DESIGN GUIDE FOR UNDERGROUND TERRACE OUTLETS

This procedure may be used to determine the required storage volume of the terrace and the release rate of the underground terrace outlet.

Sediment Storage.

The capacity of the terrace is to include the estimated 10-year sediment accumulation as determined by the Universal Soil Loss Equation. The average annual soil loss in tons per acre per year may be converted to inches lost in 10 years by the following table:

Tons/acre/year	Inches in 10 Years	Tons/acre/year	Inches in 10 Years
2	0.14	8	0.55
3	0.21	10	0.69
4	0.28	12	0.83
5	0.34	14	0.96
6	0.41	16	1.10
7	0.48	18	1.24

Water Storage and Release Rate.

The pipe discharge, when combined with the terrace storage, is to control the runoff from a 10-year, 24-hour rainfall without overtopping the terrace or significantly damaging growing crops by standing water.

The following data can be used to compute the required storage volume and the release rate of the orifice in the inlet.

Duration of Flooding (hours of removal time)	Storage Factor	Release Factor
6	0.41	4.00
12	0.53	2.00
18	0.58	1.50
24	0.63	1.00
36	0.67	0.75
48	0.75	0.50

Soil Cover Complex Number.

Curve numbers are to be computed for the specific on-site conditions of land use, vegetative cover, and hydrologic soil group for antecedent moisture condition II. The computations will not include the effect of terraces because of the negligible impact on the contributing drainage area.

Example Problem

Given:

Terrace located in Butler County
Soil Type - Norge
Hydrologic Soil Group - B
Land Use and Condition - contoured row crop
Soil Cover Complex No. 77, AMC II
Soil Loss - 4 tons/acre/year
10-year, 24-hour Rainfall - 5.4 inches
Runoff - 2.96 inches
Terrace Length - 1400 feet
Terrace Spacing - 120 feet
Duration of Flooding - 24 hours

Determine:

Total required storage and release rate.

Solution:

Storage Requirement

Sediment	= 0.28 inches
Water Storage = Runoff x Storage Factor = 2.96 inches x 0.63	= 1.86 inches
Total Storage	2.14 inches

Release Rate

= .042 cfs/ac.in. x drainage area (acres) x runoff(in.) x release factor

$$= .042 \times \left(\frac{1400 \times 120}{43560}\right) \times 2.96 \times 1.00 = 0.48 \text{ cfs}$$

Summary:

The minimum required storage capacity of the terrace is the equivalent of 2.14 inches of runoff from its drainage area.

The orifice in the riser must be sized to release an average of 0.48 cfs, or greater.

KS-8-3

Grassed Back Slope Terraces

Minimum Dimensions

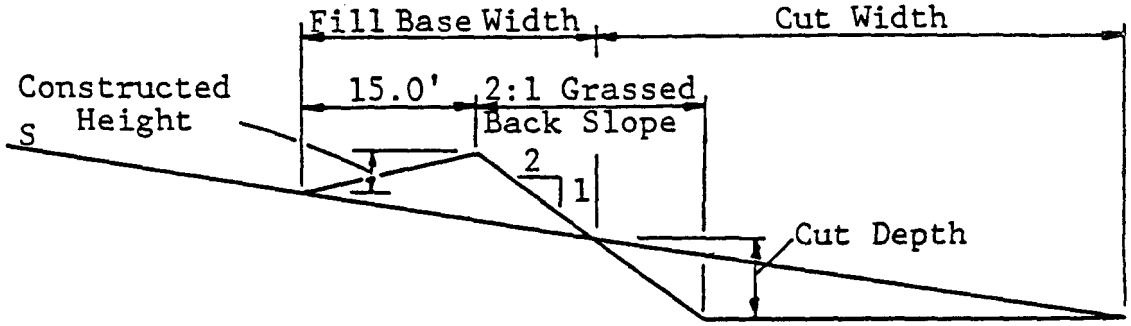


Table 2

FIELD SLOPE %	V.I. FT.	H.I. FT.	CONSTR. HEIGHT FT.	FILL BASE WIDTH FT.	CUT WIDTH FT.	CUT DEPTH FT.	VOLUME EXCAVATION CU. YD./FT.	BACK SLOPE AREA AC/1000 FT.
0.5	2.0	400	1.8	18.8	89.1	0.4	0.65	0.11
1	3.2	320	1.8	19.0	63.2	0.6	0.69	0.12
1.5	3.6	240	1.8	19.2	50.4	0.8	0.72	0.13
2	4.2	210	1.8	19.4	47.3	0.9	0.76	0.14
3	4.8	160	1.8	19.8	39.6	1.2	0.83	0.16
4	5.4	135	1.8	20.2	37.3	1.4	0.90	0.18
5	6.0	120	2.2	21.6	37.5	1.9	1.19	0.24
6	6.6	110	2.2	22.0	35.3	2.2	1.26	0.26
7	7.7	110	2.2	22.6	35.5	2.4	1.36	0.28
8	8.8	110	2.2	23.0	34.1	2.7	1.44	0.31
9	9.0	100	2.2	23.6	33.8	3.0	1.54	0.34
10	10.0	100	2.6	25.2	35.8	3.6	1.91	0.40
11	11.0	100	2.6	25.8	35.8	3.9	2.02	0.43
12	12.0	100	2.6	26.6	35.8	4.3	2.17	0.46
13	13.0	100	2.6	27.2	35.6	4.7	2.28	0.50
14	14.0	100	2.6	28.0	35.9	5.1	2.43	0.53
15	15.0	100	3.0	30.0	38.8	5.8	2.92	0.61
16	16.0	100	3.0	30.8	39.2	6.2	3.07	0.65
17	17.0	100	3.0	31.8	39.7	6.7	3.27	0.69
18	18.0	100	3.2	33.4	41.4	7.4	3.65	0.76
19	19.0	100	3.2	34.6	42.2	8.0	3.88	0.82
20	20.0	100	3.2	35.6	42.8	8.6	4.08	0.87

Discharge Through Perforated Risers for Underground Outlets in Cu. Ft./Sec.

Water Depth at Riser (Ft.)	Riser Diameter 5" Pipe 12-1" holes/ft	5" Pipe 24-1" holes/ft	6" Pipe 24-1" holes/ft	6" Pipe 30-1" holes/ft	8" Pipe 24-1" holes/ft	8" Pipe 40-1" holes/ft	8" Pipe 48-1" holes/ft
1.0	0.13	0.26	0.26	0.33	0.26	0.44	0.53
1.2	0.17	0.35	0.35	0.43	0.35	0.58	0.69
1.4	0.22	0.44	0.44	0.55	0.44	0.73	0.87
1.6	0.27	0.53	0.53	0.67	0.53	0.89	1.07
1.8	0.32	0.64	0.64	0.80	0.64	1.06	1.27
2.0	0.37	0.75	0.75	0.93	0.75	1.24	1.49
2.2	0.43	0.81	0.86	1.08	0.86	1.43	1.72
2.4	0.49	0.85	0.98	1.23	0.98	1.63	1.96
2.6	0.55	0.89	1.11	1.28	1.11	1.84	2.21
2.8	0.62	0.92	1.24	1.32	1.24	2.06	2.35
3.0	0.69	0.95	1.37	1.37	1.37	2.28	2.44
3.2	0.75	0.98	1.41	1.41	1.51	2.52	2.52
3.4	0.83	1.01	1.46	1.46	1.65	2.59	2.59
3.6	0.90	1.04	1.50	1.50	1.80	2.67	2.67
3.8	0.98	1.07	1.54	1.54	1.95	2.74	2.74
4.0	1.05	1.10	1.58	1.58	2.11	2.81	2.81

CAPACITY OF PERFORATIONS

$Q = CA\sqrt{2gh}$
C = 0.6
A = half of the area, in sq. ft., of the perforations for the storage depth (d.) It is assumed one half the perforations are plugged with trash.
h = 0.7d

Example:
Find the discharge through a 6" riser with 24, 1" dia. perforations per foot when the storage depth (d) is 1.8 ft.
Area of perforations (A) = 0.5 * .005454 sq. ft./1" dia. hole * 24 holes/ft * 1.8 ft. = 0.1178 sq.ft.
h = 0.7d = 0.7 * 1.8 = 1.26 ft.
$Q = 0.6 * 0.1178 * 8.02 * \sqrt{1.26} = 0.64$ cfs

CAPACITY OF RISER PIPE

$Q = CA\sqrt{2gh}$
C = 0.6
A = area of pipe in sq. ft.
h = 0.7d

Example:
Find pipe discharge of a 6" dia. riser with 30, 1" dia. perforations per foot when the storage depth (d) is 2.4 ft.
A = 3.1416 / 4 * 0.5 * 0.5 = 0.19635 sq. ft.
h = 0.7 * 2.4 = 1.68 ft.
$Q = 0.6 * 0.19635 * 8.02 * \sqrt{1.68} = 1.23$ cfs

DESIGN GUIDE FOR GRADIENT TERRACE

This procedure may be used to determine the minimum ridge height and channel width of gradient terraces up to 3000 feet long. It accounts for all the variables important in terrace design such as soil type, land slope, rainfall, terrace grade, terrace length, and terrace spacing.

The charts were developed for a front slope and cut slope of 6 horizontal to 1 vertical. The hydraulic flow depth is equal to the constructed height minus 0.3 foot which provides allowance for potential sediment blockages and settlement.

The charts are made for hydrologic soil group C with provision for adapting to B and D soils. A terrace laying on more than one soil group will be designed for the soil with the highest runoff potential.

Terraces will be designed to have capacity to control the runoff from a 10-year frequency, 24-hour duration rainfall without overtopping. Velocities in the channel shall be non-erosive for the soil types involved. Permissible maximum velocities are stated in the "Kansas Standard for Terrace-600" to be 2.5 fps for erosion resistant soils, 2.0 fps for average soils, and 1.5 fps for easily erodible soils.

A terrace having a varying gradient will be designed using the steepest grade along its length to determine the peak discharge, and the flattest grade to determine the size.

Example 1

Determine the minimum terrace dimensions for a gradient terrace planned to be 2800 feet long with a constant grade of 0.3 percent and a terrace spacing of 190 feet.

The average land slope is three percent and the soil is classified in hydrologic soil group C.

The maximum permissible velocity for the soil is judged to be two feet per second.

The 10 year frequency, 24-hour duration rainfall is 5.2 inches.

1. On page KS-8-11 for 0.3 percent terrace grade enter the table at the top of the page with 3 percent land slope and 2800 feet terrace length. Read 19.0. Designate this as Q.

2. Enter the left hand curve in the middle of page KS-8-11 with a rainfall of 5.2 inches and read a rainfall adjustment factor (RAF) of 0.8.

3. Enter the right hand curve in the middle of page KS-8-11 with a terrace spacing of 190 feet and 3 percent land slope, and read a terrace spacing correction factor (TSCF) of 1.18.

4. Compute the design discharge (Q_D)

$$Q_D = Q_{(\text{step 1})} \text{ X } RAF_{(\text{step 2})} \text{ X } TSCF_{(\text{step 3})}$$

$$Q_D = 19.0 \text{ X } 0.8 \text{ X } 1.18 = 17.9 \text{ cfs}$$

5. Enter the curve at the bottom of page KS-8-11 with the design discharge of 17.9 cfs. Read the channel bottom width and velocity corresponding to the various constructed heights intersected by the discharge.

   a. Constructed Height = 1.5 feet; bottom width = 5.7 feet (use 6.0); velocity = 1.6+ fps $\leq$ 2.0 fps O.K.

   b. Constructed Height = 1.3 feet, bottom width = 10.1 feet (use 10.0); velocity = 1.5+ fps $\leq$ 2.0 fps O.K.

6. The minimum design cross section can be either of the combinations determined in step 5. The landowner should choose one which equals or exceeds the minimum and best fits his farming operation.

Example 2

Determine the minimum terrace dimensions for a gradient terrace planned to be 2000 feet long with a variable grade from 0.1 to 0.4 percent.

The average land slope is three percent and the soil is classifed in hydrologic soil groups C and D.

The terrace spacing is planned to be 220 feet.

The maximum permissible velocity for the soil is judged to be 2.5 feet per second.

The 10-year frequency, 24-hour duration rainfall is 5.6 inches.

1. The terrace has a variable grade and crosses two soil groups. Determine the design discharge for the steepest grade and the hydrologic soil group having the most runoff potential. Apply the design discharge to the flattest grade to size the terrace.

   On page KS-8-12 for 0.4 percent terrace grade, enter the table at the top of the page with 3 percent land slope and 2000 feet terrace length. Read 18.9. Designate this as Q.

2. Enter the left hand curve in the middle of page KS-8-12, with a rainfall of 5.6 inches and read a rainfall adjustment factor (RAF) of 0.9.

3. Enter the right hand curve in the middle of page KS-8-12 with a terrace spacing of 220 feet and a 3 percent land slope, and read a terrace spacing correction factor (TSCF) of 1.36.

4. Compute the design discharge (Q_D) and adjust for soil group D by multiplying by 1.10.

$$Q_D = Q_{(\text{step 1})} \text{ X } RAF_{(\text{step 2})} \text{ X } TSCF_{(\text{step 3})} \text{ X } 1.10$$

$$= 18.9 \text{ X } 0.9 \text{ X } 1.36 \text{ X } 1.10 = 25.4 \text{ cfs}$$

5. On page KS-8-9 for 0.1 percent terrace grade, enter the curve at the bottom of the page with the design discharge of 25.4 cfs. Read the channel bottom width and velocity corresponding to the various constructed heights intersected by the discharge.

   a. Construction Height = 2.0 feet; bottom width = 7.9 feet (use 8.0); velocity = 1.2+ fps

   b. Constructed Height = 1.7 feet; bottom width = 14.4 feet (use 15.0); velocity = 1.1+ fps

6. Check the velocity on the steepest grade, 0.4 percent.

   Enter the curve at the bottom of page KS-8-12 with the design discharge and bottom widths from step 5. Read the velocity.

   Bottom width = 8.0 feet; velocity = 2.02 fps $\leq$ 2.5 O.K.

   Bottom width = 15.0 feet; velocity = 1.85 fps $\leq$ 2.5 O.K.

7. The minimum design cross section may be any of the combinations determined in step 5. The landowner should choose one which equals or exceeds the minimum and best fits his farming operation.

Example 3

Determine the maximum terrace length for a gradient terrace having a channel bottom width of 6.0 feet, a constructed height of 1.3 feet, a constant grade of 0.2 percent, and a terrace spacing of 200 feet.

The average land slope is 2 percent and the soil is classifed in hydrologic soil group C.

The maximum permissible velocity for the soil is judged to be 2 feet per second.

The 10-year frequency, 24-hour duration rainfall is 5.0 inches.

1. On page KS-8-10 for 0.2 percent terrace grade, enter the curve at the bottom of the page with a channel bottom width of 6 feet and a constructed height of 1.3 feet. Read the design discharge. Q_D = 10.2 cfs

2. Enter the right hand curve in the middle of page KS-8-10 with a terrace spacing of 200 feet and a 2 percent land slope, and read a terrace spacing correction factor (TSCF) of 1.0.

3. Enter the left hand curve in the middle of page KS-8-10 with a rainfall of 5.0 inches and read a rainfall adjustment factor (RAF) of 0.75.

4. Compute $Q = Q_D/RAF \times TSCF$

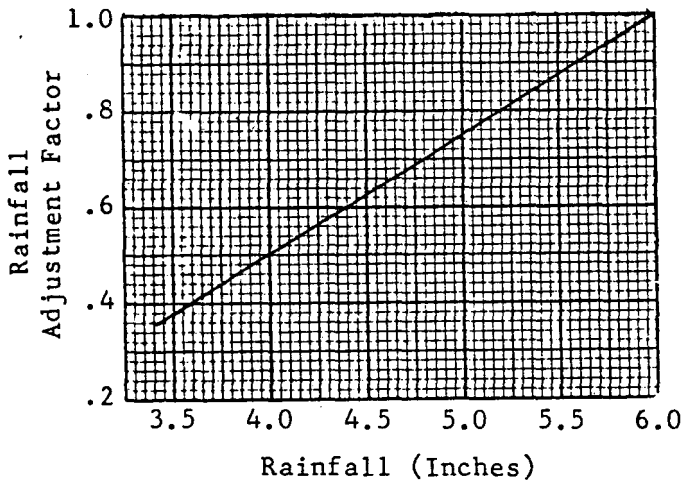
   $= 10.2/0.75 \times 1.0 = 13.6$ cfs

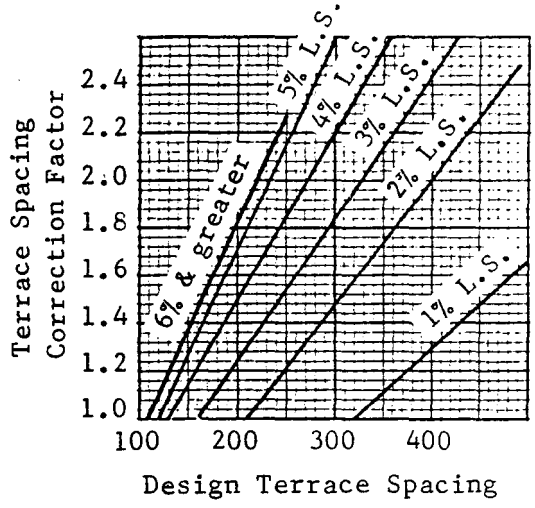
5. Enter the table at the top of page KS-8-10 with Q = 13.6 cfs and a land slope of 2 percent. Interpolate the terrace length to be 1044 feet. Round off to 1040 feet.

KS-8-9

Discharges for 0.1% Terrace Grade
on "C" Soils CN = 78

Land Slope (%)	Terrace Length (Ft.)											
	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000
1.0	14.0	16.0	17.5	18.6	19.5	20.3	20.8	21.4	21.8	22.3	22.7	23.0
2.0	10.3	11.8	13.0	13.8	14.5	15.0	15.4	15.8	16.1	16.4	16.6	16.8
3.0	8.1	9.2	9.9	10.5	11.0	11.3	11.6	11.9	12.2	12.4	12.6	12.8
4.0	6.8	7.7	8.4	8.9	9.3	9.7	9.9	10.1	10.3	10.5	10.7	10.8
5.0	6.1	7.1	7.8	8.2	8.5	8.7	8.9	9.1	9.3	9.5	9.6	9.7
6.0 & greater	5.7	6.4	6.9	7.3	7.6	7.8	8.0	8.1	8.2	8.4	8.5	8.6

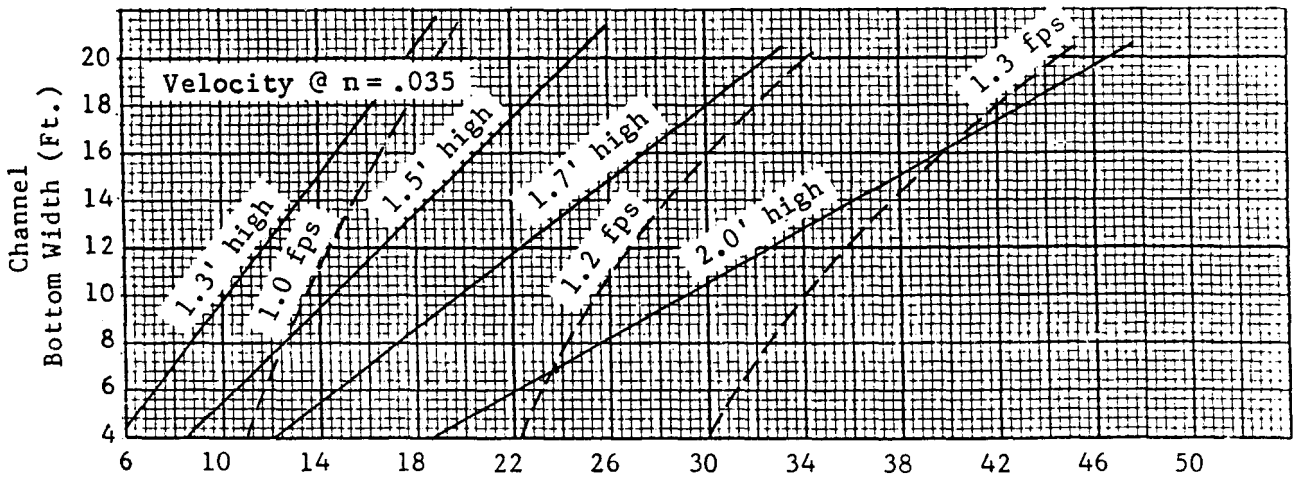




Design Discharge (Q_D) = Discharge x Rainfall Adj. Factor x Terrace Spacing Corr. Factor

For "B" soil: Multiply Q_D by 0.80 to use below

For "D" soil: Multiply Q_D by 1.10 to use below



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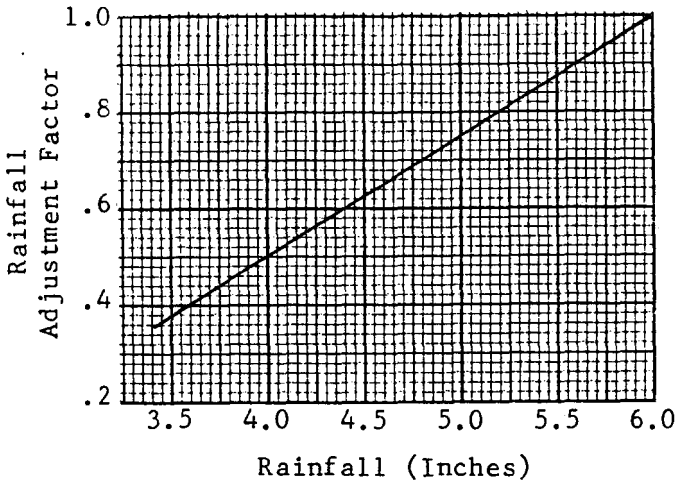
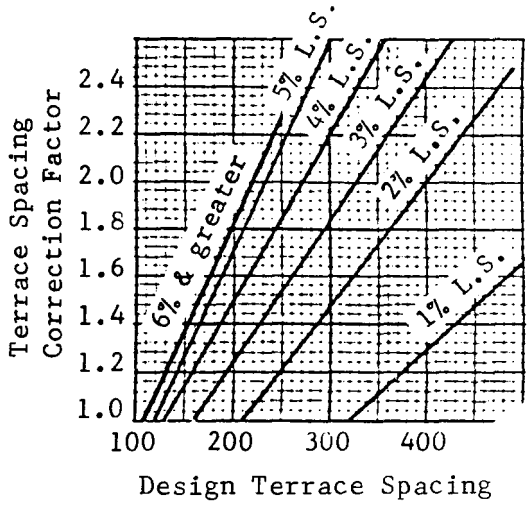
KS-8-10

Discharges for 0.2% Terrace Grade
on "C" Soils CN = 78

Land Slope (%)	Terrace Length (Ft.)											
	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000
1.0	15.0	17.8	20.2	22.3	24.0	25.6	26.8	27.8	28.7	29.4	30.0	30.5
2.0	11.2	13.2	15.0	16.5	17.7	18.6	19.4	20.0	20.6	21.2	21.7	22.2
3.0	8.8	10.3	11.6	12.8	13.6	14.2	14.8	15.2	15.6	16.0	16.3	16.6
4.0	7.6	9.0	10.0	11.0	11.7	12.3	12.8	13.2	13.6	14.0	14.4	14.7
5.0	6.8	7.9	8.9	9.6	10.2	10.7	11.2	11.5	11.8	12.1	12.4	12.6
6.0 & greater	6.3	7.4	8.2	9.0	9.5	10.0	10.4	10.8	11.1	11.4	11.6	11.8

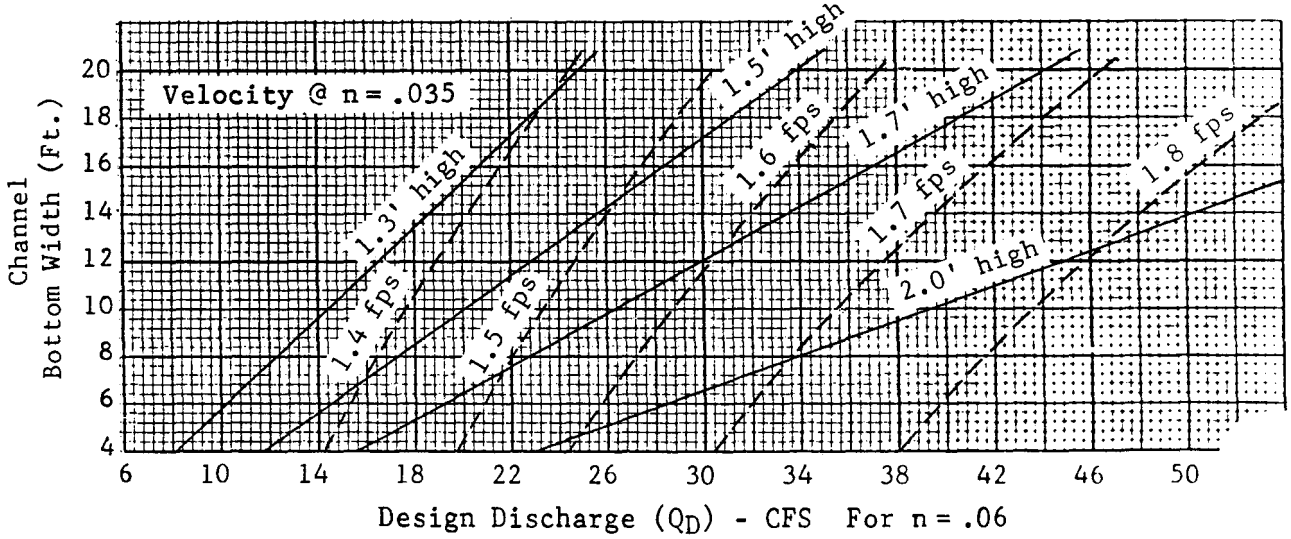




Design Discharge (Q_D) = Discharge x Rainfall Adj. Factor x Terrace Spacing Corr. Factor

For "B" soil: Multiply Q_D by 0.80 to use below

For "D" soil: Multiply Q_D by 1.10 to use below



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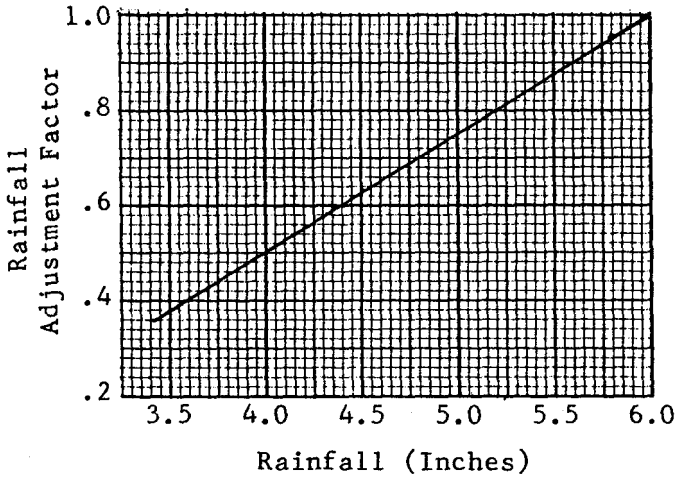
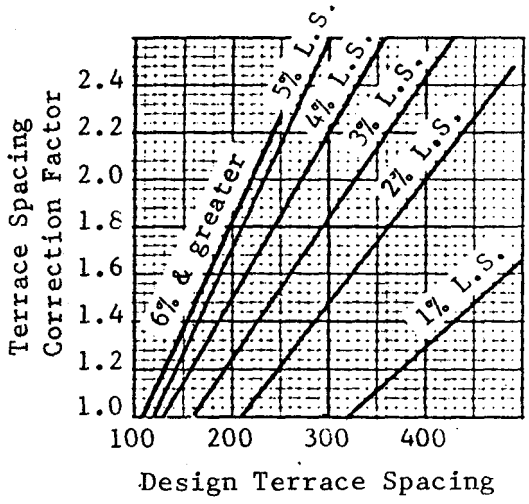
KS-8-11

Discharges for 0.3% Terrace Grade
on "C" Soils CN = 78

Land Slope (%)	Terrace Length (Ft.)											
	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000
1.0	15.8	19.1	22.0	24.6	26.8	28.7	30.4	31.6	33.0	34.0	34.8	35.4
2.0	11.8	14.0	15.9	17.6	19.1	20.3	21.3	22.2	23.0	23.7	24.4	25.0
3.0	9.4	11.1	12.7	14.2	15.4	16.4	17.1	17.7	18.2	18.6	19.0	19.3
4.0	8.0	9.4	10.7	11.9	13.0	14.0	14.8	15.3	15.7	16.1	16.4	16.7
5.0	7.2	8.4	9.5	10.5	11.3	12.0	12.5	13.0	13.4	13.8	14.1	14.4
6.0 & greater	6.7	7.8	8.8	9.7	10.5	11.2	11.7	12.1	12.4	12.7	13.0	13.3

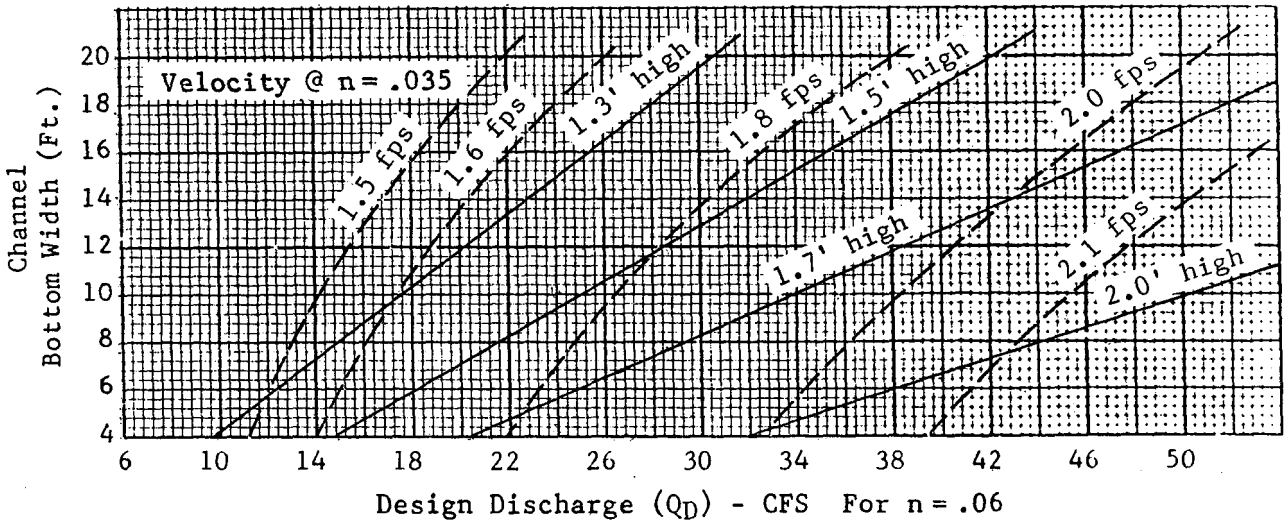




Design Discharge (Q_D) = Discharge x Rainfall Adj. Factor x Terrace Spacing Corr. Factor

For "B" soil: Multiply Q_D by 0.80 to use below

For "D" soil: Multiply Q_D by 1.10 to use below

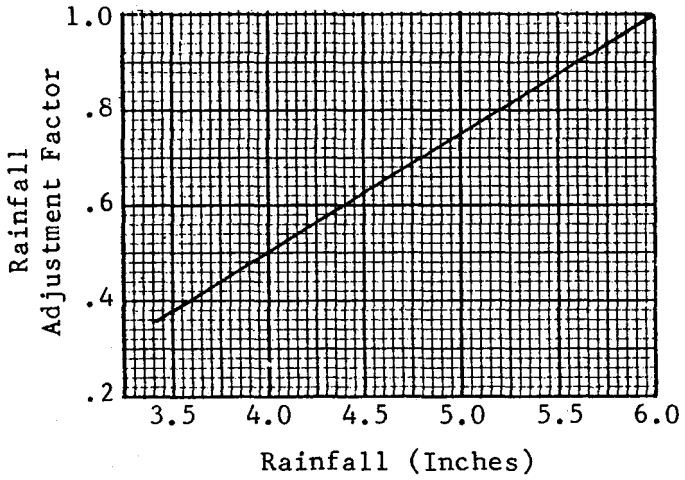


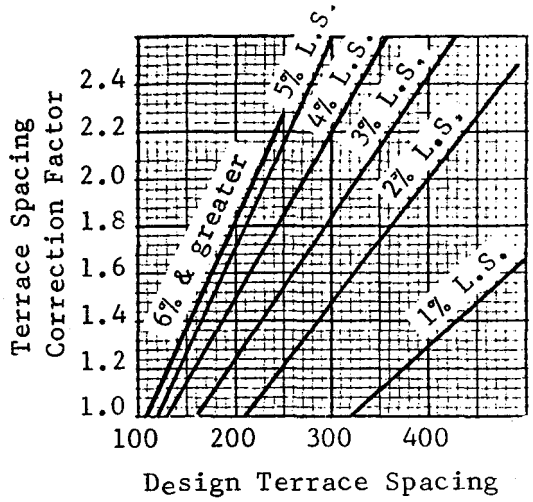
EFM Notice KS-21, August 1982

KS-8-12

Discharges for 0.4% Terrace Grade
on "C" Soils CN = 78

Land Slope (%)	Terrace Length (Ft.)											
	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000
1.0	16.1	19.7	23.0	26.0	28.6	31.1	33.1	35.0	36.6	38.0	39.2	40.2
2.0	12.5	14.8	17.0	18.8	20.5	22.2	23.6	25.0	26.1	27.0	27.7	28.2
3.0	10.0	11.7	13.4	15.0	16.5	17.8	18.9	19.7	20.4	20.9	21.4	21.8
4.0	8.4	9.8	11.2	12.5	13.7	14.9	16.0	16.9	17.6	18.0	18.4	18.7
5.0	7.7	8.9	10.0	11.2	12.2	13.2	14.0	14.8	15.4	15.8	16.1	16.4
6.0 & greater	7.1	8.2	9.3	10.3	11.2	12.1	12.9	13.7	14.3	14.7	15.1	15.4

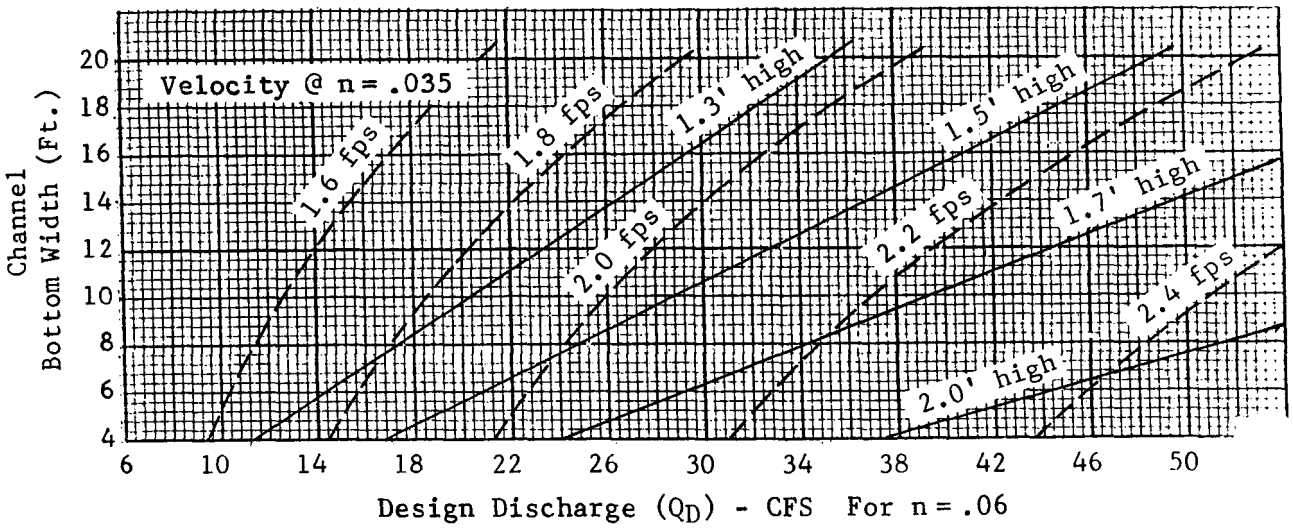




Design Discharge (Q_D) = Discharge x Rainfall Adj. Factor x
Terrace Spacing Corr. Factor

For "B" soil: Multiply Q_D by 0.80 to use below

For "D" soil: Multiply Q_D by 1.10 to use below

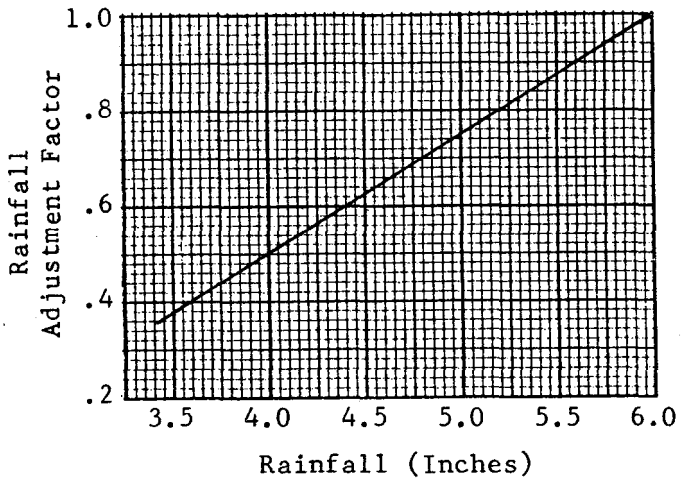


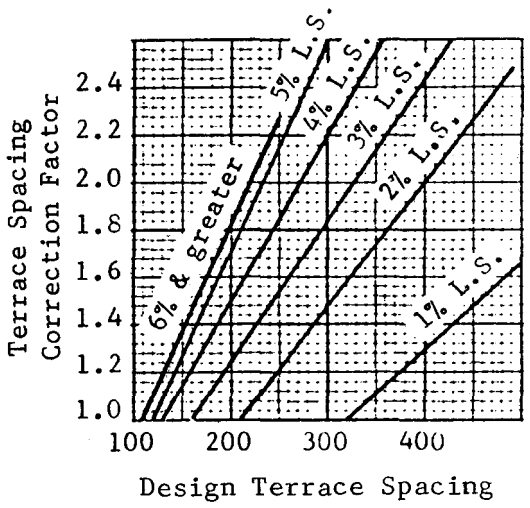
EFM Notice KS-21, August 1983

KS-8-12a

Discharges for 0.5% Terrace Grade
on "C" Soils CN = 78

Land Slope (%)	Terrace Length (Ft.)											
	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000
1.0	18.8	22.7	26.1	29.3	32.3	34.9	37.2	39.1	40.8	42.2	43.5	44.7
2.0	12.9	15.3	17.4	19.2	20.8	22.4	24.0	25.2	26.4	27.3	28.0	28.6
3.0	10.0	12.0	13.6	15.1	16.5	17.8	18.9	19.8	20.6	21.4	22.0	22.6
4.0	8.6	10.2	11.6	13.0	14.2	15.3	16.2	17.0	17.6	18.2	18.7	19.2
5.0	7.7	9.2	10.4	11.6	12.6	13.4	14.1	14.8	15.3	15.9	16.4	16.8
6.0 & greater	7.1	8.4	9.6	10.7	11.6	12.5	13.2	13.8	14.3	14.8	15.2	15.5

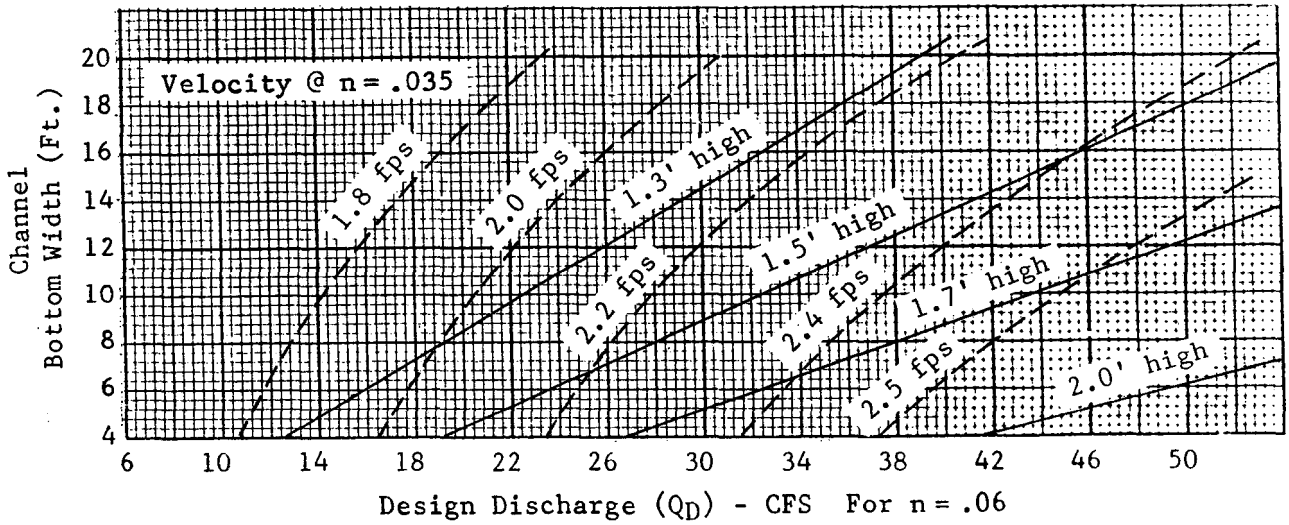




Design Discharge (Q_D) = Discharge x Rainfall Adj. Factor x Terrace Spacing Corr. Factor

For "B" soil: Multiply Q_D by 0.80 to use below

For "D" soil: Multiply Q_D by 1.10 to use below

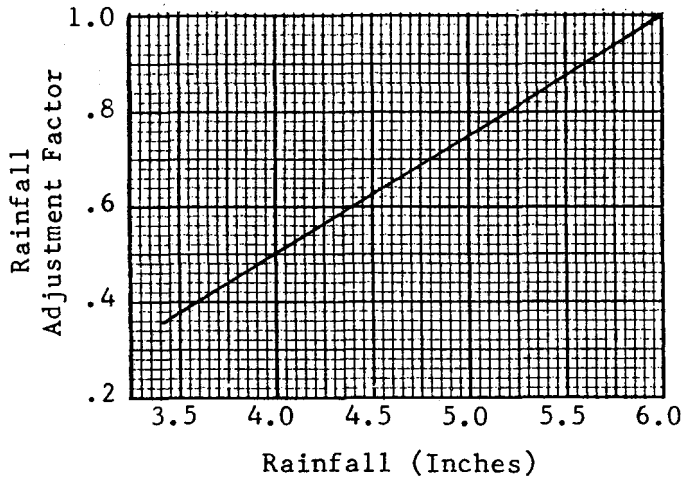


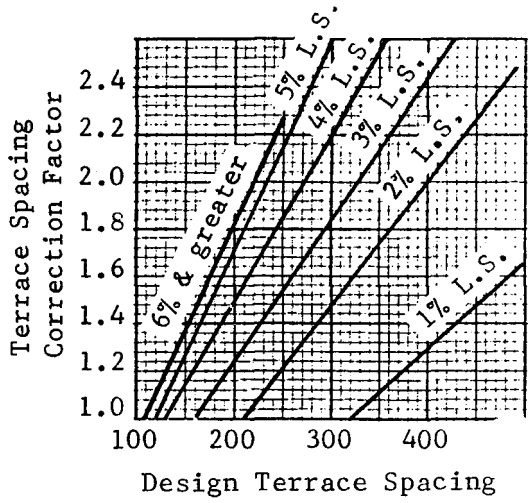
EFM Notice KS-21, August 1983

KS-8-12b

Discharges for 0.7% Terrace Grade
on "C" Soils CN = 78

Land Slope (%)	Terrace Length (Ft.)											
	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000
1.0	18.7	22.8	26.6	30.1	33.4	36.2	38.8	41.2	43.3	45.4	47.4	49.3
2.0	13.0	15.5	17.8	19.8	21.8	23.6	25.3	27.0	28.6	30.2	31.7	33.2
3.0	10.4	12.4	14.1	15.7	17.3	18.8	20.0	21.2	22.3	23.2	24.0	24.8
4.0	8.8	10.7	12.3	13.7	15.0	16.1	17.1	17.9	18.7	19.3	20.0	20.5
5.0	8.0	9.6	11.1	12.6	13.7	14.7	15.6	16.4	17.1	17.8	18.4	19.0
6.0 & greater	7.3	8.8	10.2	11.4	12.4	13.4	14.2	14.8	15.5	16.1	16.6	17.1

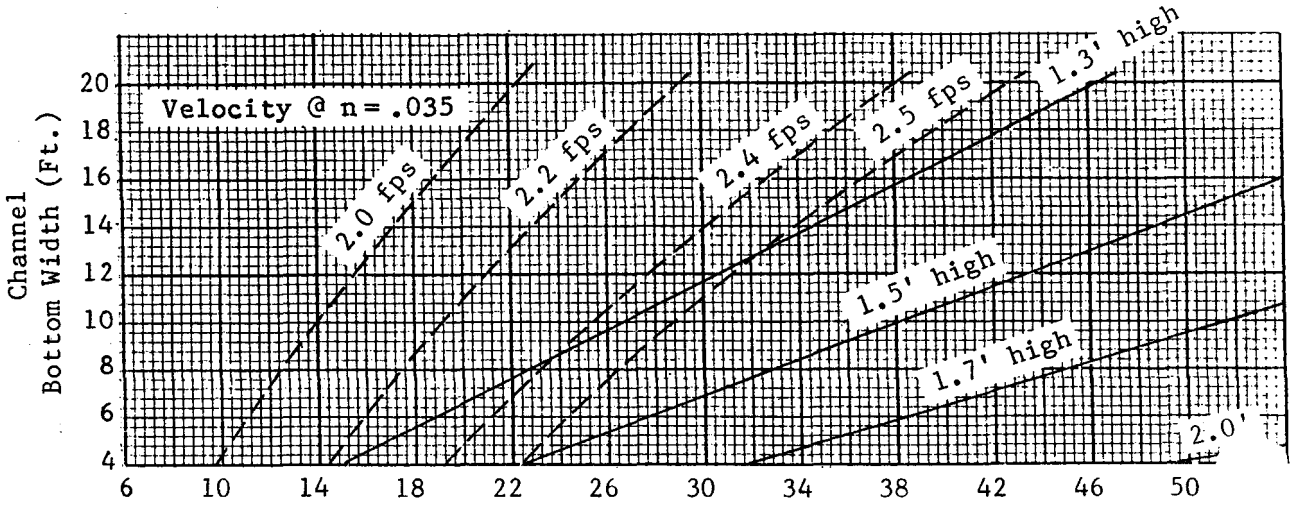




Design Discharge (Q_D) = Discharge x Rainfall Adj. Factor x Terrace Spacing Corr. Factor

For "B" soil: Multiply Q_D by 0.80 to use below

For "D" soil: Multiply Q_D by 1.10 to use below

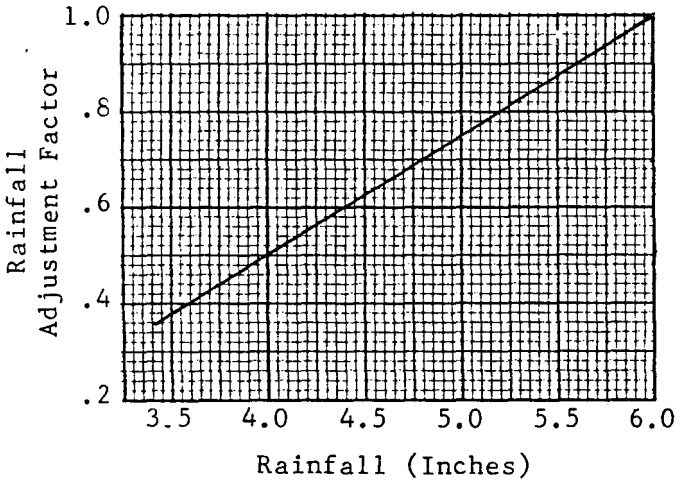


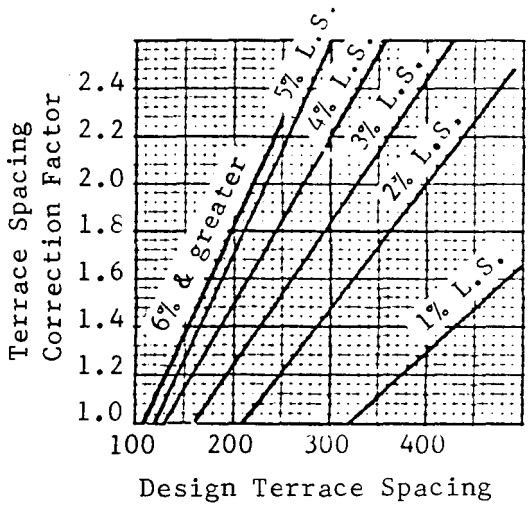
EFM Notice KS-21, August 1983

KS-8-12c

Discharges for 0.9% Terrace Grade
on "C" Soils CN = 78

Land Slope (%)	Terrace Length (Ft.)											
	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000
1.0	19.2	23.1	26.8	30.4	33.9	37.2	40.1	43.1	45.6	47.8	49.7	51.2
2.0	13.6	16.0	18.4	20.7	22.8	24.8	26.6	28.3	29.9	31.5	33.0	34.4
3.0	10.8	12.8	14.6	16.3	17.9	19.4	20.9	22.1	23.1	24.1	25.0	25.7
4.0	9.2	10.9	12.5	14.0	15.4	16.8	18.0	19.2	20.1	21.0	21.7	22.4
5.0	8.3	9.8	11.2	12.6	13.9	15.0	16.1	17.0	17.8	18.6	19.2	19.9
6.0 & greater	7.7	9.2	10.7	12.0	13.2	14.2	15.2	16.0	16.8	17.6	18.4	19.0

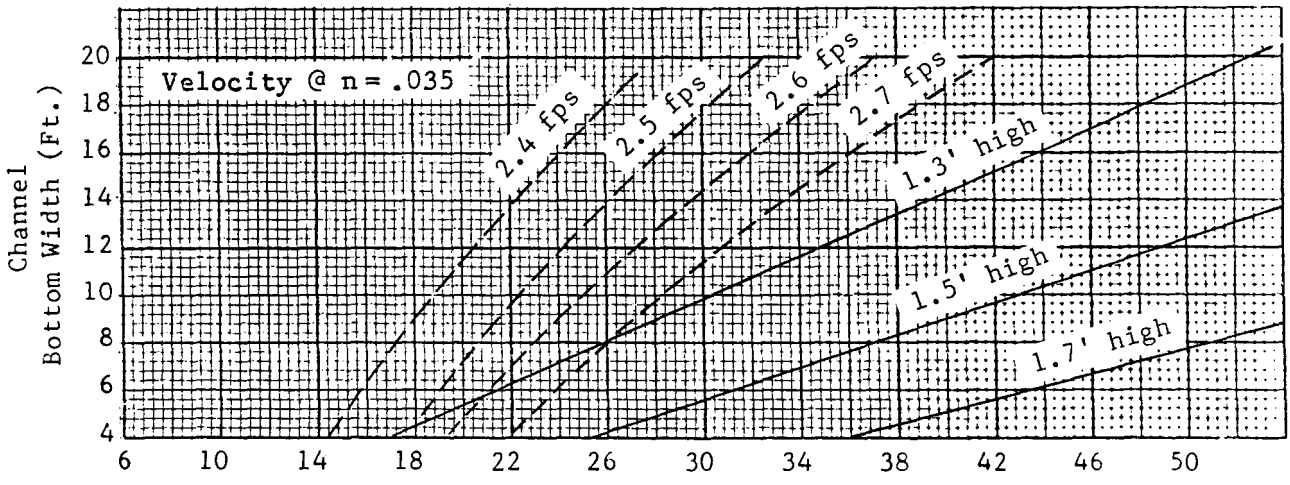




Design Discharge (Q_D) = Discharge x Rainfall Adj. Factor x
Terrace Spacing Corr. Factor

For "B" soil: Multiply Q_D by 0.80 to use below

For "D" soil: Multiply Q_D by 1.10 to use below



EFM Notice KS-21, August 1983

Terrace Storage Design Charts
(approximate method)

DEVELOPMENT OF STORAGE CURVES

The storage curves for terraces are based upon the Engineering Field Manual procedure for estimating storage of ponds using the formula - Volume = 0.4 x maximum depth x surface area (EFM Pg 11-9). The storage area is assumed to be triangular in shape with its base length (L) being the length of the pool line along the terrace and the height or pool width (W) being the distance the pool reaches upstream from the terrace. The height or pool width (W) is dependent upon the land slope (S) in percent above the terrace and maximum depth selected.

Area of a triangle = 1/2 base x height

For an assumed depth d:

Base length L = length of terrace in pool area for depth d

Height $W = d(\frac{100}{S})$

Storage area $A = 1/2\ L(\frac{100d}{S})$

Storage volume $V = 0.4\ d \times A$

$$= 0.4\ d\left[1/2\ L(\frac{100d}{S})\right]$$

$$= 20\ \frac{d^2L}{S}$$

Where the field slope is mild and depth is enough to pool water against the back of the upstream terrace, the surface area is computed by the trapezoidal formula - A = 1/2 height x ($Base_1$ + $Base_2$).

ADJUSTING L FACTOR

Chart values for storage are higher than by the EFM procedure where terrace grades are steep near the riser then flatten out towards the end of the storage pool and are lower where terrace grades are flat near the riser then get steeper at the end of the storage pool. These values may be corrected by adjusting the L figure either from the profile or from the topographic map.

On the terrace profile, lines are projected each way from the riser crossing the profile and intersecting the assumed water line. Each line is drawn at a slope which provides for roughly equal areas on each side of the line. The distance between where these lines intersect the water line is the adjusted L.

A similar procedure is used on a contour map except the lines are drawn from the upstream end of the pool area for the assumed water line contour to intersect the terrace line. Each line is drawn so that the areas on each side of the contour are roughly equal. The distance between where these lines intersect the terrace line is the adjusted L.

PROCEDURE FOR USE OF STORAGE CURVES

The use of terrace storage charts simplifies storage calculations by limiting changes in values in the trail-and error method of arriving at the design terrace height. Only three values change with any trial - height at riser, length of storage pool, and total volume of available storage.

How to use the charts:

a) Determine the required storage volume.

b) Determine the land slope above the terrace in pool area.

c) Select a trial depth of water ("Height at Riser" on chart).

d) From topo layout or terrace profile, determine the distance water will be ponded against the terrace at the trial depth. (this is "L" value on the chart)*

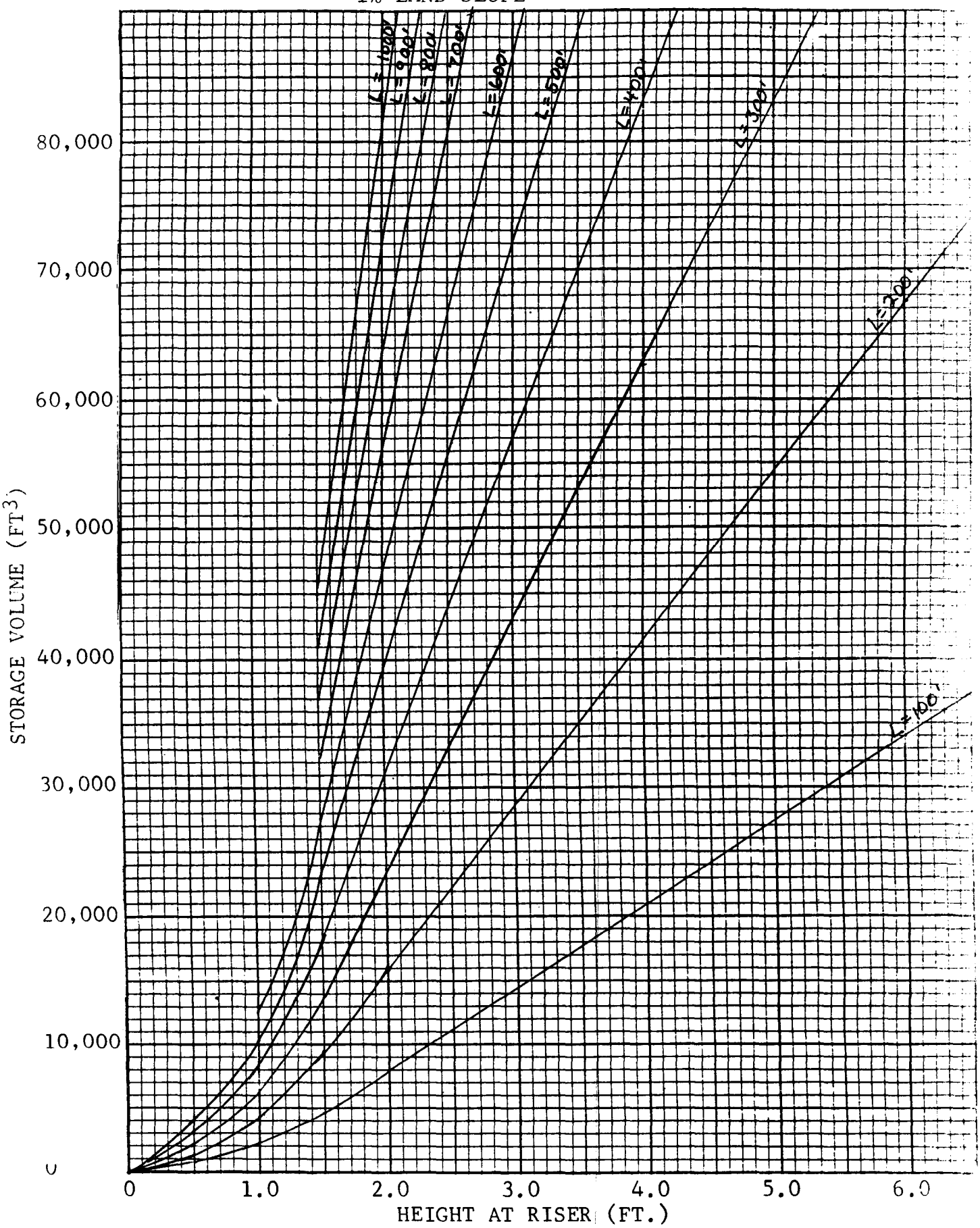
e) Read the available storage ("Storage Volume") where the "Height at Riser" intersects the ("L") length of storage pool.

f) Repeat (c) through (e) until available storage equals or slightly exceeds the required storage.

*For irregular topography adjust "L" values as indicated on drawings.

KS-8-15

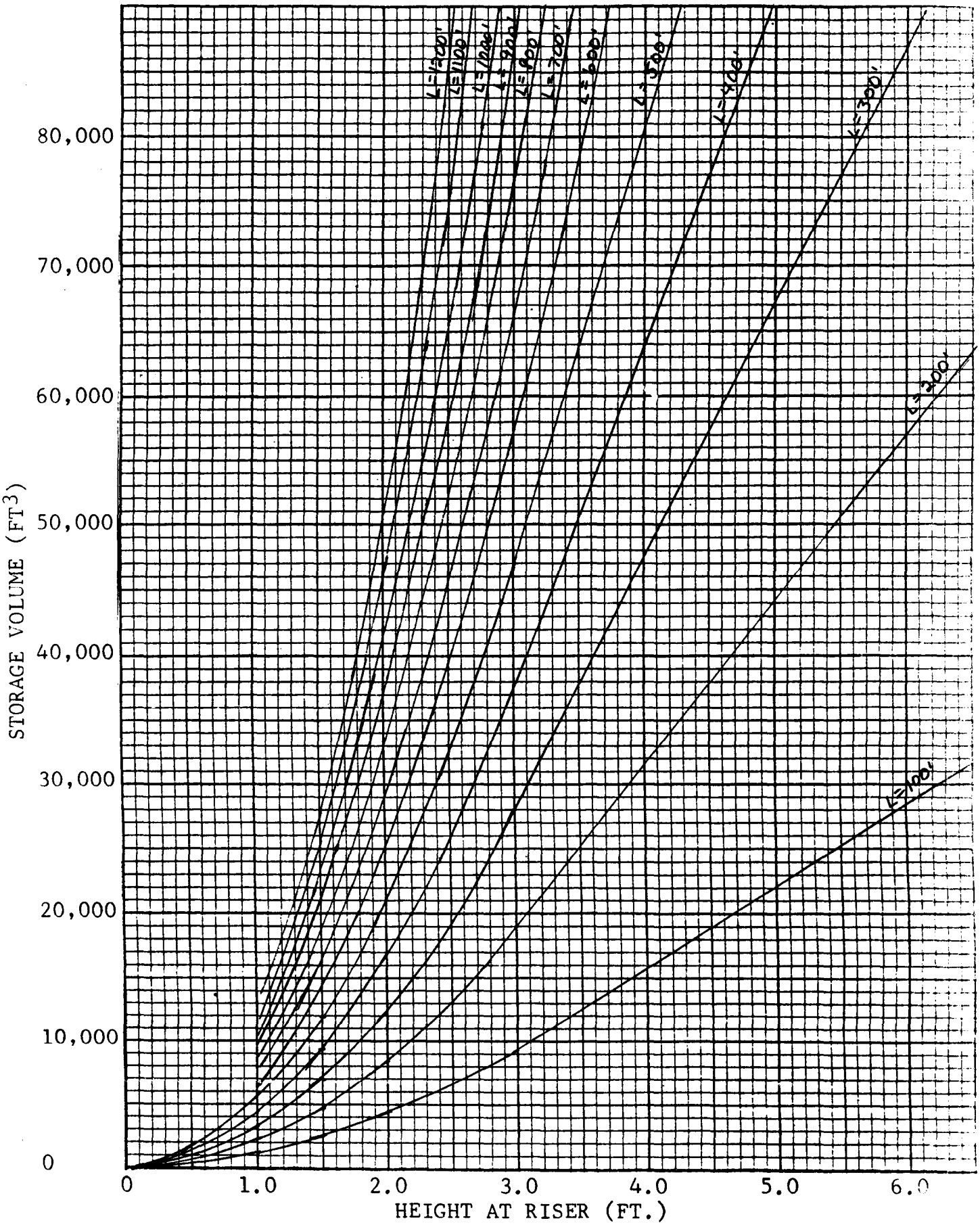
1% LAND SLOPE



EFM Notice KS-21, Aug. 1983

KS-8-16

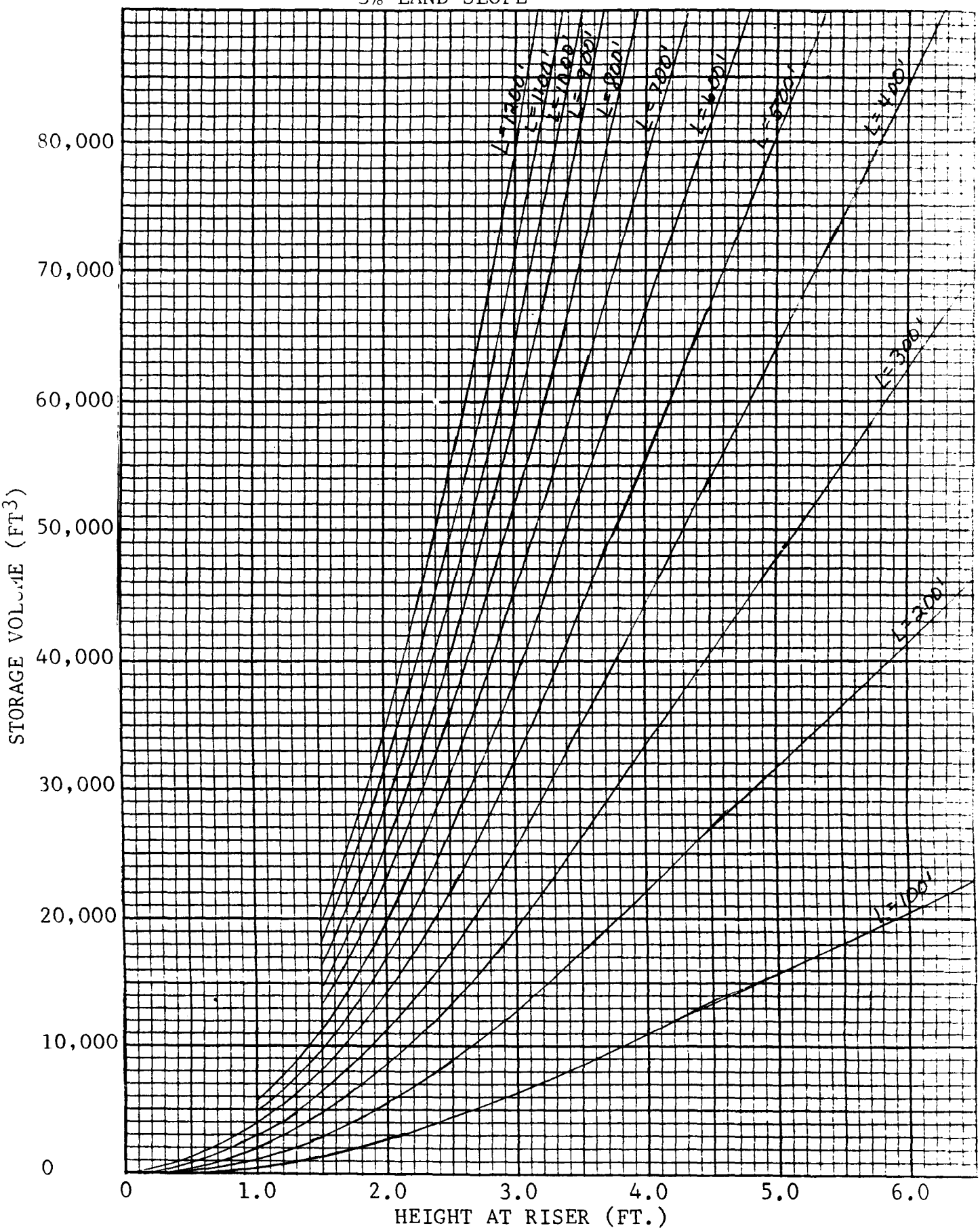
2% LAND SLOPE



EFM Notice KS-21, Aug. 1983

KS-8-17

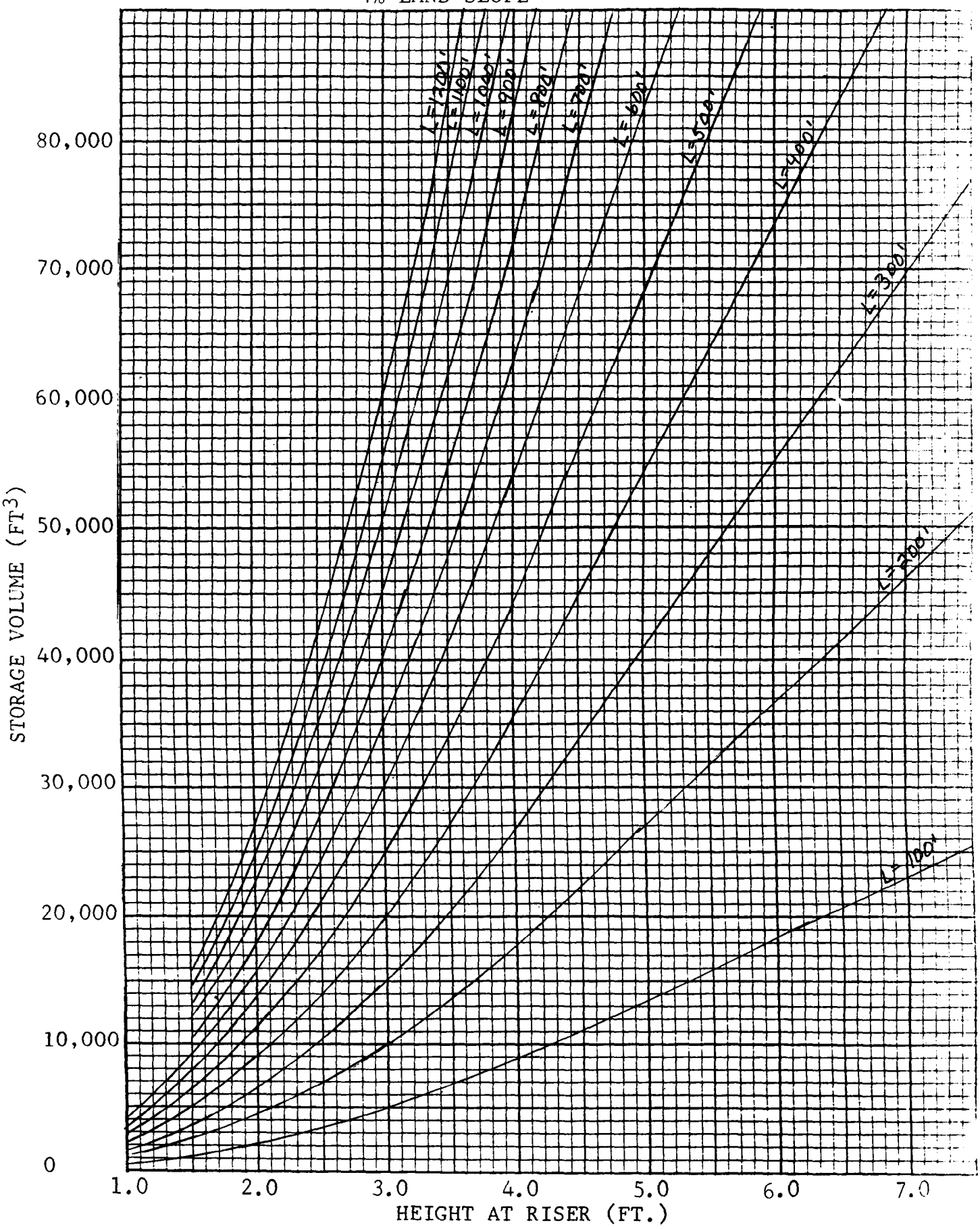
3% LAND SLOPE



EFM Notice KS-21, Aug. 1983

KS-8-18

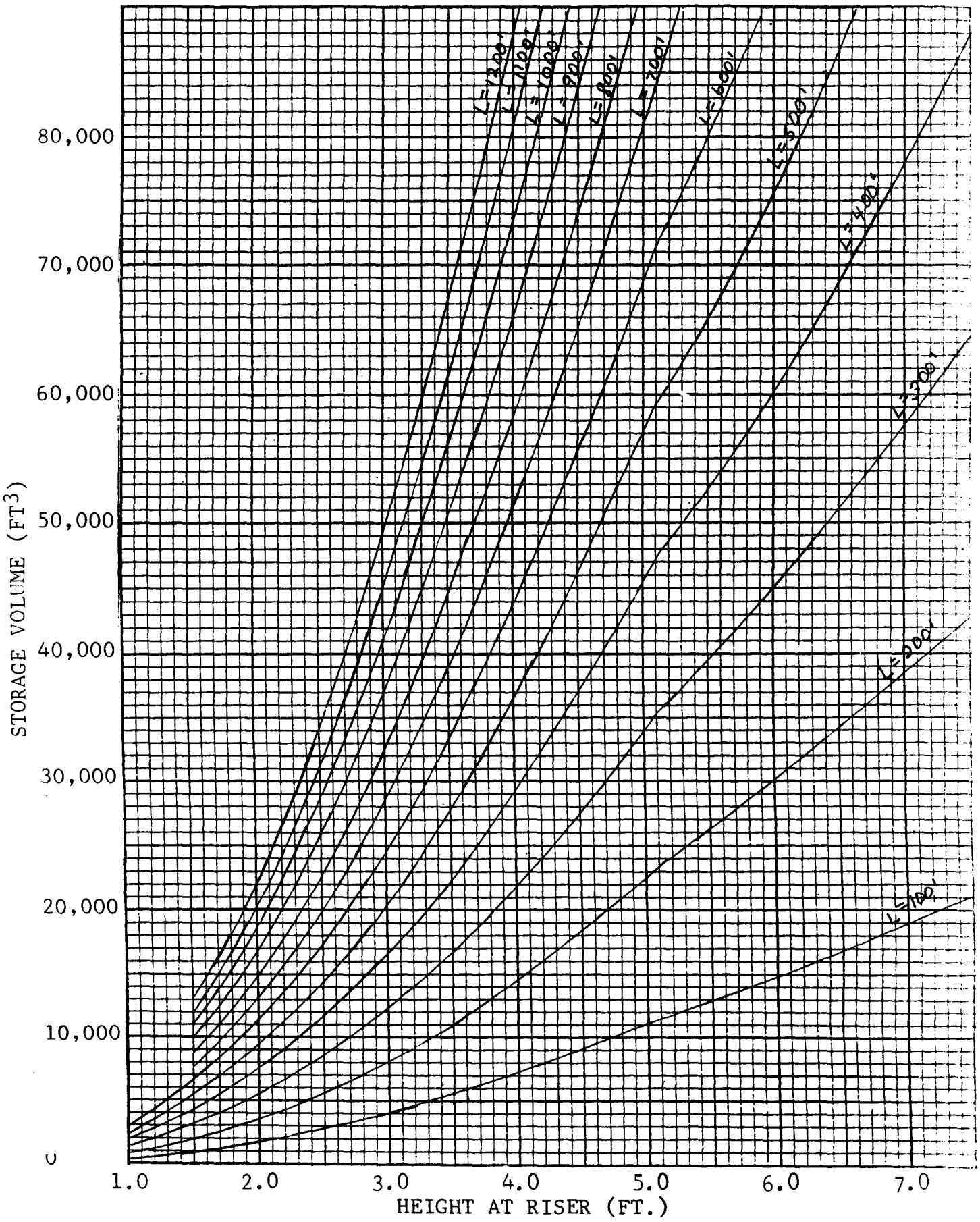
4% LAND SLOPE



EFM Notice KS-21, Aug. 1983

KS-8-19

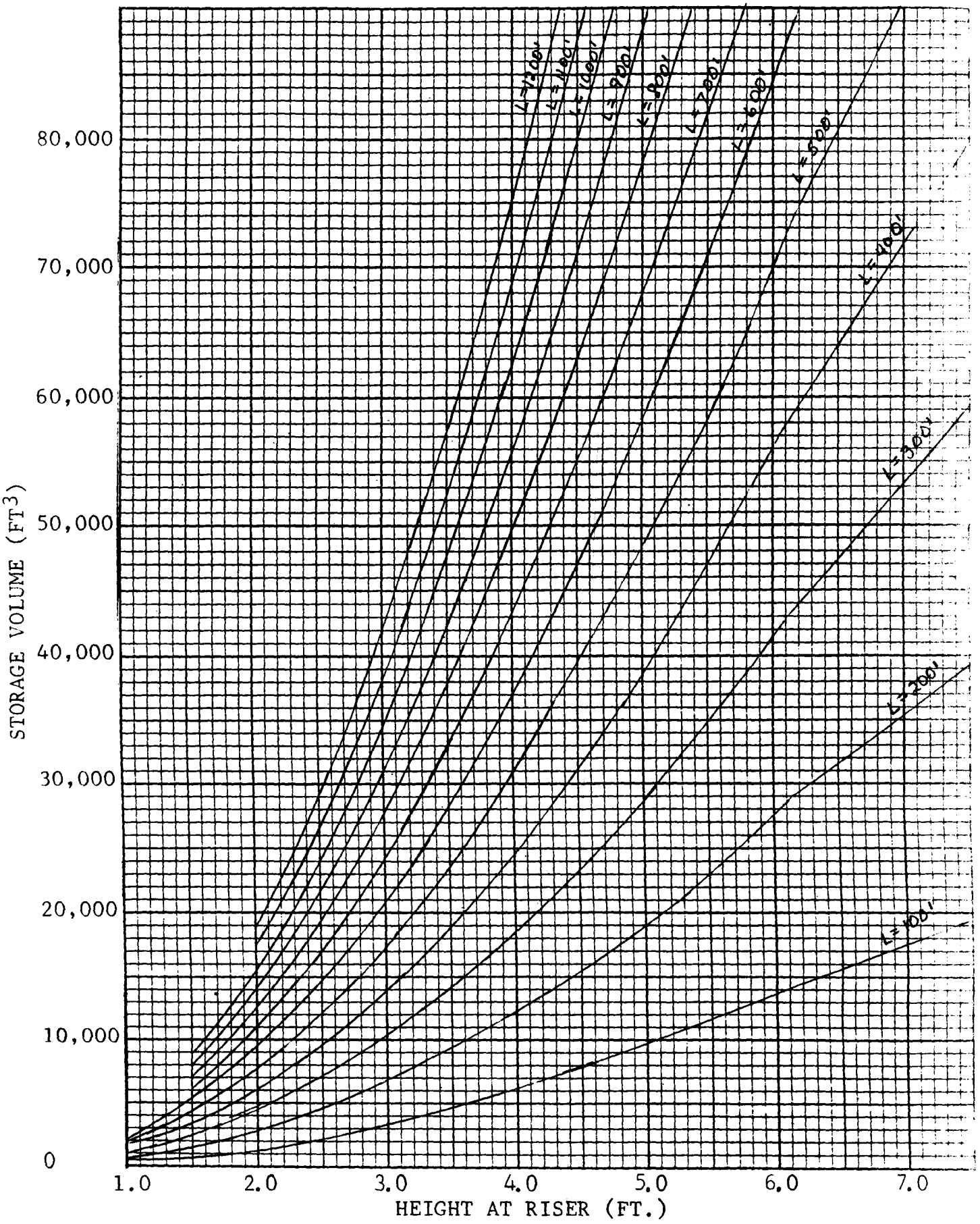
5% LAND SLOPE



EFM Notice KS-21, Aug. 1983

KS-8-20

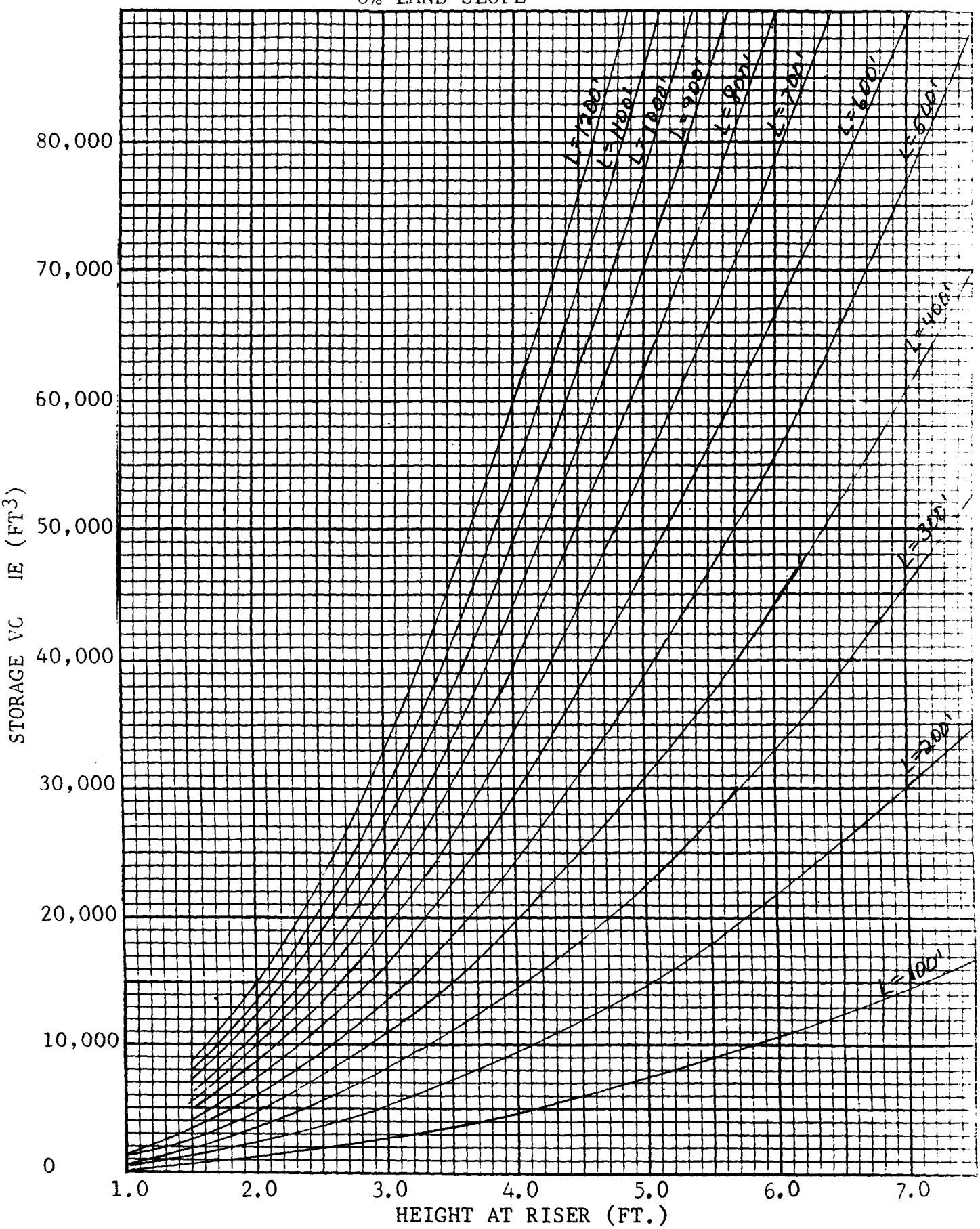
6% LAND SLOPE



EFM Notice KS-21, Aug. 1983

KS-8-21

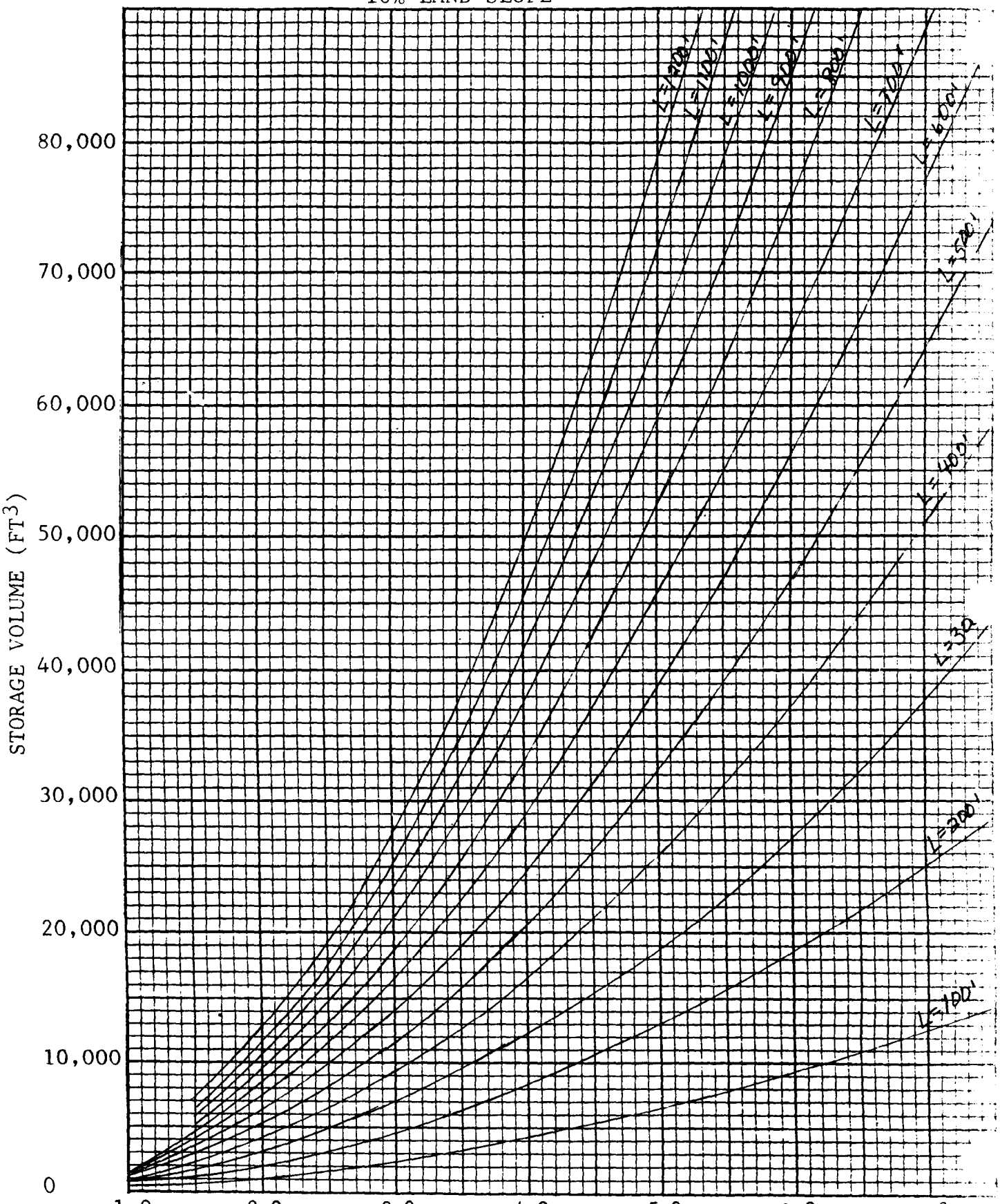
8% LAND SLOPE



EFM Notice KS-21, Aug. 1983

KS-8-22

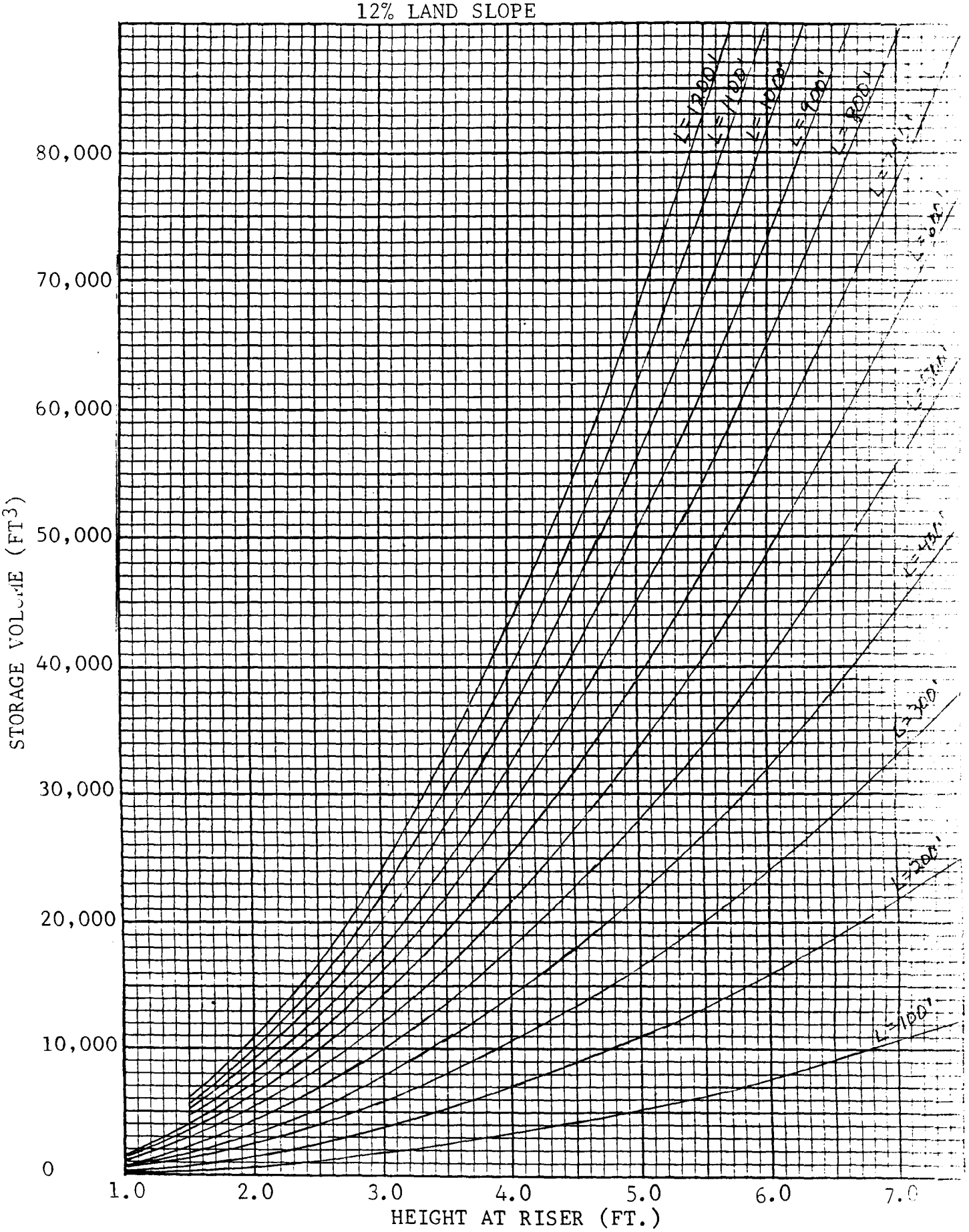
10% LAND SLOPE



EFM Notice KS-21, Aug. 1983

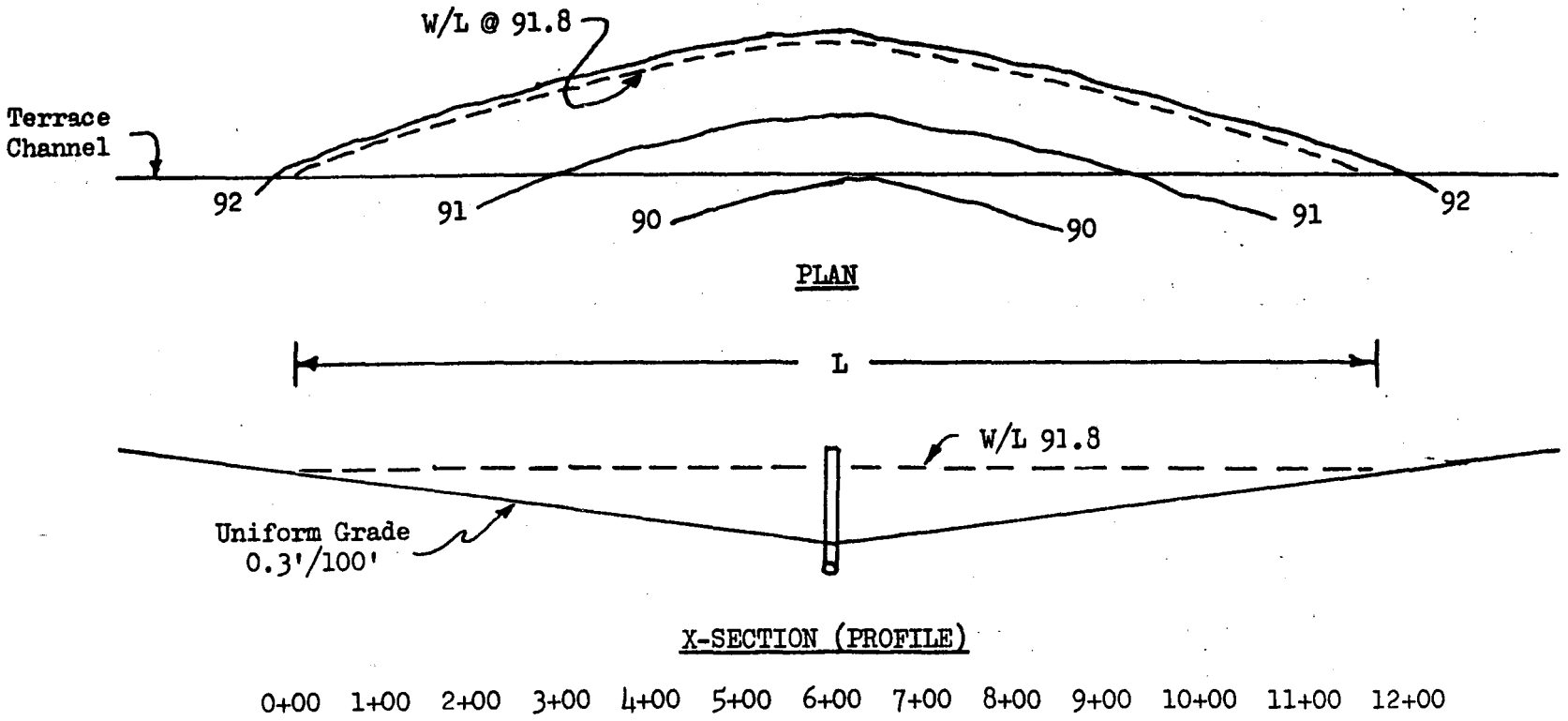
KS-8-23

12% LAND SLOPE

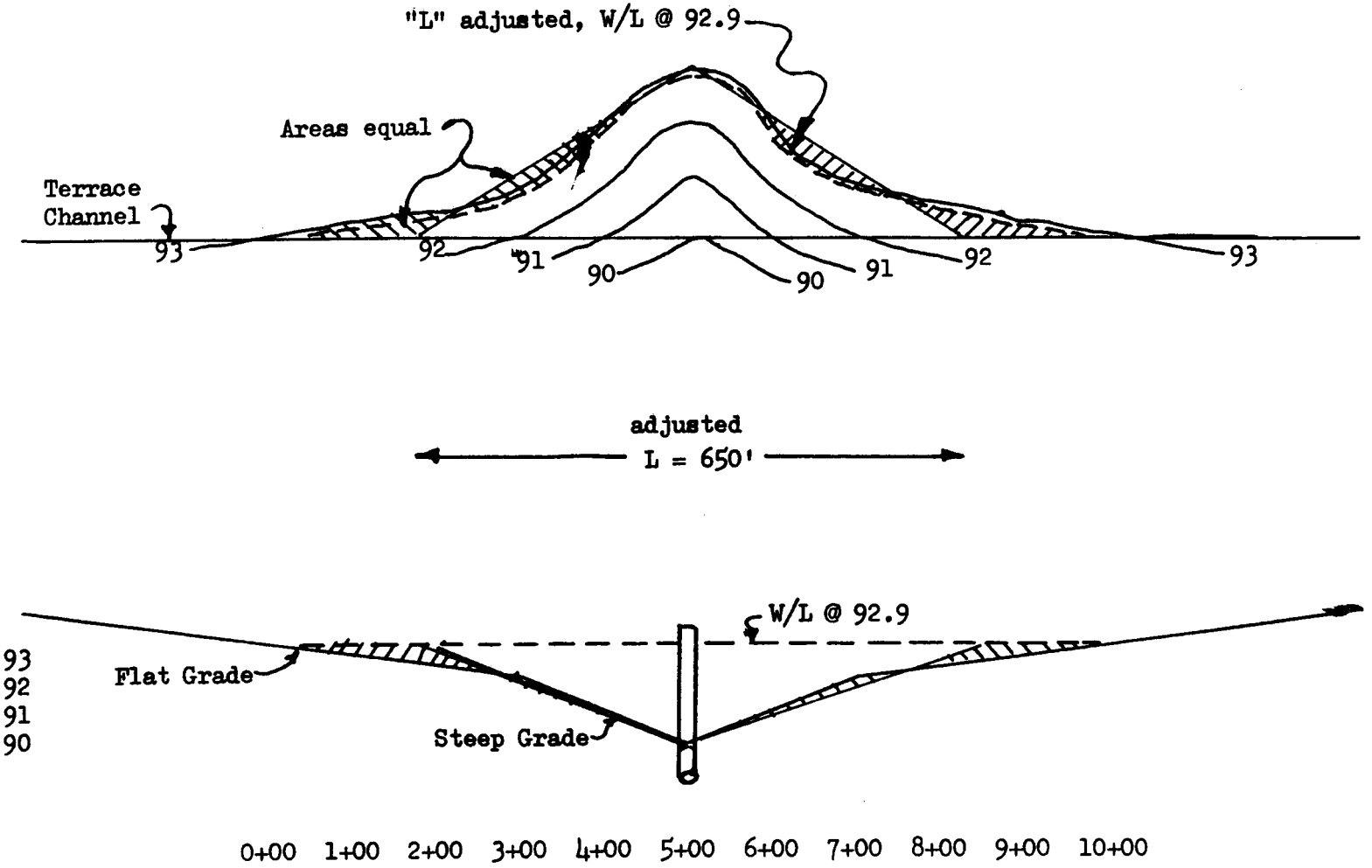


EFM Notice KS-21, Aug. 1983

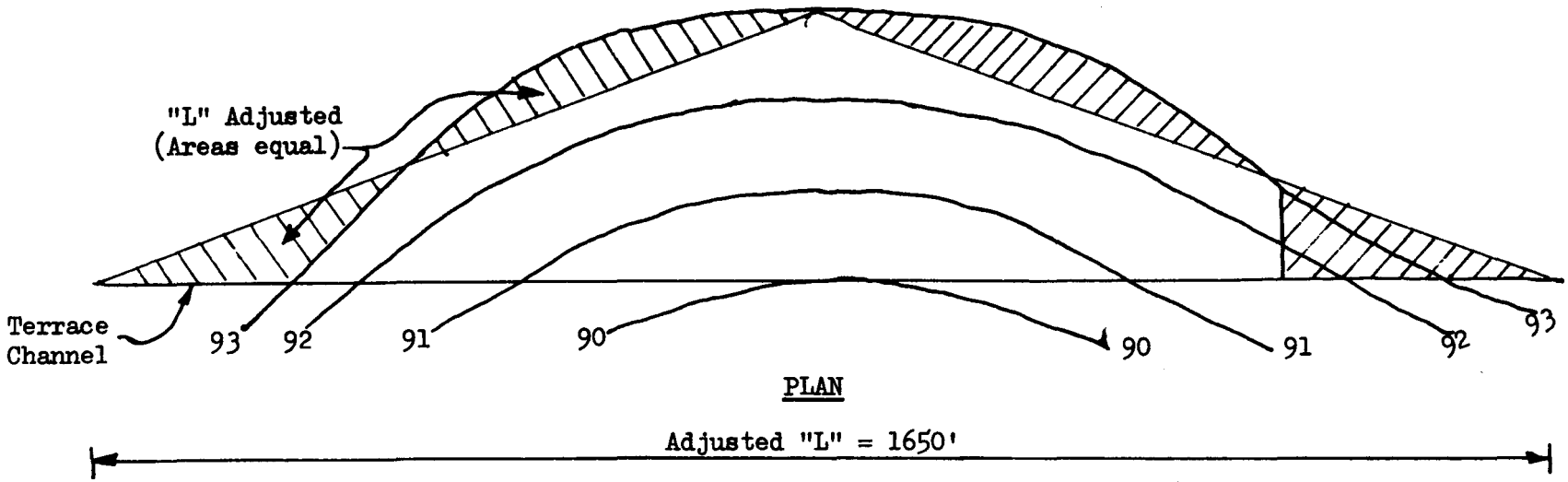
UNIFORM GRADE IN TERRACE PROFILE
(No adjustments needed)



STEEP GRADE @ RISER THEN FLAT ON EACH END
(Adjustment made in "L" as shown)

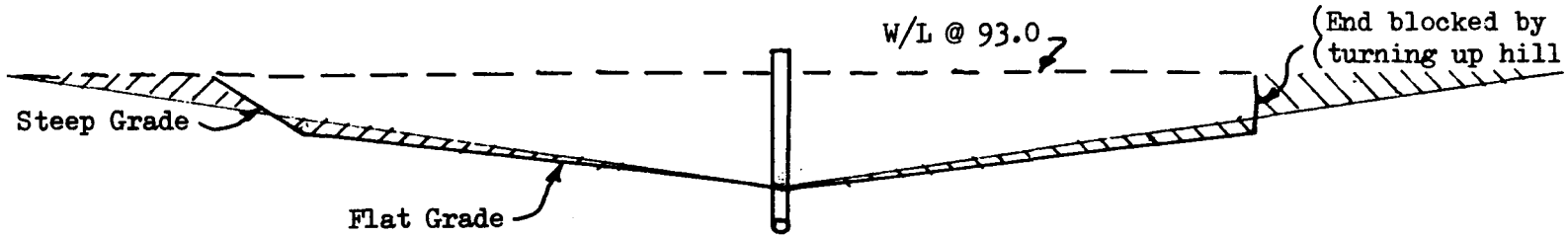


FLAT GRADE @ RISER THEN STEEP ON ENDS
(Adjustment made in "L" as shown)



PLAN

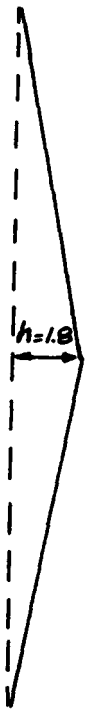
Adjusted "L" = 1650'



PROFILE

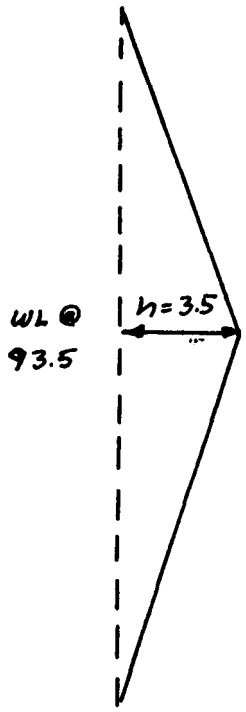
0+00 1+00 2+00 3+00 4+00 5+00 6+00 7+00 8+00 9+00 10+00 11+00

Flattest Grade Recommended (0.3'/100')

Profile	Sta.	Elev.	Depth	Storage Ft^3/LF			
				2%	4%	6%	12%
 WL @ 91.8	0+00	91.8	0.0	0	0	0	0
	1+00	91.5	0.3	4	3	3	3
	2+00	91.2	0.6	13	9	7	6
	3+00	90.9	0.9	27	16	13	10
	4+00	90.6	1.2	44	26	20	14
	5+00	90.3	1.5	67	39	29	20
	6+00	90.0	1.8	94	53	40	26
	7+00	90.3	1.5	67	39	27	20
	8+00	90.6	1.2	44	26	20	14
	9+00	90.9	0.9	27	16	13	10
	10+00	91.2	0.6	13	9	7	6
	11+00	91.5	0.3	4	3	3	3
	12+00	91.8	0.0	0	0	0	0
				404	239	184	132
				x 100	x 100	x 100	x 100
(Ft^3) EFM Method				40,400	23,900	18,400	13,200
(Ft^3) Charts (d = 1.8', L = 1200')				41,000	22,000	15,500 (6% Extrapolated)	9,000

KS-8-28

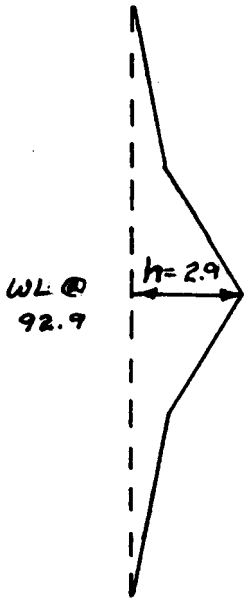
Steepest Grade Allowed by SCS - MS 600



Profile	Sta.	Elev.	Depth	Storage Ft^3/LF			
				2%	4%	6%	12%
	0+00	93.5	0.0	0	0	0	0
	0+50	92.7	0.8	22	14	11	8
	1+00	92.0	1.5	67	39	29	20
	1+50	91.5	2.0	114	64	47	31
	2+00	91.0	2.5	174	96	70	44
	2+50	90.5	3.0	246	134	96	58
	3+00	90.0	3.5	305	150	96	39
	3+50	90.5	3.0	246	134	96	58
	4+00	91.0	2.5	174	96	70	44
	4+50	91.5	2.0	114	64	42	31
	5+00	92.0	1.5	67	39	29	20
	5+50	92.7	0.8	22	14	11	8
	6+00	93.5	0.0	0	0	0	0
				1551	844	602	361
				x 50	x 50	x 50	x 50
	(Ft3) EFM Method			77,550	42,200	30,100	18,050
	(Ft3) Chart (L = 600', h = 3.5')			(78,500)	(41,300)	(28,800)	(16,800)

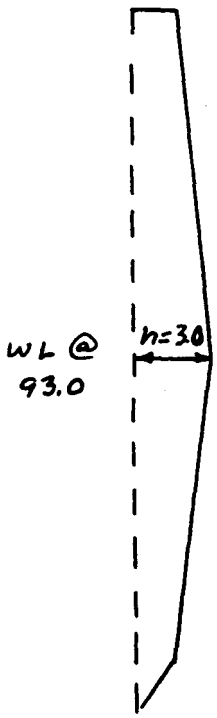
EFM Notice KS-20, 6/1/83

Steep Grade @ Riser Then Flat on Each End



Profile	Sta.	Elev.	Depth	Storage Ft^3/Ft			
				2%	4%	6%	12%
	0+00	92.9	0	0	0	0	0
	1+00	92.6	0.3	4	3	3	3
	2+00	92.3	0.6	13	9	7	6
	3+00	92.0	0.9	27	16	13	10
	4+00	91.0	1.9	104	58	43	28
	5+00	90.0	2.9	231	125	90	55
	6+00	91.0	1.9	104	58	43	28
	7+00	92.0	0.9	27	16	13	10
	8+00	92.3	0.6	13	9	7	6
	9+00	92.6	0.3	4	3	3	3
	10+00	92.9	0	0	0	0	0
				527	297	222	149
				x 100	x 100	x 100	x 100
	EFM Method (Ft^3)			52,700	29,700	22,200	14,900
	Chart $\left(\frac{h = 2.9'}{L = 650'}\right)$ (Ft^3)			58,000	30,500	21,400	12,500
	("L" adjustment made)						

Flat Grade @ Riser Then **Steep on Ends** (One End Blocked by Turning Up Hill)



Profile	Sta.	Elev.	Depth	Storage Ft^3/LF			
				2%	4%	6%	12%
	0+00	91.8	1.2	44	26	20	14
	1+00	91.5	1.5	67	39	29	20
	2+00	91.2	1.8	94	53	40	26
	3+00	90.9	2.1	125	70	51	33
	4+00	90.6	2.4	161	89	65	41
	5+00	90.3	2.7	201	110	80	49
	6+00	90.0	3.0	246	134	96	58
	7+00	90.3	2.7	201	110	80	49
	8+00	90.6	2.4	161	89	65	41
	9+00	90.9	2.1	125	70	51	33
	10+00	91.2	1.8	94	53	40	26
	11+00	91.5	1.5	67	39	29	20
	12+00	93.0	0.0	0	0	0	0
				1586	882	646	410
				x 100	x 100	x 100	x 100
	EFM Method (Ft^3)			158,600	88,200	64,600	41,000
	Chart ($h = 3.0'$, $\frac{1}{2} L = 825'$) Ft^3			79,250	41,500	29,200	17,000
				x 2	x 2	x 2	x 2
	$L = 1650'$			158,500	83,000	58,400	34,000

* U.S. GOVERNMENT PRINTING OFFICE: 1983-380-931:SCS-1114