TABLES FOR EXCAVATIONS AND EMBANKMENTS.

DISTANCES FROM CENTER OF ROADWAY FOR CROSS-SECTIONING.
ROADWAY 18 FEET WIDE. SIDE SLOPES 1 TO 1.
FOR SINGLE TRACK EXCAVATION.

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

Calculated by Julien A. Hall, M. Am. Soc. C. E.

For Keith's Railroad Curve Tabels see end of book.

EMPIRE

To

Rich Valley

Road No 86

Office of

County Engineer

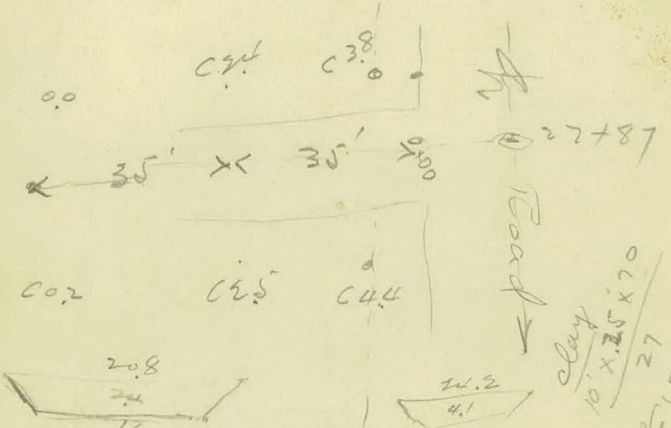
Ramsey Co.

St Paul

Minn

Proj. 2200 Sta 27+87
= ℄ Driveway Rt.

0+00 = shoulder of grade
15 ft. Rt of ℄ of Road



20.8
2½
16
18.4
2½
736
368
44.16
End area
35
22080
13248
27) 1545.60
57.2
8.6 cu yds.
81.8
110.4

14.2
4.1
16
20.1
4.1
201
804
82.1
44.16
2) 126.27
63.1 Ave. Area
35
315.5
1893
27) 2208.5 (81.8 cu yds
216
27
216

Clay
10' x 35' x 70
27
2200
27/1925 (7

End Area

Day.

23-~~25~~ 30+50 30 cyc per Sta.

ROAD No 86 - Hampton-Rich Valley

INDEX

1923

Sta	to	Sta	P.	to	P.
87+72.5	~	316+84	1	~	40
0+00	~	87+72.5	41	~	55
113+59.2	~	121	56	~	57
BM	0+00 -	317+15	58	~	59
Align.	0+00 -	316+84.5	60	~	67

F.M. Conner. Engr.

Description of Work.
& Elev. & grade stakes

" " " " "

" " " " "

Notes Gathered from plans & Note books

	+	HS	−	El.	
BM	1.58	1064 34		1062 76	
TP	6.44	1066 12	4.66	1059 68	
TP			5.75	1060 37	
TP	1.20	1055 61	11.61	1054 41	
	3.03	1047 00	11.64	1043 97	
87+72.5 BC				(38.0)	37 80
88				(39.5)	39 00 ✓
+50					41 16 ✓
89				(43.8)	43 33 ✓
	8.76	1054 88	0.86	1046 12	
+50					45 50 ✓
90				(48.1)	47 61 ✓
+50					49 84 ✓
91				(54.3)	52 00 ✓
	9.37	1062 35	1.90	1052 98	
+50					54 17 ✓
92				(57.1)	56 33 ✓

9 @ 3.4 = 30.6

5/10/23 (1)

40' Rt Sta 92 set link spike in tree.

+3.4 super -1.6 27.9		00 15	+5.6 super +0.5 28.6
+4.4 super -0.7 29.6		00 15	+5.3 super +0.7 28.3
+4.9 super -1.0 30.9		00 15	+3.3 super +1.0 23.3
+2.6 28.6		00 15	00 23
Emb no ditch	00 18	00 15	Emb no ditch
00 26	00 18	00 15	Emb no ditch
+0.9 26.9	00 18	00 15	00 23
+3.0 29.0	00 18	00 15	00 23
+4.1 30.1	00 18	00 15	00 23
+4.8 30.8	+1.8 18	00 15	+3.7 26.7

92+50		1062 35			58 50 ✓
+72.5 EC				(59.9)	59 50
BM			2.10	1060.2	+4.133%
BM	8°	1068 38		1060.37	
93				(61.)	×60 66 ✓
+27.2					
+50					62 59 ✓
94				(63.6)	64 00 ✓
+50.					65 03 ✓
95	4 48	70 50	-2.36	1066.02	×65 57 ✓
				(65.0)	+0.5%
96				(65.6)	×66 14 ✓
+50					66 31 ✓
97				(66.0)	66 24 ✓
+50					65 94 ✓
98				(65.1)	65 39 ✓
+50					64 64 ✓
99				(64.2)	×63 65 ✓
99+15	PC			(64.1)	63 32
99+50				(63.3)	62 53 ✓
BM	(Mail interior 40' Rt sta 99+60)		1.25	1069 25	-2.235%

300' VC

200' VC

Surf -0.7	+3.9 29.1	+1.6 17.2	00 15	+4.2 29.2	Surface + 0.7
	+3.3 29.8	+1.0 16.5	00 15	+5.8 28.8	Surf + 0.5
	+1.2 25.0	00 15.8	00 15	+5.7 28.4	
	+0.5 23.5	00 15	00 15	+4.4 27.4	
	-2.2/18.3	00 15	00 15	+4.0 27	
	-2.8/19.2	00 15	00 15	+4.2 27.2	
	-2.4/18.6	00 15	00 15	+4.1 27.1	
	00 23	00 15	00 15	+5.7 28.7	
	00 23	00 15	00 15	+6.0 29.0	
	+0.7 23.7	00 15	00 15	+6.3 29.3	
Surface +0.5		00 15	00 16.5	+7.0 31.5	Surface -0.5
Surface 0.8		00 15	+1.1 17.6	+7.6 33.2	Surface -0.8

		1070 50			
BM			1012	1060 38	
BM	1.38	1070 63		1069.25	
	2 15	1063 32	956	1061 07	
	5 32	1056 90	11 56	1051 66	
100				62.2	61.41
+50					60.29
101				59.9	59.18
+50				58.7	58 09
102				57.7	56 98
+50				56.3	55 87
103				55.4	54.76
+50					53.65
104				52.8	52 62
+50					51 95

-2.23 %

500 LVC

FMC 5/18/23

Ck ok.

-3.6 20.4	00 15	+1.3 18	+6.2 33.2
-3.4 20-	00 15-	+1.1 18	+5.0 33-
-4.1/2 21-	00 15-	+1.1 18	+1.9/29.9
-4.1 21	00 15-	+0.7 18	+1.6 29.6
-5.4 23-	00 15-	+0.7 18	+0.9 28.9
-2.9 19.4	work.	+0.7 18	+0.9 28.9
-2.5- 18.8	00/15	+0.6 18	+3.5- 31.5-
-3.4 20-	00/15	00/18	+0.9 28.9
-5.2 22.8	00 15	00 18	Emb. ok
-4.8 22.2	00 15	00/18	✓ ✓

1056.90

10.6
9.8

lower end Curb
upper end Curb

105 Curb PW53-36 52.6 51 58

+50 51 57

106 V.C. PI 52.5 71.74 52 00 cut

+50 52 28

107 53.6 53 01

+50 54.7 54 14

12 17 1064 03 5 04 1051 76

108 Curb Rt 15" CM 28' 56.9 55 58

+25 Curb L+ 15" CM 28'

+50 Full Super 57.9 X 57 62

109 Super + 0.6 - 0.6 59.8 59 54

+15 EC 60.6 60 12

5000' V.C.

+3.846%

FINC 5/18/23

top slab 0.1" high over 18 ft.

00/15

-4.6/21.9

0 - 9/19.4

-4.5/21.8

-0.8/19.2

-4.1
21.3

-0.7/19.0

-3.6/20.4

-0.8/19.2

-1.6/17.4

-0.8/19.2

-2.6/18.9 00/15

FE ☐ 00/18

FE ☐
00/15

+1.4/29.4

-2.8/19.2

-2.5/18.8 00/15

00/16.9 00/26.9

1064.03

1.97 1062.06

10.13 1072.19

1069+65 ETS Level Section 62.04

110 63.7 +3.84 46% 63.38

+50 65.30

111 67.2 × 67.23

+50 69.00

112 71.1 70.56

+50 71.85

113 73.7 72.72

+50 73.64

114 73.9 × 1073.17

+0.11 44%

(5)

FMC 5/18/23

00/15	00/15	
00/15	00/15	+0.8 25.8
+1.8 26.8 00/15	00/15 00/25	
+2.8 27.8 00/15	00/15 00/25	
+4.3 29.3		+1.7 26.7 FMC 5/15/23
+7.1 32.1 In cut. +1.2 15	+0.6 15	+3.7 28.7
+10.8 35.8 In Cut. 00/15	00/15	+7.3 32.3
+11.2 36.2 In cut 00/15	00/15	+10.6 36.6
+10.8 35.8 In cut 00/15	00/15	+12.1 37.1
+11.4 36.4 00/15	00/15	+11.9 36.9

114+50 73 23

115 (73.9) 1073 29

+53 6 BC

+0.11 4 96

116 (74.3) 73 40

+50

117 (74.5) 73 52

+50

118 (74.6) ×1073 63

+50 73 54

119 culv. W22-46 conc. 300' 1/2 (74.9) 73 57

FMC
5/15/23

+5.8 30.8 | ~0 15 | ~0 15 | +4.8 29.8

+0.5 25.5 level Section +0.6 15 +1.1 +0.8 25.8

-2.2 19.8 ½ Super ½ Curve. -2.0 18.0

-2.4 21.6 Full Super Full Curve. -3.4 20.4

Super -1.0 Super +1.0

-3.1 23.1 -5.0 22.5

-4.8 25.2 -5.7 23.8

Shrinkage 10%

-6.7 28.1 -7.8 26.7

-7.1 28.4 -7.3 25.9

	+	H.I.	−	Elev	
119+50					73 40
120				(74.4)	73 15
+50					72 80
+55 ± EC				(73.7)	72.75
121		106933		(65.6)	65 50
+50					
				(64.9)	
122			4.3	65°	64 50
+55					
				(64 3)	
123			5.0	64 3	63 50
				(63 5)	
124			5.8	63.5	×1062 50

BM 1 0.98'

FMC 5/15/23

-6.0
27.0

-8.2
27.3

-5.1
26.4 full Super & full Lum. -7.3
25.9

EC -2.9
20.9 1/2 ✓ — 1/2 ✓ -4.3
21.5

Equation 120+55.3 = 113+59.3 (see P. 56)

Sta 121-136
Re X Sectioned
7/17/23

(+0.4) Results shown
C 0.5 in circles.

C 0.8

C 1.0

	+	H.I.	-	E/C/V.	
		1069.33			× 1062 √0
124			5.8	63.5 E	
+					61.96
				(62.1)	
125			7.3	62.0 VC	61.34
				200'	60.64
				(60.4)	
126			9.0	60.3	× 1059 80
I.P.	0.30	1060.83	8.80	1060 √3	
+					
				(56.9)	
127			4.0	56.8	58 10
				-1.70 %	
				(53.4)	
128			7.5	53.3	56 40
+50					× 1055 55
				(51.0)	
129			9.8	51.0 VC	54 85
				300'	
+					

+0.8
C 0.7

+0.6
C 0.5

-1.2
F 1.3

-3.0
F 3.1

F 3.8

	+	H.I.	−	Elev.	
+50					54.45
		1060.83		(51.7)	
130			92	51.6	54.30
T.P.	8.84	1060.83	8.84	1051.99	
+					54.55
				(53.6)	
131			7.0	53.8	54.90
+50					×1055.99
				(57.1)	
132			3.7	57.1	56.92
				(59.5)	
133			1.2	59.6	58.58
T.P.	7.92	1067.95	0.80	1060.03	
				(62.2)	
134			5.7	62.2	60.45
+					
				(63.9)	
135			4.0	63.9	×1062.39

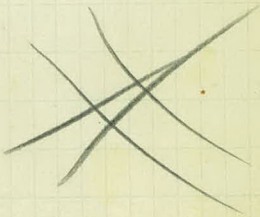
-2.6
F 2.1

-1.3
F 1.1

c 0.7

+0.9
C 1.0

c 1.8



c 1.6

	+	H.I.	−	E/CV.	
135		1067.95			×1062 30
+					63 14
				(65.2)	
136			2.9	65.0	63 90
+					64 60
				(65.7)	
137		1067.95	2.3	65.7	65 10
T.P.	4.90	1070.59	2.26	1065.69	+0.04
+					65 50
				(65.8)	
138			4.7	65.9	65 80
+					66 00
				(65.9)	
139			4.6	66.0	×1066 08
+					+0.04 2.90
				(65.8)	
140			4.7	65.9	66 12
+					
				(65.2)	
141			5.4	65.2	66 16

(10)

Sta 121-136
Re X sectioned 7/17/23
results shown in
circles.

(+1.3)
C 1.1

C 0.6

C 0.1

F 0.1

F 0.2

F 1.0

Re X sectioned 8/13/23
Sta 136-176
Results indicated by
circled figures.

	+	H. I. 1070.59	−	Elev.	
142		1070.59	5.5	(65.0) 65.1	$66\frac{20}{}$
	6.03	1070.75	5.87	1064.72	
+					
143			4.9	(65.7) 65.9	$66\frac{28}{}$
+					
144			4.7	(65.9) 66.0	$66\frac{28}{}$
+					
145			4.7	(66.0) 66.4	$66\frac{32}{}$
+					
146			4.5	(66.1) 66.3	$66\frac{36}{}$
+					
147			4.4	(66.1) 66.4	$66\frac{40}{}$

+0.04 E %

F 1.1

F 0.3

F 0.3

C 0.1

0.0

0.0

	+	H.I.	−	Elev.	
T.P.	4.24	1070.75	3.98	1066.77	
	4.24	1071.01	3.98	1066.77	
140			4.4	66.6 (66.6)	664.5
149			4.5	66.5 (66.5)	1066.50
150			4.9	66.1 (66.0)	66.17
151			5.3	65.7 (65.6)	65.84
152		1071.01	5.1	65.9 (65.8)	65.51
T.P.	3.90	1069.80	5.11	1065.90	
153			3.9	65.9 (65.8)	65.18

+100 −1000 −0.33 50

C 0.2

0.0

0.0

F 0.1

C 0.4

C 0.7

	+	H.I.	-	E/CV.	
		1069.80			
154			4.4	65.4 / 65.4	64.85
+					
155			4.6	65.1 / 65.2	64.51
+					
156			5.2	64.4 / 64.6	64.17
B.M.+25		1069.80			
	2.88	1068.74	3.94	1065.86	
157			4.4	64.3 / 64.3	×1063.83
+					
158			4.2	64.3 / 64.6	63.57
+					
159			4.4	64.4 / 64.3	×1063.46

3.33 0.00

C 0.5

C 0.7

C 0.4

Spike on tel. pole Rt. of Road
C 0.5

C 0.9

C 0.8

	+	H.I.	-	Elev	
		1068.74			
160			4.7	64.1 64.0	63.40
+					
			5.5	63.2	
161					63.35
+					
162		1068.74	5.7	63.1 63.0	63.30
T.P.	4.31	1067.71	5.34		1063.40
+					
163			3.7	64.1 64.0	63.25
+					
164			4.5	63.2 63.2	63.20
+					
165			4.7	63.0 63.0	63.15

-0.05/10

C 0.6

F 0.2

F 0.3

C 0.7

0.0

F 0.2

	+	H.I.	-	Elev.	
		1067.71			
166			4.6	63.1	63.10
+50					
167			4.4	63.3	63.05
T.P.	3.86	1067.71	3.85		1063.86
+		1067.72			
168			4.4	63.3	1063.00
+					
169			4.6	63.1	62.93
+					
170			4.5	63.2	62.86
+					
171			4.5	63.2	62.80

63.4
63.4
63.4
63.4
63.2
63.2
63.2
63.2
-0.05
-0.07

00

C 0.2

C 0.3

C 0.2

C 0.3

C 0.4

	+	H.I	−	Elev.	
		1067.72			
172		1067.72	4.8	62.9 (62.9)	62 73
T.P.	3.96	1067.13	4.55		1063.17
+					
173			4.2	62.9 (62.9)	62 66
+					
174			4.4	62.7 (62.7)	62 59
+					
175			4.6	62.5 (62.5)	62 52
+					
176			4.7	62.4 (62.4)	62 46
+					
177			5.2	61.9 (62.1)	62 40

-0.06 ft/10

F 0.5 (-0.3) 0.0 0.0 C 0.1 C 0.2 C 0.2

Re X Sect. Sta 176-201 7/18/23 results indicated by circled figures.

><

Re X-sect 8/13/23 Sta 136-176

Results indicated by circled figures.

	+	H.I.	−	Elev	
		1067.13			
T.P.	4.17	1066.26	5.04		1062.09
178			4.7	61.7 61.6	62 33
+					
179			4.4	61.9 61.9	62 26
+					
180			4.6	61.7 61.7	62 20
+					
181			4.2	62.2 62.1	62 13
+					
182		1066.26	4.0	62.4 62.3	×1062.07
T.P.	5.25	1067.86	3.65		1062.61
+					
183			5.3	62.6	62 25

−0.067%

+0.6
F 0.7

F0.4

F0.5

+0.1
00

+0.3
C0.2

+0.1
C0.4

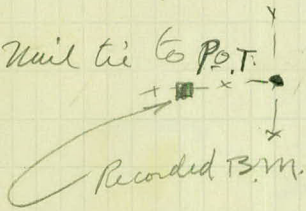
	+	H.I.	-	E/cv.	
		1067.86			
184			5.1	62.9 / 62.8	×1062.33
+					
BMAS			1.99	1065.90	1065.97
185			4.1	63.9 / 63.8	62.66
+					
186			3.5	64.5 / 64.4	×1063.00
+					
187		1067.86	3.1	64.9 / 64.8	63.16
T.P.	4.61	1069.46	3.01		1064.85
+					
188			4.2	65.2 / 65.3	63.32
+					
189			4.5	65.0	63.48

×0.33%

×0.162%

+0.6
C 0.5

Nail tie to P.O.T. corner F.P. Lt Sta 184+75

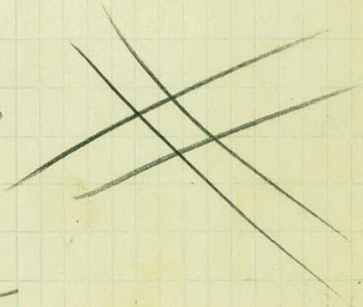


+1.3
C 1.2

Recorded B.M. O.K.

+1.5
C 1.4

+1.7
C 1.6



+1.9
C 2.0

C 1.5

	+	H.I. 1069.46	-	Elev	
				(64.6)	
190			4.9	64.6	63.65
+					
				(64.8)	
191			4.8	64.7	63.81
+					
				(64.8)	
192		1069.46	4.7	64.8	63.95
T.P.	4.10	1068.93	4.63	+0.16	1064.83
+					
				(64.5)	
193			4.4	64.5	64.12
+					
				(64.6)	
194			4.5	64.4	64.28
+					
				(64.9)	
195			4.2	64.7	64.44

C 1.0

+1.0
C 0.9

C 0.9

C 0.4

+0.3
C 0.1

+0.5
C 0.3

	+	H.I.	-	E/CV	
		106893			
196			4.1	65.1 64.8	64 60
+					
197		1068.93	4.1	65.0 64.8	64 76
T.P.	2.61	1067.72	3.82		1065.1
+					
198			2.5	65.2 60.2	+0.16270 64 93
B.M.+60			2.72	106500	×1065.05
199			3.3	64.5 64.4	×Exception
+24					×1064.25
+					
+65				61.7	×1064.25
200			5.5	62.2	6370 16
+15					×1063
+					-4.41/2 ×50VC ×005
				59.3	
201			5.3	59.2	×1059 41

L Rc cross sectioned 7/18/23 Sht 176 - 201
figures in circle obtained from 12c X-sect.

+0.1
C 0.2

+0.2
0 0

C 0.3

℄ of South Rail C.G.W.Ry

C 0.2

-2.0
F 1.5

-0.1
0 0

	+	H.I.	−	Elev.	
+50					57 54
				(56.9)	
202		1067.72	10.8	56.9	56 35
T.P.	4.44	1062.03	10.13		1057.59
+50					55 84
				(56.1)	200' VC
203			6.0	56.0	× 105600
+					
				(56.4)	
204			5.7	56.3	57 00
+					× 1.00%
				(58.8)	
205			3.4	58.6	58 00
+					
				(59.8)	
206			2.4	59.6	× 105900
+					59 33
				(59.6)	200' VC
207		1062.03	2.6	59.4	59 33

C 0.5

0.0

F 0.7

C 0.6

C 0.6

0.0

Re X-sections 8/29/23

Sts 201 - 242

Results tabulated by circled figures

	+	H.I.	−	Elev	
		1062.03			
T.P.	0.0.4	1059.86	2.21		1059.8
+50					59.00
				(57.7)	
208			1.9	58.0	× 1058.33
+					
				(57.4)	
209			4.3	57.6	× 1056.67
+50					56.00
				(55.0)	
210			4.5	55.4	55.60
+50					55.60
				(57.6)	
211			4.3	57.6	× 1055.87
✓					
				(56.4)	
212		1059.86	3.5	56.4	56.64
T.P.	7.78	1063.88	3.26		1056.1
+					
				(57.7)	
213			6.2	57.7	57.46

+0.51 ft/100 ft
−1.67%

F 0.3

0.0

F 0.2

F 0.2

F 0.2

C 0.2

	+	H.I.	−	Elev.	
		1063.88			
				(59.0)	
214			5.0	58.9	58.38
+					
				(59.6)	
215			4.2	59.7	59.10
+					
				(60.5)	
216			3.5	60.4	59.92
+					
				(61.3)	
217		1063.88	2.6	61.3	60.74
T.P.	5.05	1066.77	2.16		1061.72
+					
				(61.7)	
218			5.2	61.6	61.56
+					
				(62.2)	
219			4.7	62.1	62.38

+0.818 90

C 0.6

C 0.6

C 0.5

C 0.6

00

F 0.3

	+	H.I	−	Elev.	
		1066.77			
220			4.2	62.6 (62.6)	63 19
+					
BM1			3.6	63.2 (63.2)	1064.00
+					
BM2		1066.77	3.0	63.8 (63.8)	64 08
T. P.	5.53	1069.17	3.13		1063.64
+					
BM3			4.9	64.3 (64.4)	64 16
+					
BM4			4.5	64.7 (64.7)	64 24
+					
BM5			4 3	64.9 (64.9)	64 32

+0.8 1.8%
+0.05 0.05%

F0.6

F0.8

F0.3

C 0.1

C 0.5

C0.6

	+	H.I.	-	E/ov	
		1069.17			
226			4.0	65.1 65.2	64.41
+					
Fh 7		1069.17	4.3	64.9	64.49
T.P.	4.72	1069.58	4.31		1064.86
+					
Fh 8			4.8	64.7 64.8	64.57
+					
229			4.8	64.8 64.8	64.65
+					
Fh 30			4.3	65.3 65.3	64.74
+					
B.M. 55			3.54	1066.04	1066.19
Fh 31			4.5	65.1 65.1	64.85

+0.083%

C 0.8

C 0.4

C 0.2

C 0.2

C 0.6

80 ft Rt Spike IN 36" Cottonwood

C 0.3

	+	H.I.	−	Elev		
				(65.0)		
737		1069.58	4.7	64.9	+0.03%	64.91
T.P.	3.76	1068.66	4.68			1064.90
+						
				(64.6)		
738			4.1	64.6		1065.00
+						
				(64.6)		
739			4.2	64.5		65.07
+						
				(64.8)	+0.07%	
740			4.1	64.6		65.14
+						
				(65.2)		
741			3.7	65.0		65.21
+						
				(64.9)		
742			3.9	64.8		65.28

0.0

F 0.4

F 0.6

F 0.5

F 0.2

F 0.5

	+	#.1	-	Elev.	
		1068.66			
T.P.	4.81	1069.90	3.57		1065.09
238			5.0	64.9	65.35
+					+0.072%
239			4.9	65.0	65.43
+					
240			4.4	65.5	*1065.50
+					
241			3.7	66.2	65.75
+					
242		1069.90	3.0	66.9	66.00
T.P.	3.85	1071.42	2.33		1067.57
+					+0.250%
243			4.2	67.2	66.25

F0.5

F0.4

00

C 0.5

C 0.9

C 1.0

Re X sectioned 8/29/23
Sta 201 - 242
Results indicated by circled figures.

Re X sectioned 8/30/23
Sta 242 - 281
Results indicated by circled figures

	+	H.I.	-	Elev.	
		1071.42			
244			4.5	66.9 (67.5)	66 50
+					
245			4.8	66.6 (66.9)	66 75
+					
246			4.7	66.7 (66.8)	67 00
+					
247		1071.42	5.1	66.3 (66.6)	67 25
T.P	4.49	1071.23	4.68		1066.7
+					
248			4.7	66.5 (66.6)	67 50
+					
249			4.6	66.7 (66.8)	67 75

+0.250%

C 0.4

F 0.2

F 0.3

F 1.0

F 1.0

F 1.0

	+	H.I.	−	Elev.	
		1071.23			
250			4.2	(67.2) 67.0	68.00
+					
251			3.6	(67.9) 67.6	68.25
+					
252		1071.23	3.4	(68.0) 67.8	68.50
T.P.	4.50	1072.81	2.92		1066.31
+					
253			5.0	(68.1) 67.8	68.25
+					
254			4.7	(68.3) 68.1	69.00
+					
255			4.0	(69.0) 68.8	69.25

+0.250

F1.0

F0.6

F0.7

F1.0

F0.9

F0.5

	+	H.I.	−	Elev.	
		1072.81			
256			2.9	70.1 / 69.9	6950
+					
257		1072.81	2.3	70.7 / 70.05	6975
T.P.	360	1074.25	2.16		1070.65
+					
258			3.7	70.6 / 70.5	1070.00
+					
259			4.0	70.4 / 70.3	6977
+					
260			4.3	70.1 / 70.0	6954
+					
261			4.4	69.9 / 69.9	6931

+0.25%

−0.22%

C 0.4

C 0.8

C 0.5

C 0.5

C 0.5

C 0.6

		1074.75			
262		1074.75	4.8	69.4 (696)	1908
T.P.	2.78	1072.43	4.60	1069.65	
263			3.5	68.9 (690)	6886
264			4.1	68.3 (684)	6863
265			4.3	68.1 (679)	6840
266			4.7	67.7 (680)	6818
267			4.9	67.5 (676)	6795

-0.22 ft

C0.3

00

F0.3

F0.3

F0.5

F0.5

	+	H. I.	-		
		1072.43			
T. P.	3.50	1071.32	4.61	1067.82	
268		1071.32	4.0	67.5 67.3	67.72
+					
269			4.2	67.1 67.1	1067.50
+					
270			4.6	67.0 66.7	67.48
+					
271			4.5	67.1 66.8	67.45
+					
272			4.2	67.5 67.1	67.43
+					
273			3.6	68.1 67.7	67.40

-0.02%

-0.05%

F0.2

F0.4

F0.8

F0.7

F0.3

C 0.3

		1071.32			
T.P.	3.69	1072.04	2.97	1068.35	
274			3.9	(68.3) 68.5	67 37
+					-0.02 5%
275			4.5	(67.8) 67.5	67 35
+					
276			4.9	(67.3) 67.1	×1067 33
+					
277			5.6	(66.7) 66.4	67 13
+					200' VC
278		1072.04	5.9	(66.4) 66.1	×1066 60
T.P.	1.93	1068.45	5.52	1066.52	
+					-0.70 2%
279			3.0	(65.7) 65.5	×1065 90

C 0.7

C 0.1

F 0.1

F 0.7

F 0.5

F 0.4

Re Kaufbeuren 8/30/43

Stn 3 Alt - 2-80

Results radioed by airlift from

		1068.45			
+50					65 46
280			3.6	64.9 64.8	64 80
+50					64 00
281			5.1	63.6 63.3	63 00
+50					61 70
282			6.9	61.3 61.5	60 40
+56					58 80
283		1068.45	9.1	59.4 59.1	57 10
T.P.	0.87	1060.95	8.37	1060.08	
+50					55 15
284			5.3	55.3 55.1	× 105.97
					- 4.490%
285			9.6	51.3 51.4	48 48

Rex Sect. 7/3/23
SR 281 - 309

500' VC

Recorrido tomado 7/3/23

0.0

+0.6
0.3

+1.3
C 0.9

C 2.3

+2.5
C 2.7

+2.8
C 2.9

		1060.95			
T. P.	0.50	1049.45	12.00	1048.95	
286			3.0	46.2 / 46.5	43.99
287		1049.45	9.2	40.0 / 40.3	39.50
	1.08	1038.17	12.36	1037.09	
288			4.0	33.9 / 34.2	35.01
289			8.9	29.2 / 29.3	30.52
290			12.7	25.4 / 25.5	
T. P.	0.81	1038.17	11.22	1026.95	× 1025.98
	+.50	1027.76		24.1	24.00
291			4.9	23.1 / 22.9	22.50

1 + 4.4 + 90.50

+2.2
C 2.5

+0.5
C 0.8

-1.1
F 0.8

-1.3
F 1.2

-0.6
F 0.5

+0.1

+0.6
C 0.4

#1.
1027.76

+50					21.50
292			6.3	21.7 21.-	21.00
+50					21.00
B.M. ~~XE~~	293+10		9.24		
293		1027.76	6.2	22.0 21.6	21.50
T.P.	6.99	1029.09	5.66	1022.10	
+50					22.50
294			5.6	23.9 23.5	× 1024.14
+					
295		1029.09	2.7	27.1 26.40	27.71
T.P.	10.56	1037.19	2.46	1026.63	
+					
296			7.4	30.5 29.8	31.28
+50					× 1033.01
297			3.1	34.7 34.-	34.60

+0.7
C 0.5

1018 5-2

1019.17 − 293 + 10
+0.5
C 0.1

-0.2
F 0.6

-0.6
F 1.3

-0.8
F 1.5

+0.1
F 0.5

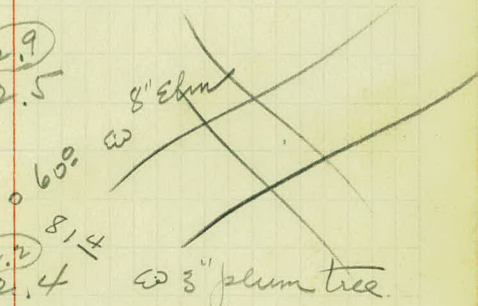
		H. I.			
		1037.19			
	537	1041.48	1.08	1036.11	
+50					35 60
298			3.7	(38.4) 37.8	36 50
+50					36 80
299			2.3	(39.6) 39.2	36 70
+50	TOT				36 20
300			3.9	(37.4) 37.6	35.20
+50					33 70
301		1041.48	8.4	(32.7) 33.1	31 90
T.P.	0.98	1030.25	1.21	1029.27	
+50					×1029 67
302			3.1	(26.9) 27.2	27 20
+					
303			9.7	(20.3) 20.5	22.25

500 ft. -4.93%

+1.9
C 1.3

+2.9
C 2.5

width of cut.
slope to slope 47 ft.



8/14

+2.2
C 2.4

+0.8
C 1.2

-0.3
0 0

-2.0
F 1.8

		1030.75			
T.P	1.83	1019.68	12.40	1017.85	
304			4.6	15.1 (14.8)	17 34
305		1019.68	10,00	09.7 (09.5)	× 1012 4
T.P.	1.92	1008.87	12.73	1006.95	
					10 10
306			2.5	06.4 (06.1)	08 30
					06 70
307			4.0	04.9 (05.3)	05 60
					05 00
308			4.6	04.3 (04.7)	× 1004 60
309			4.6	04.3 (04.1)	04 33

Sta 281 - 309 Rt Xsect. 7/3/23
circled figures obtained by Rt Xsect

300' Vc

- 4.733 %

- 0.271 %

-2.5
F 2.2

-2.9
FZ.7

-1.6
F1.9

-0.3
F 0.7

+0.1
F 0.3

+0.4
00

		1008.87			
310			4.6	04.7 04.3	04.06
+					
311		1008.87	4.6	04.7 04.3	03.79
T.P.	3.42	1004.71	4.58	1004.29	
+					
312			3.6	04.6 04.1	03.52
+					
313			4.1	03.9 03.6	03.25
+					
314			4.7	03.4 03.0	02.98
+					
315			5.1	03.0 02.6	02.71

-0.27

C0.7

C0.5

C0.6

C0.4

00

F0.1

1007.71

316 5.6 02.1 (02.1) −0.27 02.43

\+ +84.9 5.6 02.1 (02.6)

+84.9 END — Mont. MTH N-53 1002.2

USGS BM 5.18 1002.3 (1002.8)

F 0,3

F 0.1

1002.93 error 4 mi = 4 ft,

v Sta 281+317 - 7/13/23 = 0.08

	2.06	1002.06		1000.00	
	3.02	1001.59	4.02	998.04	
0+00					×998.60
+					
1				(98.2)	998.45
+					0.15
2				(98.2)	998.30
+					
3				(98.1)	998.15
+					
+75	Culv.				
4				(98.0)	×998.00
+					
5				(99.2)	998.00

00/15 00/15

-5.2/22.8 00/15 00/15 -1.5/17.3

-5.6/18.9 00/15 00/15 -2.9/19.2

36" CM 60'

-5.4/23.1 00/15 00/15 -0.5/15.7

-9.0/28.5 00/15 00/15 -1.2/16.9

1001 59

3.60 997 99

6 (98±) 998 00

+40± bridge

+ M H Sept. No 37 3/4 1 1/2 2

7 +06± bridge (98±) 998 00

+5°

8 (98±) 998 00

+

9 (98±) 998 00

+

10 (98±) 998 00

+

11 (98±) ×998 00

-3.1 19.6	00 15	00 15	-2.5 18.8
-5.3 23.0	00 15	00 15	-3.0 21
-5.8 23.1	00 15	00 15	-2.8 19.2
-5.3 23.0	00 15	00 15	-4.6 21.9
-4.6 21.9	00 15	00 15	-4.2 21.3
-3.5 20.2	00 15	00 15	-4.2 21.3

					997 99	
12					(98 3)	998 05
+						
13					(97 9)	998 10
+						
14					(98 2)	998 15
+						
15					(98 3)	× 998 21
+50						98 30
16					(98 1)	98 52
+50						98 87
17					(99 6)	99 34

+0.05 %

300 V C

-1.0 / 16.5	0.0 / 15	0.0 / 15	-4.5 / 21.8
-1.3 / 17.0	0.0 / 15	-4.7 / 22	
-0.7 / 15.7	0.0 / 15	-4.5 / 21.8	
	0.0 / 15	-4.1 / 21.2	
	0.0 / 15	0.0 / 15	-3.6 / 20.4
	0.0 / 15	0.0 / 15	-3.0

17 +50 99 94

18 (1000 6) ×1000 67

+

19 (02 1) 02 25

+

R0 (038) ×1003 83

+ 04 70

R1 (05.2) 04 72

+ 05 90

R2 1008.09 (07.1) 07 24

+ 08 73

R3 (10 1) 10.01

×1,5 83 %

400' VC

$\frac{-2.8}{19.2}$ $\frac{0.0}{15}$ $\frac{0.0}{15}$ $\frac{-3.0}{19.5}$

$\frac{-3.0}{19.5}$ $\frac{0.0}{15}$ $\frac{0.0}{15}$ $\frac{-2.9}{19.4}$

$\frac{-2.4}{18.6}$ $\frac{0.0}{15}$ $\frac{0.0}{15}$ $\frac{-2.3}{18.5}$

$\frac{0.0}{15}$ $\frac{+0.6}{23.6}$

$\frac{0.0}{15}$ $\frac{+1.0}{15}$

$\frac{+0.9}{15}$ $\frac{0.0}{15}$

6/28/23
Corrected grades

23 +50 — 12.19

24 — 1014.16 — (14.3) — × 1014.16

+

25 — 17.82 / 1018.06 — (18.3) — 17.74

+ — + 3.74%

26 — 21.56 / ~~1021.96~~ — (22.1) — + 3.58% — 21.32

+

27 — 25.30 / ~~1025.86~~ — (26.3) — 24.90

+

+87 culv - 15" CM 14' - 110cy Exc. 7 cy. clay.

28 — 29.04 / ~~1029.00~~ — (30.5) — 28.48

+

+75 — 31.90

29 — 33.2 — 32.72 / ~~1033.30~~ — (33.2) — 32.06

+2.6 +1.7 0.0
23.6 15

+1.4 0.0
26.4 25.0

+2.6 +1.8
23.6 26.8

+3.6 +5.0
25.6 30

+3.8 +6.4
28.8 30.4

+4.1 +5.0
29.1 30.0

Cov. 6/28
Grades

Prm	2.88	1043.34		1040.46	
29+50		34.37			
30	36.1	35.78 ~~1036.80~~		(35.9)	× 1035.64
+50		36.95			37.30
31	38.2	37.88 ~~1037.80~~		(38.1)	38.40
+50		38.57			39.30
32	39.2	39.02 ~~1038.80~~		(39.0)	39.73
+50		39.23			39.79
33	38.9	39.20 ~~1039.00~~		(38.9)	× 1039.47
+50		38.93			
+75		3871			
34		1038.50		(38.6)	38.40
	1.7	39.73	4.78	1038.56	
+					
35				(37.4)	37.43

500' VC

-1.016%

Moo' VC

+1.016%

FMC
5/15/23

+3.4 / 28.4

00/15

-1.6/17.4

-1.8/17.1

00/15

00/15

+3.6 / 28.6

00/15

00/15 -1.0/16.5

00/15

00/15

00/15

39.73

36		(36.2)	36.41
+			-.10 & 90
37		(35.8)	35.39
+50		(35.2)	x1034 90
38		(34.7)	34.54
+			34.48
+75	W 64 - 37' concrete.	400' VC	
39		(34.8)	34.71
+			35.74
40		(36.6)	36.07
+			37.21
41		(38.9)	38.63

FMC
5/16/23

-24/18.6

00/15

00/15 ✓

00/25 ✓

-4.5/21.8 ✓

-2.9/19.4

(M) Large ball of wire to be removed

-6.9/25.4

-7.8/26.7

-6.2/24.3 ✓

-5.0/22 ±

-3.9/20 ±

-3.3/20

	9 49	39 73 / 104 86 52	0 60	39 13	400 W/C
+50					× 1040 3
42				(42.4)	42 23
+					
43				(45.8)	45 96
	10 58	58 66	0 52	48 08	
+					
44				(49.2)	49.70
			1 36	57 30	+ 3.74 90
+	10 07	67 37			
45				(53.1)	53.44
+					
46				(57.5)	57 18
+					
47				(60.9)	60 92

FMC
5/16/23

-2.7/19.1 00/15	00/15	-1.3/17.0
-0.8/16.2 00/15	+2.2/15 00/15	00/25
+2.0/27.0	+3.0/15	+3.6/28.6
+3.9/28.9	+3/15	+6.6/31.6
+5.5/30.5	+4.4/15	+7.4/32.4
+2.9/27.9		+4.2/29.2

6137

+3.74/5

				(64.6)	
48			1.37	66.00	1064.66
	7.10	73.10			
+					66.35
49				(67.7)	67.70
+					68.70
50 TP			8.13	(68.9) 1064.82	69.30
+	7.70	1072.52			69.60
51				(69.3)	69.50
+				(69.0)	69.00
52				(68.3)	68.30
+					67.10
53				(65.7)	1065.67

500 - 1.10

FMC
5/16/23

+0.9/25.9 00/15 +0.5/25.5

+1.5/26.5 00/15 00/15 -0.8/16.2

-3.1/19.7 -3.8/20.7
PP mail on FP RT STA 53

00/15 00/5

+2.7/21.2

+0.8 -1.0
25.8 16.2 -2.0
18

-1.6/17.4 -3.2/19.7

53 — 107.52 — 106.67

54 — 10.20 — (62.4) 62.32 — -3.33% — 62.34
+10 — 2.35 — 106.67 — ×1062.00
+50 — 60.75

55 — (59.9) — 59.40

+50 — 300' VC — 59.00

56 — (57.5) — 57.67

+50 — 57.20
+65 — Culv W22 - 35' conc.

57 — (56.8) — 57.05
+10 — ×10 57.00
+

58 — (57.0) — 40 0/0 — 57.00
+

59 — (57.1) — ×10 57.00

(50)

FMC 5/17/23

00/15

00/15

+1.2/26.2

00/15

00/15

00/15

00/15

-4.3/21.5

00/15

00/15

+2.2
27.2

+1.6/26.6

		1062.67			
			6 8°	1057.87	
	46'	1062 52			
60				(56.5)	56.85
+					
61				(56.6)	× 1056 11
+					56.44
BM +20	36 4	1062 48		1058 84	
62				(56.0)	55.77
+					54.70
63				(52.6)	53.22
+					51.30
64				(48.2)	× 1049 00
+ 50				(45.9)	48 50
65	0 41	1050 89	12 00	1056 48	1044 00
				(43.7)	

- 0.14 - 70
300' VC
- 5.00 00

FMC 5/17/23

00/15

-1.8/17

00/15

-1.9/17

spike in juice post.
+2.6/27

00/15

+3.6/28

+2.7/27

+8.5/33 +47

+8.8/33

+11.2/36 +32

+10°/35°

+11°/36°

Ave 3 Hour Hood 4/25

+5.5/30

		1050 89			
	043	1039 44	1188	1039 01	
+50				(41.3)	41.5
	069	1028 33	1180	1027 64	
66	182	1018 55	1160	1016 73	1039 00
				(39.0) →	
+50					36.50
67				(34.3)	1034 00
+					
68				(28.9)	1029 00
+				500 %	
				1	
69				(24.0)	1024 00
+					
70				(19.1) ×	1019 00
+				400 VC	16 60
71				(15.2)	14 70

5E

FMC 5/17/23

+1.7/26.1	+2.0	00/21
+4.9/29.9	+0.7	00/15
+0.5/25.5	-1.3	+0.7/25.7
-2.7/19.2		-3.4/20.1
-7.9/26.9	-4.0	-9.2/28.8
-6.0/24.0	-4.0	-7.9/26.9
-6.0/24.0	-2.5	-7.3/25.9 (27.9)
-5.2/22.8		-4.6/21.9 (25.3)

		618 J-			
	3 15-	1012 42		9 28 1009 27	
+50					12.90
72 Bm			4.05-	(11.6) 1008.37	11.30
+					10.20
73				(09.2)	09.30
+					08.70
74				(08.2)	* 1008 41
+					
75				(07.6)	08 11
+					
76				(07.0)	07 82
+					
77				(77.3)	07 52

400 VC

- 0.29 50

53

FMC 5/17/23

-1.3/17°
slight on culvert

-1.5/17?

00/15

-0.7

00/15

00/15

00/15

-1.1/16?

-1.0

00/15

-3.8/20?

-4.0/21°

-2°/18°

-2.6/18?

			grade change 2/16/73		
77+20	culv.	1012.42	3.58	1008.84	-0.225 %
+50	987	1018.71	07.38		
78			07.39	(07.2)	07.23
+50			07.72	200' VC	07.20
79			08.37	(08.0)	07.41
+50			09.35		07.82
80			10.49	(10.1)	08.49
+50					09.38
81			12.77	(12.6)	10.51
+50				300' VC	11.88
82			15.04	(14.5)	13.45
+50			16.31	200' VC	15.28
83			17.84	(17.6)	17.32

Circled notes
Abandon

4177
442

FMC 5/17/23

W 10-4-33 with railing

Note railing should be removed from this culv and reset to alignment.

00/15 00/15

-3.6/20.4 00/15 00/15 -3.4/20.4

00/15 00/15 -2.0/18.0

+0.6/20.6 -0.5/15.1 00/15 -00/15 -0.6/15.9 +0.5/25.5

00/15 00/15.5 +0.4/15

+2.6/27.8 00/15 00/15 +2.2/27.2

+3.1/28 00/15 00/15 +2.9/27.9

+1.2/26.2 00/15 00/15 +1.2/26.2

00/15 00/15

00/15 00/15 -1.0/16.5

Grade change 7/16/23

1018.71

BM			−0.04	1018.67		
+50	1.06	1028.73	1019.63			19 49
			0.28	1028.45		
84	1.73	1020.18	1021.66	(20.7)		21 66
+50				(23.0)		23 82
85				(25.3)		25 99
+50						28 16
86				(30.1)		30 32
+35	Culv.				+3.33	
+50						32 49
87				(34.8)		34 66
+225	B.T.S.					35 64
+50						36 83
+125	B.C.			(38.0)		37 80

55

Finc 5/17/23

-12/80

-1.3/17 00/15 00/15 -1.1/12.6

-2.2/18.3

-0.9/16.4

-2-/18.2

00/15

-3-/19.2

-2.0/18.0

W 65°-32'

00/15

00/15

+1.5/26.5

+3.1/28.1

set 5/10/23

Equation 120+55.3 = 113+59.2

113+59.2 (73.7) 72.75

B.M. 2.57 1074.38 1071.81

114+03.9 (72.8) × 102.34

+50

115 (71.4) 71.30

+ × -0.988/50

116 (70.5) × 70.50

+

117 (69.3) 69.50

+

118 (68.3) → 68.50

44.7
59.2
103.9

56

7-16-73
HW. 7.C
E-12-W 70.2

Spike on 15" OAK - Lt of Sta -116+10 - 45' out.

-0.8/16.2 00/15 level ect. 00/15 -0.5/15.7

2.0/80

+0.9/25.9 00/15 3.2/80 00/15 +0.5/25.2

00/15 4.1/80 00/15 +0.2/25.2

00/15 5.2/80 00/15

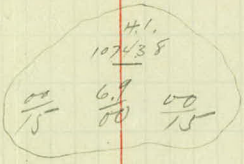
00/15 6.1/80 +0.0/15

	+	H.I.	-	Elev.	
B.M	1.12	1073.93		1072.81	
118+75			6.3		
119			6.5	67.4 ±	67.50
120			7.4	66.5	66.50
T.P.	2.70	1069.33	7.30	1066.63	
121			3.7	65.6	65.50

0.988

(cont on P. 7)

at Sta ~~116+10~~ 115+65 on Left 15" Oak



BMs (from) PLANS

Sta.	Description	Elev.	
-0+20	60 ft Lt. Spike in 30" Hack	1000.00	Assumed
30+30	33 ⌐ Rt. ⌐ ⌐ F.P.	1040.46	on Abandoned Location
92+00	42 ⌐ Rt. ⌐ ⌐ 10" Oak	1062.76	
116+00	48 ⌐ Lt. ⌐ ⌐ 15" oak	1071.81	
128+40	40 ⌐ Lt ⌐ ⌐ F.P.	1052.49	
158+00	45 ⌐ Rt ⌐ ⌐ F.P.	1065.62	
184+75	50 ⌐ Lt. ⌐ ⌐ F.P.	1066.38	
198+60	℄ So. Rail C&W Ry	1065.05	
230+55	35' Rt Spike in 36" Cot. Cw.	1066.19	
292+65	30' Rt ⌐ ⌐ 10" Oak	1018.79	
317+15	Lt. Top USGS Pipe	1002.93	
114+70	50' Lt Spike in oak	1079.22	79.38
109	60 Rt	1062.26	62.26
53	R.P. nail in FP Rt.	1064.82	
61+70	Spike in F.P. Rt.	1058.84	
774	W. End Culv. Re. Con. top Concrete	1008.38	
83	So gate post Lt	1018.67	
48+70			

BMs.

Sta	-	Location	—	Elev.
99+60	-	Nail in tree 40 ft. Rt.	—	1069.25

BIMs

32.60
11.03
43.63
42.7
1.4
43.63
43.63
36.1
7.5
7.7
43.63
34.9
8.7
40.97
40.97
2.60
38.37 T.P.
5.09
43.46
8.32
32.60
40.92
28.6
32.60
8.57
2.3
40.97 HS
23.4
5.6
4.26
4.35
7.2
36.1
39.9
10.3

ALIGNMENT

From

PLANS & Note Books

4

Sta	PT	Lt. Δ Tgt.		
				N5°-56' W
52+83	PI	0°-04'		Stone Mont.
51+00	POT			
				N5°-52' W
30+00	PI		0°-08'	
				N6°-00' W
0+00				Sec. Corner

60

13

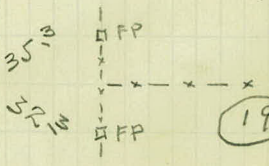
18

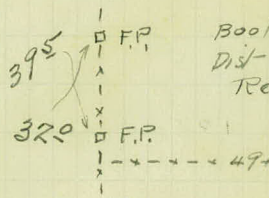
Sec Cor.

24

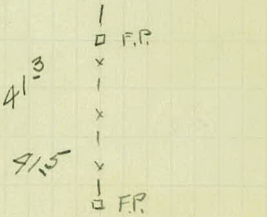
19

EMPIRE Twp.





Book 79 P4
Dist to ties
Reversed



VERMILLION Twp.

Sec. 24

18 maple

50.3

Sec. 19

Sec. 25

65.4

Sec. 30

18" Maple

Sta.	PT	Lt. Δ Rt	
+50		8-52½	
89		6-22½	
+50		3-52½	
88		1-22½	
87+72.5	BC	00	
83+00	POT		
			N5°56'W
64+48.0	POT		
52+83.0	PI	(Repeated)	Sec Cor.

Empire Twp

12" oak 62.3 30.0 6" oak

RPs on Gate Posts

F.P.

FE

32.12

28.6

F.P.

hub & Stake

100.0

39.2

43.10

100.0

hub & Stake

F.P.

N.G.

F.P. Found

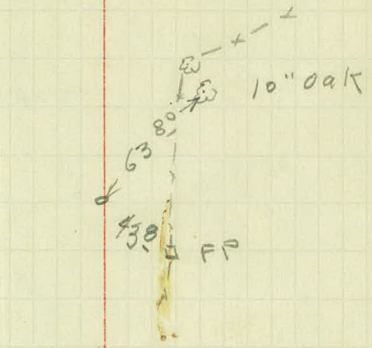
Empire Twp.

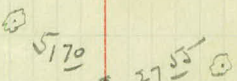
Vermillion Twp.

13 18

24 19

Sta		Lt	Δ	Tan	
				6-45	
+50					
100				4-15	
+50				1-45	
99+15.0	BC			00	
					N55°-56' W
+72.5	EC	25-00			
+50		23-52½			
92		21-22½			
+50		18-52½			
91		16-22½			
+50		13-52½			
90		11-22½			





Empire Twp

Sta	PT	Lt. Δ	Rt.
109			39-15
+50			36-45
106			34-15
+50			31-45
105	POC on Colv.		29-15
+50			26-45
104			24-15
+50			21-45
103			19-15
+50			16-45
102			14-15
+50			11-45
101			9-15

Empire Twp

Sta	PT.	Lt. ∅ Rt.		
+50		14-49		
118		12-19		
+50		9-49		
117		7-19		
+50		4-49		
116		2-19		
115+53.6	BC	00		
				N44°-04 E
+15.0	EC		50-00	
109			49-15	
+50			46-45	
108			44-15	
107+50			41-45	

EMPIRE Twp.

32 20 ⊕ 12" oak

46 10

⊕ 12" oak

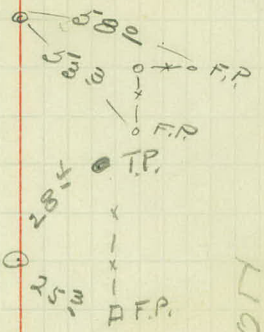
⊕ 60 10 12" Maple

39 10 ⊕ 14" oak

Sta.	PT	Lt. Δ Rt.	
			N6°00'W
158+28.9	PI	0°10'	
142+00	POT		
			N6°10' W
116+00	PI	0°14' ~~0°04'~~	
			N6°06' W

Equation Sta 120+55.3 = 113+59.2

+55.3	EC	25-05
120		22-19
+50		19-49
119		17-19



VERMILLION Twp.

15" Oak ⊖ 48.5

15" Oak ⊖ 71

EMPIRE Twp.

56 10

7th F.P. from Cor.

5 - 10

12" oak F. Cor. tie 5.5 ft. above ground.

Sta.	P.T.	Lt. △ Rt.	
238+00	P.O.T.		
216+00	POT		
			N5°55'W
211+16.5	P.I.	0°05	Sec. Cor. 1½" Iron Pipe
198+96.5	POT		
			N26°00W
184+75.0	POT		

ROSEMOUNT Twp.

MINNIESTER Twp.

EMPIRE Twp.

VERMILLION Twp.

18" Tree

38

15" Ash

35.4

18" Cotton Wood

56.5

F.P.

T115N R19W

S.E. Cor. Cement post

36

31

T115N R18W

T114N R19W

1

6

16" Maple

16" Maple

T114N R18W

mail pouch rack

59.8

66

TP

F.P.

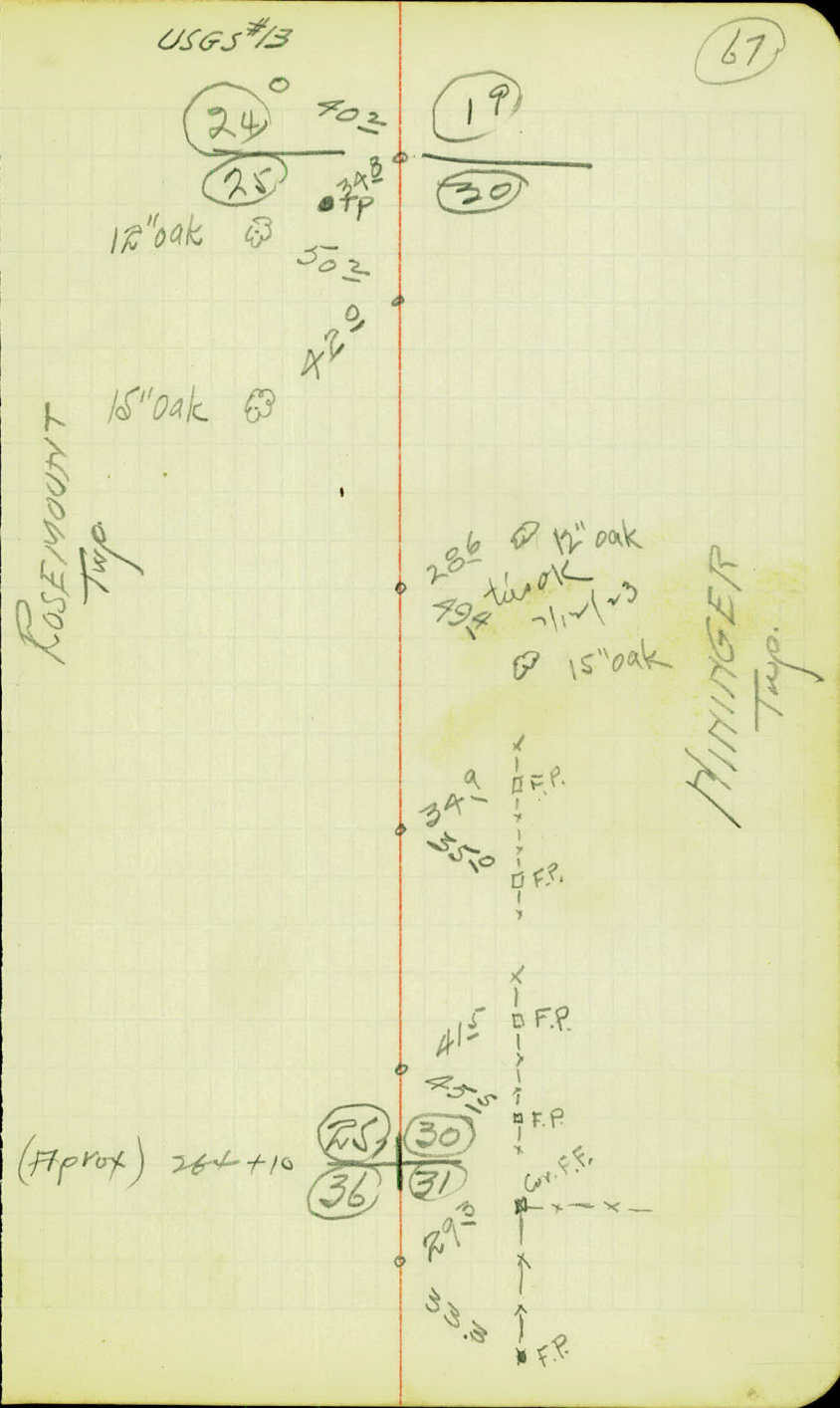
35.8

50.5

F.P.

Sta	PT	Lt. Δ	Rt. Δ	
316+84 ±	Sec Cor.			N05°12'W
299+[illegible]	POT			
293+00	POT			
285+51	POT			N05°12'W
283+00	PI	0°-04'		
				N05°-08'W
256+00	PI		0°-47'	
				N5°55'W

USGS #13


24
19
25
30
40±
34.8
FP
12" oak
50±
42.0
15" oak
ROSEMOUNT
Twp
28.6
12" oak
49.4
tie oak
15" oak
MINNEGER
Twp.
34.9
F.P.
55.0
F.P.
41.5
F.P.
45.1
F.P.
T.15
30
(Approx) 264+10
36
31
Cr. F.P.
29.3
F.P.

0+00

+

1+00

+30

1

2+00

3+00

4+00

5+00

6+00

6+37 bridge Hor. Sec.

Grade Scale

	-0.8 / 25	-0.5 / 0.0	-0.7 / 15	
-3.2 / 22	-0.8 / 15	-0.7 / 00	-1.3 / 15	-5.3 / 24
-3.2 / 22.8	-1.1 / 15	-0.9 / 100	-1.1 / 15	-1.5 / 17.8
-2.6 / 18.9	-0.7 / 15	-0.6 / 00	-0.9 / 15	-2.8 / 19.2
-3.4 / 23.1	-1.7 / 15	-0.4 / 00	-0.6 / 15	-0.5 / 15.7
→ -9.0 / 28.2	-1.7 / 15	-0.8 / 00	-1.4 / 15	-1.2 / 16.8
-3.1 / 19.6	-1.9 / 15	-1.2 / 00	-2.1 / 15	-2.5 / 18.8
-4.0 / 33	-3.4 / 21	-2.0 / 14	-1.2 / 9	-0.8 / 6
	-0.9 / 11	-2.8 / 15	-3.0 / 19	-4.0 / 33

	+	H.I.	−	Elev.	6/19/2 HW
BM	1.08	1001.08			1000.0
	5.60	999.28	7.40	993.68	
			9.72	989.56	

(Grade Rod = 7.7)

1+00

01+30

01+75

02+00

02+50

03

03+35 999.28

Rt Lt. (70)

Stakes set 2-ft above Water Elevation

Water Elevation

+6.0 +2.6
+5.7 1.7 0.1 +2.6 2.2
66.4 40 30 17 06

(230.0)

191

S +0.4 S
+5.6 7.3 +1.2 1.8
66.2 33 15 00

No. 4 This line is 15' Rt. of ℄ of Road. Dist. are measured to the Pi- from here. (114.0)

142

S
+1.2 +1.5 2.0
57.4 15 00

(56)

55

191
142
55
104
140
130
10
772 cu yds.

+1.0 +2.0 2.1
56.0 15.0 00

(62)

104

S +2.0 S +0.5
+1.4 5.7 0.72 2.6
57.8 40 2.375 00

(50)

140

+2.2 S
+2.7 5.5 +0.4 2.0
60.4 25 15 00

(101)

130

+3.9 +2.0 +0.7 S
+2.1 4.8 5.7 7.0 +2.0 2.0
59.2 2.8 2.0 1.8 1.5 00

(100)

110

	+	H.I.	−	Elev.
		999.28		6/19/43 HW
03+40				
	7.26	998.82	7.72	991.56
03+50			9.23	989.59
		Grade Rod = 7.2		
04+00	Hdr.	Section.		
04+50				
05+00				
05+50				
06+00				
06+45				
		998.87	9.18	989.64

71

PC 1

Stakes set

S S
00 00
59.2 25

L+

Two ft. above Water Elevation

0

Water Elevation

0

S +2.5 +2.2 S
+1.2 4.7 5.0 00
59.4 4.5 22 17

82

76
121
107
119
157
89

121

S +1.4 0.0 S
+1.7 5.8 7.2 00 2.6
58.4 30 23 15 00

49

593 cu yds
772 " "

107

S +2.5 +1.5 +0.6 0.0 S
2.3 4.7 5.7 6.6 7.2 00 2.1
59.4 4.7 3.7 2.8 2.3 1.6 1.0 Total 1365 " "

66

119

S +2.1 +0.3 S
+2.0 5.1 6.9 +0.5 2.0
59 3.8 23 15 00

63

157

S S
+2.2 +2.6 30
59.4 15 00

107

89

S S
00 00
55 15

0

Water Elevation

	+	H.I.	-	Elev.	6/16/22 HW
B.M.	0.86	1000.86		1000.00	
0+00					
0+50					
0+75					
01					
01+30					
+75					
02					

Rt. (72)

Borrow Pit Proj - 2V00

on right from Sta 00+00 to 6+

Base line run 85 ft. E of road from ℄

1000.9 HI
89.5 WL
11.4 Rod.

2.8 / 00

2.7 / 70 — 3.2 / 23 — 3.8 / 00

3.0 / 70 — 3.6 / 35 — 6.7 / 23 — 6.5 / 10 — 3.4 / 00

2.9 / 70 — 6.7 / 53 — 6.5 / 38 — 3.3 / 30 — 2.6 / 00

3.3 / 73 — 8.5 / 57 — 8.8 / 38 — 4.7 / 20 — 3.9 / 00

3.5 / 70 — 7.1 / 55 — 8.0 / 12 — 8.7 / 00

3.7 / 70 — 7.3 / 55 — 9.4 / 00

	+	H.I.	−	Elev.	6/16/33
		1000.86			
02+25					
03		1000.86			
T.P.	5.22	997.67	8.41	992.45	
03+35					
+45			8.16	989~	
03+50					
3+92					
04					
04+25					

Lt. Rt.

water level Rd 11.7

3.7/70 5.6/56 8.7/21 7.4/00

3.7/70 8.6/60 9.0/50 7.1/45 6.5/40

0.50/70 5.4/50 3.3/45 6.3/00

Level Section 8.16 Water reading Elev 989.5

4/16/23

Water Level Section

0.20/70 5.7/52 4.1/48 3.7/25 4.9/14 5.6/00

0.40/70 5.5/55 5.9/50 4.4/40 3.9/00

	+	H.I	-	Elev.	6/16/77
		997.67			
05					
05+50					
06					
06+40					
06+45		997.67	8.11	989.56	

0.8	5.9	6.4	5.4	4.4	3.8
70	56	50	40	30	00

1.0	5.5	5.7	4.3	4.7
70	57	47	36	50

2.0	3.3	3.8
70	58	00

94.1	98.2
3.0	46
70	50

Level Section

8.11 Water reading

Sta	Rt or Lt	Kind	Length
31+50	Lt	15" C.M.	
28			
27+90	Rt.	15" C.M.	

Gravel in Cut

Outfit in Camp 6/28-23
14 wheelers
10 dumpwagons
17 teams.
8 fresnos
6 slips
1 Elec. Grader.

	+	+1.	-	Gdds.	
B.M.	169	1063.95			1062.26
108+10				52.3	
107+80				51.8	
107+50				51.3	
	2.24	1056.95	9.24		1054.71
107				50.8	
106+50				50.3	
106				49.8	
105+50				49.1	
105+40				47.1	

Lt. Rt.

Drain on Rt. Sta 108 to 105

108+50 = Zero Excav.

+3.4 / 4.9 — +3.6 — +4.7 / 6.7

+1.7 / 3.2 — +2.4 / 3.2 — +3.3 / 4.8

Cut at end of Culv.

+1.8 / 2.5 — +1.4 / 2.9

+0.7 / 2.2 — +0.7 / +0 — +0.7 / 2.2

+0.4 / 1.9 — +0.4 / +0 — +0.3 / 1.8

+0.5 / 2.0 — +0.5 / +0 — +0.5 / 2.0

+0 / 1.5 — +0 / +0 — +0.4 / 1.9

equals 0.0 excavation

Note ditch is staked out with a 3' bottom slopes 1 to 1.

After plotting these section on X sect. of Plan. Yardage shows less than has been figured.

Ditch 26 Ft. left of Road

No Yardage is to be allowed for this Excav. it has been included in X sect. computations.

Culv. Notes Sta 105+00

+5

105+90

Upper end		9.8	47'
Lower ✓		10.6	
+100 ft		11.3	

culverts required 9/16/23

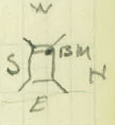
116+00	Lt.	15" C.M.
117+50	Lt.	15" C.M.

Ck Levels 5/7/28 FMC

Sta	+	H.I.	−	Elev.	
BM	2.03	1062.40		1060.37	
TP	0.90	1050.38	12.92	1049.48	
P	0.90	1039.01	12.27	1038.11	
TP	0.30	1027.47	11.84	1027.17	
BM			9.05	1018.42	1018.67 ✓
P	0.01	1015.56	11.92	1015.55	
BM	5.05	1013.18	7.43	1008.13	1008.38
P	12.18	1023.02	2.34	1010.84	
P	11.40	1034.22	0.20	1022.82	
TP	12.34	1046.29	0.27	1033.95	
TP	10.37	1056.38	0.28	1046.01	
TP	6.53	1061.84	1.07	1055.31	
BM			3.25	1058.59	1058.84 ✓
TP	9.77	1067.61	4.20	1057.64	
BM			2.84	1064.57	1064.92 ✓
TP	5.43	1072.54	.30	1067.11	
TP	1.62	1064.81	9.35	1063.19	
P	0.01	1053.57	12.25	1053.56	
P	0.02	1040.44	12.95	1040.42	
BM			7.84	1032.60	
TP	5.18	1043.66	1.96	1038.48	
BM			3.21	1040.19	4046 ✓

So. Gate Post Rt. Sta. 83

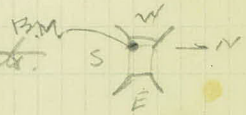
W. end of culvert N. Cor. top of Concrete



Nail in F.P. Rt. Sta 61+65

Sta 53 R

W. end Culv. So. Cor. of top of Concrete.



Rt Sta 30

Emmans & Atkison
Anoka - Minn.

KEITH'S RAILROAD CURVE TABLES.

Published by KEUFFEL & ESSER CO., New York.

HOW TO USE KEITH'S TABLES.

EXAMPLE.

Wanted a Curve with an Ext. of about 12 ft. Angle of Intersection or I. P.=23° 20′ to the R. at Station 542+72.

Ext. in Tab. IV opposite 23° 20′=120.87
120.87÷12=10.07. Say a 10° Curve.

Tan. in Tab. IV opp. 23° 20′=1183.1
1183.1÷10=118.31.

Tab. V. correction for A. 23° 20′ for a 10° Cur.=0.16
118.31+0.16=118.47=corrected Tangent.

(If corrected Ext. is required find in same way)
Ang. 23° 20′=23.33°÷10=2.3333=L. C.

2° 19½′=def. for sta.	542	I. P.=sta.	542+72
4° 49½′= " " "	+50	Tan.=	1.18.47
7° 19½′= " " "	543	B. C.=sta.	541+53.53
9° 49½′= " " "	+50	L. C.=	2.33.33
11° 40′= " " "	543+	E. C.=sta.	543+86.86
	86.86		

100—53.53=46.47×3′(def. for 1 ft. of 10° Cur.)=139.41′=
2° 19½′ =def. for sta. 542.

Def. for 50 ft.=2° 30′ for a 10° Curve.

Def. for 36.86 ft.=1° 50½′ for a 10° Curve

(These tables are published in Field Books of KEUFFEL & ESSER Co., New York, N. Y.)

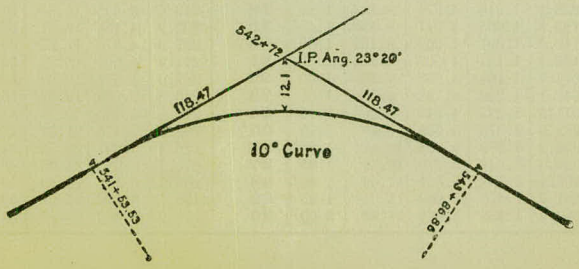


TABLE I. — Minutes in Decimals of a Degree.

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. — Radii, Ordinates and Deflections.

Deg.	Radius	Mid. Ord.	Tan. Def.	Chd. Def.	Def. for 1 Foot	Deg.	Radius	Mid. Ord.	Tan. Def.	Chd. Def.	Def. for 1 Foot
0° 10′	34377.	.036	.145	.291	0.05′	7°	819.0	1.528	6.105	12.21	2.10′
20	17189.	.073	.291	.582	0.10	20′	781.8	1.600	6.395	12.79	2.20
30	11459.	.109	.436	.873	0.15	30	764.5	1.637	6.540	13.08	2.25
40	8594.4	.145	.582	1.164	0.20	40	747.9	1.673	6.685	13.37	2.30
50	6875.5	.182	.727	1.454	0.25	8	716.8	1.746	6.976	13.95	2.40
1	5729.6	.218	.873	1.745	0.30	20	688.2	1.819	7.266	14.53	2.50
10	4911.2	.255	1.018	2.036	0.35	30	674.7	1.855	7.411	14.82	2.55
20	4297.3	.291	1.164	2.327	0.40	40	661.7	1.892	7.556	15.11	2.60
30	3819.8	.327	1.309	2.618	0.45	9	637.3	1.965	7.846	15.69	2.70
40	3437.9	.364	1.454	2.909	0.50	20	614.6	2.037	8.136	16.27	2.80
50	3125.4	.400	1.600	3.200	0.55	30	603.8	2.074	8.281	16.56	2.85
2	2864.9	.436	1.745	3.490	0.60	40	593.4	2.110	8.426	16.85	2.90
10	2644.6	.473	1.891	3.781	0.65	10	573.7	2.183	8.716	17.43	3.00
20	2455.7	.509	2.036	4.072	0.70	30	546.4	2.292	9.150	18.30	3.15
30	2292.0	.545	2.181	4.363	0.75	11	521.7	2.402	9.585	19.16	3.30
40	2148.8	.582	2.327	4.654	0.80	30	499.1	2.511	10.02	20.04	3.45
50	2022.4	.618	2.472	4.945	0.85	12	478.3	2.620	10.45	20.91	3.60
3	1910.1	.655	2.618	5.235	0.90	30	459.3	2.730	10.89	21.77	3.75
10	1809.6	.691	2.763	5.526	0.95	13	441.7	2.839	11.32	22.64	3.90
20	1719.1	.727	2.908	5.817	1.00		425.4	2.949	11.75	23.51	4.05
30	1637.3	.764	3.054	6.108	1.05	14	410.3	3.058	12.18	24.37	4.20
40	1562.9	.800	3.199	6.398	1.10	30	396.2	3.168	12.62	25.24	4.35
50	1495.0	.836	3.345	6.689	1.15	15	383.1	3.277	13.05	26.11	4.50
4	1432.7	.873	3.490	6.980	1.20	30	370.8	3.387	13.49	26.97	4.65
10	1375.4	.909	3.635	7.271	1.25	16	359.3	3.496	13.92	27.84	4.80
20	1322.5	.945	3.718	7.561	1.30	30	348.5	3.606	14.35	28.70	4.95
30	1273.6	.982	3.926	7.852	1.35	17	338.3	3.716	14.78	29.56	5.10
40	1228.1	1.018	4.071	8.143	1.40	18	319.6	3.935	15.64	31.29	5.40
50	1185.8	1.055	4.217	8.433	1.45	19	302.9	4.155	16.51	33.01	5.70
5	1146.3	1.091	4.362	8.724	1.50	20	287.9	4.374	17.37	34.73	6.00
10	1109.3	1.127	4.507	9.014	1.55	21	274.4	4.594	18.22	36.44	6.30
20	1074.7	1.164	4.653	9.305	1.60	22	262.0	4.814	19.08	38.16	6.60
30	1042.1	1.200	4.798	9.596	1.65	23	250.8	5.035	19.94	39.87	6.90
40	1011.5	1.237	4.943	9.886	1.70	24	240.5	5.255	20.79	41.58	7.20
50	982.6	1.273	5.088	10.18	1.75	25	231.0	5.476	21.64	43.28	7.50
6	955.4	1.309	5.234	10.47	1.80	26	222.3	5.697	22.50	44.99	7.80
10	929.6	1.346	5.379	10.76	1.85	27	214.2	5.918	23.35	46.69	8.10
20	905.1	1.382	5.524	11.05	1.90	28	206.7	6.139	24.19	48.38	8.40
30	881.9	1.418	5.669	11.34	1.95	29	199.7	6.360	25.04	50.07	8.70
40	859.9	1.455	5.814	11.63	2.00	30	193.2	6.583	25.88	51.76	9.00

TABLE IV. — Tangents and Externals to a 1° Curve.

Angle	Tangent	External	Angle	Tangent	External	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.

Angle	Tangent	External	Angle	Tangent	External	Angle	Tangent	External
31°	1589.0	216.3	**41°**	2142.2	387.4	**51°**	2732.9	618.4
10′	1598.0	218.7	10′	2151.7	390.7	10′	2743.1	622.8
20	1606.9	221.1	20	2161.2	394.1	20	2753.4	627.2
30	1615.9	223.5	30	2170.8	397.4	30	2763.7	631.7
40	1624.9	226.0	40	2180.3	400.8	40	2773.9	636.2
50	1633.9	228.4	50	2189.9	404.2	50	2784.2	640.7
32	1643.0	230.9	**42**	2199.4	407.6	**52**	2794.5	645.2
10	1652.0	233.4	10	2209.0	411.1	10	2804.9	649.7
20	1661.0	235.9	20	2218.6	414.5	20	2815.2	654.3
30	1670.0	238.4	30	2228.1	418.0	30	2825.6	658.8
40	1679.1	241 0	40	2237.7	421.4	40	2835.9	663.4
50	1688.1	243.5	50	2247.3	425.0	50	2846.3	668.0
33	1697.2	246.1	**43**	2257.0	428.5	**53**	2856.7	672.7
10	1706.3	248.7	10	2266.6	432.0	10	2867.1	677.3
20	1715.3	251.3	20	2276 2	435.6	20	2877.5	682.0
30	1724.4	253.9	30	2285.9	439.2	30	2888.0	686.7
40	1733.5	256.5	40	2295.6	442.8	40	2898.4	691.4
50	1742.6	259.1	50	2305.2	446.4	50	2908.9	696.1
34	1751.7	261.8	**44**	2314.9	450.0	**54**	2919.4	700.9
10	1760.8	264.5	10	2324.6	453.6	10	2929.9	705.7
20	1770.0	267.2	20	2334.3	457.3	20	2940.4	710.5
30	1779.1	269.9	30	2344.1	461.0	30	2951.0	715.3
40	1788.2	272.6	40	2353.8	464.6	40	2961.5	720.1
50	1797.4	275.3	50	2363.5	468.4	50	2972.1	725.0
35	1806.6	278.1	**45**	2373.3	472.1	**55**	2982.7	729.9
10	1815.7	280.8	10	2383.1	475.8	10	2993.3	734.8
20	1824.9	283.6	20	2392.8	479.6	20	3003.9	739.7
30	1834.1	286.4	30	2402.6	483.8	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
36	1861.7	294.9	**46**	2432.1	494.8	**56**	3046.5	759.6
10	1870.9	297.7	10	2441.9	498.7	10	3057.2	764.6
20	1880.1	300.6	20	2451.8	502.5	20	3067.9	769.7
30	1889.4	303.5	30	2461.7	506.4	30	3078.7	774.7
40	1898.6	306.4	40	2471.5	510.3	40	3089.4	779.8
50	1907.9	309.3	50	2481.4	514.3	50	3100.2	784.9
37	1917.1	312.2	**47**	2491.3	518.2	**57**	3110.9	790.1
10	1926.4	315.2	10	2501.2	522.2	10	3121.7	795.2
20	1935.7	318.1	20	2511.2	526.1	20	3132.6	800.4
30	1945.0	321.1	30	2521.1	530.1	30	3143.4	805.6
40	1954.3	324.1	40	2531.1	534.2	40	3154.2	810.9
50	1963.6	327.1	50	2541.0	538.2	50	3165.1	816.1
38	1972.9	330.2	**48**	2551.0	542.2	**58**	3176.0	821.4
10	1982.2	333.2	10	2561.0	546.3	10	3186.9	826.7
20	1991.5	336.3	20	2571.0	550.4	20	3197.8	832.0
30	2000.9	339.3	30	2581.0	554.5	30	3208.8	837.3
40	2010.2	342.4	40	2591.0	558.6	40	3219.7	842.7
50	2019.6	345.5	50	2601.1	562.8	50	3230.7	848.1
39	2029.0	348.6	**49**	2611.2	566.9	**59**	3241.7	853.5
10	2038.4	351.8	10	2621.2	571.1	10	3252.7	858.9
20	2047.8	354.9	20	2631.3	575.3	20	3263.7	864.3
30	2057.2	358.1	30	2641.4	579.5	30	3274.8	869.8
40	2066.6	361.3	40	2651.5	583.8	40	3285.8	875.3
50	2076.0	364.5	50	2661.6	588.0	50	3296.9	880.8
40	2085.4	367.7	**50**	2671.8	592.3	**60**	3308.0	886.4
10	2094.9	371.0	10	2681.9	596.6	10	3319.1	892.0
20	2104.3	374.2	20	2692.1	600.9	20	3330.3	897.5
30	2113.8	377.5	30	2702.3	605.3	30	3341.4	903.2
40	2123.3	380 8	40	2712.5	609.6	40	3352.6	908.8
50	2132 7	384.1	50	2722.7	614.0	50	3363.8	914.5

TABLE IV. — Tangents and Externals to a 1° Curve.

Angle	Tangent	External	Angle	Tangent	External	Angle	Tangent	External
61°	3375.0	920.2	**71°**	4086.9	1308.2	**81°**	4893.6	1805.3
10′	3386.3	925.9	10′	4099.5	1315.6	10′	4908.0	1814.7
20	3397.5	931.6	20	4112.1	1322.9	20	4922.5	1824.1
30	3408.8	937.3	30	4124.8	1330.3	30	4937.0	1833.6
40	3420.1	943.1	40	4137.4	1337.7	40	4951.5	1843.1
50	3431.4	948.9	50	4150.1	1345.1	50	4966.1	1852.6
62	3442.7	954.8	**72**	4162.8	1352.6	**82**	4980.7	1862.2
10	3454.1	960.6	10	4175.6	1360.1	10	4995.4	1871.8
20	3465.4	966.5	20	4188.5	1367.6	20	5010.0	1881.5
30	3476.8	972.4	30	4201.2	1375.2	30	5024.8	1891.2
40	3488.3	978.3	40	4214.0	1382.8	40	5039.5	1900.9
50	3499.7	984.3	50	4226.8	1390.4	50	5054.3	1910.7
63	3511.1	990.2	**73**	4239.7	1398.0	**83**	5069.2	1920.5
10	3522.6	996.2	10	4252.6	1405.7	10	5084.0	1930.4
20	3534.1	1002.3	20	4265.6	1413.5	20	5099.0	1940.3
30	3545.6	1008.3	30	4278.5	1421.2	30	5113.9	1950.3
40	3557.2	1014.4	40	4291.5	1429.0	40	5128.9	1960.2
50	3568.7	1020.5	50	4304.6	1436.8	50	5143.9	1970.3
64	3580.3	1026.6	**74**	4317.6	1444.6	**84**	5159.0	1980.4
10	3591.9	1032.8	10	4330.7	1452.5	10	5174.1	1990.5
20	3603.5	1039.0	20	4343.8	1460.4	20	5189.3	2000.6
30	3615.1	1045.2	30	4356.9	1468.4	30	5204.4	2010.8
40	3626.8	1051.4	40	4370.1	1476.4	40	5219.7	2021.1
50	3638.5	1057.7	50	4383.3	1484.4	50	5234.9	2031.4
65	3650.2	1063.9	**75**	4396.5	1492.4	**85**	5250.3	2041.7
10	3661.9	1070.2	10	4409.8	1500.5	10	5265.6	2052.1
20	3673.7	1076.6	20	4423.1	1508.6	20	5281.0	2062.5
30	3685.4	1082.9	30	4436.4	1516.7	30	5296 4	2073.0
40	3697.2	1089.3	40	4449.7	1524.9	40	5311.9	2083.5
50	3709.0	1095.7	50	4463.1	1533.1	50	5327.4	2094.1
66	3720.9	1102.2	**76**	4476.5	1541.4	**86**	5343.0	2104.7
10	3732.7	1108.6	10	4489.9	1549.7	10	5358.6	2115.3
20	3744.6	1115.1	20	4503.4	1558.0	20	5374.2	2126.0
30	3756.5	1121.7	30	4516.9	1566.3	30	5389.9	2136.7
40	3768.5	1128.2	40	4530.4	1574.7	40	5405.6	2147.5
50	3780.4	1134.8	50	4544.0	1583.1	50	5421.4	2158.4
67	3792.4	1141.4	**77**	4557.6	1591.6	**87**	5437.2	2169.2
10	3804.4	1148.0	10	4571.2	1600.1	10	5453.1	2180.2
20	3816.4	1154.7	20	4584.8	1608.6	20	5469.0	2191.1
30	3828.4	1161.3	30	4598.5	1617.1	30	5484.9	2202.2
40	3840.5	1168.1	40	4612.2	1625.7	40	5500.9	2213.2
50	3852.6	1174.8	50	4626.0	1634.4	50	5517.0	2224.3
68	3864.7	1181.6	**78**	4639.8	1643.0	**88**	5533.1	2235.5
10	3876.8	1188.4	10	4653.6	1651.7	10	5549.2	2246.7
20	3889.0	1195.2	20	4667.4	1660.5	20	5565.4	2258.0
30	3901.2	1202.0	30	4681.3	1669.2	30	5581.6	2269.3
40	3913.4	1208.9	40	4695.2	1678.1	40	5597.8	2280.6
50	3925.6	1215.8	50	4709.2	1686.9	50	5614.2	2292.0
69	3937.9	1222.7	**79**	4723.2	1695.8	**89**	5630.5	2303.5
10	3950.2	1229.7	10	4737.2	1704.7	10	5646.9	2315.0
20	3962.5	1236.7	20	4751.2	1713.7	20	5663.4	2326.6
30	3974.8	1243.7	30	4765.3	1722.7	30	5679.9	2338.2
40	3987.2	1250.8	40	4779.4	1731.7	40	5696.4	2349.8
50	3999.5	1257.9	50	4793.6	1740.8	50	5713.0	2361.5
70	4011.9	1265.0	**80**	4807.7	1749.9	**90**	5729.7	2373.3
10	4024.4	1272.1	10	4822.0	1759.0	10	5746.3	2385.1
20	4036.8	1279.3	20	4836.2	1768.2	20	5763.1	2397.0
30	4049.3	1286.5	30	4850.5	1777.4	30	5779.9	2408.9
40	4061.8	1293.6	40	4864.8	1786.7	40	5796.7	2420.9
50	4074.4	1300.9	50	4879.2	1796.0	50	5813.6	2432.9

TABLE IV. — Tangents and Externals to a 1° Curve.

Angle	Tangent	External	Angle	Tangent	External	Angle	Tangent	External
91°	5830.5	2444.9	**101°**	6950.6	3278.1	**111°**	8336.7	4386.1
10′	5847.5	2457.1	10′	6971.3	3294.1	10′	8362.7	4407.6
20	5864.6	2469.3	20	6992.0	3310.1	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
92	5933.2	2518.5	**102**	7075.5	3374.9	**112**	8494.6	4516.6
10	5950.5	2531.0	10	7096.6	3391.2	10	8521.3	4538.8
20	5967.9	2543.5	20	7117.8	3407.7	20	8548.1	4561.1
30	5985.3	2556.0	30	7139.0	3424.3	30	8575.0	4583.4
40	6002.7	2568.6	40	7160.3	3440.9	40	8602.1	4606.0
50	6020.2	2581.3	50	7181.7	3457.6	50	8629.3	4628.6
93	6037.8	2594.0	**103**	7203.2	3474.4	**113**	8656.6	4651.3
10	6055.4	2606.8	10	7224.7	3491.3	10	8684.0	4674.2
20	6073.1	2619.7	20	7246.3	3508.2	20	8711.5	4697.2
30	6090.8	2632.6	30	7268.0	3525.2	30	8739.2	4720.3
40	6108.6	2645.5	40	7289.8	3542.4	40	8767.0	4743.6
50	6126.4	2658.5	50	7311.7	3559.6	50	8794.9	4766.9
94	6144.3	2671.6	**104**	7333.6	3576.8	**114**	8822.9	4790.4
10	6162.6	2684.7	10	7355.6	3594.2	10	8851.0	4814.1
20	6180.2	2697.9	20	7377.8	3611.7	20	8879.3	4837.8
30	6198.3	2711.2	30	7399.9	3629.2	30	8907.7	4861.7
40	6216.4	2724.5	40	7422.2	3646.8	40	8936.3	4885.7
50	6234.6	2737.9	50	7444.6	3664.5	50	8965.0	4909.9
95	6252.8	2751.3	**105**	7467.0	3682.3	**115**	8993.8	4934.1
10	6271.1	2764.8	10	7489.6	3700.2	10	9022.7	4958.6
20	6289.4	2778.3	20	7512.2	3718.2	20	9051.7	4983.1
30	6307.9	2792.0	30	7534.9	3736.2	30	9080.9	5007.8
40	6326.3	2805.6	40	7557.7	3754.4	40	9110.3	5032.6
50	6344.8	2819.4	50	7580.5	3772.6	50	9139.8	5057.6
96	6363.4	2833.2	**106**	7603.5	3791.0	**116**	9169.4	5082.7
10	6382.1	2847.0	10	7626.6	3809.4	10	9199.1	5107.9
20	6400.8	2861.0	20	7649.7	3827.9	20	9229.0	5133.3
30	6419.5	2875.0	30	7672.9	3846.5	30	9259.0	5158.8
40	6438.4	2889.0	40	7696.3	3865.2	40	9289.2	5184.5
50	6457.3	2903.1	50	7719.7	3884.0	50	9319.5	5210.3
97	6476.2	2917.3	**107**	7743.2	3902.9	**117**	9349.9	5236.2
10	6495.2	2931.6	10	7766.8	3921.9	10	9380.5	5262.3
20	6514.3	2945.9	20	7790.5	3940.9	20	9411.3	5288.6
30	6533.4	2960.3	30	7814.3	3960.1	30	9442.2	5315.0
40	6552.6	2974.7	40	7838.1	3979.4	40	9473.2	5341.5
50	6571.9	2989.2	50	7862.1	3998.7	50	9504.4	5368.2
98	6591.2	3003.8	**108**	7886.2	4018.2	**118**	9535.7	5395.1
10	6610.6	3018.4	10	7910.4	4037.8	10	9567.2	5422.1
20	6630.1	3033.1	20	7934.6	4057.4	20	9598.9	5449.2
30	6649.6	3047.9	30	7959.0	4077.2	30	9630.7	5476.5
40	6669.2	3062.8	40	7983.5	4097.1	40	9662.6	5504.0
50	6688.8	3077.7	50	8008.0	4117.0	50	9694.7	5531.7
99	6708.6	3092.7	**109**	8032.7	4137.1	**119**	9727.0	5559.4
10	6728.4	3107.7	10	8057.4	4157.3	10	9759.4	5587.4
20	6748.2	3122.9	20	8082.3	4177.5	20	9792.0	5615.5
30	6768.1	3138.1	30	8107.3	4197.9	30	9824.8	5643.8
40	6788.1	3153.3	40	8132.3	4218.4	40	9857.7	5672.3
50	6808.2	3168.7	50	8157.5	4239.0	50	9890.8	5700.9
100	6828.3	3184.1	**110**	8182.8	4259.7	**120**	9924.0	5729.7
10	6848.5	3199.6	10	8208.2	4280.5	10	9957.5	5758.6
20	6868.8	3215.1	20	8233.7	4301.4	20	9991.0	5787.7
30	6889.2	3230.8	30	8259.3	4322.4	30	10025.0	5817.0
40	6909.6	3246.5	40	8285.0	4343.6	40	10059.0	5846.5
50	6930.1	3262.3	50	8310.8	4364.8	50	10093.0	5876.1

Table V. Corrections for use with table IV,

For Tangents Add

Δ ANGLE / CURVE	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°
10°	.03	.06	.09	.13	.16	.19	.22	.25	.28	.31	.34	.38	.42	.46
15°	.04	.10	.14	.19	.24	.29	.34	.39	.45	.51	.53	.58	.63	.68
20°	.06	.13	.19	.26	.32	.39	.45	.51	.58	.65	.72	.79	.84	.90
25°	.08	.16	.24	.33	.40	.49	.58	.67	.75	.83	.90	.99	1.06	1.14
30°	.10	.19	.29	.39	.49	.59	.69	.79	.89	.99	1.09	1.20	1.29	1.39
35°	.11	.22	.34	.47	.58	.69	.70	.81	.92	1.04	1.29	1.42	1.54	1.66
40°	.13	.26	.40	.53	.67	.80	.93	1.06	1.20	1.34	1.49	1.64	1.79	1.94
45°	.15	.30	.44	.60	.76	.91	1.06	1.21	1.37	1.52	1.70	1 87	2.04	2.21
50°	.17	.34	.51	.68	.85	1.02	1.19	1.36	1.54	1.72	1.91	2.10	2.29	2.48
55°	.19	.38	.57	.76	.95	1.14	1.32	1.52	1.72	1 92	2.14	2.35	2.56	2.77
60°	.21	.42	.63	.84	1.05	1.27	1.49	1.71	1.94	2.17	2.38	2.60	2.83	3.07
65°	.23	.46	.69	.93	1.16	1.40	1.64	1.88	2.13	2.38	2.63	2.88	3.13	3.39
70°	.25	.51	.76	1.02	1.28	1.54	1.80	2.06	2.33	2.60	2.88	3,16	3.44	3.72
75°	.27	.56	.83	1.12	1.40	1.69	1.98	2.27	2.57	2.87	3.16	3.47	3.78	4.09
80°	.30	.61	.91	1.22	1.53	1.84	2.15	2.46	2.78	3.10	3.44	3.78	4.12	4.46
85°	.33	.66	1.00	1.33	1.68	2.02	2.36	2.70	3.05	3.40	3.77	4.14	4.55	4.89
90°	.36	.72	1.09	1.45	1.83	2.20	2.57	2.94	3.32	3.70	4.10	4.50	4.91	5.32
95°	.39	.79	1.19	1.55	2.00	2.40	2.80	3.20	3.61	4.02	4.40	4.98	5.38	5.83
100°	.43	.86	1.30	1.74	2.18	2.62	3.06	3 50	3.95	4.40	4.88	5.37	5.85	6.34

For Externals Add

ANGLE / 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	.711	.845	922	1.01
70°	.080	.159	.240	.321	.403	.485	.568	.652	.735	.819	.906	.994	1.08	1.17
75°	.095	.182	.286	.383	.480	.578	.678	.777	.877	.977	1.07	1.18	1.29	1.39
80°	.110	.220	.332	.445	.558	.671	.787	.903	1.02	1.13	1 25	1.38	1 50	1.62
85°	.128	.259	.391	.524	.657	.790	.926	1.06	1.20	1.34	1.47	1 62	1.76	1.91
90°	.149	.299	.450	.603	.756	.910	1.07	1.22	1.38	1.54	1.70	1.87	2.03	2.20
95°	.174	.350	.522	.706	.985	1.06	1.25	1.43	1.62	1.80	1.99	2.18	2.38	2.58
100°	.200	.401	.604	.809	1.01	1.22	1.43	1.64	1.85	2.06	2.28	2.50	2.73	2.96

Table VI. Deflections for Sub Chords for Short Radius Curves.

Degree of Curve	Radius = 50 / sin. def. ang.	½ sub chord / R = sin of def. angle				Length of arc for 100 ft.
		12.5 Ft.	15 Ft.	20 Ft	25 Ft.	
30°	193.18	1° 51′	2° 17′	2° 58′	3° 43′	101.15
32°	181.39	1° 59′	2° 25′	3° 10′	3° 58′	101.33
34°	171.01	2° 06′	2° 33′	3° 21′	4° 12′	101.48
36°	161.80	2° 13′	2° 41′	3° 33′	4° 26′	101 66
38°	153.58	2° 20′	2° 49′	3° 44′	4° 40′	101.85
40°	146.19	2° 27′	2° 57′	3° 55′	4° 54′	102.06
42°	139.52	2° 34′	3° 05′	4° 07′	5° 08′	102.29
44°	133.47	2° 41′	3° 13′	4° 18′	5° 22′	102.53
46°	127.97	2° 48′	3° 21′	4° 29′	5° 36′	102.76
48°	122.92	2° 55′	3° 29′	4° 40′	5° 50′	103.00
50°	118 31	3° 02′	3° 38′	4° 51′	6° 04′	103 24
52°	114.06	3° 09′	3° 46′	5° 02′	6° 17′	103 54
54°	110.11	3° 16′	3° 54′	5° 13′	6° 31′	103 84
56°	106.50	3° 22′	4° 02′	5° 23′	6° 44′	104.14
58°	103.14	3° 29′	4° 10′	5° 34′	6° 57′	104 43
60°	100.00	3° 35′	4° 18′	5° 44′	7° 11′	104.72

CURVE FORMULAS.

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

$T = \frac{50 \tan. \frac{1}{2} I}{\text{Sin. D}}$

$\text{Sin. D} = \frac{50}{R}$

$\text{Sin. D} = \frac{50 \tan. \frac{1}{2} I}{T}$

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

$R = \frac{50}{\text{Sin. D}}$

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

$E = T \tan \frac{1}{4} I$

$\text{Chord def.} = \frac{\text{chord}^2}{R}$

$\text{No. chords} = \frac{\frac{1}{2} I}{D}$

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

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

Table IV. contains Tangents and Externals to a 1° curve. Tan. and Ext. to any other radius may be found nearly enough, by dividing the Tan. or Ext. opposite the given Central Angle by the given degree of curve.

To find Deg. of Curve, having the Central Angle and Tangent: Divide Tan. opposite the given Central Angle by the given Tangent.

To find Deg. of Curve, having the Central Angle and Tangent: Divide Ext. opposite the given Central Angle by the given External.

To find. Nat. Tan. and Nat. Ex. Sec. for any angle by Table IV.: Tan. or Ext. of twice the given angle divided by the radius of a 1° curve will be the Nat. Tan. or Nat. Ex. Sec.

To find angle for a given distance and deflection.

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

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

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

Right Angle Triangles. - Square the altitude, divide by twice the base. Add quotient to base for hypotenuse.

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

Given Hyp. 100, Alt. 25. $25^2 \div 200 = 3.125$. $100 - 3.125 = 96.875 =$ Base.

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

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

Natural Sines

DEG.	0′	10′	20′	30′	40′	50′	DEG.
0	0000	0029	0058	0087	0116	0145	89
1	0175	0204	0233	0262	0291	0320	88
2	0349	0378	0407	0436	0465	0494	87
3	0523	0552	0581	0610	0640	0669	86
4	0698	0727	0756	0785	0814	0843	85
5	0872	0901	0929	0958	0987	1016	84
6	1045	1074	1103	1132	1161	1190	83
7	1219	1248	1279	1305	1334	1363	82
8	1392	1421	1449	1478	1507	1536	81
9	1564	1593	1622	1650	1679	1708	80
10	1736	1765	1794	1822	1851	1880	79
11	1908	1937	1965	1994	2022	2051	78
12	2079	2108	2136	2164	2193	2221	77
13	2250	2278	2306	2334	2363	2391	76
14	2419	2447	2476	2504	2532	2560	75
15	2588	2616	2644	2672	2700	2728	74
16	2756	2784	2812	2840	2868	2896	73
17	2924	2952	2979	3007	3035	3062	72
18	3090	3118	3145	3173	3201	3228	71
19	3256	3283	3311	3338	3365	3393	70
20	3420	3448	3475	3502	3529	3557	69
21	3584	3611	3638	3665	3692	3719	68
22	3746	3773	3800	3827	3854	3881	67
23	3907	3934	3961	3987	4014	4041	66
24	4067	4094	4120	4147	4173	4200	65
25	4226	4253	4279	4305	4331	4358	64
26	4384	4410	4436	4462	4488	4514	63
27	4540	4566	4592	4617	4643	4669	62
28	4695	4720	4746	4772	4797	4823	61
29	4848	4874	4899	4924	4950	4975	60
30	5000	5025	5050	5075	5100	5125	59
31	5150	5175	5200	5225	5250	5275	58
32	5299	5324	5348	5373	5398	5422	57
33	5446	5471	5495	5519	5544	5568	56
34	5592	5616	5640	5664	5688	5712	55
35	5736	5760	5783	5807	5831	5854	54
36	5878	5901	5925	5948	5972	5995	53
37	6018	6041	6065	6088	6111	6134	52
38	6157	6180	6202	6225	6248	6271	51
39	6293	6316	6338	6361	6383	6406	50

DEG.	0′	10′	20′	30′	40′	50′	DEG.
40	6428	6450	6472	6494	6517	6539	49
41	6561	6583	6604	6626	6648	6670	48
42	6691	6713	0734	6756	6777	6799	47
43	6820	6841	6862	6884	6905	6926	46
44	6947	6967	6988	7009	7030	7050	45
45	7071	7092	7112	7133	7153	7173	44
46	7193	7214	7234	7254	7274	7294	43
47	7314	7333	7353	7373	7392	7412	42
48	7431	7451	7470	7490	7509	7528	41
49	7547	7566	7585	7604	7623	7642	40
50	7660	7679	7698	7716	7735	7753	39
51	7771	7790	7808	7826	7844	7862	38
52	7880	7898	7916	7934	7951	7969	37
53	7986	8004	8021	8039	8056	8073	36
54	8090	8107	8124	8141	8158	8175	35
55	8192	8208	8225	8241	8258	8274	34
56	8290	8307	8323	8339	8355	8371	33
57	8387	8403	8418	8434	8450	8465	32
58	8480	8496	8511	8526	8542	8557	31
59	8572	8587	8601	8616	8631	8646	30
60	8660	8675	8689	8704	8718	8732	29
61	8746	8760	8774	8788	8802	8816	28
62	8829	8843	8857	8870	8884	8897	27
63	8910	8923	8936	8949	8962	8975	26
64	8988	9001	9013	9026	9038	9051	25
65	9063	9075	9088	9100	9112	9124	24
66	9135	9147	9159	9171	9182	9194	23
67	9205	9216	9228	9239	9250	9261	22
68	9272	9283	9293	9304	9315	9325	21
69	9336	9346	9356	9367	9377	9387	20
70	9397	9407	9417	9426	9436	9446	19
71	9455	9465	9474	9483	9492	9502	18
72	9511	9520	9528	9537	9546	9555	17
73	9563	9572	9580	9588	9596	9605	16
74	9613	9621	9628	9636	9644	9652	15
75	9659	9667	9674	9681	9689	9696	14
76	9703	9710	9717	9724	9730	9737	13
77	9744	9750	9757	9763	9769	9775	12
78	9781	9787	9793	9799	9805	9811	11
79	9816	9822	9827	9833	9838	9843	10

DEG.	60′	50′	40′	30′	20′	10′	DEG.

DEG.	0′	10′	20′	30′	40′	50′	DEG.
80	9848	9853	9858	9863	9868	9872	9
81	9877	9881	9886	9890	9894	9899	8
82	9903	9907	9911	9914	9918	9922	7
83	9925	9929	9932	9936	9939	9942	6
84	9945	9948	9951	9954	9957	9959	5
85	9962	9964	9967	9969	9971	9974	4
86	9976	9978	9980	9981	9983	9985	3
87	9986	9988	9989	9990	9992	9993	2
88	9994	9995	9996	9997	9997	9998	1
89	9998	9999	9999	9999	1.0000	1.0000	0

DEG.	60′	50′	40′	30′	20′	10′	DEG.

Natural Cosines

Natural Tangents

deg.	0′	10′	20′	30′	40′	50′	deg.	deg.	0′	10′	20′	30′	40′	50′	deg.
0	0000	0029	0058	0087	0116	0145	89	40	8391	8441	8491	8541	8591	8642	49
1	0175	0204	0233	0262	0291	0320	88	41	8693	8744	8796	8847	8899	8952	48
2	0349	0378	0407	0437	0466	0495	87	42	9004	9057	9110	9163	9217	9271	47
3	0524	0553	0582	0612	0641	0670	86	43	9325	9380	9435	9490	9545	9601	46
4	0699	0729	0758	0787	0816	0846	85	44	9657	9713	9770	9827	9884	9942	45
5	0875	0904	0934	0963	0992	1022	84	45	1.0000	1.0058	1.0117	1.0176	1.0235	1.0295	44
6	1051	1080	1110	1139	1169	1198	83	46	1.0355	1.0416	1.0477	1.0533	1.0599	1.0661	43
7	1228	1257	1287	1317	1346	1376	82	47	1.0724	1.0786	1.0850	1.0913	1.0977	1 1041	42
8	1405	1435	1465	1495	1524	1554	81	48	1.1106	1.1171	1.1237	1.1303	1.1369	1.1436	41
9	1584	1614	1644	1673	1703	1733	80	49	1.1504	1.1571	1.1640	1.1708	1.1778	1.1847	40
10	1763	1793	1823	1853	1883	1914	79	50	1.1918	1 1988	1.2059	1.2131	1.2203	1.2276	39
11	1944	1974	2004	2035	2065	2095	78	51	1.2349	1.2423	1.2497	1.2572	1.2647	1.2723	38
12	2126	2156	2186	2217	2247	2278	77	52	1.2799	1.2876	1.2954	1.3032	1.3111	1.3190	37
13	2309	2339	2370	2401	2432	2462	76	53	1.3270	1.3351	1.3432	1.3514	1.3597	1 3680	36
14	2493	2524	2555	2586	2617	2648	75	54	1.3764	1.3848	1.3934	1.4019	1.4106	1.4193	35
15	2679	2711	2742	2773	2805	2836	74	55	1.4281	1.4370	1.4460	1.4550	1.4641	1.4733	34
16	2867	2899	2931	2962	2994	3026	73	56	1.4826	1.4919	1.5013	1.5108	1.5204	1 5301	33
17	3057	3089	3121	3153	3185	3217	72	57	1 5399	1.5497	1.5597	1 5697	1 5798	1.5900	32
18	3249	3281	3314	3346	3378	3411	71	58	1.6003	1.6107	1.6212	1.6319	1.6426	1.6534	31
19	3443	3476	3508	3541	3574	3607	70	59	1.6643	1 6753	1.6864	1.6977	1.7090	1 7205	30
20	3640	3673	3706	3739	3772	3805	69	60	1.7321	1.7437	1.7556	1.7675	1 7797	1.7917	29
21	3839	3872	3906	3939	3973	4006	68	61	1.8040	1.8165	1.8291	1.8418	1.8546	1.8676	28
22	4040	4074	4108	4142	4176	4210	67	62	1.8807	1.8940	1.9074	1.9210	1.9347	1.9486	27
23	4245	4279	4314	4348	4383	4417	66	63	1.9626	1.9768	1.9912	2.0057	2.0204	2.0353	26
24	4452	4487	4522	4557	4592	4628	65	64	2.0503	2.0655	2.0809	2.0965	2.1123	2.1283	25
25	4663	4699	4734	4770	4806	4841	64	65	2 1445	2.1609	2.1775	2 1943	2.2113	2.2286	24
26	4877	4913	4950	4986	5022	5059	63	66	2.2460	2.2637	2.2817	2.2998	2.3183	2.3369	23
27	5095	5132	5169	5206	5243	5280	62	67	2.3559	2.3750	2 3945	2.4142	2.4342	2.4545	22
28	5317	5354	5392	5430	5467	5505	61	68	2.4751	2.4960	2.5172	2 5386	2.5605	2.5826	21
29	5543	5581	5619	5658	5696	5735	60	69	2.6051	2 6279	2.6511	2.6746	2.6985	2.7228	20
30	5774	5812	5851	5890	5930	5969	59	70	2.7475	2 7725	2 7980	2.8239	2.8502	2.8770	19
31	6009	6048	6088	6128	6168	6208	58	71	2.9042	2.9319	2 9600	2.9887	3.0178	3.0475	18
32	6249	6289	6330	6371	6412	6453	57	72	3.0777	3 1084	3.1397	3.1716	3.2041	3.2371	17
33	6494	6536	6577	6619	6661	6703	56	73	3.2709	3 3052	3.3402	3.3759	3.4124	3.4495	16
34	6745	6787	6830	6873	6916	6959	55	74	3.4874	3.5261	3 5656	3.6059	3.6470	3.6891	15
35	7002	7046	7089	7133	7177	7221	54	75	3 7321	3.7760	3.8208	3.8657	3.9136	3.9617	14
36	7265	7310	7355	7400	7445	7490	53	76	4.0108	4.0611	4.1126	4.1653	4.2193	4.2747	13
37	7536	7581	7627	7673	7720	7766	52	77	4 3315	4.3897	4.4494	4.5107	4.5736	4.6382	12
38	7813	7860	7907	7954	8002	8050	51	78	4 7046	4.7729	4.8430	4.9152	4.9894	5 0658	11
39	8098	8146	8195	8243	8292	8342	50	79	5 1446	5 2257	5,3093	5.3955	5.4845	5.5764	10
deg.	60′	50′	40′	30	20′	10′	deg.	deg.	60′	50′	40′	30′	20′	10′	deg.

deg.	0′	10′	20′	30′	40′	50′	deg.
80	5.6713	5 7694	5.8708	5 9758	6 0844	6.1970	9
81	6 3138	6.4348	6 5606	6.6912	6.8269	6.9682	8
82	7.1154	7.2687	7.4287	7.5958	7.7704	7.9530	7
83	8.1443	8 3450	8.5555	8.7769	9.0098	9.2553	6
84	9.5144	9.7882	10.078	10.385	10.711	11.059	5
85	11.430	11.826	12.250	12.706	13.197	13.727	4
86	14.300	14.924	15.605	16.350	17.169	18.075	3
87	19.081	20.206	21.470	22.903	24.542	26.432	2
88	28.636	31.242	34.368	38.189	42.964	49.104	1
89	57.290	68.750	85.940	114.588	171.885	343.77	0
deg.	60′	50′	40′	30′	20′	10′	deg.

Natural Cotangents

44 - 00
45 - 1.3
46 - 1.5
47 - 1.5
48 - 00

50 x 1.3 x 200 / 27 / 1000

7/17/23

Proj. - 2200

38 3 • FP

136+00 • 48 3 ~~FP~~

• FP

39 9 • FP

125+00 • 44 6
POT. • FP

2.2 TOP cr. stake at sta. 71

1011.80 top grade stake
1.5-8

1017.35 HI

RA. LA

7.5/33 7.3/24 7.8/23 71 11/23 7.8/33

8.0/33 8.0/24 72 1.3/18 1.8/24 7.5/37

1041.39
.91
1042.30

Connors
2602 Phone
Hastings

at Camp

1062.76
8.53

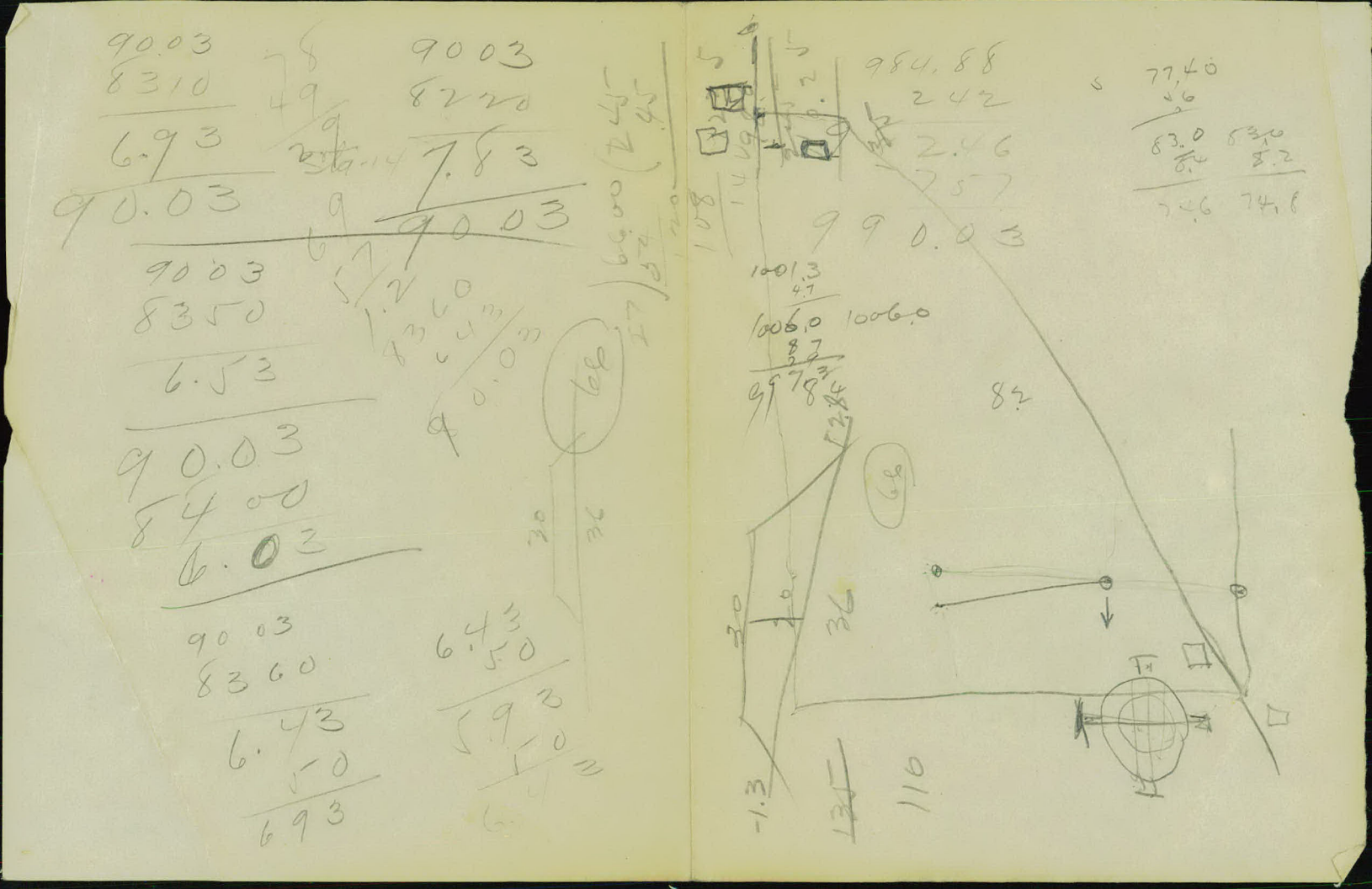
1071.29
3.37

6890
1066
824
270
7.9

1040.37
8.53

1068.90
3.37
65.53

6890
488
6402



970.06
+ 6.09
976.15
-789
968.26
+ 611
97437
-249
971.88 spike at 102+00
402
975.90
5.1
970.80
975.90
623
96967

975.90
1.02
974.88
1000
98488+1.1
7520
68
984.88
7517
9.71
84
67
1.7
4.9
10-1

84.88
776
728
84.88
74.58
10.30
71.90
54
84.88
7788
7.30
74.37
7.30
70.77

76.15
250
13.65
76.15
600
70.15
7615
650
965
7615
680
935
7615
81
805
74.37
250
7187

74.37
61
68 27
74.37
53
69 07
74.37
41
70 27
74.37
32
71 17
74.37
33
71 07
74.37
36
70 77

2.12
2.12

FORM 529 Culverts to be Installed

OFFICE OF COUNTY ENGINEER
OF RAMSEY COUNTY
COUNTY HIGHWAY CONSTRUCTION

Contractor .....

Estimate No..... Sheet No.....

Project No. ..... County .....

MISCELLANEOUS Return showing progress to .....192.... Sta.....to Sta..... ..... Asst. Eng.

STATION From	STATION To	TILE DRAIN ..." Lin. Ft.	TILE DRAIN ..." Lin. Ft.	TILE DRAIN Porous Back-fill Material Cu. Yds.	TILE DRAIN Outlet Headwalls Headwall	Stone Drains Lin.Ft.	Stone Rip Rap Cu. Yds.	Hauling Rip Rap or Stone Drain Material Cu. Yd. Mile	Concrete Curbing Lin. Ft.	Concrete Gutters Lin. Ft.	End Walls Concrete Cu. Yd.	RUBBLE GUTTERS Plain Sq. Yds.	RUBBLE GUTTERS Grouted Sq. Yds.	RUBBLE GUTTERS Exc. Cu. Yds.	GUARD Concrete Lin. Ft.	RAIL Wood Lin. Ft.	REMARKS
13+15	Rt.	Omitted for taken care of with Proj No. 2205															
13+15	Lt.																
~~127~~	~~Lt~~	omitted by Biggs 7/11/23															
27+88	Rt.	staked 14 3' 15" CM															
33+00	Lt	30+88															
40+15	Lt	43+12															
48+00	Rt	48+00															
52+90	Rt.	52+90															
58+00	Lt	58+00															
81+00	Lt.	83+00															
115+50	Lt	115+00															
117+50	Lt.	117+75															
71+00	Lt	71+00															
		Culvert removed 6/15/23 near Sta 120 Proj 2200 15" CM 14' also connecting bands & bolts.															

86.20
2.50
84.20 - F07
2.50
81.70 -
2.50
79.20 - F03
5.00
74.20 - F06

Total to Date

Previously Returned

Done During Month

To be prepared in duplicate monthly

Original to County Auditor

COUNTY OF RAMSEY

Schedule of Vouchers Transmitted to the County Auditor

BY OFFICE OF COUNTY SURVEYOR.

DATE ____________ 192__

VOUCHER NUMBER	NAME OF PAYEE	AUDITORS WARRANT NUMBER	VOUCHERS PAYABLE AMOUNT
		TOTAL	

1008.38
548
386

1907
96
9.47

19.07
36
15.47

19.07
72
11.87

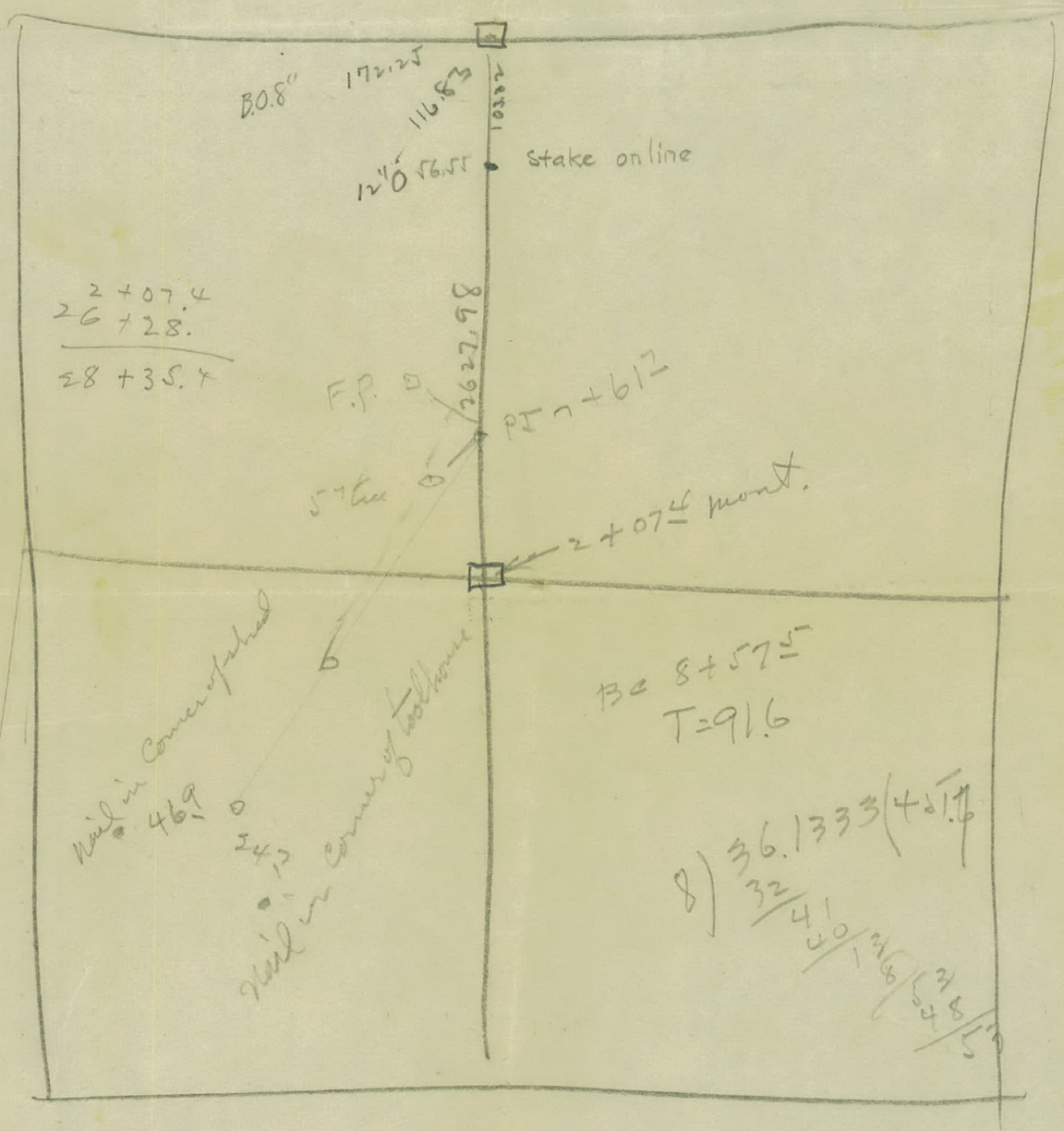
RAMSEY COUN

RECEIVED AND AUDITED ____________ 192__

By ________________________________
FOR THE COUNTY AUDITOR

E Line

Run curve Lt of tang on to Edgerton Road.



Sec. 32-30-22

DISTANCES FROM CENTER OF ROADWAY FOR CROSS-SECTIONING.

ROADWAY 14 FEET WIDE. SIDE SLOPES 1½ TO 1.

FOR SINGLE TRACK EMBANKMENT.

	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	
0	7.0	7.2	7.3	7.5	7.6	7.8	7.9	8.1	8.2	8.4	0
1	8.5	8.7	8.8	9.0	9.1	9.3	9.4	9.6	9.7	9.9	1
2	10.0	10.2	10.3	10.5	10.6	10.8	10.9	11.1	11.2	11.4	2
3	11.5	11.7	11.8	12.0	12.1	12.3	12.4	12.6	12.7	12.9	3
4	13.0	13.2	13.3	13.5	13.6	13.8	13.9	14.1	14.2	14.4	4
5	14.5	14.7	14.8	15.0	15.1	15.3	15.4	15.6	15.7	15.9	5
6	16.0	16.2	16.3	16.5	16.6	16.8	16.9	17.1	17.2	17.4	6
7	17.5	17.7	17.8	18.0	18.1	18.3	18.4	18.6	18.7	18.9	7
8	19.0	19.2	19.3	19.5	19.6	19.8	19.9	20.1	20.2	20.4	8
9	20.5	20.7	20.8	21.0	21.1	21.3	21.4	21.6	21.7	21.9	9
10	22.0	22.2	22.3	22.5	22.6	22.8	22.9	23.1	23.2	23.4	10
11	23.5	23.7	23.8	24.0	24.1	24.3	24.4	24.6	24.7	24.9	11
12	25.0	25.2	25.3	25.5	25.6	25.8	25.9	26.1	26.2	26.4	12
13	26.5	26.7	26.8	27.0	27.1	27.3	27.4	27.6	27.7	27.9	13
14	28.0	28.2	28.3	28.5	28.6	28.8	28.9	29.1	29.2	29.4	14
15	29.5	29.7	29.8	30.0	30.1	30.3	30.4	30.6	30.7	30.9	15
16	31.0	31.2	31.3	31.5	31.6	31.8	31.9	32.1	32.2	32.4	16
17	32.5	32.7	32.8	33.0	33.1	33.3	33.4	33.6	33.7	33.9	17
18	34.0	34.2	34.3	34.5	34.6	34.8	34.9	35.1	35.2	35.4	18
19	35.5	35.7	35.8	36.0	36.1	36.3	36.4	36.6	36.7	36.9	19
20	37.0	37.2	37.3	37.5	37.6	37.8	37.9	38.1	38.2	38.4	20
21	38.5	38.7	38.8	39.0	39.1	39.3	39.4	39.6	39.7	39.9	21
22	40.0	40.2	40.3	40.5	40.6	40.8	40.9	41.1	41.2	41.4	22
23	41.5	41.7	41.8	42.0	42.1	42.3	42.4	42.6	42.7	42.9	23
24	43.0	43.2	43.3	43.5	43.6	43.8	43.9	44.1	44.2	44.4	24
25	44.5	44.7	44.8	45.0	45.1	45.3	45.4	45.6	45.7	45.9	25
26	46.0	46.2	46.3	46.5	46.6	46.8	46.9	47.1	47.2	47.4	26
27	47.5	47.7	47.8	48.0	48.1	48.3	48.4	48.6	48.7	48.9	27
28	49.0	49.2	49.3	49.5	49.6	49.8	49.9	50.1	50.2	50.4	28
29	50.5	50.7	50.8	51.0	51.1	51.3	51.4	51.6	51.7	51.9	29
30	52.0	52.2	52.3	52.5	52.6	52.8	52.9	53.1	53.2	53.4	30
31	53.5	53.7	53.8	54.0	54.1	54.3	54.4	54.6	54.7	54.9	31
32	55.0	55.2	55.3	55.5	55.6	55.8	55.9	56.1	56.2	56.4	32
33	56.5	56.7	56.8	57.0	57.1	57.3	57.4	57.6	57.7	57.9	33
34	58.0	58.2	58.3	58.5	58.6	58.8	58.9	59.1	59.2	59.4	34
35	59.5	59.7	59.8	60.0	60.1	60.3	60.4	60.6	60.7	60.9	35
36	61.0	61.2	61.3	61.5	61.6	61.8	61.9	62.1	62.2	62.4	36

Calculated by Julien A. Hall, M. Am. Soc. C. E.