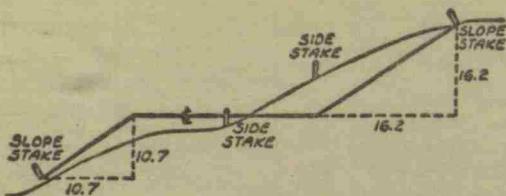


191

LETTER →

January 1911

Walter Reed



DISTANCES FROM SIDE STAKES FOR CROSS-SECTIONING
SLOPE 1 TO 1. ROADWAY OF ANY WIDTH

	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	
0	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0
1	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	1
2	2.00	2.10	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90	2
3	3.00	3.10	3.20	3.30	3.40	3.50	3.60	3.70	3.80	3.90	3
4	4.00	4.10	4.20	4.30	4.40	4.50	4.60	4.70	4.80	4.90	4
5	5.00	5.10	5.20	5.30	5.40	5.50	5.60	5.70	5.80	5.90	5
6	6.00	6.10	6.20	6.30	6.40	6.50	6.60	6.70	6.80	6.90	6
7	7.00	7.10	7.20	7.30	7.40	7.50	7.60	7.70	7.80	7.90	7
8	8.00	8.10	8.20	8.30	8.40	8.50	8.60	8.70	8.80	8.90	8
9	9.00	9.10	9.20	9.30	9.40	9.50	9.60	9.70	9.80	9.90	9
10	10.00	10.10	10.20	10.30	10.40	10.50	10.60	10.70	10.80	10.90	10
11	11.00	11.10	11.20	11.30	11.40	11.50	11.60	11.70	11.80	11.90	11
12	12.00	12.10	12.20	12.30	12.40	12.50	12.60	12.70	12.80	12.90	12
13	13.00	13.10	13.20	13.30	13.40	13.50	13.60	13.70	13.80	13.90	13
14	14.00	14.10	14.20	14.30	14.40	14.50	14.60	14.70	14.80	14.90	14
15	15.00	15.10	15.20	15.30	15.40	15.50	15.60	15.70	15.80	15.90	15
16	16.00	16.10	16.20	16.30	16.40	16.50	16.60	16.70	16.80	16.90	16
17	17.00	17.10	17.20	17.30	17.40	17.50	17.60	17.70	17.80	17.90	17
18	18.00	18.10	18.20	18.30	18.40	18.50	18.60	18.70	18.80	18.90	18
19	19.00	19.10	19.20	19.30	19.40	19.50	19.60	19.70	19.80	19.90	19
20	20.00	20.10	20.20	20.30	20.40	20.50	20.60	20.70	20.80	20.90	20
21	21.00	21.10	21.20	21.30	21.40	21.50	21.60	21.70	21.80	21.90	21
22	22.00	22.10	22.20	22.30	22.40	22.50	22.60	22.70	22.80	22.90	22
23	23.00	23.10	23.20	23.30	23.40	23.50	23.60	23.70	23.80	23.90	23
24	24.00	24.10	24.20	24.30	24.40	24.50	24.60	24.70	24.80	24.90	24
25	25.00	25.10	25.20	25.30	25.40	25.50	25.60	25.70	25.80	25.90	25
26	26.00	26.10	26.20	26.30	26.40	26.50	26.60	26.70	26.80	26.90	26
27	27.00	27.10	27.20	27.30	27.40	27.50	27.60	27.70	27.80	27.90	27
28	28.00	28.10	28.20	28.30	28.40	28.50	28.60	28.70	28.80	28.90	28
29	29.00	29.10	29.20	29.30	29.40	29.50	29.60	29.70	29.80	29.90	29
30	30.00	30.10	30.20	30.30	30.40	30.50	30.60	30.70	30.80	30.90	30
31	31.00	31.10	31.20	31.30	31.40	31.50	31.60	31.70	31.80	31.90	31
32	32.00	32.10	32.20	32.30	32.40	32.50	32.60	32.70	32.80	32.90	32
33	33.00	33.10	33.20	33.30	33.40	33.50	33.60	33.70	33.80	33.90	33
34	34.00	34.10	34.20	34.30	34.40	34.50	34.60	34.70	34.80	34.90	34
35	35.00	35.10	35.20	35.30	35.40	35.50	35.60	35.70	35.80	35.90	35
36	36.00	36.10	36.20	36.30	36.40	36.50	36.60	36.70	36.80	36.90	36
37	37.00	37.10	37.20	37.30	37.40	37.50	37.60	37.70	37.80	37.90	37
38	38.00	38.10	38.20	38.30	38.40	38.50	38.60	38.70	38.80	38.90	38
39	39.00	39.10	39.20	39.30	39.40	39.50	39.60	39.70	39.80	39.90	39
40	40.00	40.10	40.20	40.30	40.40	40.50	40.60	40.70	40.80	40.90	40
41	41.00	41.10	41.20	41.30	41.40	41.50	41.60	41.70	41.80	41.90	41
42	42.00	42.10	42.20	42.30	42.40	42.50	42.60	42.70	42.80	42.90	42
43	43.00	43.10	43.20	43.30	43.40	43.50	43.60	43.70	43.80	43.90	43
44	44.00	44.10	44.20	44.30	44.40	44.50	44.60	44.70	44.80	44.90	44
45	45.00	45.10	45.20	45.30	45.40	45.50	45.60	45.70	45.80	45.90	45
46	46.00	46.10	46.20	46.30	46.40	46.50	46.60	46.70	46.80	46.90	46
47	47.00	47.10	47.20	47.30	47.40	47.50	47.60	47.70	47.80	47.90	47
48	48.00	48.10	48.20	48.30	48.40	48.50	48.60	48.70	48.80	48.90	48
49	49.00	49.10	49.20	49.30	49.40	49.50	49.60	49.70	49.80	49.90	49
50	50.00	50.10	50.20	50.30	50.40	50.50	50.60	50.70	50.80	50.90	50

Distance of slope stake from side or shoulder stake for any width roadway, slope 1 to 1. If ground is nearly level the cut or fill at side stake is located by the double entry method in left column and to the right. The number in body of table in same row and column gives distance from side stake to slope stake. If ground is not level estimate the difference in elevation between the side stake and slope stake, lower target by this amount if cut, elevate if fill. Add this amount to cut or fill and find distance in table. Set up rod at this point, and line of sight should cut target. If it does not make the slight adjustment necessary.

DIRECTIONS FOR USE OF TABLES

TABLE No. XIV

Distance of slope stake from side or shoulder stake for any width roadway, slope $1\frac{1}{2}$ to 1. If ground is nearly level, the cut or fill at side stake is located by the double entry method in left column and top row. The number in body of table in same row and column gives distance from side stake to slope stake. If ground is not level estimate the difference in elevation between the side stake and slope stake, lower target by this amount if cut, elevate if fill. Add this amount to cut or fill and find distance in table. Set up rod at this point, and line of sight should cut target. If it does not make the slight adjustment necessary.

TABLE No. VIII

To find Tangent and External for curve of any other degree, divide by degree of curve and add correction found in column of corrections. Degree of curve with a given I may be found by dividing tangent, (or external), opposite I by given tangent, (or external).

The distance from a point on the tangent to the curve is very nearly the square of the tangent length divided by twice the radius.

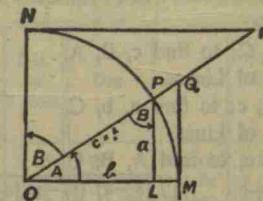


TABLE II
TRIGONOMETRIC FORMULÆ.

$$\angle A = \angle MOP \quad \angle B = \angle PON = \angle OPL \\ R = OB = c = 1$$

$$\sin A = \frac{a}{c} = \frac{a}{1} = a = \text{sos } B = LP$$

$$\text{sos } A = \frac{b}{c} = \frac{b}{1} = b = \sin B = OL$$

$$\tan A = \frac{a}{b} = \frac{MQ}{OM} = \frac{MQ}{1} = MQ = \cot B = MQ$$

$$\cot A = \frac{NT}{ON} = \frac{NT}{1} = NT = \tan B = NT$$

$$\sec A = \frac{OQ}{OM} = \frac{OQ}{1} = OQ = \csc B = OQ$$

$$\csc A = \frac{OT}{ON} = \frac{OT}{1} = OT = \sec B = OT$$

$$\text{vers } A = \frac{LM}{OP} = LM = \text{covers } B \neq$$

$$\text{covers } A = \frac{OP - LP}{OP} = OP - LP = \text{vers } B$$

$$\text{exsec } A = PQ = \text{coexsec } B$$

$$\text{coexsec } A = PT = \text{exsec } B$$

$$\sin \frac{1}{2} A = \sqrt{\frac{1 - \cos A}{2}} \quad \cos \frac{1}{2} A = \sqrt{\frac{1 + \cos A}{2}}$$

$$\sin 2A = 2 \sin A \cos A \quad \cos 2A = \cos^2 A - \sin^2 A$$

$$\text{Law of Lines} \quad \frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$$

$$\text{Law of Cosines} \quad c^2 = a^2 + b^2 - 2ab \cos C$$

$$\text{Law of Tangents} \quad \frac{a+b}{a-b} = \frac{\tan \frac{1}{2}(A+B)}{\tan \frac{1}{2}(A-B)}$$

TABLE II — Continued
TRIGONOMETRIC FORMULÆ (continued)

in any triangle:

Given a, b, C ; to find c, B, A .

Use Law of Lines.

Given A, B, c ; to find a, b, C .

Use Law of Lines.

Given a, b, c ; to find A, B, C .

$$\text{Let } \frac{a+b+c}{2} = s, \sqrt{\frac{(s-a)(s-b)(s-c)}{s}} = r$$

$$\cos \frac{1}{2} A = \sqrt{\frac{s(s-a)}{bc}}$$

$$\tan \frac{1}{2} A = \frac{r}{s-a}$$

$$\tan \frac{1}{2} B = \frac{r}{s-b}$$

$$\tan \frac{1}{2} C = \frac{r}{s-c}$$

Area of a triangle:

$$\text{Area} = \frac{1}{2} ab \sin C$$

$$\text{Area} = \sqrt{s(s-a)(s-b)(s-c)}$$

PRISMOIDAL FORMULA.

$$\text{Vol.} = \frac{h}{6}(B+b+4M)$$

h = altitude; b, B = bases; M = midsection

TABLE III
INCHES AND FRACTIONS OF AN INCH IN DECIMALS OF A FOOT

	0	1	2	3	4	5	6	7	8	9	10	11
$\frac{1}{16}$	.0052	.0885	.1719	.2552	.3385	.4219	.5052	.5885	.6719	.7552	.8385	.9219
$\frac{1}{8}$	.0104	.0938	.1771	.2604	.3438	.4271	.5104	.5938	.6771	.7604	.8438	.9271
$\frac{3}{16}$	.0156	.0990	.1823	.2656	.3490	.4323	.5156	.5990	.6823	.7656	.8490	.9323
$\frac{1}{4}$	.0208	.1042	.1875	.2708	.3542	.4375	.5208	.6042	.6875	.7708	.8542	.9375
$\frac{5}{16}$	.0260	.1094	.1927	.2760	.3594	.4427	.5260	.6094	.6927	.7760	.8594	.9427
$\frac{3}{8}$	.0313	.1146	.1979	.2813	.3646	.4479	.5313	.6146	.6979	.7813	.8646	.9479
$\frac{7}{16}$	.0365	.1198	.2031	.2865	.3698	.4531	.5365	.6198	.7031	.7865	.8698	.9531
$\frac{1}{2}$	.0417	.1250	.2083	.2917	.3750	.4583	.5417	.6250	.7083	.7917	.8750	.9583
$\frac{9}{16}$	.0469	.1302	.2135	.2969	.3803	.4635	.5469	.6302	.7135	.7969	.8802	.9635
$\frac{5}{8}$	.0521	.1354	.2188	.3021	.3854	.4688	.5521	.6354	.7181	.8021	.8854	.9688
$\frac{11}{16}$	.0573	.1406	.2240	.3073	.3906	.4740	.5573	.6400	.7240	.8073	.8906	.9740
$\frac{3}{4}$	.0625	.1458	.2292	.3125	.3958	.4792	.5625	.6458	.7292	.8125	.8958	.9792
$\frac{13}{16}$	.0677	.1510	.2344	.3177	.4010	.4844	.5677	.6510	.7344	.8177	.9010	.9844
$\frac{7}{8}$	.0729	.1563	.2396	.3229	.4063	.4896	.5729	.6563	.7396	.8229	.9063	.9896
$\frac{15}{16}$	.0781	.1615	.2448	.3281	.4115	.4948	.5781	.6615	.7448	.8281	.9115	.9948
1	.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167	1.000
	0	1	2	3	4	5	6	7	8	9	10	11

TABLE IV — 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	8	716.78	1.746	6.976	2.40
1	5729.65	.218	.873	0.30	20	688.16	1.819	7.266	2.50
10	4911.15	.255	1.018	0.35	30	674.69	1.855	7.411	2.55
20	4297.28	.291	1.164	0.40	40	661.74	1.892	7.556	2.60
30	3819.83	.327	1.309	0.45	30	650.28	1.928	7.701	2.65
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
					30	603.80	2.074	8.281	2.85
2	2864.93	.436	1.745	0.60	40	593.42	2.110	8.426	2.90
10	2644.58	.473	1.891	0.65	10	573.69	2.183	8.716	3.00
20	2455.70	.500	2.036	0.70	30	546.44	2.292	9.150	3.15
30	2292.01	.545	2.181	0.75	30	521.67	2.402	9.585	3.30
40	2148.79	.582	2.327	0.80	11	499.06	2.511	10.02	3.45
50	2022.41	.618	2.472	0.85	12	478.34	2.620	10.45	3.60
3	1910.08	.655	2.618	0.90	30	459.28	2.730	10.89	3.75
10	1809.57	.691	2.763	0.95	13	441.68	2.839	11.32	3.90
20	1719.12	.727	2.908	1.00	30	425.40	2.949	11.75	4.05
30	1637.28	.764	3.054	1.05	14	410.28	3.058	12.18	4.20
40	1562.88	.800	3.199	1.10	30	396.20	3.168	12.62	4.35
50	1494.95	.836	3.345	1.15	15	383.07	3.277	13.05	4.50
4	1432.69	.873	3.490	1.20	30	370.78	3.387	13.49	4.65
10	1375.40	.900	3.635	1.25	16	359.27	3.496	13.92	4.80
20	1322.53	.945	3.718	1.30	30	348.45	3.606	14.35	4.95
30	1273.57	.982	3.926	1.35	17	338.27	3.716	14.78	5.10
40	1228.11	1.018	4.071	1.40	18	319.62	3.935	15.64	5.40
50	1185.78	1.055	4.217	1.45	19	302.94	4.155	16.51	5.70
5	1146.28	1.091	4.362	1.50	20	287.94	4.374	17.37	6.00
10	1109.33	1.127	4.507	1.55	21	274.37	4.594	18.22	6.30
20	1074.68	1.164	4.653	1.60	22	262.04	4.814	19.08	6.60
30	1042.14	1.200	4.798	1.65	23	250.79	5.035	19.94	6.90
40	1011.51	1.237	4.943	1.70	24	240.49	5.255	20.79	7.20
50	982.64	1.273	5.088	1.75	25	231.01	5.476	21.64	7.50
6	955.37	1.309	5.234	1.80	26	222.27	5.697	22.50	7.80
10	929.57	1.346	5.379	1.85	27	214.18	5.918	23.35	8.10
20	905.13	1.382	5.524	1.90	28	206.68	6.139	24.19	8.40
30	881.95	1.418	5.669	1.95	29	199.70	6.360	25.04	8.70
40	859.92	1.455	5.814	2.00	30	193.18	6.583	25.88	9.00

Note. Chord Deflection = 2 times tangent deflection.

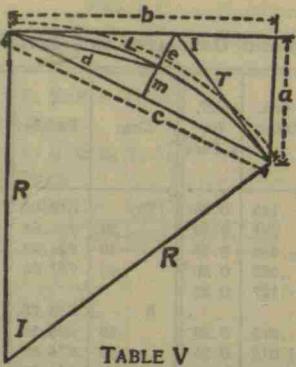


TABLE V
 CURVE FORMULÆ FOR SIMPLE CURVES
 COMPILED BY J. CALVIN LOCKE, C. E.

$$(1) \ c = \sqrt{2Ra} \quad (2) \ c = \sqrt{a^2 + b^2}$$

$$(3) \quad c = \sqrt{2R(R - \sqrt{(R+b)(R-b)})} = \sqrt{2R(R - \sqrt{R^2 - b^2})}$$

$$(4) \quad c = 2 \sqrt{m(2R-m)}$$

$$(5) \quad c = 2R \sin^{-1} \frac{1}{2} I \quad (6) \quad c = 2T \cos^{-1} \frac{1}{2} I$$

$$(7) \quad e = R \sec^{1/2} \theta$$

$$(10) \quad h = \sqrt[3]{\frac{2R - r}{2}}$$

$$10) \quad S = \sqrt{a(2R-a)}$$

$$11) \quad b = \sqrt{\left(c + \frac{c^2}{2R}\right) \left(c - \frac{c^2}{2R}\right)} = \sqrt{c^2 - \frac{c^4}{4R^2}}$$

$$12) \quad b = R \sin I \quad \quad \quad 13) \quad b = a \cot I$$

$$14) R = \frac{a^2 + b^2}{2a} = \frac{c^2}{2a} \quad (15) R = \frac{d^2}{2m} = \frac{c^2 + 4m^2}{8m}$$

$$16) \quad d = \sqrt{R} (2R - \sqrt{(2R+c)(2R-c)}) = \sqrt{R} (2R - \sqrt{4R^2 - c^2})$$

$$17) \quad d = \sqrt{2Rm} \quad (18) \quad d = 2R \sin^{-1} \frac{1}{4} I \quad (19) \quad m = \frac{c^2}{2}$$

$$20) m = R \mp \sqrt{\left(R + \frac{c}{2}\right)\left(R - \frac{c}{2}\right)} = R \mp \sqrt{R^2 - \frac{c^2}{4}}$$

$$21) m = R \sin^{-1/2} I \quad 22) m = R \sin^{-1/2} I \tan^{-1/4} I \quad 23) m = \frac{1}{2} c \tan^{-1/4} I$$

$$24) \quad a = \frac{c}{2R} \quad (25) \quad a = R - \sqrt{(R+b)(R-b)} = R - \sqrt{R^2 - b^2}$$

$$29) \quad a = b \tan^{1/2} I \quad (30) \quad a = T \sin I \quad (31) \quad T = R \tan^{1/2} I$$

$$(32) \quad I = \frac{E}{R} \times 57.295780 \quad (33) \quad R = \frac{E}{I} \times 57.295780$$

$$34) \ L = IR \times 0.01745329 \quad (35) \ L = \frac{8d - c}{3}$$

$$36 \text{ Area Seg.} = \frac{LR - R^2 \sin I}{2} = \frac{LR - Rb}{2}$$

TABLE VI

SINES, COSINES, TANGENTS, COTANGENTS

TABLE VI (continued)
SINES, COSINES, TANGENTS, COTANGENTS (continued)

deg.	sin 0'	tan 0'	sin 10'	tan 10'	sin 20'	tan 20'	sin 30'	tan 30'	sin 40'	tan 40'	sin 50'	tan 50'	deg.
46	7193	1.0355	7214	1.0416	7234	1.0477	7254	1.0533	7274	1.0599	7294	1.0661	43
47	714	.0724	333	.0786	353	.0850	373	.0913	392	.0977	412	.1041	42
48	431	.1106	451	.1171	470	.1237	490	.1303	509	.1369	528	.1436	41
49	547	.1504	566	.1571	585	.1640	604	.1708	623	.1778	642	.1847	40
50	660	1.1918	7679	1.1988	7698	1.2059	7716	1.2131	7735	1.2203	7753	1.2276	39
51	771	.2349	790	.2423	808	.2497	826	.2572	844	.2647	862	.2723	38
52	880	.2799	898	.2876	916	.2954	934	.3032	951	.3111	969	.3190	37
53	986	.3270	8004	.3351	8021	.3432	8039	.3514	8056	.3597	8073	.3680	36
54	8090	.3764	107	.3848	124	.3934	141	.4019	158	.4106	175	.4193	35
55	192	.4281	208	.4370	225	.4460	241	.4550	258	.4641	274	.4733	34
56	290	.4826	307	.4919	323	.5013	339	.5103	355	.5204	371	.5301	33
57	387	.5399	403	.5497	418	.5597	434	.5697	450	.5798	465	.5900	32
58	480	.6003	496	.6107	511	.6212	526	.6319	542	.6426	557	.6534	31
59	572	.6643	587	.6753	601	.6864	616	.6977	631	.7090	646	.7205	30
60	660	1.7321	8675	1.7437	8689	1.7556	8704	1.7675	8718	1.7797	8732	1.7917	29
61	746	.8040	760	.8165	774	.8291	788	.8418	802	.8546	816	.8676	28
62	829	.8807	843	.8940	857	.9074	870	.9210	884	.9347	897	.9480	27
63	910	.9626	923	.9768	936	.9912	949	.20057	962	.20204	975	.20353	26
64	988	2.0503	9001	2.0655	9013	2.0800	9026	.0963	9038	.1123	9051	.1283	25
65	9063	.1445	075	.1609	088	.1775	100	.1943	112	.2113	124	.2286	24
66	135	.2460	147	.2637	159	.2817	171	.2998	182	.3183	194	.3369	23
67	205	.3559	216	.3750	228	.3945	239	.4142	250	.4342	261	.4545	22
68	272	.4751	283	.4960	293	.5172	304	.5386	315	.5605	325	.5826	21
69	336	.6051	346	.6279	356	.6511	367	.6746	377	.6985	387	.7228	20
70	397	2.7475	9407	2.7725	9417	2.7980	9426	2.8239	9436	2.8502	9446	2.8770	19
71	455	.9042	465	.9319	474	.9600	483	.9887	492	.30178	502	.34075	18
72	511	3.0777	520	3.1084	528	3.1397	537	3.1716	546	.2041	555	.2371	17
73	563	.2709	572	.3052	580	.3402	588	.3759	596	.4124	605	.4495	16
74	613	.4874	621	.5261	628	.5656	636	.6059	644	.6470	652	.6891	15
75	659	.7321	667	.7760	674	.8208	681	.8657	689	.9136	696	.9617	14
76	703	4.0108	710	4.0611	717	4.1126	724	4.1653	730	4.2193	737	4.2747	13
77	744	.3315	750	.3897	757	.4494	763	.5107	769	.5736	775	.6382	12
78	781	.7046	787	.7729	793	.8430	799	.9152	805	.9894	811	.5068	11
79	816	.1446	822	.5225	827	5.3093	833	5.3955	838	5.4845	843	.5764	10
80	9848	5.6713	9853	5.7694	9858	5.8708	9863	5.9758	9868	6.0844	9872	6.1970	9
81	877	6.3138	881	6.4348	886	6.5606	890	6.6912	894	.8269	899	.9682	8
82	903	7.1154	907	7.2687	911	7.4287	914	7.5958	918	7.7704	923	7.9530	7
83	925	8.1443	929	8.3450	932	8.5555	936	8.7769	939	9.0098	942	9.2553	6
84	945	9.5144	948	9.7882	951	10.078	954	10.385	957	10.711	959	11.059	5
85	962	11.430	964	11.826	967	12.250	969	12.706	971	13.197	974	13.727	4
86	976	14.300	978	14.924	980	15.605	981	16.350	983	17.169	985	18.075	3
87	986	19.081	988	20.206	989	21.470	990	22.903	992	24.542	993	26.432	2
88	994	28.636	9995	31.242	9996	34.368	9997	38.189	9997	42.964	9998	49.104	1
89	9998	57.290	9999	68.750	9999	85.940	9999	114.58	1.000	171.88	1.000	343.77	
deg.	60'	50'	50'	40'	40'	30'	30'	20'	20'	10'	10'	10'	deg.
cos	cot	cos	cot	cos	cot	cos	cot	cos	cot	cos	cot	cos	deg.

TABLE VII Deflections for Sub Chords for Short Radius Curves.

Degree of Curve	Radius 50	$\frac{1}{2}$ sub chord $R = \sin \text{def. angle}$				Length of arc for 100 ft.
		sin. $\frac{1}{2}$ def. ang.	12.5 Ft.	15 Ft.	20 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

$$T = R \tan \frac{1}{2} I$$

$$T = \frac{50 \tan \frac{1}{2} I}{\sin \frac{1}{2} D}$$

$$\sin \frac{1}{2} D = \frac{50}{R}$$

$$E = R \operatorname{ex. sec} \frac{1}{2} I$$

$$\sin \frac{1}{2} D = \frac{50 \tan \frac{1}{2} I}{T}$$

$$R = T \cot \frac{1}{2} I$$

$$R = \frac{\sin \frac{1}{2} D}{\frac{50}{R}}$$

$$\text{No. chords} = \frac{I}{D}$$

$$E = T \tan \frac{1}{2} I$$

$$\text{Tan. def.} = \frac{1}{2} \text{ chord def.}$$

The square of any distance, divided by twice the radius, will equal the distance from tangent to curve, very nearly.

To find angle for a given distance and deflection.

Rule 1. Multiply the given distance by .01745 (def. for 1° for 1 ft. see Table II.), and divide given deflection by the product.

Rule 2. Multiply given deflection by 57.3, and divide the product by the given distance.

To find deflection for a given angle and distance. Multiply the angle by .01745, and the product by the distance.

GENERAL DATA

RIGHT ANGLE TRIANGLES. Square the altitude, divide by twice the base. Add quotient to base for hypotenuse.

Given Base 100, Alt. $10 \cdot 10^2 \div 200 = .5$, $100 + .5 = 100.5$ hyp.

Given Hyp. 100, Alt. $25.25^2 \div 200 = 3.125$, $100 - 3.125 = 96.875$ = Base.

Error in first example, .002; in last, .045.

To find Tons of Rail in one mile of track: multiply weight per yard by 11, and divide by 7.

LEVELING. The correction for curvature and refraction, in feet and decimals of feet is equal to $0.574 d^2$, where d is the distance in miles. The correction for curvature alone is closely, $\frac{3}{8} d^2$. The combined correction is negative.

PROBABLE ERROR. If $d_1, d_2, d_3, d_4, \dots$ etc. are the discrepancies of various results from the mean, and if $\Sigma d^2 =$ the sum of the squares of these differences and $n =$ the number of observations, then the probable error of the mean =

$$\pm 0.6745 \sqrt{\frac{\Sigma d^2}{n(n-1)}}$$

TABLE VIII TANGENTS AND EXTERNALS TO A 1° CURVE.

I	T	E	I=100	I	T	E	I=200	I	T	E	I=300
1°	50.00	.218		11°	551.70	26.500		21°	1061.9	97.577	
10'	58.34	.297		10'	560.11	27.313		10'	1070.6	99.155	
20'	66.67	.388	+	20'	568.53	28.137	+	20'	1079.2	100.75	+
30'	75.01	.491	50° C.	30'	576.95	28.974	50° C.	30'	1087.8	102.325	50° C.
40'	83.34	.606	T	40'	585.36	29.824	T	40'	1096.4	103.97	T
50'	91.68	.733	.03	50'	593.79	30.686	.06	50'	1105.1	105.60	.10
2°	100.01	.873	E	12°	602.21	31.561	E	22°	1113.7	107.24	E
10'	108.35	1.024	.001	10'	610.64	32.447		10'	1122.4	109.80	.013
20'	116.68	1.188		20'	619.07	33.347		20'	1131.0	110.57	
30'	125.02	1.364		30'	627.50	34.259		30'	1139.7	112.25	
40'	133.36	1.552		40'	635.93	35.183		40'	1148.4	113.95	
50'	141.70	1.752		50'	644.37	36.120		50'	1157.0	115.66	
3°	150.04	1.964	10° C.	13°	652.81	37.070	10° C.	23°	1165.7	117.38	10° C.
10'	158.38	2.188	T	10'	661.25	38.031	T	10'	1174.4	119.12	T
20'	166.72	2.425	.06	20'	669.70	39.006	.13	20'	1183.1	120.87	.19
30'	175.06	2.674	E	30'	678.15	39.993	E	30'	1191.8	122.63	E
40'	183.40	2.934	.003	40'	686.60	40.992	.011	40'	1200.5	124.41	.025
50'	191.74	3.207		50'	695.06	42.004		50'	1209.2	126.20	
4°	200.08	3.492		14°	703.51	43.029		24°	1217.9	128.00	
10'	208.43	3.790		10'	711.97	44.066		10'	1226.6	129.82	
20'	216.77	4.099		20'	720.44	45.116		20'	1235.3	131.65	
30'	225.12	4.421		30'	728.90	46.178		30'	1244.0	133.50	
40'	233.47	4.755		40'	737.37	47.253		40'	1252.8	135.35	
50'	241.81	5.100	15° C.	50'	745.85	48.341	15° C.	50'	1261.5	137.23	15° C.
5°	250.16	5.459	T	15°	754.32	49.441	T	25°	1270.2	139.11	T
10'	258.51	5.829	.09	10'	762.80	50.554	.19	10'	1279.0	141.01	.29
20'	266.86	6.211		20'	771.29	51.679		20'	1287.7	142.93	
30'	275.21	6.606	.004	30'	779.77	52.818		30'	1296.5	144.85	
40'	283.57	7.013		40'	788.26	53.969		40'	1305.3	146.79	
50'	291.92	7.432		50'	796.75	55.132		50'	1314.0	148.75	
6°	300.28	7.863		16°	805.25	56.309		26°	1322.8	150.71	
10'	308.64	8.307		10'	812.75	57.498		10'	1331.6	152.69	
20'	316.99	8.762		20'	822.25	58.699		20'	1340.4	154.69	
30'	325.35	9.230	20° C.	30'	830.76	59.914	20° C.	30'	1349.2	156.70	20° C.
40'	333.71	9.710	T	40'	839.27	61.141	T	40'	1358.0	158.72	T
50'	342.08	10.202	.13	50'	847.78	62.381	.26	50'	1366.8	160.76	.39
7°	350.44	10.707	E	17°	856.30	63.634	E	27°	1375.6	162.81	E
10'	358.81	11.224	.006	10'	864.82	64.900	.022	10'	1384.4	164.86	.051
20'	367.17	11.753		20'	873.36	66.178		20'	1393.2	166.95	
30'	375.54	12.294		30'	881.88	67.470		30'	1402.0	169.04	
40'	383.91	12.847		40'	890.41	68.774		40'	1410.9	171.15	
50'	392.28	13.413		50'	898.95	70.091		50'	1419.7	173.27	
8°	400.66	13.991		18°	907.49	71.421		28°	1428.6	175.41	
10'	409.03	14.582	25° C.	10'	916.03	72.764	25° C.	10'	1437.4	177.55	25° C.
20'	417.41	15.184	T	20'	924.58	74.119	T	20'	1446.3	179.4	T
30'	425.79	15.799	.16	30'	933.13	75.488	.32	30'	1455.1	181.89	.49
40'	434.17	16.426	E	40'	941.69	76.869	E	40'	1464.0	184.08	E
50'	442.55	17.065	.007	50'	950.25	78.264	.028	50'	1472.9	186.29	.065
9°	450.93	17.717		19°	958.81	79.671		29°	1481.8	188.51	
10'	459.32	18.381		10'	967.38	81.092		10'	1490.7	190.74	
20'	467.71	19.058		20'	975.96	82.525		20'	1499.6	192.99	
30'	476.10	19.746		30'	984.53	83.972		30'	1508.5	195.25	
40'	484.49	20.447		40'	993.12	85.431		40'	1517.4	197.53	
50'	492.88	21.161		50'	1001.7	86.904		50'	1526.3	199.82	
10°	501.28	21.887	T	20°	1010.3	88.389	T	30°	1535.3	202.12	T
10'	509.68	22.624	.19	10'	1018.9	89.888	.39	10'	1544.2	204.44	.59
20'	518.08	23.375	E	20'	1027.5	91.399	E	20'	1553.1	206.77	E
30'	526.48	24.135	.008	30'	1036.1	92.924	.034	30'	1562.1	209.12	.078
40'	534.89	24.913		40'	1044.7	94.462		40'	1571.0	211.48	
50'	543.29	25.700		50'	1053.3	96.013		50'	1580.0	213.86	

 $T = R \tan \frac{1}{2} I$ $E = R \operatorname{exsec} \frac{1}{2} I$ TABLE VIII TANGENTS AND EXTERNALS TO A 1° CURVE

I	T	E	I=400	I	T	E	I=500	I	T	E	I=600
81°	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	50° C.	20'	2161.2	394.1	50° C.	20'	2753.4	627.2	50° C.
30'	1615.9	223.5	T	30'	2170.8	397.4	T	30'	2763.7	631.7	T
40'	1624.9	226.0	.13	40'	2180.3	400.8	.17	40'	2773.9	636.2	.21
50'	1633.9	228.4	E	50'	2189.9	404.2	E	50'	2784.2	640.7	E
82°	1643.0	230.9	.023	42°	2199.4	407.6	.037	52°	2794.5	645.2	.056
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'	1767.0	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	
83°	1697.2	246.1	10° C.	43°	2257.0	428.5	10° C.	53°	2856.7	672.7	10° C.
10'	1706.3	248.7	T	10'	2266.6	432.0	T	10'	2867.1	677.3	T
20'	1715.3	251.3	.26	20'	2276.2	435.6	.34	20'	2877.5	682.0	.42
30'	1724.4	253.9	E	30'	2285.9	439.2	E	30'	2888.0	686.7	E
40'	1733.5	256.5	.046	40'	2295.6	442.8	.075	40'	2898.4	691.4	.112
50'	1742.6	259.1		50'	2305.2	446.4		50'	2908.9	696.1	
84°	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	15° C.	50'	2363.5	468.4	15° C.	50'	2972.1	725.0	15° C.
85°	1806.6	278.1		45°	2373.3	472.1		55°	2982.7	729.9	
10'	1815.7	280.8	.40	10'	2383.1	475.8	.51	10'	2993.3	734.8	.63
20'	1824.9	283.6	.070	20'	2392.8	479.6	.116	20'	3003.9	739.7	.163
30'	1834.1	286.4		30'	2402.6	483.4		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	
86°	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	T	40'	2471.5	510.3	T	40'	3089.4	779.8	T
50'	1907.9	305.3	.53	50'	2481.4	514.3	.68	50'	3100.2	784.9	.81
87°	1917.1	312.2		47°	2491.3	518.2	E	57°	3110.9	790.1	E
10'	1926.4	315.2	.093	10'	2501.2	522.2	.151	10'	3121.7	795.2	.225
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	

TABLE VIII TANGENTS AND EXTERNAKS TO A 1° CURVE.

I	T	E	I=70°	I	T	E	I=80°	I	T	E	I=90°
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	+ 5° C.	20'	4112.1	1322.9	+ 5° C.	20'	4922.5	1824.1	+ 5° C.
30'	3408.8	937.3		30'	4124.8	1330.3		30'	4937.0	1833.6	
40'	3420.1	943.1	T	40'	4137.4	1337.7	T	40'	4951.5	1843.1	T
50'	3431.4	948.9	.25	50'	4150.1	1345.1	.30	50'	4966.1	1852.6	.36
62°	3442.7	954.8	.080	72°	4162.8	1352.6	.110	82°	4980.7	1862.2	.149
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	10° C.	73°	4239.7	1398.0	10° C.	83°	5069.2	1920.5	10° C.
10'	3522.6	996.2	T	10'	4252.6	1405.7	T	10'	5084.0	1930.4	T
20'	3534.1	1002.3	.51	20'	4265.6	1413.5	.61	20'	5099.0	1940.3	.72
30'	3545.6	1008.3	E	30'	4278.5	1421.2	E	30'	5113.9	1950.3	E
40'	3557.2	1014.4	.159	40'	4291.5	1429.0	.220	40'	5128.9	1960.2	.299
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	15° C.	50'	4383.3	1484.4	15° C.	50'	5234.9	2031.4	15° C.
65°	3650.2	1063.9	T	75°	4396.5	1492.4	T	85°	5250.3	2041.7	T
10'	3661.9	1070.2	.76	10'	4409.8	1500.5	.91	10'	5265.6	2052.1	1.09
20'	3673.7	1076.6	E	20'	4423.1	1508.6	E	20'	5281.0	2062.5	.450
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	20° C.	30'	4516.9	1566.3	20° C.	30'	5389.9	2136.7	20° C.
40'	3768.5	1128.2	T	40'	4530.4	1574.7	T	40'	5405.6	2147.5	T
50'	3780.4	1134.8	.102	50'	4544.0	1583.1	.122	50'	5421.4	2158.4	1.45
67°	3792.4	1141.4	E	77°	4557.6	1591.6	E	87°	5437.2	2169.2	E
10'	3804.4	1148.0	.321	10'	4571.2	1600.1	.445	10'	5453.1	2180.2	.603
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	25° C.	10'	4653.6	1651.7	25° C.	10'	5549.2	2246.7	25° C.
20'	3889.0	1195.2	T	20'	4667.4	1660.5	T	20'	5565.4	2258.0	T
30'	3901.2	1202.0	1.28	30'	4681.3	1669.2	1.53	30'	5581.6	2269.3	1.83
40'	3913.4	1208.9	E	40'	4695.2	1678.1	E	40'	5597.8	2280.6	E
50'	3925.0	1215.8	.403	50'	4709.2	1686.9	.558	50'	5614.2	2292.0	.756
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	2320.6	
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	30° C.	50'	4793.0	1740.8	30° C.	50'	5713.0	2361.5	30° C.
70°	4011.9	1265.0	T	80°	4807.7	1749.9	T	90°	5729.7	2373.3	T
10'	4024.4	1272.1	1.54	10'	4822.0	1759.0	1.84	10'	5746.3	2385.1	2.20
20'	4036.8	1279.3	E	20'	4836.2	1768.2	E	20'	5763.1	2397.0	E
30'	4049.3	1286.5	.485	30'	4850.5	1777.4	.671	30'	5779.9	2408.9	.910
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	

$$E = R \tan \frac{1}{2} I$$

$$E = R \operatorname{exsec} \frac{1}{2} I$$

TABLE VIII TANGENTS AND EXTERNAKS TO A 1° CURVE

I	T	E	I=100°	I	T	E	I=110°	I	T	E	I=120°
81°	5830.5	2444.9		101°	6950.6	3278.1		111°	8336.7	4386.1	
10'	5847.5	2457.1		20'	6971.3	3294.1		10'	8362.7	4407.6	
20'	5864.6	2469.3	5° C.	30'	6992.0	3310.1	5° C.	20'	8388.9	4429.2	+ 5° C.
30'	5881.7	2481.5	T	40'	7012.7	3326.1	T	30'	8415.1	4450.9	T
40'	5898.9	2493.8	.43	50'	7033.6	3342.3	.51	40'	8441.5	4472.7	.62
50'	5916.0	2506.1	E	50'	7054.5	3358.5	E	50'	8468.0	4494.6	E
62°	5933.2	2518.5	.200	7075.5	3374.9	.268	112°	8494.6	4516.6	.360	
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'	8600.1	4606.0	
50'	6020.2	2581.3		50'	7181.7	3457.6		50'	8629.3	4628.6	
83°	6037.8	2594.0	10° C.	103°	7203.2	3474.7	10° C.	113°	8656.6	4651.3	10° C.
10'	6055.4	2606.8	T	10'	7224.7	3491.3	T	10'	8684.0	4674.1	T
20'	6073.1	2619.7	.86	20'	7246.3	3508.2	.103	20'	8711.5	4697.2	1.25
30'	6090.8	2632.6	E	30'	7268.0	3525.2	E	30'	8739.2	4720.3	'E
40'	6108.6	2645.5	.401	40'	7289.8	3542.4	.536	40'	8767.0	4743.6	721
50'	6126.4	2658.5		50'	7311.7	3559.6		50'	8794.9	4766.9	
64°	6144.3	2671.6		64°	7333.6	3576.8		114°	8822.9	4790.4	
10'	6162.2	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	2712.1		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	15° C.
65°	6252.8	2751.3	1.30	105°	7467.0	3682.3	1.56	115°	8993.8	4934.1	1.93
10'	6271.1	2764.8	E	10'	7489.6	3700.2	E	10'	9022.7	4958.6	E
20'	6299.4	2778.3	.604	20'	7512.2	3718.2	.806	20'	9051.7	4983.1	1.09
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	
66°	6363.4	2833.2		66°	7603.5	3791.0		116°	9160.4	5082.7	
10'	6382.1	2847.0		10'	7626.6	3809.4		10'	9199.1	5107.9	
20'	6400.8	2861.0		20'	7647.9	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'	7693.6	3865.2		40'	9289.2	5184.5	T
50'	6457.3	2903.1	1.74	50'	7719.7	3884.0	2.08	50'	9319.5	5210.3	2.52
67°	6476.2	2917.3	.809	107°	7743.2	3902.9	1.08	117°	9349.9	5236.2	E
10'	6495.2	2931.6		10'	7766.8	3921.9		10'	9380.5	5262.3	1.46
20'	6514.3	2945.9		20'	7790.5	3940.9		20'	9411.3</td		

TABLE XI

INCLINED DISTANCE OF 100 FT. REDUCED TO HORIZONTAL.

TABLE IX
MIDDLE ORDINATES OF RAILS
Length of Rail (feet)

C o'	R Feet	30 Inch	28 Inch	26 Inch	24 Inch	22 Inch	20 Inch	C o'	R Feet	30 Inch	28 Inch	26 Inch	24 Inch	22 Inch	20 Inch
0 - 20	17189	.08	.07	.06	.05	.04	.03	8	716.8	1.88	1.64	1.42	1.20	1.01	.84
0 - 40	8594	.16	.14	.12	.10	.08	.07	9	637.3	2.12	1.84	1.60	1.35	1.14	.94
1 - 0	5730	.24	.20	.18	.15	.13	.10	10	573.7	2.36	2.05	1.78	1.50	1.27	1.04
1 - 20	4297	.31	.27	.23	.20	.17	.13	11	521.7	2.59	2.26	1.95	1.65	1.39	1.15
1 - 40	3438	.39	.34	.29	.25	.21	.17	12	478.3	3.83	2.47	2.15	1.81	1.54	1.26
2 - 0	2865	.47	.41	.35	.30	.25	.20	13	441.7	3.05	2.66	2.30	1.96	1.66	1.36
2 - 20	2456	.55	.48	.41	.35	.29	.23	14	410.3	3.30	2.87	2.48	2.10	1.78	1.46
2 - 40	2149	.63	.55	.47	.40	.33	.27	15	383.1	3.54	3.08	2.68	2.26	1.91	1.57
3 - 0	1910	.71	.62	.53	.45	.38	.31	16	359.3	3.76	3.28	2.83	2.40	2.04	1.67
3 - 20	1719	.78	.68	.59	.50	.42	.35	17	338.3	4.00	3.48	3.02	2.57	2.16	1.78
3 - 40	1563	.86	.75	.65	.55	.46	.38	18	319.6	4.21	3.67	3.18	2.70	2.28	1.87
4 - 0	1433	.94	.82	.71	.60	.50	.42	19	302.9	4.45	3.89	3.36	2.86	2.41	1.98
4 - 20	1323	1.02	.89	.77	.65	.55	.45	20	287.9	4.70	4.09	3.55	3.00	2.54	2.09
4 - 40	1228	1.10	.96	.83	.70	.59	.48	22	262.0	5.16	4.44	3.84	3.30	2.80	2.29
5	1146	1.18	1.03	.89	.75	.63	.52	24	240.5	5.64	4.92	4.20	3.59	3.04	2.50
6	955.3	1.41	1.23	1.06	.90	.76	.62	26	222.3	6.07	5.29	4.58	3.88	3.29	2.70
7	819.0	1.65	1.44	1.24	1.05	.89	.73								

TABLE X
SHORT RADIUS CURVES

Radius Feet	Chord Feet	Central Angle	Deflection Angle	Deflection for 1 Foot
35	10	16-26	8-13	49.3
45	10	12-46	6-23	38.3
50	15	17-16	8-38	34.5
60	15	14-22	7-11	28.8
75	15	11-30	5-45	23.0
100	20	11-30	5-45	17.3
120	20	9-34	4-47	14.3
150	20	7-39	3-49	11.5
190	25	7-32	3-46	9.15
200	25	7-10	3-35	8.6
225	25	6-25	3-12	7.7
240	25	5-58	2-59	7.2
250	25	5-44	2-52	6.9
275	25	5-12	2-36	6.2
288	50	9-58	4-59	6.0
300	50	9-32	4-46	5.7
350	50	8-12	4-06	4.9
376	50	7-40	3-50	4.6
400	50	7-10	3-35	4.3
410	50	7-00	3-30	4.2

To find length of curve divide angle from P. C. to P. T. by central angle of chord, and multiply by length of chord.

For each foot take one one-hundredth of each reading.

TABLE XII
MINUTES IN DECIMALS OF A DEGREE.

0' 30"	.00833	10' 30"	.17500	20' 30"	.34167	30' 30"	.50833	40' 30"	.67500	50' 30"	.84167
1' 00"	.01667	11' 00"	.18333	21' 00"	.35000	31' 00"	.51667	41' 00"	.68333	51' 00"	.85000
3' 00"	.02500	30' 19' 59"	.19167	30' 39' 59"	.38533	30' 59' 59"	.52500	30' 59' 59"	.69167	30' 59' 59"	.85833
2' 00"	.03333	12' 00"	.20000	22' 00"	.36667	32' 00"	.53333	42' 00"	.70000	52' 00"	.86667
3' 30"	.04167	30' 20' 30"	.20833	30' 40' 30"	.37500	30' 50' 30"	.54167	30' 50' 30"	.70833	30' 50' 30"	.87500
3' 00"	.05000	13' 00"	.21667	23' 00"	.38333	33' 00"	.55000	43' 00"	.71667	53' 00"	.88333
3' 30"	.05833	30' 25' 00"	.22500	30' 45' 00"	.39167	30' 55' 00"	.55833	30' 55' 00"	.72500	30' 55' 00"	.89167
4' 00"	.06667	14' 00"	.23333	24' 00"	.40000	34' 00"	.56667	44' 00"	.73333	54' 00"	.90000
3' 00"	.07500	30' 30' 00"	.24167	30' 50' 00"	.40833	30' 59' 00"	.57500	30' 59' 00"	.74167	30' 59' 00"	.90833
5' 00"	.08333	15' 00"	.25000	25' 00"	.41667	35' 00"	.58333	45' 00"	.75000	55' 00"	.91667
3' 30"	.09167	30' 35' 00"	.25833	30' 55' 00"	.42500	30' 59' 30"	.59167	30' 59' 30"	.75833	30' 59' 30"	.92500
6' 00"	.10000	16' 00"	.26667	26' 00"	.43333	36' 00"	.60000	46' 00"	.76667	56' 00"	.93333
3' 00"	.10833	30' 40' 00"	.27500	30' 60' 00"	.44167	30' 59' 00"	.60833	30' 59' 00"	.77500	30' 59' 00"	.94167
7' 00"	.11667	17' 00"	.28333	27' 00"	.45000	37' 00"	.61667	47' 00"	.78333	57' 00"	.95000
3' 30"	.12500	30' 45' 00"	.29167	30' 65' 00"	.45833	30' 59' 30"	.62500	30' 59' 30"	.79167	30' 59' 30"	.95833
8' 00"	.13333	18' 00"	.30000	28' 00"	.46667	38' 00"	.63333	48' 00"	.80000	58' 00"	.96667
3' 00"	.14167	30' 50' 00"	.30833	30' 70' 00"	.47500	30' 59' 00"	.64167	30' 59' 00"	.80833	30' 59' 00"	.97500
9' 00"	.15000	19' 00"	.31667	29' 00"	.48333	39' 00"	.65000	49' 00"	.81667	59' 00"	.98333
3' 30"	.15833	30' 55' 00"	.32500	30' 75' 00"	.49167	30' 59' 30"	.65833	30' 59' 30"	.82500	30' 59' 30"	.99167
10' 00"	.16667	20' 00"	.33333	30' 00"	.50000	40' 00"	.66667	50' 00"	.83333	60' 00"	1.00000

TABLE XIII—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 VIII) 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	1.03	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	2.48	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	1.03	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	.022	.027	.029	.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	.106	.120	.127	.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	.711	.845	.922	.1.01
70°	.080	.159	.240	.321	.403	.485	.568	.652	.735	.819	.906	.994	1.08	1.17
75°	.095	.182	.286	.383	.480	.578	.678	.777	.877	.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	.985	1.06	1.25	1.43	1.62	1.80	1.99	2.18	2.38	2.58
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	.808	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

1

John A. Carter Dr.
 Middle Twp. - Hendrick Co.
 Sept. 6, 1940 H. Cook
 M. Newman

2

0700 - 8" tile S. R/W Railroad
 0734 - S. end R.R. culvert 24" C.M.P.
 0774 - N. " " "
 1404 - N. R/W R.R.
 1404 - G.R. Harvey \$.
 1412 - Harvey sewer S. end 22" C.M.P.
 1430 - " " N. "
 6446 - Tile, SW.
 12+14 - Harvey N. - Scott \$.
 15+92 - Arm #1 - W.
 19+73 - N. Scott - \$ Broyles
 32+81 - Boiler shell SWI - 48"
 32+93 - " " NE
 36+25 - Hill \$ - Broyles N.
 47+63 - " - " - Ditch turns E.
 49+25 - Broyles NE cor. - Hill's SE cor.
 50+79 - Cross old channel
 51+41 - " " "
 53+60 - " " "

53+60 - 10" file from N. 100' N King-Broyles-Hart-Hill.

54+67 - cross old channel

55+81 - " " "

58.+48 - End of ditch.

Arm #1 Carter

0+00 18" tile in conc. bowl.

0+00 8" " " " "

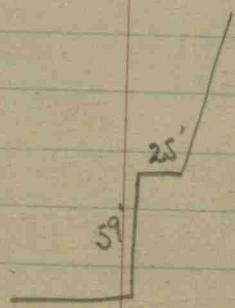
5+46 W Road

5+75 E "

10+53 End.

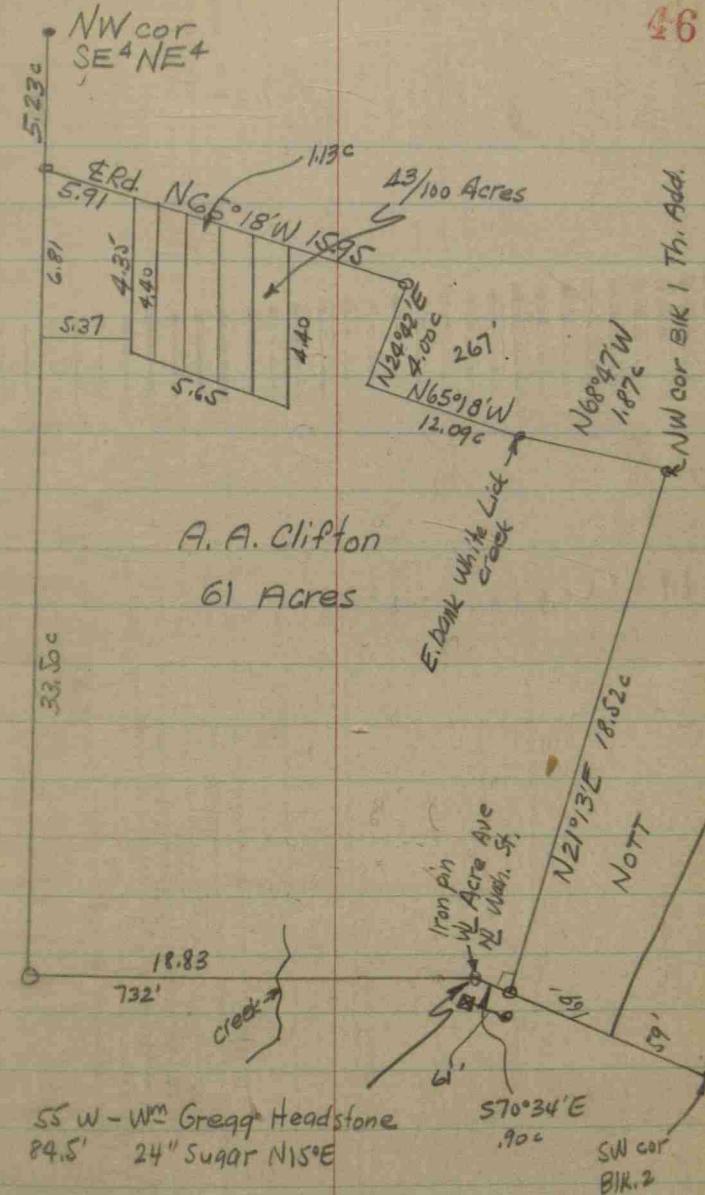
45

A. A. Clifton - Sec. 10-16-E
 Newman
 Franklin



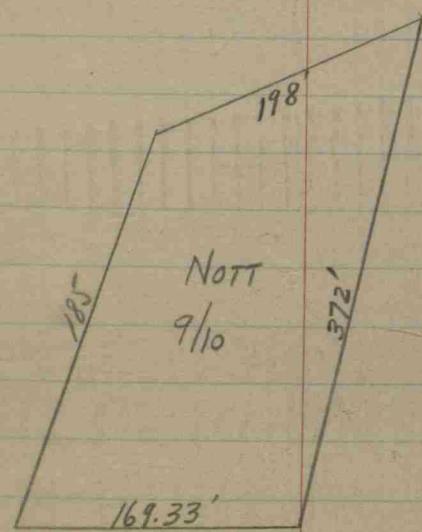
April 1941

46



47

48



49

50

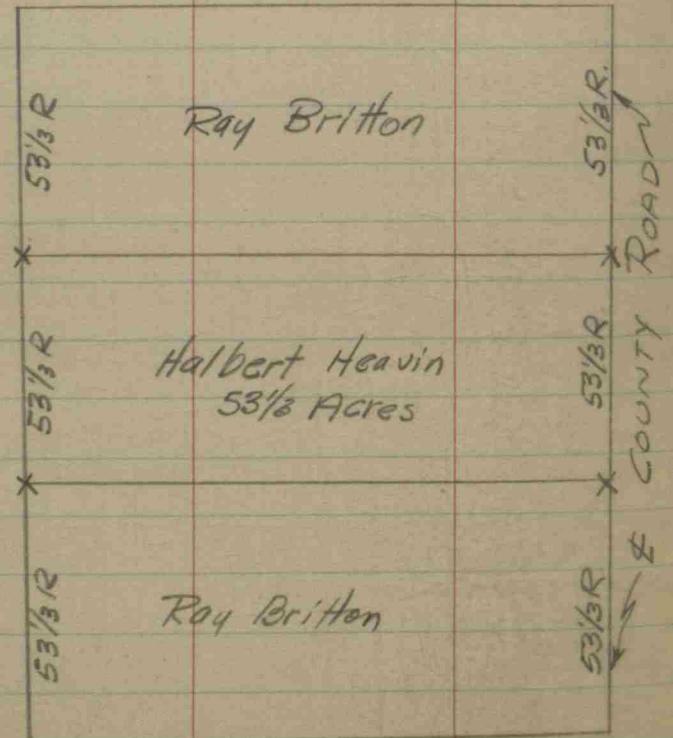
Halbert Heavin + Ray Britton

Sec 19 - 15 - 2W

May 10, 1941 Newman

Cool-Wind

51



52

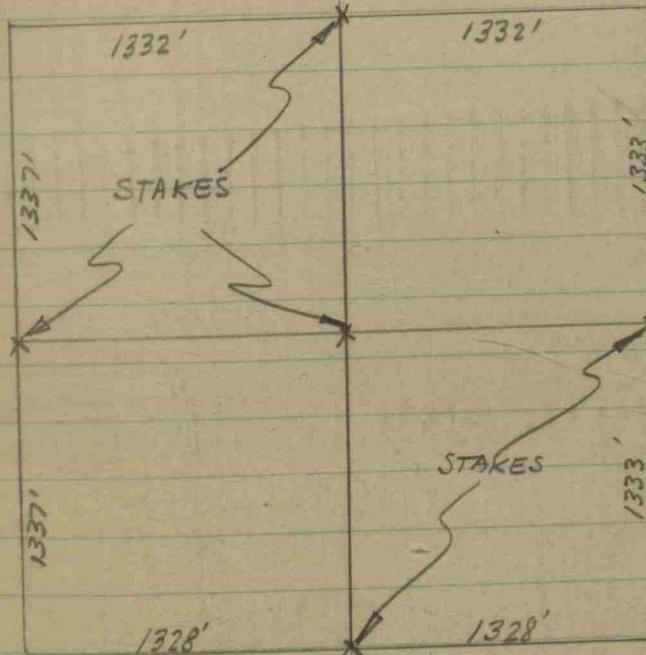
53

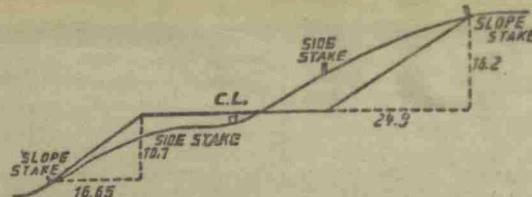
ED MILLS SURVEY
Wash Twp.

MAY 8, 1941 M. NEWMAN

54

SW⁴ SEC 8 - 15-2E





DISTANCES FROM SIDE STAKES FOR CROSS-SECTIONING.

SLOPE $1\frac{1}{6}$ TO 1. ROADWAY OF ANY WIDTH.

	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	
0	0.00	0.15	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	0
1	1.50	1.65	1.80	1.95	2.10	2.25	2.40	2.55	2.70	2.85	1
2	3.00	3.15	3.30	3.45	3.60	3.75	3.90	4.05	4.20	4.35	2
3	4.50	4.65	4.80	4.95	5.10	5.25	5.40	5.55	5.70	5.85	3
4	6.00	6.15	6.30	6.45	6.60	6.75	6.90	7.05	7.20	7.35	4
5	7.50	7.65	7.80	7.95	8.10	8.25	8.40	8.55	8.70	8.85	5
6	9.00	9.15	9.30	9.45	9.60	9.75	9.90	10.05	10.20	10.35	6
7	10.50	10.65	10.80	10.95	11.10	11.25	11.40	11.55	11.70	11.85	7
8	12.00	12.15	12.30	12.45	12.60	12.75	12.90	13.05	13.20	13.35	8
9	13.50	13.65	13.80	13.95	14.10	14.25	14.40	14.55	14.70	14.85	9
10	15.00	15.15	15.30	15.45	15.60	15.75	15.90	16.05	16.20	16.35	10
11	16.50	16.65	16.80	16.95	17.10	17.25	17.40	17.55	17.70	17.85	11
12	18.00	18.15	18.30	18.45	18.60	18.75	18.90	19.05	19.20	19.35	12
13	19.50	19.65	19.80	19.95	20.10	20.25	20.40	20.55	20.70	20.85	13
14	21.00	21.15	21.30	21.45	21.60	21.75	21.90	22.05	22.20	22.35	14
15	22.50	22.65	22.80	22.95	23.10	23.25	23.40	23.55	23.70	23.85	15
16	24.00	24.15	24.30	24.45	24.60	24.75	24.90	25.05	25.20	25.35	16
17	25.50	25.65	25.80	25.95	26.10	26.25	26.40	26.55	26.70	26.85	17
18	27.00	27.15	27.30	27.45	27.60	27.75	27.90	28.05	28.20	28.35	18
19	28.50	28.65	28.80	28.95	29.10	29.25	29.40	29.55	29.70	29.85	19
20	30.00	30.15	30.30	30.45	30.60	30.75	30.90	31.05	31.20	31.35	20
21	31.50	31.65	31.80	31.95	32.10	32.25	32.40	32.55	32.70	32.85	21
22	33.00	33.15	33.30	33.45	33.60	33.75	33.90	34.05	34.20	34.35	22
23	34.50	34.65	34.80	34.95	35.10	35.25	35.40	35.55	35.70	35.85	23
24	36.00	36.15	36.30	36.45	36.60	36.75	36.90	37.05	37.20	37.35	24
25	37.50	37.65	37.80	37.95	38.10	38.25	38.40	38.55	38.70	38.85	25
26	39.00	39.15	39.30	39.45	39.60	39.75	39.90	40.05	40.20	40.35	26
27	40.50	40.65	40.80	40.95	41.10	41.25	41.40	41.55	41.70	41.85	27
28	42.00	42.15	42.30	42.45	42.60	42.75	42.90	43.05	43.20	43.35	28
29	43.50	43.65	43.80	43.95	44.10	44.25	44.40	44.55	44.70	44.85	29
30	45.00	45.15	45.30	45.45	45.60	45.75	45.90	46.05	46.20	46.35	30
31	46.50	46.65	46.80	46.95	47.10	47.25	47.40	47.55	47.70	47.85	31
32	48.00	48.15	48.30	48.45	48.60	48.75	48.90	49.05	49.20	49.35	32
33	49.50	49.65	49.80	49.95	50.10	50.25	50.40	50.55	50.70	50.85	33
34	51.00	51.15	51.30	51.45	51.60	51.75	51.90	52.05	52.20	52.35	34
35	52.50	52.65	52.80	52.95	53.10	53.25	53.40	53.55	53.70	53.85	35
36	54.00	54.15	54.30	54.45	54.60	54.75	54.90	55.05	55.20	55.35	36
37	55.50	55.65	55.80	55.95	56.10	56.25	56.40	56.55	56.70	56.85	37
38	57.00	57.15	57.30	57.45	57.60	57.75	57.90	58.05	58.20	58.35	38
39	58.50	58.65	58.80	58.95	59.10	59.25	59.40	59.55	59.70	59.85	39
40	60.00	60.15	60.30	60.45	60.60	60.75	60.90	61.05	61.20	61.35	40
41	61.50	61.65	61.80	61.95	62.10	62.25	62.40	62.55	62.70	62.85	41
42	63.00	63.15	63.30	63.45	63.60	63.75	63.90	64.05	64.20	64.35	42
43	64.50	64.65	64.80	64.95	65.10	65.25	65.40	65.55	65.70	65.85	43
44	66.00	66.15	66.30	66.45	66.60	66.75	66.90	67.05	67.20	67.35	44
45	67.50	67.65	67.80	67.95	68.10	68.25	68.40	68.55	68.70	68.85	45
46	69.00	69.15	69.30	69.45	69.60	69.75	69.90	70.05	70.20	70.35	46
47	70.50	70.65	70.80	70.95	71.10	71.20	71.40	71.55	71.70	71.85	47
48	72.00	72.15	72.30	72.45	72.60	72.75	72.90	73.05	73.20	73.35	48
49	73.50	73.65	73.80	73.95	74.10	74.25	74.40	74.55	74.70	74.85	49
50	75.00	75.15	75.30	75.45	75.60	75.75	75.90	76.05	76.20	76.35	50

THE NATIONAL BLANK BOOK COMPANY

HOLYOKE

MASSACHUSETTS

NEW YORK

CHICAGO

BOSTON

SAN FRANCISCO