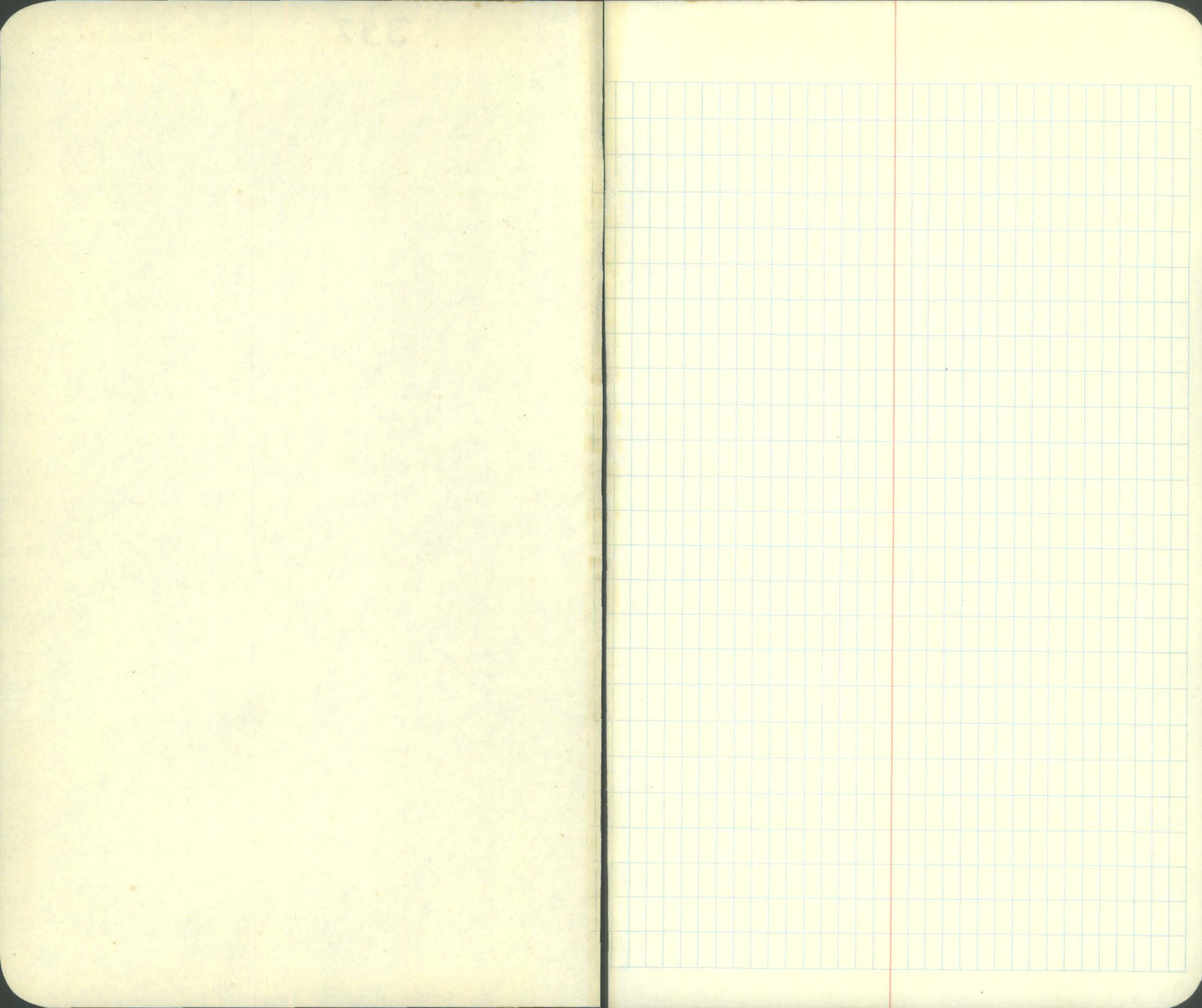


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FIELD BOOK

No. 357



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CLEARING AND GRUBBING C-438(65)

1

3-6	6-9	9-12	12-15	15-18	18-24	24-30	30-36	36-42	42-48	48-60	60-72	OVER 72
18,1,1,2, 3,1,2,1,1 1,4,3,1,4, 2,2,4,4,1 2,3,2,2, 8,	6,1,1,2 2, [12]	6,1,1,1,1 1,1 [13]	4,1,1,1,1 1, [9]	3,1,1,1 [6]	6,1,1,1,1 [10]	1,5 [6]	3 [3]	1,1 [2]		1 [1]	1 [1]	
[75]												

GRUBBING ONLY

1 [1]	3 [3]	2,1 [3]	3,1 [2]	3,1,1,1 [6]	2 [2]	1,1 [2]
----------	----------	------------	------------	----------------	----------	------------

BRUSH

Total 925.25

CLASS 12 EXCAVATION C-438 (65)

2

Date	Station	Size of hole (Length & Width)		Depth	Cu yds
8-18	264+10				12
8-20	308+50				15
8-24	337+00				186
8-25	336+00				80
8-26	364+80				20
9-13	365+50	90'	12'	6'	240
9-13	401+50	60	12	9	186

.1 2 Δ
.1 5
1.8 6
.8 0
.2 0
2.4 0
1.8 6

7.3 9 *

7.0 9 Δ

7.0 9 *

7.3 8 Δ
.9 4

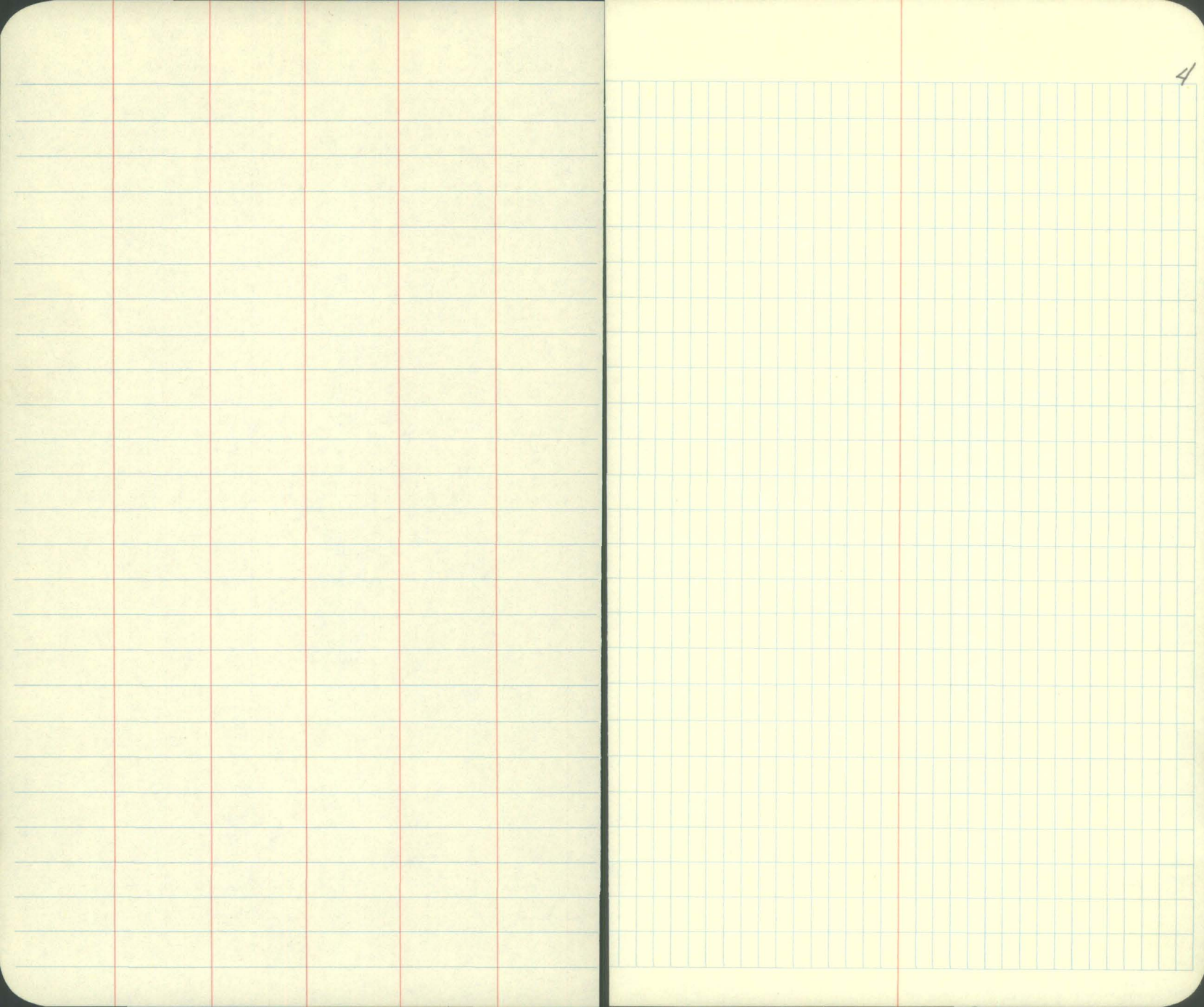
8.3 2 *

EXTRA WORK C-438 (65)

3

Sta. 295+25 Relayed 24"X6' RCP
on Rt. Side
Loyed 24"X6' Extra pipe to
Replace 24"X6' R.C.P. which broke.

Sta 423+00 Relayed 24'X6' R.C.P.
on Lt. side (bell was badly broken,
relayed it on outside)



Culverts (Roadway)

5

Sta 281+30 48"X32' RCP Extended

10' Lt. and 12' Rt.

Sta 286+27 furnished and placed 36"X54' RCP.

Broke down 3X2- R.C.B.

Sta 295+25 24"X42' Extended 4' Rt & 4' Lt.

Relayed 6' Rt., Layed extra 6' Lt.

Sta 319+32 furnish and placed 48"X44' RCP

Broke down 3X3X32 R.C.B.

Sta 372+06 furnished & placed 30"X56' C.R.P.C.

Broke down and filled 2'X2'X35 RCB.

Sta 373+61 furnished and placed 30"X60' RCP

broke down and filled 2X2X32 RCB

Sta 409+47 ~~for~~ Removed 24' of pipe at sta.

354+02 and relayed 24"X30' RCB.

Sta 423+00 furnished and placed 24"X8' R.C.B.

Culverts (Entrance)

6

Sta 272+40 Remove and Relay 30"X24' Conc.
Ent Pipe Culv.

Sta. 282+49 Remove and Relay 18"X24' C.E.P.C.
furnish and place 18"X14' C.E.P.C.

Sta 283+85 Drive was eliminated 14 ft to
Sta 337+76 and 20' to Sta 327+17
Removed 15"X28' C.E.P.C.

Sta. 303+88 Eliminate drive and move to
Sta 300+75 (No pipe Required)

Sta. 319+00 Remove 24"X20' C.M.P. and
furnish and place 24"X24' C.E.P.C.

Sta. 337+76 Remove and relay 18"X14' C.E.P.C.
furnish and place 15"X14' C.E.P.C.

Sta. 346+11 Remove and Relay 24"X75' C.M.P.

Sta. 351+10 Remove and Relay 24"X40' C.M.P.

Sta 356+10 Drive eliminated and relocated
at 359+05 - Remove and relay
15"X20' C.E.P.C., furnish and place
15"X8' C.E.P.C.

Sta 366+65 Remove 15"X28' C.E.P.C.
Pipe was eliminated.

Sta. 367+89 Drive eliminated Remove
15"X20' C.E.P.C. and relayed at 366+20
furnish and place 15"X8' C.E.P.C. 8' broke

Sta. 325+60 Removed 15"X20' C.E.P.C.

Sta. 327+17 Removed 15"X18' C.E.P.C.

Sta 359+00 furnish and place 15"X20' C.E.P.C.

Sta 366+20 furnish and place 15"X28' C.E.P.C.

Sta 385+86 Remove and Relay 15'x20' CEPC.

furnish and Place 15'x10' CEPC.

Sta 398+53 Remove 24'x24' CEPC.

furnish and place 24'x16' CEPC.

Sta 400+85 Remove 18'x24' CEPC.

and relayed 18'x40' CEPC.

Diary

8

Date	Station		Clearing and grubbing Contr started to work.
8-18	274+10	Class 20 12 Cu yd	
8-19	272+40	Removed 24" X 30' C. Ent. Pipe	
	282+49	Removed 24" X 18' C. Ent. Pipe	
	303+88	Removed 15" X 28' C. Ent. Pipe	
8-20	281+30	Layed 48" X 22 C. Rdwy Pipe	Dirt Contr. Started to move equipment
	286+27	Broke down and buried 3' X 2-33 onto job.	
		RCB w/3 Wings and Layed	
		36" X 54' C. Rdwy. Pipe	
	319+00	Removed 24" X 20' C.M.P.	
	308+50	CLASS 20 15 Cu Yds.	
8-21	319+32	Broke down and buried	
		3' X 3' X 32' R.C.B. and Layed	
		48" X 44 C. Rdwy. Pipe	
8-22		Sunday No Work	
8-23			

8-24 337+00 Class 20 186 Cu. Yds
 346+11 Removed 24" X 75' CMP.
 351+10 Removed 24" X 40 CMP

Started in on first mile Approx 2500 Cu. yds.

8-25 295+25 Removed 24" X 12' and Layed
 24" X 20' C. Rdwy. Pipe
 308+16 Compaction of backfill 9 Cu Yds
 336+00 Class 20 80 Cu. Yds.
 336+36 Compaction of backfill 10 Cu. Yds
 356+10 Removed 18" X 20' C. Ent. Pipe

Rain - Too wet to move dirt.

8-26 354+02 Removed 24" X 30' C. Rdwy Pipe
 364+80 CLASS 20 20 Cu Yds.

Approx 2500 Cu. yds.

8-27

Approx 2500 Cu. yds.

8-28

Approx 2500 Cu. yds

8-29 Sunday

No Work

8-30 Rain

No Work

8-31 Rain

No Work

9-1		Started on seconded mile	Approx 2500 Cu Yds
9-2		No Work	Approx 2500 Cu Yds
9-3		No	Approx 2500 Cu Yds
9-4		Rained about 10:00	Approx 500 Cu Yds
9-5	Sunday		
9-6	Rain	No Work	
9-7	Rain	No Work	
9-8	Rain	No Work	
9-9	Rain	No Work	Too-Wet
9-10		No Work	Too-Wet
9-11			Approx 1500 Cu Yd.
9-12	Sunday		

9-13	365150 Class 20 240 Cu. Yds	App	Approx 2000 Cu yds
9-14	Rained out around 10:30 AM Too wet to work remainder of day.		Approx 500 Cu yds
9-15	Rain	No work	
9-16	Rain	No Work	
9-17	Rain		
9-17	Rain - too wet	No Work	
9-18	Rain	No Work	
9-19	Sunday		
9-20	Rain	Too Wet	
9-21	Rain	No Work	
9-22	Rain	No Work	
9-23	Rain	No Work	
9-24	Too Wet	No Work	
9-25	Too Wet	No Work	

9-26	Sunday	Too Wet
9-27	Rain	No Work
9-28	Rain	—
9-29	Rain	No Work
9-30	Too Wet	No Work
10-1	Too Wet	—
10-2	Too Wet.	No Work
10-3	Sunday	No Work
10-4	Broke down and filled 2x2x35' RCB at Sta. 376+06. and Layed 30" x 56' Conc Rdwy Pipe Culv.	Too Wet to move dirt.
10-5	Broke down and filled 2x2x32' RCB at Sta. 373+61 and Layed 30" x 56' C.R.P.C.	
10-6	Too wet to move dirt	

10-7 Too wet

No Work

10-8 Too Wet

No Work

10-9 Layed 24" x 30' Conc Rdwy Pipe Culv.
(4' Short of Plan Quantity, short
on N. Side but will not require
additional pipe.)

10-10 Sunday

10-11 Layed 24" x 8' Conc Rdwy Pipe
at Sta 423+00 - Removed 6' and
relayed it at the outside because
of a badly broken bell.

10-12

10-13

10-14

10-15

10-16

10-17 Sunday

10-18

10-19

10-20 Rain

No Work

10-21 Too Wet

10-22

10-23

Finishing

10-24 Sunday

10-25

"

10-26

"

10-27

"

10-28

"

10-29

"

10-30

Finishing

11-1

Hauled Rock

11-2

Hauled Rock

11-3 Jim Loy inspected job. He
and wanted contractor to

wasn't satisfied with the finishing
work on finishing

11-4

11-5

11-6

11-7

11-8

11-9

Contractor went back and worked
on back slope near N.N.G.

11-10

11-11

Holiday

11-12

409				10.5	4.4	C-1.2	$\frac{7.2}{48.5}$	f-2.8	f-7.4	$\frac{11.8}{48.5}$	—
408				11.4	3.5	C-1.4	$\frac{6.1}{48.5}$	f-2.6	f-2.3	$\frac{5.8}{48.5}$	C-1.7
+80	2.90	914.85	9.11	911.96	911.95	Sp 1A.P.P.	5 - 32'				
407				13.0	8.1	C-2.9	$\frac{8.2}{48.5}$	f-0.1	C-2.0	$\frac{6.1}{48.5}$	C-6.0
+80											
406				14.5	6.6	C-6.0	$\frac{2.6}{48.5}$	C-4.0	C-1.0	$\frac{5.6}{48.5}$	C-5.0
405				15.1	6.0	C-7.6	$\frac{0.4}{48.5}$	C-5.6	f-1.8	$\frac{7.8}{48.5}$	C-2.2
404				14.7	6.4	5.7	$\frac{2.7}{48.5}$	C-3.7	f-2.8	$\frac{9.2}{48.5}$	C-1.2
φ STAKE RT. ↓	11.57	921.07	5.64	909.50							
403				13.3	1.8	3.4	$\frac{1.4}{48.5}$	C-0.4	f-3.8	$\frac{5.6}{48.5}$	C-0.2
			5.64								
402				11.5	3.6	-3.3	$\frac{4.3}{48.5}$	f-0.7	f-4.9	$\frac{8.5}{48.5}$	—
				11.5							
401				09.7	5.4	-2.6	$\frac{6.8}{48.5}$	f-1.4	f-5.3	$\frac{10.7}{48.5}$	—
400				08.3	6.8	-1.4	$\frac{7.4}{48.5}$	f-2.6	f-6.3	$\frac{13.1}{48.5}$	—
399											
+92	8.89	915.14	9.04 7.56	08.1 906.28	7.0 906.10 906.25	Boat New Ext. NE Cor	7' x 4' Box				
398				08.9	4.9	-3.8	$\frac{2.1}{48.5}$	f-0.2	f-2.9	$\frac{7.9}{48.5}$	C-1.1
φ STAKE RT. ↓	3.30	913.84	13.59	910.54							
397				10.8	13.3	5.7	$\frac{11.6}{48.5}$	C-1.7	f-0.3	$\frac{13.6}{48.5}$	C-3.7

422				03.8	8.8	C-8.0	$\frac{4.8}{48.5}$	C-4.0	C-0.8	$\frac{8.0}{48.5}$	C-4.8
421				900.4	12.2	12.1	$\frac{4.1}{48.5}$	C-8.1	C-2.8	$\frac{9.4}{48.5}$	C-6.8
420				97.8	14.8	C-10.2	$\frac{8.6}{48.5}$	C-6.2	C-3.9	$\frac{10.9}{48.5}$	C-7.9
φ ↑	12.76	912.62	1.81	899.80	899.86	No. 1 ♀					
419				96.3	5.2	C-3.8	$\frac{5.4}{48.5}$	f-0.2	f-2.5	$\frac{7.7}{48.5}$	C-1.5
418				96.0	5.5	—	$\frac{11.3}{48.5}$	f-5.8	f-9.4	$\frac{14.9}{48.5}$	—
φ 8m + 0.2	14.10	901.46	12.96 12.15	887.32	$\frac{988.50}{887.36}$	Bolt in N Hdwl of 4x4 RCB. X N Conc Hdwl 4x4 RCB					
417				96.7	2.8	—	$\frac{13.5}{48.5}$	f-10.7	f-11.2	$\frac{14.0}{48.5}$	—
416				98.6	10.8	—	$\frac{7.2}{48.5}$	f-6.3	f-1.6	$\frac{2.5}{48.5}$	C-2.4
	1.20	899.47	14.75	898.27							
415				01.5	12.7	C-4.8	$\frac{11.9}{48.5}$	C-0.8	C-3.6	$\frac{9.1}{48.5}$	C-7.6
φ											
414				05.2	8.0	C-6.3	$\frac{5.7}{48.5}$	C-2.3	C-1.6	$\frac{6.4}{48.5}$	C-5.6
413				07.9	5.3	C-8.0	$\frac{2.3}{48.5}$	C-3.0	C-1.9	$\frac{3.4}{48.5}$	C-5.9
φ	2.30	913.02	4.13	910.72							
412				09.7	5.2	C-7.5	$\frac{1.2}{48.5}$	C-3.5	C-0.9	$\frac{4.3}{48.5}$	C-4.9
411				10.5	4.4	C-5.3	$\frac{3.1}{48.5}$	C-1.3	f-3.5	$\frac{7.8}{48.5}$	C-0.5
410				10.4	4.5	C-2.1	$\frac{6.4}{48.5}$	f-1.9	f-8.5	$\frac{13.0}{48.5}$	—

			1.80	915.83	15.78	Volvo	Cent	Co Rd	X			
425				14.0	3.6	F-83	$\frac{5.3}{48.5}$	f-0.7	f-3.9	$\frac{7.5}{48.5}$	C-0.1	
φ					3.9							
↓												
424	6.70	917.63	2.69	910.93	10.6	2.0	F-0.5	$\frac{5.5}{48.5}$	f-3.5	f-6.6	$\frac{8.6}{48.5}$	5
423				07.2	54	-1.1	$\frac{8.3}{48.5}$	f-2.9	f-5.9	11.3		

Class 20 Excavation

19

Sta 286+27 72 Cu. Yds.

Sta 319+32 80 Cu. yds.

372+06 50 Cu. yds

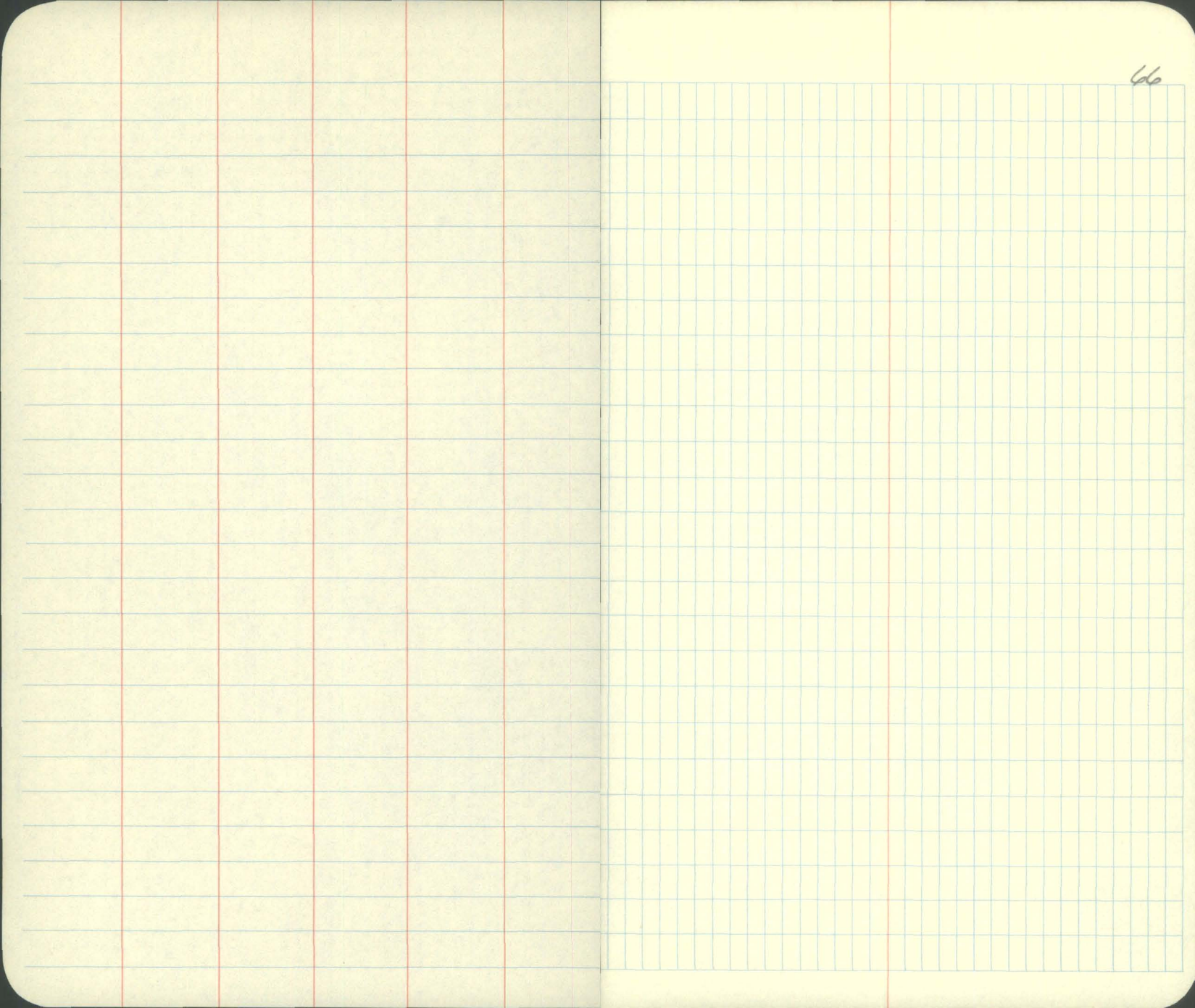
373+61 67 Cu. yds.

Total Class 20 269 Cu. yds

Compaction of Backfill

20

308+16	9	Cu. yds
336+66	10	Cu. yds.
398+92	9	Cu. yds
417+05	19	Cu. yds
Total	47	Cu. yds



IMPROVED TABLES AND INFORMATION

HORIZONTAL STADIA CORRECTIONS

2°—00' — 0.1	21°—00' — 12.8	33°—00' — 29.7
3°—00' — 0.3	21°—30' — 13.4	33°—15' — 30.1
4°—00' — 0.5	22°—00' — 14.0	33°—30' — 30.5
5°—00' — 0.8	22°—30' — 14.7	33°—45' — 30.9
6°—00' — 1.1	23°—00' — 15.3	34°—00' — 31.3
7°—00' — 1.5	23°—30' — 15.9	34°—15' — 31.7
8°—00' — 1.9	24°—00' — 16.5	34°—30' — 32.1
9°—00' — 2.5	24°—30' — 17.2	34°—45' — 32.5
10°—00' — 3.0	25°—00' — 17.9	35°—00' — 32.9
10°—30' — 3.3	25°—30' — 18.6	35°—15' — 33.3
11°—00' — 3.6	26°—00' — 19.2	35°—30' — 33.7
11°—30' — 4.0	26°—30' — 19.9	35°—45' — 34.1
12°—00' — 4.3	27°—00' — 20.6	36°—00' — 34.6
12°—30' — 4.7	27°—30' — 21.3	36°—15' — 35.0
13°—00' — 5.1	28°—00' — 22.0	36°—30' — 35.4
13°—30' — 5.5	28°—30' — 22.8	36°—45' — 35.8
14°—00' — 5.9	29°—00' — 23.5	37°—00' — 36.2
14°—30' — 6.3	29°—30' — 24.3	37°—15' — 36.6
15°—00' — 6.7	30°—00' — 25.0	37°—30' — 37.1
15°—30' — 7.2	30°—15' — 25.4	37°—45' — 37.5
16°—00' — 7.6	30°—30' — 25.8	38°—00' — 37.9
16°—30' — 8.1	30°—45' — 26.2	38°—15' — 38.3
17°—00' — 8.5	31°—00' — 26.5	38°—30' — 38.7
17°—30' — 9.0	31°—15' — 26.9	38°—45' — 39.1
18°—00' — 9.5	31°—30' — 27.3	39°—00' — 39.6
18°—30' — 10.1	31°—45' — 27.7	39°—15' — 40.0
19°—00' — 10.6	32°—00' — 28.1	39°—30' — 40.5
19°—30' — 11.2	32°—15' — 28.5	
20°—00' — 11.7	32°—30' — 28.9	
20°—30' — 12.3	32°—45' — 29.3	

Chains to Feet

1	66
2	132
3	198
4	264
5	330
6	396
7	462
8	528
9	594
10	660

Feet to Chains

100	1.515
200	3.030
300	4.545
400	6.060
500	7.575
600	9.090
700	10.606
800	12.121
900	13.636
1,000	15.151

DIRECTIONS FOR USE OF TABLES

TABLE No. 1.

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. 9.

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.

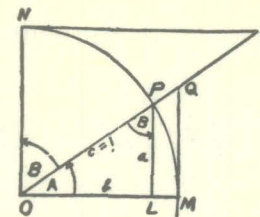


TABLE II
TRIGONOMETRIC FORMULÆ.

$$\angle A = \angle MOP \quad \angle B = \angle PON = \angle OPL$$

$$R = OP = c = 1$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

TABLE II—Continued
TRIGONOMETRIC FORMULAE (continued)

In any triangle:

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

Use Law of Sines.

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

Use Law of Sines.

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	.7188	.8021	.8854	.9688
$\frac{11}{16}$	.0573	.1406	.2240	.3073	.3906	.4740	.5573	.6406	.7240	.8073	.8906	.9740
$\frac{3}{4}$	.0625	.1458	.2292	.3125	.3958	.4792	.5625	.6458	.7292	.8125	.8958	.9792
$\frac{7}{8}$	.0677	.1510	.2344	.3177	.4010	.4844	.5677	.6510	.7344	.8177	.9010	.9844
$\frac{15}{16}$	.0729	.1563	.2396	.3229	.4063	.4896	.5729	.6563	.7396	.8229	.9063	.9896
1	.0781	.1615	.2448	.3281	.4115	.4948	.5781	.6615	.7448	.8281	.9115	.9948
	.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
USEFUL RELATIONS.

Lineal feet	×.00019	= miles
Lineal yards	×.0006	= miles
Square inches	×.007	= square feet
Square feet	×.111	= square yards
Square yards	×.0002067	= acres
Acres	×4840	= square yards
Cubic inches	×.00058	= cubic feet
Cubic feet	×.03704	= cubic yards
Links	×.22	= yards
Links	×.66	= feet
Feet	×1.5	= links
360°	= 21600'	= 1296000"
Radius	= arc of 57.2957790°	
Arc of 1° (radius = 1)	= .017453292	
Arc of 1' (radius = 1)	= .000290888	
Arc of 1" (radius = 1)	= .000004848	

$$\pi = 3.141592654 \quad \sqrt{\frac{1}{\pi}} = 0.564190$$

$$\frac{\pi}{4} = 0.785398163 \quad \sqrt[3]{\frac{6}{\pi}} = 1.240700982$$

$$\frac{\pi}{6} = 0.523598776 \quad \pi^2 = 9.869604401$$

$$\sqrt{\frac{4}{\pi}} = 1.128379167 \quad \frac{1}{\pi^2} = 0.101321184$$

$$\frac{\pi}{6} = 0.523598776 \quad \sqrt{\pi} = 1.772453851$$

$$\frac{4\pi}{3} = 4.188790205 \quad \frac{1}{\pi} = 0.3183099$$

Curvature of Earth's surface = about 0.7 feet in 1 mile

Curvature in feet = 0.667 (Dist. in miles)²

Difference between arc and chord length, 0.05 feet in 11½ miles

$$\text{Probable error of a single observation} = 0.6754 \sqrt{\frac{\sum v^2}{n-1}}$$

Error in chaining of 0.01 feet in 100 feet:

Due to—

1. Length of tape error of 0.01 feet
2. Alignment. One end 1.4 feet out of line
3. Sag of tape at centre of 0.61 feet.
4. Temperature difference of 15°
5. Difference of pull of 15 lbs.

STADIA REDUCTION FORMULAE

$$\text{Horizontal Distance} = R - R \sin^2 a + C \cos a$$

$$\text{Vertical Distance} = R \frac{1}{2} \sin 2a + C \sin a$$

$$R = \text{Reading} \times \frac{\text{distance from Object glass to cross hairs}}{\text{distance between cross hairs}}$$

C = distance from Object glass to cross hairs + distance from Object glass to center of instrument.

a = angle of elevation for mid Reading

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	314	.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	.3452	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	.5108	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	.9486	27
63	910	.9626	923	.9768	936	.9912	949	2.0057	962	2.0204	975	2.0353	26
64	988	2.0503	9001	2.0655	9013	2.0809	9026	.0965	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	3.0178	502	3.0475	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	5.0658	11
79	816	.1446	822	5.2257	827	5.3093	833	5.3955	838	5.4845	843	.5764	10
80	848	5.6713	853	5.7694	858	5.8708	863	5.9758	868	6.0844	872	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	922	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	997	38.189	997	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	0
90	60'	60'	50'	50'	40'	40'	30'	30'	20'	20'	10'	10'	deg.
	cos	cot	cos	cot	cos	cot	cos	cot	cos	cot	cos	cot	

TABLE VII
RODS IN FEET, 10THS AND 100THS OF FEET

Rods	Feet	Rods	Feet	Rods	Feet	Rods	Feet	Rods	Feet
1	16.50	21	346.50	41	676.50	61	1006.50	81	1336.50
2	33.00	22	363.00	42	693.00	62	1023.00	82	1353.00
3	49.50	23	379.50	43	709.50	63	1039.50	83	1369.50
4	66.00	24	396.00	44	726.00	64	1056.00	84	1386.00
5	82.50	25	412.50	45	742.50	65	1072.50	85	1402.50
6	99.00	26	429.00	46	759.00	66	1089.00	86	1419.00
7	115.50	27	445.50	47	775.50	67	1105.50	87	1435.50
8	132.00	28	462.00	48	792.00	68	1122.00	88	1452.00
9	148.50	29	478.50	49	808.50	69	1138.50	89	1468.50
10	165.00	30	495.00	50	825.00	70	1155.00	90	1485.00
11	181.50	31	511.50	51	841.50	71	1171.50	91	1501.50
12	198.00	32	528.00	52	858.00	72	1188.00	92	1518.00
13	214.50	33	544.50	53	874.50	73	1204.50	93	1534.50
14	231.00	34	561.00	54	891.00	74	1221.00	94	1551.00
15	247.50	35	577.50	55	907.50	75	1237.50	95	1567.50
16	264.00	36	594.00	56	924.00	76	1254.00	96	1584.00
17	280.50	37	610.50	57	940.50	77	1270.50	97	1600.50
18	297.00	38	627.00	58	957.00	78	1287.00	98	1617.00
19	313.50	39	643.50	59	973.50	79	1303.50	99	1633.50
20	330.00	40	660.00	60	990.00	80	1320.00	100	1650.00

TABLE VIII
LINKS IN FEET, 10THS AND 100THS OF FEET

Links	Feet	Links	Feet	Links	Feet	Links	Feet	Links	Feet	Links	Feet
1	0.66	18	11.88	35	23.10	52	34.32	69	45.54	86	56.76
2	1.32	19	12.54	36	23.76	53	34.98	70	46.20	87	57.42
3	1.98	20	13.20	37	24.42	54	35.64	71	46.86	88	58.08
4	2.64	21	13.86	38	25.08	55	36.30	72	47.52	89	58.74
5	3.30	22	14.52	39	25.74	56	36.96	73	48.18	90	59.40
6	3.96	23	15.18	40	26.40	57	37.62	74	48.84	91	60.06
7	4.62	24	15.84	41	27.06	58	38.28	75	49.50	92	60.72
8	5.28	25	16.50	42	27.72	59	38.94	76	50.16	93	61.38
9	5.94	26	17.16	43	28.38	60	39.60	77	50.82	94	62.04
10	6.60	27	17.82	44	29.04	61	40.26	78	51.48	95	62.70
11	7.26	28	18.48	45	29.70	62	40.92	79	52.14	96	63.36
12	7.92	29	19.14	46	30.36	63	41.58	80	52.80	97	64.02
13	8.58	30	19.80	47	31.02	64	42.24	81	53.46	98	64.68
14	9.24	31	20.46	48	31.68	65	42.90	82	54.12	99	65.34
15	9.90	32	21.12	49	32.34	66	43.56	83	54.78	100	66.00
16	10.56	33	21.78	50	33.00	67	44.22	84	55.44	101	66.66
17	11.22	34	22.44	51	33.66	68	44.88	85	56.10	102	67.32

TABLE IX. TANGENTS AND EXTERNALS TO A 1° CURVE

I	T	E	I=10°	I	T	E	I=20°	I	T	E	I=30°
1°	50.00	.218	+	11°	551.70	26.500	+	21°	1061.9	97.577	+
10'	58.34	.297	5° C.	10'	560.11	27.313	5° C	10'	1070.6	99.155	5° C
20'	66.67	.388		20'	568.53	28.137		20'	1079.2	100.75	
30'	75.01	.491	T	30'	576.95	28.974	T	30'	1087.8	102.35	T
40'	83.34	.606	.03	40'	585.36	29.824	.06	40'	1096.4	103.97	.10
50'	91.68	.733	E	50'	593.79	30.686	E	50'	1105.1	105.60	E
2°	100.01	.873	.001	12°	602.21	31.561	.006	22°	1113.7	107.24	.013
10'	108.35	1.024		10'	610.64	32.447		10'	1122.4	108.90	
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	E	20'	771.29	51.679	E	20'	1287.7	142.93	E
30'	275.21	6.606	.004	30'	779.77	52.818	.017	30'	1296.5	144.85	.038
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'	813.75	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'	873.35	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	179.72	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	30° C.	20°	1010.3	88.389	30° C.	30°	1535.3	202.12	30° C.
10'	509.68	22.624	T	10'	1018.9	89.888	T	10'	1544.2	204.44	T
20'	518.08	23.375	.19	20'	1027.5	91.399	.39	20'	1553.1	206.77	.59
30'	526.48	24.138	E	30'	1036.1	92.924	E	30'	1562.1	209.12	E
40'	534.89	24.913	.008	40'	1044.7	94.462	.034	40'	1571.0	211.48	.078
50'	543.29	25.700		50'	1053.3	96.013		50'	1580.0	213.86	

T = R tan ½ I

E = R exsec ½ I

TABLE IX. TANGENTS AND EXTERNALS TO A 1° CURVE

I	T	E	I=40°	I	T	E	I=50°	I	T	E	I=60°
31°	1589.0	216.3	+	41°	2142.2	387.4	+	51°	2732.9	618.4	+
10'	1598.0	218.7	5° C.	10'	2151.7	390.7	5° C.	10'	2743.1	622.8	5° C.
20'	1606.9	221.1	T	20'	2161.2	394.1	T	20'	2753.4	627.2	T
30'	1615.9	223.5	.13	30'	2170.8	397.4	.17	30'	2763.7	631.7	.21
40'	1624.9	226.0	E	40'	2180.3	400.8	E	40'	2773.9	636.2	E
50'	1633.9	228.4	.023	50'	2189.9	404.2	.037	50'	2784.2	640.7	.056
32°	1643.0	230.9		42°	2199.4	407.6		52°	2794.0	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	10° C.	50'	2247.3	425.0	10° C.	50'	2846.3	668.0	10° C.
33°	1697.2	246.1	T	43°	2257.0	428.5	T	53°	2856.7	672.7	T
10'	1706.3	248.7	.26	10'	2266.6	432.0	.34	10'	2867.1	677.3	.42
20'	1715.3	251.3	E	20'	2276.2	435.6	E	20'	2877.5	682.0	E
30'	1724.4	253.9	.046	30'	2285.9	439.2	.075	30'	2888.0	686.7	.112
40'	1733.5	256.5		40'	2295.6	442.8		40'	2898.4	691.4	
50'	1742.6	259.1	15° C.	50'	2305.2	446.4	15° C.	50'	2908.9	696.1	15° C.
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	15° C.	50'	2363.5	468.4	15° C.	50'	2972.1	725.0	15° C.
35°	1806.6	278.1	T	45°	2373.3	472.1	T	55°	2982.7	729.9	T
10'	1815.7	280.8	.40	10'	2383.1	475.8	.51	10'	2993.3	734.8	.63
20'	1824.9	283.6	E	20'	2392.8	479.6	E	20'	3003.9	739.7	E
30'	1834.1	286.4	.070	30'	2402.6	483.4	.116	30'	3014.5	744.6	.168
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	20° C.	30'	2461.7	506.4	20° C.	30'	3078.7	774.7	20° C.
40'	1898.6	306.4	T	40'	2471.5	510.3	T	40'	3089.4	779.8	T
50'	1907.9	309.3	.53	50'	2481.4	514.3	.68	50'	3100.2	784.9	.84
37°	1917.1	312.2	E	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	
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	25° C.	10'	2561.0	546.3	25° C.	10'	3186.9	826.7	25° C.
20'	1991.5	336.3	T	20'	2571.0	550.4	T	20'	3197.8	832.0	T
30'	2000.9	339.3	.67	30'	2581.0	554.5	.85	30'	3208.8	837.3	.105
40'	2010.2	342.4	E	40'	2591.0	558.6	E	40'	3219.7	842.7	E
50'	2019.6	345.5	.117	50'	2601.1	562.8	.189	50'	3230.7	848.1	.283
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	30° C.	50'	2661.6	588.0	30° C.	50'	3296.9	880.8	30° C.
40°	2085.4	367.7	T	50°	2671.8	592.3	T	60°	3308.0	886.4	T
10'	2094.9	371.0	.80	10'	2681.9	596.6	.102	10'	3319.1	892.0	.127
20'	2104.3	374.2	E	20'	2692.1	600.9	E	20'	3330.3	897.5	E
30'	2113.8	377.5	.141	30'	2702.3	605.3	.227	30'	3341.4	903.2	.147
40'	2123.3	380.8		40'	2712.5	609.6		40'	3352.6	908.8	.168
50'	2132.7	384.1		50'	2722.7	614.0		50'	3363.8	914.5	.190

TABLE IX. TANGENTS AND EXTERNALS 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	5° C.	10°	4099.5	1315.6	5° C.	10°	4908.0	1814.7	5° C.
20°	3397.5	931.6	T	20°	4112.1	1322.9	T	20°	4922.5	1824.1	T
30°	3408.8	937.3	T	30°	4124.8	1330.3	T	30°	4937.0	1833.6	T
40°	3420.1	943.1	.25	40°	4137.4	1337.7	.30	40°	4951.5	1843.1	.36
50°	3431.4	948.9	E	50°	4150.1	1345.1	E	50°	4966.1	1852.6	E
62°	3442.7	954.8	.080	72°	4162.8	1352.6	.110	82°	4980.7	1862.2	.149
10°	3454.1	960.6	10° C.	10°	4175.6	1360.1	10° C.	10°	4995.4	1871.8	10° C.
20°	3465.4	966.5	T	20°	4188.5	1367.6	T	20°	5010.0	1881.5	T
30°	3476.8	972.4	T	30°	4201.2	1375.2	T	30°	5024.8	1891.2	T
40°	3488.3	978.3	.51	40°	4214.0	1382.8	.61	40°	5039.5	1900.9	.62
50°	3499.7	984.3	E	50°	4226.8	1390.4	E	50°	5054.3	1910.7	E
63°	3511.1	990.2	.080	73°	4239.7	1398.0	.110	83°	5069.2	1920.5	.149
10°	3522.6	996.2	10° C.	10°	4252.6	1405.7	10° C.	10°	5084.0	1930.4	10° C.
20°	3534.1	1002.3	T	20°	4265.6	1413.5	T	20°	5099.0	1940.3	T
30°	3545.6	1008.3	T	30°	4278.5	1421.2	T	30°	5113.9	1950.3	T
40°	3557.2	1014.4	.51	40°	4291.5	1429.0	.61	40°	5128.9	1960.2	.72
50°	3568.7	1020.5	E	50°	4304.6	1436.8	E	50°	5143.9	1970.3	E
64°	3580.3	1026.6	.159	74°	4317.6	1444.6	.220	84°	5159.0	1980.4	.299
10°	3591.9	1032.8	15° C.	10°	4330.7	1452.5	15° C.	10°	5174.1	1990.5	15° C.
20°	3603.5	1039.0	T	20°	4343.8	1460.4	T	20°	5189.3	2000.6	T
30°	3615.1	1045.2	T	30°	4356.9	1468.4	T	30°	5204.4	2010.8	T
40°	3626.8	1051.4	.76	40°	4370.1	1476.4	.91	40°	5219.7	2021.1	.91
50°	3638.5	1057.7	E	50°	4383.3	1484.4	E	50°	5234.9	2031.4	E
65°	3650.2	1063.9	.240	75°	4396.5	1492.4	.332	85°	5250.3	2041.7	.450
10°	3661.9	1070.2	15° C.	10°	4409.8	1500.5	15° C.	10°	5265.6	2052.1	15° C.
20°	3673.7	1076.6	T	20°	4423.1	1508.6	T	20°	5281.0	2062.5	T
30°	3685.4	1082.9	T	30°	4436.4	1516.7	T	30°	5296.4	2073.0	T
40°	3697.2	1089.3	.76	40°	4449.7	1524.9	.91	40°	5311.9	2083.5	.91
50°	3709.0	1095.7	E	50°	4463.1	1533.1	E	50°	5327.4	2094.1	E
66°	3720.9	1102.2	.240	76°	4476.5	1541.4	.332	86°	5343.0	2104.7	.450
10°	3732.7	1108.6	15° C.	10°	4489.9	1549.7	15° C.	10°	5358.6	2115.3	15° C.
20°	3744.6	1115.1	T	20°	4503.4	1558.0	T	20°	5374.2	2126.0	T
30°	3756.5	1121.7	T	30°	4516.9	1566.3	T	30°	5389.9	2136.7	T
40°	3768.5	1128.2	.76	40°	4530.4	1574.7	.91	40°	5405.6	2147.5	.91
50°	3780.4	1134.8	E	50°	4544.0	1583.1	E	50°	5421.4	2158.4	E
67°	3792.4	1141.4	.240	77°	4557.6	1591.6	.332	87°	5437.2	2169.2	.450
10°	3804.4	1148.0	15° C.	10°	4571.2	1600.1	15° C.	10°	5453.1	2180.2	15° C.
20°	3816.4	1154.7	T	20°	4584.8	1608.6	T	20°	5469.0	2191.1	T
30°	3828.4	1161.3	T	30°	4598.5	1617.1	T	30°	5484.9	2202.2	T
40°	3840.5	1168.1	.76	40°	4612.2	1625.7	.91	40°	5500.9	2213.2	.91
50°	3852.6	1174.8	E	50°	4626.0	1634.4	E	50°	5517.0	2224.3	E
68°	3864.7	1181.6	.240	78°	4639.8	1643.0	.332	88°	5533.1	2235.5	.450
10°	3876.8	1188.4	15° C.	10°	4653.6	1651.7	15° C.	10°	5549.2	2246.7	15° C.
20°	3889.0	1195.2	T	20°	4667.4	1660.5	T	20°	5565.4	2258.0	T
30°	3901.2	1202.0	T	30°	4681.3	1669.2	T	30°	5581.6	2269.3	T
40°	3913.4	1208.9	.76	40°	4695.2	1678.1	.91	40°	5597.8	2280.6	.91
50°	3925.6	1215.8	E	50°	4709.2	1686.9	E	50°	5614.2	2292.0	E
69°	3937.7	1222.7	.240	79°	4723.2	1695.8	.332	89°	5630.5	2303.5	.450
10°	3950.0	1229.7	15° C.	10°	4737.2	1704.7	15° C.	10°	5646.9	2315.0	15° C.
20°	3962.5	1236.7	T	20°	4751.2	1713.7	T	20°	5663.4	2326.6	T
30°	3974.8	1243.7	T	30°	4765.3	1722.7	T	30°	5679.9	2338.2	T
40°	3987.2	1250.8	.76	40°	4779.4	1731.7	.91	40°	5696.4	2349.8	.91
50°	3999.5	1257.9	E	50°	4793.6	1740.8	E	50°	5713.0	2361.5	E
70°	4011.9	1265.0	.240	80°	4807.7	1749.9	.332	90°	5729.7	2373.3	.450
10°	4024.4	1272.1	15° C.	10°	4822.0	1759.0	15° C.	10°	5746.3	2385.1	15° C.
20°	4036.8	1279.3	T	20°	4836.2	1768.2	T	20°	5763.1	2397.0	T
30°	4049.3	1286.5	T	30°	4850.5	1777.4	T	30°	5779.9	2408.9	T
40°	4061.8	1293.6	.76	40°	4864.8	1786.7	.91	40°	5796.7	2420.9	.91
50°	4074.4	1300.9	E	50°	4879.2	1796.0	E	50°	5813.6	2432.9	E

T = R tan ½ I

E = R exsec ½ I

TABLE IX. TANGENTS AND EXTERNALS TO A 1° CURVE

I	T	E	I=100°	I	T	E	I=110°	I	T	E	I=120°
91°	5830.5	2444.9	+	101°	6950.6	3278.1	+	111°	8336.7	4386.1	+
10°	5847.5	2457.1	5° C.	10°	6971.3	3294.1	5° C.	10°	8362.7	4407.6	5° C.
20°	5864.6	2469.3	T	20°	6992.0	3310.1	T	20°	8388.9	4429.2	T
30°	5881.7	2481.5	T	30°	7012.7	3326.1	T	30°	8415.1	4450.9	T
40°	5898.8	2493.8	.43	40°	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
92°	5933.2	2518.5	.200	102°	7075.5	3374.9	.268	112°	8494.6	4516.6	.360
10°	5950.5	2531.0	10° C.	10°	7096.6	3391.2	10° C.	10°	8521.3	4538.8	10° C.
20°	5967.9	2543.5	T	20°	7117.8	3407.7	T	20°	8548.1	4561.1	T
30°	5985.3	2556.0	T	30°	7139.0	3424.3	T	30°	8575.0	4583.4	T
40°	6002.7	2568.6	.43	40°	7160.3	3440.9	.51	40°	8602.1	4606.0	.62
50°	6020.2	2581.3	E	50°	7181.7	3457.6	E	50°	8629.3	4628.6	E
93°	6037.8	2594.0	.200	103°	7203.2	3474.4	.268	113°	8656.6	4651.3	.360
10°	6055.4	2606.8	10° C.	10°	7224.7	3491.3	10° C.	10°	8684.0	4674.2	10° C.
20°	6073.1	2619.7	T	20°	7246.3	3508.2	T	20°	8711.5	4697.2	T
30°	6090.8	2632.6	T	30°	7268.0	3525.2	T	30°	8739.2	4720.3	T
40°	6108.6	2645.5	.43	40°	7289.8	3542.4	.51	40°	8767.0	4743.6	.62
50°	6126.4	2658.5	E	50°	7311.7	3559.6	E	50°	8794.9	4766.9	E
94°	6144.3	2671.6	.200	104°	7333.6	3576.8	.268	114°	8822.9	4790.4	.360
10°	6162.2	2684.7	10° C.	10°	7355.6	3594.2	10° C.	10°	8851.0	4814.1	10° C.
20°	6180.2	2697.9	T	20°	7377.8	3611.7	T	20°	8879.3	4837.8	T
30°	6198.3	2711.2	T	30°	7399.9	3629.2	T	30°	8907.7	4861.7	T
40°	6216.4	2724.5	.43	40°	7422.2	3646.8	.51	40°	8936.3	4885.7	.62
50°	6234.6	2737.9	E	50°	7444.6	3664.5	E	50°	8965.0	4909.9	E
95°	6252.8	2751.3	.200	105°	7467.0	3682.3	.268	115°	8993.8	4934.1	.360
10°	6271.1	2764.8	10° C.	10°	7489.6	3700.2	10° C.	10°	9022.7	4958.6	10° C.
20°	6289.4	2778.3	T	20°	7512.2	3718.2	T	20°	9051.7	4983.1	T
30°	6307.9	2792.0	T	30°	7534.9	3736.2	T	30°	9080.9	5007.8	T
40°	6326.3	2805.6	.43	40°	7557.7	3754.4	.51	40°	9110.3	5032.6	.62
50°	6344.8	2819.4	E	50°	7580.5	3772.6	E	50°	9139.8	5057.6	E
96°	6363.4	2833.2	.200	106°	7603.5	3791.0	.268	116°	9169.4	5082.7	.360
10°	6382.1	2847.0	10° C.	10°	7626.6	3809.4	10° C.	10°	9199.1	5107.9	10° C.
20°	6400.8	2861.0	T	20°	7649.7	3827.9	T	20°	9229.0	5133.3	T
30°	6419.5	2875.0	T	30°	7672.9	3846.5	T	30°	9259.0	5158.8	T
40°	6438.4	2889.0	.43	40°	7696.3	3865.2	.51	40°	9289.2	5184.5	.62
50°	6457.3	2903.1	E	50°	7719.7	3884.0	E	50°	9319.5	5210.3	E
97°	6476.2	2917.3	.200	107°	7743.2	3902.9	.268	117°	9349.9	5236.2	.360
10°	6495.2	2931.6	10° C.	10°	7766.8	3921.9	10° C.	10°	9380.5	5262.3	10° C.
20°	6514.3	2945.9	T	20°	7790.5	3940.9	T	20°	9411.3	5288.6	T
30°	6533.4	2960.3	T	30°	7814.3	3960.1	T	30°	9442.2	5315.0	T
40°	6552.6	2974.7	.43	40°	7838.1	3979.4	.51	40°	9473.2	5341.5	.62
50°	6571.9	2989.2	E	50°	7862.1	3998.7	E	50°	9504.4	5368.2	E
98°	6591.2	3003.8	.200	108°	7886.2	4018.2	.268	118°	9535.7	5395.1	.360
10°	6610.6	3018.4	10° C.	10°	7910.4	4037.8	10° C.	10°	9567.2	5422.1	10° C

TABLE X.
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 XI.
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

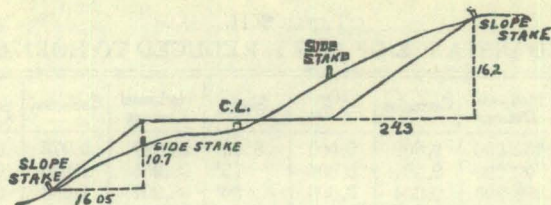
To find length of curve divide angle from P. C. to P. T. by central angle of chord, and multiply by length of chord.

TABLE XII.
INCLINED DISTANCE OF 100 FT. REDUCED TO HORIZONTAL

Slope	Horizontal Distance	Correction	Rise Per Foot	Slope	Horizontal Distance	Correction	Rise Per Foot
0°00'	100.000	0.000	0.000	8°00'	99.027	0.973	0.139
15'	99.999	0.001	0.004	15'	98.965	1.035	0.143
30'	99.996	0.004	0.009	30'	98.902	1.098	0.148
45'	99.991	0.009	0.013	45'	98.836	1.164	0.152
1 00	99.985	0.015	0.017	9 00	98.769	1.231	0.156
15	99.976	0.024	0.022	15	98.700	1.300	0.161
30	99.966	0.034	0.026	30	98.629	1.371	0.165
45	99.953	0.047	0.031	45	98.556	1.444	0.169
2 00	99.939	0.061	0.035	10 00	98.481	1.519	0.174
15	99.923	0.077	0.039	15	98.404	1.596	0.178
30	99.905	0.095	0.044	30	98.325	1.675	0.182
45	99.885	0.115	0.048	45	98.245	1.755	0.187
3 00	99.863	0.137	0.052	11 00	98.163	1.837	0.191
15	99.839	0.161	0.057	15	98.079	1.921	0.195
30	99.813	0.187	0.061	30	97.992	2.008	0.199
45	99.786	0.214	0.065	45	97.905	2.095	0.204
4 00	99.756	0.244	0.070	12 00	97.815	2.185	0.208
15	99.725	0.275	0.074	15	97.723	2.277	0.212
30	99.692	0.308	0.078	30	97.630	2.370	0.216
45	99.657	0.343	0.083	45	97.534	2.466	0.221
5 00	99.619	0.381	0.087	13 00	97.437	2.563	0.225
15	99.580	0.420	0.092	15	97.338	2.662	0.229
30	99.540	0.460	0.096	30	97.237	2.763	0.233
45	99.497	0.503	0.100	45	97.134	2.866	0.238
6 00	99.452	0.548	0.105	14 00	97.030	2.970	0.242
15	99.406	0.594	0.109	15	96.923	3.077	0.246
30	99.357	0.643	0.113	30	96.815	3.185	0.250
45	99.307	0.693	0.118	45	96.705	3.295	0.255
7 00	99.255	0.745	0.122	15 00	96.593	3.407	0.259
15	99.200	0.800	0.126	15	96.479	3.521	0.263
30	99.144	0.856	0.131	30	96.363	3.637	0.267
45	99.087	0.913	0.135	45	96.246	3.754	0.271

TABLE XIII.
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
30	.02500	80	.19167	80	.35833	30	.52500	30	.69167	30	.85833
2 00	.03333	12 00	.20000	22 00	.36667	32 00	.53333	42 00	.70000	52 00	.86667
30	.04167	30	.20833	30	.37500	30	.54167	30	.70833	30	.87500
3 00	.05000	18 00	.21667	28 00	.38333	38 00	.55000	48 00	.71667	58 00	.88333
30	.05833	30	.22500	30	.39167	30	.55833	30	.72500	30	.89167
4 00	.06667	14 00	.23333	24 00	.40000	34 00	.56667	44 00	.73333	54 00	.90000
30	.07500	80	.24167	30	.40833	30	.57500	30	.74167	30	.90833
5 00	.08333	15 00	.25000	25 00	.41667	35 00	.58333	45 00	.75000	55 00	.91667
30	.09167	30	.25833	30	.42500	30	.59167	30	.75833	30	.92500
6 00	.10000	16 00	.26667	26 00	.43333	36 00	.60000	46 00	.76667	56 00	.93333
30	.10833	30	.27500	30	.44167	30	.60833	30	.77500	30	.94167
7 00	.11667	17 00	.28333	27 00	.45000	37 00	.61667	47 00	.78333	57 00	.95000
30	.12500	30	.29167	30	.45833	30	.62500	30	.79167	30	.95833
8 00	.13333	18 00	.30000	28 00	.46667	38 00	.63333	48 00	.80000	58 00	.96667
30	.14167	30	.30833	30	.47500	30	.64167	30	.80833	30	.97500
9 00	.15000	19 00	.31667	29 00	.48333	39 00	.65000	49 00	.81667	59 00	.98333
30	.15833	30	.32500	30	.49167	30	.65833	30	.82500	30	.99167
10 00	.16667	20 00	.33333	30 00	.50000	40 00	.66667	50 00	.83333	60 00	1.00000



DISTANCES FROM SIDE STAKES FOR CROSS-SECTIONING.

SLOPE $\frac{1}{4}$ 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	71.25	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

Computed by L. Leland Locke.

1.13 West of Pin

M RAIN
T RAIN

