

Rich Valley

Empire

Hampton

} Job



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ENGINEERS'  
FIELD BOOK

No. 401

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104

Office of Ramsey and ...  
ST. PAUL, MINN.

Hampton - Rich Valley  
File No. 9 (2200)(2205)

# EUGENE DIETZGEN CO.

DRAWING MATERIALS, MATHEMATICAL and  
SURVEYING INSTRUMENTS

Chicago New York San Francisco New Orleans Pittsburg Toronto

Distances from Center of Roadway for Cross-Sectioning  
Roadway 16 feet wide. Side Slopes 1 on 1.  
For Single Track Embankment.

H	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	H
0	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	0
1	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	1
2	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	2
3	11.0	11.1	11.2	11.3	11.4	11.5	11.6	11.7	11.8	11.9	3
4	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	4
5	13.0	13.1	13.2	13.3	13.4	13.5	13.6	13.7	13.8	13.9	5
6	14.0	14.1	14.2	14.3	14.4	14.5	14.6	14.7	14.8	14.9	6
7	15.0	15.1	15.2	15.3	15.4	15.5	15.6	15.7	15.8	15.9	7
8	16.0	16.1	16.2	16.3	16.4	16.5	16.6	16.7	16.8	16.9	8
9	17.0	17.1	17.2	17.3	17.4	17.5	17.6	17.7	17.8	17.9	9
10	18.0	18.1	18.2	18.3	18.4	18.5	18.6	18.7	18.8	18.9	10
11	19.0	19.1	19.2	19.3	19.4	19.5	19.6	19.7	19.8	19.9	11
12	20.0	20.1	20.2	20.3	20.4	20.5	20.6	20.7	20.8	20.9	12
13	21.0	21.1	21.2	21.3	21.4	21.5	21.6	21.7	21.8	21.9	13
14	22.0	22.1	22.2	22.3	22.4	22.5	22.6	22.7	22.8	22.9	14
15	23.0	23.1	23.2	23.3	23.4	23.5	23.6	23.7	23.8	23.9	15
16	24.0	24.1	24.2	24.3	24.4	24.5	24.6	24.7	24.8	24.9	16
17	25.0	25.1	25.2	25.3	25.4	25.5	25.6	25.7	25.8	25.9	17
18	26.0	26.1	26.2	26.3	26.4	26.5	26.6	26.7	26.8	26.9	18
19	27.0	27.1	27.2	27.3	27.4	27.5	27.6	27.7	27.8	27.9	19
20	28.0	28.1	28.2	28.3	28.4	28.5	28.6	28.7	28.8	28.9	20
21	29.0	29.1	29.2	29.3	29.4	29.5	29.6	29.7	29.8	29.9	21
22	30.0	30.1	30.2	30.3	30.4	30.5	30.6	30.7	30.8	30.9	22
23	31.0	31.1	31.2	31.3	31.4	31.5	31.6	31.7	31.8	31.9	23
24	32.0	32.1	32.2	32.3	32.4	32.5	32.6	32.7	32.8	32.9	24
25	33.0	33.1	33.2	33.3	33.4	33.5	33.6	33.7	33.8	33.9	25
26	34.0	34.1	34.2	34.3	34.4	34.5	34.6	34.7	34.8	34.9	26
27	35.0	35.1	35.2	35.3	35.4	35.5	35.6	35.7	35.8	35.9	27
28	36.0	36.1	36.2	36.3	36.4	36.5	36.6	36.7	36.8	36.9	28
29	37.0	37.1	37.2	37.3	37.4	37.5	37.6	37.7	37.8	37.9	29
30	38.0	38.1	38.2	38.3	38.4	38.5	38.6	38.7	38.8	38.9	30
31	39.0	39.1	39.2	39.3	39.4	39.5	39.6	39.7	39.8	39.9	31
32	40.0	40.1	40.2	40.3	40.4	40.5	40.6	40.7	40.8	40.9	32
33	41.0	41.1	41.2	41.3	41.4	41.5	41.6	41.7	41.8	41.9	33
34	42.0	42.1	42.2	42.3	42.4	42.5	42.6	42.7	42.8	42.9	34
35	43.0	43.1	43.2	43.3	43.4	43.5	43.6	43.7	43.8	43.9	35
36	44.0	44.1	44.2	44.3	44.4	44.5	44.6	44.7	44.8	44.9	36
37	45.0	45.1	45.2	45.3	45.4	45.5	45.6	45.7	45.8	45.9	37
38	46.0	46.1	46.2	46.3	46.4	46.5	46.6	46.7	46.8	46.9	38
39	47.0	47.1	47.2	47.3	47.4	47.5	47.6	47.7	47.8	47.9	39
40	48.0	48.1	48.2	48.3	48.4	48.5	48.6	48.7	48.8	48.9	40

Example—If point is 22.6 ft. above grade, how far should it be from center line to be a slope stake point? Ans. from Table 30.6. For same slopes but other widths of roadbed, correct above figures by one-half difference in width of roadbed; thus in example above, for 20 ft. roadbed distance will be  $30.6 + (20 - 16) \div 2$  or 2 ft. added to 30.6 = 32.6. For slopes of 1 on 1½ see inside of back cover.

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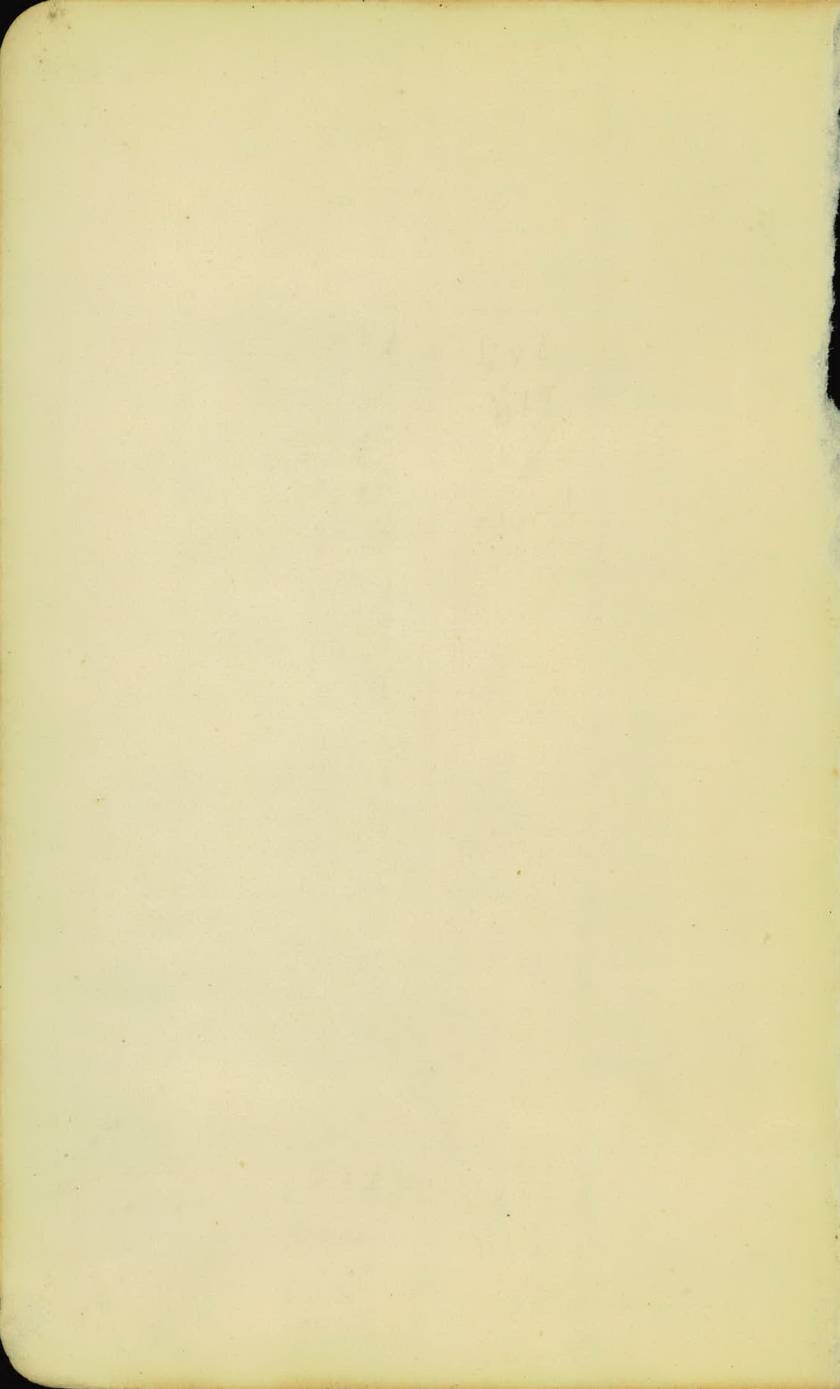
Ramsey County Surveyor  
Room 21 Court House  
ST. Paul, Minn

*Handwritten scribble*

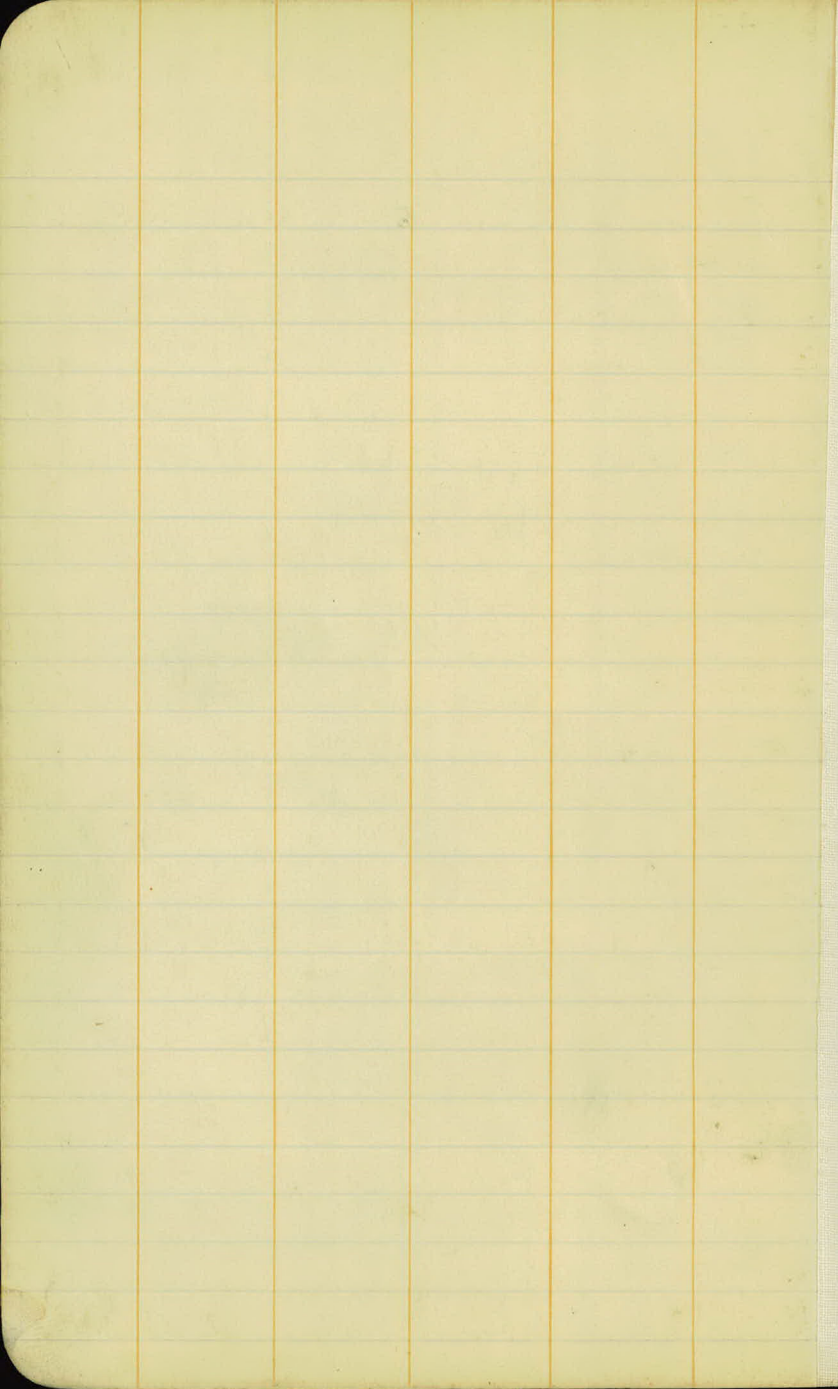
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grades Sta 202 to 316+84 Page 6 to 16



Shipping Oct-26/22 5

Gravel Pit #1 Walter

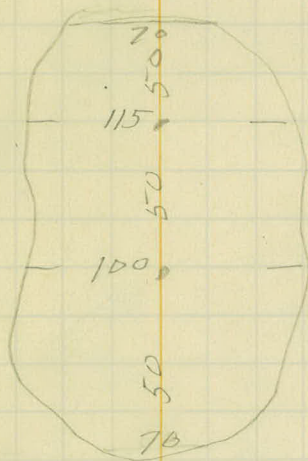
Fragnier

$80' \times 88 \times 2.5 = 615 \text{ Cycles}$

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Pit #2 Fhos Moore

1076 Cycles



2' deep

Grade Stakes  
Rick Valley - Empire

Top. So. Rail C.G.W. Ry		1065.05
2.00	1067.05	
		4.88
		1062.17
	1.21	1063.38
T.P. on Top of Conc. Gas. Intake	1.98	1061.40

→ see page 16.

209		106.71	1056.67
210		7.38	1056.0
T.P.	on Tel. Pole 210750	9.56	1053.82
	7.87	1061.69	7.37 1056.67
211		5.87	1055.82
212		5.05	1056.64
213		4.23	1057.46
214		3.41	1058.28
T.P.		1.47	1060.22
	8.44	1068.66	
215			1059.09
216			1059.91
217			1060.73
T.P.		5.99	1062.67

L

R

in front store ofa. 207

$$\begin{array}{r} \text{Grade} \\ F \frac{5.53}{8.5} \end{array}$$

$$\begin{array}{r} F \frac{5.5}{8.5} \\ F \frac{5.4}{8.5} \end{array}$$

Grd  
Grd.  
Grd

Grd  
Grd  
Co.2

$$\begin{array}{r} 64.1 \\ \frac{29}{29} \\ \hline 62.3 \end{array}$$

$$\begin{array}{r} 6 \frac{4.1}{29} \\ \frac{1.5}{29} \\ \hline 26.5 \end{array}$$

# Rich Valley - Empire City Grade Stakes

T.P.				1062.67
218	4.30	1066.97		1061.55
219				1062.37
220				1063.18
T.P. Nail in 6" Tree	221 to 220	2.37		1064.60
Tel. Pole				1053.82
	5.06	1058.88		
Elev. floor of Culvert.				1050.0
Rod 6.75				
Elev. of <u>W.S.</u>				1050.0

5-15-22

N

7

R

$$C \frac{0.2}{25.5}$$

$$F \frac{0.4}{29.5}$$

$$C \frac{0.5}{24.5}$$

$$F \frac{0.2}{25}$$

$$F \frac{0.7}{24}$$

$$220 + 37.4$$

Grade stakes  
Rich Valley - Empiro

280

281

282

283

284

285

286

287

288

289

290

291

292

293

294

295

296

297

298

299

L

R

$$\begin{array}{r} C \ 0.3 \\ \hline 25.5 \\ C \ 0.1 \\ \hline 25.0 \\ C \ 2.4 \\ \hline 27 \\ C \ 8.4 \\ \hline 33 \\ C \ 12.4 \\ \hline 37 \\ C \ 11.0 \\ \hline 36 \\ C \ 2.6 \\ \hline 28 \\ F \ 6.0 \\ \hline 24 \\ F \ 5.6 \\ \hline 23 \\ F \ 6.0 \\ \hline 24 \\ F \ 6.0 \\ \hline 24 \\ F \ 5.0 \\ \hline 23 \\ F \ 4.3 \\ \hline 22 \\ F \ 4.9 \\ \hline 22 \\ F \ 6.2 \\ \hline 24 \\ F \ 0.1 \\ \hline 33 \\ C \ 12.5 \\ \hline 38 \end{array}$$

$$\begin{array}{r} F \ 4.1 \\ \hline 21 \end{array}$$

$$\begin{array}{r} F \ 9.6 \\ \hline 30 \end{array}$$

$$\begin{array}{r} C \ 3.6 \\ \hline 32 \end{array}$$

sect. reversed on plan

$$\begin{array}{r} F \ 2.5 \\ \hline 19 \\ C \ 2.3 \\ \hline 35 \end{array}$$

$$\begin{array}{r} C \ 0.5 \\ \hline 25.5 \\ F \ 0.7 \\ \hline 24.0 \\ C \ 2.2 \\ \hline 27 \\ C \ 8.0 \\ \hline 33 \\ C \ 13.0 \\ \hline 38 \\ C \ 15.2 \\ \hline 40 \\ C \ 12.0 \\ \hline 37 \\ F \ 5.5 \\ \hline 23 \\ F \ 5.3 \\ \hline 23 \\ F \ 6.6 \\ \hline 25 \\ F \ 5.7 \\ \hline 24 \\ F \ 4.5 \\ \hline 22. \\ F \ 3.4 \\ \hline 21 \\ F \ 4.0 \\ \hline 21 \\ F \ 4.2 \\ \hline 21 \\ F \ 4.1 \\ \hline 22 \\ F \ 2.5 \\ \hline 19 \\ F \ 3.0 \\ \hline 19 \\ C \ 3.7 \\ \hline 35 \end{array}$$

Grade States  
Rich Valley - Empire

300

301

302

303

304

305

5-17-22

9

L

R

$$\frac{C4.0}{32}$$

$$\frac{F4.0}{21.5}$$

$$\frac{F8.4}{28}$$

$$\frac{C8.6}{35}$$

$$\frac{C1.2}{30}$$

$$\frac{F7.6}{26.5}$$

$$\frac{C1.6}{35}$$

$$\frac{F2.6}{19}$$

$$\frac{F7.8}{27}$$

$$\frac{F0.4}{33}$$

$$\frac{F6.2}{24}$$

$$\frac{F7.6}{26.5}$$

✓

✓

✓

✓

✓

✓

Rich Valley - Empire City  
Grades -

B.M. on U.S. Geol. Survey B.M. Top of Pipe		1002.93
31	4.59	1007.52
316 + 81.9		1002.20
316	5.09	1002.43
315	4.82	1002.7
14	4.55	1002.97
13	4.28	1003.24
312	4.00	1003.51
T.P.	2	3.98 1003.54
	5.63	1009.17
311	5.37	1003.80
310	5.11	1004.06
309	4.84	1004.33
308	4.57	1004.60
307	3.53	1005.64
T.P. on Stake in field 50 R.	4.55	
306	0.95	1008.22
306		
Culvert 306 + 50 W <del>33</del> - 38' long		
Left (W.S.)	2.87	1000.3
Right (E.S.)	9.17	1000.0

5-19-22

10

$$F \frac{6.3}{9.5}$$

$$F \frac{7.1}{10.7}$$

Grade stakes  
Rich Valley - Empire city

B.M.	292+65 on Oak to R		1018.79
	3.66	1022.45	
T.P.		0.60	1021.85
	10.84	1032.69	
T.P.		0.28	1032.41
	10.18	1042.59	
T.P.		0.54	1042.05
B.M.	on 16" Oak 50 to Right	3.80	1038.79
	10.60	1052.65	
T.P.		0.52	1052.13
	10.40	1062.53	
T.P.		0.31	1062.22
	6.38	1068.60	
B.M.	on Tel. Pole to Right 279+00	1.64	1066.96
279			1065.90
	4.72	1071.68	
		1070.62	
278			1066.60
277			1067.02
276			1067.33
275			1067.35
274			1067.38
			1069.29
T.P.	on Tel. Pole to R 273+40	2.39	1068.23

$$C \frac{0.3}{24.5}$$

$$F \frac{0.6}{24.5}$$

$$F \frac{0.2}{24.5}$$
  

$$F \frac{1.0}{25.5}$$
  

$$C \frac{0.5}{24.8}$$
  

$$F \frac{0.6}{26.5}$$
  

$$C \frac{1.1}{27}$$

Lower 1-0

$$F \frac{1.1}{26}$$
  

$$F \frac{0.2}{25.5}$$
  

$$F \frac{0.6}{26}$$
  

$$F \frac{0.9}{26}$$
  

$$F \frac{0.6}{25}$$
  

$$F \frac{0.2}{26}$$
  

$$C \frac{0.3}{26}$$

Rich Valley - Empire City  
Cut + Fill Station

T.P. on Tel. Pole to R 273+40	1069.29	
2.10	<del>1068.23</del>	
273	1067.40	✓
272	1067.43	✓
271	1067.45	✓
270	1067.48	✓
T.P.	1068.18	
	<del>1067.12</del>	
	3.21	
	1072.20	
4.02	<del>1071.14</del>	
269	1067.50	✓
268	1067.73	✓
267	1067.95	✓
266	1068.18	✓
265	1068.41	
T.P. (nail in Oak F.P. Corner)	1069.28	
5.35	<del>1068.22</del>	
	2.92	
	1064.30	
	1074.63	
	<del>1073.57</del>	
264	1068.63	✓
263	1068.86	✓
262	69.09	✓
261	69.32	✓
260	69.54	✓
259	1069.77	✓
T.P. on Corner F.P.	<del>1070.51</del>	
256+50	<del>1069.45</del>	
	4.12	

$$\frac{C1.0}{27}$$

$$\frac{F0.3}{26}$$

$$\frac{F0.5}{26}$$

$$\frac{F1.5}{26}$$

$$\frac{F1.1}{25}$$

271

270

$$\frac{FC0.4}{26.5}$$

$$\frac{F1.2}{26}$$

$$\frac{F2.0}{19}$$

$$\frac{F1.7}{25}$$

$$\frac{F1.0}{26}$$

$$\frac{F0.7}{26}$$

$$\frac{F0.8}{26}$$

$$\frac{F0.7}{26}$$

$$\frac{F0.3}{26}$$

$$\frac{F0.7}{26}$$

$$\frac{F1.2}{25}$$

$$\frac{F1.0}{25}$$

$$\frac{F0.8}{26}$$

$$\frac{F0.5}{26}$$

$$F0.7$$

$$\frac{F0.1}{18}$$

$$\frac{C0.5}{28.5}$$

$$\frac{C0.5}{24.5}$$

$$\frac{C0.8}{28.8}$$

$$\frac{F0.8}{26}$$

$$\frac{F0.1}{27}$$

$$\frac{F0.0}{27.5}$$

$$\frac{0.0}{27.5}$$

$$\frac{0.0}{27}$$

$$\frac{0.0}{26}$$

# Rich Valley Empire Grade stakes

T.P. on Corner F.R. 258450 1070.51  
1074.59  
~~1073.53~~  
4.09

258 1070.00 ✓  
 59 1069.75 ✓  
 56 1069.50 ✓  
 55 1069.25 ✓  
 54 1069.00

T.P. on Tel. Pole to R. 252450 5.67 1068.92  
3.40 1072.32

53 1068.75  
 52 1068.50  
 51 1068.25  
 50 1068.00  
 49 1067.75  
 48 67.50

T.P. on Tel. Pole to Right 248430 4.84 1067.48  
9.20 1071.68

47 67.25 ✓  
 46 67.00 ✓  
 45 66.75  
 44 66.50  
 43 66.25  
 42 66.00

$$\frac{C1.0}{29}$$

$$C1.4$$

$$\frac{29.5}{29.5}$$

$$\frac{C0.9}{29}$$

$$\frac{F0.2}{28}$$

$$\frac{F1.0}{27}$$

$$\frac{F1.3}{27}$$

$$F0.8$$

$$\frac{F0.8}{27}$$

$$\frac{F0.5}{27.5}$$

$$\frac{F1.0}{27}$$

$$\frac{F1.6}{26.5}$$

$$\frac{F1.6}{26.5}$$

$$\frac{F1.3}{26.5}$$

$$\frac{F0.9}{27.5}$$

$$\frac{F0.7}{27.5}$$

$$\frac{C0.2}{28}$$

$$\frac{C0.6}{28.5}$$

$$\frac{0.0}{27}$$

$$\frac{F0.5}{26}$$

$$\frac{C0.5}{26}$$

$$\frac{F1.0}{26}$$

$$\frac{F0.9}{26}$$

$$\frac{F0.3}{26}$$

$$\frac{0.0}{26}$$

$$\frac{F0.6}{26}$$

$$\frac{F1.4}{26}$$

$$\frac{F1.3}{26}$$

$$\frac{F1.0}{26}$$

$$\frac{F0.3}{25}$$

$$\frac{F0.2}{25}$$

$$\frac{C1.0}{24.5}$$

Rich Valley - Empire City Road  
Grade stakes

		1071.68		
A3			66.25	✓
42			66.00	
T.P.			2.92	1068.76
	1.71	1070.47		
41			1065.75	✓
40			65.50	✓
39			65.43	✓
38			65.36	
T.P. on Tol. Plots R 37+30			4.82	1065.65
	3.67	1069.32		
37			1065.27	✓
36			65.21	✓
35			65.14	✓
34			65.07	✓
233			65.00	✓
32			64.92	✓
T.P. on 30' Cottonwood dt. lapp.			3.20	1066.12
	3.79	1069.91		
231			64.84	✓
230			64.75	✓
29			64.67	✓
28			64.57	✓
27			64.50	

$\frac{C1.0}{22}$   $\frac{C1.2}{22}$  → Narrow ditch be  
 Cause of trees  
 ditch to be deep

$\frac{C0.8}{24}$  fence  
 $\frac{C1.2}{23}$  ✓

$\frac{C0.7}{29}$   
 $\frac{F0.4}{28}$   
 $\frac{F0.8}{28}$

$\frac{C0.8}{22.5}$  fence  
 $\frac{C0.2}{23}$   
 $\frac{F0.6}{23}$   $\frac{F0.4}{23}$

$\frac{F0.8}{27}$   $\frac{F0.9}{27}$   
 $\frac{F0.7}{27}$   
 $\frac{F0.9}{27}$   $\frac{F0.9}{27}$   
 $\frac{F1.0}{27}$

$\frac{F1.1}{27}$   
 $\frac{F0.7}{21.5}$   $\frac{F0.8}{27}$   
 $\frac{F1.0}{27}$   
 $\frac{F1.1}{27}$   $\frac{F0.6}{27}$

$\frac{C0.9}{28}$   $\frac{F0.5}{27.5}$   
 $\frac{C0.7}{28}$   $\frac{C0.4}{28}$   
 $\frac{C0.7}{28}$   $\frac{C0.1}{27}$

$\frac{F0.2}{27.1}$   
 $\frac{C0.8}{23}$   $\frac{C0.7}{22.5}$   
 $\frac{C0.3}{22.5}$   
 $\frac{C0.1}{27}$

Rich Valley - Empire City  
Grading Stakes

1069.91

1069.50

4.15

1065.76

3.74

1069.50

26

1064.42 ✓

25

64.34 ✓

24

64.25 ✓

23

64.17 ✓

22

64.08 ✓

21

64.00

20

63.18

T.P. on 6" Tree to Left <sup>nail</sup> 221 + 4.75

1064.75

Original

1064.60

5-24-22

15

$$\begin{array}{r} C0.6 \\ C0.5 \quad 26 \\ \hline 26 \end{array}$$

$$\begin{array}{r} C0.6 \\ C0.7 \quad 26 \\ \hline 26 \end{array}$$

$$\begin{array}{r} C0.2 \\ 0.0 \quad 26 \\ \hline 26 \end{array} \quad \begin{array}{r} F0.4 \\ \quad \quad 25 \end{array}$$
  
$$\begin{array}{r} F0.7 \\ \quad \quad 25 \end{array}$$

$$\begin{array}{r} C0.4 \\ C0.2 \quad 26 \\ \hline 26 \end{array} \quad \begin{array}{r} F0.5 \\ \quad \quad 25 \end{array}$$
  
$$\begin{array}{r} F1.3 \\ \quad \quad 24 \end{array}$$

Rich Valley - Empire City  
Grade stakes

B.M. on top of Conc. Gas. Intake	1061.40	
3.42	1064.82	
208	1058.33	✓
207	59.33	✓
206	59.00	✓
205	58.00	✓
204	57.00	✓
203	56.00	✓
202	1057.35	

to grade  
to grade

$$\begin{array}{r} C1-9 \\ \hline C2-3 \end{array} \begin{array}{r} 30 \\ 31 \end{array}$$

$$\begin{array}{r} 31.5 \\ \hline F1-4 \end{array}$$

$$\begin{array}{r} F1-8 \\ \hline 18 \end{array}$$

$$\begin{array}{r} F1-9 \\ \hline 18 \end{array}$$

to Grade

C3-0 from  
TOP Cong. Floor  
store

$$\begin{array}{r} C3-2 \\ \hline 28 \end{array}$$

$$\begin{array}{r} C1-7 \\ \hline F1-2 \end{array} \begin{array}{r} 27 \\ 27 \end{array}$$

$$\begin{array}{r} F2-1 \\ \hline 18 \end{array}$$

Change of Alignment.  
Stas. 220+38 to 283+00

220+38

On Original Line

242+00

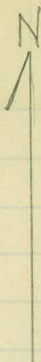
$\Delta$  0-21' to Left

264+11

$\Delta$  1°-15' to Right

283+00

$\Delta$  0-30' to Left (On Original Line)



• Spike in 6" Box Elder

71.8

80.30

• Spike in 30" Cottonwood

○ Spike in 8" Box Elder

47.1

42.8

▣ Tack in Hub.

Hub ▣ 39.2

53.35

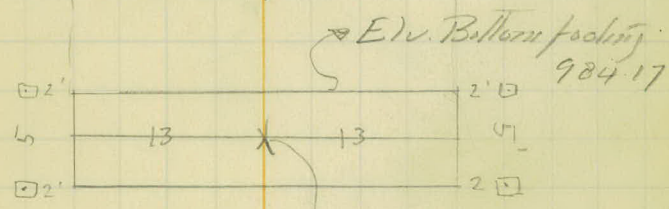
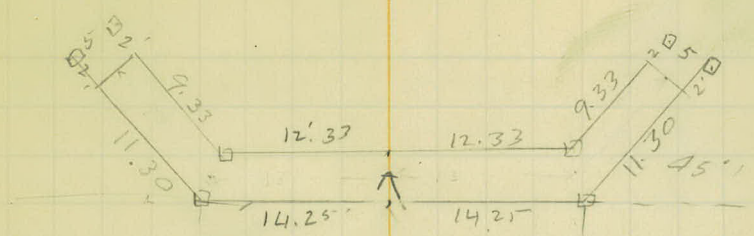
• Spike in 3rd Fence Post

1001.22  
1001.22

→ on coping W side old Cu  
about Sta 5

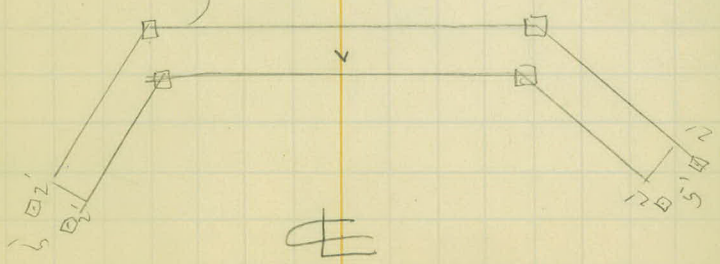
B.M.	5.17	1001.22		996.05
	Elv	bottom footing	abutments	984.50
"	"	"	Center Pier	984.17

Staking out + Bridge (Aug-25/22) 18  
 Sta 6+70.

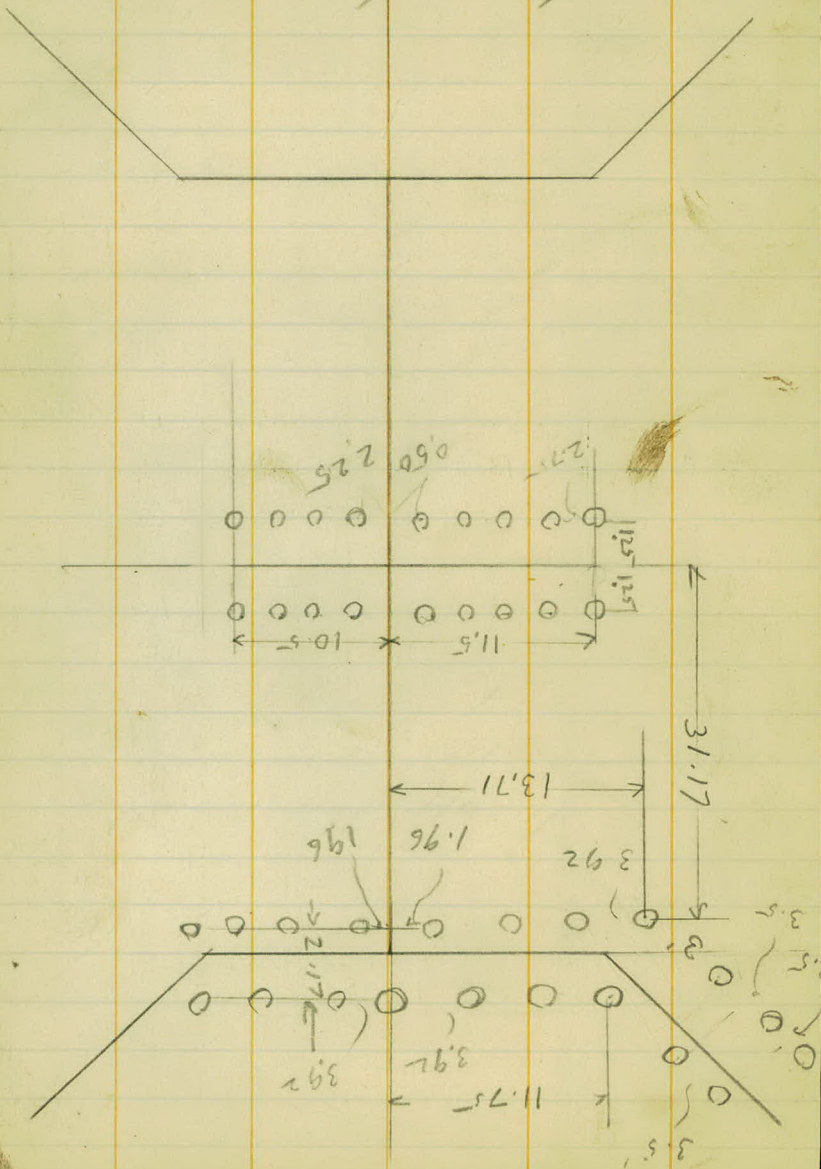


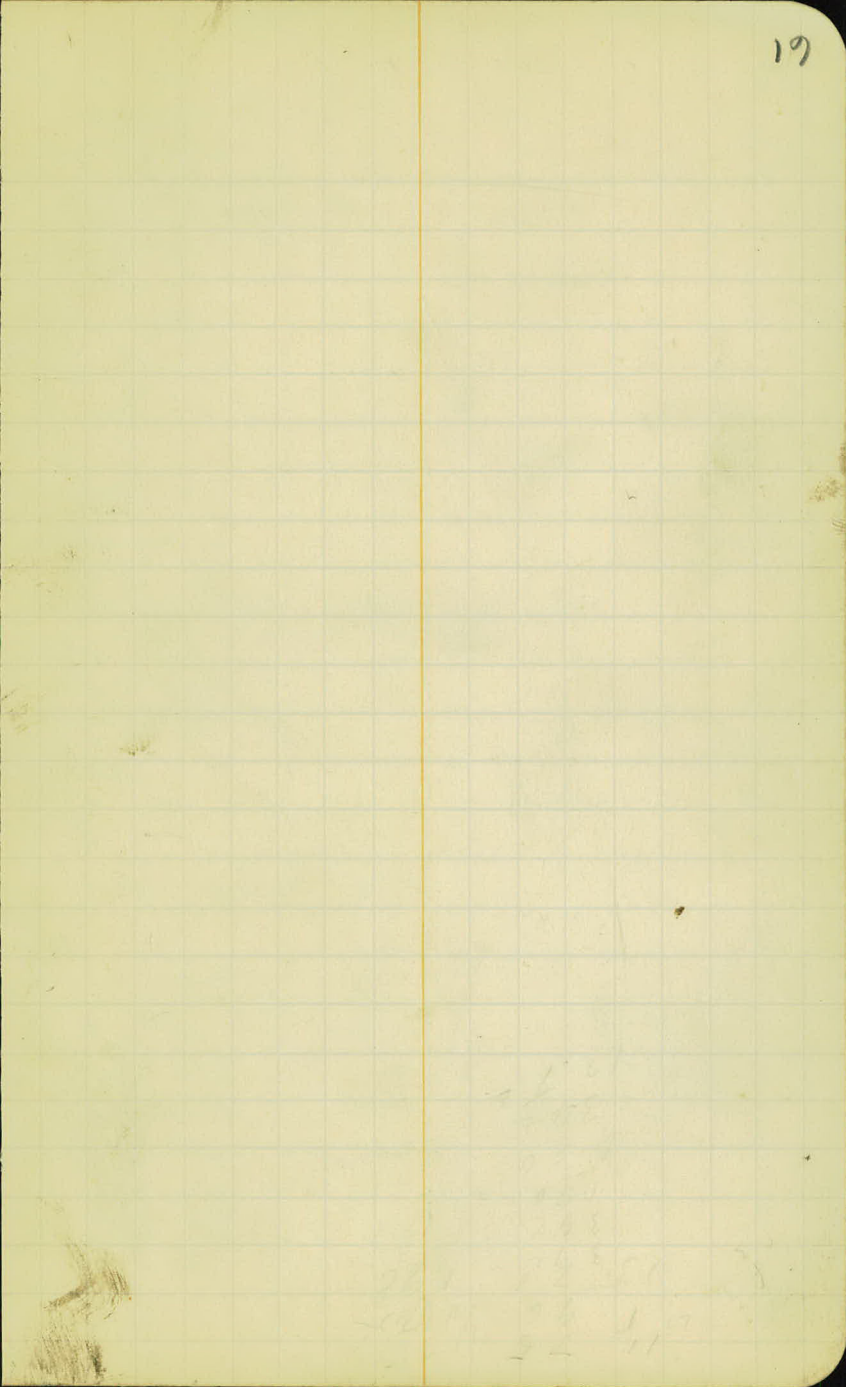
31.50'  
 Sta 6+70

Elev Bottom footing  
 984.50



Pile staking Plan for  
 Bridge at Sta 6+70  
 Rich Valley Hampton Road





# Piling Cut off

BM	2.77	1002.77		1000
	1.95	998.66	6.06	996.71
			13.16	985.50
			13.49	985.17
			8.16	990.56
			8.49	990.17
			8.55	990.11

Vermillion Bridge

Sept 26 / 22

20

on 30 Maple SW Cor Empire Road

Abutment Cut off

Center Pier " "

Nail in N Abutt Pile along cut off

" " Center Pier "

Top of Pile End of Center Pier

112

113

114

115



1071.81  
 193  
 1073.64

BM	1.83	1073.64		1071.81	Grade
116					1070.5
117					1069.53
118					1068.52
BM.	3.05	1074.86		1071.81	
119					1067.52
120					1066.51
121					1065.51
122					1064.50
T.P	3.65	1069.09	8.20	1065.44	
123					1063.50
124					1062.50
125					1061.30
	1.00	1062.24	7.85	1061.24	
126					1059.80
127	127+60	1st sta 33' R	6.50		1058.10
128					1056.40
T 50					1055.55
129	3.48	1053.27	12.45	1049.79	1055.0
130					1054.6
131	12.84	1065.07	1.04	1052.23	1055.0
131+50					1055.79
132					1056.72
	11.26	1068.04	8.29	1056.78	

From which H.S. (R)

Grade stakes, Rich Valley Empire Job

June 20/22 (22)

C.M.

L

R

SPK. 1 IN 15" oak - STA 16+00 48' L.

7

$$\begin{array}{r} 25 \\ \hline 0.4 \\ 25 \\ \hline 00 \\ 25 \\ \hline F0.8 \end{array}$$

$$\begin{array}{r} 25 \\ \hline F0.3 \\ 25 \\ \hline F0.7 \\ 25 \\ \hline F0.8 \end{array}$$

$$\begin{array}{r} 26 \\ \hline F1.0 \\ 26 \\ \hline F1.0 \\ 36 \\ \hline F0.8 \\ 15.6 \\ \hline F0.4 \end{array}$$

$$\begin{array}{r} 25 \\ \hline F0.8 \\ 25 \\ \hline F0.8 \\ 25 \\ \hline F1.0 \\ 15.4 \\ \hline F0.3 \end{array}$$

$$\begin{array}{r} 23.6 \\ \hline C0.4 \\ 29 \\ \hline C.1.10 \\ 33 \\ \hline C.2.50 \end{array}$$

$$\begin{array}{r} 23.4 \\ \hline C0.2 \\ 29 \\ \hline C1.10 \\ 33 \\ \hline C.2.3 \end{array}$$

$$\begin{array}{r} 33 \\ \hline C.2.80 \\ 18.6 \\ \hline F2.4 \\ 27.0 \\ \hline F8.0 \\ 25.5 \\ \hline F7.0 \\ 42.0 \\ \hline F18.0 \\ 40.5 \\ \hline F17. \\ 23.3 \\ \hline F5.5 \\ 17.1 \\ \hline F1.4 \\ 33 \\ \hline C4.5 \end{array}$$

$$\begin{array}{r} 33 \\ \hline C.3.60 \\ 33 \\ \hline C.2.20 \\ 25.4 \\ \hline F7.4 \\ 25.5 \\ \hline F7.0 \\ 41.1 \\ \hline F17.4 \\ 34.2 \\ \hline F12.8 \\ 23.3 \\ \hline F5.5 \\ 20.2 \\ \hline F3.5 \\ 33 \\ \hline C5.0 \end{array}$$

45 take

106804

133				1058.58
134				1060.44
135				1062.30
BM	467	1070.43	5.08	1065.76
136				1063.70
137				1065.00
138				1065.80
	5.60	1070.95	2.69	1065.35
139				1066.08
140				1066.12
A1				1066.16
142				1066.20
BM	gone		5.25	1065.70
	483	1070.84	4.63	1066.01
143				1066.25
144				1066.29
145				1066.33
				1
146				1066.37
147				1066.42
148				1066.46
149				1066.50
		1070.64		

30  
 C4.5  
30  
 C3.7  
29  
 C2.7

on F.P. R Sta 140

28  
 C1.6  
28  
 C0.4  
15.8  
 F0.5

27  
 C1.0  
2.8  
 F0.7

<u>26</u>	15.6
F0.4	F0.4
<u>26</u>	15.2
F1.0	F0.4
<u>26</u>	17.7
F2.7	F1.8
<u>26</u>	18.4
F3.26	F2.3

UNT P R Sta 42 -

27  
 F1.6  
28  
 F1.7  
28  
 F1.1

28  
 F1.1  
28  
 F1.1  
27  
 F0.6  
27  
 F1.2

30  
 C3.4  
30  
 C3.6  
29  
 C2.6

28  
 C1.5  
28  
 C0.8  
16.6  
 F1.1

28  
 C0.8  
26  
 0.0

16.4	<u>26</u>
F0.9	C0.2
<u>16.5</u>	<u>26.1</u>
F1.0	F0.9
<u>18.0</u>	<u>26</u>
F2.0	F2.3
<u>18</u>	<u>26</u>
F2.0	F2.0

27  
 F0.9  
28  
 F0.7  
28  
 F0.5

28  
 F0.6  
28  
 F0.4  
27  
 F0.3  
27  
 F0.6

5-67

July 11/22  
C/M  
D/P  
T/F  
J/M

150

Grade

1066.16

151

1065.83

152

1065.50

5.85 1070.64

153

1065.16

154

1064.83

155

1064.50

4.75 1064.79

156

1064.16

157

1063.83

158

1063.56

BM

9.0712

1065.62

159

1063.45

160

1063.40

161

1063.35

BM

5.40 10 195.21 4.05 1064.14

162

1063.30

163

1063.25

164

1063.20

4.96 1068.19

165

1063.15

166

1063.10

167

1063.05

BM

5.95 1063.23

1069.18

$$\begin{array}{r} 27 \\ \underline{F16} \\ F17 \\ \underline{26} \\ F09 \end{array}$$

$$\begin{array}{r} 26 \\ \underline{F04} \\ 26 \\ \underline{F05} \\ 25 \\ \underline{F04} \end{array}$$

$$\begin{array}{r} 23 \\ \underline{F15} \\ 20 \\ \underline{F10} \\ 25 \end{array}$$

$$\begin{array}{r} 27 \\ \underline{F09} \\ 27 \\ \underline{F08} \\ 26 \\ \underline{00} \end{array}$$

$$\begin{array}{r} 26 \\ \underline{C05} \\ 26 \\ \underline{C04} \\ 26 \\ \underline{C07} \end{array}$$

$$\begin{array}{r} 25 \\ \underline{C05} \\ 26 \\ \underline{C07} \\ 25 \end{array}$$

158+00 45' RT Spk in F. Post

$$\begin{array}{r} 25 \\ \underline{F15} \\ 26 \\ \underline{F11} \\ 27 \\ \underline{F26} \end{array}$$

$$\begin{array}{r} 25 \\ \underline{26} \\ 29 \\ \underline{F14} \end{array}$$

on Parapet of Culv E End

$$\begin{array}{r} 27 \\ \underline{F28} \\ 27 \\ \underline{F27} \\ 26 \\ \underline{F25} \end{array}$$

$$\begin{array}{r} 27 \\ \underline{F3.9} \\ 27 \\ \underline{F2.6} \\ 27 \\ \underline{F1.0} \end{array}$$

$$\begin{array}{r} 26 \\ \underline{F1.4} \\ 24 \\ \underline{F0.8} \\ 25 \\ \underline{F.03} \end{array}$$

$$\begin{array}{r} 26 \\ \underline{F0.8} \\ 24 \\ \underline{F1.3} \\ 25 \\ \underline{C07} \end{array}$$

on Cor. E Post L about Sta 167

168				1063.00
169				1062.94
170				1062.87
171				1062.80
172				1062.74
173				1062.67
	5.66	1069.18	2.72	1063.50
174				1062.60
175				1062.54
176				1062.47
177				1062.40
178				1062.34
179				1062.27
	4.78	1066.24	7.57	1061.54
180				1062.20
181				1062.14
182				1062.07
	2.75	1069.13		
183				1062.20
184				1062.33
185				1062.84
B M		1049.15	3.57	1066.24 1066.38

L  
26  
 F0.3  
25  
 F0.3  
26  
 C0.9

R  
26  
 C1.0  
25  
 0.0  
26  
 C1.7

26  
 C0.8  
25  
 0.0  
26  
 0.0

26  
 C1.10  
25  
 0.0  
25  
 C0.6

25  
 F0.2  
24  
 F1.3  
24  
 F1.4

25  
 C0.4  
25  
 F0.8  
24  
 F1.4

26  
 F3.5  
28  
 F3.7  
28  
 F1.4

26  
 F2.4  
28  
 F2.3  
28  
 F1.3

27  
 F2.4  
28  
 F1.2  
26  
 F2.0

27  
 F2.6  
28  
 F1.7  
28  
 F1.5

26  
 F3.2  
26  
 F0.9  
28  
 C1.6

26  
 F3.2  
26  
 C0.2  
28  
 C.2.2

July 10/22

CM  
DP  
TF  
JM.

186

1063.00

187

1063.17

188

1063.33

3.88 • 1069.78 2.90 1065.90

189

1063.50

190

1063.66

191

1063.82

192

1064.00

193

1064.16

194

1064.32

3.95 1068.80 4.90 1064.85

195

1064.49

196

1064.65

197

1064.81

198

1064.98

+60

BM

4.70 1069.75 1065.05

Read up

L

26  
C1.7  
27  
C1.8  
27  
C1.4

26  
C0.4  
26  
F0.9  
26  
F0.7

27  
C1.3  
28  
C0.2  
28  
F0.6

28  
F1.1  
28  
00  
28  
F1.5 L  
F3.4  
201  
F

R

27  
C2.3  
27  
C1.3  
27  
C1.8

26  
C0.3  
26  
F1.0 00  
26  
C0.2

27  
C1.4  
28  
C0.8  
27  
0,0

28  
F0.4  
28  
00  
28  
F.05 R  
F0.3  
154

SO Rail CHI. GRT. WN. RY.

BM		1002.47		1000.00	Grade
0+00					998.6
1	5.35	1001.20	6.02	995.85	998.7
2					998.8
3	4.96	1001.02	5.14	996.06	998.9
	5.59	1002.26	4.35	996.67	
4					992.0
5	4.85	1001.36	5.75	996.51	998.0
6	5.50	1001.50	5.36	996.00	998.0
7	BM on old culv		5.45	996.05	998.0
	5.03	1000.90	5.63	995.87	
8	5.09	1000.44	5.55	995.35	998.0
9	6.35	1001.57	5.22	995.22	998.0
10					998.0
11					998.0
	5.63	1001.62	5.58	995.99	
12					998.05
13					998.10
14					998.15
15					998.21
	8.39	1007.06	2.95	998.67	
16					999.0
17					999.5
18					1000.67

Aug 23/22 Remington North (27)  
Rich Valley Empire Job

Nail in 30" Maple 60L-0+20  
E of State Road 6

F3.7  
20.5  
F5.0  
27.5  
F6.5  
24.7

F6.3  
24.50

177 Creek

F3.4  
21.0  
F4.2  
21.3

F4.2  
21.3  
F5.0  
22.5  
F4.6  
21.9  
F3.8  
20.7

F4.3  
21.5  
F4.2  
21.3  
F3.3  
20.0  
F3.2  
19.8

F3.6  
20.4  
F2.0  
18.0  
F2.6  
18.9

F4.5  
21.7  
F5.2  
22.8  
F5.5  
23.3

F4.3  
21.5  
F5.1  
22.6  
F3.9  
21.0  
F4.5  
21.8

F3.8  
20.7  
F4.0  
21.0  
F3.8  
20.7  
F3.7  
21.0

F4.20  
21.30  
F4.3  
21.5  
F4.1  
21.2  
F3.6  
20.4

F4.0  
21.0  
F2.7  
19.0  
F2.2  
18.3

⊕

1007.06

grad

19

1002.25

20

1003.8

21

1005.8

22

1008.0

11.17 1017.70 0.53 1006.53

23

1011.00

24

1014.16

25

1017.7

26

1021.32

12.05 1028.71 1.04 1016.66

27

12.24 1038.77 2.18 1026.53 1024.90

28

1028.48

29

7.53 1043.26 3.04 1035.73 1032.06

30

1035.64

BM 4.75 1045.25 2.79 1040.47

31

1038.40

32

1040.00

33

1039.47

34

1038.4

2.70 1041.75 6.20 1039.05

35

1037.4

36

1036.4

37

1035.4

+50

1034.9

F28

19.2

F2.6

18.9

F2.2

18.330

F1.7

30

C1.1

30

C.26

25

F0.7

28

C2.8

30

C3.9

30

C4.1

30

C4.6

29

C3.7

C3.6

0.0

on F P 201 Rt. 30-110

20

C1.4

25

F0.4

27

F0.7

30

C0.4

31

00

124

F 2.3

31

C0.3

31

C0.4

F2.4

18.6

F2.0

18

32 8' Pilot

F1.1

30

F0.4

30

C0.8

29

C0.9

25

F1.8

28

C2.0

30

C5.6

30

C5.5

30

C5.6

29

C3.8

25

C1.4

25

F0.3

27

0.0

30

C0.9

31

C1.0

31

C0.2

31

C1.2

31

C1.0

±

1041.75

Grade

38

9.65

1040.50

10.90

1030.85

1034.6

39

1034.9

40

1036.0

41

1038.8

41+50

1040.3

42

1042.2

43

1045.9

13.67

1052.64

1.53

1038.97

44

1049.7

45

1053.4

46

1057.1

11.76

1062.37

1.97

1050.67

47

1060.72

48

10.85

1071.75

1.47

1060.90

1064.60

49

1067.0

50

1069.0

51

1069.0

52

1068.4

53

1065.6

1.56

1072.41

0.90

1070.85

54

1062.0

B.M

1.27

1066.53

7.15

1065.26

$$\begin{array}{r}
 21.9 \\
 F4.6 \\
 \hline
 25.5 \\
 F7.0 \\
 \hline
 22.9 \\
 F5.8 \\
 \hline
 19.8 \\
 F3.7 \\
 \hline
 18.9 \\
 F2.0 \\
 \hline
 18 \\
 F2.0 \\
 \hline
 25 \\
 \hline
 00
 \end{array}$$

$$\begin{array}{r}
 26 \\
 C1.8 \\
 \hline
 28 \\
 C4.0 \\
 \hline
 30 \\
 C5.4
 \end{array}$$

$$\begin{array}{r}
 28 \\
 C3.0 \\
 \hline
 25 \\
 C1.1 \\
 \hline
 25 \\
 C2.0
 \end{array}$$

$$\begin{array}{r}
 18.6 \\
 F2.4 \\
 \hline
 26 \\
 C1.5 \\
 \hline
 31 \\
 C1.2 \\
 \hline
 27 \\
 F0.7
 \end{array}$$

$$\begin{array}{r}
 30 \\
 \hline
 00
 \end{array}$$

$$\begin{array}{r}
 20.2 \\
 F3.5 \\
 \hline
 27 \\
 F8.0 \\
 \hline
 22.6 \\
 F5.1 \\
 \hline
 19.5 \\
 F3.0 \\
 \hline
 18.0 \\
 F2.0 \\
 \hline
 17 \\
 F1.3 \\
 \hline
 25 \\
 \hline
 50.5
 \end{array}$$

$$\begin{array}{r}
 28 \\
 C3.4 \\
 \hline
 31 \\
 C6.7 \\
 \hline
 31 \\
 C7.6
 \end{array}$$

$$\begin{array}{r}
 28 \\
 C4.4 \\
 \hline
 25 \\
 C1.0 \\
 \hline
 25 \\
 C2.0
 \end{array}$$

$$\begin{array}{r}
 17.5 \\
 F3.0 \\
 \hline
 26 \\
 C0.9 \\
 \hline
 17.4 \\
 F1.6 \\
 \hline
 18.9 \\
 F2.6
 \end{array}$$

$$\begin{array}{r}
 30 \\
 \hline
 F0.8
 \end{array}$$

Top of Cor stone 52+83

					± grade
		1066.53			
55					1059.6
56	8.72	1063.95	11.30	1055.23	1057.8
57					1057.0
58					1057.0
59					1057.0
60					1056.86
61					1056.71
62					1055.8
63					1053.0
64					1049.0
65					1044.0
	4.75	1061.50	7.20	1056.75	
66					1039.0
67					1034.0
68					1029.0
	0.54	1049.67	12.37	1049.13	
69	0.37	1039.58	10.46	1039.21	1024.0
70	0.28	1027.96	11.90	1027.68	1019.0
71	1.50	1017.94	11.52	1016.44	1013.8
72					1011.3

32  
 C.15  
33  
 0.0  
189  
 F2.6  
32  
 C0.7  
32  
 C2.3

30  
 F0.3  
25  
 0.0  
27  
 C2.0

28  
 C3.7  
33  
 C8.60  
37  
 C12.10

33  
 C5.4  
18.5  
 F2.3  
27.2  
 F8.1

24  
 F6.0  
22.7  
 F5.8  
14.5  
 F3.0  
17.9  
 F1.5

32  
 C1.0  
19.8  
 F3.2  
21  
 F4.0  
32  
 C1.0  
32  
 C1.6

29  
 F0.7  
17.1  
 F1.4  
27  
 C2.6

28  
 C3.10  
33  
 C9.0  
32  
 C5.5

16.2  
 F0.8  
19.6  
 F5.1  
28.2  
 F8.8

26.2  
 F7.5  
24.3  
 F6.2  
20.3  
 F3.5  
17.4  
 F1.6

£

1017.94

Grade

73					1009.0
74					1008.41
75					1008.11
	2.90	1012.51	8.33	1009.61	
76					1007.82
77					1007.52
78					1007.23
79					1007.50
80					1008.40
	7.23	1018.45	1.29	1011.22	
81					1010.56
82					1013.53
83					1017.32
	4.70	1022.13	1.02	1017.43	
84					1021.65
85					1025.98
86					1030.32
BMI	8.62	1027.32	3.43	1018.70	
87	12.15	1036.58	2.89	1024.43	1034.65
88	13.55	1047.08	3.05	1033.53	1038.98
89					1043.32

24  
 C0.6  
26  
 C1.0  
26  
 C1.2

24  
 0.0  
26  
 C0.5  
26  
 C0.4

21  
 F4.0  
20.9  
 F3.8  
19.1  
 F1.7  
25  
 C0.7  
27  
 C1.7

21  
 F4.0  
21  
 F3.4  
19.2  
 F2.8  
25  
 C0.8  
27  
 C1.2

28  
 C3.3  
27  
 C1.8  
25  
 F0.4

28  
 C3.0  
27  
 C1.2  
25  
 F0.7

18  
 F 2.0  
F 2.0  
19.7  
 F 3.8

26  
 F1.3  
29  
 C 2.6  
18.9  
 F 2.6

by So gate post Lt. Sta 83

32  
 F1.3  
30  
~~C 3.2~~ 30  
 C 3.2  
31  
 0 0

Inches El. m. l.

29  
 C 2.0  
28  
~~C 4.9~~ 28  
 C 3.6  
16.1  
 F 1.4

104708

90					1047-65
91					1051.98
92	11.98	1057.63	1.43	1045.65	1056.32
	12.50	1067.20	2.93	1054.70	
93	Enal Super	ELV			1060.66
94					1063.75
95					1065.67
	6.00	1068.77	4.43	1062.77	
96					1066.14
97					1065.80
98					1065.00
	9.38	1073.15	5.00	1063.77	
99	Super	Elanco			1063.65
100					1061.41
101					1059.18
	4.85	1070.05	7.95	1065.20	
102	6.12	1069.39	6.78	1063.27	1056.94
103	6.57	1063.20	12.76	1056.63	1054.71
103 + 50	BNI	on East - Parcel Wall of Lot 11.15		1052.05	1053.59
104	11.54	1063.59			1052.50
105	4.50	1055.89	12.20	1051.39	1051.20
106					1051.75
107					1052.75

Cont Page 42

$$\begin{array}{r} 16.2 \\ \hline F=0.8 \\ 32 \\ \hline C1.6 \\ 30 \\ \hline C3.4 \end{array}$$

$$\begin{array}{r} 25 \\ \hline C08 \\ \hline 17.5 \\ \hline F=1.7 \\ 18.8 \\ \hline F2.5 \end{array}$$

$$\begin{array}{r} 20 \\ \hline F3.3 \\ 24 \\ \hline F06 \\ 25 \\ \hline 00 \end{array}$$

$$\begin{array}{r} 24 \\ \hline F0 \\ 21 \\ \hline F3.0 \\ \hline 19.6 \\ \hline F3.1 \\ 20.4 \\ \hline F3.6 \end{array}$$

$$\begin{array}{r} 21.7 \\ \hline F4.5 \\ 18.2 \\ \hline F2.2 \\ 20.3 \\ \hline F3.5 \end{array}$$

$$\begin{array}{r} 20.5 \\ \hline F5.8 \\ 21.5 \\ \hline F4.2 \\ 20.7 \\ \hline F3.8 \\ 21.3 \\ \hline F4.2 \\ 20.1 \\ \hline F3.4 \end{array}$$

$$\begin{array}{r} 18.4 \\ \hline F2.3 \\ 17 \\ \hline F1.3 \\ 26 \\ \hline C1.8 \end{array}$$

$$\begin{array}{r} 28 \\ \hline C3.2 \\ 27 \\ \hline C3.0 \\ 27 \\ \hline C2.7 \end{array}$$

$$\begin{array}{r} 27 \\ \hline C2.5 \\ 28 \\ \hline C4.4 \\ 27 \\ \hline C4.8 \end{array}$$

$$\begin{array}{r} 33 \\ \hline C4.0 \\ 33 \\ \hline C5.8 \\ 33 \\ \hline C5.2 \\ 33 \\ \hline C4.0 \end{array}$$

$$\begin{array}{r} 31 \\ \hline C4.0 \\ 32 \\ \hline C5.0 \\ 32 \\ \hline F2.0 \\ 32 \\ \hline F0.2 \\ 32 \\ \hline F0.6 \\ 29 \\ \hline F0.5 \\ 30 \\ \hline 0.0 \end{array}$$

B M		1007.95		1000.00	
134+39					1001.81
134					1001.30
133					1000.3
132					999.55
131					999.10
130	130+84 BC				998.66
129					998.216
	9.4 <sup>3</sup>	1005.91	1147	996.48 1147	
128					997.772
127+60	EC				997.588
127					997.328
126+56					997.10
126					996.88
125+56					996.66
125					996.44
B M	T		7.15	998.76	
124+43	BC				995.8
124					995.20
123	0.65	999.41			993.50
122					991.00
121					988.50
120					986.0

Grades on slope Job 2205 (33)

Add - 15' to all dist out

L R

Spike in TP 75 L Sta 130 + 45

L	R		L	R
			C 6.15	C 4.4
			14.15	12.4
+035	-035		C 6.0	C 4.0
			14	12
			C 4.9	C 2.8
			12.9	10.8
			C 2.0	C 0.3
			10.8	8.3
			<del>8.8</del>	
			8	
			8.0	F 1.7
			8	2.5
			F 1.5	F 3.0
			2.2	4.5
			F 1.3	F 2.3
			2.0	3.4

Slope Elev

			C 3.0	0.0
			11	8
+037	-039		C 3.0	C 1.2
			11	9.2
			C 2.0	C 1.9
			18.8	7.9
			C 3.0	C 2.2
			11	10.2
			C 2.3	C 2.3
			10.3	10.3
			C 1.0	C 2.0
			9	10
			C 1.0	C 0.9
			9	8.9

Slope Elev

on F. Post about 75, Lt Sta 12 U + 03

C 0.1	F 0.2
8.1	0.3
C 0.4	F 1.4
8.4	2.1
F 0.5	F 1.0
0.8	1.5
F 1.3	F 0.0
2.0	0.9
F 1.6	F 1.7
2.4	2.5
F 0.3	F 1.3
1.2	2.0

E

~~999-41~~

Grade

119					983.7
118					980.75
117					979.30
	1.52	987.94	12.99	986.42	
116					979.0
115	10.95	992.45	6.45	981.49	980.0
114					982.6
113+57	ETC				983.5
113+07	EC				983.8
112+57	BTC				984.0
112+07					984.0
111+57					983.5
111+07					983.7
110+77.9	ETC				983.3
110+77.9	BTC 10° Curve				982.20
109+77.9	BTC				981.35
BMI	7.09	992.55	6.99	985.46	
109					980.00
108					977.58
107					975.17
	2.65	986.37	8.83	983.72	-
106					973.20
105					971.85
	4.10	978.32	12.45	973.92	

Aug 14 - 1922

(34)

F1.0  
1.5  
F0.8  
1.2  
F2.9  
4.5

F1.2  
1.8  
F1.2  
1.8  
F3.3  
5.0

F3.0  
4.5  
F3.4  
5.1  
F1.2  
1.8

F4.0  
6.0  
C1.4  
9.4  
C4.4  
E12.4

Super Elevate  
Inner outer

width

L

F0.4

R  
C4.5  
12.5

-0.39 +0.39 1.13 From Top

0.6

C4.3

+0.93 +0.93 2.29 " Curve

0.6

12.3

0.6

0.3

C1.5

0.0

9.6

0.0

F0.7

1.3

1.1

F0.3

E1.2

0.4

6.8

F0.5

F0.6

0.7

0.9

F0.2

0.0

0.3

1.5

-0.93 +0.93 2.29

F0.4

C0.7

-0.39 +0.39 1.13 From Top

0.6

12.7

F0.7

C1.1

1.0

7.1

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

1.0

On F.P. Lt Sta 113

F1.0  
1.5  
F0.8  
1.2  
F0.8  
1.2

C1.3  
9.3  
C2.0  
10.0  
C1.7  
9.7

F0.1  
3.2  
F3.0  
9.5

C1.5  
9.5  
C0.7  
8.7

E

978.32

Grade

104

970.85

103

970.25

102

970.20

7.60

977.32

8.60

969.72

101

970.15

100

970.10

99

970.05

2.63

274.00

5.95

971.37

98

970.00

97

9.25

974.47

8.78

965.22

969.85

96

969.90

BM

7.00

977.06

4.55

969.92

970.06

95

969.85

94

969.66

93+50

969.66

93

970.75

92+50

972.10

92

10.55

985.30

2.25

974.81

974.53

91

979.40

90

11.42

996.35

0.43

284.93

984.27

89+50

986.70

89

987.00

88

7.55

1002.43

1.47

994.88

992.00

87

993.60

86+50

994.44

F2.6  
3.9  
F0.8  
1.2  
C3.4  
11.4

C1.2  
10.6  
C3.2  
11.2  
C2.9  
10.9

F0.4  
0.6  
F4.6  
6.9  
F5.7  
8.5

F3.3  
4.9  
F3.0  
4.5  
C1.2  
9.2

C1.2  
9.2  
C2.0  
10.0  
C1.6  
9.6

C0.7  
8.7  
F1.1  
1.7  
F7.7  
11.5

NW cor. Bridge Coping

F2.6

F6.0  
0.0  
F4.5  
6.8  
F2.6  
3.9  
F1.7  
2.5  
F2.2  
3.3  
F1.7  
2.5  
F1.2  
1.8  
F1.6  
2.4  
C3.2  
11.6  
C3.0  
13.0  
C5.0  
13  
C4.3  
12.3

F6.5  
0.0  
F1.2  
1.8  
F1.7  
2.5  
F1.3  
2.0  
0.0  
0.0  
F1.1  
1.7  
F1.2  
1.8  
F0.1  
0.8  
C0.8  
8.8  
C5.2  
13.2  
C4.0  
12.8  
C3.5  
11.5

100243

E

Grade

86	1.64	993.72	10.35	992.08	994.58
85					994.86
<del>84</del> 850					995.01
84					995.8
83	10.10	1003.22	0.60	993.12	997.2
82+50					998.9
82	13.25	1013.74	2.76	1000.46	1000.5
81	7.23	1014.82	6.15	1007.59	1002.90
80					1004.10
79+50					1004.30
79+79	ETC				" "
78+78.7	EC 29 <sup>00</sup> Curve				" "
78+53.7					" "
78+28.7	BTC				" "
78+03.7					" "
77+78.7					" "
77+53.7	5.40	BMI ON T.P. SE. COR. X RD. 109.44	10.78	1004.04	" "
77+28.7					" "
77+03.7					" "
76+78.7					" "
76.53.7					" "
76+28.7					" "
76+17.8	ETC				" "
75+9.28					" "

C 0.9  
 8.9  
F 8.4  
 72.6  
F 11.0  
 16.5  
F 11.3  
 16.9  
F 11  
 10.7  
F 2.7  
 4.0  
F 0.8  
 1.2  
C 8.4  
 16.4  
C 5.5  
 73.5

C 0.6  
 8.6  
F 8.6  
 12.7  
F 10.0  
 15  
F 10.1  
 15.2  
F 6.6  
 9.9  
 3.2  
F 3  
C 3.3  
 11.8  
C 4.0  
 72.0  
C 1.4  
 9.4

Super Elevate  
 inner outer  
 Normal

widen

C 1.7  
4.7

C 0.4  
8.4

-0.39 +0.39

2.48

C 1.0  
9  
F 0.4  
8.6

F 0.5  
8.7  
0.0  
8.0

-0.71 +0.71

4.24

F 0.6  
8.9

C 0.4  
8.4

-0.93 +0.93

5.00

F 1.1  
10.7

C 0.6  
8.6

" "

F 2.4  
7.6

C 0.6  
8.6

" "

F 2.2  
8.4

C 0.5  
8.5

" "

F 1.7  
7.5

C 1.0  
9

" "

F 1.4  
7.1

C 0.6  
8.6

" "

F 0.9  
7.4

C 1.0  
9.0

" "

F 1.7  
7.5

C 1.2  
9.2

" "

F 0.7  
7.0

C 1.0  
9.0

" "

F 0.2  
8.4

C 0.6  
8.6

-0.93 +0.93

5.00

F 0.4  
8.4

C 0.4  
8.4

-0.71 +0.71

4.24

F 0.3  
8.7

C 0.4  
8.4

F 0.3  
8.4

C 0.4  
8.4

100944

±

grade

75+67.8 BC End

1004.35

Stas 76 to 50 Not in grading  
Contract

BM 505 1011, 11 1006.06

50

1005.20

49

1005.10

48

1004.81

47

1004.33

435 1006.36 9.10 1002.01

46

1003.63

45

1002.87

44

1002.10

43

1001.32

.125 999.59 8.02 998.34

42

1000.53

41

999.13

40

997.28

Super E angle  
17mm<sup>2</sup> Ouler  
-0.39 +0.39

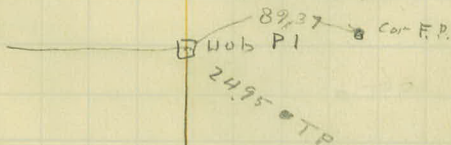
Widen  
2.98

$\frac{F07}{1.0}$

$\frac{C02}{F2}$



Ties to P1 at  
Sta 77+68.1



spike in T.P.

20' R Sta 52+00

$\frac{15}{0.0}$   
26  
C1.0  
26  
C1.7  
 $\frac{27}{1.7}$

25  
C0.2  
 $\frac{18}{F2.0}$   
 $\frac{19.8}{F3.2}$   
20.7  
F3.8

$\frac{23}{F0.2}$   
24  
F0.3  
 $\frac{29}{C.4.6}$

$\frac{15}{C.0.8}$   
26  
C1.6  
26  
C1.9  
27  
C.2.2

25  
C0.2  
26  
C2.7  
 $\frac{18}{F2.0}$   
19.2  
F2.8

28  
C.3.4  
28  
C4.0  
29  
C4.4

E  
grade

999.59

39  
38  
37  
36

994.5  
991.00  
987.00  
982.80

0 93 988.57 11.95 987.64

35  
34  
33

979.80  
978.00  
977.40

10.70 977.87

STA 18 to 33  
Not in grading Contract

E Grade

18  
17  
16  
15

964.0  
963.0  
962.31  
962.10

BM

3.90 965.99

7.07 961.83  
962.09

14  
13  
12  
11

962.10  
962.10  
961.40  
960.70

964.90

10  
9

960.0  
959.3

$$\begin{array}{r} 29 \\ \hline C4.4 \\ 26 \\ \hline C1.0 \\ 21 \\ \hline F4.0 \\ 19 \\ \hline F2.7 \end{array}$$

$$\begin{array}{r} 18 \\ \hline F2.0 \\ 17.1 \\ \hline F1.4 \\ 17.3 \\ \hline F1.5 \end{array}$$

$$\begin{array}{r} 32 \\ 0.0 \\ \hline 32 \\ \hline F0.4 \\ 32 \\ \hline F0.9 \\ 32 \\ \hline F1.3 \end{array}$$

$$\begin{array}{r} 32 \\ \hline F1.6 \\ 19.5 \\ \hline F2.9 \\ 18.6 \\ \hline F2.4 \\ 29 \\ \hline F1.3 \end{array}$$

$$\begin{array}{r} 30 \\ \hline F0.5 \\ 30 \\ \hline F0.6 \end{array}$$

$$\begin{array}{r} 26 \\ \hline C1.0 \\ 25 \\ \hline C0.7 \\ F3.0 \\ \hline 20.7 \\ 17.4 \\ \hline F1.6 \end{array}$$

$$\begin{array}{r} 25 \\ \hline C0.4 \\ 26 \\ \hline C1.0 \\ 16.5 \\ \hline F1.0 \end{array}$$

$$\begin{array}{r} 32 \\ \hline F0.6 \\ 32 \\ \hline F1.1 \\ 32 \\ \hline F1.2 \\ 32 \\ \hline F1.7 \end{array}$$

$$\begin{array}{r} 32 \\ \hline F2.3 \\ 19.9 \\ \hline F3.3 \\ 18.8 \\ \hline F2.5 \\ 29 \\ \hline F1.3 \end{array}$$

$$\begin{array}{r} 30 \\ \hline F0.2 \\ 30 \\ \hline F0.3 \end{array}$$

Top 50 Part. H & D Tree 071  $\frac{1}{2}$

E

Grade

8

758 964 90 9 40

957.32

958.60

7

957.20

6

956.75

5

956.50

462 961.72

4

956.50

3

956.50

2

956.50

1

956.50

0

956.50

BM

957.10

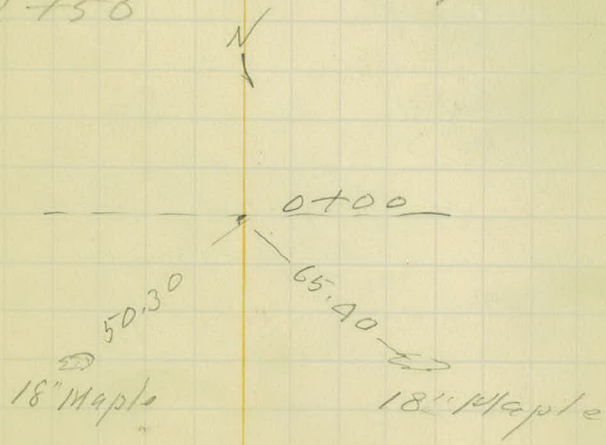
L  
30  
 F0.7  
31  
 F0.8  
31  
 0.0  
31  
 F0.9

30  
 F1.2  
30  
 F1.6  
30  
 F1.9  
30  
 F0.7

R  
30  
 F0.3  
31  
 F1.0  
31  
 F0.6  
31  
 F1.7

30  
 F3.0  
30  
 F2.0  
30  
 F1.0  
30  
 F0.2

Top of N. end E. Caping of Culv  
 Sta. 2+50



Aug 29/22

E 99.00

1009.06

3 00 1006.06

50+84 BC ✓ 1005.00

51+09 ✓ 1004.80

51+34 ✓ 1004.70

51+59 ✓ 1004.60

51+84 ✗ 1004.50

52+09 ✓ 1004.30

52+34 ✓ 1004.20

52+59 ✓ 1004.10

52+84 ✓ 1004.00

53+09 ✓ 1003.80

53+34 ✓ 1003.70

53+59 ✓ 1003.60

53+92.7 EC ✓ 1003.50

Staking out Curve Sta P1 40  
52+82 Job 2205

inner	outer	widen	
-0.25	0.00	1.00	✓
-0.30	+0.30	2.80	✓
-0.50	+0.50	5	
"	"	"	
"	"	"	
"	"	"	
"	"	"	
"	"	"	
"	"	"	
-0.50	+0.50	5	
-0.30	+0.30	2.80	
-0.25	0.00	1.00	

50+84	B C	$0^{\circ} - 0'$	
51+09		$3^{\circ} - 37\frac{1}{2}'$	✓ x
51+34		$7^{\circ} - 15'$	✓ x
51+59		$10^{\circ} - 52\frac{1}{2}'$	✓ x
51+84		$14^{\circ} - 30'$	✓ x
52+09		$18^{\circ} - 07\frac{1}{2}'$	x
52+34		$21^{\circ} - 45'$	✓ x
52+59		$25^{\circ} - 22\frac{1}{2}'$	✓ x
52+84		$29^{\circ} - 00'$	x
53+09		$32^{\circ} - 37\frac{1}{2}'$	✓ x
53+34		$36^{\circ} - 15'$	✓ x
53+59		$39^{\circ} - 52\frac{1}{2}'$	x
53+927		$44^{\circ} - 45'$	

29<sup>th</sup>/curve

sto 52 + 84

Job 2205

41

Cont from pg. 32

108	1.31	1063.59	7.31	1062.28	1056.0
108+50					1057.62
109					1059.54
110	0.78	1069.59	11.63	1068.81	1063.38
111					1067.23
112	0.60	1080.44	11.35	1079.84	1070.20
113	6.44	1091.19	0.47	1084.75	1072.70
	10.86	1085.22	2.52	1074.36	
114					1073.17
115					1073.22
116					1073.40
	6.60	1076.88	1.61	1070.88	
117					1073.51
118					1073.63
119					1073.50
120	3.39	1072.49	7.71	1069.10	1073.0
120+53.3 = 113+59.2					1072.67
					Little C
114					1072.54
115					1071.64
116					1070.53
BM	5.00	1076.81		1071.81	

Round up

$\frac{10.4}{F2.3}$   
 $\frac{18}{F2.0}$   
 $\frac{11}{F0.0}$   
 $\frac{26}{C0.4}$   
 $\frac{28}{C2.8}$   
 $\frac{33}{C8.3}$   
 $\frac{37}{C12.4}$

$\frac{29}{C1.8}$   
 $\frac{29}{C1.6}$   
 $\frac{29}{F0.4}$   
 $\frac{26}{C1.0}$   
 $\frac{25}{C0.5}$   
 $\frac{30}{C3.8}$   
 $\frac{35}{C11.0}$

$\frac{36}{C11.4}$   
 $\frac{25}{C1.0}$   
 $\frac{20.0}{F3.3}$

$\frac{36}{C11.8}$   
 $\frac{25}{F0.2}$   
 $\frac{18.1}{F2.1}$

$\frac{22.8}{F5.7}$   
 $\frac{24.4}{F6.3}$   
 $\frac{25.5}{F7.0}$

$\frac{21.6}{F4.4}$   
 $\frac{25.5}{F7.1}$   
 $\frac{24.0}{F6.0}$

$\frac{23.4}{F5.8}$   
 $\frac{19.4}{F3.0}$

$\frac{23.0}{F5.3}$   
 $\frac{20.2}{F3.5}$

$\frac{27}{C1.7}$   
 $\frac{28}{C0.3}$   
 $\frac{26}{2.6}$

$\frac{27}{C1.7}$   
 $\frac{28}{C0.2}$   
 $\frac{26}{2.6}$

spike in oak 40' L stang

10° Curve Job 2200

109+15 EC

109	0°-22½	✓
108+50	2°-52½	✓
108	5°-22½	✓
107+50	7°-52½	✓
107	10°-22½	✓
106+50	12°-52½	✓
106	15°-22½	✓
105+50	17°-52½	✓
105	20°-22½	✓

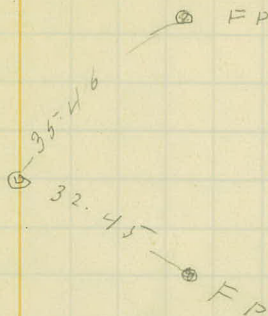
10° Curve Sta 115+53.6 = B

115+53.6

116	2°-21°	✓
116+50	4°-51°	✓
117	7°-21°	✓
117+50	9°-51°	✓
118	12°-21°	✓
118+50	14°-51°	✓
119	17°-21°	✓
119+50	19°-51°	✓
120	22°-21°	✓
120+55	25°-05°	✓ EC



Tiost to Carstrome  
Sta 52+83



B.M	4.50	1000.55	996.05
0+00			988.7
1			988.6
2			988.5
3			988.4
4			988.3
5			988.2
6			988.1
7			988.0
7+	Grade		987.95

Channel Change

Aug 31/22 <sup>44</sup>

N

S

on West coping of old Culvert

C 4.5

C 5.3

C 5.2

C 4.8

C 4.5

C 5.5

C 5.2

C 4.0

C 4.6

C 5.0

~~C 4.0~~

C 4.4

C 4.8

C 4.2

Empire City Hemp Torr Road  
JOB, 2005

0+00 P.I. 29° C R-L T. 199.7

13+16 Spike mixing

13+18.4  $\angle$  R.R.

26+38.5 P.I.  $\frac{1}{4}$  Line  $\Delta$  0°-11' L

39+70 R.O.T.

50+84.00 BC 29° C

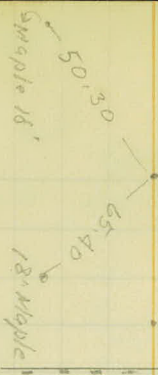
52+82.00 P.I.  $\Delta$  89°-30' L T 197.96

53+92.7 EC

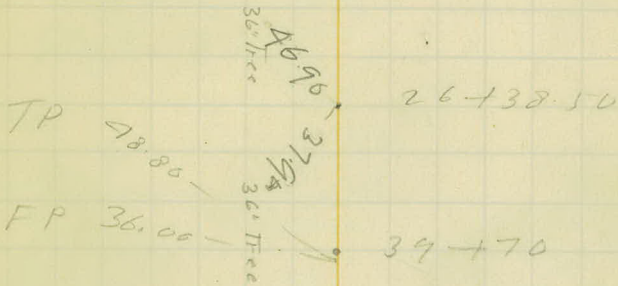
75+67.8 BC C. 29°

77+68.1 P.I.  $\Delta$  90.10<sup>0</sup> R.T 200.3

78+78.7 E.C.



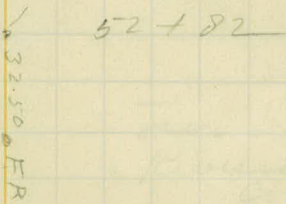
C.M. & ST. P. R.R.  
H. & D. DIV.



36' Tree

36' Tree

T.P.  
36' 20'



32' 50' ER

Empire City - Hampton Road  
- Project 2205 -

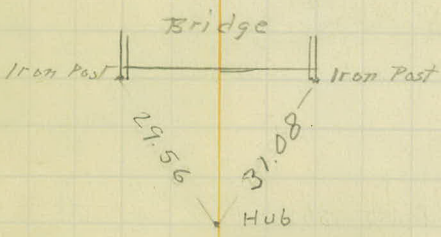
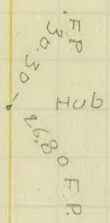
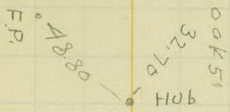
STA

80+87.0 P.O.T

87+00 P.O.T

95+00

$\Delta L 0^{\circ} 53'$



110+2190 BC  $10^{\circ}$  C.L  $\Delta$   $27^{\circ}55'$

111+70.5 PI  $\Delta$   $27^{\circ}55'$  L TAN 142.60

113+07.1 EC

124+43.30 BC  $5^{\circ}$  CR

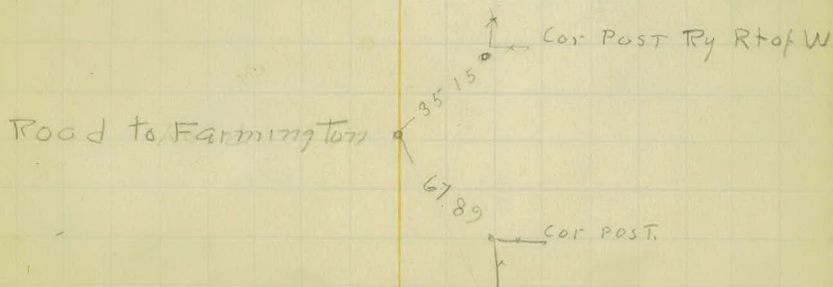
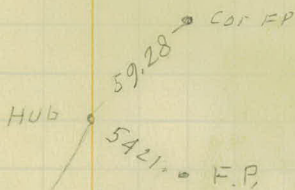
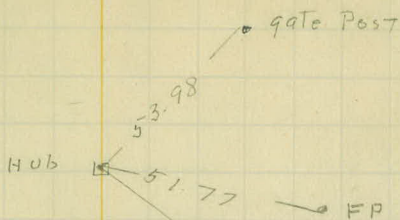
126+02.00 P.I.  $\Delta$  R  $15^{\circ}40'$  Tan 158.20

127+60.00 EC

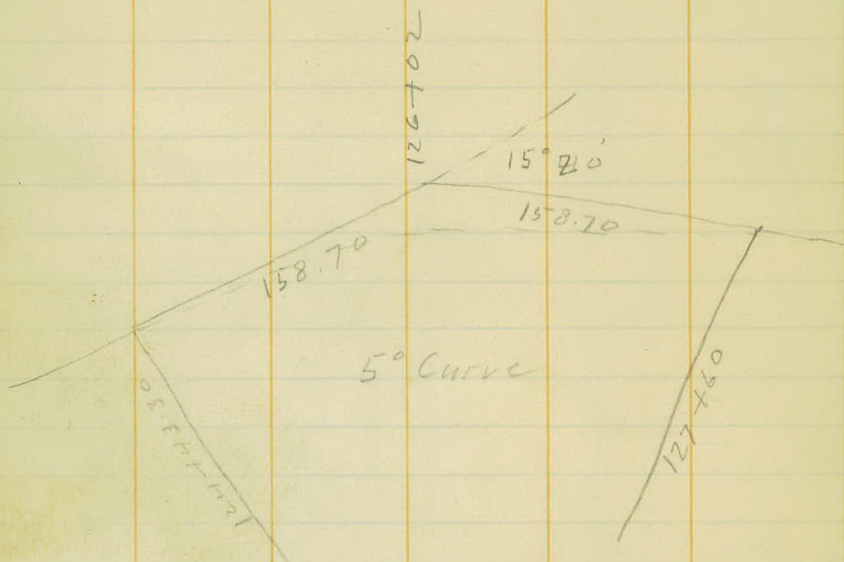
130+84.10 BC  $2^{\circ}15'$  Left

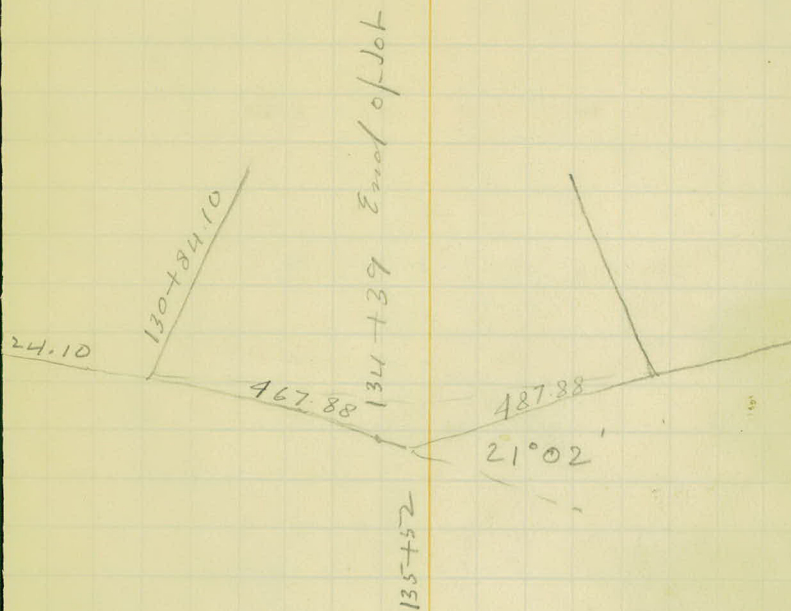
135+52 PI  $\Delta$  L  $21^{\circ}02'$  TAN 467.83

131+195 P.O.T ahead  $12^{\circ}$  TAN 150.00



Curves at End of Job 220





Job #2200

Curve of sta 87+72.5

BC 87+72.5

PI 90+40  $\Delta$  50°-00' LT

EC 92+72.5

7479.267.50

D 10°-00'

4 grad

Deflections

87+72.50	0°-00'	1037.79
88+22.50	2°-30'	1039.95
88+72.50	5°-00'	1042.12
89+22.50	7°-30'	1044.28
89+72.50	10°-00'	1046.44
90+22.50	12°-30'	1048.60
90+72.50	15°-00'	1050.76
91+22.50	17°-30'	1052.93
91+72.50	20°-00'	1055.09
92+22.50	22°-30'	1057.26
92+72.50 EC	25°-00'	1059.42

			Left	Right
Widerr	28.	25	-0.5	+0.8
	30.	28	-1.0	+1.0
	30	—	-1.0	+1.0
	<u>30</u>	—	-1.0	+1.0
	<u>30</u>	—	-1.0	+1.0
	<u>30</u>	—	-1.0	+1.0
	<u>31</u>	—	-1.0	+1.0
	<u>31</u>	—	-1.0	+1.0
	<u>30</u>	<u>25</u>	-1.0	+1.0
	<u>29</u>	<u>27</u>	-1.0	+1.0
	<u>25</u>	<u>28</u>	-0.5	+0.8

Sep 29/22

Deflections

87-7250

88  $1^{\circ} 12 \frac{1}{2}$  ✓

88-750  $3^{\circ} 42 \frac{1}{2}$  ✓

89  $6^{\circ} 12 \frac{1}{2}$  ✓

89-750  $8^{\circ} 42 \frac{1}{2}$

90-100  $11^{\circ} 12 \frac{1}{2}$

5° Curve Rt. Job 2205- 50  
Sta 124+43 = BC

Deflections

124+43 BC

125

$1^{\circ} 25 \frac{1}{2}$

125+50

$2^{\circ} 40 \frac{1}{2}$

126

$3^{\circ} 55 \frac{1}{2}$

126+50

$5^{\circ} 10 \frac{1}{2}$

127

$6^{\circ} 25 \frac{1}{2}$

127+60 EC

$7^{\circ} 55 \frac{1}{2}$

4  
Grade

B.M. 641 1005.17 998.76

124+43 995.80

125 996.44

125+50 996.66

126 996.88

126+50 997.10

127 997.328

127+60 997.568

3.40 1000.99 7.58 997.59

128 997.772

129 998.216

130 998.66

131 999.10

Grades Job 2205

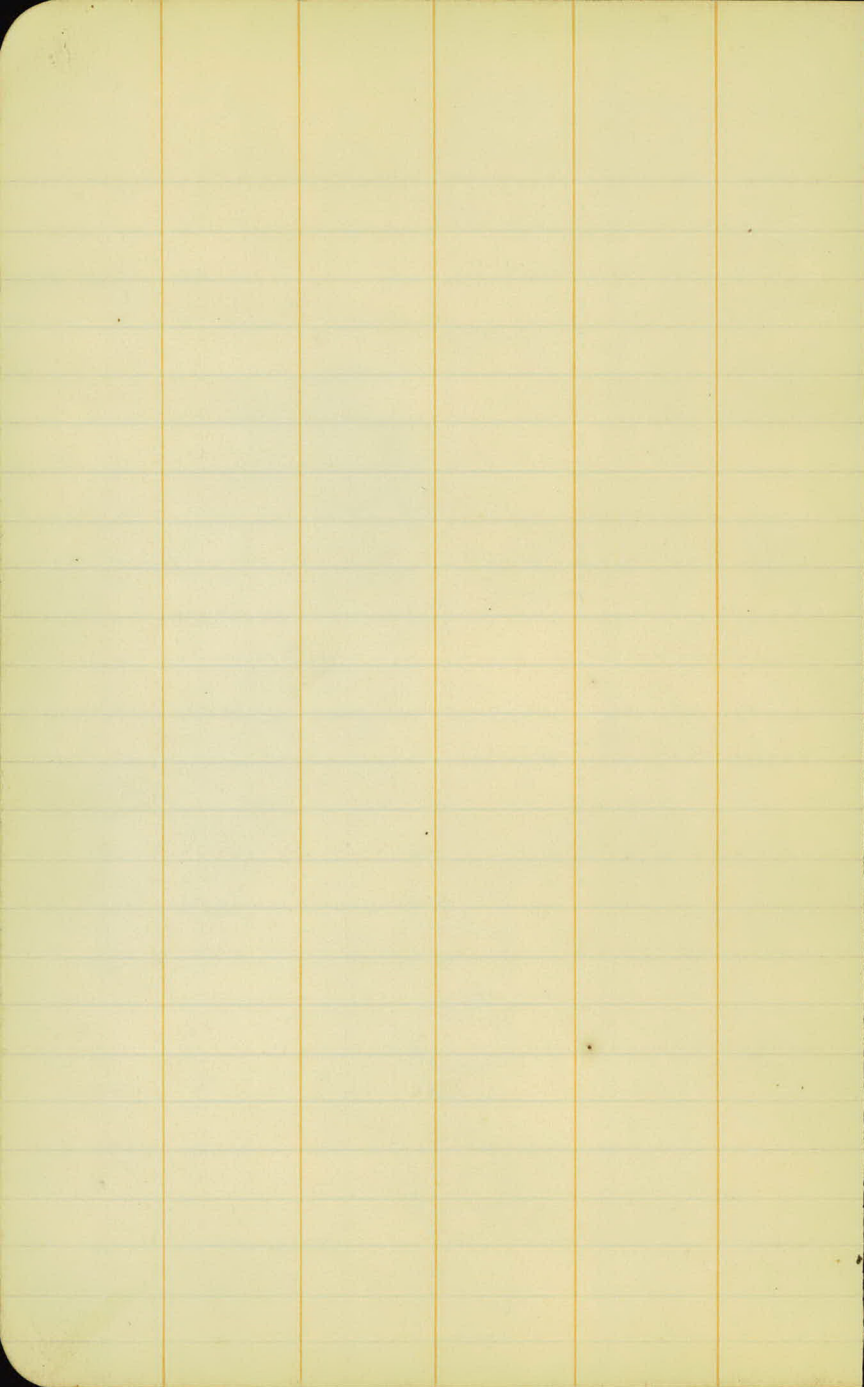
51  
Sep 29/22

on FP 75' Lt St 124+43

L	R	L	R
+0.40	-0.40	<u>28</u>	<u>24</u>
"	-0.60	F0.2	F0.2
"	"	<u>28.15</u>	<u>26</u>
"	"	C06	C09
"	"	<u>26</u>	<u>26</u>
"	"	C14	C.20
"	"	<u>27</u>	<u>26</u>
"	"	C24	C22
"	"	<u>27</u>	<u>26</u>
"	"	C2.5	C2.3
"	-0.60	<u>27</u>	<u>26</u>
"	"	C2.5	C1.9
+0.40	-0.40	<u>26</u>	<u>26</u>
		C2.7	C1.5

L  
26  
 C 2.2  
26 F1.1  
 16.6  
 F1.7  
 17.6  
 F0.6  
 15.9

R  
24  
 00  
24 F2.3  
 18.5  
 F3.0  
 19.5  
 F14  
F17.1





BM

2.30 1064.55 1062.25

4.82 1056.82 12.55 1052.00

9.82

1047.00

10.82

1046.00

Collect Sta 119 Line B

5.60 1077.41 5.60 1071.81

3.56 1072.97 8.00 1069.41

1067.0

1066.5

Culvert at 105700

55

July 2205

30"

on Road, Inflow 100' RT 107+50

C 6<sup>00</sup> 5' out

W 53 x 36

C 5<sup>00</sup> 5' out

East 5' out C 3.0

West 5' out C 3.0

} W 22 x 46

# Contents

BM	1.05	1067.43		1066.38 <del>38</del>
			443	<del>1063.00</del>
177+50	W 22-	35 Long		
			8.00	1059.43
			9.00	1058.43
			<del>7.95</del>	
BM			7.95	1059.48
BM	0.91	1062.31		1061.40
209+55	W 53-	35 Long		
			12.55	<del>1049.46</del>
			11.80	<del>1058.50</del>
BM	5.40	1011.45		1006.06
	3.05	1005.01	9.50	1001.96
Sta 43	W 22 X 32			
	0.64	992.72	12.93	992.08
	1.80	982.88	11.64	981.08
BM	4.82	982.86	4.84	978.04
	at Road		5.00	977.86
Sta 32+65			4.00	978.86
W 22 X 32			4.10	478.66

June 16/22 56

Cor. F.P. STA. 184+75 50 LT

Stake E marked C 3.0 5' out

" W " C. 3.0' 5' out

Mark in F.P. opp W End Culvert  
Top of gas cone intake

~~ground R ( 1049.5 <sup>Stake</sup> 5' out C 2.0  
" L ( ~~1049.5~~ 5' out~~

~~1051.5 5' out C 2.0~~

~~1052.0 5' out C 2.0~~

spike in T.P. sta 52 R 20'

R 998.5 L 997.5 5' out Top stake R 1001.5 C 3' 0"  
" " " " L

Mark in F Post L Sta 32+65

Stake W side Culv grade 974.86 5' out

" E side " " 944.66 5' out

# Culverts

39+00 - W64 - 37' long  
 (w.s. Left) = <sup>Rod</sup> 7.25 - (E.s. Right) <sup>Rod</sup> 7.75  
 C3.000(S) C3.00

56+65 W22 - 35' long 2'0" dip  
 (w.s. Left) <sup>Rod</sup> 5.75 (E.s. Right) <sup>Rod</sup> 7.75  
 C3'0 C4'0

77+25 W104 - 32' long Rod 6.25 C3.0

163+00 W.22 - 32' long  
 Left Side (W) 1061.00  
 Right " (E) 1060.50

177+50 - W22 - 35' long  
 Left Side (W) 1058.45  
 Right " (E) 1059.45

209+55 W53 x 35 Long 1050.00

43 W22 x 32

CA-0 on stake 5'-0 out  
 CA-0 " " 5'-0 "

CB-0 on stake 5'-0 out  
 CB-0 " " " "

{	1050.0	W End	Top stake 5' out =	1052	}
{	1049.5	E End	" " 5 "	- 1051.5	}
{	998.5	W End		1001.5	}
{	997.5	E End	" " 5 "	1000.5	}

## Culverts Job 2205

July 5/22

5/6

BM	7.82	977.66		969.84	
	10.50	987.91	0.25	977.41	
	5.50	981.36	12.05	975.86	
116+00	W 53 X 32				974.70
BM			1.90	979.46	
BM	4.49	974.33		969.84	
104+30	W 22 X 32				grade
					11
BM	10.12	980.18		970.06	
	13.00	992.26	0.92	979.26	
	8.33	1000.14	0.45	991.81	
84+47	W 22 X 52		12.89	987.25	
	5.35	992.60			grade
Surface	End Culv. R.		6.90	985.70	985.20
"	" " L		7.80	984.80	984.40
BM			4.27	988.33	

spike in Oak 37' Left Sta 104+25

974, 7 upper end R	5' out	(3.0'	} Top of stake to Top of Floor
974 2 Lower " L	5' out	(3.0'	

071 Cor F.P. Left Sta 116+90

on oak 37' Left Sta 104+25

967.5 L	C 2.0'	5' out	} Top of stake Top of Floor
967.3 R	C 2.0'	5' out	

Cor Coping NW Cor of Bridge Sta 94

R	C 3.0'	5' out
L	C 3.0'	5' out

071 T.P. Sta 84 Left

( Culverts } Job 2205  
 Concrete )

Sta	No	Length	Cyds	lbs steel	Grade
32+65	W 22	32	7.77	771	974.87
43+00	W 22	32	7.77	771	998.00
67+10	W 22	32	7.77	771	1000.40
84+47	W 22	52	11.51	1170	984.80
104+30	W 22	32	7.77	771	968.00
116+00	W 53	32	20.89	1208	974.70

Sta	Corr. Length	Metal size	Culverts where	Job	2205
17+50	20'	15"	F.E. Rt.	?	
20+20	20'	15"	F.E. Lt.	?	
22+10	24'	15"	F.E. Lt.	?	
22+50	24'	15"	F.E. Rt.	?	
32+20	20'	15"	F.E. Rt.		
48+55	20'	15"	F.E. Rt.		
49+15	20'	15"	F.E. Lt.		
49+60	24'	15"	F.E. Rt.		
55+95	20'	15"	F.E. Lt.	?	
57+00	20'	15"	F.E. Lt.	?	
62+30	20'	15"	F.E. Rt.?	?	
73+00	20'	15"	F.E. Lt.	?	
74+00	20'	15"	F.E. Lt.	?	
86+20	20'	15"	F.F. Rt.		
88+50	24'	15"	F.E. Rt.		
90+00	20'	15"	F.E. Rt.		
	<u>336</u>				

	L	⊥	R	
?	16'		16'	✓
	16'		16'	✓ RT
	16		16'	✓
	27"		25'	✓
	16'		16'	✓
	16'		16'	✓

### Corr Metal Culverts Job 2005

Sta	Length	size	where
91 + 20	- 20 -	15"	Ent RT
111 + 20	- 20 -	15"	" RT
120' + 20	- 20 -	15"	" RT
	<u>60</u>		
	336		
	<u>396</u>	Total	

BM

1006.06

~~4.06 1015.12~~

~~3.96 1006.16~~

4.25 1010.31

1006.06

4.10 1008.19 5.92 1004.39

1000 0

1000 4

Cattle Pass

Outlet at 86+40

22  
1024.00

BM

1.21 1063.97

1062.76

0.66 1051.63 13.00 1050.97

1.14 1043.06 9.71 1041.92

3.50 1034.39 12.17 1030.89

3.39 1031.00

1031.00

Top

BM

2.51 1031.88

staking Curve at 67+10 Job 2005  
W 22 x 32

80

spike in T.P. Rt Sta 52

BM on Tol Palo Rt. about Sta 62

Invert lower End 1004.0 Top Stake 5' out  
" upper End 1004.4 Top Stake 5' out  
July 22

Job 2022 (W 66 x 32)

Invert E) ✓

spike in 10' oak Sta 92+08 42 Lt

5' out L }  
5' out R } cut 7'00

on 8' oak 60' R Sta 86+40

125 1° 23' ✓

126 3° 53' ✓

127 6° 23'

Sta 124 to 136

... 250 to 303

3-40 1009.46

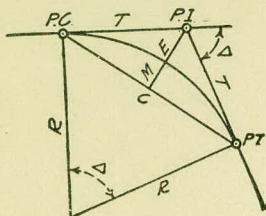
1006.06

6-25 1003.21

100

# DIETZGEN'S RAILROAD CURVE AND REDUCTION TABLES

Copyright, 1914, by Eugene Dietzgen Co., New York City



## CURVE FORMULAS

Radius= $R = \frac{50}{\sin. D/2}$  (1) Degree of Curve= $D$  and  $\sin. \frac{D}{2} = \frac{50}{R}$  (2)

Tangent= $T = R \tan \frac{\Delta}{2}$  (3) Length of Curve= $L = 100 \frac{\Delta}{D}$  (4)

Middle ordinate= $M = R(1 - \cos. \frac{\Delta}{2})$  (5)  $= R \text{vers} \frac{\Delta}{2}$  (6)

External= $E = T \tan \frac{\Delta}{4}$  (7)  $= R \div \cos. \frac{\Delta}{2} - R$  (8)  $= R \text{exsec} \frac{\Delta}{2}$  (9)

Long Chord= $C = 2 R \sin. \frac{\Delta}{2}$  (10)  $\Delta =$  Central Angle

## EXPLANATION AND USE OF TABLES

**Stations.**—Given P. I.=Sta. 161+60.35 to find Sta. of P. C. and P. T.  $\Delta=62^\circ 10'$   $D=8^\circ 20'$ . From Table IV for  $1^\circ$  curve  $T=3454.1$  and  $\div 8\frac{1}{3}=414.49$  ft. From Table V correction=.36 or  $T=414.85$  ft. P. C.=Sta. P.I.— $T=157+45.50$ . Also from (4)  $L=746.00$  and P. T.=Sta. P. C. + $L=164+91.50$ .

**Offsets.**—Tangent offsets vary (approximately) directly with  $D$  and with square of the distance. Thus tangent offset for Sta. 158 on above curve is 2.16 ft. found as follows. From Table III tangent offset for 100 ft.=7.27 ft. Distance= $158 - \text{Sta. P. C.}=54.50$ , hence offset= $7.27 (54.50 \div 100)^2=2.16$  ft. Also square of any distance divided by twice the radius equals (approximately) the distance from tangent to curve. Thus  $(54.50)^2 \div (2 \times 688.26)=2.16$  ft.

**Deflections.**—Deflection angle= $\frac{1}{2} D$  for 100 ft.,  $\frac{1}{4} D$  for 50 ft., etc. For  $c$  ft.=(in minutes)  $.3 \times C \times D^\circ$  or=defl. for 1 ft. from Table III  $\times C$ . For Sta. 158 of above curve= $.3 \times 54.5 \times 8\frac{1}{3}=136.2'$  or  $2^\circ 16.2'$ , or= $2.50 \times 54.5=136.2'$  from Table III. For Sta. 159 deflection angle= $2^\circ 16.2' + 8^\circ 20' \div 2=6^\circ 26.2'$ , etc.

**Externals.**—May be found in similar manner to tangents. Thus  $E$  for curve above is 115.37 For from Table IV for  $1^\circ$  curve  $E=960.6$  for  $8^\circ 20'=960.6 \div 8\frac{1}{3}=115.27$  and from Table V correction=.10 or  $E=115.37$  Or suppose  $\Delta=32^\circ$  and  $E$  is measured and found to be 42 ft. What is  $D$ ? From Table IV  $E=230.9$  and  $\div 42=5.5$  or  $D=5^\circ 30'$ .

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.

1-16	3-32	1/8	3-16	1/4	5-16	3/8	1/2	5/8	3/4	7/8
.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.—RADI, 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		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					
	50	3125.36	.400	1.600	0.55	9	637.28	1.965	7.846	2.70
2		2864.93	.436	1.745	0.60	20	614.56	2.037	8.136	2.80
	10	2644.58	.473	1.891	0.65	30	603.80	2.074	8.281	2.85
	20	2455.70	.509	2.036	0.70	40	593.42	2.110	8.426	2.90
	30	2292.01	.545	2.181	0.75					
	40	2148.79	.582	2.327	0.80	10	573.69	2.183	8.716	3.00
	50	2022.41	.618	2.472	0.85	30	546.44	2.292	9.150	3.15
3		1910.08	.655	2.618	0.90	11	521.67	2.402	9.585	3.30
	10	1809.57	.691	2.763	0.95	30	499.06	2.511	10.02	3.45
	20	1719.12	.727	2.908	1.00	12	478.34	2.620	10.45	3.60
	30	1637.28	.764	3.054	1.05	30	459.28	2.730	10.89	3.75
	40	1562.88	.800	3.199	1.10	13	441.68	2.839	11.32	3.90
	50	1494.95	.836	3.345	1.15	30	425.40	2.949	11.75	4.05
4		1432.69	.873	3.490	1.20	14	410.28	3.058	12.18	4.20
	10	1375.40	.909	3.635	1.25	30	396.20	3.168	12.62	4.35
	20	1322.53	.945	3.718	1.30					
	30	1273.57	.982	3.926	1.35	15	383.07	3.277	13.05	4.50
	40	1228.11	1.018	4.071	1.40	30	370.78	3.387	13.49	4.65
	50	1185.78	1.055	4.217	1.45	16	359.27	3.496	13.92	4.80
5		1146.28	1.091	4.362	1.50	30	348.45	3.606	14.35	4.95
	10	1109.33	1.127	4.507	1.55	17	338.27	3.716	14.78	5.10
	20	1074.68	1.164	4.653	1.60	18	319.62	3.935	15.64	5.40
	30	1042.14	1.200	4.798	1.65	19	302.94	4.155	16.51	5.70
	40	1011.51	1.237	4.943	1.70					
	50	982.64	1.273	5.088	1.75	20	287.94	4.374	17.37	6.00
6		955.37	1.309	5.234	1.80	21	274.37	4.594	18.22	6.30
	10	929.57	1.346	5.379	1.85	22	262.04	4.814	19.08	6.60
	20	905.13	1.382	5.524	1.90	23	250.79	5.035	19.94	6.90
	30	881.95	1.418	5.669	1.95	24	240.49	5.255	20.79	7.20
	40	859.92	1.455	5.814	2.00					
						25	231.01	5.476	21.64	7.50
						26	222.27	5.697	22.50	7.80
						27	214.18	5.918	23.35	8.10
						28	206.68	6.139	24.19	8.40
						29	199.70	6.360	25.04	8.70
						30	193.18	6.583	25.88	9.00

Note. Chord Deflection=2 times tangent deflection.

TABLE IV.—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 IV.—TANGENTS AND EXTERNALS TO A 1° CURVE.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
<b>31°</b>	1589.0	216.3	<b>41°</b>	2142.2	387.4	<b>51°</b>	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
<b>32</b>	1643.0	230.9	<b>42</b>	2199.4	407.6	<b>52</b>	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
<b>33</b>	1697.2	246.1	<b>43</b>	2257.0	428.5	<b>53</b>	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
<b>34</b>	1751.7	261.8	<b>44</b>	2314.9	450.0	<b>54</b>	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
<b>35</b>	1806.6	278.1	<b>45</b>	2373.3	472.1	<b>55</b>	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	483.8	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
<b>36</b>	1861.7	294.9	<b>46</b>	2432.1	494.8	<b>56</b>	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
<b>37</b>	1917.1	312.2	<b>47</b>	2491.3	518.2	<b>57</b>	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
<b>38</b>	1972.9	330.2	<b>48</b>	2551.0	542.2	<b>58</b>	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
<b>39</b>	2029.0	348.6	<b>49</b>	2611.2	566.9	<b>59</b>	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
<b>40</b>	2085.4	367.7	<b>50</b>	2671.8	592.3	<b>60</b>	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 IV.—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	20	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	4488.9	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 IV.—TANGENTS AND EXTERNALS TO A 1° CURVE.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
<b>91°</b>	5830.5	2444.9	<b>101°</b>	6950.6	3278.1	<b>111°</b>	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	3310.1	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
<b>92</b>	5933.2	2518.5	<b>102</b>	7075.5	3374.9	<b>112</b>	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
<b>93</b>	6037.8	2594.0	<b>103</b>	7203.2	3474.4	<b>113</b>	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
<b>94</b>	6144.3	2671.6	<b>104</b>	7333.6	3576.8	<b>114</b>	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
<b>95</b>	6252.8	2751.3	<b>105</b>	7467.0	3682.3	<b>115</b>	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
<b>96</b>	6363.4	2833.2	<b>106</b>	7603.5	3791.0	<b>116</b>	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
<b>97</b>	6476.2	2917.3	<b>107</b>	7743.2	3902.9	<b>117</b>	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
<b>98</b>	6591.2	3003.8	<b>108</b>	7886.2	4018.2	<b>118</b>	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	7934.5	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
<b>99</b>	6708.6	3092.7	<b>109</b>	8032.7	4137.1	<b>119</b>	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	5808.2	3168.7	50	8157.5	4239.0	50	9890.8	5700.9
<b>100</b>	6828.3	3184.1	<b>110</b>	8182.8	4259.7	<b>120</b>	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 V.—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	.79	.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	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	.023	.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	.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	.286	.383	.480	.578	.678	.777	.875	.971	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	2.58
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	.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 VI.—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°	.06	.00	.01	.01	.01	.01	.01	.01	.06	.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	299.73	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	196.96	287.94	370.17	441.15
34°	.15	.28	.40	.50	.55	.57	.53	.43	.25	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	388.43
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	1.26	.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 VII.—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	.037	.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	.227	.192	.163	.138	.113	28	.618	.545	.475	.411	.348	.294	.242
14	.312	.275	.239	.207	.175	.148	.122	29	.638	.564	.491	.424	.361	.303	.250
15	.334	.295	.257	.223	.188	.159	.131	30	.660	.583	.508	.438	.374	.313	.259

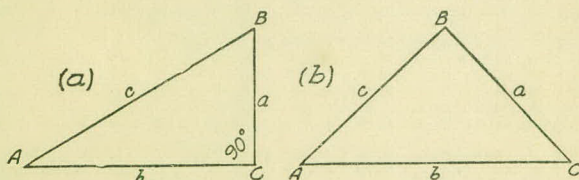
## SLOPE REDUCTIONS.

When distances are measured on a slope they may be reduced to the equivalent horizontal distance by the following approximate rule:— subtract from the slope distance the square of the rise divided by twice the slope distance. Thus for a slope distance of 250.3 ft. and a rise of 15 ft. correction =  $15^2 \div 2 \times 250.3 = .45$  (by slide rule) or horizontal distance =  $250.3 - .45 = 249.85$ . When vertical angle = V. A. is measured horizontal distance = slope distance — slope distance (1 — Cos. V. A.). Thus for slope distance of 248.7 ft. and V. A. of  $4^\circ 20'$  from Table VIII Cos = .99714 and correction =  $1 - .99714 = .00286$  per foot or total of  $.286 \times 2\frac{1}{2}$  (near enough) = .57 and horizontal distance =  $248.7 - .57 = 248.13$  ft.

See fig. (a).

### TRIGONOMETRICAL FORMULAS.

sin.  $A = \frac{a}{c}$   
 cos.  $A = \frac{b}{c}$   
 tan.  $A = \frac{a}{b}$   
 cot.  $A = \frac{b}{a}$   
 sec.  $A = \frac{c}{b}$   
 cosec.  $A = \frac{c}{a}$



### FORMULA FOR SOLVING TRIANGLES.

Given	Sought.	Right triangles. See fig. (a).
$a, c$	$A, B, b$	$\sin. A = \frac{a}{c}, \cos. B = \frac{a}{c}, b = \sqrt{(c+a)(c-a)}$
$a, b$	$A, B, c$	$\tan. A = \frac{a}{b}, \cot. B = \frac{a}{b}, c = \sqrt{a^2 + b^2}$
$A, a$	$B, b, c$	$B = 90^\circ - A, b = a \cot. A, c = \frac{a}{\sin. A}$
$A, b$	$B, a, c$	$B = 90^\circ - A, a = b \tan. A, c = \frac{b}{\cos. A}$
$A, c$	$B, a, b$	$B = 90^\circ - A, a = c \sin. A, b = c \cos. A$
Given	Sought.	Oblique triangles. See fig. (b).
$A, B, a$	$b$	$b = \frac{a \sin. B}{\sin. A}$
$A, a, b$	$B$	$\sin. B = \frac{b \sin. A}{a}$
$a, b, C$	$A - B$	$\tan. \frac{1}{2}(A - B) = \frac{(a - b) \tan. \frac{1}{2}(A + B)}{a + b}$
$a, b, c$	$A$	$\left\{ \begin{array}{l} \text{If } s = \frac{1}{2}(a + b + c), \sin. \frac{1}{2} A = \sqrt{\frac{(s - b)(s - c)}{bc}} \\ \cos. \frac{1}{2} A = \sqrt{\frac{s(s - a)}{bc}}, \tan. \frac{1}{2} A = \sqrt{\frac{(s - b)(s - c)}{s(s - a)}} \\ \sin. A = \frac{2 \sqrt{s(s - a)(s - b)(s - c)}}{bc} \end{array} \right.$
$A, B, C, a$	area	$\text{area} = \frac{a^2 \sin. B \sin. C}{2 \sin. A}$
$A, b, c$	area	$\text{area} = \frac{1}{2} bc \sin. A$
$a, b, c$	area	$s = \frac{1}{2}(a + b + c), \text{area} = \sqrt{s(s - a)(s - b)(s - c)}$

TABLE VIII.—NATURAL TRIGONOMETRICAL FUNCTIONS.

Angle	Sine.	Tan.	Cotg.	Cosin.		Angle	Sine.	Tan.	Cotg.	Cosin.	
0	0	0	∞	1	90	8	.1392	.1405	7.115	.99027	82
10	.0029	.0029	343.8	I	50	10	.1421	.1435	6.968	.98986	50
20	.0058	.0058	171.9	.99998	40	20	.1449	.1465	6.827	.98944	40
30	.0087	.0087	114.6	.99996	30	30	.1478	.1495	6.691	.98902	30
40	.0116	.0116	85.94	.99993	20	40	.1507	.1524	6.561	.98858	20
50	.0145	.0145	68.75	.99989	10	50	.1536	.1554	6.435	.98814	10
1	.0175	.0175	57.29	.99985	89	9	.1564	.1584	6.314	.98769	81
10	.0204	.0204	49.10	.99979	50	10	.1593	.1614	6.197	.98723	50
20	.0233	.0233	42.96	.99973	40	20	.1622	.1644	6.084	.98676	40
30	.0262	.0262	38.19	.99966	30	30	.1650	.1673	5.976	.98629	30
40	.0291	.0291	34.37	.99958	20	40	.1679	.1703	5.871	.98580	20
50	.0320	.0320	31.24	.99949	10	50	.1708	.1733	5.769	.98531	10
2	.0349	.0349	28.64	.99939	88	10	.1736	.1763	5.671	.98481	80
10	.0378	.0378	26.43	.99929	50	10	.1765	.1793	5.576	.98430	50
20	.0407	.0407	24.54	.99917	40	20	.1794	.1823	5.485	.98378	40
30	.0436	.0437	22.90	.99905	30	30	.1822	.1853	5.396	.98325	30
40	.0465	.0466	21.47	.99892	20	40	.1851	.1883	5.309	.98272	20
50	.0494	.0495	20.21	.99878	10	50	.1880	.1914	5.226	.98218	10
3	.0523	.0524	19.08	.99863	87	11	.1908	.1944	5.145	.98163	79
10	.0552	.0553	18.07	.99847	50	10	.1937	.1974	5.066	.98107	50
20	.0581	.0582	17.17	.99831	40	20	.1965	.2004	4.989	.98050	40
30	.0610	.0612	16.35	.99813	30	30	.1994	.2035	4.915	.97992	30
40	.0640	.0641	15.60	.99795	20	40	.2022	.2065	4.843	.97934	20
50	.0669	.0670	14.92	.99776	10	50	.2051	.2095	4.773	.97875	10
4	.0698	.0699	14.30	.99756	86	12	.2079	.2126	4.705	.97815	78
10	.0727	.0729	13.73	.99736	50	10	.2108	.2156	4.638	.97754	50
20	.0756	.0758	13.20	.99714	40	20	.2136	.2186	4.574	.97692	40
30	.0785	.0787	12.71	.99692	30	30	.2164	.2217	4.511	.97630	30
40	.0814	.0816	12.25	.99668	20	40	.2193	.2247	4.449	.97566	20
50	.0843	.0846	11.83	.99644	10	50	.2221	.2278	4.390	.97502	10
5	.0872	.0875	11.43	.99619	85	13	.2250	.2309	4.331	.97437	77
10	.0901	.0904	11.06	.99594	50	10	.2278	.2339	4.275	.97371	50
20	.0929	.0934	10.71	.99567	40	20	.2306	.2370	4.219	.97304	40
30	.0958	.0963	10.39	.99540	30	30	.2334	.2401	4.165	.97237	30
40	.0987	.0992	10.08	.99511	20	40	.2363	.2432	4.113	.97169	20
50	.1016	.1022	9.788	.99482	10	50	.2391	.2462	4.061	.97100	10
6	.1045	.1051	9.514	.99452	84	14	.2419	.2493	4.011	.97030	76
10	.1074	.1080	9.255	.99421	50	10	.2447	.2524	3.962	.96959	50
20	.1103	.1110	9.010	.99390	40	20	.2476	.2555	3.914	.96887	40
30	.1132	.1139	8.777	.99357	30	30	.2504	.2586	3.867	.96815	30
40	.1161	.1169	8.556	.99324	20	40	.2532	.2617	3.821	.96742	20
50	.1190	.1198	8.345	.99290	10	50	.2560	.2648	3.776	.96667	10
7	.1219	.1228	8.144	.99255	83	15	.2588	.2679	3.732	.96593	75
10	.1248	.1257	7.953	.99219	50	10	.2616	.2711	3.689	.96517	50
20	.1276	.1287	7.770	.99182	40	20	.2644	.2742	3.647	.96440	40
30	.1305	.1317	7.596	.99144	30	30	.2672	.2773	3.606	.96363	30
40	.1334	.1346	7.429	.99106	20	40	.2700	.2805	3.566	.96285	20
50	.1363	.1376	7.269	.99067	10	50	.2728	.2836	3.526	.96206	10
					82						74
	Cosin.	Cotg.	Tan.	Sine.	Angle.		Cosin.	Cotg.	Tan.	Sine.	Angle.

TABLE VIII.—NATURAL TRIGONOMETRICAL FUNCTIONS.

Angle	Sine.	Tan.	Cotg.	Cosin.		Angle	Sine.	Tan.	Cotg.	Cosin.	
or						or					
<b>16</b>	.2756	.2867	3.487	.96126	<b>74</b>	<b>24</b>	.4067	.4452	2.246	.91355	
10	.2784	.2899	3.450	.96046	50	10	.4094	.4487	2.229	.91236	
20	.2812	.2931	3.412	.95964	40	20	.4120	.4522	2.211	.91116	
30	.2840	.2962	3.376	.95882	30	30	.4147	.4557	2.194	.90996	
40	.2868	.2994	3.340	.95799	20	40	.4173	.4592	2.177	.90875	
50	.2896	.3026	3.305	.95715	10	50	.4200	.4628	2.161	.90753	
<b>17</b>	.2924	.3057	3.271	.95615	<b>73</b>	<b>25</b>	.4226	.4663	2.145	.90631	
10	.2952	.3089	3.237	.95545	50	10	.4253	.4699	2.128	.90507	
20	.2979	.3121	3.204	.95459	40	20	.4279	.4734	2.112	.90383	
30	.3007	.3153	3.172	.95372	30	30	.4305	.4770	2.097	.90259	
40	.3035	.3185	3.140	.95284	20	40	.4331	.4806	2.081	.90133	
50	.3062	.3217	3.108	.95195	10	50	.4358	.4841	2.066	.90007	
<b>18</b>	.3090	.3249	3.078	.95106	<b>72</b>	<b>26</b>	.4384	.4877	2.050	.89879	
10	.3118	.3281	3.048	.95015	50	10	.4410	.4913	2.035	.89752	
20	.3145	.3314	3.018	.94924	40	20	.4436	.4950	2.020	.89623	
30	.3173	.3346	2.989	.94832	30	30	.4462	.4986	2.006	.89493	
40	.3201	.3378	2.960	.94740	20	40	.4488	.5022	1.991	.89363	
50	.3228	.3411	2.932	.94646	10	50	.4514	.5059	1.977	.89232	
<b>19</b>	.3256	.3443	2.904	.94552	<b>71</b>	<b>27</b>	.4540	.5095	1.963	.89101	
10	.3283	.3476	2.877	.94457	50	10	.4566	.5132	1.949	.88968	
20	.3311	.3508	2.850	.94361	40	20	.4592	.5169	1.935	.88835	
30	.3338	.3541	2.824	.94264	30	30	.4617	.5206	1.921	.88701	
40	.3365	.3574	2.798	.94167	20	40	.4643	.5243	1.907	.88566	
50	.3393	.3607	2.773	.94068	10	50	.4669	.5280	1.894	.88431	
<b>20</b>	.3420	.3640	2.747	.93969	<b>70</b>	<b>28</b>	.4695	.5317	1.881	.88295	
10	.3448	.3673	2.723	.93869	50	10	.4720	.5354	1.868	.88158	
20	.3475	.3706	2.699	.93769	40	20	.4746	.5392	1.855	.88020	
30	.3502	.3739	2.675	.93667	30	30	.4772	.5430	1.842	.87882	
40	.3529	.3772	2.651	.93565	20	40	.4797	.5467	1.829	.87743	
50	.3557	.3805	2.628	.93462	10	50	.4823	.5505	1.816	.87603	
<b>21</b>	.3584	.3839	2.605	.93358	<b>69</b>	<b>29</b>	.4848	.5543	1.804	.87462	
10	.3611	.3872	2.583	.93253	50	10	.4874	.5581	1.792	.87321	
20	.3638	.3906	2.560	.93148	40	20	.4899	.5619	1.780	.87178	
30	.3665	.3939	2.539	.93042	30	30	.4924	.5658	1.767	.87036	
40	.3692	.3973	2.517	.92935	20	40	.4950	.5696	1.756	.86892	
50	.3719	.4006	2.496	.92827	10	50	.4975	.5735	1.744	.86748	
<b>22</b>	.3746	.4040	2.475	.92718	<b>68</b>	<b>30</b>	.5000	.5774	1.732	.86603	
10	.3773	.4074	2.455	.92609	50	10	.5025	.5812	1.720	.86457	
20	.3800	.4108	2.434	.92499	40	20	.5050	.5851	1.709	.86310	
30	.3827	.4142	2.414	.92388	30	30	.5075	.5890	1.698	.86163	
40	.3854	.4176	2.394	.92276	20	40	.5100	.5930	1.686	.86015	
50	.3881	.4210	2.375	.92164	10	50	.5125	.5969	1.675	.85866	
<b>23</b>	.3907	.4245	2.356	.92050	<b>67</b>	<b>31</b>	.5150	.6009	1.664	.85717	
10	.3934	.4279	2.337	.91936	50	10	.5175	.6048	1.653	.85567	
20	.3961	.4314	2.318	.91822	40	20	.5200	.6088	1.643	.85416	
30	.3987	.4348	2.300	.91706	30	30	.5225	.6128	1.632	.85264	
40	.4014	.4383	2.282	.91590	20	40	.5250	.6168	1.621	.85112	
50	.4041	.4417	2.264	.91472	10	50	.5275	.6208	1.611	.84959	
					<b>66</b>					<b>58</b>	
	Cosin.	Cotg.	Tan.	Sine.	Angle.		Cosin.	Cotg.	Tan.	Sine.	Angle.

TABLE VIII.—NATURAL TRIGONOMETRICAL FUNCTIONS.

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

TABLE IX.—CALCULATION OF EARTHWORK.

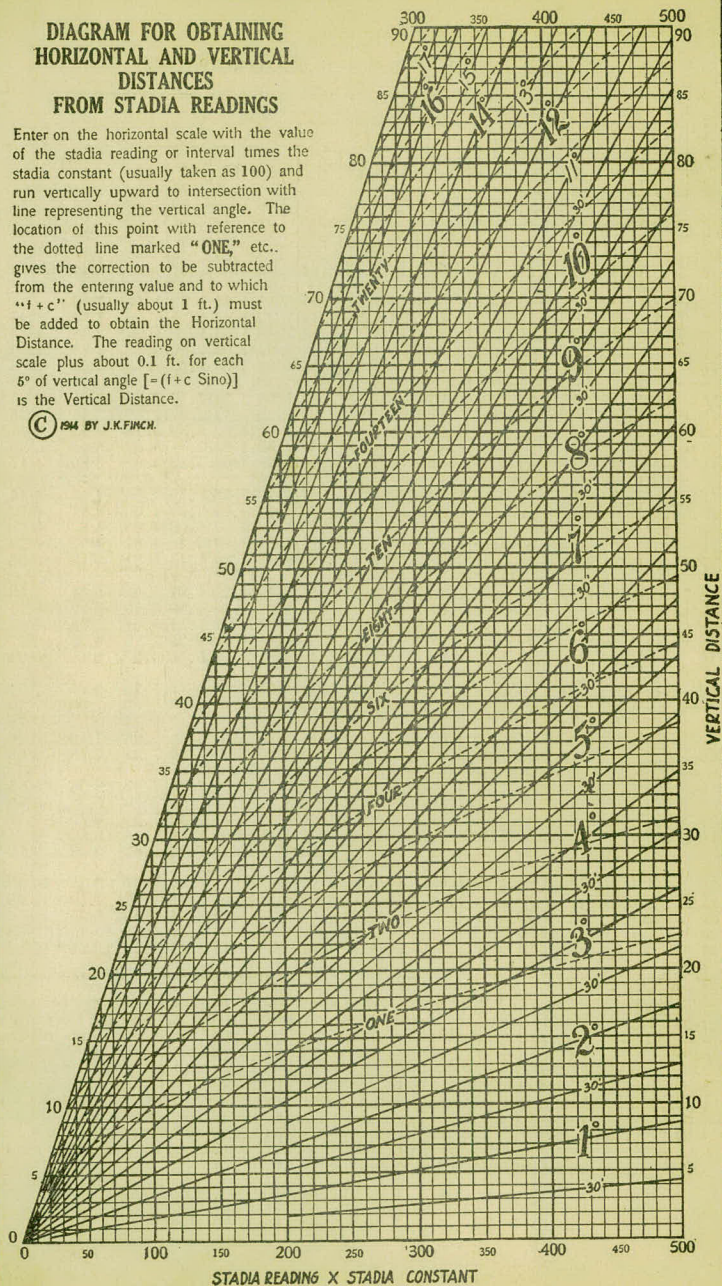
Width	HEIGHT														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	.02	.04	.06	.07	.09	.11	.13	.15	.17	.18	.20	.22	.24	.26	.28
2	.04	.07	.11	.15	.18	.22	.26	.30	.33	.37	.41	.44	.48	.52	.56
3	.06	.11	.17	.22	.28	.33	.39	.44	.50	.56	.61	.67	.72	.78	.83
4	.07	.15	.22	.30	.37	.44	.52	.59	.67	.74	.81	.89	.96	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 gives cu. yds. in 1 ft. of a triangle of given width and height. Corrections for tenths of width are one tenth the values found under each height considering the widths from 1 to 9 as tenths and similarly the corrections for tenths of height are one tenth the figures opposite width considering the heights from 1 to 9 as tenths. Thus if w = 16.2 and h = 5.3, cu. yds. = 1.48 + .028 + .089 = 1.597 cu. yds. or practically 160 cu. yds. per 100 ft. If w exceeds 40 ft., use one half and multiply result by 2, if both w and h are large use one half of each and multiply result by 4. Any cross-section may be divided into triangles by the following rule. To the triangle of the sum of the outside cuts (or fills) = h, and ½ the roadbed = w, add the triangles formed by taking the distance out to each break in turn (=w's) by the difference between the cuts (or fills) on each side of it (=h's) always subtracting the outer from the inner.

# DIAGRAM FOR OBTAINING HORIZONTAL AND VERTICAL DISTANCES FROM STADIA READINGS

Enter on the horizontal scale with the value of the stadia reading or interval times the stadia constant (usually taken as 100) and run vertically upward to intersection with line representing the vertical angle. The location of this point with reference to the dotted line marked "ONE," etc., gives the correction to be subtracted from the entering value and to which "i+c" (usually about 1 ft.) must be added to obtain the Horizontal Distance. The reading on vertical scale plus about 0.1 ft. for each 5° of vertical angle [= (i+c Sino)] is the Vertical Distance.

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DISTANCES FROM CENTER OF ROADWAY FOR  
CROSS-SECTIONING.

Roadway 16 feet wide. Side Slopes 1 on 1½.  
For Single Track Embankment.

II	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	H
0	8.0	8.2	8.3	8.5	8.6	8.8	8.9	9.1	9.2	9.4	0
1	9.5	9.7	9.8	10.0	10.1	10.3	10.4	10.6	10.7	10.9	1
2	11.0	11.2	11.3	11.5	11.6	11.8	11.9	12.1	12.2	12.4	2
3	12.5	12.7	12.8	13.0	13.1	13.3	13.4	13.6	13.7	13.9	3
4	14.0	14.2	14.3	14.5	14.6	14.8	14.9	15.1	15.2	15.4	4
5	15.5	15.7	15.8	16.0	16.1	16.3	16.4	16.6	16.7	16.9	5
6	17.0	17.2	17.3	17.5	17.6	17.8	17.9	18.1	18.2	18.4	6
7	18.5	18.7	18.8	19.0	19.1	19.3	19.4	19.6	19.7	19.9	7
8	20.0	20.2	20.3	20.5	20.6	20.8	20.9	21.1	21.2	21.4	8
9	21.5	21.7	21.8	22.0	22.1	22.3	22.4	22.6	22.7	22.9	9
10	23.0	23.2	23.3	23.5	23.6	23.8	23.9	24.1	24.2	24.4	10
11	24.5	24.7	24.8	25.0	25.1	25.3	25.4	25.6	25.7	25.9	11
12	26.0	25.2	26.3	26.5	26.6	26.8	26.9	27.1	27.2	27.4	12
13	27.5	27.7	27.8	28.0	28.1	28.3	28.4	28.6	28.7	28.9	13
14	29.0	29.2	29.3	29.5	29.6	29.8	29.9	30.1	30.2	30.4	14
15	30.5	30.7	30.8	31.0	31.1	31.3	31.4	31.6	31.7	31.9	15
16	32.0	32.2	32.3	32.5	32.6	32.8	32.9	33.1	33.2	33.4	16
17	33.5	33.7	33.8	34.0	34.1	34.3	34.4	34.6	34.7	34.9	17
18	35.0	35.2	35.3	35.5	35.6	35.8	35.9	36.1	36.2	36.4	18
19	36.5	36.7	36.8	37.0	37.1	37.3	37.4	37.6	37.7	37.9	19
20	38.0	38.2	38.3	38.5	38.6	38.8	38.9	39.1	39.2	39.4	20
21	39.5	39.7	39.8	40.0	40.1	40.3	40.4	40.6	40.7	40.9	21
22	41.0	41.2	41.3	41.5	41.6	41.8	41.9	42.1	42.2	42.4	22
23	42.5	42.7	42.8	43.0	43.1	43.3	43.4	43.6	43.7	43.9	23
24	44.0	44.2	44.3	44.5	44.6	44.8	44.9	45.1	45.2	45.4	24
25	45.5	45.7	45.8	46.0	46.1	46.3	46.4	46.6	46.7	46.9	25
26	47.0	47.2	47.3	47.5	47.6	47.8	47.9	48.1	48.2	48.4	26
27	48.5	48.7	48.8	49.0	49.1	49.3	49.4	49.6	49.7	49.9	27
28	50.0	50.2	50.3	50.5	50.6	50.8	50.9	51.1	51.2	51.4	28
29	51.5	51.7	51.8	52.0	52.1	52.3	52.4	52.6	52.7	52.9	29
30	53.0	53.2	53.3	53.5	53.6	53.8	53.9	54.1	54.2	54.4	30
31	54.5	54.7	54.8	55.0	55.1	55.3	55.4	55.6	55.7	55.9	31
32	56.0	56.2	56.3	56.5	56.6	56.8	56.9	57.1	57.2	57.4	32
33	57.5	57.7	57.8	58.0	58.1	58.3	58.4	58.6	58.7	58.9	33
34	59.0	59.2	59.3	59.5	59.6	59.8	59.9	60.1	60.2	60.4	34
35	60.5	60.7	60.8	61.0	61.1	61.3	61.4	61.6	61.7	61.9	35
36	62.0	62.2	62.3	62.5	62.6	62.8	62.9	63.1	63.2	63.4	36
37	63.5	63.7	63.8	64.0	64.1	64.3	64.4	64.6	64.7	64.9	37
38	65.0	65.2	65.3	65.5	65.6	65.8	65.9	66.1	66.2	66.4	38
39	66.5	66.7	66.8	67.0	67.1	67.3	67.4	67.6	67.7	67.9	39
40	68.0	68.2	68.3	68.5	68.6	68.8	68.9	69.1	69.2	69.4	40

**Example**—If point is 22.6 ft. above grade, how far should it be from center line to be a slope stake point? Ans. from Table 41.9. For same slopes but other widths of roadbed correct above figures by one-half difference in width of roadbed; thus in example above for 20 ft. roadbed distance will be 41.9 + (20 - 16) ÷ 2 or 2 ft. added to 41.9 = 43.9. For slopes of 1 on 1 see inside of front cover.