UNITED STATES DEPARTMENT OF AGRICULTURE

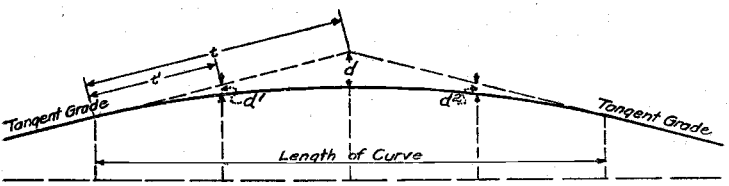
FOREST SERVICE

ENGINEERING FIELD TABLES

CONTENTS

91542—30——1

VERTICAL CURVES



Formulæ

A—Difference in elevation (d) at center of curve expressed in feet = ½ (algebraic difference of the tangent grades expressed in feet per 100) × (length of curve expressed in stations of 100 feet).

B—Intermediate difference of elevations between tangent grades and point on vertical curve.

$$d' : d : : t'^2 : t^2$$

$$d' = \frac{dt^2}{t^2}$$

SIMPLE DEGREE CURVES

D = Degree of curve
R = Radius
L = Length of curve
T = Tangent distance
E = External
Δ = (Delta) Central angle

To find

Degree of curve: (based on 100 foot chord)

$$\text{Sine } \tfrac{1}{2}D = \frac{50}{R}$$

Radius: $$R = \frac{50}{\text{Sine } \frac{1}{2}D}$$

Length of curve: $$L = 100\,\frac{\Delta}{D}$$

Tangent distance: $$T = R \tan \tfrac{1}{2}\Delta$$

External: $$E = R \text{ Ex. Sec } \tfrac{1}{2}\Delta \text{ or } E = \frac{R}{\text{Cos } \frac{\Delta}{2}} - R$$

Total deflection = ½Δ
Deflection for 100 feet = ½D

SHORT RADIUS CURVES

Radius	Chord	Degree of curve	Deflection for chord	Deflection 1 foot	Minutes in decimal of degrees			
		°	° ′	′	′	°	′	°
30	10	191.87	9 36	57.6	00	0.00	30	0.50
35	10	164.26	8 13	49.3	01	.02	31	.52
40	10	143.62	7 11	43.1	02	.03	32	.53
45	10	127.59	6 23	38.3	03	.05	33	.55
50	20	115.33	11 32	34.6	04	.07	34	.57
60	20	95.94	9 36	28.8	05	.08	35	.58
75	20	76.62	7 40	23.0	06	.10	36	.60
90	20	63.79	6 23	19.1	07	.12	37	.62
100	25	57.45	7 11	17.2	08	.13	38	.63
110	25	52.20	6 32	15.7	09	.15	39	.65
125	25	45.91	5 44	13.8				
140	25	40.98	5 07	12.3	10	.17	40	.67
150	25	38.24	4 47	11.5	11	.18	41	.68
160	25	35.85	4 29	10.3	12	.20	42	.70
175	25	32.77	4 06	9.8	13	.21	43	.72
185	25	30.99	3 53	9.3	14	.23	44	.73
200	50	28.73	7 11	8.6	15	.25	45	.75
225	50	25.52	6 23	7.6	16	.27	46	.77
250	50	22.96	5 44	6.9	17	.28	47	.78
275	50	20.87	5 13	6.3	18	.30	48	.80
300	50	19.12	4 47	5.7	19	.32	49	.82
325	50	17.65	4 25	5.3				
350	50	16.38	4 06	4.9	20	.33	50	.83
400	50	14.33	3 35	4.3	21	.35	51	.85
450	50	12.73	3 11	3.8	22	.37	52	.87
500	50	11.47	2 52	3.4	23	.38	53	.88
550	50	10.42	2 36	3.1	24	.40	54	.90
600	50	9.55	2 23	2.9	25	.42	55	.92
700	100	8.19	4 06	2.5	26	.43	56	.93
800	100	7.17	3 35	2.1	27	.45	57	.95
900	100	6.37	3 11	1.9	28	.47	58	.97
1,000	100	5.73	2 52	1.7	29	.48	59	.98

Curve formulae

(Ext. = R. Ext. Sec. $\frac{1}{2}\Delta$) $\left(\text{Radius} = \frac{\text{Ext. Dist.}}{\text{Ext. Sec. } \frac{1}{2}\Delta}\right)$

$\left(\text{Radius} = \frac{\text{Tan. Dist.}}{\text{Tan. } \frac{1}{2}\Delta}\right)$ (Tang. Dist. = R. Tan. $\frac{1}{2}\Delta$)

$\left(\text{L. C.} = \frac{\Delta}{\text{Deg. of curve}}\right)$ (Cen. Ang. of chord = 2 Def. Ang.)

$\left(\text{Def. for 1 foot} = \frac{\text{Def. Ang.}}{\text{Chord}}\right)$

NOTE.—Degree of curve based on chord shown.

TANGENT OFFSETS FOR CURVES, Radius 30 to 1,000 feet

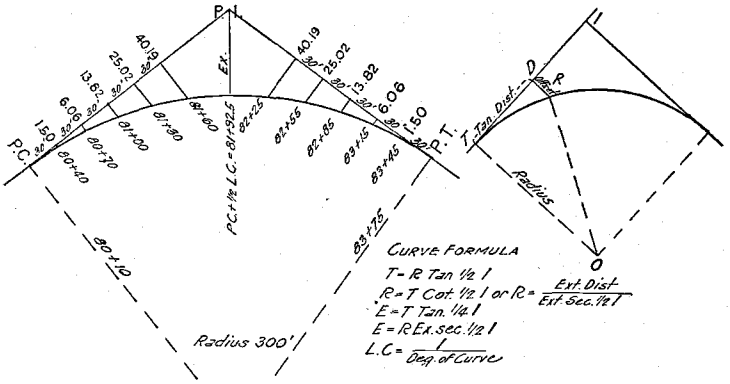
From P. C. or P. T. toward P. I. in tenths of radius distance

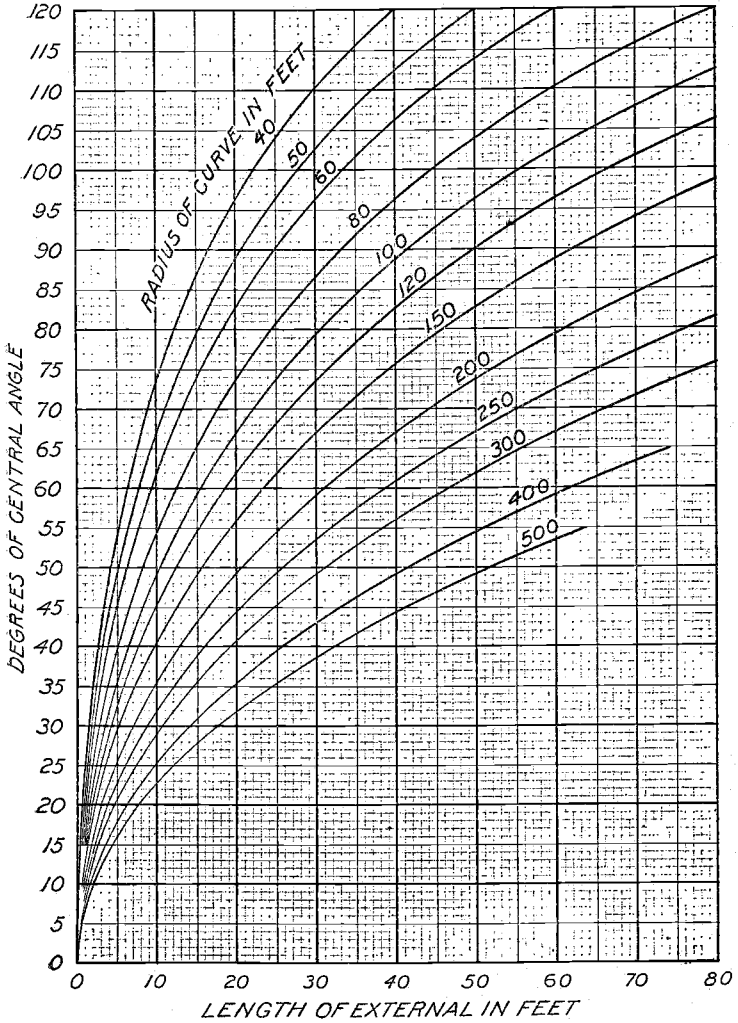
Radius	Tangent distance in tenths of radius								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
30	0.15	0.61	1.38	2.50	4.02	6.00	8.58	12.00	16.92
40	.20	.81	1.84	3.34	5.36	8.00	11.43	16.00	22.56
50	.25	1.01	2.30	4.17	6.70	10.00	14.29	20.00	28.21
60	.30	1.21	2.76	5.00	8.04	12.00	17.15	24.00	33.85
70	.35	1.41	3.22	5.84	9.38	14.00	20.01	28.00	39.49
80	.40	1.62	3.68	6.67	10.72	16.00	22.87	32.00	45.13
90	.45	1.82	4.15	7.51	12.06	18.00	25.73	36.00	50.77
100	.50	2.02	4.61	8.34	13.40	20.00	28.59	40.00	56.41
110	.55	2.22	5.07	9.17	14.74	22.00	31.44	44.00	62.05
120	.60	2.43	5.53	10.01	16.08	24.00	34.30	48.00	67.69
130	.65	2.63	5.99	10.84	17.42	26.00	37.16	52.00	73.33
140	.70	2.83	6.45	11.67	18.76	28.00	40.02	56.00	78.98
150	.75	3.03	6.91	12.51	20.10	30.00	42.88	60.00	84.62
160	.80	3.23	7.37	13.34	21.44	32.00	45.74	64.00	90.26
170	.85	3.44	7.83	14.18	22.77	34.00	48.60	68.00	95.90
180	.90	3.64	8.29	15.01	24.11	36.00	51.50	72.00	101.50
190	.95	3.84	8.75	15.84	25.45	38.00	54.30	76.00	107.20
200	1.00	4.04	9.21	16.68	26.79	40.00	57.20	80.00	112.80
210	1.05	4.24	9.67	17.51	28.13	42.00	60.00	84.00	118.50
220	1.10	4.45	10.13	18.35	29.47	44.00	62.90	88.00	124.10
230	1.15	4.65	10.59	19.18	30.81	46.00	65.70	92.00	129.70
240	1.20	4.85	11.05	20.01	32.15	48.00	68.60	96.00	135.40
250	1.25	5.05	11.52	20.85	33.49	50.00	71.50	100.00	141.00
275	1.37	5.56	12.67	22.93	36.84	55.00	78.60	110.00	155.10
300	1.50	6.06	13.82	25.02	40.19	60.00	85.80	120.00	169.20
325	1.63	6.57	14.97	27.10	43.54	65.00	92.90	130.00	183.30
350	1.75	7.07	16.12	29.19	46.89	70.00	100.10	140.00	197.40
400	2.00	8.08	18.42	33.36	53.59	80.00	114.30	160.00	225.60
450	2.25	9.09	20.73	37.53	60.29	90.00	128.60	180.00	253.80
500	2.50	10.11	23.03	41.70	66.99	100.00	142.90	200.00	282.10
550	2.75	11.12	25.33	45.86	73.68	110.00	157.20	220.00	310.30
600	3.00	12.13	27.64	50.03	80.38	120.00	171.50	240.00	338.50
700	3.50	14.15	32.24	58.37	93.78	140.00	200.10	280.00	394.90
800	4.00	16.17	36.85	66.71	107.20	160.00	228.70	320.00	451.30
900	4.50	18.19	41.45	75.05	120.60	180.00	257.30	360.00	507.70
1,000	5.00	20.21	46.06	83.39	134.00	200.00	285.90	400.00	564.10
Factor--	0.005	0.02021	0.04606	0.08339	0.13397	0.2000	0.28586	0.4000	0.56411

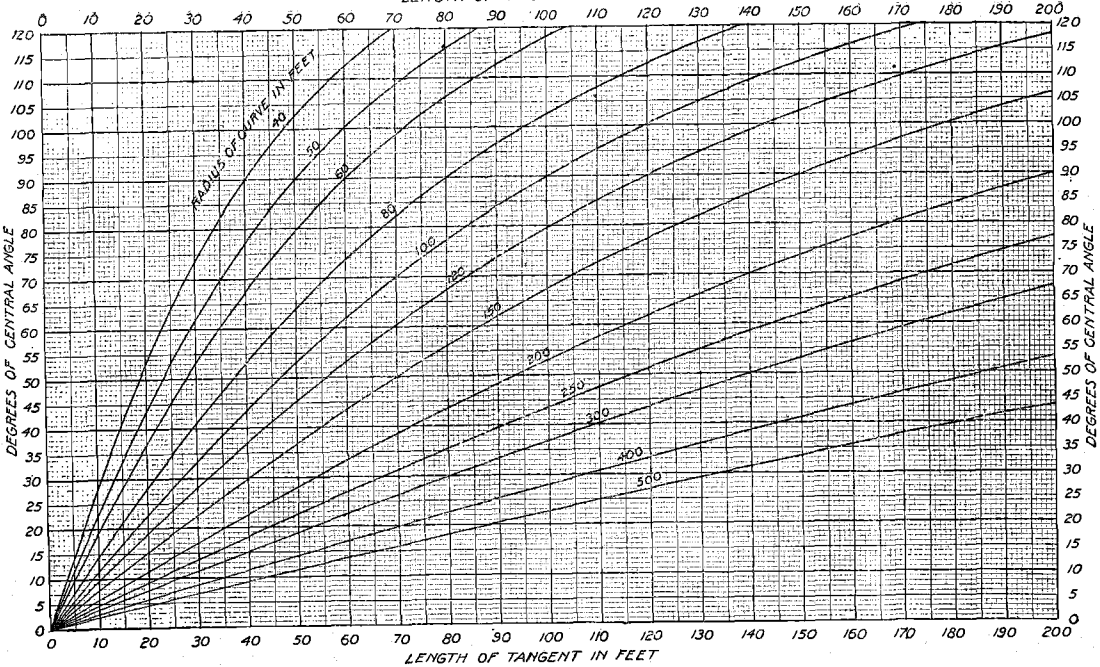
To find the tangent offset for any radius take the factor from the above table under the column for the required tenth of radius distance and multiply the factor by the radius.

EXAMPLE.—Required tangent offset for 215-foot radius curve at 0.4 of radius distance. From table opposite "Factor" under "0.4" take factor 0.08339 and multiply this by 215 as follows: Tangent offset = 0.08339 × 215 = 17.93.

Formula for tangent offset = Radius $-\sqrt{\text{Radius}^2 - \text{tangent distance}^2} = OT - \sqrt{OT^2 - TD^2}$




RADIUS OF CURVE IN FEET
40
50
60
80
100
120
150
200
250
300
400
500
DEGREES OF CENTRAL ANGLE
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
0
10
20
30
40
50
60
70
80
LENGTH OF EXTERNAL IN FEET


LENGTH OF TANGENT IN FEET
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
DEGREES OF CENTRAL ANGLE
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120
RADIUS OF CURVE IN FEET
40
50
60
80
100
150
200
250
300
400
500
LENGTH OF TANGENT IN FEET
DEGREES OF CENTRAL ANGLE

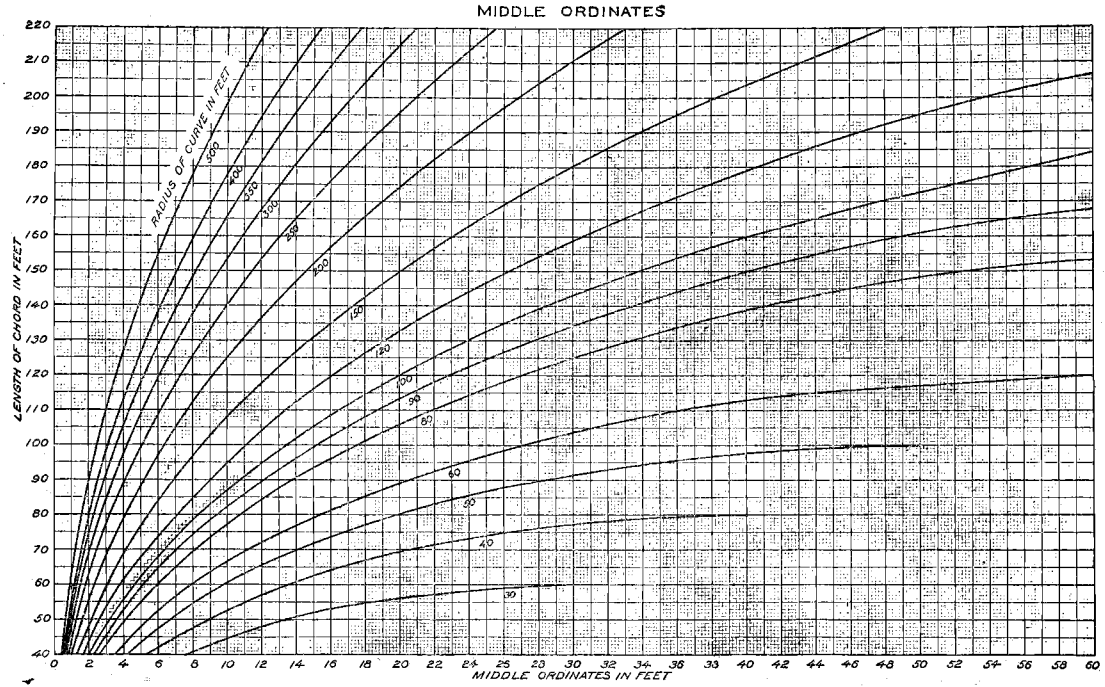

MIDDLE ORDINATES
LENGTH OF CHORD IN FEET
MIDDLE ORDINATES IN FEET
RADIUS OF CURVE IN FEET
500
400
350
300
250
200
150
120
100
90
80
60
50
40
30
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
0 2 4 6 8 10 12 14 16 18 20 22 24 25 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60

TABLE OF TANGENT LENGTHS AND TANGENT OFFSETS

Curve length, in feet

Radius of curve (feet)	10		20		25		30		40		50		60		70		80		100	
	Tangent		Tangent		Tangent		Tangent		Tangent		Tangent		Tangent		Tangent		Tangent		Tangent	
	Length	Offset	Length	Offset	Length	Offset	Length	Offset	Length	Offset	Length	Offset	Length	Offset	Length	Offset	Length	Offset	Length	Offset
30	9.8	1.6	18.6	6.4	22.0	-----	25.2	13.8	29.2	22.9	29.9	32.8	-----	-----	-----	-----	-----	-----	-----	-----
40	9.9	1.2	19.2	4.9	23.4	7.6	27.3	10.7	33.7	18.4	38.0	27.4	39.9	37.1	-----	-----	-----	-----	-----	-----
50	10.0	1.0	19.5	3.9	24.0	6.2	28.3	8.7	35.8	15.2	42.0	23.0	46.6	31.9	49.3	41.5	-----	-----	-----	-----
60	10.0	0.8	19.6	3.3	24.3	5.2	28.8	7.3	37.1	12.8	44.4	19.6	50.5	27.6	55.2	36.4	58.3	45.9	59.7	65.7
70	10.0	0.7	19.7	2.8	24.5	4.5	29.0	6.4	37.9	11.0	45.8	17.3	52.8	24.0	58.7	32.0	63.7	40.8	69.3	60.0
80	10.0	0.6	19.8	2.5	24.6	3.9	29.2	5.6	38.4	9.8	46.8	15.1	54.5	21.5	61.3	28.7	67.3	36.8	75.9	54.8
90	10.0	0.6	19.8	2.2	24.7	3.5	29.4	5.0	38.7	8.8	47.5	13.7	55.7	19.3	63.0	26.0	69.8	33.3	80.6	50.3
100	10.0	0.5	19.9	2.0	24.8	3.2	29.6	4.5	38.9	7.9	48.0	12.2	56.5	17.5	64.4	23.5	71.8	30.3	84.2	46.0
120	10.0	0.4	19.9	1.7	24.8	2.5	29.7	3.7	39.2	6.6	48.5	10.3	57.6	14.7	66.1	19.8	74.2	25.7	88.8	39.3
150	-----	-----	20.0	1.3	24.8	2.2	29.9	3.0	39.5	5.3	49.1	8.3	58.4	11.8	67.5	16.0	76.2	20.8	92.8	32.1
200	-----	-----	20.0	1.0	25.0	1.5	29.9	2.2	39.8	4.0	49.5	6.2	59.0	8.9	68.6	12.1	77.9	15.8	95.9	24.5
250	-----	-----	20.0	0.9	25.0	1.2	29.9	1.8	39.9	3.2	49.7	5.0	59.4	7.2	69.1	9.7	78.7	12.7	97.3	19.7
300	-----	-----	-----	-----	-----	-----	30.0	1.5	39.9	2.7	49.8	4.2	59.6	6.0	69.3	8.1	79.1	10.6	98.1	16.5
350	-----	-----	-----	-----	-----	-----	30.0	1.3	40.0	2.3	49.8	3.6	59.7	5.2	69.6	7.0	79.3	9.1	98.6	14.3
400	-----	-----	-----	-----	-----	-----	30.0	1.1	40.0	2.0	49.9	3.1	59.8	4.5	69.7	6.1	79.5	8.0	99.0	12.4
500	-----	-----	-----	-----	-----	-----	30.0	0.9	40.0	1.6	49.9	2.5	59.9	3.6	69.7	4.9	79.6	6.4	99.4	10.0

TABLE OF DEFLECTION ANGLES

Radius of curve	Degree of curve	Curve length, in feet: 10 — Deflection angle	20	30	40	50	60	70	80	90	100
		° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
30 feet	191.00	9 33	19 06	28 39	38 12	47 43	57 18	66 51	76 24	----------	----------
40 feet	143.25	7 10	14 20	21 29	28 39	35 49	42 58	50 08	57 18	64 28	71 37
50 feet	114.60	5 44	11 28	17 11	22 56	28 39	34 23	40 06	45 50	51 34	57 18
60 feet	95.50	4 46	9 33	14 20	19 06	23 52	28 39	33 26	38 12	42 58	47 44
70 feet	81.87	4 06	8 11	12 17	16 22	20 28	24 34	28 39	32 45	36 50	40 56
80 feet	71.62	3 35	7 10	10 45	14 20	17 54	21 29	25 04	28 39	32 14	35 49
90 feet	63.67	3 11	6 22	9 33	12 44	15 55	19 06	22 17	25 28	28 39	31 50
100 feet	57.30	2 52	5 44	8 36	11 28	14 20	17 11	20 03	22 55	25 47	28 39
120 feet	47.75	2 23	4 46	7 10	9 33	11 56	14 19	16 42	19 06	21 29	23 52
150 feet	38.20	1 55	3 49	5 44	7 38	9 33	11 28	13 22	15 17	17 11	19 06
200 feet	28.65	1 26	2 52	4 18	5 44	7 10	8 36	10 02	11 28	12 54	14 20
250 feet	22.92	1 09	2 18	3 26	4 35	5 44	6 53	8 01	9 10	10 19	11 28
300 feet	19.10	0 57	1 55	2 52	3 49	4 46	5 44	6 41	7 38	8 36	9 33
350 feet	16.37	0 49	1 38	2 27	3 16	4 06	4 55	5 44	6 33	7 22	8 11
400 feet	14.32	0 43	1 26	2 10	2 52	3 35	4 18	5 01	5 44	6 27	7 10
500 feet	11.46	0 34	1 09	1 43	2 18	2 52	3 26	4 01	4 35	5 09	5 44

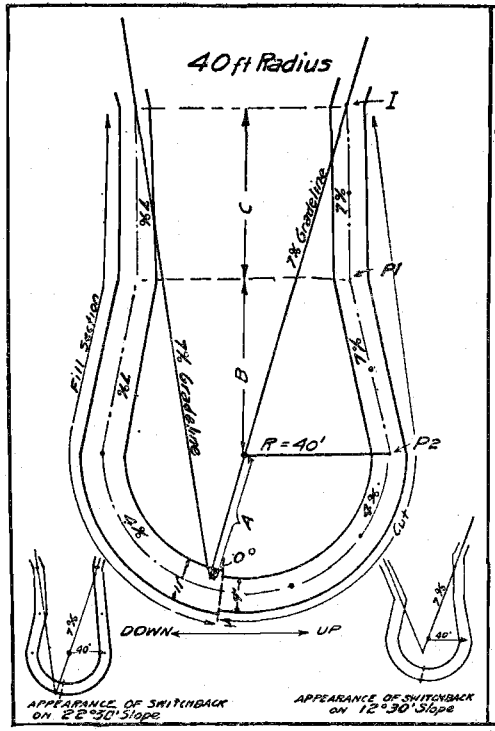
Degree of curve=5,730÷radius. For 75-foot radius: Degree of curve=$\frac{5,730}{75}$=76.4.

Deflection angle=Product of 0.3-foot multiplied by length of curve, in feet, multiplied by degree of curve. For 60-foot radius and 30 feet of curve: 0.3′×95.5×30=859.5′. 859.5′÷60=14° 20′ deflection angle.

Use 10-foot chords for laying off curves with radius of 40 feet or less.
Use not longer than 20-foot chords for radii between 50 and 90 feet.
Use not longer than 30-foot chords for radii between 100 and 150 feet.
Use not longer than 50-foot chords for radii over 150 feet.

TABLE OF MIDDLE ORDINATES

Radius of curve	Chord length, in feet											
	10	15	20	25	30	40	50	60	70	80	90	100
	Middle ordinate, in feet											
30 feet	0.4	1.0	1.7	2.7	4.0	7.6	13.4	30.0	------	------	------	------
40 feet	0.3	0.7	1.3	2.0	2.9	5.3	8.9	13.5	20.6	40.0	------	------
50 feet	0.3	0.6	1.0	1.6	2.3	4.2	6.7	10.0	14.2	20.0	28.2	50.0
60 feet	0.2	0.5	0.8	1.3	1.9	3.5	5.4	8.0	11.2	15.3	20.5	26.8
70 feet	------	0.4	0.7	1.1	1.6	2.9	4.6	6.8	9.4	12.6	16.4	21.0
80 feet	------	------	0.6	1.0	1.4	2.6	4.6	5.8	8.1	10.7	13.8	17.6
90 feet	------	------	0.6	0.9	1.3	2.3	3.5	5.1	7.1	9.4	12.1	15.2
100 feet	------	------	------	0.8	1.1	2.0	3.2	4.6	6.4	8.3	10.8	13.4
120 feet	------	------	------	0.6	1.0	1.7	2.6	3.8	5.4	6.9	9.0	10.9
150 feet	------	------	------	------	0.8	1.3	2.2	3.0	4.1	5.4	6.9	8.6
200 feet	------	------	------	------	0.6	1.0	1.6	2.3	3.1	4.0	5.2	6.4
250 feet	------	------	------	------	0.5	0.8	1.3	1.8	2.5	3.2	4.1	5.1
300 feet	------	------	------	------	0.4	0.7	1.1	1.5	2.1	2.7	3.4	4.2
350 feet	------	------	------	------	------	0.6	0.9	1.3	1.8	2.3	3.0	3.6
400 feet	------	------	------	------	------	0.5	0.8	1.1	1.5	2.0	2.5	3.1
500 feet	------	------	------	------	------	------	0.7	0.9	1.2	1.6	2.0	2.5



SWITCHBACKS IN BALANCED SECTION

BASED ON UNIFORM SLOPES

ST'D 9' ROAD

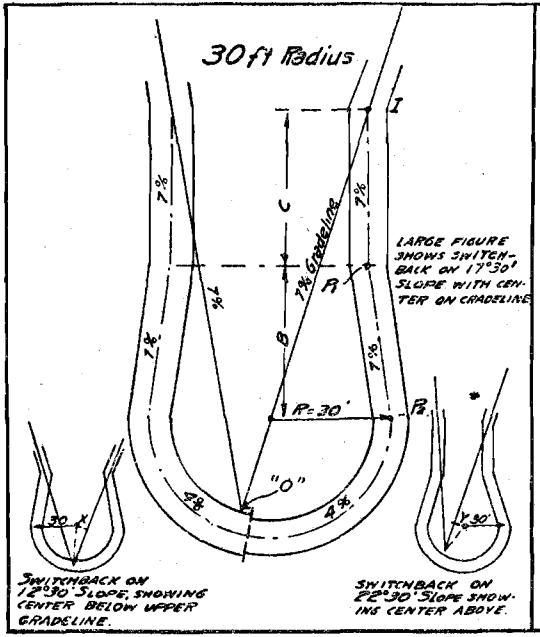
Grade · 7%. Compensation on Curve, 4%

40 ft Radius.

9' Cut ¾ : 1 — 11' Fill 1½ : 1

GROUND SLOPE		A	B	C	APPROX CU. YDS	APPROX MAX CUT and FILL		LENGTH of SWITCHBACK
°	%					Cut	Fill	Ft.
12½	22	21	50	50	247	6.3	5.3	275
15	27	25	50	50	380	9.0	6.5	300
17½	31	31	50	50	557	11.8	7.4	325
20	37	39	50	50	760	14.0	9.2	325
22½	41	49	50	50	960	16.5	10.2	325

Note: Place center on upper gradeline



30 ft Radius

9' Cut. ¾ : 1 — 11' Fill 1½ : 1

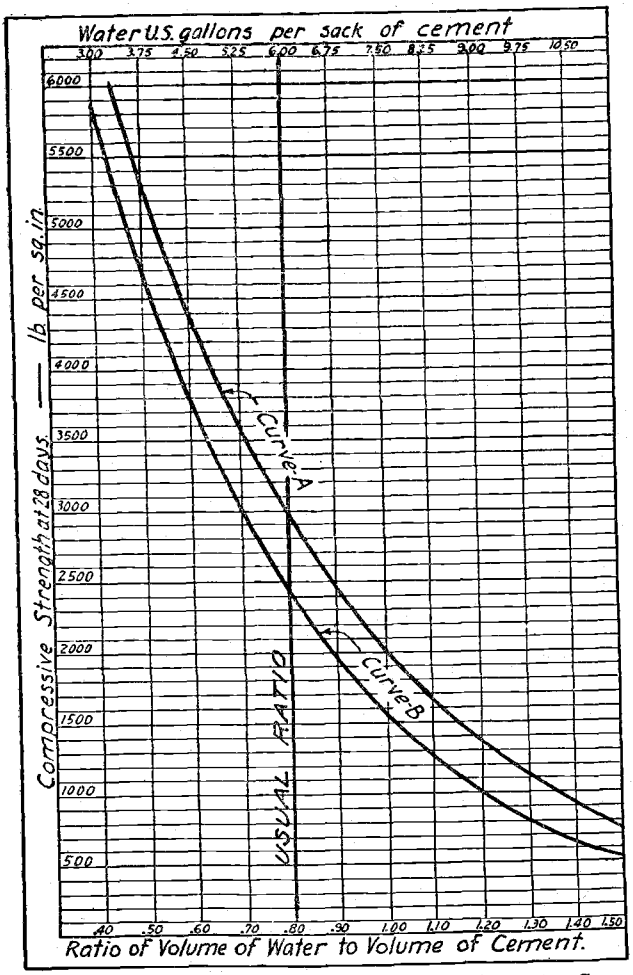
GROUND SLOPE		A	B	C	OFF SET		APPROX CU YDS	APPROX MAX CUT and FILL		LENGTH
°	%				X	Y				
										Ft.
12½	22	31	40	40	7		117	4.8	3.5	175
15	27	28	40	40	3		195			225
17½	31	26	40	40	NONE		280	8.5	5.5	250
20	37	23	40	40		5	380			250
22½	41	20	40	40		9	480	12.5	7.5	250

Note: On 12½° to 15° Slopes place center below upper gradeline. Dist X

On slopes between 15° and 20° place center on upper gradeline
On 20° to 22½° Slopes place center above upper gradeline. Dist. Y.
This applies to 30' Rad. Curves only

QUANTITIES OF INGREDIENTS OF VARIOUS PROPORTIONS

Proportion of ingredients			Ingredients required for 1 cubic yard of rammed concrete											
			Stone, 1 inch and under, dust screened out			Stone, 2½ inches and under, dust screened out			Stone, 2½ inches, with most small stone screened out			Gravel, ¾ inch and under		
Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Gravel
			Bbl.	*Cu. Yd.*	*Cu. Yd.*	*Bbl.*	*Cu. Yd.*	*Cu. Yd.*	*Bbl.*	*Cu. Yd.*	*Cu. Yd.*	*Bbl.*	*Cu. Yd.*	*Cu. Yd.*
1	1.0	2.0	2.57	0.39	0.78	2.63	0.40	0.80	2.72	0.41	0.83	2.30	0.35	0.74
1	1.0	2.5	2.29	.35	.88	2.34	.36	.89	2.41	.37	.92	2.10	.32	.80
1	1.0	3.0	2.06	.31	.94	2.10	.32	.96	2.16	.33	.98	1.89	.29	.86
1	1.0	3.5	1.84	.28	.98	1.88	.29	1.00	1.88	.29	1.05	1.71	.26	.91
1	1.5	2.5	2.05	.47	.78	2.09	.48	.80	2.16	.49	.82	1.83	.42	.73
1	1.5	3.0	1.85	.42	.84	1.90	.43	.87	1.96	.45	.89	1.71	.39	.78
1	1.5	3.5	1.72	.39	.91	1.74	.40	.93	1.79	.41	.96	1.57	.36	.83
1	1.5	4.0	1.57	.36	.96	1.61	.37	.98	1.64	.38	1.00	1.46	.33	.88
1	1.5	4.5	1.43	.33	.98	1.46	.33	1.00	1.51	.35	1.06	1.34	.31	.91
1	2.0	3.0	1.70	.52	.77	1.73	.53	.79	1.78	.54	.81	1.54	.47	.73
1	2.0	3.5	1.57	.48	.83	1.61	.49	.85	1.66	.50	.88	1.44	.44	.77
1	2.0	4.0	1.46	.44	.89	1.48	.45	.90	1.53	.47	.93	1.34	.41	.81
1	2.0	4.5	1.36	.42	.93	1.38	.42	.95	1.43	.43	.98	1.26	.38	.86
1	2.0	5.0	1.27	.39	.97	1.29	.39	.98	1.33	.39	1.03	1.17	.36	.89
1	2.5	3.5	1.45	.55	.77	1.48	.56	.79	1.51	.58	.81	1.32	.50	.70
1	2.5	4.0	1.35	.52	.82	1.38	.53	.84	1.42	.54	.87	1.24	.47	.75
1	2.5	4.5	1.27	.48	.87	1.29	.49	.88	1.33	.51	.91	1.16	.44	.80
1	2.5	5.0	1.19	.46	.91	1.21	.46	.92	1.26	.48	.96	1.10	.42	.83
1	2.5	5.5	1.13	.43	.94	1.15	.44	.96	1.18	.44	.99	1.03	.39	.86
1	2.5	6.0	1.07	.41	.97	1.07	.41	.98	1.10	.41	1.03	.98	.37	.89
1	3.0	4.0	1.26	.58	.77	1.28	.58	.78	1.32	.60	.80	1.15	.52	.72
1	3.0	4.5	1.18	.54	.81	1.20	.55	.82	1.24	.57	.85	1.09	.50	.75
1	3.0	5.0	1.11	.51	.85	1.14	.52	.87	1.17	.54	.89	1.03	.47	.78
1	3.0	5.5	1.06	.48	.89	1.07	.49	.90	1.11	.51	.93	.97	.44	.81
1	3.0	6.0	1.01	.46	.92	1.02	.47	.93	1.06	.48	.97	.92	.42	.84
1	3.0	6.5	.96	.44	.95	.98	.44	.96	1.00	.45	1.01	.88	.40	.87
1	3.0	7.0	.91	.42	.97	.92	.42	.98	.94	.42	1.05	.84	.38	.89
1	3.5	5.0	1.05	.56	.80	1.07	.57	.82	1.11	.59	.85	.96	.50	.76
1	3.5	5.5	1.00	.53	.84	1.02	.54	.85	1.06	.56	.89	.92	.48	.78
1	3.5	6.0	.95	.50	.87	.97	.51	.89	1.00	.53	.92	.88	.46	.80
1	3.5	6.5	.92	.49	.91	.93	.49	.92	.96	.51	.95	.83	.44	.82
1	3.5	7.0	.87	.47	.93	.89	.47	.95	.91	.49	.98	.80	.43	.85
1	3.5	7.5	.84	.45	.96	.86	.45	.98	.86	.47	1.01	.76	.41	.87
1	3.5	8.0	.80	.42	.97	.82	.43	1.01	.81	.45	1.04	.73	.39	.89
1	4.0	6.0	.90	.55	.82	.92	.56	.84	.95	.58	.87	.83	.51	.77
1	4.0	6.5	.87	.53	.85	.88	.53	.87	.91	.55	.90	.80	.49	.79
1	4.0	7.0	.83	.51	.89	.84	.51	.90	.87	.53	.93	.77	.47	.81
1	4.0	7.5	.80	.49	.91	.81	.50	.93	.84	.51	.96	.73	.44	.83
1	4.0	8.0	.77	.47	.93	.78	.48	.95	.81	.49	.98	.71	.43	.86
1	4.0	8.5	.74	.45	.95	.76	.46	.98	.78	.47	1.01	.68	.42	.88
1	4.0	9.0	.71	.43	.97	.73	.44	1.01	.75	.45	1.04	.65	.40	.89
1	5.0	9.0	.66	.50	.90	.67	.52	.93	.70	.53	.96	.61	.46	.83
1	5.0	10.0	.62	.47	.95	.63	.48	.96	.65	.50	1.00	.57	.43	.87

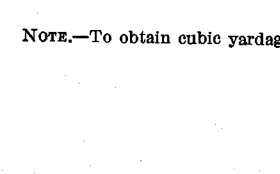


Effect of quantity of mixing water on the strength of concrete. Curves based on average values from nine series of tests made over a period of four years. Curve A to be used for design where the water-cement ratio is carefully controlled by accurate measurement of quantities of water, cement, and aggregate, with proper correction for water carried by the aggregate. Curve B to be used for design where the water-cement ratio is indifferently controlled and where only rough methods are used for measuring quantities of materials. Cr. Portland Cement Ass'n.

SLOPE STAKE AND AREA TABLES

[For use on Forest Service minor roads] **CUT SLOPE 1:1**

Slope %	Width of finished road 9				10				11				12			
	B	C	S	A	B	C	S	A	B	C	S	A	B	C	S	A
10	4.8	0.5	5.4	1.3	5.3	0.6	5.9	1.6	5.9	0.7	6.6	1.6	6.5	0.7	7.2	2.2
12	4.8	0.7	5.5	1.6	5.3	0.7	6.1	2.0	5.9	0.8	6.8	2.4	6.4	0.9	7.4	2.8
14	4.8	0.8	5.7	1.9	5.3	0.9	6.3	2.4	5.9	1.0	7.0	2.9	6.4	1.1	7.6	3.4
16	4.9	0.9	5.8	2.2	5.4	1.0	6.4	2.8	6.0	1.2	7.2	3.4	6.5	1.2	7.8	4.0
18	4.9	1.1	6.0	2.5	5.4	1.2	6.6	3.2	6.0	1.3	7.4	3.9	6.5	1.4	8.0	4.6
20	4.9	1.2	6.2	2.9	5.4	1.4	6.9	3.6	6.0	1.5	7.6	4.5	6.5	1.6	8.3	5.2
22	4.9	1.4	6.4	3.4	5.4	1.5	7.2	4.1	6.0	1.7	7.9	5.1	6.5	1.9	8.6	6.0
24	4.9	1.6	6.7	3.9	5.4	1.7	7.4	4.7	6.0	1.9	8.2	5.8	6.6	2.1	8.9	6.9
26	5.0	1.7	6.9	4.4	5.5	1.9	7.6	5.3	6.1	2.1	8.5	6.5	6.6	2.3	9.2	7.8
28	5.0	1.9	7.2	4.9	5.5	2.1	7.9	5.9	6.1	2.4	8.8	7.2	6.7	2.6	9.6	8.7
30	5.0	2.1	7.5	5.4	5.5	2.4	8.2	6.5	6.1	2.6	9.1	7.9	6.7	2.9	10.0	9.6
32	5.0	2.4	7.8	6.1	5.5	2.6	8.6	7.3	6.1	2.9	9.5	8.7	6.7	3.2	10.4	10.8
34	5.1	2.6	8.1	6.8	5.6	2.9	8.9	8.2	6.2	3.2	9.9	9.5	6.8	3.5	10.8	12.0
36	5.1	2.9	8.5	7.5	5.6	3.2	9.3	9.1	6.2	3.5	10.3	10.4	6.8	3.8	11.3	13.2
38	5.2	3.2	8.9	8.2	5.7	3.4	9.7	10.0	6.3	3.8	10.8	11.3	6.9	4.2	11.8	14.5
40	5.2	3.5	9.3	9.0	5.7	3.8	10.2	10.9	6.3	4.2	11.3	13.2	6.9	4.6	12.4	15.9
42	5.3	3.8	9.8	10.3	5.8	4.2	10.7	12.2	6.4	4.6	11.8	14.7	7.0	5.0	13.0	17.5
44	5.4	4.2	10.4	11.6	5.9	4.6	11.4	13.6	6.5	5.1	12.5	16.6	7.1	5.5	13.8	19.5
46	5.5	4.6	11.0	12.9	6.0	5.0	12.1	15.0	6.5	5.5	12.2	17.9	7.2	6.1	14.6	22.0
48	5.5	5.1	11.7	13.3	6.0	5.6	12.8	16.8	6.6	6.1	14.0	20.1	7.3	6.7	15.5	24.5
50	5.6	5.6	12.6	15.7	6.1	6.1	13.6	18.6	6.7	6.7	15.0	22.5	7.4	7.4	16.6	27.4
52	5.7	6.1	13.3	17.4	6.2	6.8	14.6	21.1	6.8	7.4	16.0	25.1	7.5	8.2	17.7	30.7
54	5.9	6.8	14.3	20.0	6.4	7.4	15.7	23.7	7.0	8.2	17.2	28.7	7.7	9.0	19.0	34.7
56	6.0	7.5	15.4	22.5	6.5	8.3	16.9	27.0	7.2	9.1	18.6	32.7	7.9	10.0	20.4	39.5
58	6.2	8.4	16.7	26.0	6.7	9.2	18.4	30.8	7.4	10.2	20.2	37.8	8.1	11.1	22.1	45.0
60	6.3	9.5	18.4	29.8	6.9	10.4	20.1	35.7	7.6	11.4	22.2	43.2	8.3	12.5	24.2	51.8
62	6.7	10.8	20.4	36.2	7.4	11.9	22.5	44.0	8.1	13.2	24.7	53.5	8.9	14.3	27.0	63.8
64	7.1	12.5	23.1	44.3	7.9	13.8	25.7	54.5	8.7	15.2	28.1	66.0	9.5	16.5	28.6	78.5
66	7.6	14.8	26.9	56.5	8.5	16.4	30.1	70.0	9.3	18.2	32.9	84.5	10.1	19.7	35.5	99.5
68	9.0	19.1	34.0	86.0	10.0	21.2	37.7	106.0	11.0	23.4	41.6	128.5	12.0	25.5	45.3	152.5
70	---	21.0	36.6	94.5	---	23.3	40.5	116.5	---	25.7	44.8	141.0	---	28.0	48.8	168.0
72	---	23.1	39.7	104.0	---	25.7	44.0	128.5	---	28.2	48.3	155.0	---	30.9	52.6	185.5
74	---	25.6	43.0	115.2	---	28.5	47.9	142.5	---	31.3	52.3	172.0	---	34.2	56.9	205.0
76	---	38.5	46.9	128.5	---	31.7	52.4	158.5	---	34.8	57.0	191.0	---	38.0	62.2	228.0
78	---	32.0	52.0	144.0	---	35.4	57.6	177.0	---	39.0	63.0	214.0	---	42.5	68.8	255.0
80	---	36.0	57.6	162.0	---	40.0	64.0	200.0	---	44.0	70.3	242.0	---	48.0	76.7	288.0
82	---	41.0	64.6	184.5	---	45.5	71.8	227.5	---	50.2	78.3	275.5	---	54.3	86.7	326.0
84	---	47.3	73.5	213.0	---	52.5	81.6	262.5	---	57.7	89.7	317.0	---	63.0	98.0	377.5
86	---	55.3	84.8	249.0	---	61.4	94.2	307.0	---	67.6	103.6	371.5	---	73.7	113.0	441.5
88	---	66.1	100.5	297.5	---	73.3	111.0	366.5	---	80.6	121.9	443.0	---	88.0	133.4	528.0
90	---	81.0	121.0	364.0	---	90.0	134.5	450.0	---	99.0	148.0	545.0	---	108.0	162.1	648.0
92	---	103.5	152.4	466.0	---	115.0	170.0	575.0	---	126.5	186.8	695.0	---	138.0	203.8	827.5
94	---	141.0	205.8	635.0	---	156.5	228.4	782.5	---	172.5	251.8	947.5	---	188.0	274.4	1,128.0
96	---	216.0	311.8	972.5	---	240.0	348.0	1,200.0	---	264.0	381.1	1,400.0	---	288.0	416.0	1,725.0
98	---	441.0	629.0	1,982.5	---	490.0	700.0	2,450.0	---	539.0	770.0	2,965.0	---	588.0	840.5	3,525.0
100	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---



B=distance, in feet, cut into hillside from grad stake to toe of cut slope.
C=vertical cut, in feet, to be marked on cut stake.
S=distance along slope, to be measured from grade stake to cut stake.
A=area, in square feet, of cut section.
W=width of finished road.

SHRINKAGE FACTOR

Common

20 per cent for slopes 10 to 40 per cent.
30 per cent for slopes 40 to 66 per cent.

Solid rock

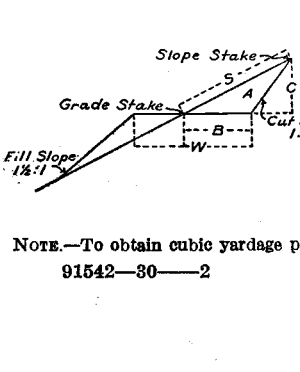
15 per cent for slopes 10 to 40 per cent.
10 per cent for slopes 40 to 66 per cent.

NOTE.—To obtain cubic yardage per 100 feet, multiply average end areas by 3.7.

SLOPE STAKE AND AREA TABLES

[For use on Forest Service minor roads] **CUT SLOPE 1:1**

Slope %	Width of finished road															
	13				14				15				16			
	B	C	S	A	B	C	S	A	B	C	S	A	B	C	S	A
10	6.9	0.8	7.7	2.7	7.5	0.8	8.4	3.2	8.0	0.9	8.9	3.6	8.5	1.0	9.5	4.0
12	6.9	1.0	7.9	3.4	7.5	1.0	8.6	4.0	8.0	1.1	9.2	4.5	8.5	1.2	9.7	5.0
14	6.9	1.1	8.1	4.1	7.5	1.2	8.9	4.8	8.0	1.3	9.4	5.4	8.5	1.4	10.0	6.0
16	7.0	1.3	8.4	4.8	7.6	1.4	9.1	5.6	8.1	1.5	9.7	6.3	8.6	1.6	10.3	7.1
18	7.0	1.5	8.7	5.5	7.6	1.7	9.4	6.4	8.1	1.8	10.0	7.2	8.6	1.9	10.6	8.2
20	7.0	1.8	8.9	6.2	7.6	1.9	9.7	7.2	8.1	2.0	10.3	8.2	8.6	2.2	11.0	9.3
22	7.0	2.0	9.3	7.2	7.6	2.2	10.0	8.3	8.1	2.3	10.7	9.5	8.6	2.5	11.4	10.7
24	7.1	2.2	9.6	8.2	7.7	2.4	10.4	9.5	8.2	2.6	11.1	10.8	8.7	2.8	11.8	12.2
26	7.1	2.5	10.0	9.2	7.7	2.7	10.7	10.7	8.2	2.9	11.5	12.1	8.7	3.1	12.2	13.7
28	7.2	2.8	10.3	10.2	7.8	3.0	11.2	11.9	8.3	3.2	11.9	13.5	8.8	3.4	12.6	15.2
30	7.2	3.1	10.8	11.2	7.8	3.4	11.7	13.1	8.3	3.6	12.4	14.9	8.8	3.8	13.2	16.7
32	7.3	3.4	11.2	12.4	7.8	3.7	12.1	14.4	8.4	4.0	12.9	16.8	8.9	4.2	13.7	18.7
34	7.3	3.8	11.7	13.9	7.9	4.1	12.6	16.2	8.4	4.3	13.5	18.0	8.9	4.6	14.3	20.5
36	7.4	4.1	12.2	15.2	7.9	4.4	13.1	17.4	8.5	4.7	14.0	20.0	9.0	5.0	14.9	22.5
38	7.5	4.6	12.8	17.3	8.0	4.9	13.7	19.6	8.6	5.2	14.7	22.4	9.1	5.5	15.6	25.0
40	7.5	5.0	13.4	18.7	8.0	5.4	14.4	21.4	8.6	5.8	15.4	24.8	9.1	6.1	16.3	27.7
42	7.6	5.5	14.1	20.9	8.1	5.8	15.1	23.5	8.7	6.3	16.2	27.4	9.2	6.7	17.2	30.8
44	7.7	6.0	14.9	23.1	8.2	6.4	16.0	26.3	8.8	6.9	17.2	30.3	9.4	7.3	18.2	34.3
46	7.8	6.6	15.8	26.4	8.4	7.1	16.9	29.8	8.9	7.6	18.2	34.8	9.5	8.1	19.3	38.5
48	7.9	7.2	16.8	28.4	8.5	7.9	18.0	33.6	9.0	8.4	19.3	37.8	9.7	8.9	20.5	43.2
50	8.0	8.0	17.9	32.0	8.6	8.6	19.3	37.0	9.2	9.2	20.7	42.3	9.8	9.8	21.9	48.3
52	8.2	8.8	19.1	36.1	8.8	9.6	20.5	42.3	9.4	10.2	22.1	48.0	10.0	10.8	23.4	54.0
54	8.4	9.7	20.5	40.8	9.1	10.5	22.0	47.5	9.6	11.3	23.8	54.3	10.2	12.0	25.2	61.3
56	8.6	10.8	22.1	46.4	9.3	11.6	23.8	54.0	9.8	12.5	25.5	61.3	10.5	13.3	27.32	70.0
58	8.8	12.1	24.0	53.4	9.5	13.0	25.8	61.8	10.1	14.0	27.7	70.5	10.8	14.9	29.5	80.5
60	9.0	13.5	26.3	60.7	9.7	14.6	28.3	70.6	10.4	15.6	30.3	81.5	11.1	16.7	32.4	93.0
62	9.6	15.5	29.3	74.5	10.4	16.5	31.4	86.0	11.1	17.8	33.7	99.0	11.9	19.0	36.0	113.0
64	10.3	18.0	33.3	93.0	11.1	19.2	35.6	106.5	11.9	20.8	38.5	124.0	12.7	22.1	40.8	141.0
66	11.0	21.4	38.8	117.7	11.8	23.0	41.6	135.0	12.7	24.7	44.8	756.0	13.5	26.2	47.5	178.0
68	13.0	27.6	49.0	179.5	14.0	29.8	52.8	208.5	15.0	31.9	56.6	239.0	16.0	34.0	60.3	272.0
70	----	30.3	52.7	192.0	----	32.7	56.8	228.5	----	35.0	60.8	263.0	----	37.3	64.8	298.0
72	----	33.4	57.0	217.0	----	36.0	61.5	252.0	----	38.6	65.9	289.0	----	41.2	70.2	333.0
74	----	37.0	61.7	240.5	----	39.8	66.6	278.5	----	42.7	71.3	320.0	----	45.6	76.6	364.0
76	----	41.2	67.4	267.5	----	44.3	72.7	310.0	----	47.5	77.8	356.0	----	50.7	83.9	405.0
78	----	46.1	74.5	299.0	----	49.7	80.4	347.5	----	53.2	86.0	399.0	----	56.8	92.3	454.0
80	----	52.0	84.0	337.5	----	56.0	89.6	391.5	----	60.0	97.0	450.0	----	64.0	102.5	512.0
82	----	59.3	93.0	387.5	----	63.8	100.0	446.0	----	67.4	107.0	505.0	----	72.8	114.8	584.0
84	----	68.3	106.0	444.0	----	73.5	114.2	514.0	----	78.8	122.0	591.0	----	84.0	130.0	672.5
86	----	79.8	123.0	519.0	----	86.0	132.0	602.0	----	92.2	142.0	691.0	----	98.3	150.9	788.0
88	----	95.2	144.0	619.0	----	102.8	155.6	720.0	----	110.0	166.0	825.0	----	117.2	177.6	938.0
90	----	117.0	175.0	760.0	----	126.0	188.1	881.0	----	135.0	202.0	1,011.0	----	144.0	215.2	1,150.0
92	----	149.5	221.2	971.0	----	161.0	237.7	1,130.0	----	172.5	256.0	1,295.0	----	184.0	274.0	1,475.0
94	----	203.3	297.0	1,320.0	----	219.0	320.0	1,531.0	----	235.0	343.0	1,760.0	----	250.5	366.0	2,000.0
96	----	312.0	451.0	2,025.0	----	336.0	485.3	2,350.0	----	360.0	520.0	2,700.0	----	384.0	554.5	3,070.0
98	----	637.0	910.0	4,135.0	----	685.0	978.6	4,790.0	----	735.0	1,050	5,510.0	----	785.0	1,121	6,290.0
100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----



B=distance, in feet, cut into hillside from grade stake to toe of cut slope.
C=vertical cut, in feet, to be marked on cut stake.
S=distance along slope, to be measured from grade stake to cut stake.
A=area, in square feet, of cut section.
W=width of finished road.

SHRINKAGE FACTOR

Common

20 per cent for slopes 10 to 40 per cent.
30 per cent for slopes 40 to 66 per cent.

Solid rock

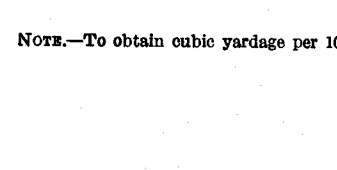
15 per cent for slopes 10 to 40 per cent.
10 per cent for slopes 40 to 66 per cent.

NOTE.—To obtain cubic yardage per 100 multiply average end areas by 3.7.

SLOPE STAKE AND AREA TABLES

[For use on Forest Service minor roads] **CUT SLOPE ¾ : 1**

Slope %	Width of finished road 9				10				11				12			
	B	C	S	A	B	C	S	A	B	C	S	A	B	C	S	A
10	4.9	0.5	5.3	1.3	5.4	0.6	5.9	1.6	6.0	0.7	6.5	2.0	6.5	0.7	7.1	2.3
12	4.9	0.7	5.4	1.6	5.4	0.7	6.0	2.0	6.0	0.8	6.7	2.4	6.5	0.9	7.2	2.8
14	4.9	0.8	5.6	1.9	5.4	0.9	6.1	2.4	6.0	1.0	6.8	2.9	6.5	1.0	7.4	3.4
16	5.0	0.9	5.7	2.2	5.5	1.0	6.3	2.8	6.1	1.1	7.0	3.3	6.6	1.2	7.6	3.9
18	5.0	1.0	5.8	2.6	5.5	1.2	6.4	3.2	6.1	1.3	7.1	3.8	6.6	1.4	7.7	4.5
20	5.0	1.2	6.0	2.9	5.5	1.3	6.6	3.6	6.1	1.4	7.3	4.3	6.6	1.6	7.9	5.1
22	5.0	1.3	6.1	3.3	5.5	1.5	6.8	4.1	6.1	1.6	7.5	4.9	6.6	1.8	8.1	5.7
24	5.0	1.5	6.3	3.7	5.6	1.6	7.0	4.6	6.1	1.8	7.7	5.6	6.7	2.0	8.4	6.5
26	5.1	1.6	6.5	4.1	5.6	1.8	7.2	5.1	6.2	2.0	7.9	6.3	6.7	2.2	8.6	7.2
28	5.1	1.8	6.7	4.6	5.7	2.0	7.4	5.7	6.2	2.2	8.2	6.9	6.8	2.4	8.9	8.0
30	5.1	2.0	6.9	5.0	5.7	2.2	7.7	6.2	6.2	2.5	8.4	7.6	6.8	2.6	9.2	8.8
32	5.1	2.2	7.1	5.6	5.7	2.4	7.9	6.9	6.2	2.7	8.7	8.5	6.8	2.9	9.5	9.9
34	5.2	2.4	7.3	6.2	5.8	2.6	8.2	7.7	6.3	2.9	9.0	9.4	6.9	3.2	9.8	11.0
36	5.2	2.6	7.6	6.8	5.8	2.9	8.4	8.4	6.3	3.2	9.3	10.3	7.0	3.4	10.1	12.1
38	5.3	2.8	7.9	7.4	5.9	3.1	8.7	9.2	6.4	3.4	9.7	11.1	7.0	3.7	10.5	13.2
40	5.3	3.0	8.2	8.0	5.9	3.4	9.1	9.9	6.5	3.7	10.0	12.0	7.1	4.1	10.9	14.4
42	5.4	3.3	8.5	9.0	6.0	3.7	9.5	11.1	6.6	4.0	10.4	13.4	7.2	4.4	11.3	15.8
44	5.5	3.6	8.9	10.0	6.1	4.0	9.9	13.2	6.7	4.4	10.9	14.8	7.4	4.8	11.9	17.8
46	5.6	3.9	9.3	11.1	6.3	4.4	10.4	13.9	6.9	4.8	11.5	16.6	7.5	5.2	12.5	19.5
48	5.7	4.3	9.8	12.2	6.4	4.8	10.9	15.4	7.0	5.2	12.0	18.2	7.6	5.7	13.1	21.7
50	5.8	4.6	10.4	13.3	6.5	5.2	11.6	16.9	7.1	5.7	12.7	20.2	7.7	6.2	13.8	23.8
52	5.9	5.0	10.9	14.7	6.6	5.6	12.2	18.5	7.3	6.2	13.3	22.6	7.9	6.8	14.6	26.8
54	6.1	5.5	11.5	16.8	6.8	6.1	12.8	20.8	7.5	6.7	14.1	25.1	8.1	7.3	15.4	29.5
56	6.3	5.9	12.2	18.6	7.0	6.7	13.6	23.5	7.6	7.3	14.9	27.8	8.3	7.9	16.3	32.8
58	6.4	6.5	13.0	20.8	7.1	7.2	14.4	25.5	7.8	8.0	15.9	31.2	8.5	8.6	17.3	36.5
60	6.5	7.1	13.8	23.0	7.3	7.9	15.5	28.8	8.0	8.7	17.0	34.8	8.7	9.5	18.4	41.3
62	7.0	7.9	15.0	2?.7	7.7	8.8	16.7	33.4	8.5	9.7	18.3	41.2	9.2	10.5	19.9	48.2
64	7.4	8.9	16.4	32.9	8.2	9.9	18.3	40.6	9.0	10.9	20.1	49.0	9.8	11.8	21.8	58.0
66	7.8	10.2	18.5	39.8	8.7	11.4	20.6	49.4	9.6	12.5	22.8	60.0	10.4	13.6	24.7	71.5
68	9.0	12.5	22.2	56.3	10.0	13.9	24.7	69.5	11.0	15.3	27.2	84.0	12.0	16.7	29.6	101.0
70	----	13.3	23.1	60.0	----	14.8	25.7	74.0	----	16.3	28.3	89.5	----	17.7	30.9	106.0
72	----	14.1	24.1	63.5	----	15.6	28.9	78.0	----	17.3	29.4	94.5	----	18.8	32.1	113.0
74	----	14.9	25.1	67.0	----	16.6	29.6	83.0	----	18.4	30.8	101.0	----	20.0	33.5	120.0
76	----	15.9	26.0	71.6	----	17?7	30.4	88.5	----	19.5	32.1	107.0	----	21.3	35.0	127.5
78	----	16.9	27.4	76.0	----	18.8	31.2	94.0	----	20.7	33.3	114.0	----	22.6	36.6	135.5
80	----	18.0	28.9	81.0	----	20.0	32.0	100.0	----	22.1	35.2	121.5	----	24.1	38.6	144.5
82	----	19.1	30.2	86.0	----	21.4	33.6	107.0	----	23.5	37.0	129.0	----	25.7	40.3	154.0
84	----	20.3	31.6	91.5	----	22.9	35.2	114.5	----	25.1	39.0	138.0	----	27.3	42.3	164.0
86	----	21.9	33.6	98.5	----	24.3	37.0	121.5	----	26.8	41.0	147.5	----	29.1	44.6	174.5
88	----	23.1	35.2	104.0	----	26.0	39.1	130.0	----	28.6	43.4	157.0	----	31.1	47.2	186.5
90	----	25.0	37.4	112.5	----	27.8	41.4	139.0	----	30.7	46.0	169.0	----	33.3	49.8	200.0
92	----	26.9	39.7	121.0	----	29.8	44.0	149.0	----	32.9	48.7	181.0	----	35.8	52.8	215.0
94	----	28.8	42.1	129.5	----	32.1	46.5	160.5	----	35.4	51.6	194.5	----	38.6	56.2	231.0
96	----	31.0	44.8	139.5	----	34.6	49.8	173.0	----	38.1	54.7	209.0	----	41.4	60.5	248.5
98	----	33.5	48.0	150.5	----	37.2	53.2	186.0	----	41.0	58.6	225.0	----	44.6	64.4	267.5
100	----	36.3	51.4	163.5	----	40.3	57.0	201.5	----	44.4	62.8	244.0	----	48.4	68.4	290.0



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A=area, in square feet, of cut section.
W=width of finished road.

SHRINKAGE FACTOR

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30 per cent for slopes 40 to 66 per cent.

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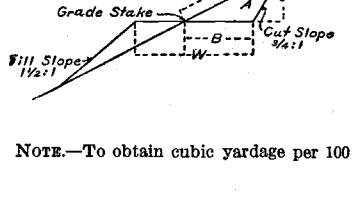
NOTE.—To obtain cubic yardage per 100 feet, multiply average end areas by 3.7.

SLOPE STAKE AND AREA TABLES

[For use on Forest Service minor roads] **CUT SLOPE ¾:1**

Slope %	Width of finished road 13				14				15				16			
	B	C	S	A	B	C	S	A	B	C	S	A	B	C	S	A
10	7.0	0.7	7.6	2.6	7.6	0.8	8.2	3.1	8.0	0.9	8.7	3.6	8.5	0.9	9.2	3.9
12	7.0	0.9	7.8	3.3	7.5	1.0	8.3	3.8	8.0	1.1	8.9	4.4	8.5	1.1	9.4	4.9
14	7.0	1.1	7.9	4.0	7.6	1.2	8.5	4.6	8.1	1.3	9.1	5.2	8.6	1.3	9.7	5.9
16	7.1	1.3	8.1	4.6	7.6	1.4	8.7	5.3	8.1	1.5	9.3	6.1	8.6	1.6	9.9	6.8
18	7.1	1.5	8.3	5.3	7.7	1.6	9.0	6.1	8.2	1.7	9.6	7.0	8.7	1.8	10.2	7.8
20	7.1	1.7	8.5	6.0	7.7	1.8	9.2	6.9	8.2	1.9	9.8	7.9	8.7	2.0	10.4	8.8
22	7.1	1.9	8.8	6.9	7.7	2.0	9.4	7.9	8.2	2.2	10.1	9.1	8.7	2.3	10.7	10.2
24	7.2	2.1	9.0	7.7	7.8	2.3	9.7	8.9	8.3	2.4	10.4	10.3	8.8	2.6	11.0	11.6
26	7.2	2.4	9.3	8.5	7.8	2.5	10.0	10.0	8.4	2.7	10.7	11.5	8.9	2.9	11.4	13.0
28	7.3	2.6	9.6	9.4	7.9	2.8	10.3	11.0	8.5	3.0	11.0	12.7	8.9	3.2	11.7	14.4
30	7.3	2.8	9.9	10.3	7.9	3.1	10.6	12.1	8.5	3.3	11.4	14.0	9.0	3.5	12.2	15.8
32	7.4	3.1	10.2	11.5	8.0	3.4	11.0	13.4	8.6	3.6	11.8	15.5	9.1	3.8	12.6	17.3
34	7.4	3.4	10.6	12.7	8.1	3.7	11.4	14.9	8.7	3.9	12.2	17.0	9.2	4.2	13.0	19.3
36	7.5	3.7	10.9	14.0	8.1	4.0	11.8	16.3	8.7	4.3	12.7	18.7	9.3	4.6	13.5	21.4
38	7.6	4.1	11.3	15.6	8.2	4.4	12.3	17.8	8.8	4.7	13.2	20.7	9.4	5.0	14.0	23.5
40	7.7	4.4	11.8	17.0	8.3	4.7	12.8	19.4	8.9	5.1	13.7	23.0	9.5	5.4	14.6	25.7
42	7.8	4.8	12.3	18.7	8.4	5.3	13.3	22.2	9.0	5.5	14.3	24.8	9.6	5.9	15.2	28.8
44	8.0	5.2	12.9	20.8	8.6	5.6	13.9	24.0	9.3	6.0	15.0	27.9	9.8	6.4	15.9	31.4
46	8.1	5.7	13.5	23.3	8.7	6.1	14.6	26.5	9.4	6.5	15.7	30.6	10.0	7.0	16.6	35.0
48	8.3	6.2	14.2	25.8	8.9	6.6	15.3	29.4	9.6	7.1	16.5	34.1	10.1	7.6	17.5	38.4
50	8.4	6.7	15.0	28.1	9.0	7.2	16.1	32.4	9.7	7.8	17.3	37.6	10.3	8.3	18.5	42.8
52	8.6	7.3	15.8	31.4	9.2	7.8	17.0	35.9	9.9	8.4	18.3	41.5	10.5	9.0	19.4	47.3
54	8.8	7.9	16.6	34.8	9.5	8.6	18.0	40.8	10.2	9.2	19.3	47.0	10.8	9.8	20.5	53.0
56	9.0	8.6	17.6	38.3	9.7	9.3	19.0	45.1	10.4	10.0	20.4	52.0	11.1	10.6	21.7	59.0
58	9.2	9.4	18.7	43.3	10.0	10.2	20.1	51.0	10.7	10.9	21.7	58.5	11.4	11.6	23.0	66.0
60	9.4	10.2	19.9	48.0	10.2	11.1	21.5	56.5	10.9	11.9	23.1	65.0	11.6	12.7	24.6	73.5
62	10.0	11.4	21.5	57.0	10.8	12.2	23.2	66.0	11.6	13.2	24.9	76.5	12.3	14.0	26.5	86.0
64	10.6	12.8	22.7	68.0	11.5	13.7	25.4	78.8	12.3	14.7	27.3	90.5	13.1	15.6	29.0	102.0
66	11.3	14.8	26.8	83.5	12.1	15.8	28.8	95.5	13.0	17.0	30.9	111.0	13.9	18.2	33.0	126.5
68	13.0	18.1	32.1	117.5	14.0	19.5	34.6	136.5	15.0	20.8	37.0	156.0	16.0	22.3	39.6	178.5
70	----	19.2	33.4	125.0	-----	20.6	35.0	144.0	-----	22.1	38.5	165.0	----	23.7	41.3	189.5
72	----	20.5	34.8	133.5	-----	21.9	37.4	153.0	-----	23.5	40.1	176.0	----	25.1	43.0	201.0
74	----	21.7	36.3	141.0	-----	23.3	39.0	163.0	-----	24.9	41.8	187.0	----	26.7	44.6	213.5
76	----	23.1	37.9	150.0	-----	24.8	40.8	173.5	-----	26.6	43.8	199.5	----	28.4	46.6	227.0
78	----	24.4	39.7	158.5	-----	26.4	42.7	184.5	-----	28.2	45.9	211.5	----	30.2	48.8	241.5
80	----	26.1	41.7	169.5	-----	28.1	45.0	197.0	-----	30.0	48.0	225.0	----	32.1	51.4	257.0
82	----	27.8	43.8	180.5	-----	29.9	47.1	209.0	-----	32.1	50.5	241.0	----	34.2	54.0	273.5
84	----	29.9	46.2	194.0	-----	31.9	49.3	223.5	-----	34.2	53.1	256.0	----	36.5	56.7	292.0
86	----	31.7	48.6	206.0	-----	34.1	52.0	238.5	-----	36.6	56.6	274.0	----	39.0	59.7	312.0
88	----	33.8	51.2	219.5	-----	36.4	54.9	254.5	-----	39.0	59.0	292.5	----	41.7	63.2	333.0
90	----	36.3	54.1	236.0	-----	39.0	58.2	273.0	-----	41.7	62.0	312.5	----	44.5	66.6	356.0
92	----	38.8	57.3	252.0	-----	41.7	61.4	291.0	-----	44.7	66.0	335.0	----	47.8	70.0	382.5
94	----	41.7	60.7	271.0	-----	44.8	65.4	313.5	-----	48.0	70.0	360.0	----	51.3	74.8	410.0
96	----	44.8	64.7	291.0	-----	48.3	69.6	338.0	-----	51.8	74.8	388.0	----	55.2	79.9	440.0
98	----	48.4	69.0	314.0	-----	52.0	74.3	363.5	-----	55.9	79.9	419.0	----	59.6	85.3	477.0
100	----	52.4	74.2	340.0	-----	56.4	79.8	394.0	-----	60.5	85.5	453.0	----	64.5	91.2	516.0



B=distance, in feet, cut into hillside from grade stake to toe of cut slope.
C=vertical cut, in feet, to be marked on cut stake.
S=distance along slope, to be measured from grade stake to cut stake.
A=area, in square feet, of cut section.
W=width of finished road.

SHRINKAGE FACTOR

Common

20 per cent for slopes 10 to 40 per cent.
30 per cent for slopes 40 to 66 per cent.

Solid rock

15 per cent for slopes 10 to 40 per cent.
10 per cent for slopes 40 to 66 per cent.

NOTE.—To obtain cubic yardage per 100 feet, multiply average end areas by 3.7.

SLOPE STAKE AND AREA TABLES

[For use on Forest Service minor roads] **CUT SLOPE ½:1**

Slope, %	Width of finished road 9				10				11				12			
	B	C	S	A	B	C	S	A	B	C	S	A	B	C	S	A
10	4.9	0.5	5.2	1.3	5.5	0.6	5.8	1.6	6.0	0.6	6.3	1.9	6.5	0.7	6.9	2.2
12	4.9	0.6	5.3	1.6	5.5	0.7	5.9	1.9	6.0	0.8	6.5	2.3	6.5	0.8	7.0	2.7
14	4.9	0.7	5.3	1.9	5.5	0.8	6.0	2.3	6.0	0.9	6.6	2.7	6.6	1.0	7.1	3.2
16	5.0	0.9	5.4	2.2	5.6	1.0	6.1	2.7	6.1	1.1	6.7	3.1	6.6	1.2	7.3	3.8
18	5.0	1.0	5.5	2.5	5.6	1.1	6.3	3.1	6.1	1.2	6.8	3.6	6.7	1.3	7.4	4.4
20	5.0	1.1	5.7	2.8	5.6	1.3	6.4	3.5	6.1	1.4	7.0	4.1	6.7	1.5	7.6	5.0
22	5.0	1.2	5.8	3.2	5.6	1.4	6.5	4.0	6.1	1.5	7.1	4.6	6.7	1.7	7.7	5.6
24	5.1	1.4	5.9	3.6	5.7	1.6	6.7	4.5	6.2	1.7	7.3	5.2	6.8	1.8	7.9	6.3
26	5.1	1.5	6.1	4.0	5.7	1.7	6.8	5.0	6.2	1.9	7.5	5.8	6.8	2.0	8.1	7.0
28	5.2	1.7	6.2	4.4	5.8	1.9	7.0	5.5	6.3	2.1	7.6	6.4	6.9	2.2	8.3	7.7
30	5.2	1.8	6.4	4.8	5.8	2.0	7.2	6.0	6.3	2.2	7.8	7.0	6.9	2.4	8.5	8.4
32	5.2	2.0	6.5	5.3	5.8	2.2	7.3	6.6	6.4	2.4	8.0	7.9	7.0	2.7	8.7	9.4
34	5.3	2.2	6.7	5.8	5.9	2.4	7.5	7.2	6.5	2.7	8.3	8.8	7.1	2.9	9.0	10.4
36	5.4	2.4	6.9	6.4	6.0	2.6	7.7	7.9	6.5	2.9	8.5	9.7	7.1	3.1	9.2	11.4
38	5.4	2.5	7.1	7.0	6.0	2.8	8.0	8.6	6.6	3.1	8.0	10.6	7.2	3.4	9.5	12.4
40	5.5	2.8	7.4	7.6	6.1	3.0	8.2	9.3	6.7	3.4	9.0	11.5	7.3	3.7	9.8	13.4
42	5.6	3.0	7.6	8.4	6.2	3.3	8.5	10.3	6.8	3.6	9.3	12.8	7.4	3.9	10.2	14.4
44	5.7	3.2	7.8	9.2	6.3	3.5	8.8	11.3	6.9	3.9	9.6	14.1	7.6	4.2	10.5	16.0
46	5.7	3.4	8.1	10.0	6.4	3.8	9.1	12.4	7.0	4.2	10.0	15.4	7.6	4.6	10.9	17.5
48	5.8	3.7	8.4	10.9	6.5	4.1	9.4	13.4	7.1	4.5	10.4	16.7	7.8	4.9	11.4	19.1
50	5.9	4.0	8.8	11.7	6.6	4.4	9.8	14.5	7.3	4.9	10.9	17.9	8.0	5.4	11.9	21.4
52	6.1	4.2	9.2	12.8	6.7	4.7	10.2	15.8	7.5	5.2	11.3	19.5	8.2	5.7	12.4	23.3
54	6.2	4.6	9.6	14.3	6.9	5.1	10.7	17.6	7.7	5.6	11.8	21.6	8.4	6.2	12.9	26.0
56	6.4	4.9	10.0	15.7	7.1	5.5	11.2	19.5	7.9	6.0	12.4	23.8	8.6	6.7	13.5	28.7
58	6.6	5.3	10.6	17.5	7.3	5.9	11.8	21.5	8.1	6.5	13.0	26.3	8.8	7.1	14.2	31.3
60	6.8	5.9	11.3	19.9	7.5	6.4	12.5	24.0	8.3	7.1	13.8	29.5	9.0	7.7	15.0	34.7
62	7.2	6.4	12.1	23.0	7.9	7.1	13.4	28.0	8.8	7.7	14.7	33.8	9.5	8.4	16.0	40.0
64	7.6	7.0	13.0	26.6	8.4	7.7	14.4	32.4	9.3	8.5	15.9	39.5	10.0	9.3	17.2	46.5
66	8.0	7.9	14.3	31.4	8.9	8.8	16.0	39.0	9.8	9.7	17.6	47.2	10.6	10.5	19.0	55.5
68	9.0	9.3	16.5	41.9	10.0	10.3	18.3	51.5	11.0	10.4	20.2	52.0	12.0	12.4	22.0	74.5
70	----	9.7	16.9	43.6	----	10.8	18.8	54.0	----	11.9	20.7	65.5	----	12.9	22.5	77.5
72	----	10.1	17.3	45.4	----	11.3	19.2	56.5	----	12.4	21.2	68.2	----	13.5	23.1	81.0
74	----	10.5	17.7	47.3	----	11.7	19.7	58.5	----	12.9	21.7	71.0	----	14.1	23.6	84.5
76	----	11.0	18.2	49.5	----	12.3	20.2	61.5	----	13.5	22.3	74.3	----	14.8	24.3	89.0
78	----	11.5	18.7	51.8	----	12.8	20.8	64.0	----	14.1	22.9	77.5	----	15.3	24.9	92.0
80	----	12.0	19.2	54.0	----	13.4	21.4	67.0	----	14.7	23.5	81.0	----	16.0	25.6	96.0
82	----	12.5	19.7	56.3	----	13.9	21.9	69.5	----	15.3	24.1	84.0	----	16.7	26.3	100.0
84	----	13.0	20.2	58.5	----	14.5	22.5	72.5	----	15.9	24.7	87.5	----	17.4	27.0	104.5
86	----	13.6	20.8	61.1	----	15.1	23.1	75.5	----	16.6	25.5	91.0	----	18.1	27.3	108.5
88	----	14.1	21.4	63.5	----	15.7	23.8	78.5	----	17.3	26.2	95.0	----	18.9	28.5	113.5
90	----	14.7	22.0	66.1	----	16.4	24.5	82.0	----	18.0	26.9	99.0	----	19.7	29.3	119.0
92	----	15.3	22.6	69.0	----	17.0	25.1	85.0	----	18.7	27.7	103.0	----	20.4	30.2	122.5
94	----	16.0	23.3	72.0	----	17.7	25.8	88.5	----	19.5	28.5	107.0	----	21.2	31.0	127.0
96	----	16.6	23.9	75.0	----	18.4	26.6	92.0	----	20.3	29.3	111.5	----	22.1	31.9	132.5
98	----	17.3	24.7	78.0	----	19.2	27.4	96.0	----	21.1	30.2	116.0	----	23.1	32.9	138.5
100	----	18.0	25.4	81.0	----	20.0	28.3	100.0	----	22.0	31.1	121.0	----	24.0	33.9	144.0

B=distance, in feet, cut into hillside from grade stake to toe of cut slope.
C=vertical cut, in feet, to be marked on cut stake.
S=distance along slope, to be measured from grade stake to cut stake.
A=area, in square feet, of cut section.
W=width of finished road.

SHRINKAGE FACTOR

Common

20 per cent for slopes 10 to 40 per cent.
30 per cent for slopes 40 to 66 per cent.

Solid rock

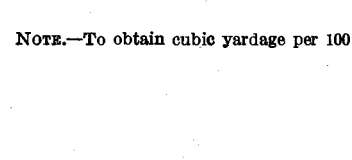
15 per cent for slopes 10 to 40 per cent.
10 per cent for slopes 40 to 66 per cent.

NOTE.—To obtain cubic yardage per 100 feet, multiply average end areas by 3.7.

SLOPE STAKE AND AREA TABLES

[For use on Forest Service minor roads] **CUT SLOPE ½:1**

Slope %	Width of finished road															
	13				14				15				16			
	B	C	S	A	B	C	S	A	B	C	S	A	B	C	S	A
10	7.0	0.7	7.4	2.6	7.5	0.8	8.0	3.0	8.0	0.9	8.6	3.4	8.6	0.9	9.1	3.9
12	7.0	0.9	7.6	3.2	7.5	1.0	8.1	3.7	8.1	1.0	8.7	4.3	8.6	1.1	9.3	4.8
14	7.1	1.1	7.7	3.8	7.6	1.1	8.3	4.4	8.2	1.2	8.9	5.2	8.7	1.3	9.4	5.7
16	7.1	1.2	7.8	4.4	7.6	1.3	8.4	5.1	8.2	1.4	9.0	6.1	8.7	1.5	9.6	6.7
18	7.2	1.4	8.0	5.1	7.7	1.5	8.6	5.8	8.3	1.6	9.2	7.0	8.8	1.7	9.8	7.7
20	7.2	1.6	8.2	5.8	7.7	1.7	8.7	6.6	8.3	1.9	9.4	7.9	8.8	2.0	10.0	8.7
22	7.3	1.8	8.3	6.6	7.7	1.9	8.9	7.5	8.4	2.1	9.6	8.9	8.9	2.2	10.2	9.8
24	7.3	2.0	8.5	7.4	7.8	2.1	9.1	8.4	8.5	2.3	9.8	9.9	8.9	2.4	10.4	11.0
26	7.4	2.2	8.7	8.2	7.8	2.5	9.3	9.3	8.5	2.5	10.0	11.0	9.0	2.7	10.6	12.2
28	7.4	2.4	8.9	9.0	7.9	2.6	9.6	10.3	8.6	2.8	10.3	12.2	9.0	2.9	10.9	13.4
30	7.5	2.7	9.2	9.9	8.0	2.8	9.8	11.3	8.6	3.1	10.6	13.2	9.1	3.2	11.2	14.6
32	7.6	2.9	9.4	11.0	8.1	3.1	10.1	12.6	8.7	3.3	10.8	14.7	9.2	3.5	11.5	16.2
34	7.7	3.1	9.7	12.1	8.2	3.3	10.4	13.9	8.8	3.6	11.1	16.2	9.3	3.8	11.8	17.9
36	7.7	3.4	9.9	13.2	8.3	3.6	10.7	15.3	8.9	3.9	11.5	17.7	9.4	4.1	12.1	19.6
38	7.8	3.7	10.2	14.4	8.4	3.9	11.0	16.7	9.0	4.2	11.8	19.2	9.5	4.5	12.5	21.3
40	7.9	4.0	10.6	15.6	8.5	4.3	11.4	18.1	9.1	4.6	12.2	20.7	9.6	4.8	12.9	23.0
42	8.0	4.2	10.9	16.8	8.6	4.5	11.7	19.3	9.2	4.9	12.6	22.5	9.8	5.2	13.4	25.5
44	8.2	4.6	11.3	18.9	8.8	4.9	12.2	21.5	9.4	5.3	13.1	25.0	10.0	5.6	13.9	28.0
46	8.3	4.9	11.8	20.3	8.9	5.3	12.7	23.6	9.6	5.7	13.6	27.3	10.2	6.0	14.0	31.0
48	8.5	5.3	12.2	22.5	9.1	5.7	13.2	26.0	9.8	6.2	14.2	30.4	10.4	6.5	15.0	33.8
50	8.6	5.8	12.8	24.8	9.3	6.2	13.9	28.8	10.0	6.7	14.9	33.4	10.6	7.1	15.8	37.5
52	8.8	6.2	13.3	27.3	9.5	6.6	14.4	31.3	10.2	7.2	15.5	36.2	10.8	7.6	16.4	41.0
54	9.0	6.6	13.9	29.6	9.7	7.1	15.0	34.5	10.4	7.7	16.1	40.0	11.0	8.1	17.1	44.5
56	9.2	7.1	14.5	32.7	9.9	7.7	15.7	38.1	10.6	8.2	16.8	43.4	11.3	8.7	17.8	49.1
58	9.4	7.7	15.3	36.3	10.2	8.3	16.5	42.3	10.9	8.9	17.7	48.5	11.6	9.3	18.7	54.0
60	9.7	8.3	16.2	40.3	10.5	9.0	17.5	47.2	11.2	9.6	18.7	53.8	11.9	10.2	19.8	60.7
62	10.3	9.1	17.2	47.0	11.1	9.8	18.6	54.5	11.9	10.5	19.9	62.5	12.6	11.2	21.0	70.5
64	10.9	10.0	18.5	54.5	11.7	10.8	20.0	63.3	12.6	11.5	21.4	72.5	13.3	12.3	22.7	81.8
66	11.4	11.2	20.4	64.0	12.4	12.2	22.2	76.0	13.3	13.1	23.8	87.0	14.1	13.9	25.2	98.0
68	13.0	13.4	23.8	87.0	14.0	14.5	25.7	101.5	15.0	15.3	27.5	115.0	16.0	16.5	29.4	132.0
70	----	14.0	24.4	91.0	----	15.1	26.3	105.5	----	16.2	28.2	121.5	----	17.3	30.1	138.0
72	----	14.6	25.0	96.0	----	15.7	26.9	110.0	----	16.9	28.9	127.0	----	18.0	30.8	144.0
74	----	15.2	25.6	99.0	----	16.4	27.6	115.0	----	17.6	29.6	132.0	----	18.8	31.6	150.0
76	----	15.9	26.3	103.5	----	17.1	28.3	119.5	----	18.4	30.3	138.0	----	19.6	32.4	156.5
78	----	16.6	27.0	108.0	----	17.9	29.1	125.0	----	19.2	31.2	144.0	----	20.5	33.3	162.4
80	----	17.3	27.7	112.5	----	18.7	29.9	131.0	----	20.0	32.0	150.0	----	21.4	34.2	171.0
82	----	18.1	28.5	117.5	----	19.5	30.7	136.5	----	20.9	32.9	157.0	----	22.3	35.1	178.0
84	----	18.8	29.2	122.0	----	20.2	31.5	141.5	----	21.7	33.7	163.0	----	23.2	36.0	185.5
86	----	19.6	30.0	127.5	----	21.1	32.3	147.5	----	22.6	34.7	169.5	----	24.2	37.0	193.5
88	----	20.4	30.9	132.5	----	22.0	33.3	154.0	----	23.6	35.7	177.0	----	25.2	38.0	201.5
90	----	21.3	31.8	138.5	----	22.9	34.2	160.0	----	24.6	36.7	184.5	----	26.2	39.2	210.0
92	----	22.1	32.6	143.5	----	23.8	35.2	166.5	----	25.6	37.7	192.0	----	27.2	40.2	217.5
94	----	23.0	33.6	149.5	----	24.8	36.2	173.5	----	26.6	38.8	199.5	----	28.3	41.4	226.0
96	----	23.9	34.6	155.5	----	25.8	37.2	180.5	----	27.7	39.9	207.5	----	29.5	42.5	236.0
98	----	25.0	35.6	162.5	----	26.9	38.4	188.0	----	28.8	41.1	216.0	----	30.7	43.9	246.0
100	----	26.0	36.8	169.0	----	28.0	39.6	196.0	----	30.0	42.4	225.0	----	32.0	45.3	256.0



B=distance, in feet, cut into hillside from grade stake to toe of cut slope.
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W=width of finished road.

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20 per cent for slopes 10 to 40 per cent.
30 per cent for slopes 40 to 66 per cent.

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10 per cent for slopes 40 to 66 per cent.

NOTE.—To obtain cubic yardage per 100 feet, multiply average end areas by 3.7.

SLOPE STAKE AND AREA TABLES

[For use on Forest Service minor roads] **CUT SLOPE ¼:1**

Slope, %	Width of finished road															
	9				10				11				12			
	B	C	S	A	B	C	S	A	B	C	S	A	B	C	S	A
10	4.8	0.5	5.0	1.2	5.3	0.5	5.5	1.5	5.9	0.6	6.1	1.8	6.4	0.7	6.7	2.1
12	4.8	0.6	5.0	1.4	5.3	0.7	5.5	1.8	5.9	0.7	6.2	2.2	6.4	0.8	6.7	2.6
14	4.9	0.7	5.1	1.7	5.4	0.8	5.6	2.1	6.0	0.9	6.2	2.6	6.5	1.0	6.8	3.1
16	4.9	0.8	5.2	2.0	5.4	0.9	5.7	2.5	6.0	1.0	6.3	3.0	6.5	1.1	7.0	3.6
18	5.0	1.0	5.3	2.3	5.5	1.0	5.8	2.9	6.1	1.2	6.4	3.4	6.6	1.3	7.1	4.1
20	5.0	1.0	5.4	2.6	5.5	1.2	5.9	3.3	6.1	1.3	6.6	3.9	6.7	1.4	7.2	4.7
22	5.0	1.2	5.5	2.9	5.5	1.3	6.0	3.7	6.1	1.4	6.7	4.4	6.7	1.6	7.3	5.3
24	5.1	1.3	5.6	3.3	5.6	1.4	6.1	4.1	6.2	1.6	6.8	4.9	6.8	1.8	7.5	5.9
26	5.1	1.4	5.7	3.7	5.6	1.6	6.3	4.5	6.2	1.8	6.9	5.5	6.8	1.9	7.6	6.5
28	5.2	1.6	5.8	4.1	5.7	1.7	6.4	5.0	6.3	1.9	7.1	6.1	6.9	2.1	7.7	7.2
30	5.3	1.7	6.0	4.5	5.8	1.9	6.5	5.5	6.4	2.1	7.2	6.7	7.0	2.3	7.9	7.9
32	5.4	1.9	6.1	5.0	5.8	2.0	6.7	6.0	6.4	2.3	7.4	7.4	7.1	2.5	8.1	8.7
34	5.4	2.0	6.2	5.5	5.9	2.2	6.8	6.5	6.5	2.4	7.6	8.1	7.2	2.7	8.2	9.5
36	5.5	2.2	6.4	6.0	5.9	2.4	7.0	7.1	6.6	2.6	7.7	8.8	7.2	2.9	8.4	10.4
38	5.5	2.3	6.5	6.5	6.0	2.5	7.1	7.7	6.7	2.8	7.9	9.5	7.3	3.1	8.6	11.3
40	5.6	2.5	6.7	7.0	6.1	2.7	7.3	8.3	6.8	3.0	8.1	10.2	7.4	3.3	8.9	12.2
42	5.7	2.7	6.8	7.6	6.2	2.9	7.5	9.0	6.9	3.2	8.3	11.0	7.5	3.5	9.1	13.1
44	5.7	2.8	7.0	8.2	6.3	3.1	7.7	9.7	7.0	3.4	8.5	11.9	7.6	3.8	9.4	14.4
46	5.8	3.0	7.2	8.8	6.4	3.3	7.9	10.8	7.1	3.7	8.8	13.1	7.7	4.0	9.6	15.4
48	5.9	3.2	7.4	9.5	6.5	3.5	8.2	11.3	7.2	3.9	9.0	14.1	7.8	4.3	9.9	16.8
50	6.0	3.4	7.7	10.2	6.6	3.8	8.5	12.6	7.3	4.2	9.3	15.3	8.0	4.6	10.2	18.4
52	6.1	3.6	7.9	11.0	6.7	4.0	8.7	13.4	7.5	4.5	9.7	16.9	8.2	4.9	10.5	20.1
54	6.3	3.9	8.2	12.3	6.9	4.3	9.1	14.8	7.7	4.8	10.0	18.5	8.4	5.2	10.9	21.8
56	6.4	4.2	8.5	13.5	7.1	4.6	9.4	16.3	7.9	5.1	10.4	20.1	8.6	5.6	11.3	24.1
58	6.6	4.5	8.9	14.8	7.3	4.9	9.8	17.8	8.1	5.4	10.8	21.4	8.8	5.9	11.8	26.0
60	6.8	4.8	9.3	16.3	7.5	5.3	10.3	19.9	8.3	5.9	11.3	24.4	9.0	6.4	12.4	28.8
62	7.2	5.2	9.9	18.2	7.9	5.8	10.9	23.3	8.8	6.3	12.0	27.8	9.5	6.9	13.1	32.8
64	7.6	5.7	10.5	20.7	8.4	6.3	11.6	26.5	9.3	6.9	12.8	32.1	10.1	7.5	14.0	38.4
66	8.0	6.3	11.5	25.2	8.9	7.0	12.8	31.1	9.8	7.8	14.0	38.2	10.7	8.5	15.4	45.4
68	9.0	7.4	13.1	33.3	10.0	8.2	14.6	41.0	11.0	9.0	16.0	49.5	12.0	9.8	17.5	54.0
70	----	7.6	13.3	34.2	----	8.5	14.8	42.5	----	9.3	16.3	51.5	----	10.2	17.7	61.3
72	----	7.9	13.5	35.6	----	8.8	15.0	44.0	----	9.8	16.5	54.0	----	10.5	18.0	63.0
74	----	8.2	13.7	36.9	----	9.1	15.2	45.5	----	10.0	16.8	55.0	----	10.9	18.3	65.5
76	----	8.4	14.0	37.6	----	9.4	15.5	47.0	----	10.3	17.0	56.5	----	11.2	18.6	67.0
78	----	8.7	14.2	39.2	----	9.7	15.8	48.5	----	10.7	17.3	59.0	----	11.6	18.9	69.5
80	----	9.0	14.4	40.5	----	10.0	16.0	50.0	----	11.0	17.6	60.5	----	12.0	19.2	72.0
82	----	9.3	14.7	41.9	----	10.3	16.3	51.5	----	11.3	17.9	62.0	----	12.4	19.5	74.5
84	----	9.6	14.9	43.2	----	10.6	16.5	53.0	----	11.7	18.2	64.5	----	12.7	19.8	76.3
86	----	9.9	15.1	44.5	----	11.0	16.8	55.0	----	12.1	18.5	66.5	----	13.1	20.1	78.5
88	----	10.2	15.4	45.9	----	11.3	17.1	56.5	----	12.4	18.8	68.3	----	13.5	20.5	81.0
90	----	10.5	15.6	47.3	----	11.6	17.4	58.0	----	12.8	19.1	70.5	----	13.9	20.8	83.5
92	----	10.8	15.9	48.5	----	12.0	17.6	60.0	----	13.1	19.4	72.0	----	14.3	21.1	86.0
94	----	11.1	16.1	49.9	----	12.3	17.9	61.5	----	13.5	19.7	74.3	----	14.7	21.5	88.0
96	----	11.4	16.4	51.3	----	12.6	18.2	63.0	----	13.9	20.0	76.5	----	15.1	21.8	90.5
98	----	11.7	16.8	52.6	----	13.0	18.5	65.0	----	14.3	20.4	78.5	----	15.6	22.2	93.5
100	----	12.0	17.0	54.0	----	13.4	18.9	67.0	----	14.8	20.8	81.5	----	16.0	22.7	96.0

B = distance, in feet, cut into hillside from grade stake to toe of cut slope.
C = vertical cut, in feet, to be marked on cut stake.
S = distance along slope, to be measured from grade stake to cut stake.
A = area, in square feet, of cut section.
W = width of finished road.

SHRINKAGE FACTOR

Common

20 per cent for slopes 10 to 40 per cent.
30 per cent for slopes 40 to 66 per cent.

Solid rock

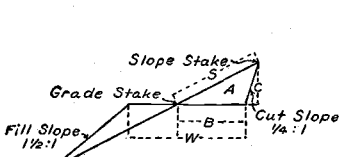
15 per cent for slopes 10 to 40 per cent.
10 per cent for slopes 40 to 66 per cent.

NOTE.—To obtain cubic yardage per 100 feet, multiply average end areas by 3.7.

SLOPE STAKE AND AREA TABLES

[For use on Forest Service minor roads] **CUT SLOPE ¼:1**

Slope %	Width of finished road															
	13				14				15				16			
	B	C	S	A	B	C	S	A	B	C	S	A	B	C	S	A
10	7.0	0.7	7.2	4.9	7.5	0.8	7.7	2.8	8.0	0.8	8.2	3.2	8.5	0.9	8.8	3.8
12	7.0	0.9	7.3	5.0	7.5	1.0	7.8	3.5	8.0	1.0	8.4	4.0	8.5	1.1	8.9	4.7
14	7.1	1.0	7.4	5.1	7.6	1.1	8.0	4.2	8.1	1.2	8.5	4.8	8.6	1.3	9.0	5.6
16	7.1	1.2	7.5	5.2	7.6	1.2	8.1	4.9	8.1	1.4	8.6	5.7	8.6	1.5	9.2	6.5
18	7.2	1.4	7.7	5.3	7.7	1.5	8.2	5.6	8.2	1.6	8.8	6.5	8.7	1.7	9.3	7.4
20	7.3	1.5	7.8	5.5	7.8	1.7	8.4	6.4	8.3	1.8	8.9	7.4	8.8	1.9	9.5	8.3
22	7.3	1.7	7.9	6.2	7.8	1.8	8.5	7.3	8.3	2.0	9.1	8.2	8.9	2.1	9.7	9.4
24	7.4	1.9	8.1	6.9	7.9	2.0	8.7	8.2	8.4	2.2	9.2	9.2	9.0	2.3	9.8	10.5
26	7.4	2.1	8.2	7.7	8.0	2.2	8.8	9.1	8.5	2.4	9.4	10.2	9.1	2.5	10.0	11.6
28	7.5	2.3	8.4	8.5	8.1	2.4	9.0	10.1	8.6	2.6	9.6	11.2	9.2	2.8	10.2	12.8
30	7.6	2.5	8.6	9.3	8.2	2.7	9.2	11.1	8.7	2.8	9.8	12.2	9.3	3.0	10.4	14.0
32	7.7	2.7	8.8	10.2	8.2	2.9	9.4	11.9	8.8	3.1	10.0	13.5	9.4	3.3	10.7	15.5
34	7.8	2.9	9.0	11.2	8.3	3.1	9.6	12.9	8.9	3.3	10.2	14.8	9.5	3.5	10.9	16.6
36	7.8	3.1	9.2	12.3	8.4	3.3	9.8	13.9	9.0	3.6	10.5	16.2	9.6	3.8	11.1	18.3
38	7.9	3.3	9.4	13.4	8.5	3.6	10.0	15.3	9.1	3.8	10.7	17.5	9.7	4.1	11.4	19.9
40	8.0	3.6	9.6	14.4	8.6	3.8	10.3	16.4	9.2	4.1	11.0	18.9	9.8	4.4	11.7	21.6
42	8.1	3.8	9.8	15.4	8.7	4.1	10.5	17.5	9.3	4.4	11.3	20.5	9.9	4.7	12.0	23.3
44	8.2	4.1	10.1	16.8	8.9	4.4	10.8	19.6	9.5	4.7	11.6	22.3	10.1	5.0	12.4	25.3
46	8.3	4.3	10.3	17.9	9.0	4.7	11.1	21.2	9.6	5.0	12.0	24.0	10.2	5.3	12.7	27.0
48	8.4	4.6	10.6	19.3	9.2	5.0	11.5	23.0	9.8	5.3	12.4	26.0	10.4	5.7	13.1	29.6
50	8.6	5.0	11.0	21.6	9.3	5.3	11.9	24.6	10.0	5.7	12.8	28.5	10.6	6.1	13.5	32.3
52	8.8	5.2	11.3	22.9	9.5	5.7	12.3	27.1	10.2	6.1	13.2	31.1	10.8	6.5	14.0	35.1
54	9.0	5.6	11.8	25.2	9.8	6.0	12.7	29.4	10.4	6.5	13.7	33.8	11.0	6.9	14.5	37.9
56	9.2	6.0	12.2	27.6	10.0	6.4	13.2	32.0	10.7	6.9	14.2	36.9	11.3	7.3	15.0	41.3
58	9.4	6.4	12.8	30.1	10.3	6.9	13.7	35.5	11.0	7.4	14.8	40.7	11.6	7.8	15.6	45.3
60	9.7	6.9	13.3	33.5	10.5	7.4	14.4	38.8	11.3	8.0	15.5	45.2	11.9	8.6	16.4	50.0
62	10.3	7.4	14.0	38.1	11.1	8.1	15.3	45.0	11.9	8.6	16.4	51.0	12.6	9.1	17.2	57.5
64	10.9	8.1	15.0	44.1	11.8	8.7	16.3	51.0	12.6	9.4	17.5	59.3	13.3	9.9	18.5	66.0
66	11.6	9.2	16.7	53.5	12.5	9.9	18.0	62.0	13.3	10.5	19.1	70.0	14.1	11.1	20.2	78.5
68	13.0	10.7	18.9	69.5	14.0	11.4	20.2	80.0	15.0	12.3	21.9	92.0	16.0	13.1	23.3	104.0
70	----	11.0	19.2	71.5	----	11.9	20.7	83.5	----	12.7	22.2	94.5	----	13.6	23.7	109.0
72	----	11.4	19.5	74.0	----	12.3	21.0	86.0	----	13.2	22.5	99.0	----	14.0	24.0	112.0
74	----	11.8	19.8	76.5	----	12.7	21.4	89.0	----	12.6	22.9	102.0	----	14.5	24.4	116.0
76	----	12.2	20.1	79.0	----	13.1	21.7	92.0	----	14.1	23.3	106.0	----	15.0	24.8	120.0
78	----	12.6	20.5	82.0	----	13.6	22.0	95.0	----	14.6	23.6	109.5	----	15.5	25.2	124.0
80	----	13.0	20.8	84.5	----	14.0	22.4	98.0	----	15.0	24.0	112.5	----	16.0	25.7	128.0
82	----	13.4	21.1	87.0	----	14.5	22.8	101.0	----	15.5	24.4	116.5	----	16.5	26.0	132.0
84	----	13.8	21.5	89.5	----	14.9	23.1	104.0	----	16.0	24.8	120.0	----	17.0	26.5	136.0
86	----	14.2	21.8	92.5	----	15.3	23.5	107.0	----	16.5	25.2	124.0	----	17.5	26.9	140.0
88	----	14.7	22.2	95.5	----	15.8	23.9	110.5	----	17.0	25.6	127.5	----	18.1	27.3	145.0
90	----	15.1	22.6	98.0	----	16.3	24.3	114.0	----	17.4	26.1	130.5	----	18.6	27.8	149.0
92	----	15.5	23.0	101.0	----	16.8	24.7	117.5	----	18.0	25.5	135.0	----	19.1	28.2	153.0
94	----	16.0	23.3	104.0	----	17.2	25.1	120.5	----	18.4	26.9	138.0	----	19.7	28.7	157.5
96	----	16.4	23.6	106.5	----	17.7	25.5	124.0	----	18.9	27.3	142.0	----	20.2	29.1	161.5
98	----	16.9	24.1	110.0	----	18.2	25.9	127.5	----	19.5	27.8	146.0	----	20.8	29.6	166.0
100	----	17.3	24.5	112.5	----	18.7	26.4	131.0	----	20.0	28.3	150.0	----	21.4	30.3	171.0



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20 per cent for slopes 10 to 40 per cent.
30 per cent for slopes 40 to 66 per cent.

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15 per cent for slopes 10 to 40 per cent.
10 per cent for slopes 40 to 66 per cent.

NOTE.—To obtain cubic yardage per 100 feet, multiply average end areas by 3.7

VOLUME TABLES

Cubic yards for sum of end areas 100 feet apart

1,200	1,100	1,000	900	800	700	600	500	400	300	200	100	00	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
648	594	540	486	432	378	324	270	216	162	108	54	0	0.00	0.19	0.37	0.56	0.74	0.93	1.11	1.30	1.48	1.67
649	595	541	487	433	379	325	271	217	163	109	55	1	1.85	2.04	2.22	2.41	2.59	2.78	2.96	3.15	3.33	3.52
650	596	542	488	434	380	326	272	218	164	110	56	2	3.70	3.89	4.07	4.26	4.44	4.63	4.81	5.00	5.19	5.37
651	597	543	489	435	381	327	273	219	165	111	57	3	5.56	5.74	5.93	6.11	6.30	6.48	6.67	6.85	7.04	7.22
652	598	544	490	436	382	328	274	220	166	112	58	4	7.41	7.59	7.78	7.96	8.15	8.33	8.52	8.70	8.89	9.07
653	599	545	491	437	383	329	275	221	167	113	59	5	9.26	9.44	9.63	9.81	10.00	10.19	10.37	10.56	10.74	10.93
654	600	546	492	438	384	330	276	222	168	114	60	6	11.11	11.30	11.48	11.67	11.85	12.04	12.22	12.41	12.59	12.78
655	601	547	493	439	385	331	277	223	169	115	61	7	12.96	13.15	13.33	13.52	13.70	13.89	14.07	14.26	14.44	14.63
656	602	548	494	440	386	332	278	224	170	116	62	8	14.81	15.00	15.19	15.37	15.56	15.74	15.93	16.11	16.30	16.48
657	603	549	495	441	387	333	279	225	171	117	63	9	16.67	16.85	17.04	17.22	17.41	17.59	17.78	17.96	18.15	18.33
658	604	550	496	442	388	334	280	226	172	118	64	10	18.52	18.70	18.89	19.07	19.26	19.44	19.63	19.81	20.00	20.19
659	605	551	497	443	389	335	281	227	173	119	65	11	20.37	20.56	20.74	20.93	21.11	21.30	21.48	21.67	21.85	22.04
660	606	552	498	444	390	336	282	228	174	120	66	12	22.22	22.41	22.59	22.78	22.96	23.15	23.33	23.52	23.70	23.89
661	607	553	499	445	391	337	283	229	175	121	67	13	24.07	24.26	24.44	24.63	24.81	25.00	25.19	25.37	25.56	25.74
662	608	554	500	446	392	338	284	230	176	122	68	14	25.93	26.11	26.30	26.48	26.67	26.85	27.04	27.22	27.41	27.59
663	609	555	501	447	393	339	285	231	177	123	69	15	27.78	27.96	28.15	28.33	28.52	28.70	28.89	29.07	29.26	29.44
664	610	556	502	448	394	340	286	232	178	124	70	16	29.63	29.81	30.00	30.19	30.37	30.56	30.74	30.93	31.11	31.30
665	611	557	503	449	395	341	287	233	179	125	71	17	31.48	31.67	31.85	32.04	32.22	32.41	32.59	32.78	32.96	33.15
666	612	558	504	450	396	342	288	234	180	126	72	18	33.33	33.52	33.70	33.89	34.07	34.26	34.44	34.63	34.81	35.00
667	613	559	505	451	397	343	289	235	181	127	73	19	35.19	35.37	35.56	35.74	35.93	36.11	36.30	36.48	36.67	36.85
668	614	560	506	452	398	344	290	236	182	128	74	20	37.04	37.22	37.41	37.59	37.78	37.96	38.15	38.33	38.52	38.70
669	615	561	507	453	399	345	291	237	183	129	75	21	38.89	39.07	39.26	39.44	39.63	39.81	40.00	40.19	40.37	40.56
670	616	562	508	454	400	346	292	238	184	130	76	22	40.74	40.93	41.11	41.30	41.48	41.67	41.85	42.04	42.22	42.41
671	617	563	509	455	401	347	293	239	185	131	77	23	42.59	42.78	42.96	43.15	43.33	43.52	43.70	43.89	44.07	44.26
672	618	564	510	456	402	348	294	240	186	132	78	24	44.44	44.63	44.81	45.00	45.19	45.37	45.56	45.74	45.93	46.11
673	619	565	511	457	403	349	295	241	187	133	79	25	46.30	46.48	46.67	46.85	47.04	47.22	47.41	47.59	47.78	47.96
674	620	566	512	458	404	350	296	242	188	134	80	26	48.15	48.33	48.52	48.70	48.89	49.07	49.26	49.44	49.63	49.81
675	621	567	513	459	405	351	297	243	189	135	81	27	50.00	50.19	50.37	50.56	50.74	50.93	51.11	51.30	51.48	51.67
676	622	568	514	460	406	352	298	244	190	136	82	28	51.85	52.04	52.22	52.41	52.59	52.78	52.96	53.15	53.33	53.52
677	623	569	515	461	407	353	299	245	191	137	83	29	53.70	53.89	54.07	54.26	54.44	54.63	54.81	55.00	55.19	55.37

2,000 square foot end areas=3,703.70 cubic yards.
3,000 square foot end areas=5,555.56 cubic yards.
4,000 square foot end areas=7,407.41 cubic yards.
5,000 square foot end areas=9,259.26 cubic yards.

EXAMPLE.—To find cubic yards in 100-foot station (423.6 sum of end areas):

Heading of column in which 423 is found	700
To right of 423 and in column headed 0.6; reading is	84.44
Total	784.44

Cubic yards for sum of end areas 100 feet apart

1,200	1,100	1,000	900	800	700	600	500	400	300	200	100	00	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
678	624	570	516	462	408	354	300	246	192	138	84	30	55.56	55.74	55.93	56.11	56.30	56.48	56.67	56.85	57.04	57.22
679	625	571	517	463	409	355	301	247	193	139	85	31	57.41	57.59	57.78	57.96	58.15	58.33	58.52	58.70	58.89	59.07
680	626	572	518	464	410	356	302	248	194	140	86	32	59.26	59.44	59.63	59.81	60.00	60.19	60.37	60.56	60.74	60.93
681	627	573	519	465	411	357	303	249	195	141	87	33	61.11	61.30	61.48	61.67	61.85	62.04	62.22	62.41	62.59	62.78
682	628	574	520	466	412	358	304	250	196	142	88	34	62.96	63.15	63.33	63.52	63.70	63.89	64.07	64.26	64.44	64.63
683	629	575	521	467	413	359	305	251	197	143	89	35	64.81	65.00	65.19	65.37	65.56	65.74	65.93	66.11	66.30	66.48
684	630	576	522	468	414	360	306	252	198	144	90	36	66.67	66.85	67.04	67.22	67.41	67.59	67.78	67.96	68.15	68.33
685	631	577	523	469	415	361	307	253	199	145	91	37	68.52	68.70	68.89	69.07	69.26	69.44	69.63	69.81	70.00	70.19
686	632	578	524	470	416	362	308	254	200	146	92	38	70.37	70.56	70.74	70.93	71.11	71.30	71.48	71.67	71.85	72.04
687	633	579	525	471	417	363	309	255	201	147	93	39	72.22	72.41	72.59	72.78	72.96	73.15	73.33	73.52	73.70	73.89
688	634	580	526	472	418	364	310	256	202	148	94	40	74.07	74.26	74.44	74.63	74.81	75.00	75.19	75.37	75.56	75.74
689	635	581	527	473	419	365	311	257	203	149	95	41	75.93	76.11	76.30	76.48	76.67	76.85	77.04	77.22	77.41	77.59
690	636	582	528	474	420	366	312	258	204	150	96	42	77.78	77.96	78.15	78.33	78.52	78.70	78.89	79.07	79.26	79.44
691	637	583	529	475	421	367	313	259	205	151	97	43	79.63	79.81	80.00	80.19	80.37	80.56	80.74	80.93	81.11	81.30
692	638	584	530	476	422	368	314	260	206	152	98	44	81.48	81.67	81.85	82.04	82.22	82.41	82.59	82.78	82.96	83.15
693	639	585	531	477	423	369	315	261	207	153	99	45	83.33	83.52	83.70	83.89	84.07	84.26	84.44	84.63	84.81	85.00
694	640	586	532	478	424	370	316	262	208	154	100	46	85.19	85.37	85.56	85.74	85.93	86.11	86.30	86.48	86.67	86.85
695	641	587	533	479	425	371	317	263	209	155	101	47	87.04	87.22	87.41	87.59	87.78	87.96	88.15	88.33	88.52	88.70
696	642	588	534	480	426	372	318	264	210	156	102	48	88.89	89.07	89.26	89.44	89.63	89.81	90.00	90.19	90.37	90.56
697	643	589	535	481	427	373	319	265	211	157	103	49	90.74	90.93	91.11	91.30	91.48	91.67	91.85	92.04	92.22	92.41
698	644	590	536	482	428	374	320	266	212	158	104	50	92.59	92.78	92.96	93.15	93.33	93.52	93.70	93.89	94.07	94.26
699	645	591	537	483	429	375	321	267	213	159	105	51	94.44	94.63	94.81	95.00	95.19	95.37	95.56	95.74	95.93	96.11
700	646	592	538	484	430	376	322	268	214	160	106	52	96.30	96.48	96.67	96.85	97.04	97.22	97.41	97.59	97.78	97.96
701	647	593	539	485	431	377	323	269	215	161	107	53	98.15	98.33	98.52	98.70	98.89	99.07	99.26	99.44	99.63	99.81

2,000 square foot end areas=3,703.70 cubic yards.
3,000 square foot end areas=5,555.56 cubic yards.
4,000 square foot end areas=7,407.41 cubic yards.
5,000 square foot end areas=9,259.26 cubic yards.

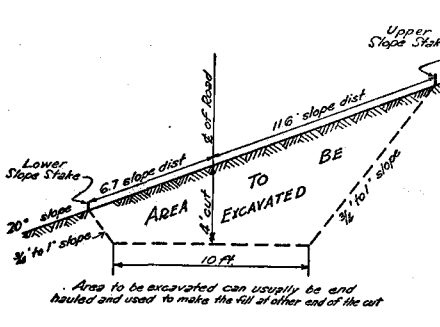
EXAMPLE.—To find cubic yards in 100-foot station (423.6 sum of end areas):

Heading of column in which 423 is found	700
To right of 423 and in column headed 0.6; reading is	84.44
Total	784.44

TABLE TO BE USED FOR SETTING SLOPE STAKES IN THROUGH CUTS

Distance to upper slope stake from ℄ stake															
Cut at	Slope Angles 0° to 30°														
Center-Ft.	0°	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°
0																
1.0	5.7	5.8	6.0	6.3	6.5	6.7	7.0	7.2	7.5	7.9	*8.3	8.9	9.8	10.0	10.8	11.7
1.5	6.1	6.3	6.5	6.7	6.9	7.1	7.5	7.7	8.0	8.5	9.0	9.5	10.0	10.6	11.5	12.5
2.0	6.5	6.6	6.8	7.0	7.3	7.6	7.9	8.3	8.5	9.0	9.5	10.0	10.6	11.5	12.2	13.3
2.5	6.9	7.0	7.2	7.5	7.7	8.0	8.3	8.6	9.0	9.5	10.0	10.5	11.2	12.0	13.0	14.0
3.0	7.3	7.4	7.6	8.0	8.2	8.5	8.8	9.0	9.5	10.0	10.5	11.1	11.8	12.6	13.7	14.9
3.5	7.5	7.8	8.0	8.3	8.6	8.9	9.2	9.5	10.0	10.5	11.0	11.7	12.5	13.3	14.4	15.5
4.0	7.9	8.2	8.5	8.7	9.0	9.4	9.7	10.0	10.6	11.0	11.6	12.4	13.2	14.0	15.1	16.4
4.5	8.3	8.6	8.8	9.0	9.5	9.8	10.2	10.6	11.0	11.6	12.2	13.0	13.7	14.7	15.8	17.1
5.0	8.7	9.0	9.3	9.6	10.0	10.2	10.6	11.0	11.6	12.1	12.8	13.5	14.4	15.3	16.5	18.0
5.5	9.1	9.4	9.6	10.0	10.3	10.6	11.0	11.5	12.0	12.6	13.4	14.1	15.0	16.0	17.2	18.7
6.0	9.5	9.8	10.1	10.4	10.7	11.1	11.5	12.0	12.5	13.2	14.0	14.7	15.6	16.8	18.0	19.4
6.5	9.8	10.1	10.5	10.8	11.1	11.5	12.0	12.5	13.0	13.6	14.5	15.3	16.2	17.3	18.6	20.1
7.0	10.2	10.5	10.8	11.2	11.6	12.0	12.5	13.0	13.5	14.2	15.0	15.9	16.8	18.0	19.3	20.9
7.5	10.6	10.9	11.3	11.6	12.0	12.5	13.0	13.5	14.0	14.8	15.5	16.4	17.5	18.7	20.1	21.6
8.0	11.0	11.4	11.7	12.0	12.5	13.0	13.5	14.0	14.5	15.3	16.1	17.0	18.1	19.5	21.0	22.5
8.5	11.4	11.7	12.0	12.4	12.9	13.3	13.9	14.4	15.0	15.8	16.6	17.5	18.6	20.0	21.6	23.2
9.0	11.8	12.1	12.5	12.9	13.4	13.8	14.3	14.8	15.5	16.4	17.2	18.2	19.4	20.7	22.3	24.1
9.5	12.1	12.5	12.8	13.2	13.8	14.2	14.7	15.3	16.0	16.9	17.8	18.9	20.1	21.4	23.1	24.8
10.0	12.5	13.0	13.3	13.6	14.2	14.6	15.2	15.9	16.5	17.4	18.4	19.4	20.7	22.1	23.8	25.8
10.5	12.9	13.3	13.6	14.0	14.5	15.0	15.7	16.4	17.1	18.0	18.9	20.0	21.3	22.8	24.5	26.5
11.0	13.2	13.7	14.0	14.5	15.0	15.5	16.1	16.8	17.5	18.5	19.4	20.5	21.9	23.6	25.1	27.3
11.5	13.6	14.0	14.5	14.9	15.4	16.0	16.5	17.2	18.0	19.0	20.0	21.1	22.4	24.0	26.6	28.0
12.0	14.0	14.4	14.9	15.3	15.9	16.5	17.1	17.7	18.5	19.5	20.5	21.6	23.0	24.5	26.4	28.6

Distance to lower slope stake from ℄ stake															
0															
1.0	5.7	5.6	5.5	5.4	5.2	5.1	*4.8	*4.3	*3.6	*3.2	*2.9	*2.6	*2.4	*2.2	*2.1	*2.0
1.5	6.1	6.0	5.9	5.7	5.6	5.5	5.5	5.3	5.1	*4.8	*4.3	*4.0	*3.6	*3.4	*3.2	*3.0
2.0	6.5	6.3	6.2	6.0	5.9	5.8	5.7	5.6	5.5	5.5	*5.4	*5.1	*4.9	*4.5	*4.2	*4.0
2.5	6.9	6.7	6.5	6.4	6.3	6.2	6.1	6.0	5.9	5.8	5.7	5.7	5.6	*5.5	*5.3	*5.0
3.0	7.3	7.1	6.9	6.8	6.6	6.5	6.4	6.3	6.2	6.2	6.1	6.0	6.0	*5.9	*5.9	*5.9
3.5	7.5	7.4	7.2	7.0	6.9	6.8	6.7	6.6	6.5	6.4	6.4	6.3	6.2	6.2	6.1	6.1
4.0	7.9	7.8	7.6	7.5	7.3	7.2	7.0	7.0	6.9	6.8	6.8	6.6	6.6	6.5	6.5	6.5
4.5	8.3	8.2	8.0	7.8	7.6	7.5	7.4	7.3	7.1	7.0	7.0	7.0	6.9	6.8	6.7	6.7
5.0	8.7	8.5	8.3	8.2	8.0	7.9	7.7	7.5	7.4	7.4	7.3	7.1	7.1	7.1	7.1	7.0
5.5	9.1	8.9	8.7	8.5	8.3	8.2	8.0	7.9	7.8	7.7	7.6	7.5	7.5	7.4	7.4	7.4
6.0	9.5	9.3	9.1	8.8	8.6	8.5	8.4	8.2	8.1	8.0	8.0	7.9	7.9	7.7	7.7	7.6
6.5	9.8	9.6	9.4	9.2	9.0	8.9	8.7	8.6	8.5	8.4	8.2	8.1	8.0	8.0	8.0	8.0
7.0	10.2	10.0	9.7	9.5	9.4	9.2	9.0	8.9	8.7	8.6	8.5	8.5	8.4	8.3	8.3	8.2
7.5	10.6	10.3	10.1	9.9	9.7	9.5	9.4	9.2	9.1	9.0	8.9	8.8	8.7	8.6	8.6	8.5
8.0	11.0	10.7	10.5	10.2	10.0	9.9	9.7	9.6	9.4	9.3	9.2	9.1	9.0	9.0	8.9	8.9
8.5	11.4	11.1	10.8	10.6	10.4	10.2	10.0	9.9	9.7	9.6	9.5	9.4	9.4	9.2	9.2	9.1
9.0	11.8	11.5	11.2	10.9	10.7	10.6	10.4	10.2	10.1	10.0	9.8	9.7	9.6	9.6	9.5	9.5
9.5	12.1	11.8	11.5	11.3	11.1	10.8	10.7	10.5	10.4	10.2	10.1	10.0	10.0	9.9	9.8	9.7
10.0	12.5	12.2	11.9	11.6	11.4	11.2	11.0	10.9	10.7	10.6	10.5	10.4	10.3	10.2	10.1	10.1
10.5	12.9	12.6	12.3	12.0	11.8	11.6	11.4	11.2	11.0	10.9	10.8	10.6	10.6	10.5	10.5	10.4
11.0	13.2	12.9	12.6	12.3	12.1	11.9	11.7	11.5	11.3	11.2	11.1	11.0	10.9	10.8	10.7	10.6
11.5	13.6	13.3	13.0	12.7	12.5	12.2	12.0	11.8	11.6	11.5	11.4	11.3	11.2	11.1	11.0	11.0
12.0	14.0	13.6	13.3	13.0	12.8	12.5	12.3	12.1	12.0	11.9	11.7	11.6	11.5	11.4	11.3	11.3



Area to be excavated can usually be end hauled and used to make the fill at other end of the cut

Refer to table at the top of this sheet 4 Ft cut at the center on a 20° slope gives a slope distance of 116 Ft to slope stake on the up side, and 6.7 Ft. to Slope stake on the low side.

In case roadbed of 10 Ft is increased to include ditching etc, use the table as it is for 10 Ft roadbed, and increase horizontally from the slope stake the additional distance required.

The mean between any two values in the table is the value for the intermediate slope

All distances shown in table are to be measured on the slope.

* is the slope distance out from center stake where grade line intersects slope

OBSERVATION OF POLARIS AT AN HOUR ANGLE

To clearly illustrate the use of this method, the following example is used:
Date of observation, September 15, 1927.
Latitude, 47° 8½′; longitude, 115° 52½′; both derived from ¼-inch Forest map by interpolation.
Watch is adjusted to standard time of the one hundred and fifth meridian (mountain time).

FIELD WORK

From a transit station on the surveyed line a reference line is established to the west of the star. (See fig. 3.) From this the following observations are made:

Observation	Horizontal angle star to reference point	Standard time
	° ′	
1. Direct	3 49	7.38 p. m.
2. Reverse	3 47	7.46 p. m.
3. Direct	3 46	7.50 p. m.
4. Reverse	3 47	7.54 p. m.

With this information available the following office computations are necessary to complete the observation:

1. *Tables needed*

(*a*) "Ephemeris of the Sun and Polaris and Tables of Azimuths and Altitudes of Polaris." (This pamphlet is published each year by the General Land Office; also it is believed that most instrument manufacturers publish a pocket "Ephemeris" each year which includes tables of azimuths for hour angles.)
(*b*) Correction tables for longitude (siderial conversion table), included in this book, page 30.

2. *Longitude and time*

The following relation exists between longitude and time:
15° longitude equals ---------- 1 hour of time.
1° longitude equals ---------- 4 minutes of time.
1′ longitude equals ---------- 4 seconds of time.

3. *Computations*

(*a*) To obtain local mean time of observation:

	°	′	
Longitude of observation	115	52. 5	
Longitude of mountain (watch) time	105	0	
Difference in longitude	10	52. 5	
Multiply by 4 (see 2, Longitude and time)	4	4	
Difference in time	43^m	30^s	=43. 5^m

Standard time of observation, 1 (*d*)	7^h	38. 0^m
(Watch is faster than local mean time) minus*		−43. 5
Local mean time of observation, 1 (*d*)	6^h	54. 5^m

*Add when observation is east of meridian to which watch is set.

(*b*) Hour angle:

	°	′	
Local mean time of upper culmination at Greenwich Sept. 15, 1927	2^h	4. 1^m	a. m.
Time correction subtracted from Greenwich local mean time (table of Siderial Conversions)		−1. 2	
Local mean time of upper culmination on Sept. 15, 1927	2^h	2. 9^m	a. m.
Local mean time of observation 1 (*d*), Sept. 15, 1927	6^h	54. 5^m	p. m.
	+12	00. 0	
Hour angle at observation 1 (*d*) (see fig. 1)	16^h	51. 6^m	

FIGURE 1.—From 2^h 2.9^m a. m. until 2^h 2.9^m p. m. equals 12 hours; from 2^h 2.9^m p.m. until time of observation 6^h 54.5^m p. m. equals 4^h 41.6^m plus 12 hours equals 16^h 51.6^m hour angle.

(c) Time argument:

To obtain time argument consult Figure 2. If the hour angle (time elapsed between upper culmination and time of observation) is less than $11^h\ 58^m$ the star is west of the meridian; if greater the star is east of the meridian. If hour angle is greater than $11^h\ 58^m$ subtract from $23^h\ 56^m$. The time argument at observation 1 (d) is, therefore, $23^h\ 56^m$ minus $16^h\ 51.6^m$ equals $7^h\ 04\frac{1}{2}^m$.

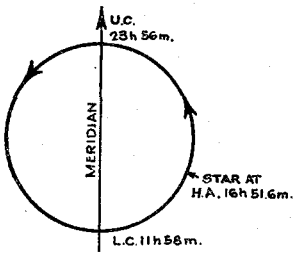


FIGURE 1

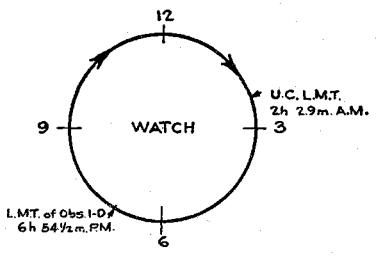


FIGURE 2

(d) Azimuth of Polaris:

Use time argument $7^h\ 04\frac{1}{2}^m$ and latitude 47° 8½′ N. in hour angle table in back of Ephemeris and by interpolation obtain azimuth	1° 31′
From Ephemeris for date Sept. 15, 1927, obtain +88° 54′ 44.99″ and with time argument $7^h\ 04\frac{1}{2}^m$ refer to angle hour table in back of Ephemeris and obtain correction (addative)	+0. 2′
Azimuth of Polaris at observation 1 (d) is	1° 31. 2′

From the field observations and computations we then have the following:

Observation	Standard time	Local mean time	Hour angle	Time argument	Azimuth
	$h\ m$	$h\ m$	$h\ m$	$h\ m$	° ′
1. Direct	7 38	6 54½	16 51½	7 04½	1 31
2. Reverse	7 46	7 2½	16 59½	6 56½	1 32
3. Direct	7 50	7 6½	17 3½	6 52½	1 32½
4. Reverse	7 54	7 10½	17 7½	6 48½	1 33

Observation	Angle	Azimuth of star	Bearing of reference line
	° ′	° ′	
1. Direct	3 49	1 31	N. 2° 18′ W.
2. Reverse	3 47	1 32	N. 2° 15′ W.
3. Direct	3 46	1 32½	N. 2° 13½′ W.
4. Reverse	3 47	1 33	N. 2° 14′ W.
Mean (see fig. 3)	3 47	1 32	N. 2° 15′ W.

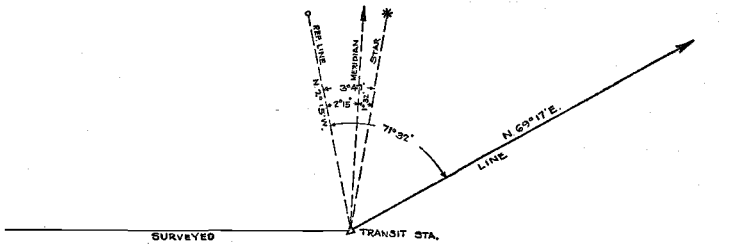


FIGURE 3

OBSERVATION OF POLARIS AT ELONGATION

EXAMPLE.—Date, May 2, 1927; latitude, 46° 32′ North; longitude, 110° 36′ West. Latitude and longitude derived from ¼ inch Forest map by interpolation.

Mean time of eastern elongation at Greenwich, May 2, 1927	5h 1.3m a. m.
Correction (subtractive) for longitude 110° 36′ from table of Siderial Conversions.	1.2m
Time of eastern elongation, corrected for longitude, May 2, 1927	5h 0.1m a. m.
Correction to time of elongation, latitude 46° 32′ N. (addative)	1.0m
Local mean time of eastern elongation, May 2, 1927	5h 1.1m a. m.

Longitude of observation	110°	36′ W.
Longitude of Mountain (watch) time	105	0 W.
Difference in longitude	5°	36′
Relation of longitude to time, multiply by 4	4	4

Difference in time	22m	24s = 22.4m
Local mean time of eastern elongation		5h 1.1m a. m.
Watch is fast of local mean time		+22.4m
Local mean time of observation		5h 23.5m a. m.

Interpolating in Ephemeris for latitude 46° 32′ N. and declination +88° 54′ 40.45″=1° 34′ 58″ equals N. 1° 35′ E. azimuth of Polaris.

For true meridian, therefore, lay off to left if eastern elongation and to right if western elongation.

SIDEREAL CONVERSIONS

Longitude	Hours	Longitude													
		0° 0′		2° 30′		5° 0′		7° 30′		10° 0′		12° 30′		15° 0′	
		Minutes													
		0		10		20		30		40		50		60	
°		m	s	m	s	m	s	m	s	m	s	m	s	m	s
0	0	0	0	0	2	0	3	0	5	0	7	0	8	0	10
15	1	0	10	0	11	0	13	0	15	0	16	0	18	0	20
30	2	0	20	0	21	0	23	0	25	0	26	0	28	0	30
45	3	0	30	0	31	0	33	0	34	0	36	0	38	0	39
60	4	0	39	0	41	0	43	0	44	0	46	0	48	0	49
75	5	0	49	0	51	0	53	0	54	0	56	0	57	0	59
90	6	0	59	1	1	1	2	1	4	1	6	1	7	1	9
105	7	1	9	1	11	1	12	1	14	1	15	1	17	1	19
120	8	1	19	1	20	1	22	1	24	1	25	1	27	1	29
135	9	1	29	1	30	1	32	1	34	1	35	1	37	1	38
150	10	1	38	1	40	1	42	1	43	1	45	1	47	1	48
165	11	1	48	1	50	1	52	1	53	1	55	1	56	1	58
180	12	1	58	2	0	2	1	2	3	2	5	2	6	2	8
195	13	2	8	2	10	2	11	2	13	2	15	2	16	2	18
210	14	2	18	2	19	2	21	2	23	2	24	2	26	2	28
225	15	2	28	2	29	2	31	2	33	2	34	2	36	2	37
240	16	2	37	2	39	2	41	2	42	2	44	2	46	2	47
255	17	2	47	2	49	2	51	2	52	2	54	2	56	2	57
270	18	2	57	2	59	3	0	3	2	3	4	3	5	3	7
285	19	3	7	3	9	3	10	3	12	3	14	3	15	3	17
300	20	3	17	3	18	3	20	3	22	3	23	3	25	3	27
315	21	3	27	3	28	3	30	3	32	3	33	3	35	3	37
330	22	3	37	3	38	3	40	3	41	3	43	3	45	3	46
345	23	3	46	3	48	3	50	3	51	3	53	3	55	3	56

Sidereal into mean solar time, to be subtracted from a sidereal time interval: Argument hours and minutes of sidereal interval.

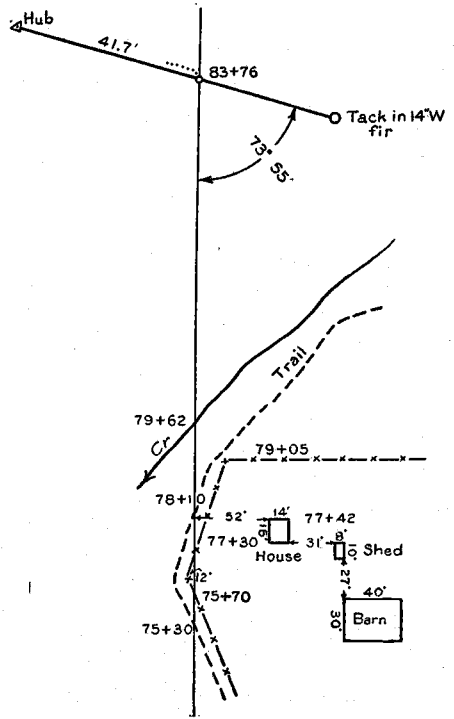
Mean solar into sidereal time, to be added to a mean time interval: Argument hours and minutes of mean time interval.

Upper culmination of Polaris, amount to be subtracted from the Greenwich mean time of upper culmination of Polaris, or of elongation, to obtain the local mean time of upper culmination, or of elongation: Argument longitude west from Greenwich.

The above table is an abridged mean of two tables given in the American Ephemeris and Nautical Almanac for similar conversions; reductions involving a refinement exceeding 0.8 seconds must be made from the more elaborate tables.

TRANSIT NOTES

Sta.	L.	R.	Mag	True	Curve Sta.
			N. 40° 15′ W.	N. 40° 30′ W.	
					P. T. 84+13.4
+76	21° 30′				Ex. 83+75.7
	R. 200′				
	T. 38.0′				P. C. 83+38.0
	L. 75.4′				
	Ex. 3.6′				
248.9′			N. 19° 10′ W.	N. 19° 00′ W.	
					P. T. 81+90.8
81+33.5		34° 30′			Ex. 81+30.3
		R. 200′			
		T. 63.7			P. C. 80+69.8
		L. 121.0			
		Ex. 9.4			
183.5′			N. 53° 30′ W.	N. 53° 30′ W.	
					P. T. 79+97.0
79+51	26° 30′				Ex. 79+50.5
	R. 200′				
	T. 47.0				P. C. 79+04.0
	L. 93.0				
	Ex. 5.5				
390.4′			N. 27° 30′ W.	N. 27° 00′ W.	
					P. T. 76+48.8
75+63	20° 0′				Ex. 75+61.8
	R. 500				
	T. 88.2				P. C. 74+74.8
	L. 174.0				
	Ex. 7.7				
			N. 6° 45′ W.	N. 7° 00′ W.	



LEVEL NOTES

Sta.	(Back Sight) +	H. I.	(Fore Sight) −	Rod	Elev.	
B. M.					4165.07	Nail in base of 26″ Fir 70′ left of sta 0+50
	1.49	4166.56				
T. P.			1.90		4164.66	
	6.88	4171.54				
0+00				0.5	4171.0	
+75				2.0	4169.5	
1+00				4.0	4167.5	
+20				10.2	4161.3	
+37				11.8	4159.7	
+53				11.0	4160.5	W. L. South side of creek
2+00				7.2	4164.3	Bottom of channel Willow Creek.
+50				8.3	4163.2	W. L. North side of creek
T. P.			6.88		4164.66	
	0.75	4165.41				
4+00				3.2	4162.2	
+50				3.8	4161.6	
5+00				5.1	4160.3	
+27				4.2	4161.2	
+36				6.2	4159.2	
+52				8.1	4157.3	−15.98
+76				7.0	4158.4	+ 9.12
+89				6.2	4159.2	− 6.86
6+00				5.1	4160.3	4165.07
T. P.			7.20		4158.21	4158.21
	9.12		15.98			

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CROSS-SECTION NOTES, PER CENT ABNEY

Sta.	L	℄		R			CLASSIFICATION AND DRAINAGE: Exc.	Clear. & Grub.	Drainage	Remarks.
196	+60/100	+27/11	+35/7	−32/30						
+15		+66/100	+35/8	−37/30						
+33	+50/30	+62/11	+34/7	−20/25	−33/30					
+60		+37/30	+33/20	−21/9	−1/12	−42/21 −52/30	70% S. R. 30% L. R.	" "	+22−12″ pipe	Spring-Need Ditch 50′ each way. Turnout
+84		+55/30	+19/5	−48/16	−36/30					
197+18		20°/21°	+26/15	−45/10	−31/30		20% S. R. 60% L. R. 20% C.	Brush and Alders—Avg. about 2— 10″ Firs per. sta.—Few windfalls. Est. Cl.-$ Gr.-$		
+84	+10/20	2°/27°	+4/7	−10/12	−31/30					
198	+2/13	4°/23°	+10/7	−35/25						
199	+53/30 +52/20	+58/11	+8/5	−40/25	W.L.		50% S. R. 50% L. R.	Dense reproduction 25 yrs. old Small amount of down timber. per Ac. " "		
+60	+32/15	3°/16°	+25/11	−25/10	−43/12	−41/21 W.L.				
200	+64/42	+11/4	3°/16°	0/4	−28/15	−37/26 W. L.	100% S. R.	Est. Cl.-$ Gr.-$	+12−18″ pipe	Camp site across creek
+50	+88/20	+125/11	+36/8	−31/25						

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ABNEY SURVEY FIELD NOTES

Sta.	Dist. in feet	Grade	Mag. bearing	Side slope %		Remarks
				L	R	
28+00						
	100	−7%	S. 50° W..	−25	+15	
27+00						
	100	−7%	S. 30° W..	−30	+30	
26+00						
	50	−7%	S. 40° W..	−25	+25	
25+50						
	100	−7%	S. 50° W..	−30	+30	End of loose rock.
24+50						
	100	−7%	S. 30° W..	−40	+40	Loose rock.
23+50						
	55	−7%	S. 40° W..	−55	+55	End of solid rock.
+95						
	45	−7%	S. 30° W..	−60	+60	Solid rock.
22+50						
	100	−7%	S. 20° W..	−45	+50	In solid rock.
+50						Solid rock at 21+55.
	50	−7%	S. 30° W..	−40	+40	
21+00						
	85	−7%	S. 40° W..	−20	+20	
20+15						
	65	−7%	S. 40° W..	−25	+25	
+50						
	50	−7%	S. 45° W..	−30	+30	
19+00						

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CARRYING CAPACITY OF SHORT CORRUGATED PIPES

Capacities are for corrugated culverts with straight end wall entrance, length, 30.6 feet; discharge in cubic feet per second

[Use for ordinary road culverts and canal turnouts]

Per cent of culvert incline	Head on pipe, in feet	12-inch	15-inch [1]	18-inch	21-inch [1]	24-inch	30-inch	36-inch [1]	42-inch [1]	48-inch [1]	54-inch [1]	60-inch [1]	66-inch [1]	72-inch [1]	78-inch [1]	84-inch [1]
0.033	0.01	0.31	.52	0.79	1.13	1.54	2.57	3.92	5.60	7.62	10.0	12.8	15.9	19.4	23.4	27.7
.066	.02	.44	.73	1.12	1.60	2.17	3.64	5.55	7.92	10.8	14.2	18.0	22.5	27.5	33.1	39.3
.100	.03	.54	.90	1.37	1.96	2.66	4.46	6.79	9.70	13.2	17.3	22.1	27.6	33.7	40.5	48.1
.133	.04	.62	1.04	1.58	2.26	3.07	5.15	7.84	11.2	15.2	20.0	25.5	31.8	38.9	46.8	55.5
.166	.05	.69	1.16	1.77	2.52	3.44	5.76	8.77	12.5	17.0	22.3	28.5	35.6	43.5	52.3	62.1
.200	.06	.76	1.27	1.94	2.77	3.76	6.30	9.61	13.7	18.7	24.5	31.3	39.0	47.7	57.3	68.0
.233	.07	.82	1.37	2.09	2.99	4.07	6.82	10.4	14.8	20.2	26.5	33.8	42.1	51.5	62.0	73.6
.266	.08	.88	1.47	2.24	3.19	4.35	7.28	11.1	15.8	21.5	28.3	36.9	45.0	55.0	66.2	78.5
.300	.09	.93	1.56	2.38	3.39	4.61	7.72	11.8	16.8	22.9	30.0	38.3	47.7	58.4	70.2	83.3
.333	.1	.98	1.64	2.50	3.57	4.86	8.14	12.4	17.7	24.1	31.7	40.4	50.3	61.5	74.0	87.8
.666	.2	1.39	2.32	3.54	5.05	6.87	11.5	17.5	25.0	34.1	44.7	57.1	71.2	87.0	104	124
1.00	.3	1.70	2.84	4.33	6.18	8.42	14.1	21.5	30.7	41.8	54.8	69.9	87.1	106	128	152
1.33	.4	1.96	3.28	5.00	7.14	9.72	16.3	24.8	35.4	48.2	63.3	80.7	106	123	148	175
1.66	.5	2.19	3.67	5.59	7.98	10.9	18.2	27.7	39.6	53.9	70.7	90.3	112	137	165	196
2.00	.6	2.40	4.02	6.13	8.75	11.9	19.9	30.4	43.4	59.1	77.5	98.9	123	158	181	215
2.33	.7	2.59	4.34	6.62	9.45	12.9	21.5	32.8	46.9	63.8	83.7	106	133	163	196	232
2.66	.8	2.77	4.64	7.07	10.1	13.8	23.0	35.1	50.1	68.2	89.4	114	142	174	209	248
3.00	.9	2.94	4.92	7.51	10.7	14.6	24.4	37.2	53.1	72.3	94.9	121	151	184	212	263
3.33	1.0	3.10	5.19	7.91	11.3	15.4	25.7	39.2	56.0	76.2	100	127	159	194	234	277
3.66	1.2	3.40	5.69	8.66	12.4	16.8	28.2	43.0	61.3	83.5	109	140	174	213	256	304
4.66	1.4	3.67	6.14	9.36	13.4	18.2	30.5	46.4	66.3	90.2	118	151	188	230	277	328
5.33	1.6	3.92	6.57	10.00	14.3	19.4	32.6	49.6	70.8	96.4	126	161	201	246	296	351
6.00	1.8	4.16	6.96	10.60	15.2	20.6	34.5	52.6	75.1	102.0	134	171	213	261	314	372
6.66	2.0	4.38	7.34	11.20	16.0	21.7	36.4	55.5	79.2	108	142	180	225	275	331	392
7.33	2.2	4.60	7.70	11.74	16.8	22.8	38.2	58.2	83.1	113	148	189	236	289	347	413
8.00	2.4	4.80	8.04	12.25	17.5	23.8	39.9	60.8	86.8	118	155	198	246	301	362	430
8.66	2.6	5.00	8.37	12.81	18.2	24.8	41.7	63.0	90.3	123	161	206	257	314	377	448
9.33	2.8	5.19	8.69	13.24	18.9	25.7	43.1	65.6	93.7	128	167	213	266	325	392	465
10.00	3.0	5.37	8.99	13.70	19.6	26.6	44.6	67.9	97.0	132	173	221	276	337	405	481
10.66	3.2	5.55	9.29	14.26	20.2	27.5	46.1	70.2	100.2	136	179	228	285	348	418	497
11.33	3.4	5.72	9.57	14.60	20.8	28.4	47.5	72.3	103.5	141	184	235	293	359	431	512
11.66	3.5	5.80	9.71	14.80	21.1	28.8	48.2	73.4	105.0	143	187	239	298	364	438	519

[1] No experiments made on these sizes; quantity computed by formula.

This table is based on the formula $Q=3.10\ D^{2.31}\ H^{0.50}$ for corrugated pipe, in which Q = discharge in cubic feet per second. D = diameter of pipe in feet and H = head on pipe, in feet — difference of elevation of inlet and outlet ends of pipe.

Compiled from figures obtained through a series of tests made by the Bureau of Public Roads at the hydraulic testing plant of the Univeristy of Iowa. This table can be used for shorter lengths of pipe with little error. For shorter pipe the capacities would be somewhat greater for equal heads, the capacity of a 14-foot pipe being nearly 20 per cent greater than for a 30-foot length of the same diameter.

CORRUGATED METAL CULVERT PIPE

DIMENSIONS AND WEIGHTS

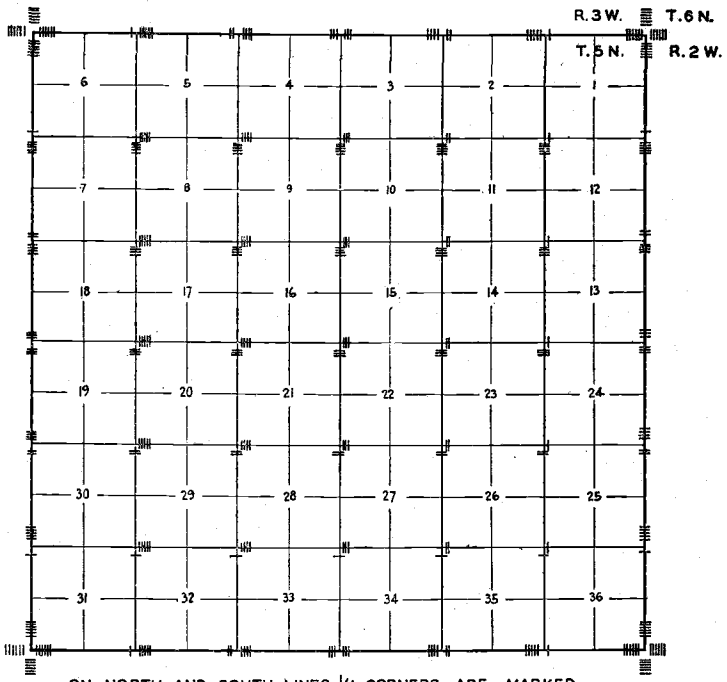
[Department circular No. 331]

Nominal diameter	Length of sheet before forming	Width of lap	Minimum gage, United States standard	Theoretical weight per linear foot of finished culvert exclusive of end finish
	Inches	*Inches*		*Pounds*
12 inches	40	2.0	16	10.5
15 inches	50	2.0	16	13.1
18 inches	60	2.5	16	15.7
21 inches	70	2.5	14	22.5
24 inches	80	3.0	14	25.8
30 inches	100	3.5	14	32.2
36 inches	120	3.5	12	53.3

Culvert companies reckon weight of band equal to two-thirds weight of 1 linear foot of pipe corresponding diameter.

SYSTEM OF MARKING CORNERS AS EMPLOYED BY THE GENERAL LAND OFFICE.

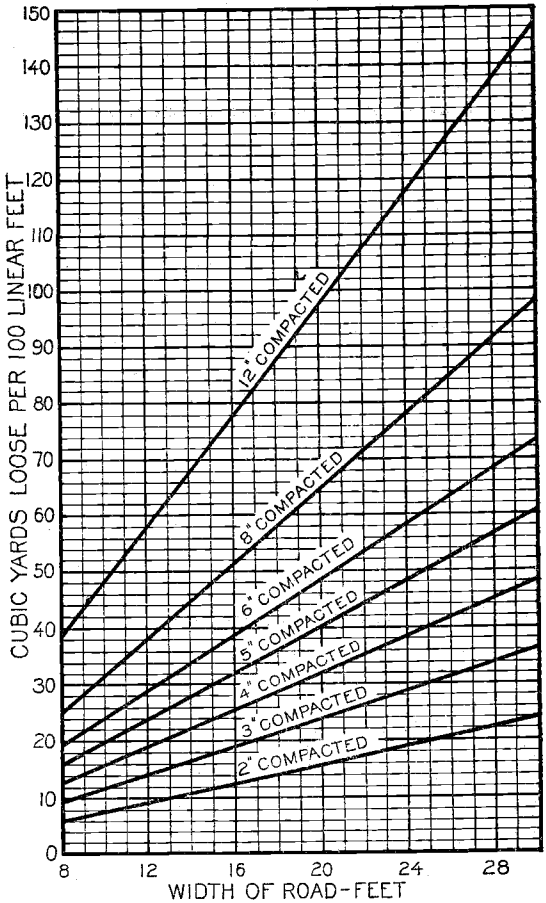
TOWNSHIP NO. 5 N. RANGE NO. 3 W. MERIDIAN.



ON NORTH AND SOUTH LINES 1/4 CORNERS ARE MARKED (1/4 S) ON WEST FACE.

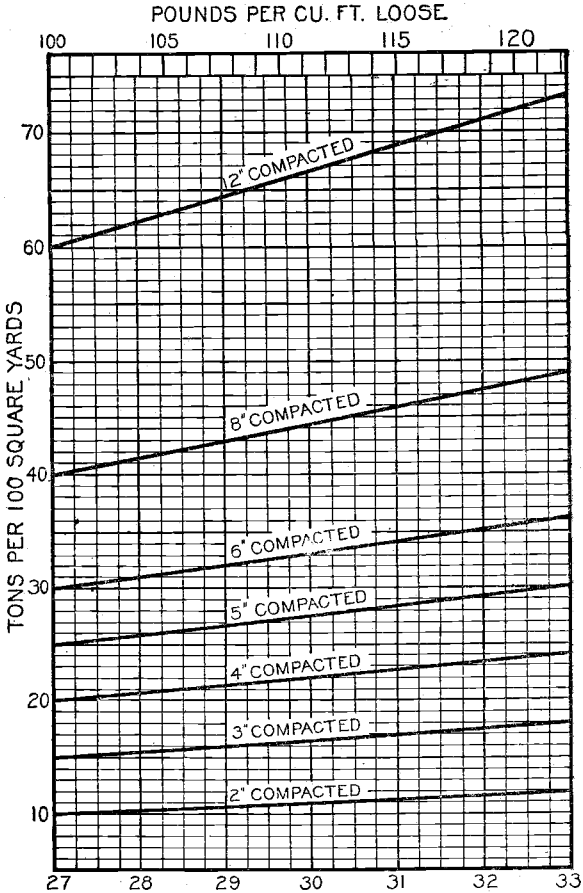
ON EAST AND WEST LINES 1/4 CORNERS ARE MARKED (1/4S) ON NORTH FACE.

Range and Township line corners bear grooves on the faces of the stone. Section corners are marked with notches on the edges of the stone.



CUBIC YARDS OF GRAVEL REQUIRED FOR GRAVEL ROAD CONSTRUCTION

The ratio of compact to loose gravel and crushed stone is approximately 1:1½ or 1:1¼.
To use this diagram in connection with the standard designs, compute the average depth of surfacing in the cross-section.



TONS OF GRAVEL REQUIRED FOR GRAVEL ROAD CONSTRUCTION

The ratio of compact to loose gravel and crushed stone is approximately 1:1½ or 1:1¼.
To use this diagram in connection with the standard designs, compute the average depth of surfacing in the cross-section.

WORKING STRESSES PERMISSIBLE—BENDING

Pounds per square inch for structural timbers of select (S2) grade [1]
[Department Circular 295, U. S. Department of Agriculture]

Species	Bending				
	Allowable stress in extreme fiber for select (S2) grade			Allowable horizontal shear stress, select (S2) grade, all locations	Allowable modulus of elasticity for all grades, all locations
	Damp or wet location (docks, piling, and sills)	Outside, not in contact with soil (bridges and open sheds)	Under shelter in dry location (factories and warehouses)		
Ash, black	800	900	1,000	90	1,100,000
Ash, commercial white (green, biltmore, white)	1,000	1,200	1,400	125	1,500,000
Aspen and large-tooth aspen	500	650	800	80	900,000
Basswood	500	650	800	80	900,000
Beech	1,000	1,300	1,500	125	1,600,000
Birch, paper	600	750	900	80	1,000,000
Birch, yellow and sweet	1,000	1,300	1,500	120	1,600,000
Cedar, Alaska	800	900	1,000	90	1,100,000
Cedar, western red	750	800	900	80	1,000,000
Cedar, northern and southern white	600	650	750	70	800,000
Cedar, Port Orford	900	1,000	1,100	100	1,200,000
Chestnut	700	850	950	90	1,000,000
Cottonwood, common and black	500	650	800	80	900,000
Cypress, bald	900	1,100	1,300	100	1,400,000
Douglas fir (western Washington and Oregon) [2]	1,000	1,300	1,500	90	1,600,000
Douglas fir (Rocky Mountain type)	700	900	1,100	85	1,200,000
Elm, cork	1,000	1,300	1,500	125	1,300,000
Elm, slippery and white	800	900	1,100	100	1,200,000
Fir, balsam	600	750	900	70	1,000,000
Fir, commercial white (white, noble, grand)	800	900	1,100	70	1,200,000
Gum, black and cotton	800	900	1,100	100	1,200,000
Gum, red	800	900	1,100	100	1,200,000
Hemlock, western	900	1,100	1,300	75	1,400,000
Hemlock, eastern	800	900	1,000	70	1,100,000
Hickory, true and pecan	1,200	1,500	1,900	140	1,800,000
Larch, western	900	1,100	1,200	100	1,300,000
Maple, sugar and black	1,000	1,300	1,500	150	1,600,000
Maple, red and silver	700	900	1,000	100	1,100,000
Oak, commercial red and white	1,000	1,200	1,400	125	1,500,000
Pine, southern yellow [2]	1,000	1,300	1,500	110	1,600,000
Pine, white, sugar, western white, western yellow	750	800	900	85	1,000,000
Pine, Norway	800	1,000	1,100	85	1,200,000
Poplar, yellow	800	900	1,000	80	1,100,000
Redwood	800	1,000	1,200	70	1,200,000
Spruce, red white, Sitka	800	900	1,100	85	1,200,000
Spruce, Engelmann	500	650	750	70	800,000
Sycamore	800	900	1,100	80	1,200,000
Tamarack, eastern	900	1,100	1,200	95	1,300,000

[1] Working stresses for extra select (S1), extra select (S1) dense, standard (S3), and common (S4) grades are obtained by multiplying the basic stress by 7/6, 8/6, 5/6, and 4/6, respectively.

[2] The working stresses of any grade of timbers of Douglas fir and southern yellow pine which meet the density requirements of the American Society of Testing Materials shall be increased one-sixth the allowable stress given in the table for the basic or select (S2) grade.

WORKING STRESSES PERMISSIBLE—COMPRESSION

Pounds per square inch for structural timbers of select (S2) grade

Species	Compression					
	Allowable stress parallel to grain "Short Columns" for select (S2) grade [1]			Allowable stress perpendicular to grain for all grades		
	Wet location	Dry outside location	Dry inside location	Wet location	Dry outside location	Dry inside location
Ash, black	500	550	650	150	200	300
Ash, commercial white (green, biltmore, white)	900	1,000	1,100	300	375	500
Aspen and large-tooth aspen	450	550	700	100	125	150
Basswood	450	550	700	100	125	150
Beech	900	1,100	1,200	300	375	500
Birch, paper	450	550	650	100	150	200
Birch, yellow and sweet	900	1,100	1,200	300	375	500
Cedar, Alaska	650	750	800	150	200	250
Cedar, western red	650	700	700	125	150	200
Cedar, northern and southern white	450	500	550	100	140	175
Cedar, Port Orford	750	825	900	150	200	250
Chestnut	600	700	800	150	200	300
Cottonwood, common and black	450	550	700	100	125	150
Cypress, bald	800	1,000	1,100	225	250	350
Douglas fir (western Washington and Oregon)[2]	850	1,000	1,100	200	225	325
Douglas fir (Rocky Mountain type)	700	800	800	200	225	275
Elm, cork	900	1,100	1,200	300	375	500
Elm, slippery and white	650	750	800	125	175	250
Fir, balsam	500	600	700	100	125	150
Fir, commercial white (white, noble, grand)	650	750	800	150	200	300
Gum, black and cotton	650	750	800	150	200	300
Gum, red	650	750	800	150	200	300
Hemlock, western	800	900	900	200	225	300
Hemlock, eastern	600	700	700	200	225	300
Hickory, true and pecan	1,000	1,200	1,500	350	400	600
Larch, western	800	1,000	1,100	200	275	325
Maple, sugar and black	900	1,100	1,200	300	375	500
Maple, red and silver	600	700	800	200	250	350
Oak, commercial red and white	800	900	1,000	300	375	500
Pine, southern yellow [2]	850	1,000	1,100	200	225	325
Pine, white, sugar, western white, western yellow	650	750	750	125	150	250
Pine, Norway	700	800	800	150	175	300
Poplar, yellow	600	700	800	125	150	250
Redwood	750	900	1,000	125	150	250
Spruce, red, white, Sitka	650	750	800	125	150	250
Spruce, Engelmann	450	550	600	100	140	175
Sycamore	650	750	800	150	200	300
Tamarack, eastern	800	900	1,000	200	225	300

[1] The influence of knots on compressive strength of columns of constant cross section decreases as the length increases. When the length reaches 30 times the least dimension, knots such as are allowable in select (S2) timbers have no appreciable effect on the strength as a column.

[2] The working stresses of any grade of timbers of Douglas fir and southern yellow pine which meet the density requirements of the American Society of Testing Materials shall be increased one-sixth the allowable stress given in the table for the basic or select (S2) grade.

MINIMUM DIMENSIONS FOR STRINGERS ON NONTRUSS BRIDGES

Span	4-stringer bridge, 10 feet wide in clear		Span	4-stringer bridge, 10 feet wide in clear	
	Sawed timber	Round timber, diameter		Sawed timber	Round timber, diameter
	Inches	*Inches*		*Inches*	*Inches*
8 feet	3 x 8	7	20 feet	10 x 12	12
10 feet	3 x 10	8	22 feet	10 x 12	13
12 feet	3 x 12	8	24 feet	12 x 12	14
14 feet	4 x 12	9	26 feet	12 x 14	14
16 feet	6 x 12	10	28 feet	12 x 14	15
18 feet	8 x 12	11	30 feet	14 x 14	16

4 by 12 inches planking or 6 inches round, hewed flat, under wheel track.

In measuring round timbers deduct one-half the depth of sapwood on each side of the heart. The timber dimensions specified provide a load factor of 125 pounds per square foot, with safety factor of 6. For especially heavy snowloads or unusually heavy vehicles, an extra stringer may be added if Douglas fir is not available for stringers.

For bridges 12 feet wide having 11 feet clear roadway use not less than 5 stringers.

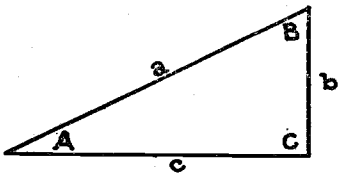
For 10-ton truck loading the spacing of stringers should not exceed 30 inches for 4-inch decking and 20 inches for 3-inch decking.

RELATIVE STRENGTHS OF SAWED LUMBER AND ROUND TIMBER BEAMS

Sawed lumber (*b* x *d*)	Square lumber corresponding	Round timber, corresponding diameter	Sawed lumber (*b* x *d*)	Square lumber, corresponding	Round timber, corresponding diameter
	Inches	*Inches*		*Inches*	*Inches*
3 x 8 inches	6	7	7 x 7 inches	7	8
3 x 10 inches	7	8	7 x 10 inches	9	10
3 x 12 inches	8	9	7 x 12 inches	10	11
4 x 6 inches	6	7	8 x 8 inches	8	9
4 x 8 inches	7	8	8 x 10 inches	9	10
4 x 10 inches	8	9	8 x 12 inches	11	13
4 x 12 inches	9	10	10 x 10 inches	10	11
6 x 6 inches	6	7	10 x 12 inches	12	14
6 x 8 inches	7	8	12 x 12 inches	12	14
6 x 10 inches	9	10	12 x 14 inches	13	15
6 x 12 inches	10	11	14 x 14 inches	14	16

FORMULAE FOR SOLUTION OF RIGHT AND OBLIQUE TRIANGLES

RIGHT TRIANGLES



To find A

Given	Formulae	Given	Formulae
b, c	$\tan A = \frac{b}{c}$	c, b	$\cot A = \frac{c}{b}$
b, a	$\sin A = \frac{b}{a}$	c, a	$\cos A = \frac{c}{a}$

To find B

Given	Formulae	Given	Formulae
b, c	$\cot B = \frac{b}{c}$	c, b	$\tan B = \frac{c}{b}$
b, a	$\cos B = \frac{b}{a}$	c, a	$\sin B = \frac{c}{a}$

To find a

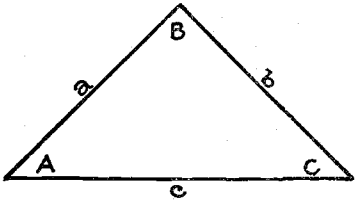
A, b	$a = \frac{b}{\sin A}$	B, b	$a = \frac{b}{\cos B}$
A, c	$a = \frac{c}{\cos A}$	B, c	$a = \frac{c}{\sin B}$

To find b

A, c A, a	$b = c \tan A$ $b = a \sin A$	B, a B, c	$b = a \cos B$ $b = c \cot B$

To find c

A, a A, b	$c = a \cos A$ $c = b \cot A$	B, a B, b	$c = a \sin B$ $c = b \tan B$



To find a, b, c		To find A, B, C	
Given	Formulae	Given	Formulae
A, b, C	$a=\frac{b \sin C}{\sin A}$	a, b, C	$\sin A=\frac{b \sin C}{a}$
A, B, c	$b=\frac{c \sin A}{\sin B}$	A, b, c	$\sin B=\frac{c \sin A}{b}$
A, B, b	$c=\frac{b \sin B}{\sin A}$	A, a, b	$\sin C=\frac{a \sin A}{b}$

To find A, B, C
$s=\frac{1}{2}(a+b+c)$

Given	Formulae
a, c, s	$\sin \frac{1}{2} A=\sqrt{\frac{(s-a)(s-c)}{ac}}$
a, b, s	$\sin \frac{1}{2} B=\sqrt{\frac{(s-a)(s-b)}{ab}}$
b, c, s	$\sin \frac{1}{2} C=\sqrt{\frac{(s-b)(s-c)}{bc}}$

ACRES REQUIRED FOR DIFFERENT WIDTHS

[Per mile, and per 100 feet]

Width, feet	Acres per mile	Acres per 100 feet	Width, feet	Acres per mile	Acres per 100 feet	Width, feet	Acres per mile	Acres per 100 feet	Width, feet	Acres per mile	Acres per 100 feet
1	0.121	0.002	26	3.15	0.060	52	6.30	0.119	78	9.45	0.179
2	.242	.005	27	3.27	.062	53	6.42	.122	79	9.58	.181
3	.364	.007	28	3.39	.064	54	6.55	.124	80	9.70	.184
4	.485	.009	29	3.52	.067	55	6.67	.126	81	9.82	.186
5	.606	.011	30	3.64	.069	56	6.79	.129	82	9.94	.188
6	.727	.014	31	3.76	.071	57	6.91	.131	82½	10.00	.189
7	.848	.016	32	3.88	.073	57¾	7.00	.133	83	10.10	.190
8	.970	.018	33	4.00	.076	58	7.03	.133	84	10.20	.193
8¼	1.00	.019	34	4.12	.078	59	7.15	.135	85	10.30	.195
9	1.09	.021	35	4.24	.080	60	7.27	.138	86	10.40	.197
10	1.21	.023	36	4.36	.083	61	7.39	.140	87	10.50	.200
11	1.33	.025	37	4.48	.085	62	7.52	.142	88	10.70	.202
12	1.46	.028	38	4.61	.087	63	7.64	.145	89	10.80	.204
13	1.58	.030	39	4.73	.090	64	7.76	.147	90	10.90	.207
14	1.70	.032	40	4.85	.092	65	7.88	.149	90¾	11.00	.209
15	1.82	.034	41	4.97	.094	66	8.00	.151	91	11.00	.209
16	1.94	.037	41¼	5.00	.094	67	8.12	.154	92	11.20	.211
16½	2.00	.038	42	5.09	.096	68	8.24	.156	93	11.30	.213
17	2.06	.039	43	5.21	.099	69	8.36	.158	94	11.40	.216
18	2.18	.041	44	5.33	.101	70	8.48	.161	95	11.50	.218
19	2.30	.044	45	5.45	.103	71	8.61	.163	96	11.60	.220
20	2.42	.046	46	5.58	.106	72	8.73	.165	97	11.80	.223
21	2.55	.048	47	5.70	.108	73	8.85	.168	98	11.90	.225
22	2.67	.051	48	5.82	.110	74	8.97	.170	99	12.00	.227
23	2.79	.053	49	5.94	.112	74¼	9.00	.170	100	12.10	.230
24	2.91	.055	49½	6.00	.114	75	9.09	.172			
24¾	3.00	.057	50	6.06	.115	76	9.21	.174			
25	3.03	.057	51	6.18	.117	77	9.33	.177			

CONTENTS OF LUMBER

Number of board feet in various sizes, for lengths given

Size of piece	Length of piece, in feet							
	10	12	14	16	18	20	22	24
2 x 4 inches	6⅔	8	9⅓	10⅔	12	13⅓	14⅔	16
2 x 6 inches	10	12	14	16	18	20	22	24
2 x 8 inches	13⅓	16	18⅔	21⅓	24	26⅔	29⅓	32
2 x 10 inches	16⅔	20	23⅓	26⅔	30	33⅓	36⅔	40
2 x 12 inches	20	24	28	32	36	40	44	48
2 x 14 inches	23⅓	28	32⅔	37⅓	42	46⅔	51⅓	56
2 x 16 inches	26⅔	32	37⅓	42⅔	48	53⅓	58⅔	64
3 x 6 inches	15	18	21	24	27	30	33	36
3 x 8 inches	20	24	28	32	36	40	44	48
3 x 10 inches	25	30	35	40	45	50	55	60
3 x 12 inches	30	36	42	48	54	60	66	72
3 x 14 inches	35	42	49	56	63	70	77	84
3 x 16 inches	40	48	56	64	72	80	88	96
4 x 4 inches	13⅓	16	18⅔	21⅓	24	26⅔	29⅓	32
4 x 6 inches	20	24	28	32	36	40	44	48
4 x 8 inches	26⅔	32	37⅓	42⅔	48	53⅓	58⅔	64
4 x 10 inches	33⅓	40	46⅔	53⅓	60	66⅔	73⅓	80
4 x 12 inches	40	48	56	64	72	80	88	96
4 x 14 inches	46⅔	56	65⅓	74⅔	84	93⅓	102⅔	112
4 x 16 inches	53⅓	64	74⅔	85⅓	96	106⅔	117⅓	128
6 x 6 inches	30	36	42	48	54	60	66	72
6 x 8 inches	40	48	56	64	72	80	88	96
6 x 10 inches	50	60	70	80	90	100	110	120
6 x 12 inches	60	72	84	96	108	120	132	144
6 x 14 inches	70	84	98	112	126	140	154	168
6 x 16 inches	80	96	112	128	144	160	176	192
6 x 18 inches	90	108	126	144	162	188	198	216
6 x 20 inches	100	120	140	160	180	200	220	240
8 x 8 inches	53⅓	64	74⅔	85⅓	96	106⅔	117⅓	128
8 x 10 inches	66⅔	80	93⅓	106⅔	120	133⅓	146⅔	160
8 x 12 inches	80	96	112	128	144	160	176	192
8 x 14 inches	93⅓	112	130⅔	149⅓	168	186⅔	205⅓	224
10 x 10 inches	83⅓	100	116⅔	133⅓	150	166⅔	183⅓	200
10 x 12 inches	100	120	140	160	180	200	220	240
10 x 14 inches	116⅔	140	163⅓	186⅔	210	233⅓	256⅔	280
10 x 16 inches	133⅓	160	186⅔	213⅓	240	266⅔	293⅓	320
12 x 12 inches	120	144	168	192	216	240	264	288
12 x 14 inches	140	168	196	224	252	280	308	336
12 x 16 inches	160	192	224	256	288	320	352	384
14 x 14 inches	163⅓	196	228⅔	261⅓	294	326⅔	359⅓	392
14 x 16 inches	186⅔	224	261⅓	298⅔	336	373⅓	410⅔	448

EQUIVALENTS OF PER CENTS IN DEGREES

Per cent	Degrees	Per cent	Degrees	Per cent	Degrees	Per cent	Degrees
	° ′		° ′		° ′		° ′
1	34	26	14 34	51	27 01	76	37 14
2	1 09	27	15 07	52	27 28	77	37 36
3	1 43	28	15 39	53	27 55	78	37 57
4	2 17	29	16 10	54	28 22	79	38 19
5	2 52	30	16 42	55	28 49	80	38 40
6	3 26	31	17 13	56	29 15	81	39 00
7	4 00	32	17 45	57	29 41	82	39 21
8	4 34	33	18 16	58	30 07	83	39 42
9	5 09	34	18 47	59	30 32	84	40 02
10	5 43	35	19 17	60	30 58	85	40 22
11	6 17	36	19 48	61	31 23	86	40 42
12	6 51	37	20 18	62	31 48	87	41 01
13	7 24	38	20 48	63	32 13	88	41 21
14	7 58	39	21 18	64	32 37	89	41 40
15	8 32	40	21 48	65	33 01	90	41 59
16	9 05	41	22 18	66	33 25	91	42 18
17	9 39	42	22 47	67	33 49	92	42 37
18	10 12	43	23 16	68	34 13	93	42 55
19	10 45	44	23 45	69	34 36	94	43 14
20	11 19	45	24 14	70	35 00	95	43 32
21	11 52	46	24 42	71	35 22	96	43 59
22	12 24	47	25 10	72	35 45	97	44 08
23	12 57	48	25 38	73	36 08	98	44 25
24	13 30	49	26 06	74	36 30	99	44 43
25	14 02	50	26 34	75	36 52	100	45 00

EQUIVALENTS OF DEGREES IN PER CENT

Degrees	Per cent	Degrees	Per cent	Degrees	Per cent	Degrees	Per cent
1	1.74	16	28.67	31	60.09	46	103.55
2	3.49	17	30.57	32	62.49	47	107.24
3	5.24	18	32.49	33	64.94	48	111.06
4	6.99	19	34.43	34	67.45	49	115.04
5	8.75	20	36.40	35	70.02	50	119.18
6	10.51	21	38.39	36	72.65	51	123.49
7	12.28	22	40.40	37	75.35	52	127.99
8	14.05	23	42.45	38	78.13	53	132.70
9	15.84	24	44.52	39	80.98	54	137.64
10	17.63	25	46.63	40	83.91	55	142.81
11	19.44	26	48.77	41	86.93	56	148.26
12	21.26	27	50.95	42	90.04	57	153.99
13	23.09	28	53.17	43	93.25	58	160.03
14	24.93	29	55.43	44	96.57	59	166.43
15	26.80	30	57.73	45	100.00	60	173.20

INCHES REDUCED TO DECIMALS OF A FOOT

Inches	Foot	Inches	Foot	Inches	Foot	Inches	Foot	Inches	Foot	Inches	Foot
0	0.0000	2	0.1667	4	0.3333	6	0.5000	8	0.6667	10	0.8333
1/32	.0026		.1693		.3359		.5026		.6693		.8359
1/16	.0052		.1719		.3385		.5052		.6719		.8385
3/32	.0078		.1745		.3411		.5078		.6745		.8411
1/8	.0104	1/8	.1771	1/8	.3438	1/8	.5104	1/8	.6771	1/8	.8438
5/32	.0130		.1797		.3464		.5130		.6797		.8464
3/16	.0156		.1823		.3490		.5156		.6823		.8490
7/32	.0182		.1849		.3516		.5182		.6849		.8516
1/4	.0208	1/4	.1875	1/4	.3542	1/4	.5208	1/4	.6875	1/4	.8542
9/32	.0234		.1901		.3568		.5234		.6901		.8568
5/16	.0260		.1927		.3594		.5260		.6927		.8594
11/32	.0286		.1953		.3620		.5286		.6953		.8620
3/8	.0313	3/8	.1979	3/8	.3646	3/8	.5313	3/8	.6979	3/8	.8646
13/32	.0339		.2005		.3672		.5339		.7005		.8672
7/16	.0365		.2031		.3698		.5365		.7031		.8698
15/32	.0391		.2057		.3724		.5391		.7057		.8724
1/2	.0417	1/2	.2083	1/2	.3750	1/2	.5417	1/2	.7083	1/2	.8750
17/32	.0443		.2109		.3776		.5443		.7109		.8776
9/16	.0469		.2135		.3802		.5469		.7135		.8802
19/32	.0495		.2161		.3828		.5495		.7161		.8828
5/8	.0521	5/8	.2188	5/8	.3854	5/8	.5521	5/8	.7188	5/8	.8854
21/32	.0547		.2214		.3880		.5547		.7214		.8880
11/16	.0573		.2240		.3906		.5573		.7240		.8906
23/32	.0599		.2266		.3932		.5599		.7266		.8932
3/4	.0625	3/4	.2292	3/4	.3958	3/4	.5625	3/4	.7292	3/4	.8958
25/32	.0651		.2318		.3984		.5651		.7318		.8984
13/16	.0677		.2344		.4010		.5677		.7344		.9010
27/32	.0703		.2370		.4036		.5703		.7370		.9036
7/8	.0729	7/8	.2396	7/8	.4063	7/8	.5729	7/8	.7396	7/8	.9063
29/32	.0755		.2422		.4089		.5755		.7422		.9089
15/16	.0781		.2448		.4115		.5781		.7448		.9115
31/32	.0807		.2474		.4141		.5807		.7474		.9141
1	.0833	3	.2500	5	.4167	7	.5833	9	.7500	11	.9167
1/32	.0859		.2526		.4193		.5859		.7526		.9193
1/16	.0885		.2552		.4219		.5885		.7552		.9219
3/32	.0911		.2578		.4245		.5911		.7578		.9245
1/8	.0938	1/8	.2604	1/8	.4271	1/8	.5938	1/8	.7604	1/8	.9271
5/32	.0964		.2630		.4297		.5964		.7630		.9297
3/16	.0990		.2656		.4323		.5990		.7656		.9323
7/32	.1016		.2682		.4349		.6016		.7682		.9349
1/4	.1042	1/4	.2708	1/4	.4375	1/4	.6042	1/4	.7708	1/4	.9375
9/32	.1068		.2734		.4401		.6068		.7734		.9401
5/16	.1094		.2760		.4427		.6094		.7760		.9427
11/32	.1120		.2786		.4453		.6120		.7786		.9453
3/8	.1146	3/8	.2813	3/8	.4479	3/8	.6146	3/8	.7813	3/8	.9479
13/32	.1172		.2839		.4505		.6172		.7839		.9505
7/16	.1198		.2865		.4531		.6198		.7865		.9531
15/32	.1224		.2891		.4557		.6224		.7891		.9557
1/2	.1250	1/2	.2917	1/2	.4583	1/2	.6250	1/2	.7917	1/2	.9583
17/32	.1276		.2943		.4609		.6276		.7943		.9609
9/16	.1302		.2969		.4635		.6302		.7969		.9635
19/32	.1328		.2995		.4661		.6328		.7995		.9661
5/8	.1354	5/8	.3021	5/8	.4688	5/8	.6354	5/8	.8021	5/8	.9688
21/32	.1380		.3047		.4714		.6380		.8047		.9714
11/16	.1406		.3073		.4740		.6406		.8073		.9740
23/32	.1432		.3099		.4766		.6432		.8099		.9766
3/4	.1458	3/4	.3125	3/4	.4792	3/4	.6458	3/4	.8125	3/4	.9792
25/32	.1484		.3151		.4818		.6484		.8151		.9818
13/16	.1510		.3177		.4844		.6510		.8177		.9844
27/32	.1536		.3203		.4870		.6536		.8203		.9870
7/8	.1563	7/8	.3229	7/8	.4896	7/8	.6563	7/8	.8229	7/8	.9896
29/32	.1589		.3255		.4922		.6589		.8255		.9922
15/16	.1615		.3281		.4948		.6615		.8281		.9948
31/32	.1641		.3307		.4974		.6641		.8307		.9974

CONVERSION OF SLOPE DISTANCES TO HORIZONTAL DISTANCES

Per cent Abney and 100-foot tape

Slope distance, feet	Per cent																			
	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
2	2.0	2.0	2.0	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.6	1.6	1.6	1.5	1.5	1.5	1.4
4	4.0	4.0	3.9	3.9	3.8	3.8	3.7	3.6	3.6	3.5	3.4	3.4	3.3	3.2	3.1	3.0	3.0	2.9	2.8
6	6.0	5.9	5.9	5.8	5.7	5.7	5.6	5.5	5.4	5.3	5.1	5.0	4.9	4.8	4.7	4.6	4.5	4.4	4.2
8	8.0	7.9	7.8	7.8	7.7	7.6	7.4	7.3	7.2	7.0	6.9	6.7	6.6	6.4	6.2	6.1	5.9	5.8	5.7
10	10.0	9.9	9.8	9.7	9.6	9.4	9.3	9.1	8.9	8.8	8.6	8.4	8.2	8.0	7.8	7.6	7.4	7.3	7.1
12	11.9	11.9	11.8	11.6	11.5	11.3	11.1	10.9	10.7	10.5	10.3	10.1	9.8	9.6	9.4	9.1	8.9	8.7	8.5
14	13.9	13.8	13.7	13.6	13.4	13.2	13.0	12.8	12.5	12.3	12.0	11.7	11.2	11.2	10.9	10.7	10.4	10.2	9.9
16	15.9	15.8	15.7	15.5	15.3	15.1	14.9	14.6	14.3	14.0	13.7	13.4	13.1	12.8	12.5	12.2	11.9	11.6	11.3
18	17.9	17.8	17.7	17.5	17.2	17.0	16.7	16.4	16.1	15.8	15.4	15.1	14.7	14.4	14.1	13.7	13.4	13.1	12.7
20	19.9	19.8	19.6	19.4	19.2	18.9	18.6	18.2	17.9	17.5	17.1	16.8	16.4	16.0	15.6	15.2	14.9	14.5	14.1
22	21.9	21.8	21.6	21.3	21.1	20.8	20.4	20.1	19.7	19.3	18.9	18.4	18.0	17.6	17.2	16.8	16.4	15.9	15.6
24	23.9	23.7	23.5	23.3	23.0	22.7	22.3	21.9	21.5	21.0	20.6	20.1	19.7	19.2	18.7	18.3	17.8	17.4	17.0
26	25.9	25.7	25.5	25.2	24.9	24.5	24.1	23.7	23.3	22.8	22.3	21.8	21.3	20.8	21.3	19.8	19.3	19.8	18.4
28	27.9	27.7	27.5	27.2	26.8	26.4	26.0	25.5	25.0	24.5	24.0	23.5	22.4	22.9	21.9	21.3	20.8	20.3	19.8
30	29.9	29.7	29.4	29.1	28.7	28.3	27.9	27.4	26.8	26.3	25.7	25.2	24.6	24.0	23.4	22.9	22.3	21.7	21.2
32	31.8	31.6	31.4	31.0	30.7	30.2	29.7	29.2	28.6	28.0	27.4	26.8	26.2	25.6	25.0	24.4	23.8	23.2	22.6
34	33.8	33.6	33.3	33.0	32.6	32.1	31.6	31.0	30.4	29.8	29.2	28.5	27.9	27.2	26.5	25.9	25.3	24.6	24.0
36	35.8	35.6	35.3	34.9	34.5	34.0	33.4	32.8	32.2	31.5	30.9	30.2	29.5	28.8	28.1	27.4	26.8	26.1	25.5
38	37.8	37.6	37.3	37.0	36.4	35.9	35.3	34.7	34.0	33.3	32.6	31.9	31.1	30.4	29.7	29.0	28.2	27.5	26.9
40	39.8	39.6	39.2	38.8	38.3	37.8	37.1	36.5	35.8	35.0	34.3	33.5	32.8	32.0	31.2	30.5	29.7	29.0	28.3
42	41.8	41.5	41.2	40.7	40.2	39.6	39.0	38.3	37.6	36.8	36.0	35.2	34.4	33.6	32.8	32.0	31.2	30.4	29.7
44	43.8	43.5	43.1	42.7	42.1	41.5	40.9	40.1	39.4	38.6	37.7	37.9	36.0	35.2	34.4	33.5	32.7	31.9	31.1
46	45.8	45.5	45.1	44.6	44.1	43.4	42.7	41.9	41.1	40.3	39.4	38.6	37.7	36.8	35.9	35.0	34.2	33.3	32.5
48	47.8	47.5	47.1	46.6	46.0	45.3	44.6	43.8	42.9	42.1	41.2	40.2	39.3	38.4	37.5	36.6	35.7	34.8	33.9
50	49.8	49.4	49.0	48.5	47.9	47.2	46.4	45.6	44.7	43.8	42.9	41.9	41.0	40.0	39.0	38.1	37.2	36.2	35.4
52	51.7	51.4	51.0	50.4	49.8	49.1	48.3	47.4	46.5	45.6	44.6	43.6	42.6	41.6	40.6	39.6	38.7	37.7	36.8
54	53.7	53.4	53.0	52.4	51.7	51.0	50.1	49.2	48.3	47.3	46.3	45.3	44.2	43.2	42.2	41.1	40.1	39.1	38.2
56	55.7	55.4	54.9	54.3	53.6	52.9	52.0	51.1	50.1	49.1	48.0	47.0	45.9	44.8	43.7	42.7	41.6	40.6	39.6
58	57.7	57.4	56.9	56.3	55.6	54.7	53.9	52.9	51.9	50.8	49.7	48.6	47.5	46.4	45.3	44.2	43.1	42.0	41.0
60	59.7	59.3	58.8	58.2	57.5	56.6	55.7	54.7	53.7	52.6	51.4	50.3	49.1	48.0	46.8	45.7	44.6	43.5	42.4
62	61.7	61.3	60.8	60.1	59.4	58.5	57.6	56.5	55.5	54.3	53.2	52.0	50.8	49.6	48.4	47.2	46.1	44.9	43.8
64	63.7	63.3	62.8	62.1	61.3	60.4	59.4	58.4	57.2	56.1	54.9	53.7	52.4	51.2	50.0	48.8	47.6	46.4	45.3
66	65.7	65.3	64.7	64.0	63.2	62.3	61.3	60.2	59.0	57.8	56.6	55.3	54.1	52.8	51.5	50.3	49.1	47.8	46.7
68	67.7	67.2	66.7	66.0	65.1	64.2	63.1	62.0	60.8	59.6	58.3	57.0	55.7	54.4	53.1	51.8	50.5	49.3	48.1
70	69.7	69.2	68.6	67.9	67.0	66.1	65.0	63.8	62.6	61.3	60.0	58.7	57.3	56.0	54.7	53.3	52.0	50.7	49.5
72	71.6	71.2	70.6	69.9	69.0	68.0	66.9	65.7	64.4	63.1	61.7	60.4	59.0	57.6	56.2	54.9	53.5	52.2	50.9
74	73.6	73.2	72.6	71.8	70.9	69.8	68.7	67.5	66.2	64.8	63.5	62.0	60.6	59.2	57.8	56.4	55.0	53.6	52.3
76	75.6	75.2	74.5	73.7	72.8	71.7	70.6	69.3	68.0	66.6	65.2	63.7	62.3	60.8	59.3	57.9	56.5	55.1	53.7
78	77.6	77.1	76.5	75.7	74.7	73.6	72.4	71.1	69.8	68.3	66.9	65.4	63.9	62.4	60.9	59.4	58.0	56.5	55.2
80	79.6	79.1	78.4	77.6	76.6	75.5	74.3	73.0	71.6	70.1	68.6	67.1	65.5	64.0	62.5	61.0	59.5	58.0	56.6
82	81.6	81.1	80.4	79.6	78.5	77.4	76.1	74.8	73.3	71.9	70.3	68.8	67.2	65.6	64.0	62.5	61.0	59.4	58.0
84	83.6	83.1	82.4	81.5	80.5	79.3	78.0	76.6	75.1	73.6	72.0	70.4	68.8	67.2	65.6	64.0	62.4	60.9	59.4
86	85.6	85.0	84.3	83.4	82.4	81.2	79.9	78.4	76.9	75.4	73.7	72.1	70.4	68.8	67.1	65.5	53.9	62.3	60.8
88	87.6	87.0	86.3	85.4	84.3	83.1	81.7	80.2	78.7	77.1	75.5	73.8	72.1	70.4	68.7	67.0	65.4	63.8	62.2
90	89.6	89.0	88.3	87.3	86.2	85.0	83.6	82.1	80.5	78.9	77.2	75.5	73.7	72.0	70.3	68.6	66.9	65.2	63.6
92	91.5	91.0	90.2	89.3	88.1	86.8	85.4	83.9	82.3	80.6	78.9	77.1	75.4	73.6	71.8	70.1	68.4	66.7	65.1
94	93.5	93.0	92.2	91.2	90.0	88.7	87.3	85.7	84.1	82.4	80.6	78.8	77.0	75.2	73.4	71.6	69.9	68.1	66.5
96	95.5	94.9	94.1	93.1	92.0	90.6	89.1	87.5	85.9	84.1	82.3	80.5	78.6	76.8	75.0	73.1	71.4	69.6	67.9
98	97.5	96.9	96.1	95.1	93.9	92.5	91.0	89.4	87.7	85.9	84.0	82.2	80.3	78.4	76.5	74.7	72.8	71.0	69.3
100	99.5	98.9	98.1	97.0	95.8	94.4	92.8	91.2	89.4	87.6	85.7	83.8	81.9	80.0	78.1	76.2	74.3	72.5	70.7

WEIGHTS AND MEASURES

LINEAR UNITS

1 foot=12 inches.
1 yard=36 inches (3 feet).
1 rod=16.5 feet (5.5 yards).
1 mile=5,280 feet (1,760 yards, 320 rods, 80 chains).

Gunthers

1 chain=66 feet (4 rods, 100 links).
1 link=7.92 inches (0.66 foot).

SURFACE

1 square foot=144 square inches.
1 square yard=1,296 square inches (9 square feet).
1 acre=43,560 square feet (4,840 square yards, 160 square rods, 10 square chains).
1 square mile=27,878,400 square feet (3,097,600 square yards, 640 acres).

VOLUME

1 cubic foot=1,728 cubic inches.
1 cubic foot=7.48 United States gallons.
1 cubic yard=46,656 cubic inches (27 cubic feet).
1 acre-foot=325,851 gallons United States liquid (43,560 cubic feet; 1,613.333+ cubic yards).

WEIGHT

1 pound=16 ounces.
1 ton, ordinary=2,000 pounds.
1 ton, long=2,240 pounds.

Water

1 cubic foot weighs 62.4283 pounds.
1 cubic yard weighs 1,685.56 pounds.
1 United States gallon weighs 8.34545 pounds.
1 United States gallon=231 cubic inches.
1 Imperial gallon weighs 10.0172 pounds.
1 Imperial gallon=277.27 cubic inches.

Timber

	Weight per f. b. m.			
	Logs	Lumber		
		Green	Dry, rough	Dry, surface
Sugar pine	7.25	4.50	2.50	2.00
California white pine	7.00	3.50	2.50	2.00
White fir (coast)	7.00	4.50	2.70	2.20
Douglas fir	7.00	3.50	3.00	2.50
Western yellow pine	7.00	3.50	2.60	1.90
Western white pine	6.00	3.50	2.40	1.80
Redwood	7.00	3.50	2.40	2.00
Larch	9.00	4.00	2.80	2.50
Spruce	7.00	3.00	2.60	2.30
Western hemlock	8.00	3.50	3.00	2.50
Red cedar	5.50	3.00	2.20	1.70

Materials

	Weight per cubic foot, pounds
Brick (common building)	125
Cement (Portland)	75–90
Concrete 1:2:4 mix (gravel)	152
Concrete 1:3:6 mix (about 5 pounds less).	
Earth:	
Common, loose, and dry	70
Common, moist, and rammed	100
Sand or gravel, loose and dry	100
Sand or gravel, wet	120
Masonry:	
Mortar rubble	155
Dry rubble	125
Crushed gravel	95–104
Crushed granite	90
Crushed limestone	94

WIRE NAILS

Size	Length	Number per pound	Size	Length	Number per pound
	Inches			*Inches*	
2d	1	900	20d	4	29
3d	1¼	615	30d	4½	23
4d	1½	322	40d	5	17
5d	1¾	250	50d	5½	13½
6d	2	200	60d	6	10½
7d	2¼	154	70d	7	7
8d	2½	106	80d	8	6
9d	2¾	85	90d	9	5
10d	3	74	100d	10	4
12d	3¼	57	120d	12	3
16d	3½	46			

FENCE STAPLES

Size	Number per pound	Size	Number per pound	Size	Number per pound
1 inch	108	1¼ inches	87	1¾ inches	65
1⅓ inches	96	1½ inches	72	2 inches	58

ABNEY LEVEL—BUBBLE ADJUSTMENT

Select two trees or other objects about 100 feet apart on nearly level ground, as shown in figure. Set a mark at *a;* then move to *b*. Set the index arm of the Abney at 0 and sight *a* from *b;* move the Abney up and down at *b* till some point is found which apparently is on a level line through *a*. Mark the point at *b*.

Now move to position *c* and repeat the operations that were performed at *b* and determine point *c*. Set a point *d* midway between *a* and *c* which produces the true level line *db* from which the adjustment should be made.

As a final test, read up and down between two definite objects on a steep slope (30 to 45 per cent). If both readings are identical, the instrument is in good adjustment.