(A) ~~Alignment Notes: Top Contour & Dam Line - Tule Springs Res. Site.~~

Sta.	Bearing	Distance
C11+00 Dam →	S50°38'E	670.3
0	N59°16'E	116.5
1	S83°40'E	222.8
2	S59°31'E	203.0
3	N11°03'E	67.3
4	N42°04'E	161.8
5	N4°59'E	203.8
6	N43°58'E	231.9
7	N75°14'E	118.1
8	~~S48°38'E~~	~~223.3~~ ok
9	N0°49'W	140.3
10	N72°56'E	133.6
11	N85°29'E	152.7
12	N40°43'W	76.8
13	N68°47'W	150.6
14	~~N79°25'W~~	~~206.0~~ ok
15	N22°36'W	171.7
16	N36°05'E	70.3
17	N50°37'W	109.8
18	N62°44'E	119.3
19	N56°28'W	213.4
20	N8°30'E	126.5
21		

Sta.	Bearing	Distance
21	N58°55'E	269.6
22	S79°11'W	185.5
23	N27°13'E	137.3
24	N46°37'E	227.2
25	N33°14'E	256.2
26	N43°45'E	425.5
27	S70°40'W	483.6
28	S79°52'W	271.1
29	N75°25'W	158.0
30	N22°58'W	248.1
31	S13°56'W	132.1
32	S54°56'W	282.8
33	N42°38'W	149.8
34	S28°15'W	277.2
35	S43°35'W	145.9
36	S83°06'W	237.8
37	N32°28'W	300.9
38	S1°54'E	367.4
39	S0°05'W	360.4
40	S33°21'W	91.7
41	S19°21'W	592.9
42	S69°25'E	385.5
Dam → C11+00		

227.2 − 64 = 163.2

223.3 − 56.1 = 167.2

206.0 − 73.1 = 132.9

271.1 − 26.7 = 244.4

69 25 − 50 38 = 18-47

Course		N	S	E	W
Med	1605.0				1605.0
N42°33'W	379.0	279.2			256.3
S24°05'W	1041.0		950.4		424.8
S1°02'W	1172.0		1171.8		21.1
S27°10'W	1248.0		1110.3		
N50°49'W	206	129.9			159.4
N37°23'W	99	78.4			59.9
N62°28'W	80	70.9			37.0
S72°59'W	100.6		29.44		96.20
		279.2	294.4 − 279.2 = 15.2		1218.3 + 6.2 = 1224.5

300 − 16 = 284

17 Min

N22°54'E
22

298.5 − 294.4 = 4.1

41 | 1233.1 | 241784 31

41 | 1232.7 | 3

N 2 | 1218.3 | (80.75 31

NE 89°17

S22°54'E

18.42 / 1.84 / 20.26

18.42 − .92 = 17.34

1218.3 / 8.3 / 1226

Tule River,

Tie Rancho line to 1/4 cor bet Secs 25 & 36

Course	Dist	N	S	E	W
S89°43'E	1226.0		6.1	1226.0	
S22°54'E	279.0		257.0	108.6	
S34°24'E	131.0		110.81	74.0	
S13°36'W	198.0		192.5		46.6
S35°57'E	178.0		143.8	104.3	
S23°51'W	433.0		395.9		175.1
S10°52'W	237.0		232.5		44.6
S80°28'W	139.0		23.0		136.9
S16°24'W	340.0		326.5		96.1
S33°24'W	1302.0		1086.2		718.5
S19°20'W	280.		264.2		92.7
			3035.8	1512.9	1310.5

1512.9
1310.5
3035.8) 202.4000 (.06667 = 3°49'
182148
202520
182148
203720
182148
215720

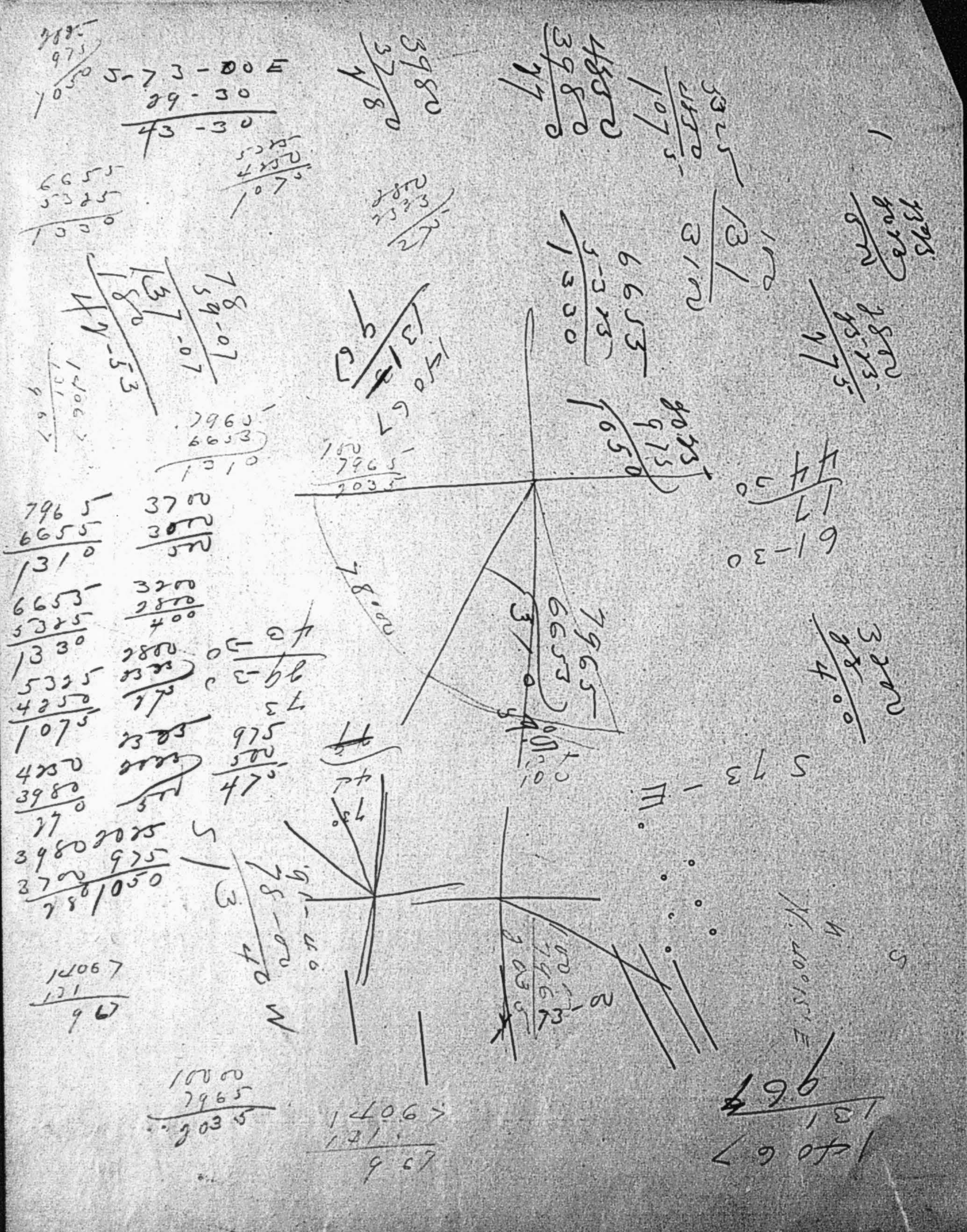
99778) 3035.80000 (3042.
299334
424600
399112
254880

Tie to Santa Maria Outlet

Course	Dist	N	S	E	W
N74°30'E	199.0	53.2		191.8	
N62°07'E	2473.0	1156.6		2185.9	
S63°02'W	2667.8		1209.8		2377.7
		1209.8	1209.8	2377.7	2377.7
S74°30'W	135.0		36.1		130.1
N63°02'E	2667.7	1209.8		2377.7	
S62°25'W	2535.0		1173.7		2247.6
		1209.8			

Cos Sin
26.7238 − 96.3631
9.3533 33.7275
36.0771 130.0906

2377.7 1209.8
130.1 36.1
2247.6 1173.7



Sutherland Conduit Tie to Santa Maria Res   Sheet 3

Course	Dist	N	S	E	W	
		25445	78956	60197	58067	
S 83° 45' E	261.0		284	2594		99
S 12° 10' W	257.0		2512		542	100
S 84° 10' W	277.0		282		2756	101
S 13° 55' E	120.0		1165	289		102
S 64° 03' E	437.0		1912	3929		103
N 61° 39' E	192.0	912	[illegible]	1690		104
S 65° 36' E	264.0		1091	2404		105
N 0° 46' W	200.0	2000			27	106
N 79° 29' E	318.0	580		3127		107
S 27° 57' W	268.0		2367		1258	108
S 58° 23' E	311.0		1630	2648		109
S 16° 53' E	374.0		3579	1086		110
S 54° 01' E	536.0		3149	4337		111
S 44° 14' E	376.0		2694	2623		112
S 74° 51' W	286.0		748		2761	113
S 75° 21' W	408.0		1057		4044	114
S 35° 51' W	346.0		2804		2026	115
S 87° 59' E	275.0		97	2748		116
S 75° 59' E	290.0		702	2814		117
S 63° 57' E	298.0		1307	2678		118
		28937	106336	93164	71481	
			28937	71481		
			77399	21683		
N 15° 39' W	8038.0					

216830
154798
620320
619192
11.2800
77399
354010

1.28014

96293 √7739.90000 | 8038.
7703 44
364600
288879
757210

Sutherland Conduit - Tie at Santa Maria Res - Sheet 2

		N	S	E	W	
S 1°01' W	200.0		2000		36	68
N 47°29' W	240.0	1622			1769	69
N 10°49' W	289.0	2839			542	70
N 76°19' W	298.0	705			2895	71
S 40°56' W	132.0		997		865	72
S 13°36' W	252.0		2449		593	73
S 41°09' E	240.0		1807	1579		74
S 77°31' W	382.0		826		3730	75
S 56°56' W	303.0		1653		2539	76
S 48°52' W	200.0		1316		1506	77
S 12°09' E	135.0		1320	284		78
S 39°02' E	262.0		2035	1650		79
S 4°55' E	245.0		2441	210		80
S 52°15' E	186.0		1139	1471		81
S 65°05' E	247.0		1041	2240		82
S 1°10' W	111.0		1110		23	83
S 20°15' E	173.0		1623	599		84
S 47°15' E	250.0		1697	1836		85
S 85°20' E	300.0		244	2990		86
S 38°10' E	283.0		2225	1749		87
S 82°40' E	394.0		503	3908		88
S 30°50' E	567.0		4869	2906		89
S 58°45' E	497.0		2578	4249		90
S 66°55' E	357.0		1400	3284		91
S 46°35' E	711.0		4887	5165		92
N 76°05' E	237.0	570		2300		93
N 1°35' W	382.0	3819			105	94
S 80°55' E	216.0		341	2123		95
S 38°10' E	268.0		2107	1656		96
		23445	76115	56816	57128	
S 80°20' E	343.0		576	3381		97
S 22°20' W	247.0		2285		939	98
		25445	78956	60197	58067	

Sutherland Conduit - Tie at Connection with Santa Maria Res - Sheet 1

Course	Distance	N	S	E	W	
West	1040.0				10400	114 Cor to Sta 37
S 44°20' E	163.0		1166	1139		38
S 14°52' W	241.0		2329		618	39
S 38°13' E	387.0		3041	2394	[illegible]	40
S 20°38' E	358.0		3350	1262	[illegible]	41
S 6°38' E	312.0		3099	360		42
S 85°27' W	454.0		360		4526	43
S 33°27' W	81.0		676		446	44
S 18°03' E	84.0		799	260		45
S 34°51' E	169.0		1387	966	[illegible]	46
S 51°26' E	210.0		1309	1642		47
S 17°04' E	172.0		1644	505		48
S 39°14' E	271.0		2099	1714		49
S 48°19' E	436.0		2900	3256		50
S 87°41' W	193.0		78		1928	51
S 10°59' E	379.0		3721	718		52
N 34°14' W	309.0	2555			1738	53
N 76°24' W	181.0	426			1759	54
N 24°14' W	223.0	2034			915	55
N 79°24' W	184.0	338			1809	56
S 31°06' W	225.0		1927		1162	57
S 2°06' W	322.0		3218		118	58
N 45°59' W	279.0	1939			2006	59
N 35°29' W	207.0	1686			1202	60
S 86°41' W	308.0		178		3075	61
N 72°19' W	397.0	1206			3782	62
N 44°46' E	341.0	2421		2401		63
N 23°34' W	208.0	1906			832	64
N 47°29' W	204.0	1379			1504	65
S 89°46' W	325.0		13		3250	66
S 81°41' W	147.0		213		1455	67
		[illegible]	[illegible]	16617	[illegible]	

535.40 + 2.72 = 538.12   292.31 + 1.48 = 293.79

817 / 408   2853 + 2611 = 5464, 2732

829.408 + 3.55 = 832.96 (+ 1) = 832.97   132.73 + .57 = 133.30

Black Canyon ~~Southeast~~ Conduit

Sheet 1

No.		dist.	Revised Sta.	Sta. on Transit line
1			0+00	
2		331.8	3+31.8	0+00
3	110.2	442.0 *(122.1)	4+42.0	1+10.2
4	121.1	563.1	5+64.1	2+32.3
5	136.0	799.1	7+00.1	3+68.3
6	165.7	964.8	8+65.8	5+34.0
7	97.0	1061.8	9+62.8	6+31.0
8	77.8	1139.6	10+40.6	7+08.8
9	146.8	1286.4 *(A 2.4)	11+87.4	8+55.6
10	41.4	1327.8	12+29.8	8+98.0
11	55.9	1383.7	12+85.7	9+53.9
12	246.1	1629.8	15+31.8	12+00.0
13	58.0	1687.8	15+89.8	
14	53.4	1741.2	16+43.2	13+02.5
15	56.2	1797.4	16+99.4	13+58.7
16	246.4	2043.8	19+45.8	16+05.1
17	71.3	2115.1	20+17.1	
18	57.0	2172.1	20+74.1	16+98.6
19	89.4	2261.5	21+63.5	17+88.0
20	78.0	2339.5	22+41.5	
21	76.0	2415.5	23+17.5	18+92.1
22	87.7	2503.2	24+05.2	19+79.8
23	145.1	2648.3	25+50.3	21+24.9
24	86.6	2734.9	26+36.9	22+11.5
25	86.1	2821.0	27+23.0	22+97.6
26	63.2	2884.2	27+86.2	
27	75.0	2959.2	28+61.2	23+91.1
28	55.5	3014.7	29+16.7	24+46.6
29	89.0	3103.7	30+05.7	
30	68.3	3172.0	30+74.0	25+64.9
31	137.7	3309.7	32+11.7	27+02.6
32	49.1	3358.8	32+60.8	27+51.7

Sub. 100'

Corr. 331.8   340.7   375.5   425.9   470.1   160.9

See Map 340 File D-10 for revised line.

Total distance checked with adding machine 16309.5'

B.C. & S. Conduit

Sheet 2

No.		dist.	Revised Sta.	Sta. on Transit line
32		3358.8	32+60.8	27+51.7
33	61.4	3420.2	33+22.2	28+13.1
34	49.5	3469.7	33+71.7	28+62.6
35	207.4 *(207.6)	3677.1	35+79.8	30+70.2
36	56.4	3733.5	36+35.5	31+26.6
37	99.5	3833.0	37+35.0	32+26.1
38	59.4	3892.4	37+94.6	32+85.5
39	148.3	4040.7	39+42.9	34+33.8
40	71.7	4112.4	40+14.6	35+05.5
41	64.5	4176.9	40+79.4	35+70.0
42	123.4	4300.3	42+02.5	36+93.0
43	133.4	4433.7	43+35.9	38+26.8
44	108.4	4542.1	44+44.3	39+35.2
45	33.1	4575.2	44+77.4	39+68.3
46	104.2	4679.4	45+81.6	40+72.5
47	120.3	4799.7	47+01.9	41+92.8
48	127.6	4927.3	48+29.5	43+20.4
49	214.6	5141.9	50+44.1	45+35.0
50	56.0	5197.9	51+00.1	45+91.0
51	111.1	5309.0	52+11.2	47+02.1
52	51.9	5360.9	52+63.1	
53	95.0	5455.9	53+58.1	48+39.1
54	93.8	5549.7	54+51.9	49+32.9
55	125.5	5675.2	55+77.4	50+58.4
56	200.4	5875.6	57+77.8	52+58.8
57	51.4	5927.0	58+29.2	53+10.2
58	71.4	5998.4	59+00.6	
59	90.0	6088.4	59+90.6	53+98.1
60	33.2	6121.6	60+23.8	54+31.3
61	84.3	6205.9	61+08.1	
62	98.0	6303.9	62+06.1	55+05.8
63	58.6	6362.5	62+64.7	55+64.4
64	68.3	6430.8	63+33.0	56+32.7
65	167.6	6598.4	65+00.6	58+00.3
66	167.8	6766.2	66+68.4	59+68.1
67	118.5	6884.7	67+86.9	60+86.6
68	49.2	6933.9	68+36.1	61+35.8
69	65.1	6999.0	69+01.2	62+00.9
70	192.1	7191.1	70+93.1	63+93.0
71	110.6	7301.7	72+03.9	
72	75.0	7376.7	72+78.9	64+86.1

Sub. 100'

517.0   592.5   700.3

B.C. & S. Conduit — Sheet 3

No.	Distance	Diff.	Sta.	Sta.	Note
72	7376.7	73.4	72+78.9	64+86.1	
73	7450.1	183.9	73+52.8	65+59.5	
74	7634.0	49.1	75+36.2	67+43.4	
75	7683.1	150.9	75+85.3	67+92.5	
76	7834.0	74.5	77+36.2	69+43.4	
77	7908.5	207.4	78+10.7	70+17.9	792.2
78	8115.9	105.7	80+18.1	72+25.3	
79	8221.6	88.7	81+23.8	73+31.0	
80	8310.3	76.4	82+12.5	74+19.7	
81	8386.7	47.0	82+88.9		
82	8433.7	288.0	83+35.9	75+18.2	
83	8721.7	94.2	86+23.9	78+06.2	
84	8815.9	125.2	87+18.1	79+00.4	
85	8941.1	189.9	88+43.3	80+25.6	*(223.9)
86	9131.0	123.9	90+33.2	82+15.5	817.7
87	9254.9	50.7	92+57.1	84+39.4	
88	9305.6	95.9	93+07.8	84+90.1	
89	9401.5	153.7	94+03.7	85+86.0	
90	9555.2	38.9	95+57.4	87+39.7	
91	9594.1	85.0	95+96.3	87+78.6	
92	9679.1	93.0	96+81.3		
93	9772.1	66.4	97+74.3	88+46.2	
94	9838.5	175.7	98+40.7	89+12.6	928.1
95	10014.2	12.5	100+16.4	90+88.8	
96	10026.7	56.0	100+28.9		
97	10082.7	147.0	101+84.9	92+42.7	
98	10229.7	48.9	102+31.9		
99	10278.6	118.8	102+80.8	93+31.7	
100	10397.4	190.5	103+99.6	94+50.5	
101	10587.9	66.7	105+90.1	96+41.0	
102	10654.6	109.1	106+56.8	97+07.7	
103	10763.7	40.0	107+65.9		
104	10803.7	96.3	108+05.9	98+10.3	
105	10900.0	71.0	109+02.2	99+06.6	
106	10971.0	103.6	109+73.2	99+77.6	*130.6
107	11074.6	60.0	111+03.8	101+08.2	
108	11134.6	75.2	110+63.8		
109	11209.8	60.1	112+32.0	102+02.0	
110	11269.9	58.2	112+89.9	102+62.1	
111	11328.1	70.0	113+57.8		
112	11398.1		114+27.3	103+42.0	

No.	Distance	Diff.	Sta.	Sta.	Note
112	11398.1	50.5	114+27.3	103+42.0	
113	11448.6	53.5	114+77.8	103+92.5	1085.3
114	11502.1	140.0	115+31.3	104+46.0	
115	11642.1	120.8	116+71.3		
116	11762.9	52.8	117+92.1	105+36.1	1256.0
117	11815.7	40.0	118+44.9	105+88.9	
118	11855.7	47.0	118+84.9		
119	11902.7	197.5	119+31.9	106+52.0	
120	12100.2	75.0	121+29.4	108+49.5	1279.9
121	12175.2	44.0	122+04.4		
122	12219.2	74.2	122+48.4		
123	12293.4	238.3	123+22.6	109+18.3	1404.3
124	12531.7	58.5	125+60.9		
125	12590.2	201.4	126+19.4	111+48.8	
126	12791.6	121.9	128+20.8	113+50.2	
127	12913.5	107.2	129+42.7	114+72.1	
128	13020.7	75.1	130+49.9	115+79.3	
129	13095.8	58.7	131+24.8	116+54.4	1470.6
130	13154.5	56.9	131+83.7	117+13.1	
131	13211.4	108.0	132+40.6	117+70.0	
132	13319.4	204.7	133+48.6	118+78.0	
133	13524.1	97.0	135+53.3	120+82.7	
134	13621.1	47.1	136+50.3	121+79.7	
135	13668.2	225.6	136+87.4	122+26.8	
136	13893.8	207.0	139+23.0	124+52.4	
137	14100.8	84.6	141+30.0	126+59.4	
138	14185.4	91.7	142+14.6	127+44.0	
139	14277.1	73.5	143+06.3	128+35.7	
140	14350.6	74.7	143+79.8	129+09.2	
141	14425.3	199.1	144+54.5	129+83.9	
142	14624.4	91.6	146+53.6	131+83.0	
143	14716.0	115.5	147+45.2	132+74.6	
144	14831.5	122.6	148+60.7	133+90.1	
145	14954.1	250.6	149+83.3	135+12.7	
146	15204.7	121.4	152+33.9	137+63.3	
147	15326.1	232.1	153+55.3	138+84.7	
148	15558.2	269.0	155+87.3	141+16.8	
149	15827.2	221.0	158+56.4	143+85.8	
150	16048.2	361.3	160+77.4	146+06.8	
151	16409.5		164+38.7	149+68.1	

O.K. D.O.M.

Black Canyon – Southerland Conduit. No. 1

Sta.	Course	Dist	N	S	E	W	N +	E +
0+00 of Res. Site to								
	N 67°14' E	331.8	128.4		305.9		128.4	305.9
0+00	N 16°49' E	110.2	105.5		31.9		233.9	337.8
1+10.2	N 37°21' E	121.1x N.G.	96.3		73.5		330.2	411.3
2+32.3	N 47°47' E	136.0	91.4		100.7		421.6	512.0
3+68.3	N 55°00' E	165.7	95.0		135.7		516.6	647.7
5+34.0	N 26°46' E	97.0	86.6		43.7		603.2	691.4
6+31.0	N 41°14' W	77.8	58.5			51.3	661.7	640.1
7+08.8	N 57°18' W	146.8	79.3			123.5	741.0	516.6
8+55.6	N 34°34' W	41.4x N.G.	34.1			23.5	775.1	493.1
8+98.0	N 19°15' W	55.9	52.8			18.4	827.9	474.7
9+53.9	N 11°47' W	246.1	240.9			50.3	1068.8	424.4
12+00	N 4°17' W	58.0	57.8			4.3	1126.6	420.1
	N 50°19' W	53.4	34.1			41.1	1160.7	379.0
13+02.5	N 33°28' W	56.2	46.9			30.9	1207.6	348.1
13+58.7	N 19°56' W	246.4	231.6			84.0	1439.2	264.1
16+05.1	N 38°51' E	71.3	55.5		44.7		1494.7	308.8
	N 48°09' W	57.0	38.0			42.5	1532.7	266.3
16+98.6	N 8°22' W	89.4	88.4			13.0	1621.1	253.3
17+88.0	N 27°39' E	78.0	69.1		36.2		1690.2	289.5
	N 67°21' W	76.0	29.3			70.1	1719.5	219.4
18+92.1	N 41°37' W	87.7	65.6			58.2	1785.1	161.2
19+79.8	N 38°02' W	145.1	114.3			89.4	1899.4	71.8
21+24.9	N 1°09' E	86.6	86.6		1.7		1986.0	73.5
22+11.5	N 12°37' E	86.1	84.0		18.8		2070.0	92.3
22+97.6								
	N 37°40' E	63.2	50.0		38.6		2120.0	130.9
	N 57°34' W	75.0	40.2			63.3	2160.2	67.6
23+91.1	N 24°38' W	55.5	50.4			23.1	2210.6	44.5
24+46.6	N 12°53' W	89.0	86.8			19.8	2297.4	24.7
	S 83°26' W	68.3		7.8		67.8	2289.6	-43.1
25+64.9	N 58°05' W	137.7	72.8			116.9	2362.4	-160.0
27+02.6	S 38°14' W	49.1		38.6		30.4	2323.8	-190.4
+51.7	S 87°15' W	61.4		2.9		61.3	2320.9	-251.7
28+13.1	N 52°35' W	49.5	30.1			39.3	2351.0	-291.0
+62.6	N 25°09' W	207.4 N.G.	187.7			88.1	2538.7	-379.1
30+70.0			2588.0	49.3	831.4	1210.5		

Black Canyon Sutherland
Conduit
~~Stations.~~

Black Canyon - Southerland
Conduit

No 2

Sta.	Course	Dist	N	S	E	W	N+	E+
							2538.7	-379.1
0+70.2	N32°28'W	56.4	47.6			30.2	2586.3	-409.3
1+26.6	S31°22'W	99.5 (36)		84.9		51.8	2501.4	-461.1
32+26.1	S37°49'W	59.4		46.9		36.4	2454.5	-497.5
+85.5	S53°37'W	148.3 (38)		88.0		119.4	2366.5	-616.9
34+33.8	S83°18'W	71.7		8.4		71.2	2358.1	-688.1
	Tie to old cor 17-16 / 20-21							
35+05.5	S9°36'W	166.2		163.9		27.7	+2194.2	-715.8
35+05.5	N82°31'W	64.5 (40)	8.4			63.9	2366.5	-752.0
+70.0	S67°46'W	123.4		46.7		114.2	2319.8	-866.2
36+93.4	N87°05'W	133.4 (45)	6.8			133.2	2326.6	-999.4
38+26.8	N68°33'W	108.4	39.6			100.9	2366.2	-1100.3
39+35.2	S59°54'W	33.1 (46)		16.6		28.6	2349.6	-1128.9
+68.3	S71°05'W	104.2		33.8		98.6	2315.8	-1227.5
40+72.5	N64°36'W	120.3 (48)	51.6			108.7	2367.4	-1336.2
41+92.5	N6°56'W	127.6	126.7			15.4	2494.1	-1351.6
43+20.4	N8°22'E	214.6 (48)	212.3		31.2		2706.4	-1320.4
45+35.9	N23°08'W	56.0	51.5			22.0	2757.9	-1372.4
+91.0	N0°41'E	111.1 (50)	111.1		1.3		2869.0	-1341.1
47+02.1	N26°55'E	51.9	46.3		23.5		2915.3	-1317.6
	N17°36'W	95.0 (52)	90.6			28.7	3005.9	-1346.3
48+39.1	N9°07'W	93.8	92.6			14.9	3098.5	-1361.2
49+32.9	N0°21'W	125.5 (54)	125.5			.8	3224.0	-1362.0
50+58.4	N12°03'E	200.4	196.0		41.8		3420.0	-1320.2
52+58.8	N42°35'E	51.4 (56)	37.8		34.8		3457.8	-1285.4
53+10.2	N14°58'E	71.4	69.0		18.4		3526.8	-1239.3
	S79°47'W	90.0 (58)		16.0		88.6	3510.8	-1355.6
53+98.1	N52°58'W	33.2	20.0			26.5	3530.8	-1382.1
54+31.3	N12°27'W	84.3 (60)	82.3			18.2	3613.1	-1400.3
	S35°03'W	98.0		80.2		56.3	3532.9	-1456.6
55+05.5	S2°13'W	58.6 (62)		58.6		2.3	3474.3	-1458.9
+64.4	S18°44'W	68.3		64.7		21.9	3409.6	-1480.8
56+32.7	S48°23'W	167.6 (64)		111.3		125.3	3298.3	-1606.1
58+00.3	S69°21'W	167.8		59.2		157.0	3239.1	-176[illegible]
59+68.1	S40°31'W	118.5 (66)		90.1		77.0	3149.0	-1840.1
60+86.6	S81°22'W	49.2		7.4		48.6	3141.6	-1888.7
61+35.8	N56°44'W	65.1 (68)	35.7			54.4	3177.3	-1943.1
			~~1449.2~~	812.8	151.0	1406.0		

No 3

Sta.	Course	Dist.	N	S	E	W	N+	E
							+3177.3	-1943.1
62+00.9	N24°50'W	192.1	174.3			80.7	3351.6	-2023.8
63 63+93.0	N2°23'E	110.6 (70)	110.5		4.6		3462.1	-2019.2
	S59°26'W	75.0		38.1		64.6	3424.0	-2083.8
64+86.1	S85°39'W	73.4 (72)		5.6		73.2	3418.4	-2157.0
65+59.5	N80°00'W	183.9	31.9			181.1	3450.3	-2338.1
67+43.4	N30°49'W	49.1 (74)	42.2			25.1	3492.5	-2363.2
+92.5	N4°24'W	150.9	150.5			11.6	3643.0	-2374.8
69+43.4	N6°39'W	74.5 (76)	74.0			8.6	3717.0	-2383.4
70+17.9	N22°44'E	207.4	191.3		80.1		3908.3	-2303.3
72+25.3	N36°12'E	105.7 (78)	85.3		62.4		3993.6	-2240.9
73+31.0	N44°11'E	88.7	63.6		61.8		4057.2	-2179.1
74+19.7	N35°50'W	76.4 (80)	61.9			44.7	4119.1	-2223.8
	S67°34'W	47.0		17.9		43.4	4101.2	-2267.2
75+18.2	S78°53'W	288.0 (82)		55.5		282.6	4045.7	-2549.8
78+06.2	N78°05'W	94.2	19.4			92.2	4065.1	-2642.0
	Tie to water notice							
79+00.4	N36°20'W	648.0	522.0			383.9	+4587.1	-3025.9
	N0°30'W	72.2	72.2			6	+4659.3	-3026.5
	W.C. 8-9 / 17-16 S37°56'W 3634.2							
79+00.4	N12°13'E	125.2 (84)	122.4		26.5		4187.5	-2615.5
80+25.6	N46°57'E	189.9	129.6		138.8		4317.1	-2476.7
82+15.5	N55°55'E	N.G. 123.9 (86)	69.4		102.6		4386.5	-2374.1
84+39.4	N69°25'E	50.7	17.8		47.5		4404.3	-2326.6
+90.1	N89°16'E	95.9 (88)	1.2		95.9		4405.5	-2230.7
85+86.0	N58°36'E	153.7	80.1		131.2		4485.6	-2099.5
87+39.7	N78°35'E	38.9 (90)	7.7		38.1		4493.3	-2061.4
+78.6	S88°59'E	85.0		1.5	85.0		4491.8	-1976.4
	N44°35'W	93.0 (92)	66.2			65.3	4558.0	-2041.7
88+46.2	N42°24'W	66.4	49.0			44.8	4607.0	-2086.5
89+12.6	N4°09'W	175.7 (94)	175.2			12.7	4782.2	-2099.2
90+88.3	N37°01'E	112.5	89.8		67.7		4872.0	-2031.5
	N13°11'W	56.0 (96)	54.5			12.8	4926.5	-2044.3
92+42.2	N26°49'E	47.0	41.9		21.2		4968.4	-2023.1
	N16°53'W	48.9 (98)	46.8			14.2	5015.2	-2037.3
93+31.2	N18°53'E	118.8	112.4		38.4		5127.6	-1998.9
94+50.5	N10°30'E	190.5 (100)	187.3		34.7		5314.9	-1964.2
96+41.0	N31°10'E	66.7	57.1		34.5		5372.0	-1929.7
			2313.3	118.6	1070.9	1057.6		

Sta.	Course	Dist	N	S	E	W	N+	E+
							+5372.0	№ 4 -1929.7
97+07⁷	N57°49'E	109.1	58.1		92.3	(92.3)	5430.1	-1837.4
	N51°51'W	40.0	24.7			31.5	5454.8	-1868.9
98+10³	N32°56'E	96.3	80.8		52.3		5535.6	-1816.6
99+06⁶	N39°13'E	71.0	55.0		44.9		5590.6	-1771.7
+77⁶	N51°58'E	N.G. (103.6)	63.8		81.6		5654.4	-1690.1
101+08³	N71°13'E	60.0	19.3		56.8		5673.7	-1633.3
	N21°23'W	75.2	70.0			27.4	5743.7	-1660.7
102+02⁰	N29°48'E	60.1	52.2		29.9		5795.9	-1630.8
+62¹	S87°56'E	58.2		2.1	58.2		5793.8	-1572.6
	N11°34'W	70.0	68.6			14.0	5862.4	-1586.6
103+42⁹	N33°36'E	50.5	42.1		27.9		5904.5	-1558.7
+92⁵	N9°45'E	53.5	52.7		9.1		5957.2	-1549.6
	N68°25'E	140	51.5		130.2			
104+46⁸	~~S87°44'E~~	~~140.0~~		~~5.5~~	~~139.9~~		6008.7	-1419.4
	N72°01'W	120.8	37.3			114.9	6046.0	-1534.3
	~~N52°53'W~~	~~156.3~~	~~94.3~~		~~124.6~~			
105+36¹	N25°34'E	52.8	47.6		22.8		6093.6	-1511.5
+88⁹	N68°18'E	40.0	14.8		37.2		6108.4	-1474.3
	N19°06'W	47.0	44.4			15.4	6152.8	-1489.7
106+52⁰	N22°47'E	197.5	182.1		76.4		6334.9	-1413.3
108+49⁵	N86°17'E	75.0	4.9		74.8		6339.8	-1338.5
	N9°10'E	44.0	43.4		7.0		6383.2	-1331.5
	N74°36'W	74.2	19.7			71.5	6402.9	-1403.0
109+18³	N25°57'E	238.3	214.3		104.3		6617.2	-1298.7
	N86°52'W	58.5	3.2			58.4	6620.4	-1357.1
111+48⁸	N1°56'E	201.4	201.3		6.8		6821.7	-1350.3
113+50³	N2°30'E	121.9	121.8		5.2		6943.5	-1345.1
114+72¹	N37°53'E	107.2	84.6		65.8		7028.1	-1279.3
115+79³	N41°18'E	75.1	56.4		49.6		7084.5	-1229.7
116+54⁴	N13°18'W	58.7	57.1			13.5	7143.6	-1243.2
117+13¹	N8°25'E	56.9	56.4		8.3		7200.0	-1234.9
+70⁰	N21°46'E	108.0	100.3		39.0		7300.3	-1195.9
118+78⁰	N36°24'E	204.7	164.8		121.5		7465.1	-1074.4
120+82⁷	N21°57'E	97.0	90.0		36.3		7555.1	-1038.1
121+79⁷	N23°11'W	47.1	43.3			18.5	7598.4	-1056.6
122+26⁸	N14°56'E	225.6	218.0		58.1		7816.4	-998.5
124+52⁴	N30°39'E	207.0	178.1		105.5		7994.5	-893.0
126+59⁴	N16°27'E	84.6	81.1		23.9		8075.6	-869.1
			2714.4	7.6	1428.7	365.5		

Sta.	Course	Dist	N	S	E	W	N+	E+
							+8075.6	№ 5 -869.1
127+44⁰	N4°16'E	91.7	91.4		6.8		8167.0	-862.3
128+35³	N15°36'E	73.5	70.8		19.8		8237.8	-842.5
129+09²	N40°21'E	74.7	56.9		48.4		8294.7	-794.1
+83⁹	N60°34'E	199.1	97.8		173.4		8392.5	-620.7
131+83⁰	N18°01'E	91.6	97.1		28.3		8489.6	-592.4
132+74⁶	N68°21'W	115.5	42.6			107.3	8532.2	-699.7
133+90¹	N83°36'W	122.6	13.6			121.8	8545.8	-821.5
135+12⁷	N40°20'W	250.6	191.0			162.2	8736.8	-983.7
137+63³	N19°24'W	121.4	114.5			40.3	8851.3	-1024.0
138+84⁷	N10°39'W	232.1	228.1			42.9	9079.4	-1066.9
141+16⁸	N41°23'W	269.0	201.8			177.8	9281.2	-1244.7
143+85⁸	N8°02'W	221.0	218.8			30.9	9500.0	-1275.6
146+06⁸	N5°41'E	361.3	359.5		35.8		9859.5	-1239.8
149+68¹	N58°46'E	587.0	304.4 Tie to 1/4 cor.		312.5	683.2	10163.9	-1737.9

T 12 S R 2 E

Sta.	Course	Dist	N	S	E	W	N+	E+
120+82⁷	N77°40'E	283.9	60.6 Tie to N.C. Cor.		277.3 To 8|9 / 17|16		+7525.7	-797.7

Mistakes in distances of 129.2 found Dec 26, 1913 D.G.M.

This traverse must be corrected. see distances marked thus (N.G. 103.6) in traverse

[C. WARNER PROJ] CBM

ESTIMATE ON PIPE (Making and Laying Only)

Reinforced Concrete Pipe

46" -	7.34	(Bowen)
42" -	5.00	(Bent's Bid)

38" Wood Stave (Ed Bowen)

50'	head	at	$4.30
100'	"	"	5.36
150'	"	"	6.47
200'	"	"	7.53

30" Wood Stave

50'	head	at	$3.34
100'	"	"	4.15
150'	"	"	4.96
200'	"	"	5.77

24" Wood Stave

50'	head	at	$2.76
100'	"	"	3.37
150'	"	"	4.18
200'	"	"	5.09

Irrigating Flume Built with the Cement-Gun

Self-Supporting Flume with 2-In. Walls Built Up on Inside Forms—130 Linear Feet per 8-Hour Shift

CONSTRUCTION is now under way on a 6-mile line of 4 x 6-ft. flume which will convey the high-level water-supply for the Lindsay-Strathmore irrigation district in the San Joaquin Valley of California. The route follows along a side hill which has an average slope of 16°, and it was found possible to locate the flume for the most part on bench cut. Before selecting the design to be adopted, experiments were made with full-size sections. As a result of these it was decided to build a cement mortar flume with 2-in. walls, reinforced by wire longitudinal strips of wire mesh.

The walls were topped with beams which are connected at 8-ft. intervals by transverse struts consisting of ⅜-in. square rods incased in 2 x 2-in. concrete blocks for protection against rust. These struts were cast in a yard and delivered ready for putting in place, but the longitudinal beams were cast in place by hand, using forms braced from the outside.

Proper Lap in Reinforcing Important

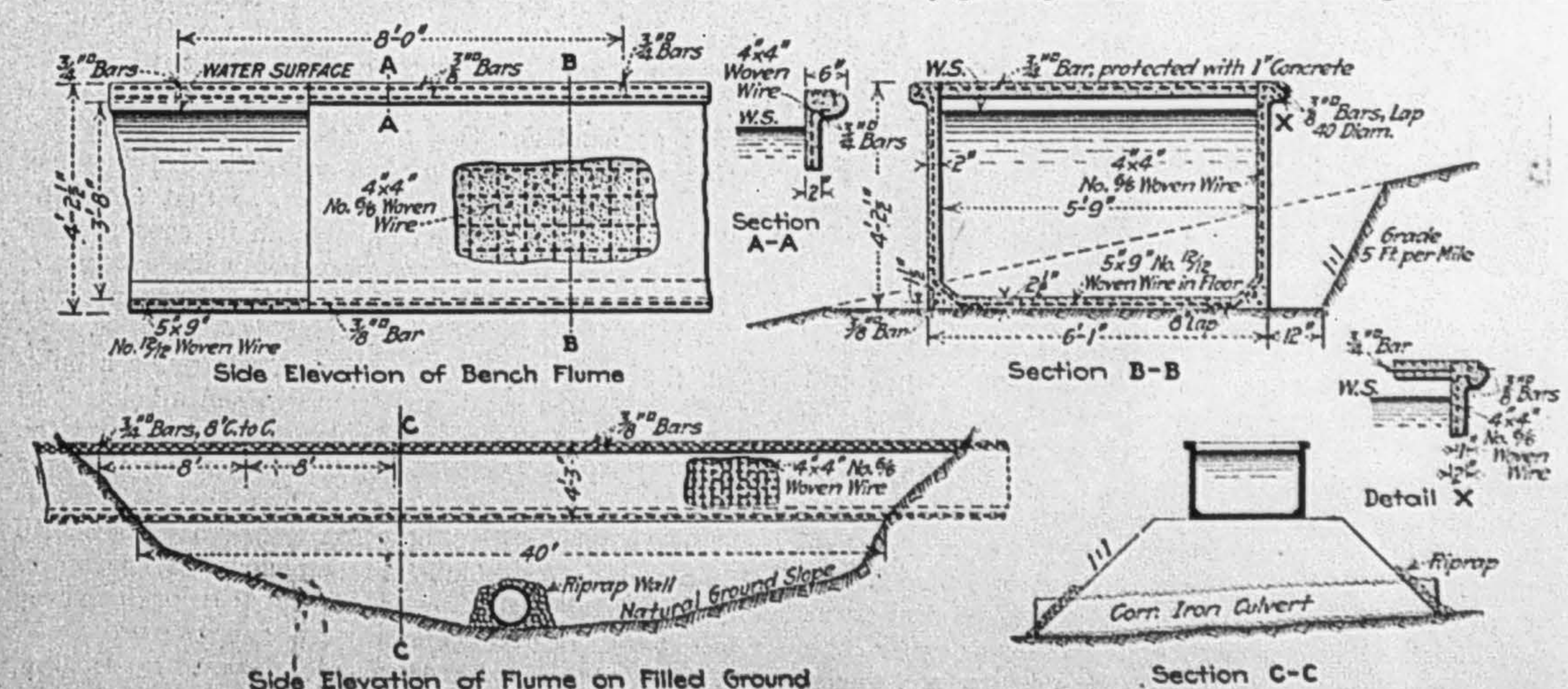
The side walls are reinforced with No. 6 woven wire mesh with 4-in. spacing both ways. The upper edge of the reinforcing in the side walls is bent around the ⅜-in. bars which reinforce the longitudinal beam 4 in. deep and 6 in. wide. The floors, which are 2½ in. thick on solid cut, are reinforced with No. 12 woven wire mesh with 5 x 9-in. spacing. This reinforcing is laced to the side reinforcing with No. 10 wire. The reinforcing mesh comes in rolls 5 ft. wide, which allows enough for attaching to the beam reinforcing on top and lapping the floor reinforcing at the bottom.

At the beginning of the work, sand, cement and lime were placed in piles 100 ft. apart along the flume line. It was soon found, however, that by spacing the materials at 50-ft. intervals the capacity of the plant was increased 15%, and this spacing was thereafter used. Materials were delivered to the work by two 5-ton motor trucks operating on the bench ahead of the flume. The use of the bench as a roadway was considered an advantage in helping to pack down the fills.

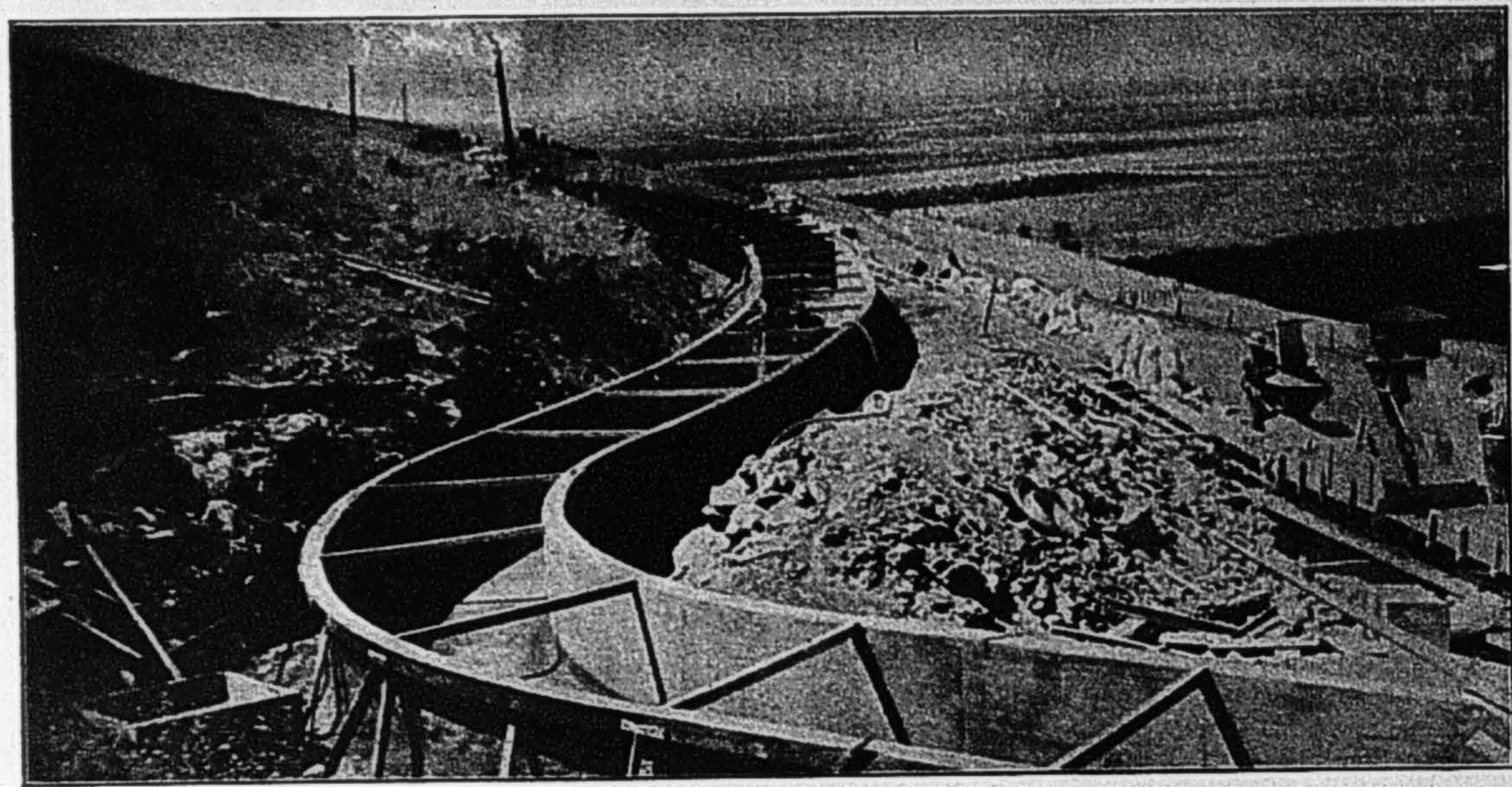
The Cement-Gun Train

The cement-gun was found to operate most economically when within 50 ft. of the point of application. To keep it within this range, a narrow-gage track was laid parallel to the flume and just below it, and the gun is moved along this track. Two trailers were attached to the truck on which the gun was mounted. The one next the gun carries a 4 x 6-ft. box, 1 ft. deep, and is equipped with an inclined screen, while the rear truck serves as a measuring box into which cement, sand and lime are placed in proper proportions, mixed dry and shoveled through the screen into the forward box. From the forward box it is shoveled into the gun hopper as required. The mix consists of one part cement plus 10% hydrated lime and 4½ parts of coarse sand.

A compact type of gas-engine-driven air compressor supplied by the cement-gun manufacturers provides air at 45-lb. pressure for operating the gun. This equipment is kept on the bench ahead of the flume, and a 2-in. pipe parallels the flume with taps every 100 ft. With this equipment the operators claim that about 25% additional capacity is secured through operating an additional nozzle so that throughout the work only one nozzle has been served by the gun. Water for the gun is supplied from a 2 x 3-in. double cylinder pump driven by gas engine and attached to the gun train. It



DESIGN BASED ON TESTS OF FULL-SIZED EXPERIMENTAL SECTIONS

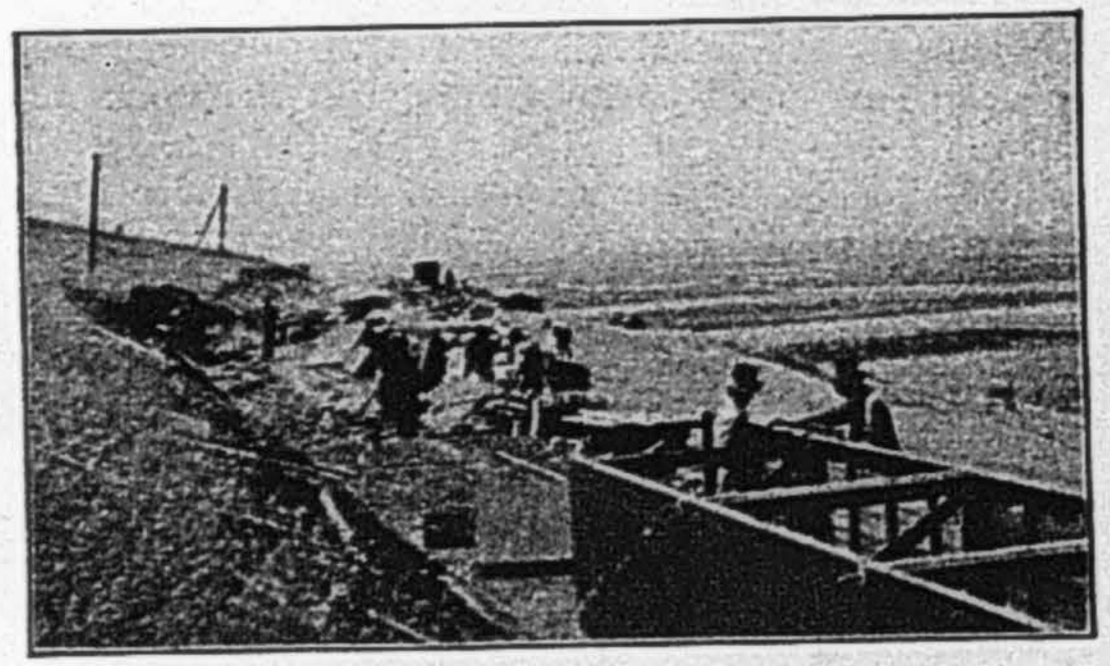


ROUTE FOLLOWS A HILLSIDE

was found that the two rubber nozzles, one at the discharge end of the hose and one between the gun and the hose, required replacement after about every 300 cu.yd. of material.

Wood Forms Used Repeatedly

In starting a new section of the work the wood forms for the walls are first set up, and the reinforcing is attached to them. Inside forms only are used and are made up in 8-ft. sections from 1-in. tongue and groove flooring, well studded and braced. A wood block is used



ONLY INSIDE FORMS ARE USED

to keep the forms the required distance above the grades. The forms are kept well oiled and after having built 1½ miles of flume were still in good shape. About 500 lin.ft. of forms are in use, and the cost of repairing these on the first 1½ miles of flume was $28. Six standard curves are used, these being of 25-, 50-, 100-, 150-, 200-, 250-ft. radii respectively. The forms for these curves are made up of light steel plate fastened over a wood framework. In the use of these steel forms it is notable that considerable difficulty was experienced in making the cement adhere to the steel surface, enough to prevent "overhang."

The reinforcement in the walls is placed 1¼ in. from the inner face of the flume. This spacing is maintained by 1¼ x ½-in. bars placed between the form and the reinforcing wire, which are removed when the concrete is shot up to this depth. The side walls are shot first and immediately followed by the beam, which is poured by hand into a form clamped to the wall form. Material for this beam is provided by mixing the rebound or wastage from the side walls with 33⅓% of cement. This rebound is caught on canvas previously placed along the bottom of the wall form. The forms are left on 24 hours and, finally, after their removal, the floor slab is shot with the gun.

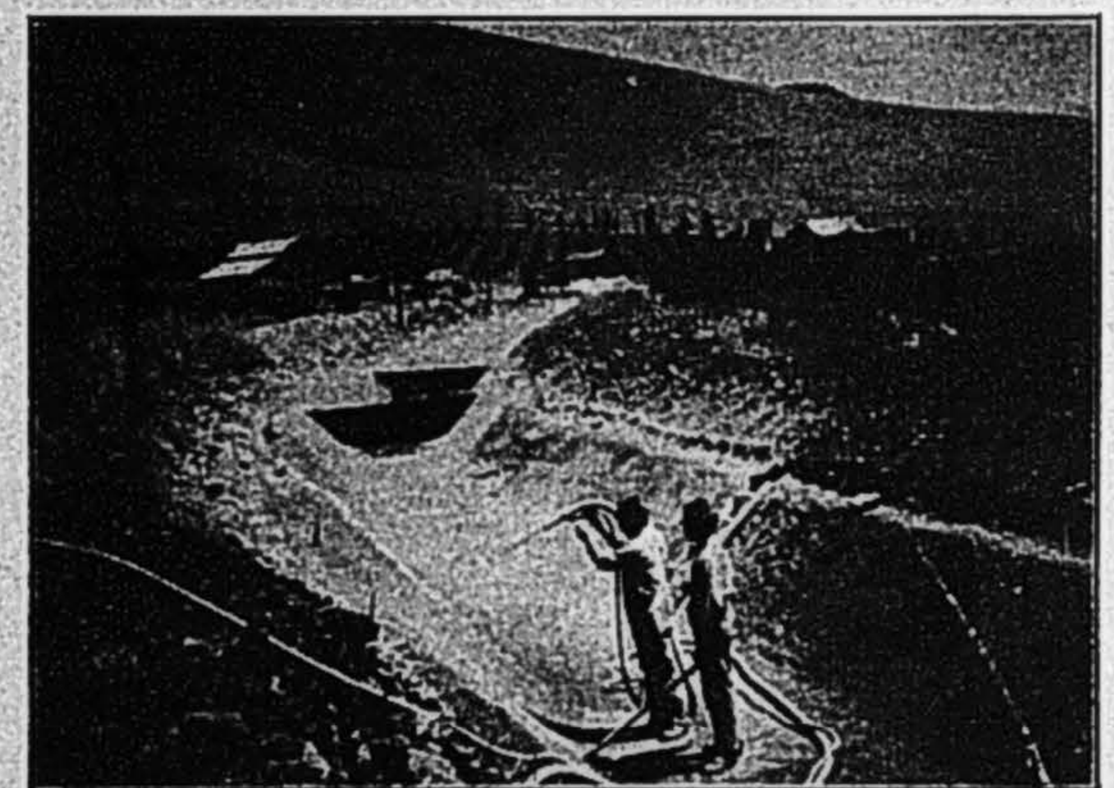
Finished Flume Kept Full

Near the upper end of the flume, water from wells is pumped into it and allowed to flow down to a bulkhead near the point where work is under way. The flume is bulkheaded at close intervals with a light wooden bulkhead faced with gunite, so that the mortar is kept wet during the setting period and water is always at hand for the gun and for hosing exposed surfaces. Permanent radial breast gates are provided at approximately one-mile intervals, so that after the flume is in operation its contents can be conserved in case of a shutdown. These were not made automatic, as it was not believed that this additional expense was warranted.

On the completion of a section of the flume a bulkhead is placed at the downstream end and a hole cut in the bulkhead of the preceding day's work to admit the water. Previous to this, immediately after the side walls are constructed, burlap is hung over the walls and is sprinkled with a hose during the day time until this section of the flume is completed and the water admitted. With this procedure the curing has been effected without developing any cracks whatever.

To reduce the likelihood of cracks caused by settling, the thickness of the bottom slab is increased to 3 in. over fills and the reinforcement is here made the same size as that used in the walls. The fills, however, are not over 10 ft. in height and average about 6 ft. They were placed about 8 months ahead of flume construction and before the rainy season was over. Specifications called for wetting and tamping in thin layers. However, on those fills which showed considerable settlement, the flume was supported on three longitudinal beams running down to solid material. Culverts were placed for all watercourses, and cross drains of 6-in. sewer tile were put under the flume at 400-ft. intervals to take care of all drainage from above the bench.

The gun crews work 8 hours per day, the crews usually being made up as follows: One gun operator; 1 nozzleman; 1 nozzleman assistant; 1 compressor operator; 1 laborer shoveling sand, etc.; 2 laborers



CREW PLACED 130 LIN.FT. PER SHIFT

screening; 4 laborers mixing and turning material; 10 laborers finishing grade and wrecking forms; 4 men placing steel; 3 men setting forms.

This crew can place about 130 lin.ft. of flume, or 147 cu.yd., per 8-hour day. The side walls are shot in two layers. The first layer, which comes up to and covers the reinforcement, is 1½ in. thick; and after this has set for 20 min., the final outside layer of ½-in. thickness is applied. In shooting these walls it is found that the rebound which collects on the canvas strips at their base amounts to about 10% of the material which adheres to the forms. In remixing this rebound for use in the longitudinal beams it is considered as inert sand, although doubtless it has a certain per cent. of cement content. The crew which remixes this rebound follows the gun crew immediately, so that there is no time for initial set to have taken place between the two operations.

The flume was designed and constructed under the supervision of Stephen E. Kieffer, M. Am. Soc. C. E., consulting engineer, of San Francisco. The contract for the work is held by James Kennedy, of Los Angeles.

Harlem River Draw Is 389 Ft. Long

The swing bridge of the New York Central Railroad across the Harlem River, which was repaired by the unusual pin bushing method described in our issue of Aug. 9, has a swing span 389 ft. long, instead of 310, as by error marked on the drawing shown on p. 245.

Well Yields Different Water After Being Sealed a Year

Peculiar Phenomenon in Saratoga Springs District—Change from Soda to Salt Water with Burst Upon Pumping

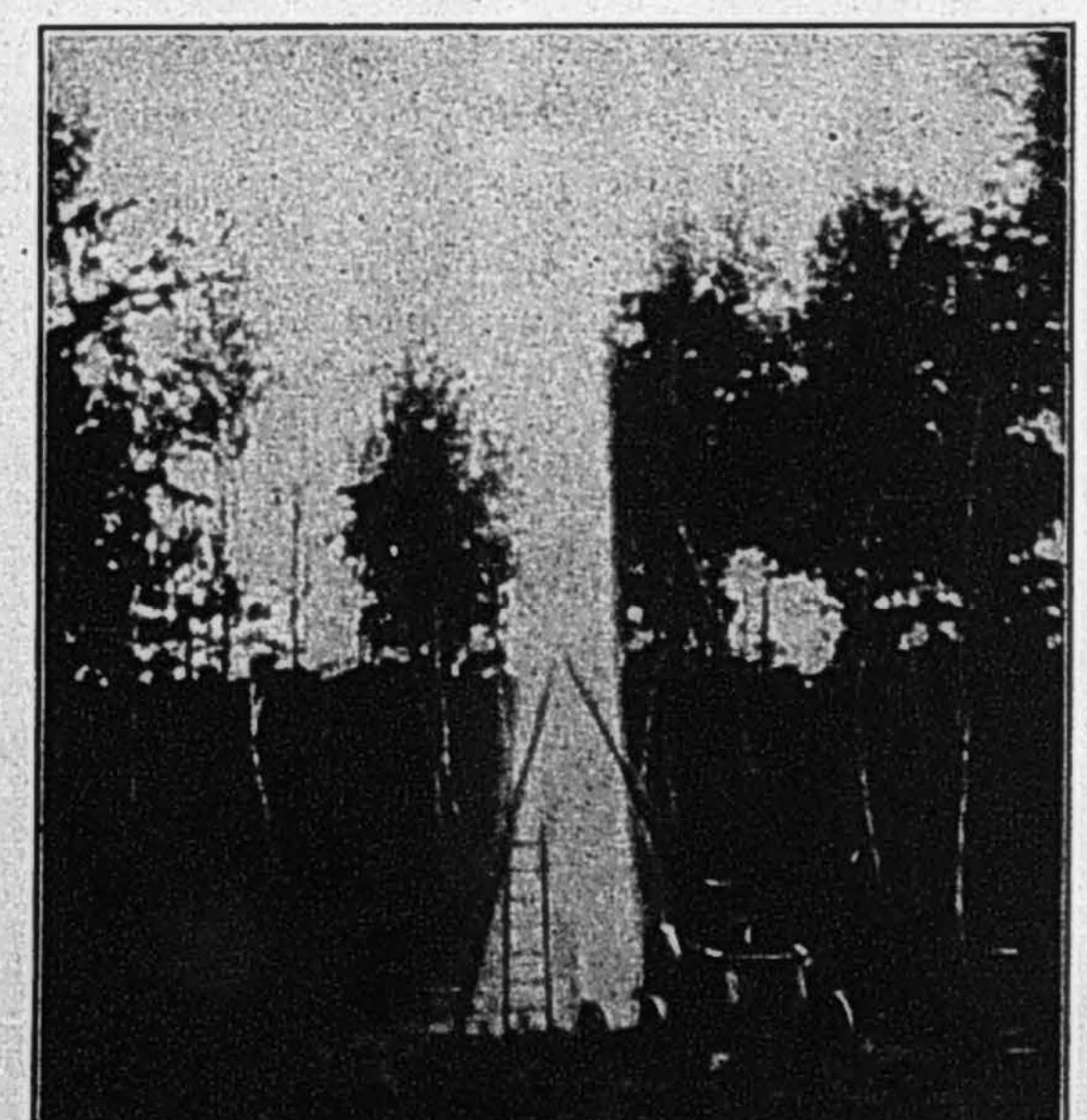
By Charles G. Anthony
Chief Engineer, State Reservation, Saratoga Springs, N. Y.

Among the many interesting natural phenomena observed in the series of studies in the mineral water basin of Saratoga Springs conducted during the last few years, the following changes in the character of the yield of a deep well within a year after it was drilled may be noted.

In 1914 a 6-in. drill hole was sunk to a depth of 420 ft. at Saratoga Springs for purposes of experiment and observation. The drill passed through a heavy deposit of drift and Hudson River shales and terminated in limestone. The well was dry for 150 ft. Below this depth an abundance of water was found.

As soon as the shales were penetrated, a strong odor of sulphuretted hydrogen gas became apparent. A few hours after the appearance of water in the hole, the water bubbled and effervesced as do all the Saratoga mineral waters. The other springs and wells in this basin show large quantities of CO_2 gas with now and then a trace of sulphuretted hydrogen, while the experimental bore showed large quantities of sulphuretted hydrogen and just a trace of CO_2 gas.

When a vessel was filled with the thick muck brought up by the sand bucket, the mass exhibited a curious behavior, rising and flowing over the edges of the vessel like batter until a large collection of gas that had formed in the interior of the mass came to the surface and passed off into the atmosphere. The contents of the vessel then seemed to collapse and sink to about one-



A SIX-INCH STREAM OF FROTHY WATER SPOUTED TO THE TOPS OF THE NEIGHBORING PINES half of its original volume. At short intervals this mass would again overflow the vessel until it was practically empty. The chemist found the gases thus given off to be mainly sulphuretted hydrogen with a small admixture of hydro-carbon gases.

After reaching a depth of 420 ft. the well was thoroughly sand bucketed and pumped until a clear, sparkling sample was obtained. The result of an analysis was a complete surprise, for the water had very few of the characteristics of the Saratoga waters. The water was quite devoid of chloride of sodium but carried a very large amount of sodium bicarbonate. All of the other springs show sodium chloride ranging from a minimum of 2091 to a maximum of 10,646 p.p.m., yet not a trace could be found in this water.

The well was pumped to capacity (10 gal. per min.) for a few days, then closed by means of a cap placed at the top of the 6-in. casing.

ANALYSIS UNCHANGED AT FIRST

A year later the well was opened, a deep-well pump installed and by means of rubber seals the well was pumped in successive 20-ft. sections. Yields from 0 to 10 gal. per min. were found, but a complete analysis showed the water to be the same as that analyzed the year before.

On the eighth day after pumping started the well belched forth great quantities of CO_2 gas, the tubing and seals were thrown high in the air and were shortly followed by a 6-in. stream of frothy water that spouted over the tops of the neighboring pine trees. A separator was installed and careful measurement showed a ratio of 120 volumes of gas to 1 volume of water. An analysis of this water showed that the mineralization had doubled and that the water then contained 5707 p.p.m. of sodium chloride and no sodium bicarbonate. The total mineral contents at this time were 10,419 p.p.m., against 6533 a year before.

States Spend $33,087,410 for Roads

Out of a total outlay of $85,099,088 for permanent improvements by the 48 states of the Union within the year, $33,087,410 went for the construction of new roads and the permanent improvement of existing highways. The figures given are from a report on the "Financial Statistics of States, 1916," compiled under the direction of Starke M. Grogan, chief statistician for statistics of states and cities, which will be published by S. L. Rogers, U. S. Bureau of the Census, Washington, D. C. More than half of the road outlays covered by the total given were made in two states, New York having spent $10,742,913 and California $7,706,376. Maryland expended $3,563,697. The circular issued by the Bureau of the Census says further: "Only 21 states—Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Ohio, Michigan, Minnesota, Maryland, Louisiana, Montana, Idaho, New Mexico, Arizona, Utah, Washington, Oregon and California—expended money directly on the construction and improvement of roads during the fiscal year, but a number of the other states apportioned sums to counties, municipalities, etc., which were spent in the construction and improvement of roads."

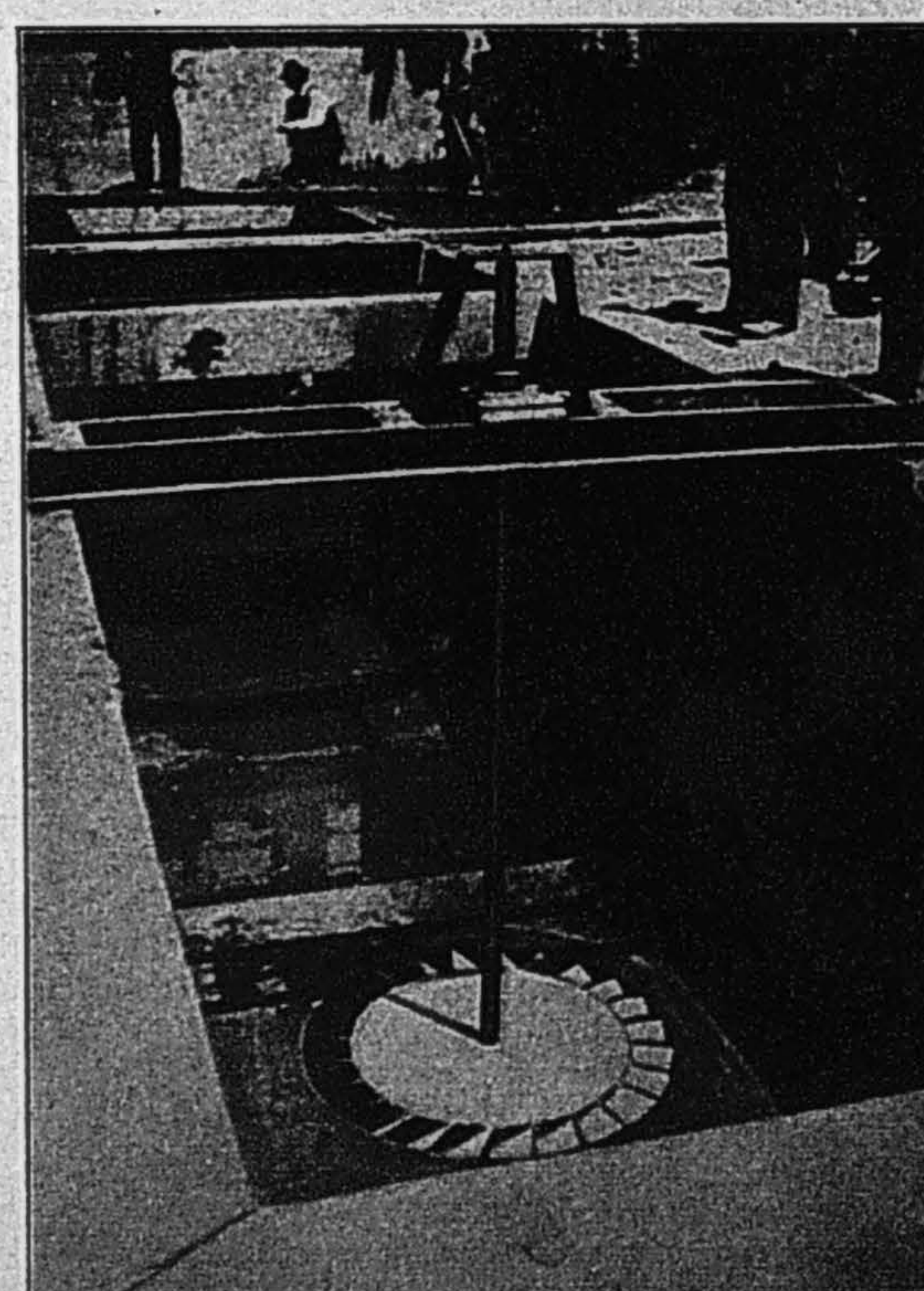
Los Angeles Sets Large Velocity Meter in Open Conduit

Costing $800, It Registers on Less Than One Second-Foot, Showing an Efficiency Greater Than 98 Per Cent.

BY J. E. PHILLIPS
Engineering Department, Bureau of Water-Works and Supply, City of Los Angeles

THE NECESSITY for some means of accurately measuring and recording the daily amount of water supplied to the City of Los Angeles, Calif., through the several main trunk lines led to the construction and installation of a large meter at the south portal of Franklin tunnel where the aqueduct supply enters the Upper Franklin reservoir. It was designed by William Mulholland, chief engineer of the Los Angeles City Water Department, and built and installed under the supervision of Fred J. Fischer, chief mechanical engineer.

The meter operates on much the same principle as the so-called velocity-crest meters, its size and the results obtained with it being the main features of interest. It was placed in an uncovered, concrete-lined conduit, at which point the quantity of water at present passing varies from 10 to 50 or more sec.-ft. The value of the meter as a measuring device depended upon whether or not, between the above limits, a constant quantity of water would pass the meter per revolution of the propeller wheels. The results obtained with the one in-



METER IN PLACE BEFORE WATER TURNED THROUGH

MAP SHOWING
COMPARATIVE PLANS FOR POWER DEVELOPMENT
WATER FROM
WARNER AND SUTHERLAND RESERVOIRS
LETTER OF SEPT. 25, 1917
Thos. P. Ellis

LEGEND:
ESTIMATE #1 —— BAUM
" #2 - - - POST - - -
" #3 ——— ELLIS ...

Merriam Res.

Contours	Depth	Area	Ac. Ft.
1030	100	133	3341
1040	110	158	4796
1050	120	176	6466
			21
			64
960			

D. Q. M.

If the draft is 4 ac ft per day for 95 days or 380 ac ft. then 34 sec ft may be turned in for 67.3) 6780 (100 days.

Merriam Dam

Earth fill

130' high to 1060' contour

20' wide on top

upstream slope 2½ to 1

downstream slope 2 to 1

480,000 yds.

D. Q. M.

1-4-18.

85000 cu yds of earth for dike

.07 cu yds

3000 lbs to the

300 lbs to the ft

16 ft 1 ton

16) 72300 (5000 tons

.08 cu yds aggregate

15 lbs to the foot

400 ton

8 miles 5300

37,100 ft.

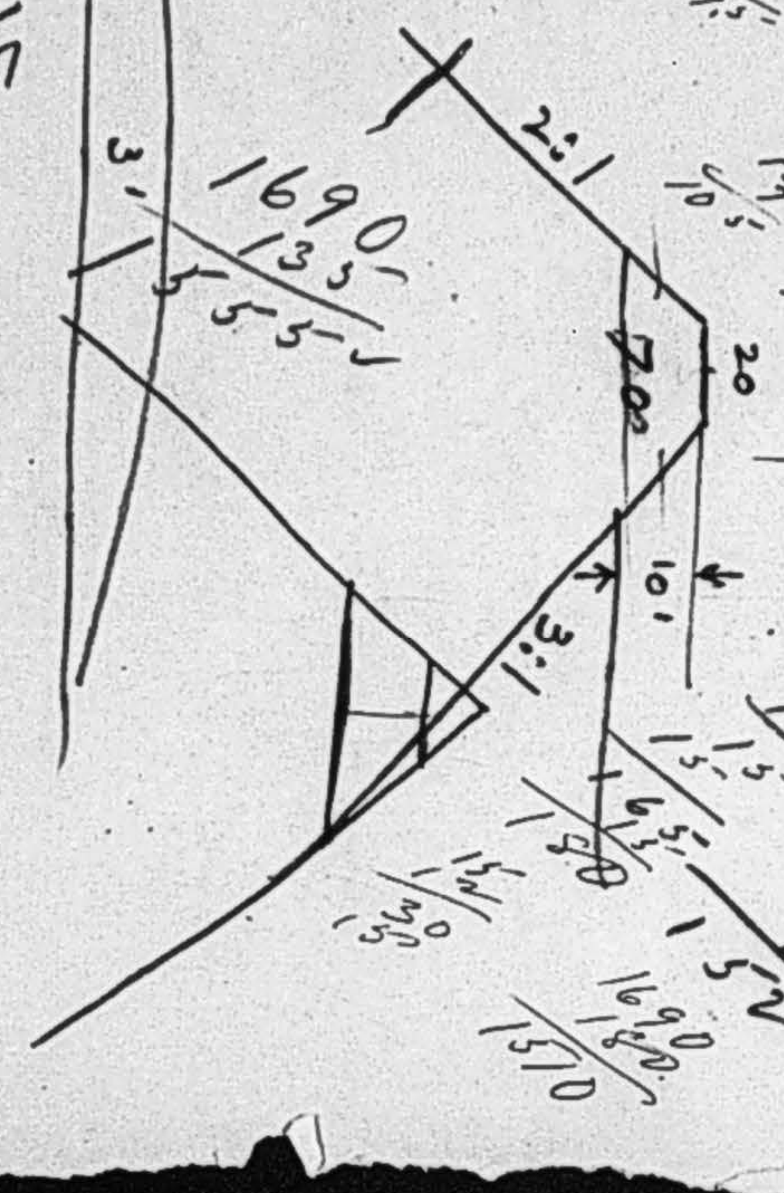
18 5 5,000 lbs

9 27 tons

1 sack .01 cu yds cement

9.5 miles

13 miles



Burnt Mt. Res.

Elev.	Depth	Area	Capac. ac. ft.
820	50	123	2605
830	60	160	4020
840	70	197	5805

Various locations & costs Warner - Merriam Conduit
Water supplied to the ...
VISTA IRRIGATION DISTRICT

(1)

The gross acreage of this district is about 40,000 acres of which perhaps 25,000 acres are subject to irrigation. The following figures assume a 22 M.G.D. supply from Warner Reservoir conveying to Merriam Reservoir at Living Oaks for distribution. Figures comparative only.

Estimate No. 1. (S.L.Rey River - Esc Ditch + W.M. Conduit)

Water from Warner Dam via San Luis Rey River and Escondido Ditch to San Pasqual Indian Reservation thence by westerly by newly constructed conduit to Merriam Reservoir.

Warner Dam 107 ft water line	$ 307,000
Along channel of San Luis Rey River	
Relining of Escondido Ditch 10½ Mi @ $8,000	84,000
42" Wood Stave pipe S.P. Ind Res to Merriam Power Drop	
10 miles @ $15,000	150,000
500 ft drop 2000 ft of steel pipe @ $10	20,000
Generating Plant	10,000
Merriam Dam	75,000
	$ 646,000

Estimate No. 2 (New const. throughout 29 miles)

Water from Warner Dam via wood stave pipe along 2600 ft elevation to Roderick Mt power drop, thence along 1700 ft elevation to Merriam Power Drop.

Warner Dam 107 ft water line	$ 307,000
Along 2600 ft elev. to Roderick Mt Power Drop	
42" wood stave pipe 13½ mi @ 15,000	202,500
840 ft drop 2600 ft of steel pipe @ $10	26,000
Generating Plant	10,000
Along 1700 ft elevation to Merriam P. Drop	
42" wood stave pipe 15 mi @ 15,000	225,000
500 ft drop 2000 ft of steel pipe @ $10	20,000
Generating Plant	10,000
Merriam Dam	75,000
	875,000.

840
500
1340 ft
P. drop

44" concrete pipe at 1.25 per 1000 or 6.6 ft per mile will carry 22 million gallons per day

(2)

Estimate No 3 (New to Esc Intake - Esc Ditch - W.M. Conduit)

Water from Warner Dam via wood stave pipe along 2600 ft elev to Esc. Intake Power Drop thence along Esc. Ditch to San Pasqual Ind Res. thence along 1700 ft elev to Merriam Power Drop

Warner Dam 107 ft water line	$ 307,000
Along 2600 ft elev. to Esc. Intake Power Drop	
42" Wood Stave pipe 10 mi @ 15,000	150,000
814 ft drop 1300 ft of steel pipe @ $10	13,000
Generating plant	10,000
Relining Escondido Ditch 10½ mi @ $8,000	84,000
Constructing along 1700 elev. to Merriam P. Drop	
42" Wood Stave pipe 10 miles @ $15,000	150,000
500 ft drop 2000 ft of steel pipe @ $10	20,000
Generating Plant	10,000
Merriam Dam	75,000
	$ 819,000

34 sec ft (min.) = (723.8 X 34) acft year

24,610

with storage of

4(24,610

6,152 acft. + a some

4(24,610 what larger conduit this

6152 could be delivered in 8 mos

Warner - Pamo - Vista Conduit.

Water supplied to the

VISTA IRRIGATION DISTRICT

The following comparative figures are to show the net cost of conducting 22 M.G.D. of Warner Water to Vista Irrigation District. The Pamo & Sutherland water not considered nor the cost of storing or carrying such. Same to be diverted from main conduit at San Pasqual to fill San Clemente

__Estimate No. 1.__ (Via 25,407 ft tunnel & Lomas Muertas Conduit)

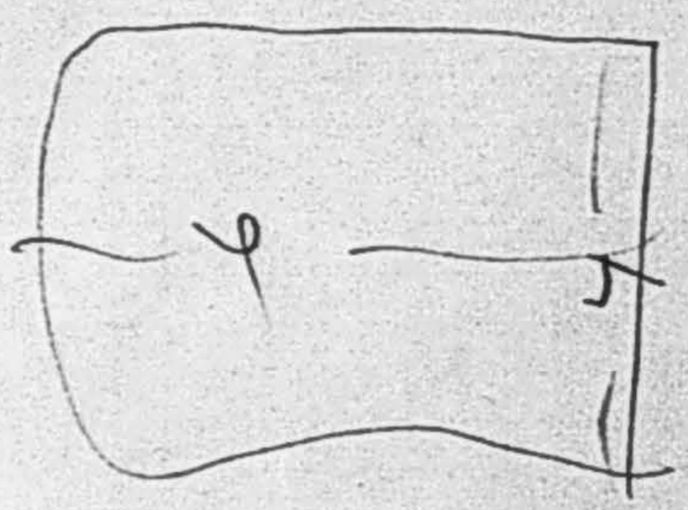
	Warner Dam 107 ft water line	$307,000
	Tunnels 5.84 miles @ $116,160 (22.0 per ft)	678,374
(8.3 miles)	R.W. Conduit 2.46 " @ $15,000	36,900
	{Pressure pipe to P.H. 1.26 " @ 19 per ft {Head 1590 feet	124,400
	Power House	10,000
	Thru Pamo (Resr not built) (2¼ miles) —	
	Along Lomas Muertas Conduit	
	To San Clemente Branch R.W. pipe 11 miles @ 15,000	165,000
24 mi.	from 11th mile to Lower Merriam Resr	
	R.W. pipe 13 miles @ 15,000	195,000
	Balance of distance for correct comparison	
4	4 miles @ 15,000	60,000
36.3	Lower Merriam Dam	75,000
other 2.2 / 38.5 mi		$1,651,674

Additional cost necessary to carry Pamo & Sutherland Water to San Clemente via above conduit enlarged to carry 50 M.G.D crossing Santa Ysabel Cr. from North to South side near East line of Bernardo Ro.

(See page 4)

__San Clemente Aux__ (Add'l to use Sutherland Pamo Water)

	Sutherland Dam	140 ft	720,000
	Power conduit	4.78 miles 15,000	72,000
	Pressure Pipe	0.47 " (910 ft) @ 53,000	25,000
	Power Plant		10,000
	Thru Pamo Resr		—
	Pamo Dam		1,360,000
	11 miles of 50 M.G.D. Conduit	$25,000	275,000
	(22 M.G.D. of this is accounted for)		—
20 mi addl	20 miles addl to carry 30 M.G.D.	25,000	500,000
	San Clemente Dam		690,000
			$3,652,000



[orig. signed by Ellis - in his file] csm

SAN DIEGO, CALIFORNIA, October 24, 1917

Col. Ed Fletcher,
Office.

Dear Sir:-

This is a memo to correct your notes:-

WARNER - SUTHERLAND HYDRO-ELECTRIC POWER DEVELOPMENT

(Lengths in feet)

	Tunnels	Total Conduit	Pressure Pipe	Head
Post's Pine Mt. High Pressure	11,000	46,850	6,670	1,500
Post's Kerr Mt. Low Pressure	-	24,063	2,000	890
		13.43 miles	1.64 miles	
Baum Blk Mt. Circuit High Pressure	19,550	54,082	4,460	1,542
Low Pressure	820	36,233	2,250	849
		17.11 miles	1.27 miles	
Fletcher - Ellis Blk Canyon - S.Y. Circuit				
High Pressure	25,400	49,542	6,650	1,570
Low Pressure	820	25,215	2,480	860
		14.16 miles	1.73 miles	
Fletcher - Ellis Alternate Via Quoquaffe Tunnel High Pressure	30,840	43,411	6,665	1,576
Low Pressure	820	25,215	2,480	860
		13 miles	1.73 miles	

m+o 4%
+ $9 per Kw year
10% Interest + sinking fund.

2,259,208
04
90368.32

4119
8.75
20595
28833
32952
36041.25

225920

45,850 / 1,118,000 = 1/30
2%

1118,000
4
4472000

4119
50
205950

280000
280) 2,259,208 (.8
2240000

2,259,208) 280000.0 (.12
225920 8
54 07920

Theoretical HP 1520
Salable HP 2/3 520 x 2 = 1040
" ~~Kw~~ 3/4 of 1040 = 4)3120
780

17) 2600 (153
17
90
85
50

153
17
1071
153
2601

150
14
60
15
2100

21 ac ft.

1 sec ft = 723.8 ac ft / year

1,135 x 15.5 x 89
89
1395
1240
13795
1.14
55180
13795
13795
15726.30

1.13 x 60 x 7 420

592,000
1667208
2259,208

To produce this income & deliver power to S. D — ~~Sutter~~ R 592,000

Warner Elec. 1,118,000
Const 549,208
1,667208

$\frac{3}{4} \times \frac{3}{4} = \frac{9}{16} = 0.562$

16)90(0.562

A

$\frac{1500 \times 62.4 \times 34}{550}$ (.113) = 16)5763(360.2 9/ — 3242.0 + 877 = 4119 ✓

$\frac{890 \times 62.4 \times 15.5}{550}$ (.113) = 16)1559(97.44 9/ — 876.96 — 877. ✓

B

$\frac{1542 \times 62.4 \times 34}{550}$ (.113) = 16)5924(370.25 9/ — 3332.25 — 3332.0 + 998 = 4330 ✓

$\frac{849 \times 62.4 \times 18.5}{550}$ (.113) = 16)1774(110.9 9/ — 998.0 ✓

C

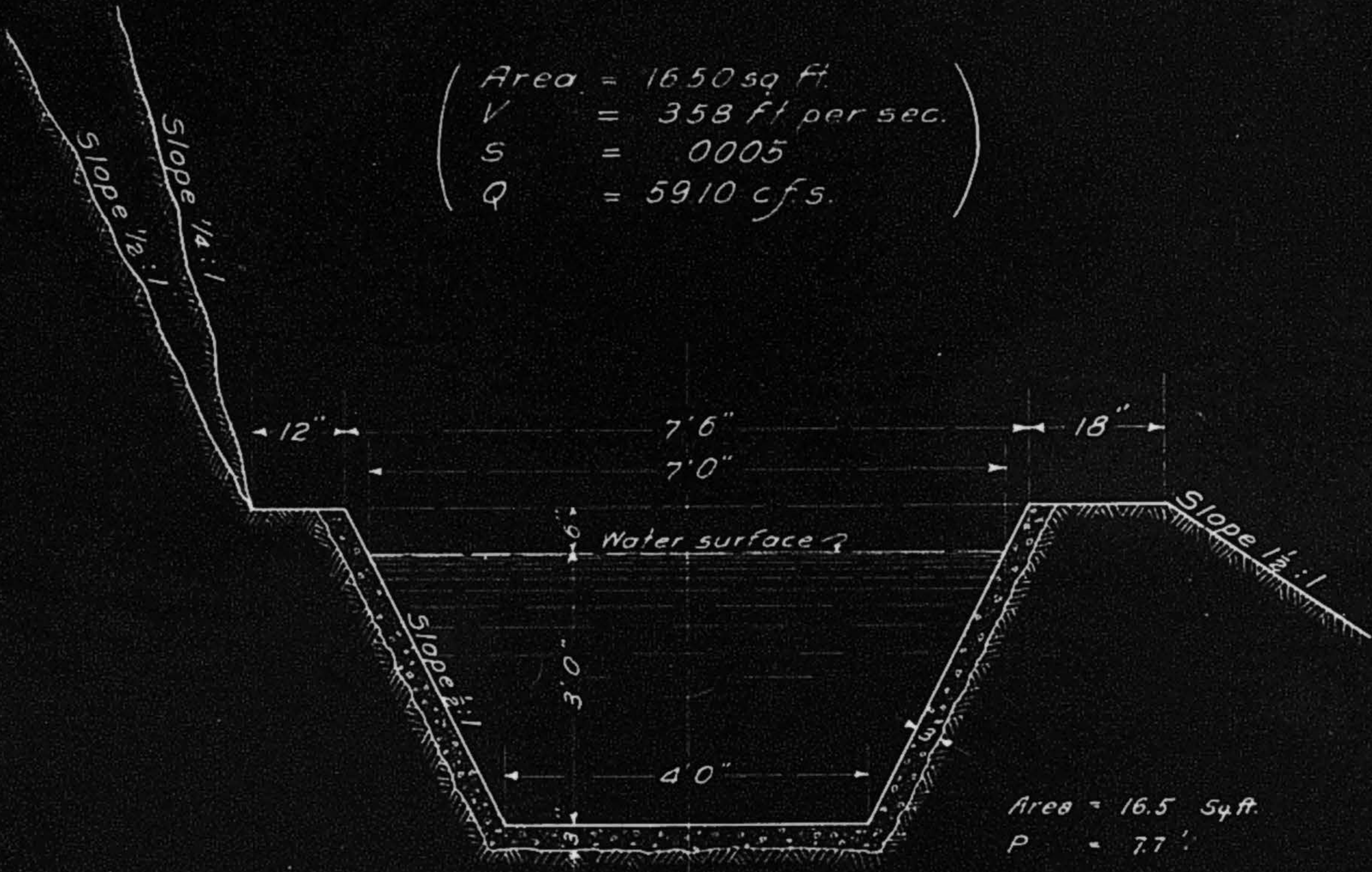
$\frac{1570 \times 62.4 \times 34}{550}$ (.113) = 16)6032(377 9/ — 3393 — 3393 + 1012 = 4405 ✓

$\frac{860 \times 62.4 \times 18.5}{550}$ (.113) = 16)1798(112.4 9/ — 1011.6 — 1012 ✓

D

$\frac{1576 \times 62.4 \times 34}{550}$ (.113) = 16)6055(378.4 9/ — 3405.6 — 3406 + 1012 = 4418 ✓

$\frac{860 \times 62.4 \times 18.5}{550}$ (.113) = 16)1798(112.4 9/ — 1011.6 = 1012



Area	=	16.5 Sq. ft.
P	=	7.7'
Hy. R	=	2.14'
S	=	.001
Adopt ...... n	=	.015
C	=	113
V	=	5.2' per sec.
Q	=	86. c.f.s.

VOLCAN LAND & WATER CO.

WARNER CONDUIT

CANAL

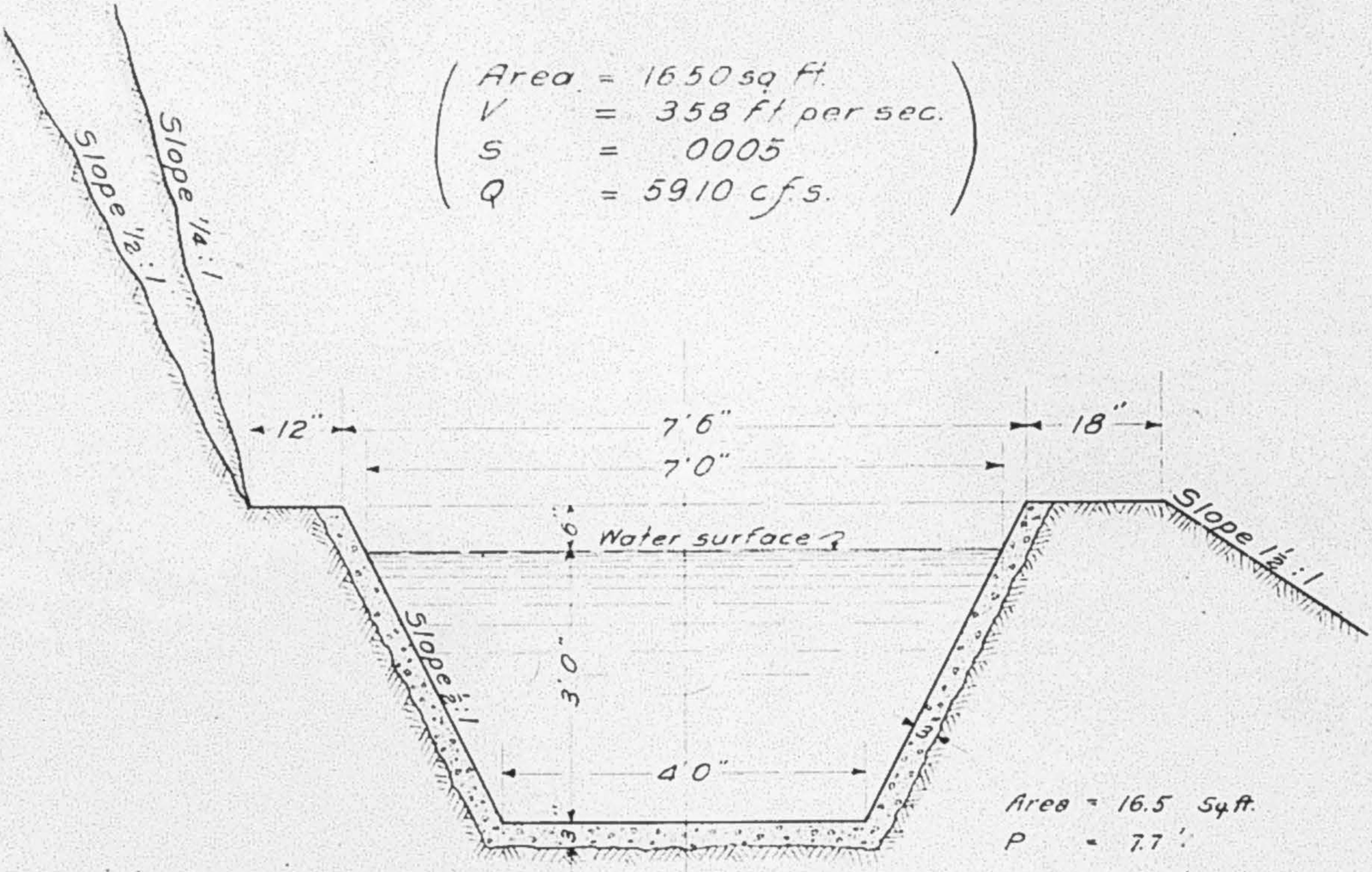
FOR GRADE OF .0005

SCALE : 1/2" = 1'

W. S. POST, Eng'r DEC. 1, 1914

Drawing No. 484
File No. T-1

Area = 16.50 sq ft.
V = 3.58 ft per sec.
S = .0005
Q = 59.10 c.f.s.



Area = 16.5 Sq.ft.
P = 7.7'
Hy.R = 2.14'
S = .001
Adopt ...... n = .015
C = 113
V = 5.2' per sec.
Q = 86. c.f.s.

VOLCAN LAND & WATER CO.
WARNER CONDUIT
CANAL

FOR GRADE OF .0005

SCALE : $\frac{1}{2}"$ = 1'

W. S. POST, Eng'r DEC. 1, 1914

Drawing No 484
File No T-1

Pricon Incline

Incline cost 50¢ ft.
Haul " 50¢
Material in pipe 1.60
Labor → 1.10

Merriam Conduit

Haul per ft. 35¢
Laid 35¢
Excav + backfill. 1.60
Pipe cost. 3.00 3.00
$5.30
.90
$6.20

1650
1500
150
95
90
30

68
50
20

1.20
200

4 675
25¢

53000
16
53000
1
318000

300

πr²

.45 yd in 3 ft.
.15 yd in 1 ft.

6/3.00
6/3.70
5/10

.90
.50
.20
1.60

75 ft.
50
50

1.20

17,50,000
70,01,000
50,000
4,0000
30.30
90) 30

THE PURPOSE OF THIS REPORT is to set down and arrange the results of various surveys and estimates as have to do with the economic delivering of twenty-two million gallons of water per day from Warner Reservoir to the proposed Irrigation District (of 37,000 gross acres) extending from Escondido to Oceanside, California: and to give as complete an estimate of cost for each alternate route as the preliminary nature of such data will permit.

In estimate No. 1, a continuous pipe line is adopted extending from the portal of the outlet tunnel at Warner Damsite westerly twenty-nine miles to Merriam Reservoir. The Merriam Reservoir is situated at the head of the South Fork of Moosa Canyon in the Merriam mountains and borders the east limits of the proposed Irrigation District, and is at such elevation that the outlet pipe will supply gravity water to all tillable lands within the proposed district.

Estimate No. 1. presents a highly advantageous development for this proposed district. It co-ordinates the power, agricultural and domestic supply possibilities and presents minimum losses of water and head. More extensive surveys, and special agreements, and the ultimate values of water for power and both domestic and irrigation use may alter any of these figures.

Monarch - Merriam Conduit System

Outline accompanying Estimate No. 1 (see map)

WARNER RESERVOIR provides the storage for this system with a 107 foot dam, with capacity of 203,000 ac. ft. This allows a net safe yield of 34 sec. ft. or 22 M.G.D. The outlet grade has an elevation of 2640 feet with discharges into the

MONARCH CANAL. This conduit runs westerly 13.7 miles skirting the 2600 foot contour of the range of mountains bordering the south bank of the San Luis Rey River to the (located near the San Pasqual Indian Boundary) HELL HOLE POWER DROP having a head of 8-- feet. At this point, the range breaks abruptly and proceeds westerly at a lower elevation. The valley land of the San Pasqual Indian Reservation practically controls the grade of the

MERRIAM CONDUIT. Same being the lower feed line to the Merriam Reservoir. This conduit is 10 miles long and skirts the 1600 foot contour to the

MERRIAM POWER DROP located in the Merriam mountains. Here the Merriam conduit discharges from elevation 1500 feet to 1000 feet giving a power head of 500 feet, into the

Merriam RESERVOIR. which provides a storage of ____ ac. ft. with dam of ___ ft in height. This volume will carry the distribution load of 22 MGD for ___ days. The outlet at the 900 foot elevation.

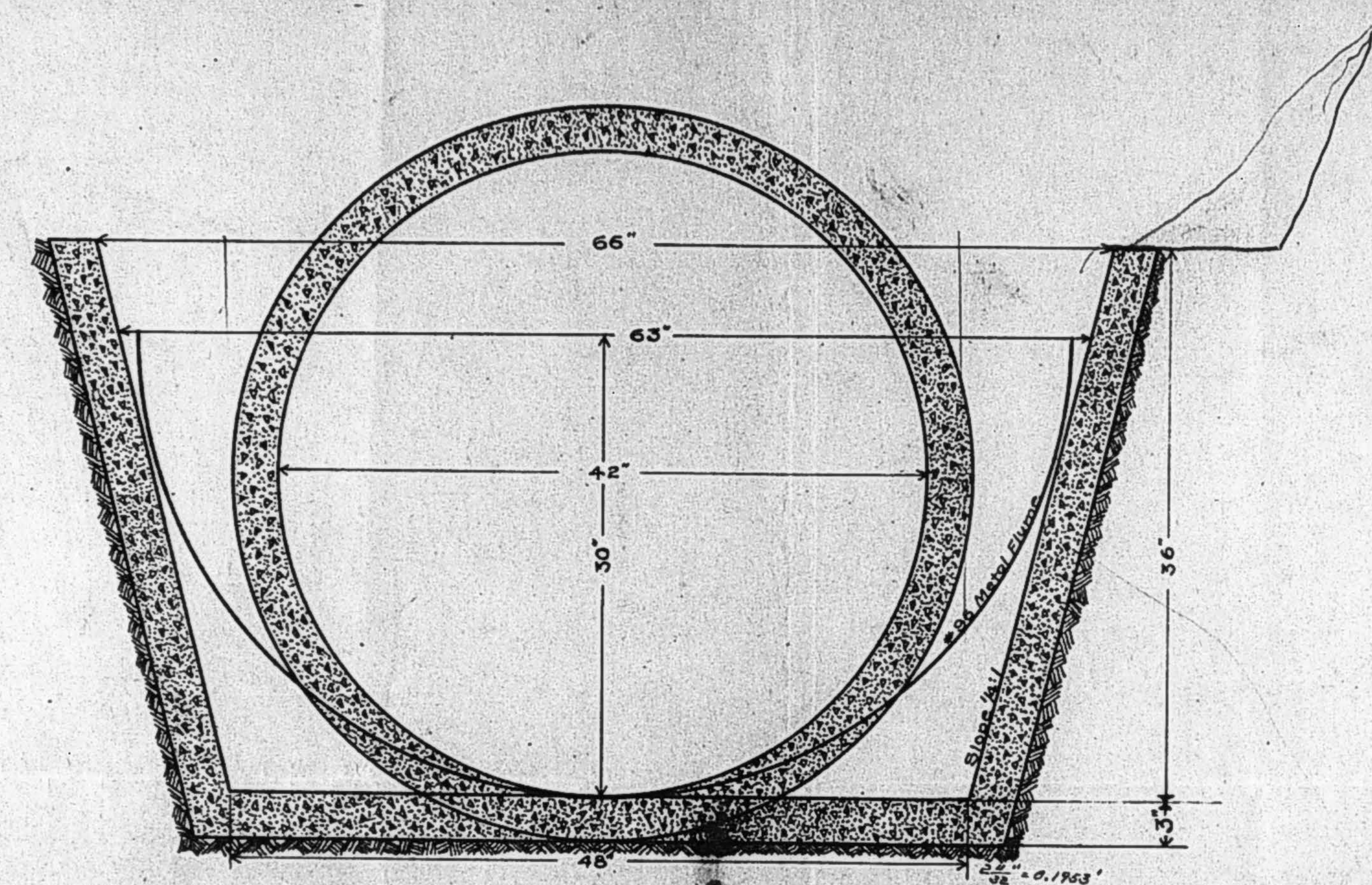
TWIN OAKS DISTRIBUTION. This line is a portion of the main distribution line from Merriam Reservoir carried to a point on the hillside above Twin Oaks where a syphon ~~can~~ be used to cross the valley. The ~~reason~~ for inserting this short length of ___ miles ~~being inserted in the estimate~~ of pipe is that this point of ~~outlet~~ to the Twin Oaks syphon represents a most westerly point at which to terminate ~~the~~ other estimates

Memorandum.

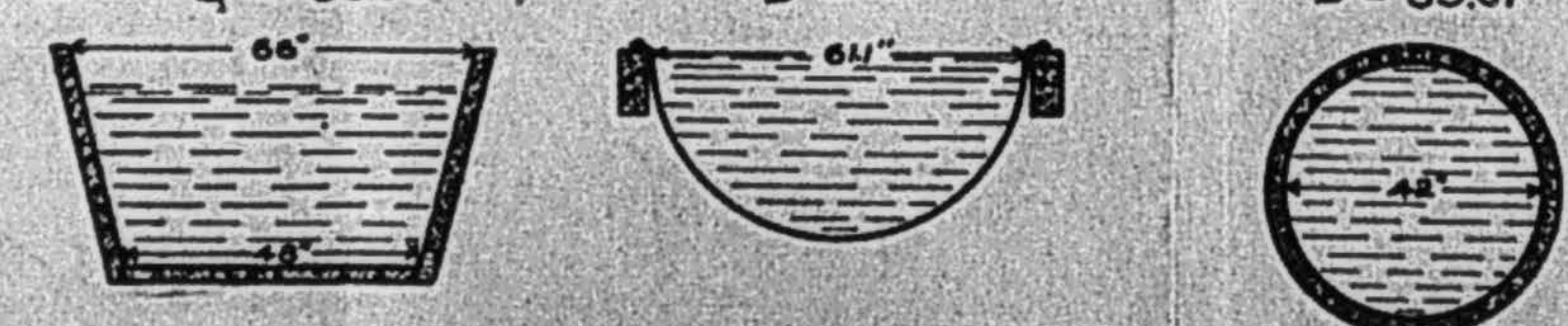
The last station or outlet into the San Dieguito Reservoir and those proceeding it are as follows:

Station	Elevation
244+51	241.6
Conduit (1606 ft.)	
228+45	242.28
Syphon (555 ft.)	
222+90	242.84

A very deep section occurs between stations 228+45 and 244+51. To meet the back water of the reservoir from elevation 250 feet the side walls of the conduit are simply extended upward on same slope, viz., 1/4 to 1.



	Conduit (With 6" Free Board)	Metal Flume (Total Capacity)	42" Concrete Pipe (Total Capacity)
.001	S = .00045	S =	S = .001
.015	n = .012	n =	n = .012
10.41	A = 11.56	A =	A = 9.62
9.1	P = 9.17	P =	P = 11.0
1.14	R = 1.26	R =	R = 0.874
	C = 132	C =	C = 124
3.42	V = 3.14	V =	V = 3.67
35.6	D = 36.30	D =	D = 35.31



SAN DIEGUITO MUTUAL WATER CO.

RELATION AND CAPACITY OF CONCRETE CONDUIT, METAL FLUME AND CONCRETE PIPE.

SCALE 1 IN = 10 IN

REFERENCE MAP

FIELD BOOK NO.

DRAWN BY W.D.McF. & Z.R.

CHECKED BY

E.W. Case ~~POST~~ CHIEF ENGR.

DATE July 1917

DRAWING NO. 209

FILE NO. S 2

WARNER - SUTHERLAND HYDRO-ELECTRIC POWER DEVELOPMENT

(Lengths in Miles)

Tabulation giving the result of three different power surveys for the use of the Warner-Sutherland Waters

T. P. Ellis - October 22,1917

Class of Construction	"A" (Post & Hawgood) PINE AND KERR MOUNTAINS (2 Power Houses)			"B" (Baum) BLACK MOUNTAIN CIRCUIT (2 Hd Power House)			"C" WARNER-BLACK CANYON (2 Hd Power House)			"D" QUOQUAFFE CONDUIT		
	S.L.Rey Pine Mt.	South S.Y. Kerr Mt.	Total	E.Pamo Valley	North SY Blk Mt.	Total	BC - SY Circuit	N.of SY Creek	Total	W-QUO Tunnels	N of SY Creek	Total
Bench	5.78	2.96	8.74	6.08	6.35	12.43	4.22	4.49	8.71	2.16	4.49	6.65
Tunnels	2.08	-	2.08	3.70	0.15	3.85	4.81	0.15	4.96	5.84	0.15	5.99
Syphon or Trestle	1.00	1.60	2.60	0.30	0.32	0.62	0.25	0.13	0.38	0.17	0.13	0.30
Heavy Cut	-	-	-	0.16	0.04	0.20	0.18	-	0.18	0.13	-	0.13
Forebay	$5400											
Entire Conduit	8.87	4.56	13.43	10.24	6.86	17.11	9.38	4.77	14.16	8.22	4.78	13.00
Pressure Pipe	1.26	0.38	1.64	0.84	0.42	1.27	1.26	0.47	1.73	1.26	0.47	1.73
Head (in feet)	1,500 ft	890 ft	-	1,542 ft	849 ft	-	1,570 ft	860 ft	-	1,576 ft	860 ft	-

SAN DIEGO, CALIFORNIA, October 24, 1917

Col. Ed Fletcher,
Office.

Dear Sir:-

This is a memo to correct your notes:-

WARNER - SUTHERLAND HYDRO-ELECTRIC POWER DEVELOPMENT

(Lengths in feet)

	Tunnels	Total Conduit	Pressure Pipe	Head
Post's Pine Mt. High Pressure	11,000	46,850	6,670	1,500
Post's Kerr Mt. Low Pressure	-	24,063	2,000	890
		13.43 miles	1.64 miles	
Baum Blk Mt.Circuit High Pressure	19,550	54,082	4,460	1,542
Low Pressure	820	36,233	2,250	849
		17.11 miles	1.27 miles	
Fletcher - Ellis Blk Canyon - S.Y.Circuit				
High Pressure	25,400	49,542	6,650	1,570
Low Pressure	820	25,213	2,480	860
		14.16 miles	1.73 miles	
Fletcher - Ellis Alternate Via Quoquaffe Tunnel				
High Pressure	30,840	43,411	6,665	1,576
Low Pressure	820	25,213	2,480	860
		13 miles	1.73 miles	

T. R. Ellis

Business Records - Water Companies - Volcan Land and Water Company - San Dieguito System - Warner Dam (Lake Henshaw) and associated projects - Sutherland-Black Canyon project field data