)
208.239.3307 (POCATELLO)

ROAD CONSTRUCTION:
208.334.8888



22 of

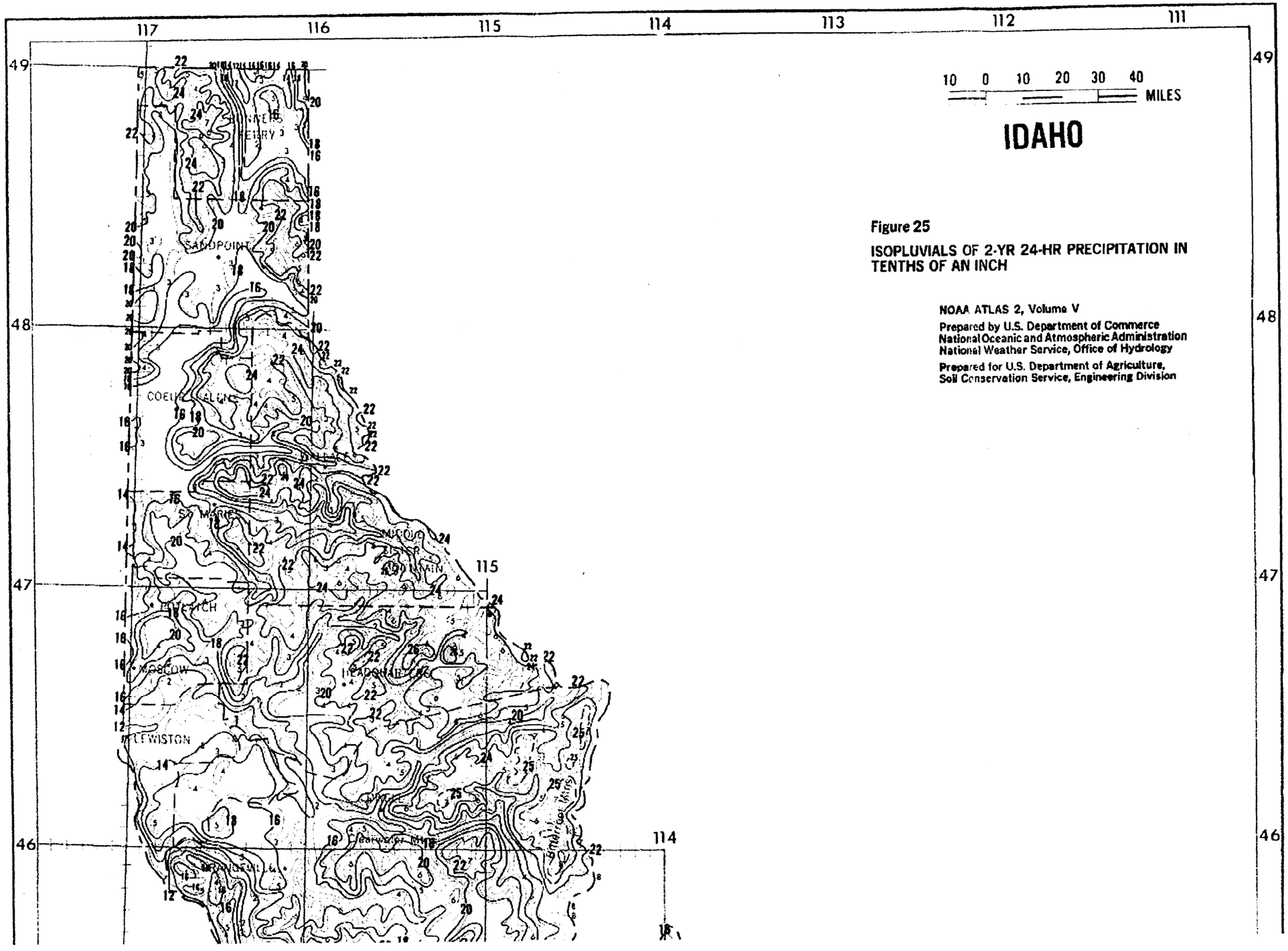


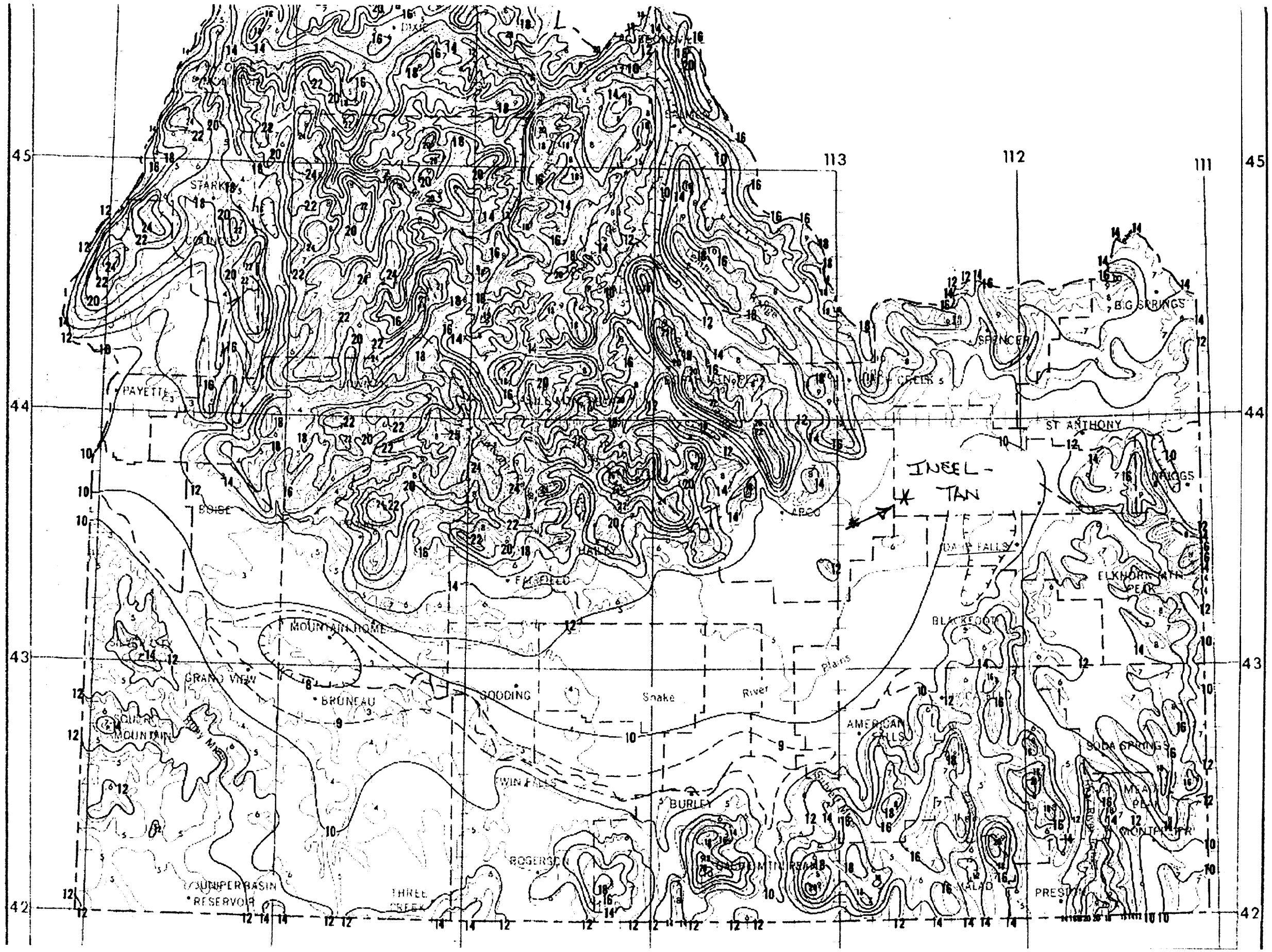
Figure 25

ISOPLUVIALS OF 2-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

NOAA ATLAS 2, Volume V

Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division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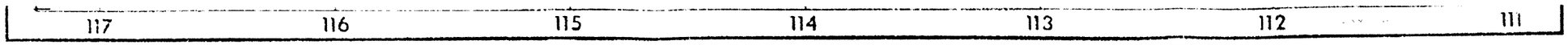
44
43
42
113
112
111
STARKEY
PAYETTE
BOISE
MOUNTAIN HOME
GRAND VIEW
BRUNEAU
GOODING
Snake
River
Plains
TWIN FALLS
BURLEY
ROGERSON
JUNIPER BASIN
RESERVOIR
THREE
ARCO
HAILEY
KETCHUM
SUN VALLEY
AMERICAN FALLS
BLACKFOOT
SPRINGS
SPRINGS
ST ANTHONY
INEEL-
TAN
SODA SPRINGS
MONTPELIER
PRESTON


117
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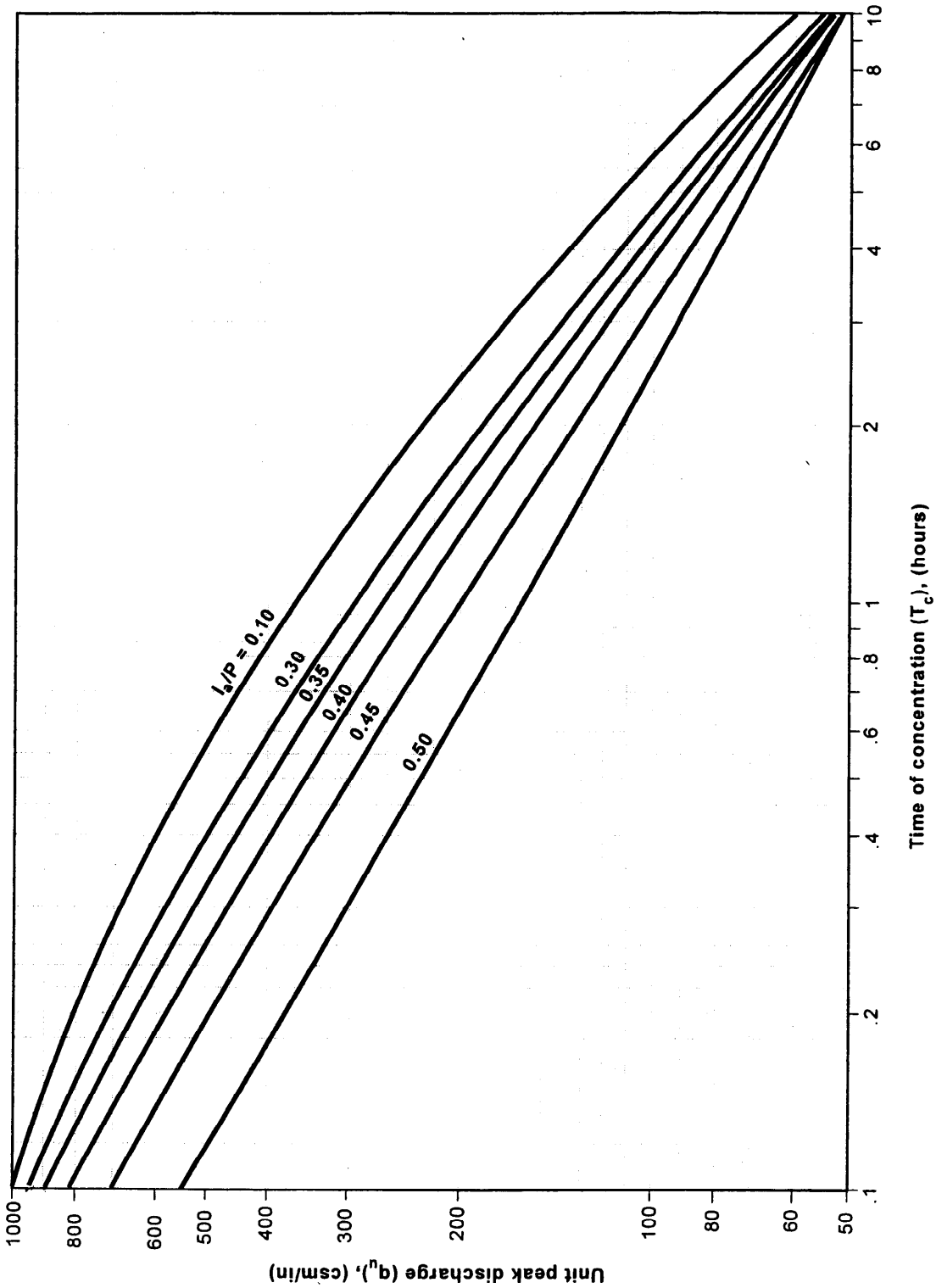
112
111

Exhibit 4-II Unit peal discharge (q_u) for NRCS (SCS) type II rainfall distribution



Chapter 4 Graphical Peak Discharge Method

This chapter presents the Graphical Peak Discharge method for computing peak discharge from rural and urban areas. The Graphical method was developed from hydrograph analyses using TR-20, "Computer Program for Project Formulation—Hydrology" (SCS 1983). The peak discharge equation used is:

$$q_p = q_u A_m Q F_p \qquad \text{[eq. 4-1]}$$

where:

q_p = peak discharge (ft^3/s)
q_u = unit peak discharge (csm/in)
A_m = drainage area (mi^2)
Q = runoff (in)
F_p = pond and swamp adjustment factor

The input requirements for the Graphical method are as follows: (1) T_c (hr), (2) drainage area (mi^2), (3) appropriate rainfall distribution (I, IA, II, or III), (4) 24-hour rainfall (in), and (5) *CN*. If pond and swamp areas are spread throughout the watershed and are not considered in the T_c computation, an adjustment for pond and swamp areas is also needed.

Peak discharge computation

For a selected rainfall frequency, the 24-hour rainfall (*P*) is obtained from appendix B or more detailed local precipitation maps. *CN* and total runoff (*Q*) for the watershed are computed according to the methods outlined in chapter 2. The CN is used to determine the initial abstraction (I_a) from table 4-1. I_a/P is then computed.

If the computed I_a/P ratio is outside the range in exhibit 4 (4-I, 4-IA, 4-II, and 4-III) for the rainfall distribution of interest, then the limiting value should be used. If the ratio falls between the limiting values, use linear interpolation. Figure 4-1 illustrates the sensitivity of I_a/P to *CN* and *P*.

Peak discharge per square mile per inch of runoff (*qu*) is obtained from exhibit 4-I, 4-IA, 4-II, or 4-III by using T_c (chapter 3), rainfall distribution type, and I_a/P ratio. The pond and swamp adjustment factor is obtained from table 4-2 (rounded to the nearest table value). Use worksheet 4 in appendix D to aid in computing the peak discharge using the Graphical method.

Figure 4-1 Variation of I_a/P for *P* and *CN*

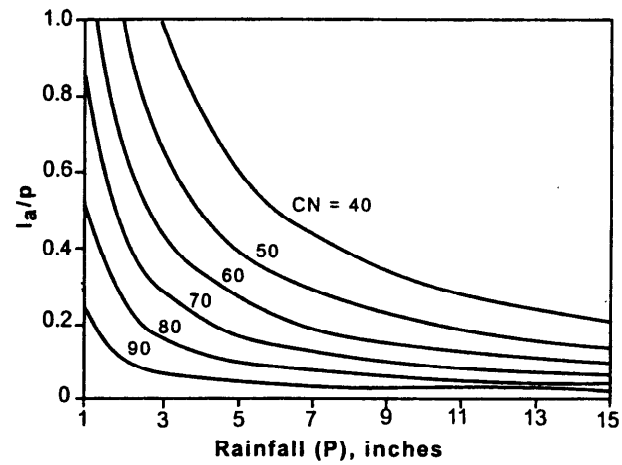


Table 4-1 I_a values for runoff curve numbers

Curve number	I_a (in)	Curve number	I_a (in)
40	3.000	70	0.857
41	2.878	71	0.857
42	2.762	72	0.817
43	2.651	73	0.778
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0. 899		

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SHEET ____ of ____

CLIENT/SUBJECT _____ W.O. NO. _____

TASK DESCRIPTION _____ TASK NO. _____

PREPARED BY _____ DEPT _____ DATE _____

MATH CHECK BY _____ DEPT _____ DATE _____

METHOD REV. BY _____ DEPT _____ DATE _____

APPROVED BY _____

DEPT _____ DATE _____

Stormwater Runoff from Buildings 615, 616

Area for Building 615 = 1267 SF, 0.029 AC, 4.545×10^{-5}

Area for Building 616 = 3956 SF, 0.091 AC, 1.42×10^{-4}

CN = 98, impervious

$S = \frac{1000}{98} - 10 = 0.20$

Q = 0.89 in

$V_R = Q \times A_M \times 53.33$

$V_{R_{615}}$ = 0.00216 AC.FT => 93.97 CF, USE 94.0 CF

$V_{R_{616}}$ = 0.00674 AC.FT => 293.59 CF, USE 294 CF

Basin 1 V-Ditch
Worksheet for Triangular Channel

Project Description	
Project File	c:\haestad\fmw\vtank.fm2
Worksheet	V-ditch at East Boundary
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Equal Side Slopes

Input Data		
Mannings Coefficient	0.022	
Channel Slope	0.010000	ft/ft
Depth	1.00	ft
Discharge	0.03	cfs

Results		
Left Side Slope	0.048049	H : V
Right Side Slope	0.048049	H : V
Flow Area	0.05	ft^2
Wetted Perimeter	2.00	ft
Top Width	0.10	ft
Critical Depth	0.46	ft
Critical Slope	0.662071	ft/ft
Velocity	0.56	ft/s
Velocity Head	0.49e-2	ft
Specific Energy	1.00	ft
Froude Number	0.14	
Flow is subcritical.		

Basin 2 V-Ditch
Worksheet for Triangular Channel

Project Description	
Project File	c:\haestad\fmw\vtank.fm2
Worksheet	V-ditch at East Boundary
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Equal Side Slopes

Input Data		
Mannings Coefficient	0.022	
Channel Slope	0.010000	ft/ft
Depth	1.00	ft
Discharge	0.04	cfs

Results		
Left Side Slope	0.063902	H : V
Right Side Slope	0.063902	H : V
Flow Area	0.06	ft^2
Wetted Perimeter	2.00	ft
Top Width	0.13	ft
Critical Depth	0.49	ft
Critical Slope	0.441963	ft/ft
Velocity	0.68	ft/s
Velocity Head	0.01	ft
Specific Energy	1.01	ft
Froude Number	0.17	
Flow is subcritical.		

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SHEET ____ of ____

CLIENT/SUBJECT _____ W.O. NO. _____

TASK DESCRIPTION _____ TASK NO. _____

PREPARED BY _____ DEPT _____ DATE _____

MATH CHECK BY _____ DEPT _____ DATE _____

METHOD REV. BY _____ DEPT _____ DATE _____

APPROVED BY _____

DEPT _____ DATE _____

Find AREA.

Assume pipe designed for 100 yr /24 hr storm

$P = 2.6$

$C = 79$

$Q = 7.02$ CFS

$t_c = .10$

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

$$S = \frac{1000}{79} = 2.66$$

$Q = 0.9045$ in

$t_c = .10$

100yr = 5 AC

2yr = 75 AC

$p = 1.1$

7 AC = 11 CFS

6 AC = 8 CFS

5 AC = 7 CFS

Worksheet
Worksheet for Circular Channel

Project Description	
Project File	c:\haestad\fmw\temp.fm2
Worksheet	21" pipe
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Input Data		
Mannings Coefficient	0.024	
Channel Slope	0.006700	ft/ft
Diameter	21.00	in

Results		
Depth	1.75	ft
Discharge	7.02	cfs
Flow Area	2.41	ft²
Wetted Perimeter	5.50	ft
Top Width	0.00	ft
Critical Depth	0.98	ft
Percent Full	100.00	
Critical Slope	0.018413	ft/ft
Velocity	2.92	ft/s
Velocity Head	0.13	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	7.56	cfs
Full Flow Capacity	7.02	cfs
Full Flow Slope	0.006700	ft/ft