

4/17

DIETZGEN

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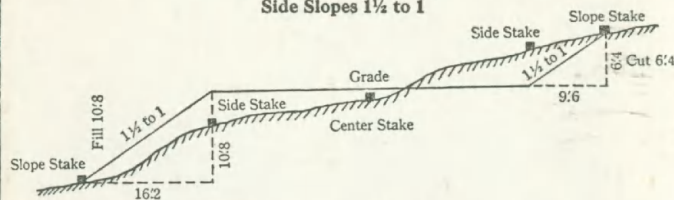
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DISTANCES FROM SIDE STAKES FOR CROSS-SECTIONING

Roadway of any Width

Side Slopes 1½ to 1



In the figure above: Opposite 6 under "Cut or Fill" and under .4 read 9.6 the distance from the side stake to the slope stake at right. Opposite 10 under "Cut or Fill" and under .8 read 16.2, the distance from the side stake to the slope stake at the left.

Cut or Fill	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	Cut or Fill
Distance out from Side or Shoulder Stake											
0	0.0	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	0
1	1.5	1.7	1.8	2.0	2.1	2.3	2.4	2.6	2.7	2.9	1
2	3.0	3.2	3.3	3.5	3.6	3.8	3.9	4.1	4.2	4.4	2
3	4.5	4.7	4.8	5.0	5.1	5.3	5.4	5.6	5.7	5.9	3
4	6.0	6.2	6.3	6.5	6.6	6.8	6.9	7.1	7.2	7.4	4
5	7.5	7.7	7.8	8.0	8.1	8.3	8.4	8.6	8.7	8.9	5
6	9.0	9.2	9.3	9.5	9.6	9.8	9.9	10.1	10.2	10.4	6
7	10.5	10.7	10.8	11.0	11.1	11.3	11.4	11.6	11.7	11.9	7
8	12.0	12.2	12.3	12.5	12.6	12.8	12.9	13.1	13.2	13.4	8
9	13.5	13.7	13.8	14.0	14.1	14.3	14.4	14.6	14.7	14.9	9
10	15.0	15.2	15.3	15.5	15.6	15.8	15.9	16.1	16.2	16.4	10
11	16.5	16.7	16.8	17.0	17.1	17.3	17.4	17.6	17.7	17.9	11
12	18.0	18.2	18.3	18.5	18.6	18.8	18.9	19.1	19.2	19.4	12
13	19.5	19.7	19.8	20.0	20.1	20.3	20.4	20.6	20.7	20.9	13
14	21.0	21.2	21.3	21.5	21.6	21.8	21.9	22.1	22.2	22.4	14
15	22.5	22.7	22.8	23.0	23.1	23.3	23.4	23.6	23.7	23.9	15
16	24.0	24.2	24.3	24.5	24.6	24.8	24.9	25.1	25.2	25.4	16
17	25.5	25.7	25.8	26.0	26.1	26.3	26.4	26.6	26.7	26.9	17
18	27.0	27.2	27.3	27.5	27.6	27.8	27.9	28.1	28.2	28.4	18
19	28.5	28.7	28.8	29.0	29.1	29.3	29.4	29.6	29.7	29.9	19
20	30.0	30.2	30.3	30.5	30.6	30.8	30.9	31.1	31.2	31.4	20
21	31.5	31.7	31.8	32.0	32.1	32.3	32.4	32.6	32.7	32.9	21
22	33.0	33.2	33.3	33.5	33.6	33.8	33.9	34.1	34.2	34.4	22
23	34.5	34.7	34.8	35.0	35.1	35.3	35.4	35.6	35.7	35.9	23
24	36.0	36.2	36.3	36.5	36.6	36.8	36.9	37.1	37.2	37.4	24
25	37.5	37.7	37.8	38.0	38.1	38.3	38.4	38.6	38.7	38.9	25
26	39.0	39.2	39.3	39.5	39.6	39.8	39.9	40.1	40.2	40.4	26
27	40.5	40.7	40.8	41.0	41.1	41.3	41.4	41.6	41.7	41.9	27
28	42.0	42.2	42.3	42.5	42.6	42.8	42.9	43.1	43.2	43.4	28
29	43.5	43.7	43.8	44.0	44.1	44.3	44.4	44.6	44.7	44.9	29
30	45.0	45.2	45.3	45.5	45.6	45.8	45.9	46.1	46.2	46.4	30
31	46.5	46.7	46.8	47.0	47.1	47.3	47.4	47.6	47.7	47.9	31
32	48.0	48.2	48.3	48.5	48.6	48.8	48.9	49.1	49.2	49.4	32
33	49.5	49.7	49.8	50.0	50.1	50.3	50.4	50.6	50.7	50.9	33
34	51.0	51.2	51.3	51.5	51.6	51.8	51.9	52.1	52.2	52.4	34
35	52.5	52.7	52.8	53.0	53.1	53.3	53.4	53.6	53.7	53.9	35
36	54.0	54.2	54.3	54.5	54.6	54.8	54.9	55.1	55.2	55.4	36
37	55.5	55.7	55.8	56.0	56.1	56.3	56.4	56.6	56.7	56.9	37
38	57.0	57.2	57.3	57.5	57.6	57.8	57.9	58.1	58.2	58.4	38
39	58.5	58.7	58.8	59.0	59.1	59.3	59.4	59.6	59.7	59.9	39
40	60.0	60.2	60.3	60.5	60.6	60.8	60.9	61.1	61.2	61.4	40

EUGENE DIETZGEN CO.

Property of _____

Address _____

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This Field Book is manufactured of a High Grade 50% Rag Paper having a WATER RESISTING SURFACE, and is sewed with Bing Special Enamel Waterproof thread.

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T 16A

75-76 3L

35-15

Δ 74

244-46

Δ 72

296-55

T 16 75-76 - 1022 LL

75-76 3L

215° 15'

16A

Δ 80

171° 00'

Δ 74

223-46

Δ 72

265-36

Δ 66

281-20

76-20

135-30

76-8

111-00

75-22

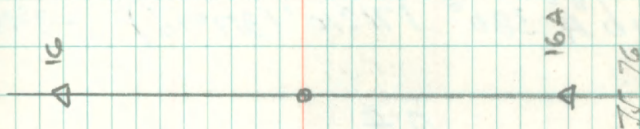
232-00

DL 16A

N 56, 264.6 E 6, 718.9

Δ 74

N 56, 015.4 E 6, 190.5



State Line Dominion N 54° 45' W

171-16

$$\begin{array}{r} 180 \\ 351 \end{array} \begin{array}{l} 10 \\ 10 \end{array}$$

116.

LL Pole 136-08

Tr. House 97-15

HL Pole 96-33

Pump House Pole 185-37

D-14

- 1-30

Hub "A" 380° 171°10' (351°10') - 3°10'

1.4

Hub 16 351°10'

T-1. 660 115°02' (295°02') 4.1

Pole 106-55

H.L. Pole 135-05

Tr. House 77-40

T-2 780 102-05 (282°45')

1-T-2

A 282-05

T-1 200 -3°10' - 234-38 14-38

H.L.P. 137-10

D-80 188-22

Pole 1 265-55

2 292-22

3 281-20

1 294-05

306-15

322-04

T T. 1

4

295.02

T. 2

54-30 (234.30)

D-80

184.47

220 171-10 - 5.35

230 144-40 - 4.05

220 135-10 - 4.10

115 139-10 - 7-10

T. D. 365 115.25 295.253.6

T T. P.

T. T 295.25

145' 272-40

175 255-10

220 233-45

195 225-35

90 233-30

80 214-40

75 133-45

170 121-10

190 157-15

Dolan

274-15

283-50

296-45 4+100

313-40

6.6

327-40

342-45

8'-0"

④

Census.

21-June-1966

Dm. reading.

2219

2593

- 1844

- 2219

6.5

367

- 274

2968

- 2593

Area 366

365

6

6

6

6

Area: $366 \times 159.05 =$

$= 58,213 \text{ Sq. Ft.}$

$58,213 \times 6' = 349,278 \text{ Cu. Ft.}$

$= 12,936 \text{ Cu. Yds.}$

AT-1

TP 250 137-20 (317-20) 5.3

AT.D.

350 94-30

280 89-50

240 82-40

190 81-45

130 55-20

~~110 19~~

150 315-00

Dump. St. 284-10

120 187-10

160 258-10

AT-1.

450 107-15

360 107-15

200 109-00

200 129-10

165 137-10

115 140-00

195 186

I

(2)

June 24 - '66

J. Cleanup.

Plan readings.

$$\begin{array}{r} 1205 \\ - 0946 \\ \hline 259 \end{array} \quad \begin{array}{r} 1463 \\ - 1205 \\ \hline 258 \end{array}$$

Area $259 \times 159.05 = 41,194.95$

$4.5 \times 41,194.95 = 185,373$

$\frac{185,373 \text{ Cu. ft.}}{27} = 6866$

Cu. Yd

(6) Jun 27

Bedrock Channel

9' high.

$$\begin{array}{r} 1423 \\ - 1300 \\ \hline 123 \end{array} \quad \begin{array}{r} 0387 \\ - 0264 \\ \hline 123 \end{array}$$

$123 \times 159.05 = 19,563.15$

$19,563.15 \times 9 = 176,067.35 \text{ Cu. ft.}$

$\frac{176,067.35}{27} = 6521 \text{ Cu. Yd}$

T.-2

240 224.35

260 239.00

280 258.45

310 260.00

360 253.20

June 30 - 1966.

282-08

No 8 Clump

Man readings. area:

$$\begin{array}{r} 7913 \\ - 7665 \\ \hline 248 \end{array}$$

$$\begin{array}{r} 8164 \\ - 7913 \\ \hline 251 \end{array}$$

250 ✓

$$\text{Area } 250 \times 159.05 = \underline{39,763.5} \text{ sq ft} \quad \checkmark$$

$$39,763.5 \times 5' = 198,817.5 \text{ cu ft} \quad \checkmark$$

$$\frac{198,817.5}{27} = \underline{7364 \text{ cu yd}} \quad \checkmark$$

T-1 AD-80

T.P. 370 147-38 (327-32)

T.T.P.

T-1
 327-32
 195 81-50
 170 75-10
 110 94-95
 65 16-20
 90 28-00
 120 31-10
 25 0°10
 160 359°00
 185 337-40
 195 329-00
 210 299-30

July - 5 - 60

No 9. (Overcup)

$$\textcircled{9} - \begin{array}{r} 1702 \\ - 1615 \\ \hline 87 \end{array} - \begin{array}{r} 1793 \\ - 1702 \\ \hline 91 \end{array}$$

I
6' (1/2)

$$\textcircled{6} - \begin{array}{r} 1879 \\ - 1799 \\ \hline 80 \end{array} - \begin{array}{r} 1963 \\ - 1879 \\ \hline 84 \end{array}$$

June 30 N.E.
82

Area $\textcircled{9}$

$$89 \times 159,05 = 14,156.55$$

$$14,156 \times 6' = 84,936 \text{ cu. ft.}$$

Area $\textcircled{6}$

$$82 \times 159,05 = 13,042 \text{ cu. ft.}$$

2' Extra

26,084

84,936

111,020 Cu. ft.

= 4110 Cu. yds

T.T.-2

305 320.00

250 323-10

270 332-48

230 343-10

230 0.00

360 5.00

410 358-30

Buy 358-20

B/P-1 359-35

D-88 282-00

T.T.-2

D-8 188-22

T.P. 200 112-10 292-10

T.T.P

D-8 192-55

1 150 413-40

95 149-40

35 168.00

60 208-00

125 254-00

120 235

104°

July 8 - '66

10. Newcap

Area: read. 5850

-5745
105

5957

-5850
107

$$106 \times 159.05 = 16,859 \text{ sq. ft.}$$

$$16,859 \times 8 = 134,872 \text{ cu. ft.}$$

$$\frac{134,872}{27} = 4995 \text{ cu. yds.}$$

July 14 - 12

10. Corners

2881 2920
-2881
93 99 96

$$96 \times 159.05 = 15,269 \text{ sq. ft.}$$

$$15,269 \times 8 = 122,152 \text{ cu. ft.}$$

$$\frac{122,152}{27} = 4524 \text{ cu. yds.}$$

$\overline{17-2}$
 380 261-20
 350 266-20
 280 258-35
 220 241-50
 180 215-41

$\overline{17-2}$
 145 133-30
 75 146-00
 95 265-00
 160 242-30

12. Cl. up. July - 15 - 1966

3740
 $- 3666$
74

3884
 $- 3813$
71

73

Area:

$$73 \times 159.05 = 11,610.94$$

$$11,610 \times 6' = 69,660 \text{ Cu. Ft.}$$

$$\frac{69,660}{27} = 2,580 \text{ Cu. Yd.}$$

(13)

July 19, 1966

3125
 $- 2973$
152

3275
 $- 3125$
150

Aug 15

$$151 \times 159.05 = 24,017.55$$

$$24,017 \times 7' = 168,119$$

$$\frac{168,119}{27} = 6227 \text{ Cu. Yd.}$$

T-2

500 123-00
430 119-50
470 110-10
320 108-15
250 106-50

Aug. 6' High

T-A

T-3 840 101-06 (281-06)

T-T-3

A. 281-06

460 134-00
400 114-95
360 114-00
185 115-00

269.55

July - 22 - '60

14. C.I.O.

	2767	2892
Plan. Read.	- 2646	- 2767
	121	125

$$121 \times 159.05 = 19,245 \text{ G. I.}$$

$$19,245 \times 6 = 115,470 \text{ Cu. Ft.}$$

$$\frac{115,470}{27} = 4277 \text{ Cu. Ft.}$$

July - 26 - 66

15.

Plan. read.

2829	2910	2991
- 2791	- 2829	- 2910
38	81	81

$$81 \times 159.05 = 12,883 \text{ G. Ft.}$$

$$\frac{12,883}{32,128}$$

$$32,128 \times 4 = 128,512 \text{ Cu. Ft.}$$

$$\frac{128,512}{27} = 4760 \text{ Cu. Ft.}$$

A-T-3.

310 280.00
 370 281.50
 440 282.45
 490 279.00
 510 275.30

Hill. B/e 137-25
 4 189.37

A-T-3

270 112-20
 110 117-10
 135 153° -10°

July-29.

4260	4429	
-4085	-4260	
<u>175</u>	<u>169</u>	172

$$172 \times 159.05 = 27,357 \text{ G.Ft.}$$

$$27,357 \times 5 = 137,785 \text{ Cu Ft}$$

137,785
 27

5103
 1 Cu. $\frac{1}{4}$

Aug. -1 - '66.

5875
 -5793
82

5958
 -5875
83

$$83 \times 159.05 = 13,201 \text{ G.Ft.}$$

$$13,201 \times 8 = 105,608 \text{ Cu. Ft.}$$

105,608
 27 = 3911 Cu. $\frac{1}{10}$

Hub A Aug-5-66

550 102-05
450 99-50
340 95-30
250 91-00
200 84-40
170 112-40

Hub A Aug 8-66

700 98-10
535 84-00
520 77-00
Com. 480 64-45
360 71-30
280 84-00

17

5676
- 5475
201
5878
- 5676
202

$$202 \times 159.05 = 32,128 \text{ G. It}$$

$$32,128 \text{ G. It} \times 5' = 160,640 \text{ Cu. ft}$$

$$\frac{160,640}{27} = 5950 \text{ Cu. ft}$$

6828
- 6395
433
7256
- 6828
428

Aug 436

68391

Area $159.05 \times 436 = 69,346 \text{ G. It.}$

$$69,346 \times 3' = 208,038$$

$$\frac{208,038}{27} = 7705 \text{ Cu. ft}$$

110 $\bar{A}$ 113-10

$\bar{A}$ 4064

670 96-20

530 84-50

500 72-10

440 64-20

370 51-30

270 42-00

$\bar{A}$ 4

23 23 47

280 48-00

215 60-00

190 35-00

80 100-00

T.P. 100' 105-35 (285-35)

$\bar{A}$ T.P.

T.P. 100' 74-55

Pole 49-00

20 40

Area same as 18 40 (2. 140)

$$68,391 \text{ Sq. Ft.} \times 2.5 = 170,978 \text{ Cu. Ft.}$$

$$\frac{170,978}{27} = 6,333 \text{ Cu. Yds.}$$

$$\begin{array}{r} 5361 \\ - 5218 \\ \hline 143 \end{array}$$

$$\begin{array}{r} 5505 \\ - 5361 \\ \hline 144 \end{array}$$

$$159,05 \times 144 = 22,903 \text{ Sq. Ft.}$$

$$22,903 \times 6 = 137,418 \text{ Cu. Ft.}$$

$$\frac{137,418}{27} = 5,090 \text{ Cu. Yds.}$$

T.P 135 173-10 353-10 23rd Aug 26.
Cleanup

T.P.

H.L 135-2645

100 127-10

20 203-30

120 287-20

130 272-40

100 177-30

160 157-00

T.P.

115 288-30

170 263-30

110 210-30

190 206-20

200 194-30

200 167-00

6000
-1861
149

6139
-6000
139

6273
-6133
140

$$159,05 \times 140 = 22,267 \text{ Gt}$$

$$22,267 \times 4 = 89,068 \text{ Gt}$$

$$\frac{89,068}{27} = 3299 \text{ Cu. lbs}$$

5000
-4869
131

5133
-5000
133

132

$$159,05 \times 132 = 20,995 \text{ Gt}$$

$$20,995 \times 4 = 83,980 \text{ Gt}$$

$$\frac{83,980}{27} = 3110 \text{ Cu. lbs}$$

106,006

T.T.P

270 167-50

Dumpst 187-10

185 199-40

T.T.P. Sept-6.

200 288-10

240 270-30

280 208-00

Sept-1-'60

3369

- 3211

158

3125

- 3369

161

160.

$$159,05 \times 160 = 25,448 \text{ Gt}$$

$$25,448 \times 5 = 127,240 \text{ Cu. Ft}$$

$$\frac{127,240}{27} = 4713 \text{ Cu. Yd}$$

Sept 6-66

6772

- 6640

- 132

8898

- 6772

126

129.

$$159,05 \times 129 = 20,518 \text{ Gt}$$

$$20,518 \times 6 = 123,108 \text{ Cu. Ft}$$

$$\frac{123,108}{27} = 4560 \text{ Cu. Yd}$$

T.T.D
 Dump Pt. 187-10
 300' 293-10
 380' 292-30
 420' 274-50

T.T.P. Sept 12
 370 292-30
 430 267-15
 360 259-30

5332 5403
 - 5260 - 5332
 72 71

Aug. Area: $72 \times 15905 = 11452$
 11,452 $\times 5 = 57260$ Cu. Ft.

Sept. 9-60
 Plan. readings:

6978
 - 6789
 189

7169
 - 6978
 191 ≈ 190

$159,05 \times 190 = 30,220$ Sq. Ft.

$30,220 \times 3.5' = 105,770$ Cu. Ft.

$\frac{105,770 \text{ Cu. Ft.}}{27} = 3,917$ Cu. Yds.

From previous Aug.

$30,220 \times 1.5 = 45,330$

45,330 Cu. Ft.

57,260 Cu. Ft.

102,590

$\frac{102,590}{27} = 3800$ Cu. Yds.

29 Cleanup. Sept-15-60

$$\begin{array}{r} \text{Area: } 1946 \\ - 1824 \\ \hline 122 \end{array} \quad \begin{array}{r} 2067 \\ - 1946 \\ \hline 121 \end{array}$$

$$159.05 \times 122 = 19,404 \text{ Sq. Ft.}$$

$$19,404 \times 6 = 116,424 \text{ Cu. Ft.}$$

$$\frac{116,424}{27} = \underline{\underline{4312 \text{ Cu. Yd}}}$$

31 Cleanup Sept 20-60

Plan Baseline.

$$\begin{array}{r} 0665 \\ - 0592 \\ \hline 73 \end{array} \quad \begin{array}{r} 0735 \\ - 0665 \\ \hline 70 \end{array}$$

$$159.05 \times 72 = 11,452 \text{ Sq. Ft.}$$

$$11,452 \times 3 = 34,356 \text{ Cu. Ft.}$$

$$\frac{34,356}{27} = \underline{\underline{1,273 \text{ Cu. Yd}}}$$

Dr. No G.

200 T/House 0.-0

Tr. Hg. 253-54

Stacker. 109-50

330 49-50

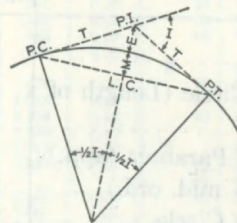
300 30-10

240 26-15

175 27-40

CURVE AND REDUCTION TABLES

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CURVE FORMULAS

1. Radius : $R = \frac{50}{\sin D/2}$
2. Degree of Curve: $D = 100 \frac{I}{L}$. Also, $\sin D/2 = \frac{50}{R}$
3. Tangent : $T = R \tan \frac{1}{2} I$. Also, $T = \frac{T \text{ for } 1^\circ \text{ curve}}{D} + C$.
4. Length of Curve: $L = 100 \frac{I}{D}$
5. Long Chord : $L.C. = 2R \sin \frac{1}{2} I$.
6. Middle Ordinate: $M = R (1 - \cos \frac{1}{2} I)$
7. External : $E = \frac{R}{\cos \frac{1}{2} I} - R$. Also, $E = T \tan \frac{1}{4} I$.

EXPLANATION AND USE OF TABLES

Given P.I. Sta. 83+40.7, $I = 45^\circ 20'$ and $D = 6^\circ 30'$ find:

Stations—P.C. = P.I. - T. $T = \frac{T \text{ for } 1^\circ \text{ Curve}}{D} + C$. From Tables V and VI
 $T = \frac{2392.8}{6.5} + .197 = 368.32 = 3 + 68.32$. Sta. P. C. = 83+40.7 - (3+68.32) = 79+72.38.

P. T. = P. C. + L, and $L = 100 \frac{I}{D} = 100 \frac{45.33}{6.5} = 697.38$. Therefore, P. T. = (79+72.38) + (6+97.38) = 86+69.76.

Offsets—Tangent offsets vary (approximately) directly with D and with the square of the distance. From Table III Tangent Offset for 100 feet = 5.669 feet. Distance = 80 - Sta. P. C. = 27.62. Hence offset = $5.66 \times \left(\frac{27.62}{100}\right)^2 = .432$ ft. Also, square of any distance, divided by twice the radius equals (approximately) the distance from tangent to curve. Thus $(27.62)^2 \div (2 \times 881.95) = .432$ ft.

Deflections—Deflection angle = $\frac{1}{2} D$ for 100 ft., $\frac{1}{4} D$ for 50 ft., etc. For "X" ft., Deflection Angle (in minutes) = $.3 \times X \times D$. For Sta. 80 of above curve Deflection Angle = $.3 \times 27.62 \times 6.5 = 53.86'$. Also Deflection Angle = dfl. for 1 ft. from Table III $\times X = 1.95 \times 27.62 = 53.86'$. For Sta. 181 Deflection Angle = $53.86' + \frac{6^\circ 30'}{2} = 4^\circ 8.86'$.

Externals—From Table V for 1° curve, with central angle of $45^\circ 20'$, $E = 479.6$. Therefore, for $6^\circ 30'$ curve, $E = \frac{479.6}{6.5} + \text{Correction from Table VI} = 7.378 + .039 = 7.417$.

General Equations and Useful Data

	Symbol on Equation	Numerical Value
Area of circle.....	$\frac{\pi d^2}{4}$	
Area of Sector of Circle (Length of arc = l).....	$1/2 lr$	
Area of Segment of Parabola (app.) (c = chord; m = mid. ord.).....	$2/3 cm$	
Area of Segment of Circle.....	$2/3 cm$	
Cubic Feet in 1 Cubic Meter.....		35.3145
Cubic Inches in 1 Imperial Gallon.....		277.274
Cubic Inches in 1 U.S. Gallon.....		231
Feet in 1 Meter.....		3.2808
Feet in 1 Mile.....		5280
Gallons (Imperial) in 1 Cubic Foot.....		6.2321
Gallons (U.S.) in 1 Cubic Foot.....		7.48
Miles in 1 Kilometer.....		0.6213
Pounds (Av.) in 1 Kilogram.....		2.2046
Ratio of Circumference to Diameter	π	3.14159
Reciprocal of π		0.31831
Square Feet in 1 Acre.....		43,560
Volume of Sphere.....	$4/3 \pi r^3$	

Table I.—Minutes in Decimals of a Degree.

1'	.0167	11'	.1833	21'	.3500	31'	.5167	41'	.6833	51'	.8500
2	.0333	12	.2000	22	.3667	32	.5333	42	.7000	52	.8667
3	.0500	13	.2167	23	.3833	33	.5500	43	.7167	53	.8833
4	.0667	14	.2333	24	.4000	34	.5667	44	.7333	54	.9000
5	.0833	15	.2500	25	.4167	35	.5833	45	.7500	55	.9167
6	.1000	16	.2667	26	.4333	36	.6000	46	.7667	56	.9333
7	.1167	17	.2833	27	.4500	37	.6167	47	.7833	57	.9500
8	.1333	18	.3000	28	.4667	38	.6333	48	.8000	58	.9667
9	.1500	19	.3167	29	.4833	39	.6500	49	.8167	59	.9833
10	.1667	20	.3333	30	.5000	40	.6667	50	.8333	60	1.0000

Table II.—Inches in Decimals of a Foot.

$\frac{1}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729				
1	2	3	4	5	6	7	8	9	10	11				
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167				

Table III.—Radii, Ordinates and Deflections

Deg.	Radius	Mid. Ord.	Tan Offset	Def. for 1 Foot	Deg.	Radius	Mid. Ord.	Tan Offset	Def. for 1 Foot
0° 10'	34377.5	.036	.145	0.05'	7°	819.02	1.528	6.105	2.10'
20	17188.8	.073	.291	0.10	20	781.84	1.600	6.395	2.20
30	11459.2	.109	.436	0.15	30	764.49	1.637	6.540	2.25
40	8594.42	.145	.582	0.20	40	747.89	1.673	6.685	2.30
50	6875.55	.182	.727	0.25					
1	5729.65	.218	.873	0.30	8	716.78	1.746	6.976	2.40
10	4911.15	.255	1.018	0.35	20	688.16	1.819	7.266	2.50
20	4297.28	.291	1.164	0.40	30	674.69	1.855	7.411	2.55
30	3819.83	.327	1.309	0.45	40	661.74	1.892	7.556	2.60
40	3437.87	.364	1.454	0.50	9	637.28	1.965	7.846	2.70
50	3125.36	.400	1.600	0.55	20	614.56	2.037	8.136	2.80
2	2864.93	.436	1.745	0.60	30	603.80	2.074	8.281	2.85
10	2644.58	.473	1.891	0.65	40	593.42	2.110	8.426	2.90
20	2455.70	.509	2.036	0.70	10	573.69	2.183	8.716	3.00
30	2292.01	.545	2.181	0.75	30	546.44	2.292	9.150	3.15
40	2148.79	.582	2.327	0.80	11	521.67	2.402	9.585	3.30
50	2022.41	.618	2.472	0.85	12	499.06	2.511	10.02	3.45
3	1910.08	.655	2.618	0.90	30	478.34	2.620	10.45	3.60
10	1809.57	.691	2.763	0.95	13	459.28	2.730	10.89	3.75
20	1719.12	.727	2.908	1.00	30	441.68	2.839	11.32	3.90
30	1637.28	.764	3.054	1.05	14	425.40	2.949	11.75	4.05
40	1562.88	.800	3.199	1.10	30	410.28	3.058	12.18	4.20
50	1494.95	.836	3.345	1.15	15	396.20	3.168	12.62	4.35
4	1432.69	.873	3.490	1.20	16	383.07	3.277	13.05	4.50
10	1375.40	.909	3.635	1.25	30	370.78	3.387	13.49	4.65
20	1322.53	.945	3.718	1.30	17	359.27	3.496	13.92	4.80
30	1273.57	.982	3.926	1.35	30	348.45	3.606	14.35	4.95
40	1228.11	1.018	4.071	1.40	18	338.27	3.716	14.78	5.10
50	1185.78	1.055	4.217	1.45	19	319.62	3.935	15.64	5.40
5	1146.28	1.091	4.362	1.50	20	302.94	4.155	16.51	5.70
10	1109.33	1.127	4.507	1.55	21	287.94	4.374	17.37	6.00
20	1074.68	1.164	4.653	1.60	22	274.37	4.594	18.22	6.30
30	1042.14	1.200	4.798	1.65	23	262.04	4.814	19.08	6.60
40	1011.51	1.237	4.943	1.70	24	250.79	5.035	19.94	6.90
50	982.64	1.273	5.088	1.75	25	240.49	5.255	20.79	7.20
6	955.37	1.309	5.234	1.80	26	231.01	5.476	21.64	7.50
10	929.57	1.346	5.379	1.85	27	222.27	5.697	22.50	7.80
20	905.13	1.382	5.524	1.90	28	214.18	5.918	23.35	8.10
30	881.95	1.418	5.669	1.95	29	206.68	6.139	24.19	8.40
40	859.92	1.455	5.814	2.00	30	199.70	6.360	25.04	8.70
						193.18	6.583	25.88	9.00

NOTE. Chord Deflection = 2 times tangent deflection.

Table IV.—Deflections for Sub Chords for Short Radius Curves

Degree of Curve	Radius	Deflection Angles for Sub Chords of Various Lengths				Length of Arc for 100 Ft. Chord
		12.5 Ft.	15 Ft.	20 Ft.	25 Ft.	
30°	193.18	1° 51'	2° 17'	2° 58'	3° 43'	101.15
32°	181.39	1° 59'	2° 25'	3° 10'	3° 58'	101.33
34°	171.01	2° 06'	2° 33'	3° 21'	4° 12'	101.48
36°	161.80	2° 13'	2° 41'	3° 33'	4° 26'	101.66
38°	153.58	2° 20'	2° 49'	3° 44'	4° 40'	101.85
40°	146.19	2° 27'	2° 57'	3° 55'	4° 54'	102.06
42°	139.52	2° 34'	3° 05'	4° 07'	5° 08'	102.29
44°	133.47	2° 41'	3° 13'	4° 18'	5° 22'	102.53
46°	127.97	2° 48'	3° 21'	4° 29'	5° 36'	102.76
48°	122.92	2° 55'	3° 29'	4° 40'	5° 50'	103.00
50°	118.31	3° 02'	3° 38'	4° 51'	6° 04'	103.24
52°	114.06	3° 09'	3° 46'	5° 02'	6° 17'	103.54
54°	110.11	3° 16'	3° 54'	5° 13'	6° 31'	103.84
56°	106.50	3° 22'	4° 02'	5° 23'	6° 44'	104.14
58°	103.14	3° 29'	4° 10'	5° 34'	6° 57'	104.43
60°	100.00	3° 35'	4° 18'	5° 44'	7° 11'	104.72

Table V.—Tangents and Externals to a 1° Curve.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
1°	50.00	.22	11°	551.70	26.50	21°	1061.9	97.57
10'	58.34	.30	10'	560.11	27.31	10'	1070.6	99.16
20	66.67	.39	20	568.53	28.14	20	1079.2	100.75
30	75.01	.49	30	576.95	28.97	30	1087.8	102.35
40	83.34	.61	40	585.36	29.82	40	1096.4	103.97
50	91.68	.73	50	593.79	30.68	50	1105.1	105.60
2	100.01	.87	12	602.21	31.56	22	1113.7	107.24
10	108.35	1.02	10	610.64	32.45	10	1122.4	108.90
20	116.68	1.19	20	619.07	33.35	20	1131.0	110.57
30	125.02	1.36	30	627.50	34.26	30	1139.7	112.25
40	133.36	1.55	40	635.93	35.18	40	1148.4	113.95
50	141.70	1.75	50	644.37	36.12	50	1157.0	115.66
3	150.04	1.96	13	652.81	37.07	23	1165.7	117.38
10	158.38	2.19	10	661.25	38.03	10	1174.4	119.12
20	166.72	2.43	20	669.70	39.01	20	1183.1	120.87
30	175.06	2.67	30	678.15	39.99	30	1191.8	122.63
40	183.40	2.93	40	686.60	40.99	40	1200.5	124.41
50	191.74	3.21	50	695.06	42.00	50	1209.2	126.20
4	200.08	3.49	14	703.51	43.03	24	1217.9	128.00
10	208.43	3.79	10	711.97	44.07	10	1226.6	129.82
20	216.77	4.10	20	720.44	45.12	20	1235.3	131.65
30	225.12	4.42	30	728.90	46.18	30	1244.0	133.50
40	233.47	4.76	40	737.37	47.25	40	1252.8	135.35
50	241.81	5.10	50	745.85	48.34	50	1261.5	137.23
5	250.16	5.46	15	754.32	49.44	25	1270.2	139.11
10	258.51	5.83	10	762.80	50.55	10	1279.0	141.01
20	266.86	6.21	20	771.29	51.68	20	1287.7	142.93
30	275.21	6.61	30	779.77	52.89	30	1296.5	144.85
40	283.57	7.01	40	788.26	53.97	40	1305.3	146.79
50	291.92	7.43	50	796.75	55.13	50	1314.0	148.75
6	300.28	7.86	16	805.25	56.31	26	1322.8	150.71
10	308.64	8.31	10	813.75	57.50	10	1331.6	152.69
20	316.99	8.76	20	822.25	58.70	20	1340.4	154.69
30	325.35	9.23	30	830.76	59.91	30	1349.2	156.70
40	333.71	9.71	40	839.27	61.14	40	1358.0	158.72
50	342.08	10.20	50	847.78	62.38	50	1366.8	160.76
7	350.44	10.71	17	856.30	63.63	27	1375.6	162.81
10	358.81	11.22	10	864.82	64.90	10	1384.4	164.86
20	367.17	11.75	20	873.35	66.18	20	1393.2	166.95
30	375.54	12.29	30	881.88	67.47	30	1402.0	169.04
40	383.91	12.85	40	890.41	68.77	40	1410.9	171.15
50	392.28	13.41	50	898.95	70.09	50	1419.7	173.27
8	400.66	13.99	18	907.49	71.42	28	1428.6	175.41
10	409.03	14.58	10	916.03	72.76	10	1437.4	177.55
20	417.41	15.18	20	924.58	74.12	20	1446.3	179.72
30	425.79	15.80	30	933.13	75.49	30	1455.1	181.89
40	434.17	16.43	40	941.69	76.86	40	1464.0	184.08
50	442.55	17.07	50	950.25	78.26	50	1472.9	186.29
9	450.93	17.72	19	958.81	79.67	29	1481.8	188.51
10	459.32	18.38	10	967.38	81.09	10	1490.7	190.74
20	467.71	19.06	20	975.96	82.53	20	1499.6	192.99
30	476.10	19.75	30	984.53	83.97	30	1508.5	195.25
40	484.49	20.45	40	993.12	85.43	40	1517.4	197.53
50	492.88	21.16	50	1001.7	86.90	50	1526.3	199.82
10	501.28	21.89	20	1010.3	88.39	30	1535.3	202.12
10	509.68	22.62	10	1018.9	89.89	10	1544.2	204.44
20	518.08	23.38	20	1027.5	91.40	20	1553.1	206.77
30	526.48	24.14	30	1036.1	92.92	30	1562.1	209.12
40	534.89	24.91	40	1044.7	94.46	40	1571.0	211.48
50	543.29	25.70	50	1053.3	96.01	50	1580.0	213.86

Table V.—Tangents and Externals to a 1° Curve.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
31°	1589.0	216.3	41°	2142.2	387.4	51°	2732.9	618.4
10'	1598.0	218.7	10	2151.7	390.7	10	2743.1	622.8
20	1606.9	221.1	20	2161.2	394.1	20	2753.4	627.2
30	1615.9	223.5	30	2170.8	397.4	30	2763.7	631.7
40	1624.9	226.0	40	2180.3	400.8	40	2773.9	636.2
50	1633.9	228.4	50	2189.9	404.2	50	2784.2	640.7
32	1643.0	230.9	42	2199.4	407.6	52	2794.5	645.2
10	1652.0	233.4	10	2209.0	411.1	10	2804.9	649.7
20	1661.0	235.9	20	2218.6	414.5	20	2815.2	654.3
30	1670.0	238.4	30	2228.1	418.0	30	2825.6	658.8
40	1679.1	241.0	40	2237.7	421.4	40	2835.9	663.4
50	1688.1	243.5	50	2247.3	425.0	50	2846.3	668.0
33	1697.2	246.1	43	2257.0	428.5	53	2856.7	672.7
10	1706.3	248.7	10	2266.6	432.0	10	2867.1	677.3
20	1715.3	251.3	20	2276.2	435.6	20	2877.5	682.0
30	1724.4	253.9	30	2285.9	439.2	30	2888.0	686.7
40	1733.5	256.5	40	2295.6	442.8	40	2898.4	691.4
50	1742.6	259.1	50	2305.2	446.4	50	2908.9	696.1
34	1751.7	261.8	44	2314.9	450.0	54	2919.4	700.9
10	1760.8	264.5	10	2324.6	453.6	10	2929.9	705.7
20	1770.0	267.2	20	2334.3	457.3	20	2940.4	710.5
30	1779.1	269.9	30	2344.1	461.0	30	2951.0	715.3
40	1788.2	272.6	40	2353.8	464.6	40	2961.5	720.1
50	1797.4	275.3	50	2363.5	468.4	50	2972.1	725.0
35	1806.6	278.1	45	2373.3	472.1	55	2982.7	729.9
10	1815.7	280.8	10	2383.1	475.8	10	2993.3	734.8
20	1824.9	283.6	20	2392.8	479.6	20	3003.9	739.7
30	1834.1	286.4	30	2402.6	483.3	30	3014.5	744.6
40	1843.3	289.2	40	2412.4	487.2	40	3025.2	749.6
50	1852.5	292.0	50	2422.3	491.0	50	3035.8	754.6
36	1861.7	294.9	46	2432.1	494.8	56	3046.5	759.6
10	1870.9	297.7	10	2441.9	498.7	10	3057.2	764.6
20	1880.1	300.6	20	2451.8	502.5	20	3067.9	769.7
30	1889.4	303.5	30	2461.7	506.4	30	3078.7	774.7
40	1898.6	306.4	40	2471.5	510.3	40	3089.4	779.8
50	1907.9	309.3	50	2481.4	514.3	50	3100.2	784.9
37	1917.1	312.2	47	2491.3	518.2	57	3110.9	790.1
10	1926.4	315.2	10	2501.2	522.2	10	3121.7	795.2
20	1935.7	318.1	20	2511.2	526.1	20	3132.6	800.4
30	1945.0	321.1	30	2521.1	530.1	30	3143.4	805.6
40	1954.3	324.1	40	2531.1	534.2	40	3154.2	810.9
50	1963.6	327.1	50	2541.0	538.2	50	3165.1	816.1
38	1972.9	330.2	48	2551.0	542.2	58	3176.0	821.4
10	1982.2	333.2	10	2561.0	546.3	10	3186.9	826.7
20	1991.5	336.3	20	2571.0	550.4	20	3197.8	832.0
30	2000.9	339.3	30	2581.0	554.5	30	3208.8	837.3
40	2010.2	342.4	40	2591.0	558.6	40	3219.7	842.7
50	2019.6	345.5	50	2601.1	562.8	50	3230.7	848.1
39	2029.0	348.6	49	2611.2	566.9	59	3241.7	853.5
10	2038.4	351.8	10	2621.2	571.1	10	3252.7	858.9
20	2047.8	354.9	20	2631.3	575.3	20	3263.7	864.3
30	2057.2	358.1	30	2641.4	579.5	30	3274.8	869.8
40	2066.6	361.3	40	2651.5	583.8	40	3285.8	875.3
50	2076.0	364.5	50	2661.6	588.0	50	3296.9	880.8
40	2085.4	367.7	50	2671.8	592.3	60	3308.0	886.4
10	2094.9	371.0	10	2681.9	596.6	10	3319.1	892.0
20	2104.3	374.2	20	2692.1	600.9	20	3330.3	897.5
30	2113.8	377.5	30	2702.3	605.3	30	3341.4	903.2
40	2123.3	380.8	40	2712.5	609.6	40	3352.6	908.8
50	2132.7	384.1	50	2722.7	614.0	50	3363.8	914.5

Table V.—Tangents and Externals to a 1° Curve.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
61°	3375.0	920.2	71°	4086.9	1308.2	81°	4893.6	1805.3
10'	3386.3	925.9	10'	4099.5	1315.6	10'	4908.0	1814.7
20	3397.5	931.6	20	4112.1	1322.9	20	4922.5	1824.1
30	3408.8	937.3	30	4124.8	1330.3	30	4937.0	1833.6
40	3420.1	943.1	40	4137.4	1337.7	40	4951.5	1843.1
50	3431.4	948.9	50	4150.1	1345.1	50	4966.1	1852.6
62°	3442.7	954.8	72°	4162.8	1352.6	82°	4980.7	1862.2
10	3454.1	960.6	10	4175.6	1360.1	10	4995.4	1871.8
20	3465.4	966.5	20	4188.5	1367.6	20	5010.0	1881.5
30	3476.8	972.4	30	4201.2	1375.2	30	5024.8	1891.2
40	3488.3	978.3	40	4214.0	1382.8	40	5039.5	1900.9
50	3499.7	984.3	50	4226.8	1390.4	50	5054.3	1910.7
63°	3511.1	990.2	73°	4239.7	1398.0	83°	5069.2	1920.5
10	3522.6	996.2	10	4252.6	1405.7	10	5084.0	1930.4
20	3534.1	1002.3	20	4265.6	1413.5	20	5099.0	1940.3
30	3545.6	1008.3	30	4278.5	1421.2	30	5113.9	1950.3
40	3557.2	1014.4	40	4291.5	1429.0	40	5128.9	1960.2
50	3568.7	1020.5	50	4304.6	1436.8	50	5143.9	1970.3
64°	3580.3	1026.6	74°	4317.6	1444.6	84°	5159.0	1980.4
10	3591.9	1032.8	10	4330.7	1452.5	10	5174.1	1990.5
20	3603.5	1039.0	20	4343.8	1460.4	20	5189.3	2000.6
30	3615.1	1045.2	30	4356.9	1468.4	30	5204.4	2010.8
40	3626.8	1051.4	40	4370.1	1476.4	40	5219.7	2021.1
50	3638.5	1057.7	50	4383.3	1484.4	50	5234.9	2031.4
65°	3650.2	1063.9	75°	4396.5	1492.4	85°	5250.3	2041.7
10	3661.9	1070.2	10	4409.8	1500.5	10	5265.6	2052.1
20	3673.7	1076.6	20	4423.1	1508.6	20	5281.0	2062.5
30	3685.4	1082.9	30	4436.4	1516.7	30	5296.4	2073.0
40	3697.2	1089.3	40	4449.7	1524.9	40	5311.9	2083.5
50	3709.0	1095.7	50	4463.1	1533.1	50	5327.4	2094.1
66°	3720.9	1102.2	76°	4476.5	1541.4	86°	5343.0	2104.7
10	3732.7	1108.6	10	4489.9	1549.7	10	5358.6	2115.3
20	3744.6	1115.1	20	4503.4	1558.0	20	5374.2	2126.0
30	3756.5	1121.7	30	4516.9	1566.3	30	5389.9	2136.7
40	3768.5	1128.2	40	4530.4	1574.7	40	5405.6	2147.5
50	3780.4	1134.8	50	4544.0	1583.1	50	5421.4	2158.4
67°	3792.4	1141.4	77°	4557.6	1591.6	87°	5437.2	2169.2
10	3804.4	1148.0	10	4571.2	1600.1	10	5453.1	2180.2
20	3816.4	1154.7	20	4584.8	1608.6	20	5469.0	2191.1
30	3828.4	1161.3	30	4598.5	1617.1	30	5484.9	2202.2
40	3840.5	1168.1	40	4612.2	1625.7	40	5500.9	2213.2
50	3852.6	1174.8	50	4626.0	1634.4	50	5517.0	2224.3
68°	3864.7	1181.6	78°	4639.8	1643.0	88°	5533.1	2235.5
10	3876.8	1188.4	10	4653.6	1651.7	10	5549.2	2246.7
20	3889.0	1195.2	20	4667.4	1660.5	20	5565.4	2258.0
30	3901.2	1202.0	30	4681.3	1669.2	30	5581.6	2269.3
40	3913.4	1208.9	40	4695.2	1678.1	40	5597.8	2280.6
50	3925.6	1215.8	50	4709.2	1686.9	50	5614.2	2292.0
69°	3937.9	1222.7	79°	4723.2	1695.8	89°	5630.5	2303.5
10	3950.2	1229.7	10	4737.2	1704.7	10	5646.9	2315.0
20	3962.5	1236.7	20	4751.2	1713.7	20	5663.4	2326.6
30	3974.8	1243.7	30	4765.3	1722.7	30	5679.9	2338.2
40	3987.2	1250.8	40	4779.4	1731.7	40	5696.4	2349.8
50	3999.5	1257.9	50	4793.6	1740.8	50	5713.0	2361.5
70°	4011.9	1265.0	80°	4807.7	1749.9	90°	5729.7	2373.3
10	4024.4	1272.1	10	4822.0	1759.0	10	5746.3	2385.1
20	4036.8	1279.3	20	4836.2	1768.2	20	5763.1	2397.0
30	4049.3	1286.5	30	4850.5	1777.4	30	5779.9	2408.9
40	4061.8	1293.6	40	4864.8	1786.7	40	5796.7	2420.9
50	4074.4	1300.9	50	4879.2	1796.0	50	5813.6	2432.9

Table V.—Tangents and Externals to a 1° Curve.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
91°	5830.5	2444.9	101°	6950.6	3278.1	111°	8336.7	4386.1
10'	5847.5	2457.1	10'	6971.3	3294.1	10'	8362.7	4407.6
20	5864.6	2469.3	20	6992.0	3310.2	20	8388.9	4429.2
30	5881.7	2481.5	30	7012.7	3326.1	30	8415.1	4450.9
40	5898.8	2493.8	40	7033.6	3342.3	40	8441.5	4472.7
50	5916.0	2506.1	50	7054.5	3358.5	50	8468.0	4494.6
92°	5933.2	2518.5	102°	7075.5	3374.9	112°	8494.6	4516.6
10	5950.5	2531.0	10	7096.6	3391.2	10	8521.3	4538.8
20	5967.9	2543.5	20	7117.8	3407.7	20	8548.1	4561.1
30	5985.3	2556.0	30	7139.0	3424.3	30	8575.0	4583.4
40	6002.7	2568.6	40	7160.3	3440.9	40	8602.1	4606.0
50	6020.2	2581.3	50	7181.7	3457.6	50	8629.3	4628.6
93°	6037.8	2594.0	103°	7203.2	3474.4	113°	8656.6	4651.3
10	6055.4	2606.8	10	7224.7	3491.3	10	8684.0	4674.2
20	6073.1	2619.7	20	7246.3	3508.2	20	8711.5	4697.2
30	6090.8	2632.6	30	7268.0	3525.2	30	8739.2	4720.3
40	6108.6	2645.5	40	7289.8	3542.4	40	8767.0	4743.6
50	6126.4	2658.5	50	7311.7	3559.6	50	8794.9	4766.9
94°	6144.3	2671.6	104°	7333.6	3576.8	114°	8822.9	4790.4
10	6162.6	2684.7	10	7355.6	3594.2	10	8851.0	4814.1
20	6180.2	2697.9	20	7377.8	3611.7	20	8879.3	4837.8
30	6198.3	2711.2	30	7399.9	3629.2	30	8907.7	4861.7
40	6216.4	2724.5	40	7422.2	3646.8	40	8936.3	4885.7
50	6234.6	2737.9	50	7444.6	3664.5	50	8965.0	4909.9
95°	6252.8	2751.3	105°	7467.0	3682.3	115°	8993.8	4934.1
10	6271.1	2764.8	10	7489.6	3700.2	10	9022.7	4958.6
20	6289.4	2778.3	20	7512.2	3718.2	20	9051.7	4983.1
30	6307.9	2792.0	30	7534.9	3736.2	30	9080.9	5007.8
40	6326.3	2805.6	40	7557.7	3754.4	40	9110.3	5032.6
50	6344.8	2819.4	50	7580.5	3772.6	50	9139.8	5057.6
96°	6363.4	2833.2	106°	7603.5	3791.0	116°	9169.4	5082.7
10	6382.1	2847.0	10	7626.6	3809.4	10	9199.1	5107.9
20	6400.8	2861.0	20	7649.7	3827.9	20	9229.0	5133.3
30	6419.5	2875.0	30	7672.9	3846.5	30	9259.0	5158.8
40	6438.4	2889.0	40	7696.3	3865.2	40	9289.2	5184.5
50	6457.3	2903.1	50	7719.7	3884.0	50	9319.5	5210.3
97°	6476.2	2917.3	107°	7743.2	3902.9	117°	9349.9	5236.2
10	6495.2	2931.6	10	7766.8	3921.9	10	9380.5	5262.3
20	6514.3	2945.9	20	7790.5	3940.9	20	9411.3	5288.6
30	6533.4	2960.3	30	7814.3	3960.1	30	9442.2	5315.0
40	6552.6	2974.7	40	7838.1	3979.4	40	9473.2	5341.5
50	6571.9	2989.2	50	7862.1	3998.7	50	9504.4	5368.2
98°	6591.2	3003.8	108°	7886.2	4018.2	118°	9535.7	5395.1
10	6610.6	3018.4	10	7910.4	4037.8	10	9567.2	5422.1
20	6630.1	3033.1	20	7934.6	4057.4	20	9598.9	5449.2
30	6649.6	3047.9	30	7959.0	4077.2	30	9630.7	5476.5
40	6669.2	3062.8	40	7983.5	4097.1	40	9662.6	5504.0
50	6688.8	3077.7	50	8008.0	4117.0	50	9694.7	5531.7
99°	6708.6	3092.7	109°	8032.7	4137.1	119°	9727.0	5559.4
10	6728.4	3107.7	10	8057.4	4157.3	10	9759.4	5587.4
20	6748.2	3122.9	20	8082.3	4177.5	20	9792.0	5615.5
30	6768.1	3138.1	30	8107.3	4197.9	30	9824.8	5643.8
40	6788.1	3153.3	40	8132.3	4218.4	40	9857.7	5672.3
50	6808.2	3168.7	50	8157.5	4239.0	50	9890.8	5700.9
100°	6828.3	3184.1	110°	8182.8	4259.7	120°	9924.0	5729.7
10	6848.5	3199.6	10	8208.2	4280.5	10	9957.5	5758.6
20	6868.8	3215.1	20	8233.7	4301.4	20	9991.0	5787.7
30	6889.2	3230.8	30	8259.3	4322.4	30	10025.0	5817.0
40	6909.6	3246.5	40	8285.0	4343.6	40	10059.0	5846.5
50	6930.1	3262.3	50	8310.8	4364.8	50	10093.0	5876.1

Table VI.—Corrections for Tangents and Externals.

These corrections are to be added to the approximate values, found by dividing the tangent, or external, for a 1° curve (Table IV) by the degree of curve, in order to obtain the true tangents, or externals. Intermediate values may be obtained by interpolation.

FOR TANGENTS ADD

Central Angle	DEGREE OF CURVE															
	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°		
10°	.03	.06	.09	.13	.16	.19	.22	.25	.28	.31	.34	.38	.42	.46		
15°	.04	.10	.14	.19	.24	.29	.34	.39	.45	.51	.53	.58	.63	.68		
20°	.06	.13	.19	.26	.32	.39	.45	.51	.58	.65	.72	.79	.84	.90		
25°	.08	.16	.24	.33	.40	.49	.58	.67	.75	.83	.90	.99	1.06	1.14		
30°	.10	.19	.29	.39	.49	.59	.69	.79	.89	.99	1.09	1.20	1.29	1.39		
35°	.11	.22	.34	.47	.58	.69	.70	.81	.92	1.04	1.29	1.42	1.54	1.66		
40°	.13	.26	.40	.53	.67	.80	.93	1.06	1.20	1.34	1.49	1.64	1.79	1.94		
45°	.15	.30	.44	.60	.76	.91	1.06	1.21	1.37	1.52	1.70	1.87	2.04	2.21		
50°	.17	.34	.51	.68	.85	1.02	1.19	1.36	1.54	1.72	1.91	2.10	2.29	2.48		
55°	.19	.38	.57	.76	.95	1.14	1.32	1.52	1.72	1.92	2.14	2.35	2.56	2.77		
60°	.21	.42	.63	.84	1.05	1.27	1.49	1.71	1.94	2.17	2.38	2.60	2.83	3.07		
65°	.23	.46	.69	.93	1.16	1.40	1.64	1.88	2.13	2.38	2.63	2.88	3.13	3.39		
70°	.25	.51	.76	1.02	1.28	1.54	1.80	2.06	2.33	2.60	2.88	3.16	3.44	3.72		
75°	.27	.56	.83	1.12	1.40	1.69	1.98	2.27	2.57	2.87	3.16	3.47	3.78	4.09		
80°	.30	.61	.91	1.22	1.53	1.84	2.15	2.46	2.78	3.10	3.44	3.78	4.12	4.46		
85°	.33	.66	1.00	1.33	1.68	2.02	2.36	2.70	3.05	3.40	3.77	4.14	4.55	4.89		
90°	.36	.72	1.09	1.45	1.83	2.20	2.57	2.94	3.32	3.70	4.10	4.50	4.91	5.32		
95°	.39	.79	1.19	1.55	2.00	2.40	2.80	3.20	3.61	4.02	4.40	4.98	5.38	5.83		
100°	.43	.86	1.30	1.74	2.18	2.62	3.06	3.50	3.95	4.40	4.88	5.37	5.85	6.34		
110°	.51	.83	1.56	2.08	2.61	3.14	3.67	4.21	4.76	5.31	5.86	6.43	7.01	7.60		
120°	.62	1.25	1.93	2.52	3.16	3.81	4.45	5.11	5.77	6.44	7.12	7.80	8.50	9.22		

FOR EXTERNALS ADD

Central Angle	DEGREE OF CURVE															
	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°		
10°	.001	.003	.004	.006	.007	.008	.009	.011	.012	.014	.015	.017	.018	.020		
15°	.003	.007	.010	.014	.018	.023	.027	.032	.035	.039	.043	.047	.051			
20°	.006	.011	.017	.022	.028	.034	.038	.045	.051	.057	.063	.070	.076	.083		
25°	.009	.018	.027	.036	.046	.056	.065	.074	.083	.093	.103	.112	.120	.135		
30°	.013	.025	.038	.051	.065	.078	.090	.103	.116	.129	.149	.170	.179	.188		
35°	.018	.035	.054	.072	.086	.109	.131	.153	.175	.197	.213	.230	.247	.264		
40°	.023	.046	.070	.093	.117	.141	.172	.203	.234	.265	.277	.290	.315	.341		
45°	.030	.060	.093	.119	.153	.184	.216	.254	.289	.325	.351	.378	.411	.445		
50°	.037	.075	.116	.151	.189	.227	.266	.305	.345	.384	.425	.467	.508	.550		
55°	.046	.093	.142	.188	.236	.283	.332	.381	.420	.479	.530	.582	.641	.700		
60°	.056	.112	.168	.225	.283	.340	.398	.457	.516	.575	.636	.697	.774	.851		
65°	.067	.135	.204	.273	.343	.412	.483	.554	.625	.697	.771	.845	.922	1.01		
70°	.080	.159	.240	.321	.403	.485	.568	.652	.735	.819	.906	.994	1.08	1.17		
75°	.095	.182	.266	.353	.440	.528	.617	.707	.797	.887	.977	1.07	1.18	1.29	1.39	
80°	.110	.220	.332	.445	.558	.671	.787	.903	1.02	1.13	1.25	1.38	1.50	1.62		
85°	.128	.259	.391	.524	.657	.790	.926	1.06	1.20	1.34	1.47	1.62	1.76	1.91		
90°	.149	.299	.450	.603	.756	.910	1.07	1.22	1.38	1.54	1.70	1.87	2.03	2.20		
95°	.174	.350	.522	.706	.885	1.06	1.25	1.43	1.62	1.80	1.99	2.18	2.38	2.53		
100°	.200	.401	.604	.809	1.01	1.22	1.43	1.64	1.85	2.06	2.28	2.50	2.73	2.96		
110°	.268	.536	.806	1.08	1.35	1.63	1.91	2.20	2.48	2.76	3.05	3.35	3.66	3.96		
120°	.360	.721	1.08	1.45	1.82	2.19	2.57	2.95	3.33	3.72	4.11	4.50	4.91	5.32		

Table VII.—Corrections for Sub-Chords

and Long Chords.

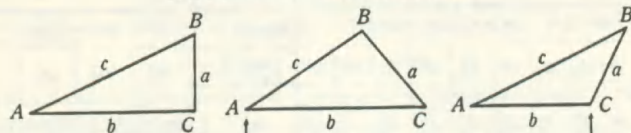
FOR SUB-CHORDS ADD										Excess of arc per 100 ft.	LONG CHORDS				
D	10	20	30	40	50	60	70	80	90		D	200	300	400	500
4°	.00	.00	.01	.01	.01	.01	.01	.01	.00	.02	1	199.99	299.97	399.92	499.85
6	.00	.01	.01	.02	.02	.02	.02	.01	.01	.05	2	199.97	299.88	399.70	499.39
8	.01	.02	.02	.03	.03	.03	.03	.02	.01	.08	3	199.93	299.78	399.32	498.63
10	.01	.02	.03	.04	.05	.05	.05	.04	.02	.13	4	199.88	299.51	398.78	497.57
12	.02	.04	.05	.06	.07	.07	.07	.05	.03	.18	5	199.81	299.24	398.10	496.20
14	.02	.05	.07	.08	.09	.10	.09	.07	.04	.25	6	199.73	298.90	397.26	494.53
16	.03	.06	.09	.11	.12	.12	.12	.09	.05	.33	7	199.63	298.51	396.28	492.57
18	.04	.08	.11	.14	.15	.16	.15	.12	.07	.41	8	199.51	298.05	395.14	490.31
20	.05	.10	.14	.17	.19	.20	.18	.15	.09	.51	9	199.38	297.54	393.86	487.75
22	.06	.12	.17	.21	.23	.24	.22	.18	.10	.62	10	199.24	296.96	392.42	484.90
24	.07	.14	.20	.25	.28	.28	.26	.21	.12	.74	12	198.90	295.63	389.12	478.34
26	.09	.17	.24	.29	.32	.33	.31	.25	.15	.86	14	198.51	294.06	385.22	470.65
28	.10	.19	.27	.34	.37	.38	.36	.29	.17	1.00	16	198.05	292.25	380.76	461.86
30	.11	.22	.31	.39	.43	.44	.41	.33	.19	1.15	18	197.54	290.21	375.74	452.02
32	.13	.25	.36	.44	.49	.50	.47	.38	.22	1.31	20	196.90	287.94	370.17	441.15
34	.15	.28	.40	.50	.55	.57	.53	.43	.28	1.48	22	196.32	285.44	364.06	429.30
36	.17	.32	.45	.56	.62	.64	.59	.48	.28	1.66	24	195.63	282.71	357.43	416.53
38	.18	.36	.51	.62	.70	.71	.66	.53	.31	1.86	26	194.87	279.76	350.30	402.89
40	.21	.40	.56	.69	.77	.79	.73	.59	.35	2.06	28	194.06	276.59	342.69	388.42
42	.23	.44	.62	.76	.85	.87	.81	.65	.38	2.28	30	193.18	273.20	334.61	373.20
44	.25	.48	.68	.84	.94	.96	.89	.72	.42	2.50	32	192.25	269.61	326.08	357.28
46	.27	.52	.75	.92	1.02	1.05	.98	.78	.46	2.74	34	191.26	265.81	317.12	340.73
48	.30	.57	.81	1.00	1.12	1.14	1.06	.86	.50	2.99	36	190.21	261.80	307.77	323.61
50	.32	.62	.89	1.09	1.21	1.24	1.15	.93	.55	3.24	38	189.10	257.60	298.03	305.99
52	.35	.67	.96	1.18	1.31	1.35	1.25	1.01	.59	3.52	40	187.94	253.21	287.94	287.94
54	.38	.73	1.04	1.28	1.42	1.46	1.35	1.09	.64	3.80	42	186.72	248.63	277.51	269.54
56	.41	.78	1.12	1.38	1.53	1.57	1.46	1.17	.69	4.09	44	185.44	243.87	266.78	250.85
58	.44	.84	1.20	1.48	1.65	1.69	1.57	1.20	.74	4.40	46	184.10	239.93	255.78	231.95
60	.47	.91	1.29	1.59	1.76	1.81	1.68	1.35	.80	4.72	48	182.71	233.83	244.51	212.92

NOTE.—When a chord of less than 100 ft. is used the corrections given in the above table should be added to the nominal length of chord to get the length which should be used in order that the 100 ft. points will check with those obtained by using the standard 100 ft. chord. Thus in locating a 14° curve by 25 ft. chords measure 25' .06 for each chord. Long chords are useful in passing obstacles.

Table VIII.—Middle Ordinates for Rails in Feet.

Deg. of Curve	LENGTH OF RAILS							Deg. of Curve	LENGTH OF RAILS						
	32	30	28	26	24	22	20		32	30	28	26	24	22	20
1°	.022	.020	.016	.013	.011	.009	.008	16°	.356	.313	.273	.236	.200	.170	.139
2	.045	.038	.034	.029	.025	.021	.017	17	.378	.333	.290	.252	.213	.180	.148
3	.067	.058	.051	.044	.037	.031	.026	18	.400	.351	.306	.265	.225	.190	.156
4	.089	.079	.069	.060	.050	.042	.035	19	.423	.371	.324	.280	.238	.201	.165
5	.112	.099	.086	.074	.063	.053	.044	20	.445	.392	.341	.296	.250	.212	.174
6	.134	.117	.102	.088	.076	.064	.052	21	.466	.410	.357	.309	.262	.222	.182
7	.156	.137	.120	.104	.088	.074	.061	22	.487	.430	.375	.325	.275	.233	.191
8	.179	.158	.137	.119	.100	.085	.070	23	.509	.450	.390	.338	.287	.243	.199
9	.201	.175	.153	.133	.112	.095	.078	24	.531	.469	.408	.354	.299	.253	.208
10	.223	.196	.171	.148	.125	.106	.087	25	.552	.486	.424	.367	.311	.263	.216
11	.245	.216	.188	.163	.139	.117	.096	26	.573	.506	.441	.382	.323	.274	.225
12	.268	.236	.206	.179	.151	.128	.105	27	.594	.524	.457	.396	.335	.284	.233
13	.290	.254	.222	.192	.163	.138	.113	28	.615	.545	.475	.411	.348	.294	.242
14	.312	.275	.239	.207	.177	.148	.122	29	.636	.564	.491	.424	.361	.305	.250
15	.334	.295	.257	.223	.188	.159	.131	30	.658	.583	.508	.438	.374	.313	.259

TRIGONOMETRIC FORMULÆ



Right Triangle

Oblique Triangles

Solution of Right Triangles

For Angle A. $\sin = \frac{a}{c}$, $\cos = \frac{b}{c}$, $\tan = \frac{a}{b}$, $\cot = \frac{b}{a}$, $\sec = \frac{c}{b}$, $\csc = \frac{c}{a}$

Given	Required	
a, b	A, B, c	$\tan A = \frac{a}{b} = \cot B, c = \sqrt{a^2 + b^2} = a\sqrt{1 + \frac{b^2}{a^2}}$
a, c	A, B, b	$\sin A = \frac{a}{c} = \cos B, b = \sqrt{(c+a)(c-a)} = c\sqrt{1 - \frac{a^2}{c^2}}$
A, a	B, b, c	$B = 90^\circ - A, b = a \cot A, c = \frac{a}{\sin A}$
A, b	B, a, c	$B = 90^\circ - A, a = b \tan A, c = \frac{b}{\cos A}$
A, c	B, a, b	$B = 90^\circ - A, a = c \sin A, b = c \cos A$

Solution of Oblique Triangles

A, B, a	b, c, C	$b = \frac{a \sin B}{\sin A}, C = 180^\circ - (A+B), c = \frac{a \sin C}{\sin A}$
A, a, b	B, c, C	$\sin B = \frac{b \sin A}{a}, C = 180^\circ - (A+B), c = \frac{a \sin C}{\sin A}$
a, b, C	A, B, c	$A+B = 180^\circ - C, \tan \frac{1}{2}(A-B) = \frac{(a-b) \tan \frac{1}{2}(A+B)}{a+b}$
		$c = \frac{a \sin C}{\sin A}$
a, b, c	A, B, C	$s = \frac{a+b+c}{2}, \sin \frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{bc}}$
		$\sin \frac{1}{2} B = \sqrt{\frac{(s-a)(s-c)}{ac}}, C = 180^\circ - (A+B)$
a, b, c	Area	$s = \frac{a+b+c}{2}, \text{area} = \sqrt{s(s-a)(s-b)(s-c)}$
A, b, c	Area	$\text{area} = \frac{bc \sin A}{2}$
A, B, C, a	Area	$\text{area} = \frac{a^2 \sin B \sin C}{2 \sin A}$

REDUCTION TO HORIZONTAL

Horizontal distance = slope distance multiplied by the cosine of the vertical angle. Thus, for a slope distance of 403.6 ft. and a vertical angle of $4^\circ 40'$ —the cosine of $4^\circ 40'$, taken from a table of natural trigonometrical functions, = .9967, and horizontal distance = $403.6 \times .9967 = 402.27$ ft.

Horizontal distance also = Slope distance minus slope distance times (1—cosine of vertical angle). Using the same figures as in the preceding example— $\cos 4^\circ 40' = .9967, 1 - .9967 = .0033, 403.6 \times .0033 = 1.33$ ft. Horizontal dist. = $403.6 - 1.33 = 402.27$ ft.

When the rise is known, the horizontal distance may be found by the following approximate rule:—the slope distance less the square of the rise divided by twice the slope distance. Thus, for a slope distance of 372.5 ft., and a rise of 15 ft. the horizontal distance =

$$372.5 - \frac{15 \times 15}{2 \times 372.5} = 372.5 - .30 = 372.2 \text{ ft.}$$

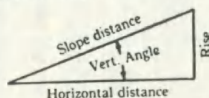


Table IX.—Natural Trigonometrical Functions.

Angle	Sin	Tan	Cot	Cos	Angle	Sin	Tan	Cot	Cos
0°	0	0	∞	1	90°	1	∞	0	0
1°	.0175	.0175	57.29	.99985	89°	.9825	.0175	57.29	.99985
2°	.0349	.0349	28.64	.99939	88°	.9659	.0349	28.64	.99939
3°	.0523	.0523	19.08	.99863	87°	.9496	.0523	19.08	.99863
4°	.0698	.0698	14.30	.99756	86°	.9336	.0698	14.30	.99756
5°	.0872	.0872	11.43	.99619	85°	.9174	.0872	11.43	.99619
6°	.1045	.1045	9.514	.99452	84°	.9011	.1045	9.514	.99452
7°	.1219	.1228	8.144	.99255	83°	.8847	.1219	8.144	.99255
8°	.1392	.1405	7.115	.99027	82°	.8682	.1392	7.115	.99027
9°	.1564	.1584	6.314	.98769	81°	.8517	.1564	6.314	.98769
10°	.1736	.1763	5.671	.98481	80°	.8351	.1736	5.671	.98481
11°	.1908	.1944	5.145	.98163	79°	.8185	.1908	5.145	.98163
12°	.2079	.2126	4.705	.97815	78°	.8018	.2079	4.705	.97815
13°	.2250	.2309	4.331	.97437	77°	.7851	.2250	4.331	.97437
14°	.2419	.2493	4.011	.97030	76°	.7683	.2419	4.011	.97030
15°	.2588	.2679	3.732	.96593	75°	.7514	.2588	3.732	.96593
16°	.2756	.2864	3.492	.96126	74°	.7344	.2756	3.492	.96126
17°	.2924	.3044	3.292	.95630	73°	.7173	.2924	3.292	.95630
18°	.3090	.3219	3.130	.95106	72°	.7001	.3090	3.130	.95106
19°	.3256	.3394	2.996	.94563	71°	.6829	.3256	2.996	.94563
20°	.3420	.3567	2.886	.94001	70°	.6656	.3420	2.886	.94001
21°	.3583	.3743	2.796	.93420	69°	.6482	.3583	2.796	.93420
22°	.3745	.3922	2.722	.92820	68°	.6308	.3745	2.722	.92820
23°	.3906	.4092	2.662	.92201	67°	.6133	.3906	2.662	.92201
24°	.4066	.4265	2.612	.91563	66°	.5958	.4066	2.612	.91563
25°	.4225	.4432	2.571	.90916	65°	.5782	.4225	2.571	.90916
26°	.4383	.4638	2.538	.90260	64°	.5606	.4383	2.538	.90260
27°	.4540	.4843	2.512	.89596	63°	.5429	.4540	2.512	.89596
28°	.4696	.5047	2.492	.88923	62°	.5251	.4696	2.492	.88923
29°	.4851	.5250	2.476	.88242	61°	.5073	.4851	2.476	.88242
30°	.5005	.5454	2.464	.87553	60°	.4894	.5005	2.464	.87553
31°	.5158	.5657	2.456	.86856	59°	.4715	.5158	2.456	.86856
32°	.5310	.5859	2.451	.86151	58°	.4535	.5310	2.451	.86151
33°	.5461	.6061	2.449	.85438	57°	.4355	.5461	2.449	.85438
34°	.5611	.6262	2.449	.84717	56°	.4174	.5611	2.449	.84717
35°	.5760	.6463	2.451	.83989	55°	.3993	.5760	2.451	.83989
36°	.5909	.6663	2.456	.83253	54°	.3811	.5909	2.456	.83253
37°	.6057	.6862	2.464	.82510	53°	.3629	.6057	2.464	.82510
38°	.6204	.7061	2.476	.81760	52°	.3446	.6204	2.476	.81760
39°	.6350	.7259	2.492	.81003	51°	.3263	.6350	2.492	.81003
40°	.6496	.7456	2.512	.80240	50°	.3079	.6496	2.512	.80240
41°	.6641	.7653	2.538	.79471	49°	.2895	.6641	2.538	.79471
42°	.6786	.7849	2.571	.78696	48°	.2710	.6786	2.571	.78696
43°	.6930	.8045	2.612	.77916	47°	.2525	.6930	2.612	.77916
44°	.7074	.8240	2.662	.77130	46°	.2339	.7074	2.662	.77130
45°	.7217	.8435	2.722	.76339	45°	.2152	.7217	2.722	.76339
46°	.7360	.8629	2.796	.75543	44°	.1965	.7360	2.796	.75543
47°	.7502	.8822	2.886	.74743	43°	.1777	.7502	2.886	.74743
48°	.7644	.9015	2.996	.73938	42°	.1589	.7644	2.996	.73938
49°	.7785	.9207	3.130	.73129	41°	.1400	.7785	3.130	.73129
50°	.7926	.9398	3.292	.72316	40°	.1211	.7926	3.292	.72316
51°	.8066	.9588	3.492	.71500	39°	.1021	.8066	3.492	.71500
52°	.8206	.9777	3.732	.70681	38°	.0831	.8206	3.732	.70681
53°	.8345	.9965	4.011	.69860	37°	.0641	.8345	4.011	.69860
54°	.8483	1.0152	4.331	.69037	36°	.0450	.8483	4.331	.69037
55°	.8621	1.0339	4.705	.68212	35°	.0259	.8621	4.705	.68212
56°	.8758	1.0525	5.145	.67385	34°	.0068	.8758	5.145	.67385
57°	.8895	1.0710	5.671	.66556	33°		.8895	5.671	.66556
58°	.9032	1.0894	6.314	.65725	32°		.9032	6.314	.65725
59°	.9168	1.1077	7.115	.64892	31°		.9168	7.115	.64892
60°	.9304	1.1259	8.144	.64057	30°		.9304	8.144	.64057
61°	.9439	1.1440	9.514	.63220	29°		.9439	9.514	.63220
62°	.9573	1.1620	11.43	.62382	28°		.9573	11.43	.62382
63°	.9706	1.1799	14.30	.61542	27°		.9706	14.30	.61542
64°	.9838	1.1977	19.08	.60700	26°		.9838	19.08	.60700
65°	.9969	1.2154	28.64	.59856	25°		.9969	28.64	.59856
66°	1.0099	1.2330	39.07	.59010	24°		1.0099	39.07	.59010
67°	1.0228	1.2505	50.00	.58162	23°		1.0228	50.00	.58162
68°	1.0356	1.2679	63.06	.57312	22°		1.0356	63.06	.57312
69°	1.0483	1.2852	79.04	.56460	21°		1.0483	79.04	.56460
70°	1.0609	1.3024	100.00	.55606	20°		1.0609	100.00	.55606
71°	1.0734	1.3195	127.06	.54750	19°		1.0734	127.06	.54750
72°	1.0858	1.3365	161.98	.53892	18°		1.0858	161.98	.53892
73°	1.0981	1.3534	200.00	.53032	17°		1.0981	200.00	.53032
74°	1.1103	1.3703	244.75	.52170	16°		1.1103	244.75	.52170
75°	1.1225	1.3871	299.14	.51306	15°		1.1225	299.14	.51306
76°	1.1346	1.4038	367.01	.50440	14°		1.1346	367.01	.50440
77°	1.1467	1.4205	450.52	.49572	13°		1.1467	450.52	.49572
78°	1.1587	1.4371	559.74	.48702	12°		1.1587	559.74	.48702
79°	1.1707	1.4537	695.26	.47830	11°		1.1707	695.26	.47830
80°	1.1826	1.4702	867.58	.46956	10°		1.1826	867.58	.46956
81°	1.1945	1.4867	1077.76	.46080	9°		1.1945	1077.76	.46080
82°	1.2063	1.5031	1326.37	.45202	8°		1.2063	1326.37	.45202
83°	1.2181	1.5195	1614.94	.44322	7°		1.2181	1614.94	.44322
84°	1.2298	1.5358	1944.00	.43440	6°		1.2298	1944.00	.43440
85°	1.2415	1.5521	2314.24	.42556	5°		1.2415	2314.24	.42556
86°	1.2531	1.5683	2726.27	.41670	4°		1.2531	2726.27	.41670
87°	1.2647	1.5845	3180.61	.40782	3°		1.2647	3180.61	.40782
88°	1.2762	1.6006	3677.76	.39892	2°		1.2762	3677.76	.39892
89°	1.2877	1.6167	4218.24	.39000	1°		1.2877	4218.24	.39000
90°	1.2992	1.6328	4802.56	.38106	0°		1.2992	4802.56	.38106

Table IX.—Natural Trigonometrical Functions.

Angle	Sin	Tan	Cot	Cos		Angle	Sin	Tan.	Cot	Cos	
0/						0/					
16	.2756	.2867	3.487	.96126	74	24	.4067	.4452	2.246	.91355	66
10	.2784	.2899	3.450	.96046	50	10	.4094	.4487	2.229	.91236	50
20	.2812	.2931	3.412	.95964	40	20	.4120	.4522	2.211	.91116	40
30	.2840	.2962	3.376	.95882	30	30	.4147	.4557	2.194	.90996	30
40	.2868	.2994	3.340	.95799	20	40	.4173	.4592	2.177	.90875	20
50	.2896	.3026	3.305	.95715	10	50	.4200	.4628	2.161	.90753	10
17	.2924	.3057	3.271	.95630	73	25	.4226	.4663	2.145	.90631	65
10	.2952	.3089	3.237	.95545	50	10	.4253	.4699	2.128	.90507	50
20	.2979	.3121	3.204	.95459	40	20	.4279	.4734	2.112	.90383	40
30	.3007	.3153	3.172	.95372	30	30	.4305	.4770	2.097	.90259	30
40	.3035	.3185	3.140	.95284	20	40	.4331	.4806	2.081	.90133	20
50	.3062	.3217	3.108	.95195	10	50	.4358	.4841	2.066	.90007	10
18	.3090	.3249	3.078	.95106	72	26	.4384	.4877	2.050	.89879	64
10	.3118	.3281	3.048	.95015	50	10	.4410	.4913	2.035	.89752	50
20	.3145	.3314	3.018	.94924	40	20	.4436	.4950	2.020	.89623	40
30	.3173	.3346	2.989	.94832	30	30	.4462	.4986	2.006	.89493	30
40	.3201	.3378	2.960	.94740	20	40	.4488	.5022	1.991	.89363	20
50	.3228	.3411	2.932	.94646	10	50	.4514	.5059	1.977	.89232	10
19	.3256	.3443	2.904	.94552	71	27	.4540	.5095	1.963	.89101	63
10	.3283	.3476	2.877	.94457	50	10	.4566	.5132	1.949	.88968	50
20	.3311	.3508	2.850	.94361	40	20	.4592	.5169	1.935	.88835	40
30	.3338	.3541	2.824	.94264	30	30	.4617	.5206	1.921	.88701	30
40	.3365	.3574	2.798	.94167	20	40	.4643	.5243	1.907	.88566	20
50	.3393	.3607	2.773	.94068	10	50	.4669	.5280	1.894	.88431	10
20	.3420	.3640	2.747	.93969	70	28	.4695	.5317	1.881	.88295	62
10	.3448	.3673	2.723	.93869	50	10	.4720	.5354	1.868	.88158	50
20	.3475	.3706	2.699	.93769	40	20	.4746	.5392	1.855	.88020	40
30	.3502	.3739	2.675	.93667	30	30	.4772	.5430	1.842	.87882	30
40	.3529	.3772	2.651	.93565	20	40	.4797	.5467	1.829	.87743	20
50	.3557	.3805	2.628	.93462	10	50	.4823	.5505	1.816	.87603	10
21	.3584	.3839	2.605	.93358	69	29	.4848	.5543	1.804	.87462	61
10	.3611	.3872	2.583	.93253	50	10	.4874	.5581	1.792	.87321	50
20	.3638	.3906	2.560	.93148	40	20	.4899	.5619	1.780	.87178	40
30	.3665	.3939	2.539	.93042	30	30	.4924	.5658	1.767	.87036	30
40	.3692	.3973	2.517	.92935	20	40	.4950	.5696	1.756	.86892	20
50	.3719	.4006	2.496	.92827	10	50	.4975	.5735	1.744	.86748	10
22	.3746	.4040	2.475	.92718	68	30	.5000	.5774	1.732	.86603	60
10	.3773	.4074	2.455	.92609	50	10	.5025	.5812	1.720	.86457	50
20	.3800	.4108	2.434	.92499	40	20	.5050	.5851	1.709	.86310	40
30	.3827	.4142	2.414	.92388	30	30	.5075	.5890	1.698	.86163	30
40	.3854	.4176	2.394	.92276	20	40	.5100	.5930	1.686	.86015	20
50	.3881	.4210	2.375	.92164	10	50	.5125	.5969	1.675	.85866	10
23	.3907	.4245	2.356	.92050	67	31	.5150	.6009	1.664	.85717	59
10	.3934	.4279	2.337	.91936	50	10	.5175	.6048	1.653	.85567	50
20	.3961	.4314	2.318	.91822	40	20	.5200	.6088	1.643	.85416	40
30	.3987	.4348	2.300	.91706	30	30	.5225	.6128	1.632	.85264	30
40	.4014	.4383	2.282	.91590	20	40	.5250	.6168	1.621	.85112	20
50	.4041	.4417	2.264	.91472	10	50	.5275	.6208	1.611	.84959	10
					66						58
	Cos	Cot	Tan.	Sin	Angle		Cos	Cot	Tan.	Sin	Angle

Table IX.—Natural Trigonometrical Functions.

Angle	Sin	Tan	Cot	Cos		Angle	Sin	Tan	Cot	Cos	
°						°					
32	.5299	.6249	1.600	.84805	58	30	.6225	.7954	1.257	.78261	30
10	.5324	.6289	1.590	.84650	50	40	.6248	.8002	1.250	.78079	20
20	.5348	.6330	1.580	.84495	40	50	.6271	.8050	1.242	.77897	10
30	.5373	.6371	1.570	.84339	30						
40	.5398	.6412	1.560	.84182	20	39	.6293	.8098	1.235	.77715	51
50	.5422	.6453	1.550	.84025	10	10	.6316	.8146	1.228	.77531	50
33	.5446	.6494	1.540	.83867	57	20	.6338	.8195	1.220	.77347	40
10	.5471	.6536	1.530	.83708	50	30	.6361	.8243	1.213	.77162	30
20	.5495	.6577	1.520	.83549	40	40	.6383	.8292	1.206	.76977	20
30	.5519	.6619	1.511	.83389	30	50	.6406	.8342	1.199	.76791	10
40	.5544	.6661	1.501	.83228	20						
50	.5568	.6703	1.492	.83066	10	40	.6428	.8391	1.192	.76604	50
34	.5592	.6745	1.483	.82904	56	10	.6450	.8441	1.185	.76417	50
10	.5616	.6787	1.473	.82741	50	20	.6472	.8491	1.178	.76229	40
20	.5640	.6830	1.464	.82577	40	30	.6494	.8541	1.171	.76041	30
30	.5664	.6873	1.455	.82413	30	40	.6517	.8591	1.164	.75851	20
40	.5688	.6916	1.446	.82248	20	50	.6539	.8642	1.157	.75661	10
50	.5712	.6959	1.437	.82082	10						
35	.5736	.7002	1.428	.81915	55	41	.6561	.8693	1.150	.75471	49
10	.5760	.7046	1.419	.81748	50	10	.6583	.8744	1.144	.75280	50
20	.5783	.7089	1.411	.81580	40	20	.6604	.8796	1.137	.75088	40
30	.5807	.7133	1.402	.81412	30	30	.6626	.8847	1.130	.74896	30
40	.5831	.7177	1.393	.81242	20	40	.6648	.8899	1.124	.74703	20
50	.5854	.7221	1.385	.81072	10	50	.6670	.8952	1.117	.74509	10
36	.5878	.7265	1.376	.80902	54						
10	.5901	.7310	1.368	.80730	50	42	.6691	.9004	1.111	.74314	48
20	.5925	.7355	1.360	.80558	40	10	.6713	.9057	1.104	.74120	50
30	.5948	.7400	1.351	.80386	30	20	.6734	.9110	1.098	.73924	40
40	.5972	.7445	1.343	.80212	20	30	.6756	.9163	1.091	.73728	30
50	.5995	.7490	1.335	.80038	10	40	.6777	.9217	1.085	.73531	20
37	.6018	.7536	1.327	.79864	53	50	.6799	.9271	1.079	.73333	10
10	.6041	.7581	1.319	.79688	50						
20	.6065	.7627	1.311	.79512	40	43	.6820	.9325	1.072	.73135	47
30	.6088	.7673	1.303	.79335	30	10	.6841	.9380	1.066	.72937	50
40	.6111	.7720	1.295	.79158	20	20	.6862	.9435	1.060	.72737	40
50	.6134	.7766	1.288	.78980	10	30	.6884	.9490	1.054	.72537	30
38	.6157	.7813	1.280	.78801	52	40	.6905	.9545	1.048	.72337	20
10	.6180	.7860	1.272	.78622	50	50	.6926	.9601	1.042	.72136	10
20	.6202	.7907	1.265	.78442	40						
						44	.6947	.9657	1.036	.71934	46
						10	.6967	.9713	1.030	.71732	50
						20	.6988	.9770	1.024	.71529	40
						30	.7009	.9827	1.018	.71325	30
						40	.7030	.9884	1.012	.71121	20
						50	.7050	.9942	1.006	.70916	10
							.7071	1.	1.	.70711	45
											°
	Cos	Cot	Tan	Sin	Angle		Cos	Cot	Tan	Sin	Angle

STADIA REDUCTION DIAGRAM

Enter on the horizontal scale with the value of the stadia reading (the interval times the stadia constant) and run vertically upward to intersection with line representing the vertical angle. The location of this point with reference to the dotted lines marked "ONE" etc. gives the correction to be subtracted from the entering value, and to which "f + c" (usually about 1 foot) must be added to obtain the true horizontal distance. The reading on the vertical scale plus about 0.1 ft. for each 5° of vertical angle $(f + c) \sin \alpha$ is the true vertical distance.

If the vertical angle is beyond the range of diagram, use $H = R \cos^2 \alpha + 1$ to find true horizontal distance and $V = R \times \frac{1}{2} \sin 2\alpha$ for true vertical distance, where R equals observed stadia distance and α equals vertical angle.

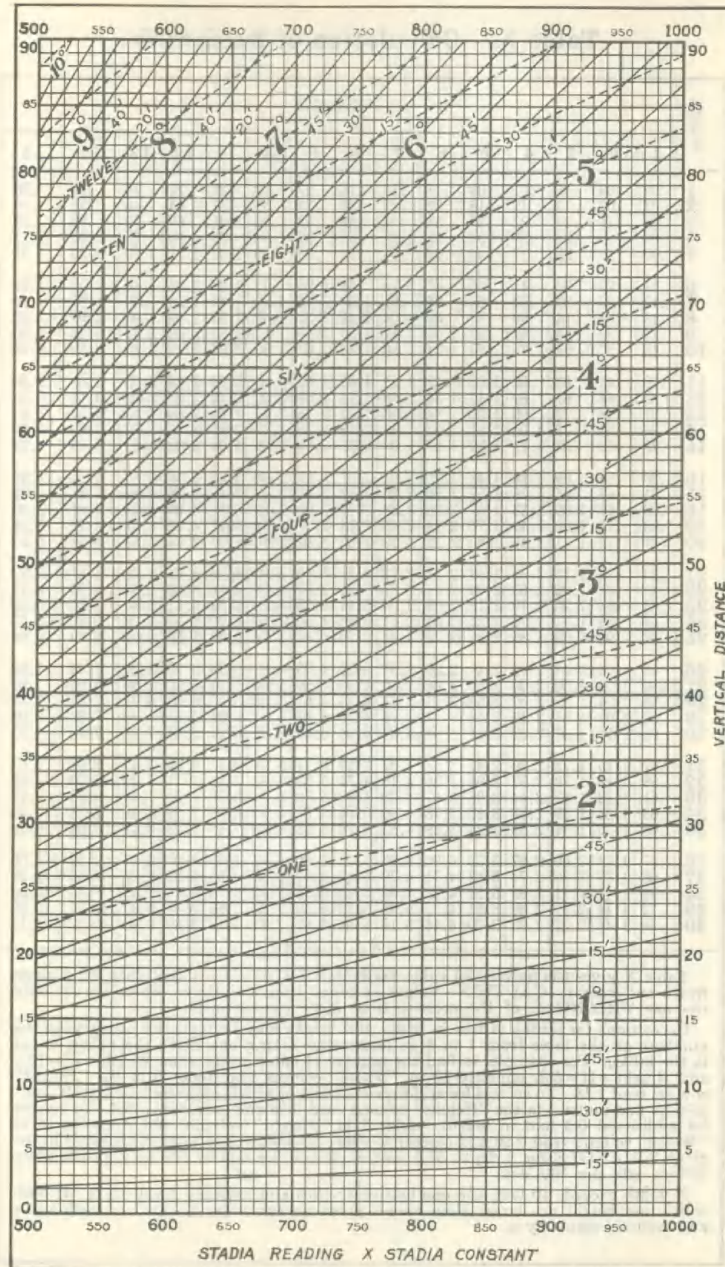
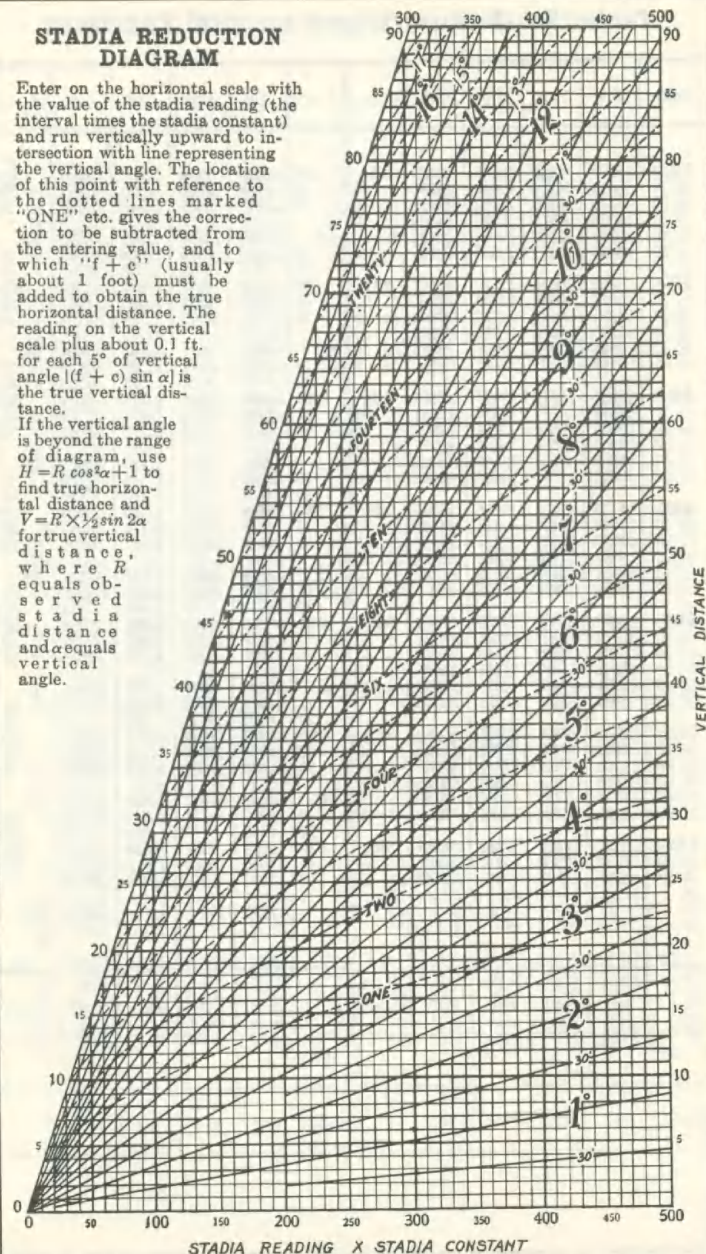


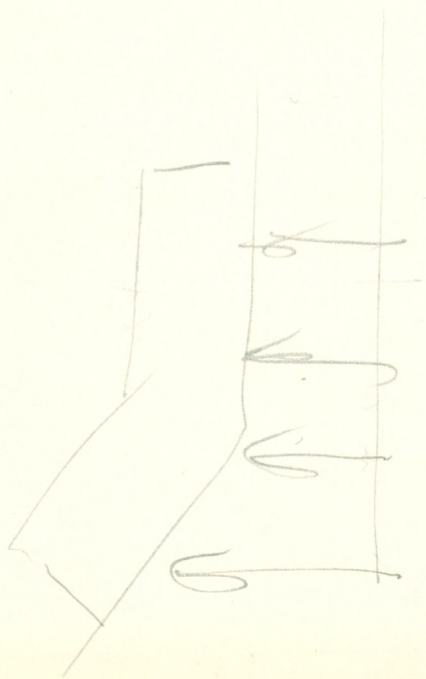
Table X.—Calculation of Earthwork.

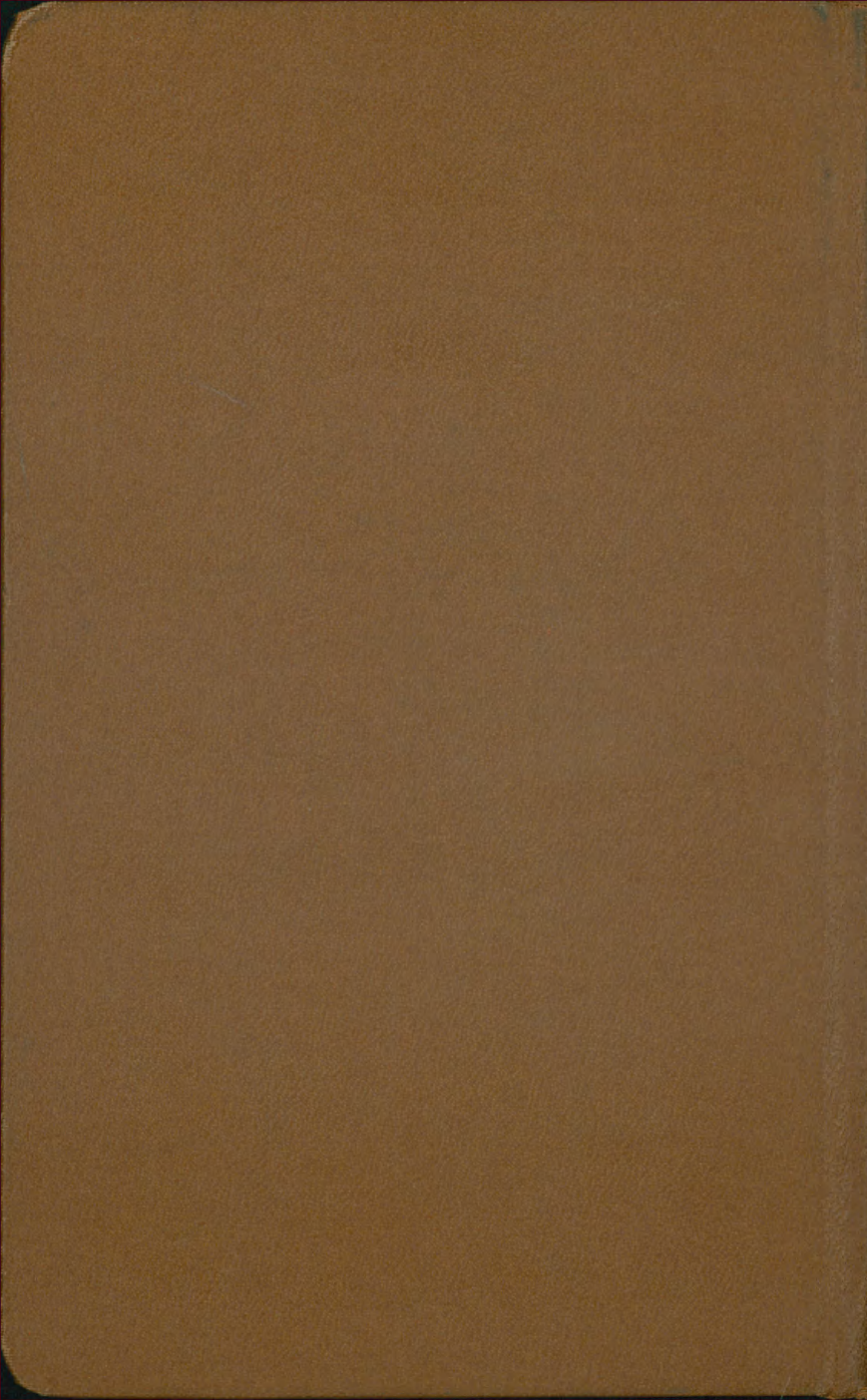
Width	HEIGHT														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	.02	.04	.06	.07	.09	.11	.13	.15	.17	.18	.20	.22	.24	.26	.28
2	.04	.07	.11	.15	.18	.22	.26	.30	.33	.37	.41	.44	.48	.52	.56
3	.06	.11	.17	.22	.28	.33	.39	.44	.50	.56	.61	.67	.72	.78	.83
4	.07	.15	.22	.30	.37	.44	.52	.59	.67	.74	.81	.89	.96	1.04	1.11
5	.09	.19	.28	.37	.46	.56	.65	.74	.83	.93	1.02	1.11	1.20	1.30	1.39
6	.11	.22	.33	.44	.56	.67	.78	.89	1.00	1.11	1.22	1.33	1.44	1.55	1.67
7	.13	.26	.39	.52	.65	.78	.91	1.04	1.16	1.30	1.42	1.55	1.68	1.81	1.94
8	.15	.30	.44	.59	.74	.89	1.04	1.19	1.33	1.48	1.63	1.78	1.92	2.08	2.22
9	.17	.33	.50	.67	.83	1.00	1.17	1.33	1.50	1.67	1.83	2.00	2.17	2.33	2.50
10	.18	.37	.56	.74	.93	1.11	1.30	1.48	1.67	1.85	2.04	2.22	2.41	2.59	2.78
11	.20	.41	.61	.82	1.02	1.22	1.43	1.63	1.83	2.04	2.24	2.44	2.65	2.85	3.06
12	.22	.44	.67	.89	1.11	1.33	1.56	1.78	2.00	2.22	2.44	2.67	2.89	3.11	3.33
13	.24	.48	.72	.96	1.20	1.44	1.68	1.92	2.16	2.41	2.65	2.89	3.13	3.37	3.61
14	.26	.52	.78	1.04	1.30	1.55	1.81	2.08	2.33	2.59	2.85	3.11	3.37	3.63	3.89
15	.28	.56	.83	1.11	1.39	1.67	1.94	2.22	2.50	2.78	3.06	3.33	3.61	3.89	4.17
16	.30	.59	.89	1.18	1.48	1.78	2.07	2.37	2.67	2.96	3.26	3.56	3.85	4.15	4.44
17	.31	.63	.94	1.26	1.57	1.89	2.20	2.52	2.83	3.15	3.46	3.78	4.09	4.41	4.72
18	.33	.67	1.00	1.33	1.67	2.00	2.33	2.67	3.00	3.33	3.67	4.00	4.33	4.67	5.00
19	.35	.70	1.06	1.41	1.76	2.11	2.46	2.82	3.17	3.52	3.87	4.22	4.57	4.92	5.28
20	.37	.74	1.11	1.48	1.85	2.22	2.59	2.96	3.33	3.70	4.07	4.44	4.81	5.18	5.56
21	.39	.78	1.17	1.55	1.94	2.33	2.72	3.11	3.50	3.89	4.28	4.67	5.06	5.44	5.83
22	.41	.81	1.22	1.63	2.04	2.44	2.85	3.26	3.67	4.07	4.48	4.89	5.30	5.70	6.11
23	.43	.85	1.28	1.70	2.13	2.56	2.98	3.41	3.83	4.26	4.68	5.11	5.54	5.96	6.39
24	.44	.89	1.33	1.78	2.22	2.67	3.11	3.56	4.00	4.44	4.89	5.33	5.78	6.22	6.67
25	.46	.92	1.39	1.85	2.31	2.78	3.24	3.70	4.17	4.63	5.09	5.56	6.02	6.48	6.94
26	.48	.96	1.44	1.92	2.41	2.89	3.37	3.85	4.33	4.82	5.30	5.78	6.26	6.74	7.24
27	.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50
28	.52	1.04	1.55	2.07	2.59	3.11	3.63	4.15	4.67	5.18	5.70	6.22	6.74	7.26	7.78
29	.54	1.07	1.61	2.15	2.68	3.22	3.76	4.30	4.83	5.37	5.91	6.44	6.98	7.52	8.06
30	.56	1.11	1.67	2.22	2.78	3.33	3.89	4.44	5.00	5.55	6.11	6.67	7.22	7.78	8.33
31	.57	1.15	1.72	2.30	2.87	3.44	4.02	4.59	5.17	5.74	6.32	6.89	7.46	8.04	8.61
32	.59	1.18	1.78	2.37	2.96	3.56	4.15	4.74	5.33	5.92	6.52	7.11	7.70	8.30	8.89
33	.61	1.22	1.83	2.44	3.05	3.67	4.28	4.89	5.50	6.11	6.72	7.33	7.94	8.55	9.17
34	.63	1.26	1.89	2.52	3.15	3.78	4.40	5.04	5.67	6.29	6.93	7.56	8.18	8.81	9.44
35	.65	1.30	1.94	2.59	3.24	3.89	4.53	5.18	5.83	6.48	7.13	7.78	8.42	9.08	9.72
36	.67	1.33	2.00	2.67	3.33	4.00	4.66	5.33	6.00	6.67	7.33	8.00	8.67	9.33	10.00
37	.68	1.37	2.06	2.74	3.42	4.11	4.79	5.48	6.17	6.85	7.54	8.22	8.91	9.59	10.28
38	.70	1.41	2.11	2.82	3.52	4.22	4.92	5.63	6.33	7.03	7.74	8.44	9.15	9.85	10.56
39	.72	1.44	2.17	2.89	3.61	4.33	5.05	5.78	6.50	7.22	7.95	8.67	9.39	10.11	10.83
40	.74	1.48	2.22	2.96	3.70	4.44	5.18	5.92	6.67	7.41	8.15	8.89	9.63	10.37	11.11

Table X gives the number of cubic yards in a TRIANGLE 1 foot deep for a given width and height. CAUTION: Values obtained from the above tables are for only the one TRIANGLE of the cross-section under consideration.

Corrections for tenths of feet in width and height may be made by considering the numbers on the table from 1 to 9 as tenths and taking one tenth the values found in the tables. For example, to find the number of cubic yards when Width = W = 16.2 and Height = H = 5.3, opposite 16 in "Width" column and under 5 in the "Height" column read 1.18. To correct for additional 0.2 foot of width, opposite 2 in the "Width" column and under 5 in the "Height" column read 0.18 and correct to .018. To correct for additional 0.3 foot in height, under 3 in "Height" column and opposite 16 in "Width" column read 0.89 and correct to .089. Therefore, the total cubic yards in the given TRIANGLE for a depth of 1 foot = $1.18 + .018 + .089 = 1.587$ or approximately 159 cu. yds. per 100 feet.

If width exceeds 40 feet, use one half real width and multiply result by 2. If both width and height are larger than values given on table use one half of each value and multiply result by 4.







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