Carmen Johnson
44-01 3/20/12

EROSION CONTROL PLAN
FOR
LANDFILL 6 AREA A

CHAMPION INTERNATIONAL CORPORATION
CANTON, NORTH CAROLINA

SEPTEMBER 1990

PREPARED BY:

SIRRINE ENVIRONMENTAL CONSULTANTS
GREENVILLE, SOUTH CAROLINA

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1.0 Introduction

Champion International Corporation, Canton Mill, retained Sirrine Environmental Consultants (SEC) to design and permit the construction of Landfill 6, Area A. This area is part of an existing landfill site which Champion obtained a permit for in 1983. This Erosion Control Plan is to be submitted with the permit application to construct Landfill 6, Area A to the North Carolina Department of Environment, Health, and Natural Resources (NCDNR) for review and approval. The Erosion Control Plan covers the erosion which may occur during and after construction for both the landfill and spoil areas.

The goal of this plan is to assure that soil erosion is prevented during all phases of site development, operation, closure, and post closure. The plan is consistent with erosion control measures taken during prior development at the site which have proven effective.

2.0 Existing Conditions

2.1 General

Landfill 6, Area A is located north of the existing cells B and C. Area A is bordered on the south by the existing access road and on the north by Interstate 40. The site currently consists of pasture and forested land. The overall site drainage is east to a 36 inch culvert which directs flow to Bowen Branch. Figure 1, the Site Plan, shows the existing and future landfill development along with the dominant drainage features.

2.2 Land Use and Zoning

Since the area has already been permitted for use as a landfill, the land is properly zoned with the appropriate land use.

2.3 Site Access

Access to Area A will be from the existing access road which encompasses the existing landfill areas. An access road will be constructed on top of the dike that is to contain Area A. The access road will tie into the existing road at the east and west ends of Area A. There will also be temporary access roads on top of the cell divider dikes.

2.4 Stormwater Runoff Calculations

The Soil Conservation Service (SCS) method of calculating runoff was used to estimate the peak flow and volume of runoff. The 25-year 24-hour storm event was used as the design storm to size various culverts and runoff control structures.

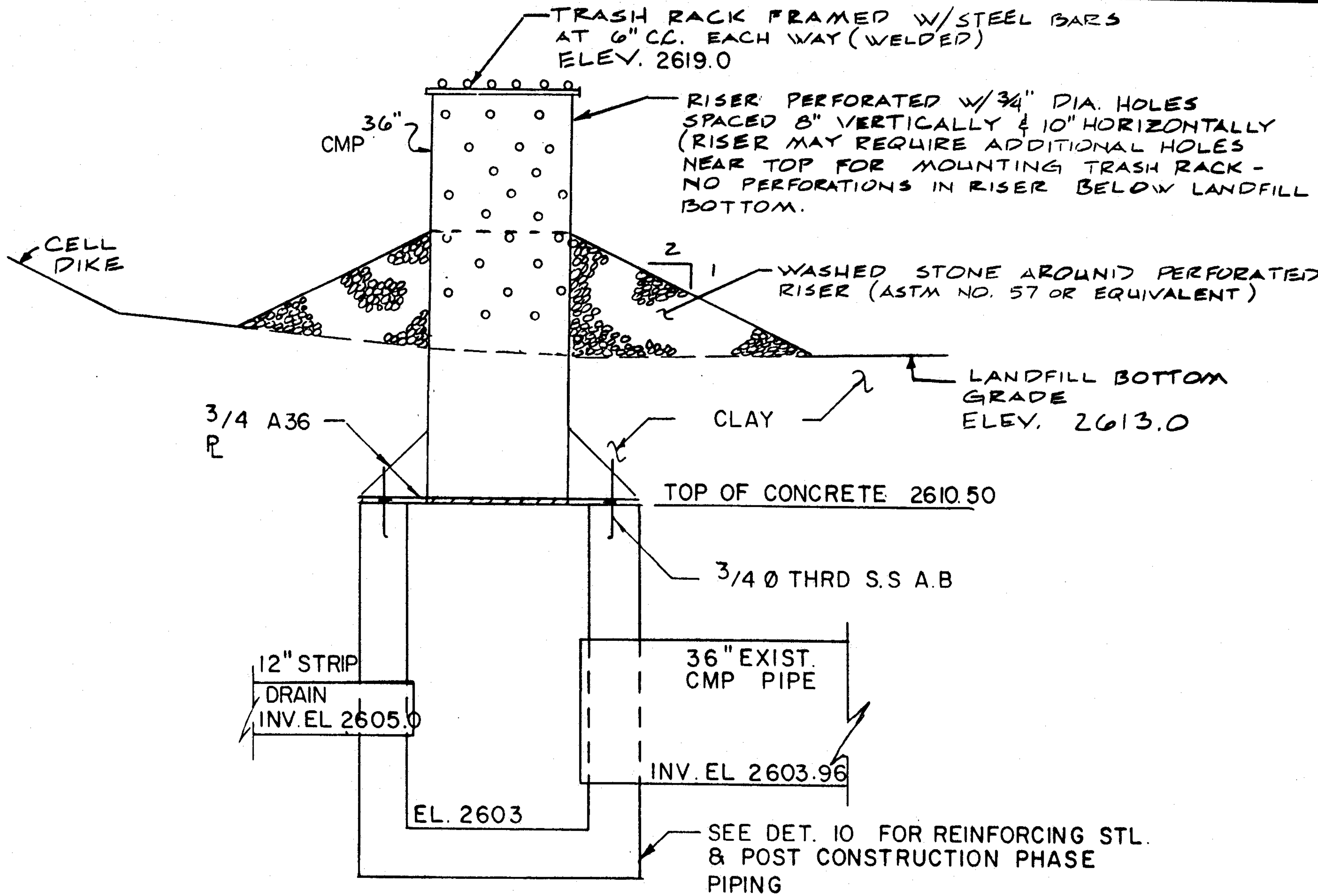
3.0 Erosion Control Measures During Construction

The erosion control measures required during the construction of Area A are separated into three different areas. The areas are 1) inside the landfill area, 2) outside the landfill area, and 3) the excess material spoil area. Figure 2, the Erosion Control Plan, shows the erosion control measures necessary to effectively control erosion and protect the environment.

3.1 Inside the Landfill Area

Controlling erosion and runoff inside the landfill area during initial construction prior to the HDPE liner installation will consist of collecting the runoff inside Area A dikes in a sediment pond. The sediment pond will be located at the east end of Area A where there is an existing drainage pipe. The existing drainage pipe currently directs runoff from the drainage area to Bowen Branch. A riser will be connected to the upstream end of the drainage pipe to control the release of collected runoff resulting in the formation of a sediment pond. Figure 3 provides a detail of the riser to be installed during the initial phase of construction.

The sediment pond will provide a surface area of approximately 43500 square feet at elevation 2619 which is two times the required surface area. Calculations show that for design inflow rates of 150 cfs approximately 22500 square feet of surface area is required to remove 40 micron particles. The sediment pond has 152800 cubic feet of storage providing a minimum retention time of 17 minutes at design inflow rates. The pond has a length to width ratio of 3 and the outlet riser is located at the opposite end from the inflows to prevent short circuiting.



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Greenville, South Carolina

FIGURE 3

CONSTRUCTION PHASE RUNOFF COLLECTION

During construction the sediment pond will receive sediment during storm events and will need to be frequently cleaned out. Initial construction will consist of clearing Area A and removing all the topsoil to facilitate the construction of the dikes and installation of the liner. This activity will leave exposed soils that can erode during storm events. Thus, the sediment pond will be inspected periodically and after every storm event. Sediment will be allowed to collect in the sediment pond to the top of the stone filter or approximately 2 feet before it is removed.

Since the liner will cover the entire area inside the dikes, erosion will not be a consideration after the liner has been installed. The sediment pond riser will be removed from the concrete outlet box and replaced with the arrangement shown in Figure 4. With the plastic liner covering the landfill area the amount of runoff and the peak flow from the area will increase. The 12 inch stormwater outlet will restrict flow from the area to an amount significantly less than the capacity of the existing 36 inch pipe. The outlet will be limited to 7.5 cfs (3352 gpm) with the peak runoff from the 32 acre cell in excess of 150 cfs for the 25-year 24-hour storm. Excess runoff will pond in the cell and gradually drain to Bowen Branch in approximately 30.2 hours. This represents the worst condition since the landfill area will be divided into smaller cells by divider dikes. As filling operations begin, a divider will be constructed at the east end of Area A to create an 8 acre fill area and the remaining 24 acres will continue to contribute uncontaminated runoff. Reducing the drainage area decreases the runoff volume and shortens the time to drain the retained runoff to 26 hours.

The 12 inch stormwater pipe will be extended up the slope beyond the divider dikes to collect runoff from lined area where waste is not being placed. This progression of divider dikes and line extensions will continue until the final 8

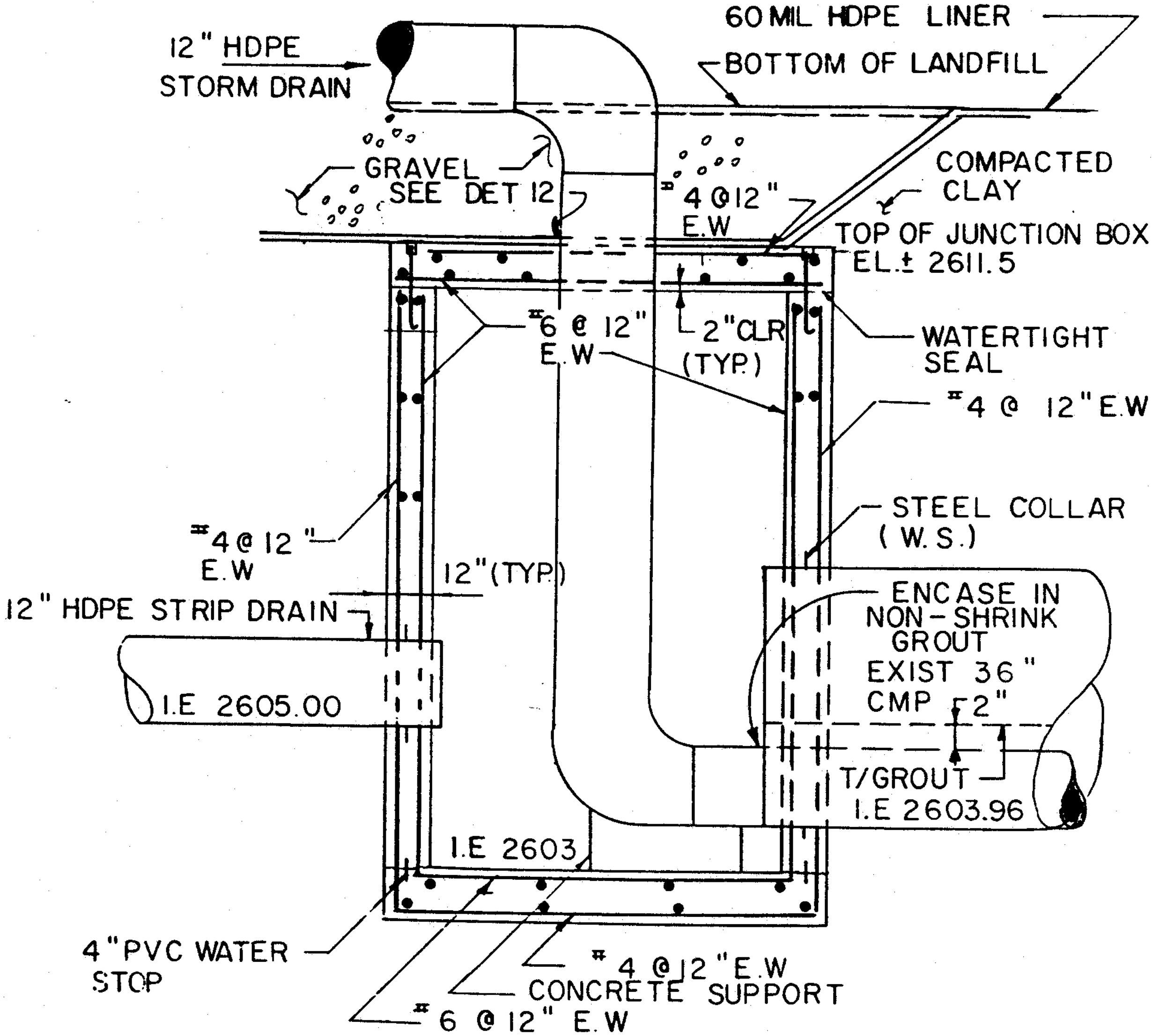

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FIGURE 4

**UNCONTAMINATED
RUNOFF DRAINAGE DET.**

acre cell is ready for filling at which time the stormwater pipe will be capped. It should also be noted that the leachate collection system will also be extended in the same manner as the stormwater pipe. The runoff from the uncontaminated areas will remain separate from the contaminated runoff by using various dikes, berms and ditches. Figures 5, 6, and 7 show the progression of the filling operations and the runoff collection system.

3.2 Outside the Landfill Area

Erosion control measures outside the landfill area will basically consist of silt fencing around the entire diked area. Silt fencing will effectively control runoff from the dike area since side slope lengths are 100 feet or less. There are also no ditches or other measures which direct runoff toward the fencing. Figure 2 provides the layout and installation details for the silt fencing. The side slopes will be seeded and mulched upon completion of dike construction, according to the enclosed seeding specification. The maintenance of appropriate grass cover on the side slopes will be monitored and additional seeding will be performed as necessary to effectively control erosion of the side slopes. The silt fencing will periodically be inspected and maintained as necessary to insure proper performance.

3.3 The Excess Material Spoil Area

The excess material spoil area will be located west of Area A in future Area D. Excavated material and topsoil from Area A which is not used during construction will be deposited in this area. The material deposited in the spoil area will be spread to promote drainage and prevent erosion of the material. A silt fence will be required on the down-slope side of the spoil area. Since the volume of spoil material is uncertain, the length of silt fence required and

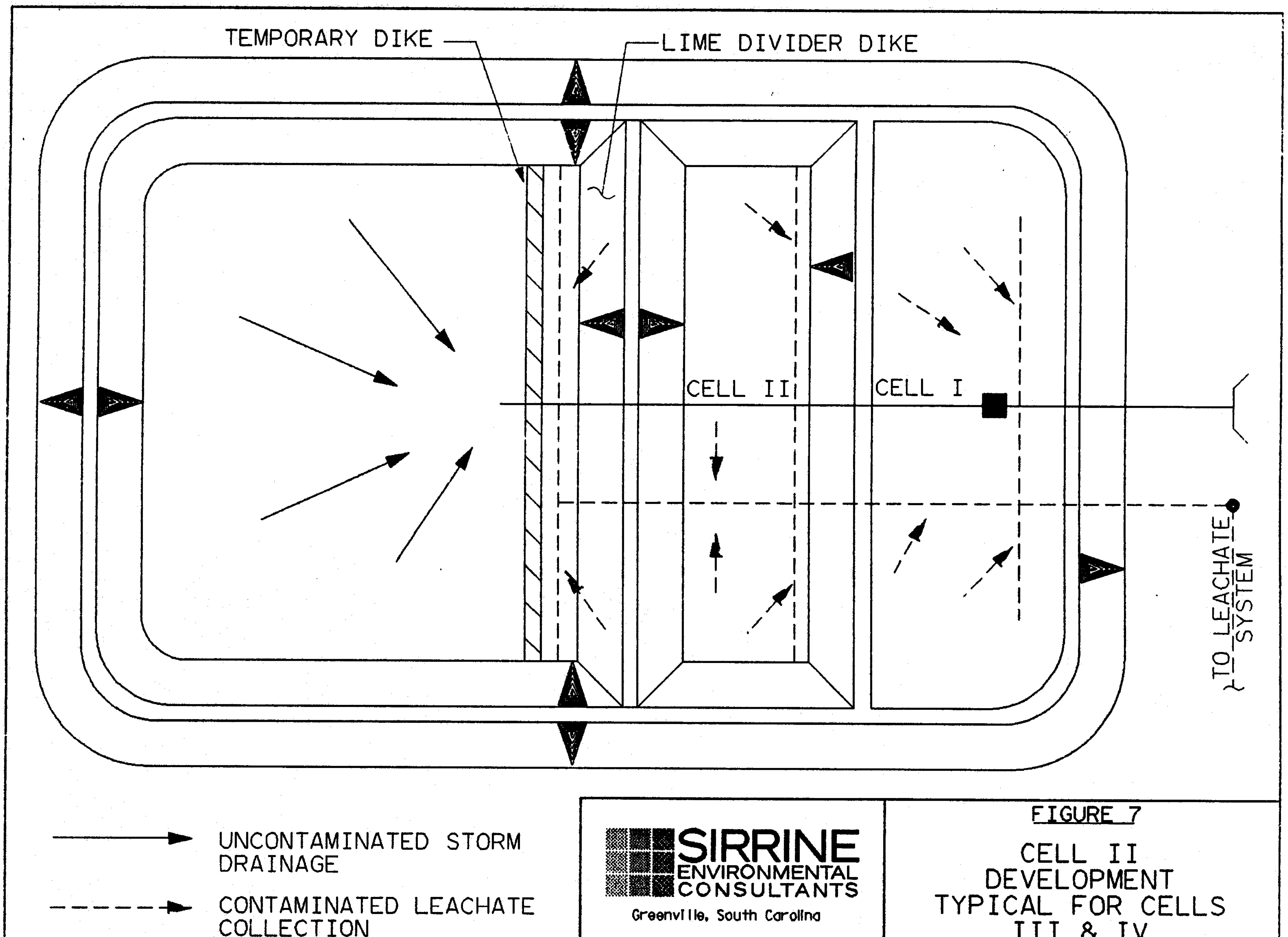

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FIGURE 7

CELL II DEVELOPMENT TYPICAL FOR CELLS III & IV

4.0 Erosion Control Measures After Landfill Completion

As the landfill cells are completed, final cover will be placed and vegetation will be established. The final cover will be sloped toward Bowen Branch at 5 percent and toward the ditches on each side of the landfill at 1 percent. These relatively flat slopes will prevent erosion of the top cover and provide a stable slope. Each cell will drain equally to each ditch which results in 4 acres of drainage to each ditch for each cell. The peak runoff from each 4 acre cell for the 25-year 24-hour storm event is approximately 17 cfs. Thus, each ditch will carry 70 cfs at the final discharge point and the total flow from the landfill area will equal 140 cfs. The culverts and ditches have been sized for these flows as they accumulate from each cell. The ditches will be rip-rapped to prevent erosion since the velocities are greater than 5 fps. The final contours along with the culverts and ditches are shown on Figure 8. This figure provides specifications and details for the rip-rapped ditch sections.

APPENDIX OF CALCULATIONS

EROSION CONTROL MEASURES
CHAMPION
CANTON, NC
SEC JOB NO. G-9083

Required: Estimate the stormwater runoff discharge during development of the 32 acre landfill Cell A at landfill No. 6

Given:

Utilize SCS methodology (TR-55 Chart Method)

From attached calculation (For 25 year storm)

Q_{p2} = 150 cfs

From attached calculation (For 10 year storm)

Q_{p10} = 120 cfs

* Check the retention time in the Sedimentation Control Pond when the peak flows occur; See Attached Drawings

1. Calculate Approximate Storage Volume:

Elevation	Surface Area	Storage Volume
2613	0	22,000 ft^3
2615	22,000 ft^2	130,800 ft^3
2619	43,400 ft^2	130,800 ft^3
	Vol =	152,800 ft^3

2. Check retention times at peak flows

$$10\text{ yr. storm} = 152{,}800\ ft^3 \times \frac{1\ sec}{120\ ft^3} \times \frac{1\ min}{60\ sec} = 21.2\ min$$

$$25\text{ yr. storm} = 152{,}800\ ft^3 \times \frac{1\ sec}{150\ ft^3} \times \frac{1\ min}{60\ sec} = 17.0\ min$$

Summary: During peak discharge from the 25 year storm, the retention pond has greater than 15 minute retention. Normal operation will provide substantially greater retention. This should provide adequate retention time for settling of the sediments during the landfill cell development.

TABLE 5. COMPUTATION SHEET FOR CHART METHOD

PROJECT Chapin - Canton, NC Computed By TYC Date ________
Checked By ______ Date ________

1. Required Input

A = 32 Acres : Drainage Area
10 T = 25 Years : Design Frequency (return period)
6.0 P = 7.0 Inches: Rainfall depth for 24-hour, T-year event (See TP-40)
Y = 5 % : Average watershed slope
CN = 80 : Runoff Curve Number

2. Compute Volume of Runoff, Q

3.8 Q = 4.75 Inches: Use CN and P as input to Fig. 5

3. Watershed Shape Adjustment (Optional: if adjustment is not made, set EA = A)

HL = ________ feet : Hydraulic Length
EA = 32 Acres : Equivalent Drainage Area (use Fig. 10)
HF = 1.0 : HF = A/EA

4. Obtain Unit Peak Discharge, QU

QU = 30 cfs/inch Q : Use EA with Fig. 11 (Sheet 1, 2, and 3 for flat, moderate, and steep slopes, respectively)

5. Watershed Slope Interpolation Factor, SF (Optional: if adjustment is not made, set SF = 1.0)

SF = 1.05 : Use Y and EA with Table 7

6. Ponding and Swamp Storage Adjustment Factor, PF (Optional: if adjustment is not made, set PF = 1.0)

PPS = ________ % : % of Ponds and Swampy Area (Based on actual drainage area A)
Location in watershed (check one):
Design Point (6-a)___; Center or Spread out (6-b)___; Upper Reaches (6-c)___

PF = 1.0 : Use PPS and T with Table 6-a, 6-b, or 6-c.

7. Peak Discharge QP, Calculation with Adjustments

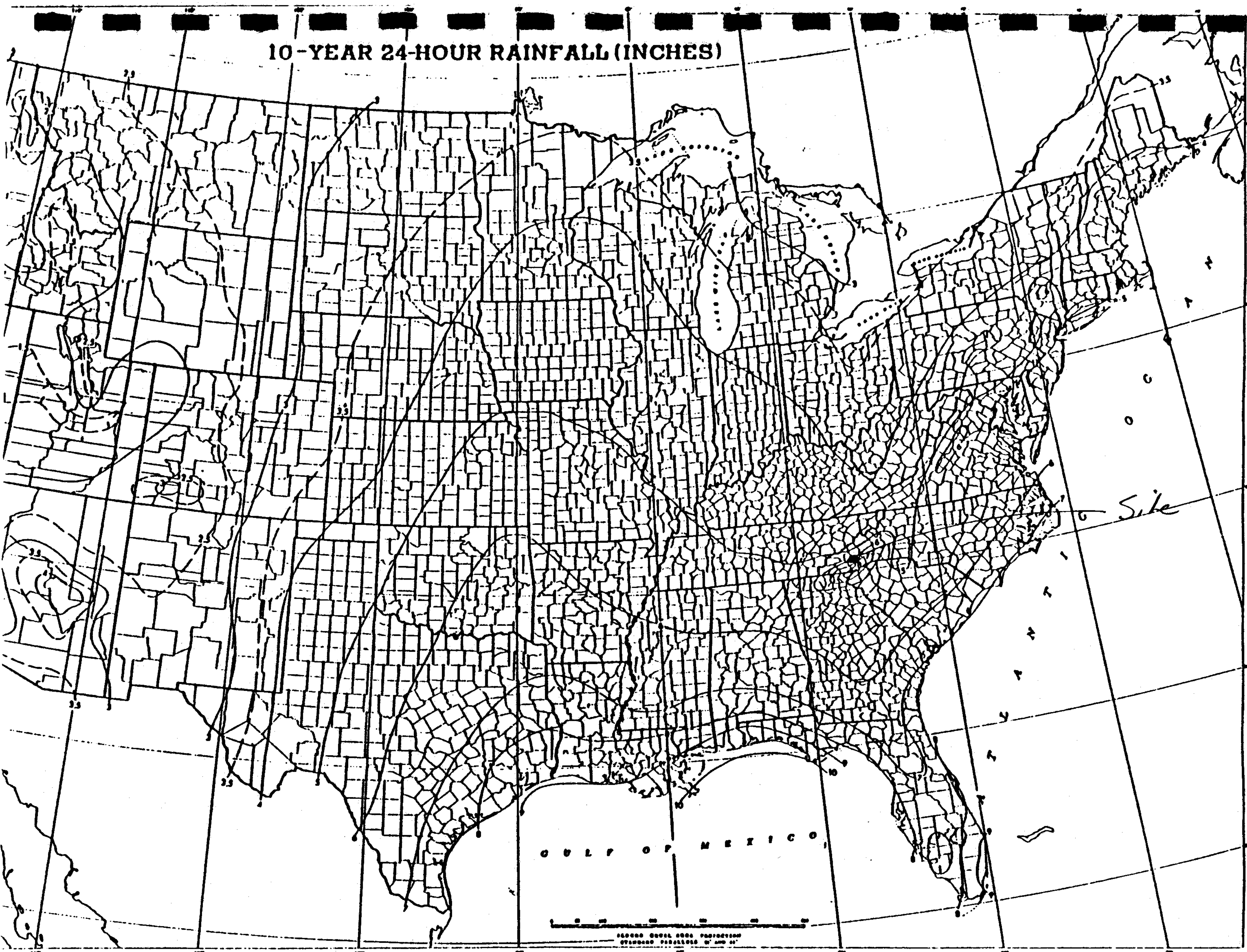
QP = QU x Q x HF x SF x PF
= 30 x 4.75 x 1.0 x 1.05 x 1.0
25 = 150 cfs
10 = 120 cfs

8. Modifications for Urbanization (N/A)

IMP = ________ % : Percentage of Impervious Area (based on actual drainage area A)
IMPF = ________ : Impervious Area Adjustment Factor (Fig. 12)
HLM = ________ % : Percentage of Hydraulic Length Modified
HLMF = ________ : Hydraulic Length Modified Factor (Fig. 13)

QPU = QP x IMPF x HLMF
= ______ x ______ x ______
= ______ cfs

10-YEAR 24-HOUR RAINFALL (INCHES)



25-YEAR 24-HOUR RAINFALL (INCHES)

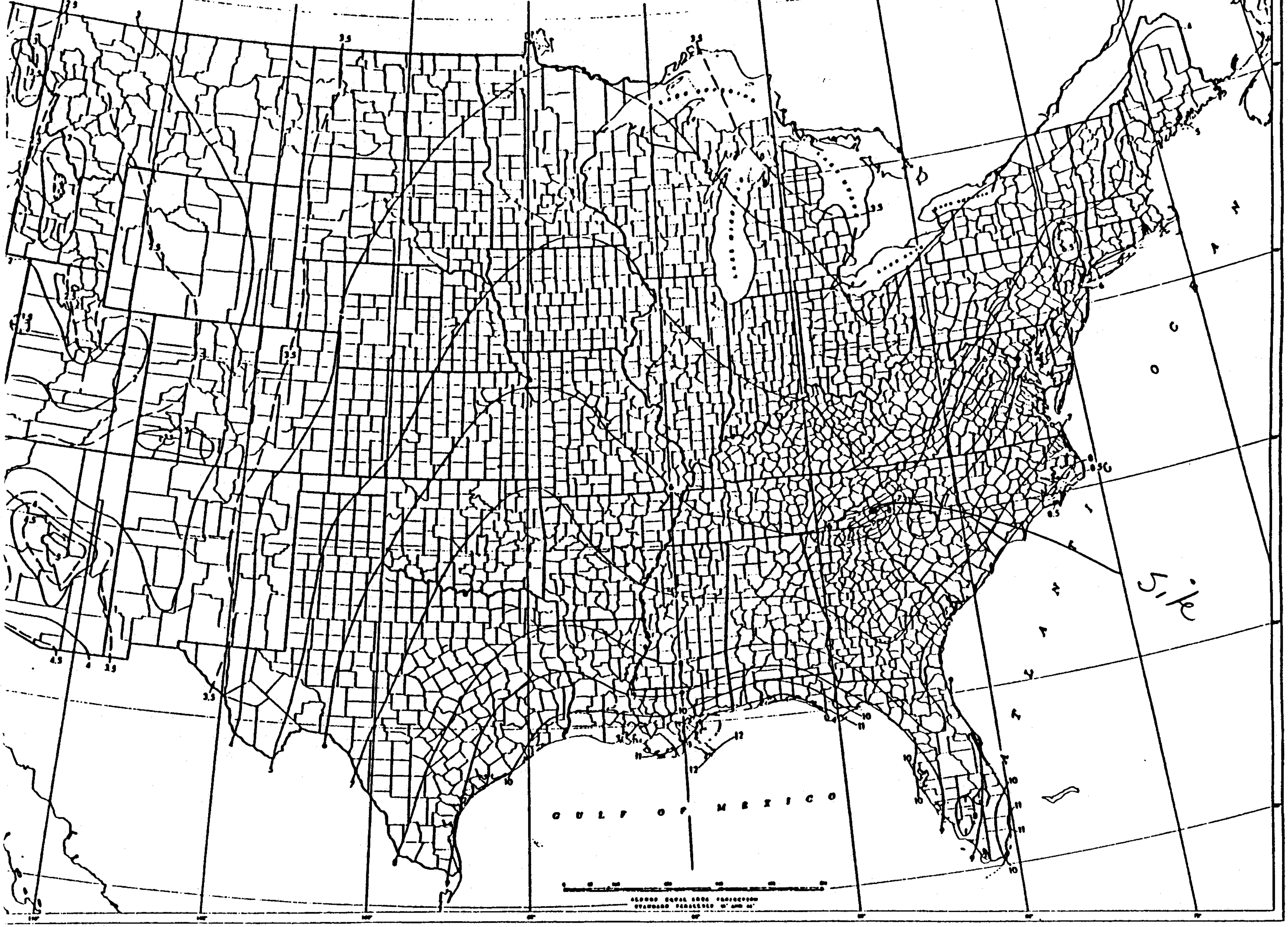


TABLE 2. Runoff Curve Numbers for Hydrologic Soil-Cover Complexes
(Antecedent Moisture Condition II, and $I_a = 0.2 S$)

Land Use Description/Treatment/Hydrologic Condition			Hydrologic Soil Group A	B	C	D
Residential:[1/]	Average lot size	Average % Impervious[2/]				
	1/8 acre or less	65	77	85	90	92
	1/4 acre	38	61	75	83	87
	1/3 acre	30	57	72	81	86
	1/2 acre	25	54	70	80	85
	1 acre	20	51	68	79	84
Paved parking lots, roofs, driveways, etc.[3/]			98	98	98	98
Streets and roads:						
	paved with curbs and storm sewers[3/]		98	98	98	98
	gravel		76	85	89	91
	dirt		72	82	87	89
Commercial and business areas (85% impervious)			89	92	94	95
Industrial districts (72% impervious)			81	88	91	93
Open Spaces, lawns, parks, golf courses, cemeteries, etc.						
	good condition: grass cover on 75% or more of the area		39	61	74	80
	fair condition: grass cover on 50% to 75% of the area		49	69	79	84
Fallow	Straight row	---	77	86	91	94
Row crops	Straight row	Poor	72	81	88	91
	Straight row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Contoured & terraced	Poor	66	74	80	82
	Contoured & terraced	Good	62	71	78	81
Small grain	Straight row	Poor	65	76	84	88
		Good	63	75	83	87
	Contoured	Poor	63	74	82	85
		Good	61	73	81	84
	Contoured & terraced	Poor	61	72	79	82
		Good	59	70	78	81
Close-seeded legumes[4/] or rotation meadow	Straight row	Poor	66	77	85	89
	Straight row	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	Contoured	Good	55	69	78	83
	Contoured & terraced	Poor	63	73	80	83
	Contoured & terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods or Forest land		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		---	59	74	82	86

Use CN = 80

[1/] Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.

[2/] The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

[3/] In some warmer climates of the country a curve number of 95 may be used.

[4/] Close-drilled or broadcast.

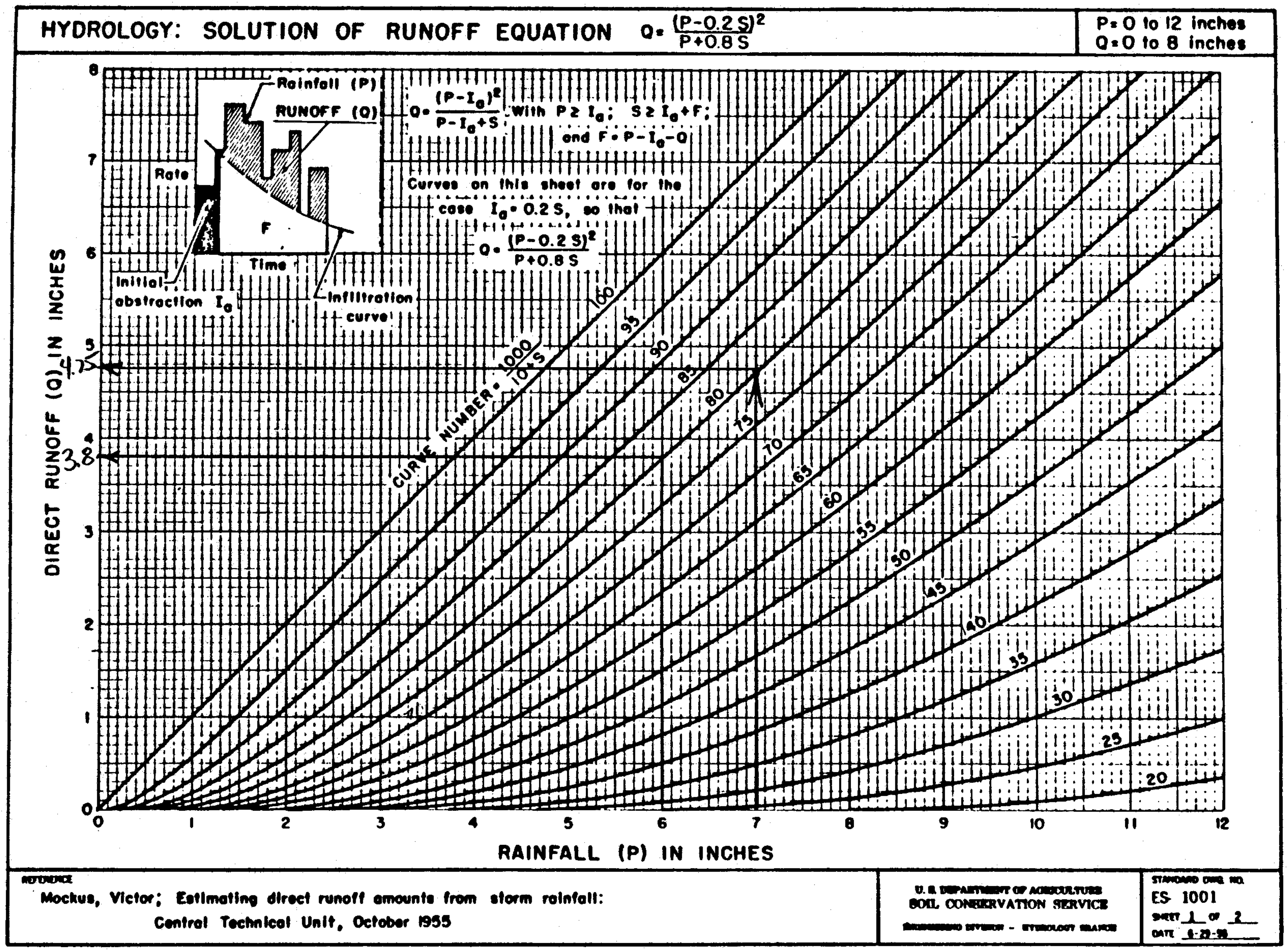


FIGURE 5. Graphical Solution of Rainfall-Runoff Equation

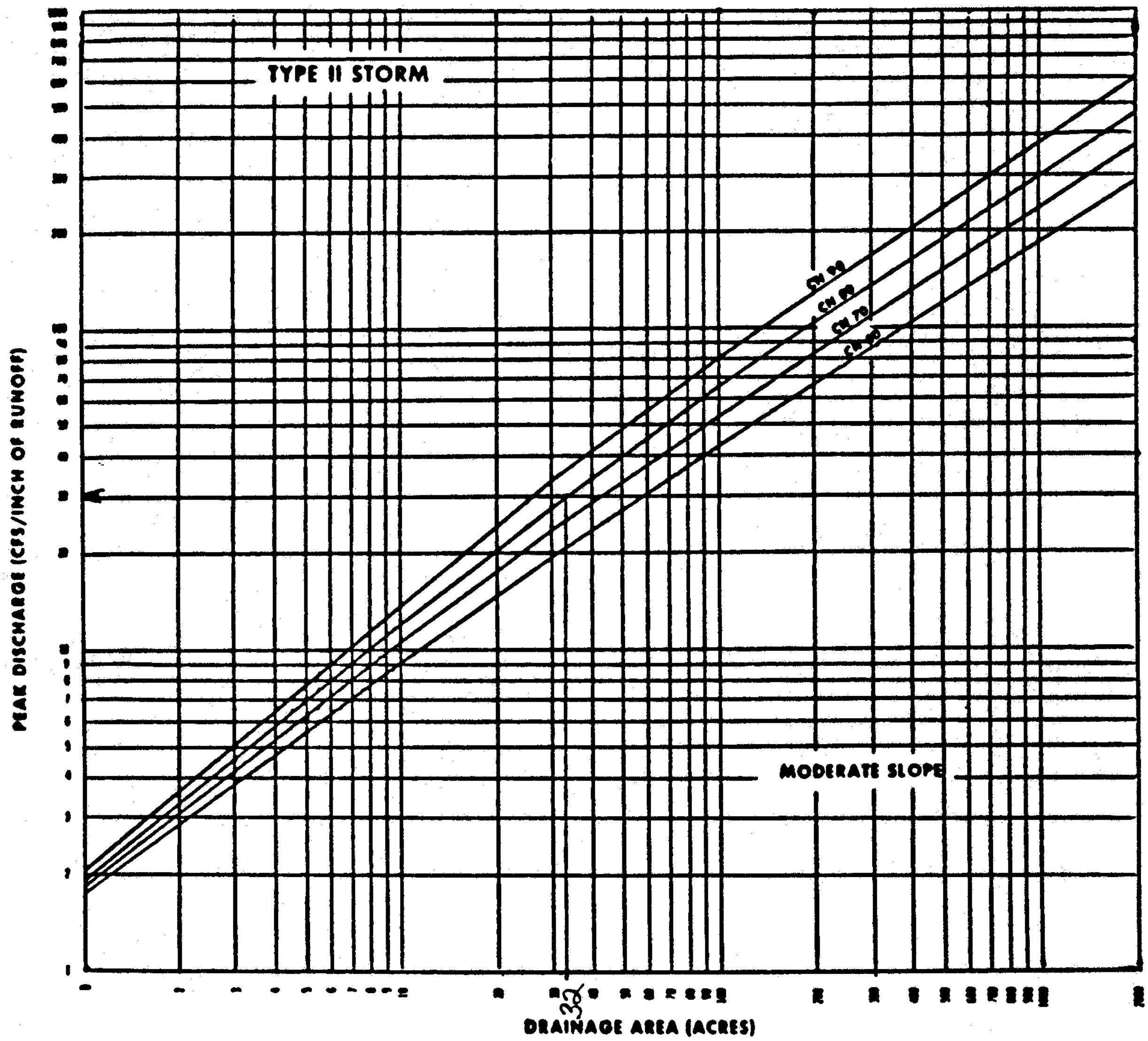


Figure 11 .--Peak rates of discharge for small watersheds (24-hour, type-II storm distribution). Sheet 2 of 3

Table 7 .--Slope adjustment factors by drainage areas

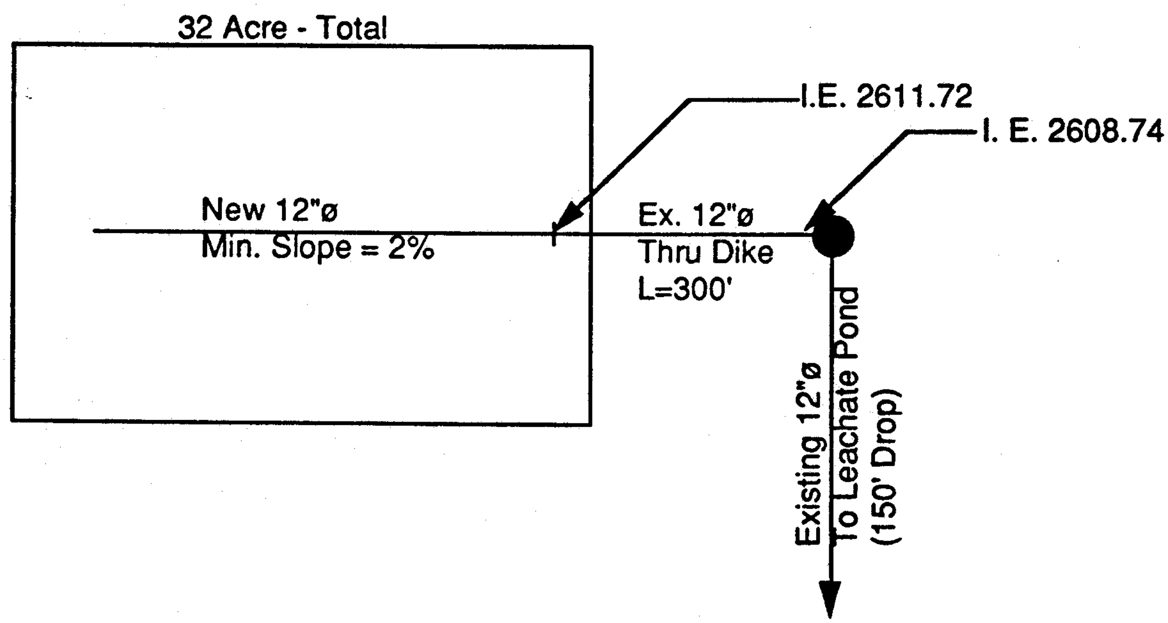
Slope (per-cent)	10 acres	20 acres	50 acres	100 acres	200 acres	500 acres	1,000 acres	2,000 acres
FLAT SLOPES								
0.1	0.49	0.47	0.44	0.43	0.42	0.41	0.41	0.40
0.2	.61	.59	.56	.55	.54	.53	.53	.52
0.3	.69	.67	.65	.64	.63	.62	.62	.61
0.4	.76	.74	.72	.71	.70	.69	.69	.69
0.5	.82	.80	.78	.77	.77	.76	.76	.76
0.7	.90	.89	.88	.87	.87	.87	.87	.87
1.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.5	1.13	1.14	1.14	1.15	1.16	1.17	1.17	1.17
2.0	1.21	1.24	1.26	1.28	1.29	1.30	1.31	1.31
MODERATE SLOPES								
3	.93	.92	.91	.90	.90	.90	.89	.89
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1.04	1.05	1.07	1.08	1.08	1.08	1.09	1.09
6	1.07	1.10	1.12	1.14	1.15	1.16	1.17	1.17
7	1.09	1.13	1.18	1.21	1.22	1.23	1.23	1.24
STEEP SLOPES								
8	.92	.88	.84	.81	.80	.78	.78	.77
9	.94	.90	.86	.84	.83	.82	.81	.81
10	.96	.92	.88	.87	.86	.85	.84	.84
11	.96	.94	.91	.90	.89	.88	.87	.87
12	.97	.95	.93	.92	.91	.90	.90	.90
13	.97	.97	.95	.94	.94	.93	.93	.92
14	.98	.98	.97	.96	.96	.96	.95	.95
15	.99	.99	.99	.98	.98	.98	.98	.98
16	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10
25	1.06	1.08	1.12	1.14	1.15	1.16	1.17	1.19
30	1.09	1.11	1.14	1.17	1.20	1.22	1.23	1.24
40	1.12	1.16	1.20	1.24	1.29	1.31	1.33	1.35
50	1.17	1.21	1.25	1.29	1.34	1.37	1.40	1.43

SYSTEM HYDRAULIC CALCULATIONS
CHAMPION
CANTON, NC
SEC JOB NO. G-9083

Required: Perform hydraulic calculations to evaluate the hydraulic capacity and adequacy of the proposed leachate, uncontaminated stormwater, and underdrain collection systems

I. Leachate Collection System

System Sketch



1. Check the hydraulic capacity of the drainage system

Note: The existing 12"ø thru the dike will be the limiting segment

$$\text{Slope} = \frac{2611.72 - 2608.74}{300'} = .0099 \text{ ft/ft}$$

N = .010 (HDPE Pipe)

Utilizing Manning's Eqta:

$$Q = \frac{1.486}{.010} \left(\frac{.5'}{2}\right)^{2/3} (.010)^{1/2} (\pi (.5)^2) = 4.63 \text{ cfs} = 2079 \text{ gpm}$$

2. Check the adequacy of this system to drain the leachate

Note: 1. Cell development is limited to 8 acres at one time since that is the limit of storage available in the Leachate Collection Pond

2. Leachate Volume is from two sources; rainwater & water from the sludge. Stormwater will be the major portion.

3. Ensure the system is adequate to drain the cell in 24 hours.

25 yr. - 24 hr. rainfall = 7.0"

Assume all runs off

Runoff Volume/24 hrs

$$= 7.0" \times \frac{1'}{12"} \times 84 \text{ acres} \times 43{,}500 \text{ ft}^2/\text{acre}$$

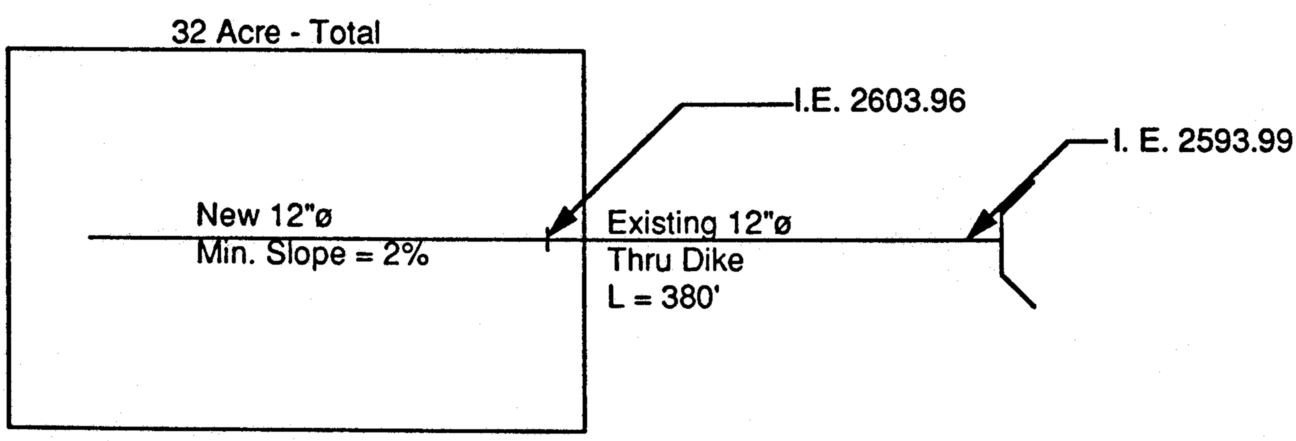
$$= 203{,}280 \text{ ft}^3 = 1{,}520{,}534 \text{ gal/24 hrs}$$

$$1{,}520{,}534 \text{ gal/24hr} \times \frac{1 \text{hr}}{60 \text{ min}} = 1056 \text{ gpm}$$

=> This existing system has adequate capacity and will drain leachate in approximately 12 hours.

II. Uncontaminated Stormwater Collection

System Sketch



1. Check the hydraulic capacity of the drainage system

Note: The existing 12"ø must drain the entire 32 acres. The new 12" will only be required to drain 24 acres since it will only be used after cell development begins and the initial 8 acres will discharge to the leachate collection system.

A. Existing 12"ø

$$\text{Slope} = \frac{2603.96 - 2593.99}{380'} = .026 \text{ ft/ft}$$

N = .010

$$\therefore Q = \frac{1.486}{.010} \left(\frac{.5'}{2}\right)^{2/3} (.026)^{1/2} (\pi(.5)^2) = 7.47 \text{ cfs} = 3352 \text{ gpm}$$

B. New 12"ø

$$Q = \frac{1.486}{.010} \frac{.5'}{2}^{2/3} (.02)^{1/2} (\pi(.5)^2) = 6.55 \text{ cfs} = 2934 \text{ gpm}$$

2. Check drainage times

A. 32 acre cell

Runoff Volume/24 hr

$$= 7.0" \times \frac{1'}{12"} \times 32 \text{ acres} \times 43{,}560 \text{ ft}^2\text{/acre}$$

$$= 813{,}120 \text{ ft}^3\text{/24 hr} = 6{,}082{,}138 \text{ gal/24hr}$$

At a drainage rate of 3352 gpm

$$= 6{,}082{,}138 \times \frac{1 \text{ min}}{3352 \text{ gal}} \times \frac{1 \text{ hr}}{60 \text{ min}} = 30.2 \text{ hrs}$$

B. 24 Acre Cell

Runoff Volume/24hr

$$= 6{,}082{,}138 \text{ gal/24hr} \times \frac{24 \text{ acres}}{32 \text{ acres}} = 4{,}561{,}603 \text{ gal/24hr}$$

At a drainage rate of 2934 gpm

$$= 4{,}561{,}603 \text{ gal/24 hr} \times \frac{1 \text{ min}}{2934 \text{ gal}} \times \frac{1 \text{ hr}}{60 \text{ min}} = 26 \text{ hrs}$$

III. Underdrain System

1. Measured flow in field = 10 gal/min

2. Capacity @ 6% slope (Per Geotechnical Report)
   12"ø HDPE

$$Q = \frac{1.486}{.010} \left(\frac{.5'}{2}\right)^{2/3} (.06)^{1/2} (\pi(.5)^2) = 11.34 \text{ cfs} = 5091 \text{ gpm}$$

SEDIMENTATION BASIN SIZING
CHAMPION
CANTON, NC
SEC JOB NO. G-9083

1. Settled out fine sands with a diameter of 40 microns with a settling velocity of .21 cm/sec from APWA, Practices in Detention of Urban Stormwater Runoff page 116.

2. The particle settling velocity equal to upflow velocity under ideal conditions.

3. $A = \frac{Q}{V_5}$ Q = Peak inflow, V_5 = Settling velocity

   $A = \frac{150 \text{ cfs}}{.21 \text{ cm/s}} = 21750 \text{ sq. ft.}$

4. Outlet riser is placed at opposite end of sediment basin to prevent short-circuiting.

5. Pond depth will range form 2 to deeper depths.

6. The stone filter around the base of the riser will drain the pond and trap sediment.

7. Sediment will accumulate to top of stone filter and then be removed.

EROSION CONTROL MEASURES
CHAMPION
CANTON, NC
SEC JOB NO. G-9083

Estimate runoff from final land fill cover slope 5%

- Half of runoff is directed to each side of cell
- Use cell area of 4 acres
- Use curve number of 70 for final cover
  Represents grassed area

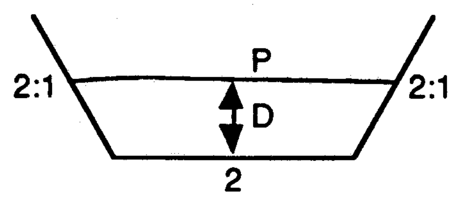
Each four acre cell contributes 17.3 cfs peak flow for a 25 year - 24 hour storm

		From Chart 5 (Attached)
1st pipe	17.3 cfs	use 18" *
2nd pipe	34.6 cfs	use 24"
3rd pipe	51.9 cfs	use 36"
4th pipe	69.2 cfs	use 36"

* Maximum HW water depth 5 feet.

Calculate channel velocities for rip-rapped runoff channel. Using open channel computer program using Manning's Equation. Use n=.03

Ditch section on landfill surface

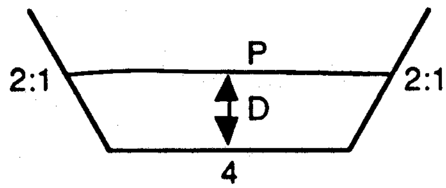


Slope = .05 ft/ft

	Q(cfs)	D(ft)	V(fps)
Section I	17.3	.77	7.2
Section II	34.6	1.1	8.5
Section III	51.9	1.4	9.5
Section IV	69.2	1.6	10.0

Final outfall ditch

$Q = 69.2\ (2) = 138.4$
$S = .05$
$n = .03$



$D = 1.5$ ft
$V = 11.8$

Rip-rap is required for all ditches since the velocities are greater than 5 fps. See detail of rip-rapped ditch on final contour drawing.

TABLE 5. COMPUTATION SHEET FOR CHART METHOD

PROJECT Champion ______ Computed By TMD Date ______
Checked By ______ Date ______

1. Required Input

A = 4 Acres : Drainage Area
T = 25 Years : Design Frequency (return period)
P = 7.0 Inches: Rainfall depth for 24-hour, T-year event
Y = 5 % : Average watershed slope
CN = 70 : Runoff Curve Number

2. Compute Volume of Runoff, Q

Q = 3.6 Inches: Use CN and P as input to Fig. 5

3. Watershed Shape Adjustment (Optional: if adjustment is not made, set EA = A)

HL = 600 feet : Hydraulic Length
EA = 5.81 Acres : Equivalent Drainage Area (use Fig. 10) $EA = .00013586\ HL^{5/3}$
HF = 0.69 : HF = A/EA

4. Obtain Unit Peak Discharge, QU

QU = 6.7 cfs/inch Q : Use EA with Fig. 11 (Sheet 1, 2, and 3 for flat, moderate, and steep slopes, respectively)

5. Watershed Slope Interpolation Factor, SF (Optional: if adjustment is not made, set SF = 1.0)

SF = 1.04 : Use Y and EA with Table 7

6. Ponding and Swamp Storage Adjustment Factor, PF (Optional: if adjustment is not made, set PF = 1.0)

PPS = ______ % : % of Ponds and Swampy Area (Based on actual drainage area A)

Location in watershed (check one):
Design Point (6-a)___; Center or Spread out (6-b)___; Upper Reaches (6-c)___

PF = ______ : Use PPS and T with Table 6-a, 6-b, or 6-c.

7. Peak Discharge QP, Calculation with Adjustments

QP = QU x Q x HF x SF x PF
= 6.7 x 3.6 x 0.69 x 1.04 x —
= 17.3 cfs

8. Modifications for Urbanization

IMP = ______ % : Percentage of Impervious Area (based on actual drainage area A)
IMPF = ______ : Impervious Area Adjustment Factor (Fig. 12)
HLM = ______ % : Percentage of Hydraulic Length Modified
HLMF = ______ : Hydraulic Length Modified Factor (Fig. 13)

QPU = QP x IMPF x HLMF
= ______ x ______ x ______
= ______ cfs

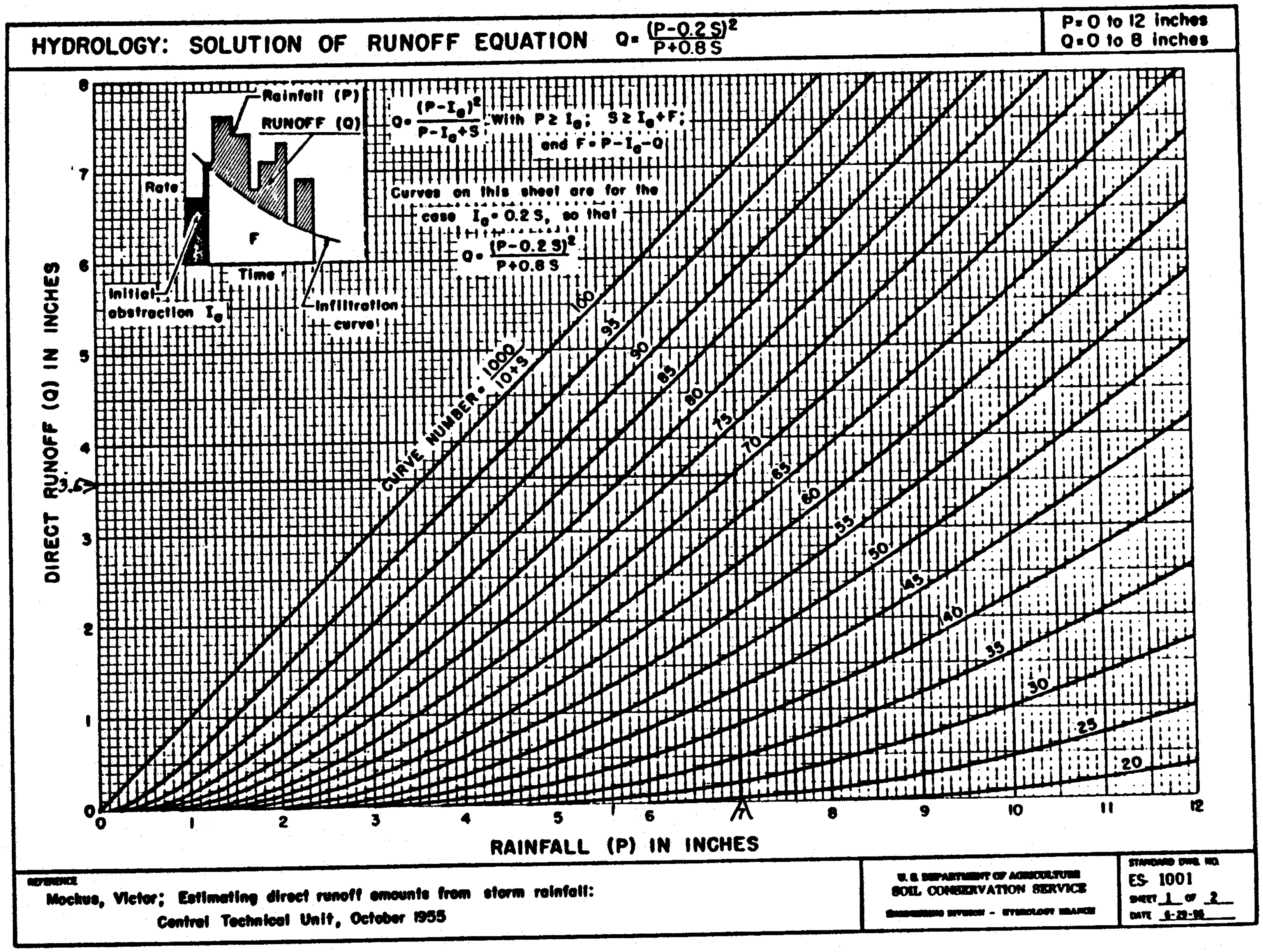


FIGURE 5. Graphical Solution of Rainfall-Runoff Equation

SECTION 9

THE TR-55 CHART METHOD

Another procedure for computing the peak discharge, which is called the chart method, is described in TR-55. The chart method was designed for use in estimating the effect of development on the peak discharge rate. The input data includes: the hydraulic length (ft), drainage area (acres), the percentage of ponds and swampy area, the design return period (years), the CN, the watershed slope (%), the precipitation depth (inches) for the design return period T, and the percentages of both the impervious area and the hydraulic length modified. All of the data are not necessary for all cases because some of the options are not mandatory. Application of the method is limited to watersheds from 1 acre to 2000 acres. The method is based on a 24-hour storm volume and a type II storm distribution.

An estimate of the peak discharge rate is easily obtained using the computation sheet of Table 5.

The hydraulic length (HL) is used when it is desired to make a shape adjustment. The hydraulic length is entered in Fig. 10 and the effective area (EA) is obtained and entered on the computation sheet. Alternatively, the effective area can be computed using the equation:

$$EA = 0.00013586\ HL^{5/3} \tag{12}$$

If a watershed shape adjustment is not desired, then the HL is not necessary and EA should be set equal to the drainage area A.

If a significant portion of the watershed is swampy and/or in ponds, the pond and swamp adjustment factor PF can be obtained from Table 6. The value depends on the location of the ponds or swampy area within the watershed, the return period T (or storm frequency), and the percentage of ponding and swampy area PPS.

The unit discharge, which will be discussed below, is obtained from charts designed for index slopes of 1%, 4%, and 16%. For slopes other than these three index values, the slope adjustment factor SF can be obtained from Table 7. The following table indicates the slope designations:

Slope Designation	Index Slope	Slope Range
flat	1%	$SP \leq 2.5\%$
moderate	4%	$2.5 < SP \leq 7.5\%$
steep	16%	$7.5 < SP$

The effective area EA and slope SP are used as input to the appropriate part of Table 7, and the slope adjustment factor SF is obtained and recorded on the computation sheet.

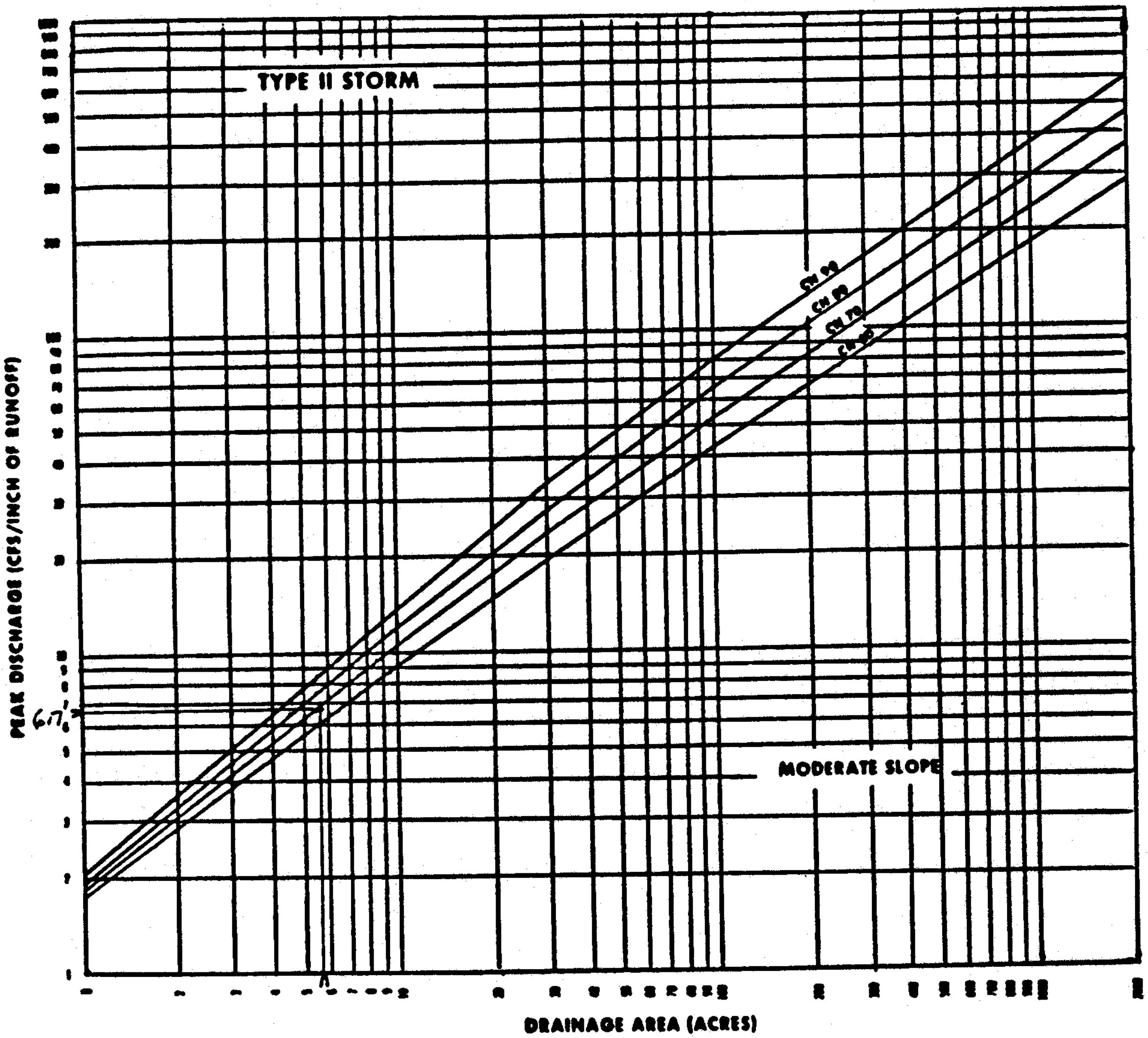
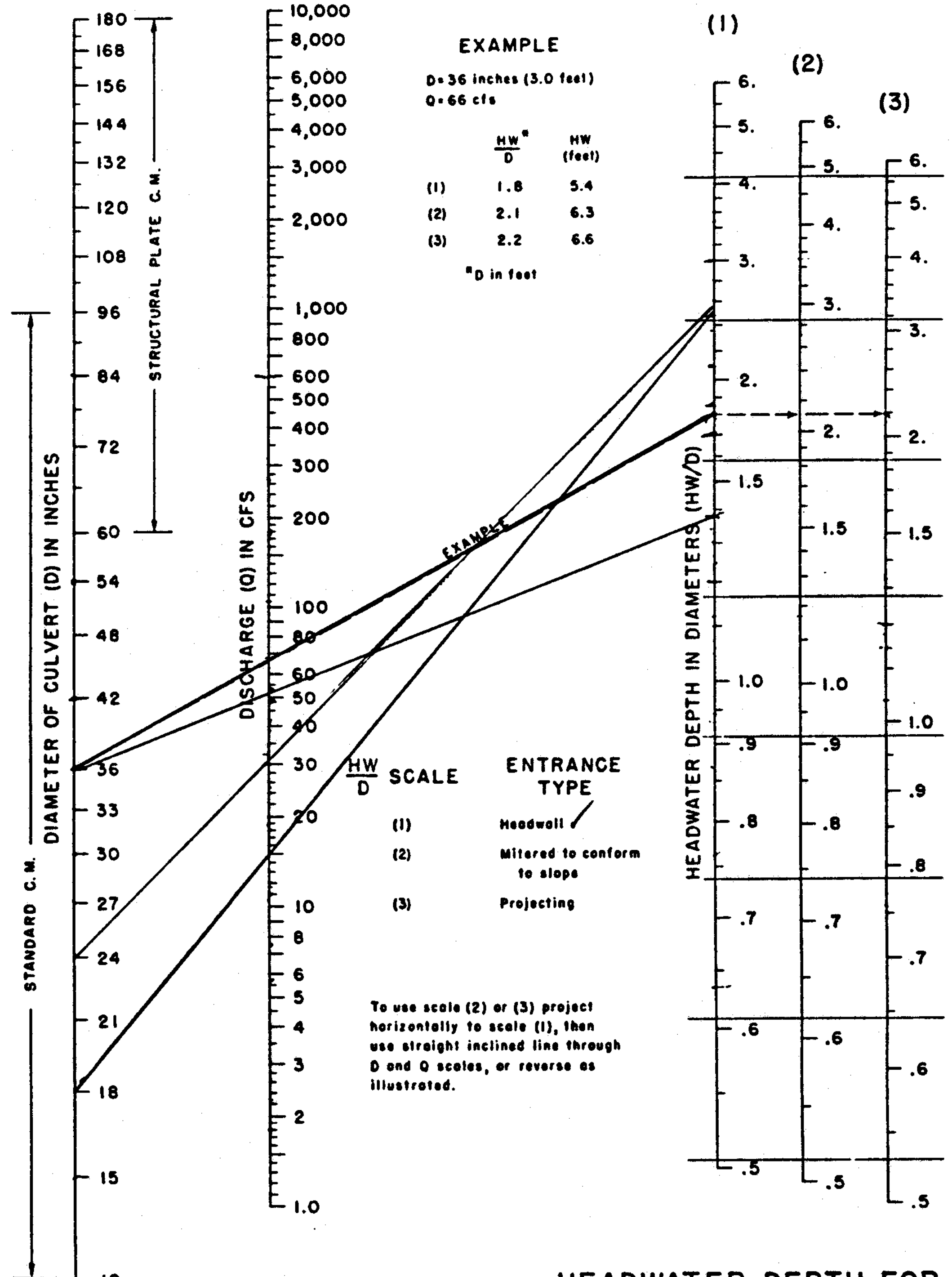


Figure 11 .--Peak rates of discharge for small watersheds (24-hour, type-II storm distribution). Sheet 2 of 3

Table 7 .--Slope adjustment factors by drainage areas

Slope (percent)	10 acres	20 acres	50 acres	100 acres	200 acres	500 acres	1,000 acres	2,000 acres
FLAT SLOPES								
0.1	0.49	0.47	0.44	0.43	0.42	0.41	0.41	0.40
0.2	.61	.59	.56	.55	.54	.53	.53	.52
0.3	.69	.67	.65	.64	.63	.62	.62	.61
0.4	.76	.74	.72	.71	.70	.69	.69	.69
0.5	.82	.80	.78	.77	.77	.76	.76	.76
0.7	.90	.89	.88	.87	.87	.87	.87	.87
1.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.5	1.13	1.14	1.14	1.15	1.16	1.17	1.17	1.17
2.0	1.21	1.24	1.26	1.28	1.29	1.30	1.31	1.31
MODERATE SLOPES								
3	.93	.92	.91	.90	.90	.90	.89	.89
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1.04	1.05	1.07	1.08	1.08	1.08	1.09	1.09
6	1.07	1.10	1.12	1.14	1.15	1.16	1.17	1.17
7	1.09	1.13	1.18	1.21	1.22	1.23	1.23	1.24
STEEP SLOPES								
8	.92	.88	.84	.81	.80	.78	.78	.77
9	.94	.90	.86	.84	.83	.82	.81	.81
10	.96	.92	.88	.87	.86	.85	.84	.84
11	.96	.94	.91	.90	.89	.88	.87	.87
12	.97	.95	.93	.92	.91	.90	.90	.90
13	.97	.97	.95	.94	.94	.93	.93	.92
14	.98	.98	.97	.96	.96	.96	.95	.95
15	.99	.99	.99	.98	.98	.98	.98	.98
16	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10
25	1.06	1.08	1.12	1.14	1.15	1.16	1.17	1.19
30	1.09	1.11	1.14	1.17	1.20	1.22	1.23	1.24
40	1.12	1.16	1.20	1.24	1.29	1.31	1.33	1.35
50	1.17	1.21	1.25	1.29	1.34	1.37	1.40	1.43

CHART 5



HEADWATER DEPTH FOR
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