DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
O. H. TITTMANN
SUPERINTENDENT

HYPSOMETRY

PRECISE LEVELING FROM BRIGHAM, UTAH, TO SAN FRANCISCO, CALIFORNIA

BY

WILLIAM BOWIE
Inspector of Geodetic Work, and Chief of the Computing Division
U. S. Coast and Geodetic Survey

SPECIAL PUBLICATION No. 22

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PRECISE LEVELING FROM BRIGHAM, UTAH, TO SAN FRANCISCO, CAL.

By William Bowie,
Inspector of Geodetic Work and Chief of the Computing Division, United States Coast and Geodetic Survey.

GENERAL STATEMENT.

This publication gives the results of a line of precise levels run along the Southern Pacific Railway from Brigham, Utah, to San Francisco, Cal., during the seasons of 1911 and 1912 by a party of this Survey under the charge of Assistant John H. Peters. The line is 891 miles (1434 kilometers) in length and fixes the elevations of 315 bench marks.

Several noteworthy features of this line are: (1) That all of the work was done by one observer. So far as the writer is aware, this is the longest continuous line of levels in the United States ever run by one person. (2) For the first time a motor-driven velocipede car was used by a precise-leveling party of the United States Coast and Geodetic Survey. (3) The excellent progress made by Mr. Peters on his first season's leveling; he had done no precise leveling previous to 1911. This is especially remarkable, as the country traversed is thinly populated and villages at which the party could live were far apart.

The engineer who wishes only to obtain the standard elevations of the bench marks and their descriptions may find the desired data on pages 45 to 60. At the back of this volume there is given an index which enables one to find easily the pages on which are the elevations and descriptions of marks at any particular place.

Several members of the field and office force assisted in the computation of the line of levels and in the preparation of this report. Especial credit is due H. G. Avers, who had direct charge of the computations and prepared the descriptions of the bench marks for publication, and J. H. Peters who assisted in the study of errors.

STANDARD ELEVATIONS.

There have been four general adjustments of the precise levels of the United States, each succeeding one having been made necessary by important additions to the net. The last adjustment showed the net to be sufficiently strong to serve without change (except for disturbed local areas) for giving fixed or standard elevations to the public. To this net, as fixed by the 1912 adjustment (the results of which are shown in Special Publication No. 18, of the Coast and Geodetic Survey), will be adjusted the separate lines as they may be run in the future.

The line under discussion, from Brigham, Utah, to San Francisco, Cal., has been fitted in or adjusted to the elevation of a bench mark at Brigham, with which it was connected, as given by the last general adjustment, and the elevations of certain bench marks in San Francisco which had been determined by a connection with tidal bench marks at the Presidio by the city engineering department.

The elevations given on pages 45 to 47 of this publication are considered as standard or fixed.

From time to time in the future, general adjustments of the level net will no doubt be made in order to obtain the theoretically best elevations of the junction points, but such adjustments will not disturb the standard elevations, unless they are found to be greatly in error on account of blunders in the leveling or due to the rising or settling of the bench marks from earthquake disturbances or the operations of man. Occasionally the elevations of bench marks are changed by mining operations, drainage, and other local agencies.

ORTHOMETRIC CORRECTION.[1]

The orthometric correction was applied to the observed differences in elevation shown on pages 8 to 25 before they were adjusted between the San Francisco and Brigham elevations. This correction eliminates from the observed results the effect of the convergence of level surfaces as the poles of the earth are approached, and the elevations obtained represent the vertical distances of the points above mean sea level.

On the line San Francisco to Brigham the total orthometric correction is −0.3122 meters.

THEORETICALLY BEST ELEVATIONS.

Every new line added to the precise level net will have some influence on the elevation of nearly every bench mark in the net, though in most cases this influence will probably be so small as to be negligible. Therefore for surveying and engineering purposes it is desirable that the elevations of bench marks be held fixed rather than be continually changed by very small amounts as new data are added to the net. But it is sometimes desirable to know the theoretically best orthometric elevation of a bench mark. This can be obtained for a bench mark on the line between Brigham, Utah, and San Francisco, Cal., by applying to the standard elevation of the bench mark in question a correction which bears the same proportion to the difference between the theoretically best orthometric elevation and the standard elevation of bench mark "R" at Brigham as the distance between Brigham and the bench mark bears to the whole distance between Brigham and San Francisco. The theoretically best orthometric elevation of bench mark "R" at Brigham as obtained by the methods described on pages 57 and 58 of Special Publication No. 18 is 1309.1510 meters.

DYNAMIC NUMBERS.[1]

When the orthometric correction has been applied to the observed elevation of two bench marks which are in the same level surface, the surface of the water at rest in an elevated north-and-south canal, for instance, the two marks will have different elevations above sea level. This difference is so slight in practically all cases in which engineers are interested that it may be ignored. There are occasions, however, when it is desired to know the exact distance in terms of some unit between the level surfaces in which two bench marks are situated. The difference between the two orthometric elevations will not give this information. In such cases the dynamic number of each bench mark must be computed, then the distance between the surfaces may be obtained in terms of the work done in raising a unit mass through a unit distance. If the stations should be in the same level surface then the difference between their dynamic numbers will be zero. As stated above, the orthometric elevations of two points in the same level surface will differ by the amount by which the surface containing them converges toward the sea-level surface in going from the more southern point to the other one. The convergence is a function only of the difference in latitude and the average elevation of the points.

MEAN SEA LEVEL AT SAN FRANCISCO, CAL.

The elevations of the bench marks established by the city of San Francisco, upon which the elevations of the line under discussion depend, are based upon a preliminary elevation of 8.970 feet above mean sea level for bench mark No. 15.

Bench mark No. 15, also known as "Granite B. M.," is the reference bench mark for the tidal station at the Presidio. It is the top of the rounded head of a copper bolt set in the top of a granite post, 12 inches square in cross section and 36 inches long, imbedded in concrete on the east side of the road leading from the Presidio wharf to the Barracks and about 255

[1] The orthometric correction and also dynamic numbers are discussed on pp. 49 to 53 of Special Publication No. 18 of the Coast and Geodetic Survey; also at length by Charles Lallemand on pp. 358 to 387 of his "Nivellement de Haute Précision" in the Encyclopédie des Travaux Publics; Paris et Liege, 1912.

feet from the shore end of the wharf. The top of the stone is marked "U. S. C. S., 1897, B. M." The bench mark was established in August, 1897, and subsequently covered by the edge of the macadamizing of the road to the Quartermaster's warehouse.

The tide staff at the Presidio was established in 1897. Since then continuous tidal observations have been in progress.

The following table gives the value of mean sea level above the zero of the tide staff of 1897, for each calendar year since its establishment.

Year.	Height.	Year.	Height.	Year.	Height.	Year.	Height.
	Feet.		*Feet.*		*Feet.*		*Feet.*
1898.....	8.30	1902.....	8.57	1906.....	8.58	1910.....	8.42
1899.....	8.44	1903.....	8.53	1907.....	8.66	1911.....	8.61
1900.....	8.50	1904.....	8.63	1908.....	8.43	1912.....	8.49
1901.....	8.46	1905.....	8.65	1909.....	8.53	1913.....	8.51

Mean sea level for 16 years (1898 to 1913) = 8.519 feet on the staff.

The above readings have been reduced to the staff of 1897 on the assumption that bench mark No. 15 remained unchanged during the entire period of observations. The elevation of bench mark No. 15 above the zero of the tide staff of 1897 was accepted as 17.493 feet, which is the mean of 8 sets of levels taken at various times between the years 1897 and 1905.

The elevation of bench mark No. 15 above mean sea level from the tidal observations 1898 to 1913 is therefore 17.493 − 8.519 = 8.974 feet. The difference between this value and the one (8.970) used in the computation of the elevations of the precise leveling bench marks is only 0.004 foot (1.2 millimeters) and is so small that the elevations have not been corrected to accord with the latest value of mean sea level.

DETAILED STATEMENT OF RESULTS.

BRIGHAM, UTAH, TO BEOWAWE, NEV.

This section was run between June 26, and November 8, 1911.

Precise level No. 7 and rods CC and DD were used for the entire line. The lengths of these rods at 0°C., as determined by the instrument division of this Survey, are as follows: June 8, 1911, rod CC, 3.0013 meters, rod DD, 3.0015 meters; January 12, 1912, rod CC, 3.0008 meters, rod DD, 3.0012 meters.

These measurements show a slight shortening of the rods. The field measurements give no indication of a sudden change during the period of leveling. In the computation the mean length of the rods at 0.0° C. for the season, 3.0012 meters, or an excess of 0.40 millimeter per meter was used. The index correction of rod CC was −0.3 millimeter; of rod DD, −0.2 millimeter.

Three bench marks, Q, R, and T, on the line of levels between Ogden, Utah, and Pocatello, Idaho, were recovered. The new determination of the differences of elevations between these three bench marks showed that R and T had maintained the relative position in which they were established, while Q had settled about 26 millimeters.

The elevation of bench mark Q, published on page 132 of Special Publication No. 18, should therefore be used with caution for engineering and survey purposes.

The elevations in the following table are based on an assumed elevation of 1308.9203 meters for bench mark R at Brigham, Utah.

Results of leveling, Brigham, Utah, to Beowawe, Nev.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. R.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1911.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
								Q	12.115	1300.0369
June 29	Q–10	1.568	− 3.7553	+ 3.7497	− 3.7524	+3.5	+12.0	10	10.547	1296.2845
			− 3.7529	+ 3.7515						
July 1–June 29	10–9	1.375	− 4.1826	+ 4.1866	− 4.1846	−4.0	+15.5	9	9.172	1292.0999
July 1–June 28	9–8	0.987	+ 2.3468	− 2.3491	+ 2.3480	+2.3	+11.5	8	8.185	1294.4479
June 28–28	8–7	0.964	+ 3.0333	− 3.0329	+ 3.0331	−0.4	+13.8	7	7.221	1297.4810
Do	7–6	1.227	− 1.5243	+ 1.5274	− 1.5258	−3.1	+13.4	6	5.994	1295.9552
June 28–27	6–5	0.983	− 1.6416	+ 1.6427	− 1.6422	−1.1	+10.3	5	5.011	1294.3130
June 27–27	5–4	0.986	− 1.4722	+ 1.4722	− 1.4722	0.0	+ 9.2	4	4.025	1292.8408
Do	4–3	0.977	+ 4.1190	− 4.1166	+ 4.1178	−2.4	+ 9.2	3	3.048	1296.9586
Do	3–2	1.170	+ 8.5729	− 8.5728	+ 8.5738	−2.1	+ 6.8	2	1.878	1305.5324
Do	2–J_9	1.128	+ 7.6399	− 7.6337	+ 7.6363	−4.6	+ 4.7	J_9	0.750	1313.1687
June 28–27	2–J_9	1.128	+ 7.6374	− 7.6344						
June 26–26	J_9–1	0.628	+19.1368	−19.1370	+19.1369	+0.2	+ 4.9	1	1.378	1332.3056
Do	1–K_9	0.614	+20.3941	−20.3939	+20.3940	−0.2	+ 4.7	K_9	1.992	1352.6996
Do	J_9–R	0.750	− 4.2484	+ 4.2485	− 4.2484	−0.1	+ 0.1	R	0.000	1308.9203
July 1–1	R–11	1.075	− 7.7889	+ 7.7882	− 7.7886	+0.7	+ 0.7	11	1.075	1301.1317
July 3–8	11–12	1.311	− 9.2179	+ 9.2224	− 9.2200	−4.1	− 3.4	12	2.386	1291.9117
July 8–8	11–12	1.311	.....	+ 9.2216						
July 3–3	12–13	1.192	− 5.3208	+ 5.3239	− 5.3224	−3.1	− 6.5	13	3.578	1286.5892
Do	13–14	1.271	− 0.4404	+ 0.4382	− 0.4393	+2.2	− 4.3	14	4.849	1286.1500
Do	14–15	1.263	+ 0.4679	− 0.4681	+ 0.4680	+0.2	− 4.1	15	6.112	1286.6180
Do	15–16	1.102	+ 0.5403	− 0.5414	+ 0.5408	+1.1	− 3.0	16	7.214	1287.1588
Do	16–17	1.269	+ 0.8441	− 0.8466	+ 0.8454	+2.5	− 0.5	17	8.483	1288.0042
July 3–5	17–18	0.986	+ 1.5476	− 1.5482	+ 1.5479	+0.6	+ 0.1	18	9.469	1289.5521
July 5–5	18–19	1.291	+ 3.1569	− 3.1564	+ 3.1566	−0.5	− 0.4	19	10.760	1292.7087
Do	19–20	1.210	+ 4.5292	− 4.5298	+ 4.5295	+0.6	+ 0.2	20	11.970	1297.2387
Do	20–21	2.014	+ 1.1856	− 1.1825	+ 1.1840	−3.1	− 2.9	21	13.984	1298.4227
July 7–7	21–L_9	0.254	+ 2.4001	− 2.3993	+ 2.3997	−0.8	− 3.7	L_9	14.238	1300.8219
Do	L_9–22	1.207	+ 4.0557	− 4.0542	+ 4.0550	−1.5	− 5.2	22	15.445	1304.8766
Do	22–23	1.420	+ 1.7453	− 1.7454	+ 1.7454	+0.1	− 5.1	23	16.865	1306.6223
July 6–7	23–24	1.293	+ 3.3513	− 3.3538	+ 3.3526	+2.5	− 2.6	24	18.158	1309.9749
July 6–6	24–25	1.273	+ 0.3498	− 0.3495	+ 0.3496	−0.3	− 2.9	25	19.431	1310.3243
Do	25–26	1.272	+ 2.4588	− 2.4619	+ 2.4604	+3.1	+ 0.2	26	20.703	1312.7847
Do	26–27	1.151	+ 2.8321	− 2.8281	+ 2.8301	−4.0	− 3.8	27	21.854	1315.6150
Do	27–T	1.161	+ 1.7431	− 1.7435	+ 1.7433	+0.4	−3.4	T	23.015	1317.3583
July 1–1	11–28	1.095	−10.9068	+10.9082	−10.9075	−1.6	− 0.9	28	2.170	1290.1642
Do	28–29	1.211	− 2.7640	+ 2.7646	− 2.7643	−0.6	− 1.5	29	3.381	1287.3999
July 11–11	29–M_9	1.134	− 0.0789	+ 0.0793	− 0.0791	−0.4	− 1.9	M_9	4.515	1287.3208
Do	M_9–30	1.096	+ 0.9181	− 0.9174	+ 0.9178	−0.7	− 2.6	30	5.611	1288.2386
Do	30–31	1.041	− 0.5942	+ 0.5899	− 0.5930	+0.3	− 2.3	31	6.652	1287.6456
July 12–12	30–31	1.041	− 0.5920	+ 0.5957						
July 11–11	31–32	0.789	− 0.3135	+ 0.3155	− 0.3145	−2.0	− 4.3	32	7.441	1287.3311
July 11–12	32–N_9	1.007	+ 1.4582	− 1.4591	+ 1.4586	+0.9	− 3.4	N_9	8.448	1288.7897
July 12–12	N_9–33	1.116	+ 1.3355	− 1.3345	+ 1.3345	−2.0	− 5.4	33	9.564	1290.1242
Do	33–34	1.022	+ 0.3801	− 0.3827	+ 0.3814	+2.6	− 2.8	34	10.586	1290.5056
Do	34–O_9	1.244	− 0.3078	+ 0.3109	− 0.3094	−3.1	− 5.9	O_9	11.830	1290.1962
July 12–13	O_9–35	1.023	+ 1.4855	− 1.4848	+ 1.4852	−0.7	− 6.6	35	12.853	1291.6814
July 13–13	35–36	1.320	+ 1.5162	− 1.5181	+ 1.5172	+1.9	− 4.7	36	14.173	1293.1986
Do	36–P_9	1.376	+ 0.1301	− 0.1284	+ 0.1292	−1.7	− 6.4	P_9	15.549	1293.3278
Do	P_9–37	1.197	+ 0.8488	− 0.8514	+ 0.8501	+2.6	− 3.8	37	16.746	1294.1779
Do	37–38	1.137	− 0.5364	+ 0.5363	− 0.5364	+0.1	− 3.7	38	17.883	1293.6415
July 13–14	38–39	1.467	− 2.2275	+ 2.2220	− 2.2250	+1.6	− 2.1	39	19.350	1291.4165
July 17–17	38–39	1.467	− 2.2241	+ 2.2263						
July 14–14	39–Q_9	1.559	+ 2.6350	− 2.6371	+ 2.6360	+2.1	0.0	Q_9	20.909	1294.0525
Do	Q_9–40	1.351	− 5.3485	+ 5.3466	− 5.3476	+1.9	+ 1.9	40	22.260	1288.7049
Do	40–41	1.356	− 0.3329	+ 0.3272	− 0.3313	+3.8	+ 5.7	41	23.616	1288.3736
July 17–17	40–41	1.356	− 0.3335	+ 0.3315						
July 14–17	41–42	1.161	− 0.0479	+ 0.0454	− 0.0466	+2.5	+ 8.2	42	24.777	1288.3270
July 17–17	42–R_9	0.613	+ 1.2777	− 1.2780	+ 1.2778	+0.3	+ 8.5	R_9	25.390	1289.6048
July 17–18	R_9–43	1.115	− 1.8929	+ 1.8957	− 1.8943	−2.8	+ 5.7	43	26.505	1287.7105
July 18–18	43–44	1.385	+ 0.3152	− 0.3139	+ 0.3146	−1.3	+ 4.4	44	27.890	1288.0251
Do	44–S_9	1.325	+ 2.5690	− 2.5734	+ 2.5712	+4.4	+ 8.8	S_9	29.215	1290.5963
Do	S_9–45	1.285	+ 2.3873	− 2.3845	+ 2.3859	−2.8	+ 6.0	45	30.500	1292.9822
Do	45–46	1.582	+ 3.3836	− 3.3854	+ 3.3845	+1.8	+ 7.8	46	32.082	1296.3667
July 18–24	46–47	1.132	− 1.2972	+ 1.2904	− 1.2950	+2.8	+10.6	47	33.214	1295.0717
July 24–24	46–47	1.132	− 1.2956	+ 1.2968						
Do	47–T_9	0.682	+ 0.3097	− 0.3098	+ 0.3098	+0.1	+10.7	T_9	33.896	1295.3815
Do	T_9–48	0.824	+ 0.9584	− 0.9582	+ 0.9583	−0.2	+10.5	48	34.720	1296.3398
Do	48–U_9	1.205	+ 4.8963	− 4.8924	+ 4.8944	−3.9	+ 6.6	U_9	35.925	1301.2342
Do	U_9–49	1.648	+ 9.9556	− 9.9484	+ 9.9544	−1.5	+5.1	49	37.573	1311.1886
July 25–25	U_9–49	1.648	+ 9.9549	− 9.9590						
Do	49–V_9	0.993	+12.5909	−12.5922	+12.5916	+1.3	+ 6.4	V_9	38.566	1323.7802
Do	V_9–50	0.461	+ 4.9811	− 4.9821	+ 4.9816	+1.0	+ 7.4	50	39.027	1328.7618
Do	50–W_9	0.857	+ 4.6148	− 4.6155	+ 4.6152	+0.7	+ 8.1	W_9	39.884	1333.3770
Do	W_9–51	0.557	− 1.9222	+ 1.9213	− 1.9218	+0.9	+ 9.0	51	40.441	1331.4552
Do	51–52	1.097	+13.2035	−13.2025	+13.2030	−1.0	+ 8.0	52	41.538	1344.6582
Do	52–53	1.017	+14.8016	−14.8007	+14.8012	−0.9	+ 7.1	53	42.555	1359.4594
July 26–25	53–54	1.057	+15.4260	−15.4274	+15.4267	+1.4	+ 8.5	54	43.612	1374.8861
July 26–26	54–X_9	1.121	+16.5604	−16.5593	+16.5598	−1.1	+ 7.4	X_9	44.733	1391.4459
Do	X_9–55	1.090	+16.3466	−16.3393	+16.3434	−2.4	+ 5.0	55	45.823	1407.7893
			+16.3425	−16.3451						
Do	55–56	0.747	+12.7663	−12.7646	+12.7654	−1.7	+ 3.3	56	46.570	1420.5547
Do	56–57	1.028	+17.2740	−17.2780	+17.2780	+2.4	+ 5.7	57	47.598	1437.8327
July 27–27	56–57	1.028	+17.2797	−17.2803						
July 27–26	57–58	0.985	+14.6043	−14.6047	+14.6045	+0.4	+ 6.1	58	48.583	1452.4372
July 27–27	58–59	1.071	+15.0254	−15.0264	+15.0259	+1.0	+ 7.1	59	49.654	1467.4631
Do	59–60	1.059	+15.4858	−15.4857	+15.4858	−0.1	+ 7.0	60	50.713	1482.9489
Do	60–61	1.020	− 1.5021	+ 1.5012	− 1.5016	+0.9	+ 7.9	61	51.733	1481.4473

Results of leveling, Brigham, Utah, to Beowawe, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. R.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1911.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km*	*m.*
July 27–27	61–62	1.027	+ 6.5173	− 6.5188	+ 6.5180	+1.5	+ 9.4	62	52.760	1487.9653
July 28–27	62–63	0.947	+ 5.5724	− 5.5725	+ 5.5724	+0.1	+ 9.5	63	53.707	1493.5377
July 27–28	63–Y_9	0.782	+ 0.5000	− 0.5003	+ 0.5002	+0.3	+ 9.8	Y_9	54.489	1494.0379
July 28–Aug. 4	Y_9–64	1.025	− 2.3035	+ 2.3047	− 2.3041	−1.2	+ 8.6	64	55.514	1491.7338
Do	64–65	1.171	− 2.9050	+ 2.9036	− 2.9043	+1.4	+10.0	65	56.685	1488.8295
Do	65–66	1.174	− 4.0912	+ 4.0874	− 4.0893	+3.8	+13.8	66	57.859	1484.7402
Do	66–Z_9	0.524	− 0.1363	+ 0.1360	− 0.1362	+0.3	+14.1	Z_9	58.383	1484.6040
July 28–29	Z_9–67	0.974	− 4.6886	+ 4.6875	− 4.6880	+1.1	+15.2	67	59.357	1479.9160
Do	67–68	1.026	−13.7523	+13.7490	−13.7506	+3.3	+18.5	68	60.383	1466.1654
Do	68–69	1.154	−13.6138	+13.6138	−13.6138	0.0	+18.5	69	61.537	1452.5516
Do	69–70	1.035	−10.1499	+10.1525	−10.1512	−2.6	+15.9	70	62.572	1442.4004
Do	70–A_{10}	0.427	− 1.4078	+ 1.4075	− 1.4076	+0.3	+16.2	A_{10}	62.999	1440.9928
Do	A_{10}–71	1.071	− 8.3503	+ 8.3508	− 8.3506	−0.5	+15.7	71	64.070	1432.6422
July 29–29	71–72	1.102	−13.3475	+13.3493	−13.3484	−1.8	+13.9	72	65.172	1419.2938
Do	72–B_{10}	1.729	−19.4542	+19.4525	−19.4534	+1.7	+15.6	B_{10}	66.901	1399.8404
July 31–31	B_{10}–73	1.288	− 4.3392	+ 4.3480	− 4.3431	−5.2	+10.4	73	68.189	1395.4973
Aug. 2–2	B_{10}–73	1.288	− 4.3418	+ 4.3434						
July 31–31	73–74	1.173	+ 7.4020	− 7.4053	+ 7.4036	+3.3	+13.7	74	60.362	1402.9009
Do	74–75	1.156	+ 1.9302	− 1.9360	+ 1.9330	+3.7	+17.4	75	70.518	1404.8339
Aug. 2–2	74–75	1.156	+ 1.9320	− 1.9335						
July 31–31	75–C_{10}	0.788	− 6.0788	+ 6.0829	− 6.0810	−2.7	+14.7	C_{10}	71.306	1398.7529
Aug. 2–2	75–C_{10}	0.788	− 6.0804	+ 6.0817						
July 31–31	C_{10}–76	1.125	− 6.5148	+ 6.5127	− 6.5138	+2.1	+16.8	76	72.431	1392.2391
Do	76–77	1.137	−14.2508	+14.2512	−14.2510	−0.4	+16.4	77	73.568	1377.9881
July 31–Aug. 2	77–78	1.322	−15.2620	+15.2625	−15.2622	−0.5	+15.9	78	74.890	1362.7259
Aug. 2–2	78–79	1.201	−15.2976	+15.3040	−15.3018	−2.3	+13.6	79	76.091	1347.4241
Aug. 3–3	78–79	1.201	−15.3035	+15.3018						
Aug. 2–2	79–80	0.990	−12.1599	+12.1624	−12.1612	−2.5	+11.1	80	77.081	1335.2629
Do	80–D_{10}	0.712	− 9.8945	+ 9.8965	− 9.8955	−2.0	+ 9.1	D_{10}	77.793	1325.3674
Aug. 2–3	D_{10}–81	1.476	−17.1452	+17.1494	−17.1473	−4.2	+ 4.9	81	79.269	1308.2201
Aug. 3–3	81–82	1.045	−13.2580	+13.2599	−13.2590	−1.9	+ 3.0	82	80.314	1294.9611
Do	82–83	0.980	− 9.7977	+ 9.7979	− 9.7978	−0.2	+ 2.8	83	81.294	1285.1633
Do	83–E_{10}	1.328	− 1.1365	+ 1.1335	− 1.1350	+3.0	+ 5.8	E_{10}	82.622	1284.0283
Aug. 7–7	E_{10}–84	1.514	+ 0.0424	− 0.0398	+ 0.0411	−2.6	+ 3.2	84	84.136	1284.0694
Do	84–85	1.096	− 0.0501	+ 0.0520	− 0.0510	−1.9	+ 1.3	85	85.232	1284.0184
Do	85–86	1.247	− 0.0383	+ 0.0364	− 0.0374	+1.9	+ 3.2	86	86.479	1283.9810
Do	86–87	1.281	− 0.0356	+ 0.0356	− 0.0356	0.0	+ 3.2	87	87.760	1283.9454
Aug. 9–9	87–F_{10}	1.044	+ 3.0519	− 3.0504	+ 3.0512	−1.5	+ 1.7	F_{10}	88.804	1286.9966
Do	F_{10}–88	1.230	− 1.4176	+ 1.4187	− 1.4182	−1.1	+ 0.6	88	90.034	1285.5784
Do	88–89	1.089	+ 0.0670	− 0.0608	+ 0.0684	+2.8	+ 3.4	89	91.123	1285.6468
Do	89–90	1.096	+ 0.2706	− 0.2717	+ 0.2712	+1.1	+ 4.5	90	92.219	1285.9180
Do	00–91	1.148	+ 1.4713	− 1.4692	+ 1.4702	−2.1	+ 2.4	91	93.367	1287.3882
Aug. 10–10	91–G_{10}	0.922	+ 0.6391	− 0.6371	+ 0.6381	−2.0	+ 0.4	G_{10}	94.289	1288.0263
Do	G_{10}–92	0.567	+ 0.3741	− 0.3755	+ 0.3748	+1.4	+ 1.8	92	94.856	1288.4011
Do	92–93	1.183	− 0.2180	+ 0.2187	− 0.2184	−0.7	+ 1.1	93	96.039	1288.1827
Do	93–94	1.165	+ 1.6830	− 1.6840	+ 1.6835	+1.0	+ 2.1	94	97.204	1289.8662
Aug. 10–11	94–95	1.039	+ 1.9174	− 1.9187	+ 1.0180	+1.3	+ 3.4	95	98.243	1291.7842
Do	95–96	1.165	+ 3.1361	− 3.1342	+ 3.1352	−1.9	+ 1.5	96	99.408	1294.9194
Aug. 11–11	96–H_{10}	1.006	− 2.6467	+ 2.6489	− 2.6478	−2.2	− 0.7	H_{10}	100.414	1292.2716
Do	H_{10}–97	1.140	− 3.0171	+ 3.0180	− 3.0176	−0.9	− 1.6	97	101.554	1289.2540
Do	97–98	0.937	− 1.3460	+ 1.3459	− 1.3460	+0.1	− 1.5	98	102.491	1287.9080
Do	98–99	1.186	− 1.6523	+ 1.6523	− 1.6523	0.0	− 1.5	99	103.677	1286.2557
Aug. 11–12	99–100	1.190	+ 0.5055	− 0.5072	+ 0.5064	+1.7	+ 0.2	100	104.867	1286.7621
Do	100–101	1.001	+ 0.5163	− 0.5161	+ 0.5162	−0.2	0.0	101	105.868	1287.2783
Aug. 12–12	101–I_{10}	1.083	− 0.4080	+ 0.4126	− 0.4107	−2.2	− 2.2	I_{10}	106.951	1286.8676
Do	101–I_{10}	1.083	− 0.4112	+ 0.4111						
Aug. 19–19	I_{10}–102	0.975	+ 0.3731	− 0.3716	+ 0.3724	−1.5	− 3.7	102	107.926	1287.2400
Do	102–103	1.097	− 0.2443	+ 0.2435	− 0.2439	+0.8	− 2.9	103	109.023	1286.9961
Do	103–104	1.199	− 0.4785	+ 0.4784	− 0.4784	+0.1	− 2.8	104	110.222	1286.5177
Do	104–105	1.090	− 1.0812	+ 1.0775	− 1.0794	+3.7	+ 0.9	105	111.312	1285.4383
Do	105–106	1.359	− 0.3526	+ 0.3550	− 0.3538	−2.4	− 1.5	106	112.671	1285.0845
Do	106–J_{10}	1.090	+ 0.7974	− 0.7936	+ 0.7955	−3.8	− 5.3	J_{10}	113.761	1285.8800
Do	J_{10}–107	1.129	− 0.6697	+ 0.6720	− 0.6708	−2.3	− 7.6	107	114.890	1285.2092
Aug. 19–22	107–108	0.926	+ 0.9834	− 0.9825	+ 0.9830	−0.9	− 8.5	108	115.816	1286.1922
Do	108–K_{10}	1.551	+ 0.3567	− 0.3582	+ 0.3574	+1.5	− 7.0	K_{10}	117.367	1286.5496
Aug. 14–14	K_{10}–109	1.079	+ 0.4631	− 0.4591	+ 0.4602	−2.1	− 9.1	109	118.446	1287.0098
Do	K_{10}–109	1.079	+ 0.4594							
Do	109–110	1.026	+ 0.5481	− 0.5480	+ 0.5480	−0.1	− 9.2	110	119.472	1287.5578
Do	110–111	1.225	− 1.5512	+ 1.5535	− 1.5524	−2.3	−11.5	111	120.697	1286.0054
Do	111–112	1.101	+ 0.4926	− 0.4936	+ 0.4931	+1.0	−10.5	112	121.798	1286.4985
Do	112–113	1.065	+ 0.5146	− 0.5128	+ 0.5137	−1.8	−12.3	113	122.863	1287.0122
Aug. 14–15	113–114	1.066	+ 6.3794	− 6.3820	+ 6.3807	+2.6	− 9.7	114	123.929	1293.3929
Do	114–115	1.077	+13.3915	−13.3940	+13.3928	+2.5	− 7.2	115	125.006	1306.7857
Aug. 15–15	115–L_{10}	1.450	+19.2418	−19.2464	+19.2441	+4.6	− 2.6	L_{10}	126.456	1326.0298
Do	L_{10}–116	1.024	+11.5834	−11.5840	+11.5837	+0.6	− 2.0	116	127.480	1337.6135
Do	116–117	1.043	+11.9673	−11.9658	+11.9666	−1.5	− 3.5	117	128.523	1349.5801
Do	117–118	1.027	+11.9756	−11.9764	+11.9760	+0.8	− 2.7	118	129.550	1361.5561
Aug. 15–16	118–119	1.037	+12.8233	−12.8218	+12.8226	−1.5	− 4.2	119	130.587	1374.3787
Aug. 16–16	119–M_{10}	0.627	+ 9.5497	− 9.5539	+ 9.5520	+3.0	− 1.2	M_{10}	131.214	1383.9307
Do	119–M_{10}	0.627	+ 9.5513	− 9.5531						
Do	M_{10}–120	1.028	+11.1290	−11.1310	+11.1300	+2.0	+ 0.8	120	132.242	1395.0607
Do	120–121	1.152	+14.5343	−14.5341	+14.5342	−0.2	+ 0.6	121	133.394	1409.5949
Do	121–122	1.061	+13.3493	−13.3559	+13.3529	+2.2	+ 2.8	122	134.455	1422.9478
Aug. 17–16	121–122	1.061	+13.3542	−13.3520						
Aug. 16–17	122–N_{10}	1.663	+13.4530	−13.4572	+13.4551	+4.2	+ 7.0	N_{10}	136.118	1436.4029
Aug. 17–17	N_{10}–123	1.151	−13.4437	+13.4463	−13.4450	−2.6	+ 4.4	123	137.269	1422.9579
Do	123–124	1.080	+ 0.6167	− 0.6160	+ 0.6161	−0.2	+ 4.2	124	138.349	1423.5740
Aug. 18–18	123–124	1.080	+ 0.6156							
Aug. 17–17	124–125	1.037	− 7.7885	+ 7.7849	− 7.7867	+3.6	+ 7.8	125	139.386	1415.7873
Do	125–126	1.025	− 4.6399	+ 4.6419	− 4.6409	−2.0	+ 5.8	126	140.411	1411.1464

Results of leveling, Brigham, Utah, to Beowawe, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. R.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1911.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
Aug. 18–18	126–127	1.077	+ 1.6473	− 1.6515	+ 1.6506	+3.5	+ 9.3	127	141.488	1412.7970
Aug. 21–21	126–127	1.077	+ 1.6503	− 1.6531						
Aug. 18–18	127–128	1.031	− 1.7188	+ 1.7176	− 1.7182	+1.2	+10.5	128	142.519	1411.0788
Do	128–129	1.021	− 1.8733	+ 1.8750	− 1.8742	−1.7	+ 8.8	129	143.540	1409.2046
Do	129–130	1.013	+ 0.1014	− 0.1014	+ 0.1014	0.0	+ 8.8	130	144.553	1409.3060
Do	130–O_{10}	0.916	− 5.4012	+ 5.4006	− 5.4009	+0.6	+ 9.4	O_{10}	145.469	1403.9051
Aug. 21–21	O_{10}–131	1.007	− 5.9264	+ 5.9336	− 5.9293	−3.8	+ 5.6	131	146.476	1397.9758
Aug. 25–25	O_{10}–131	1.007	− 5.9284	+ 5.9288						
Aug. 21–21	131–132	1.114	+ 0.1530	− 0.1532	+ 0.1531	+0.2	+ 5.8	132	147.590	1398.1289
Do	132–133	1.019	− 1.6055	+ 1.6050	− 1.6052	+0.5	+ 6.3	133	148.609	1396.5237
Do	133–134	1.038	+ 0.2171	− 0.2153	+ 0.2162	−1.8	+ 4.5	134	149.647	1396.7399
Aug. 26–21	134–135	1.017	+ 5.7854	− 5.7865	+ 5.7860	+1.1	+ 5.6	135	150.664	1402.5259
Aug. 26–26	135–136	1.128	− 1.1661	+ 1.1666	− 1.1664	−0.5	+ 5.1	136	151.792	1401.3595
Do	136–137	1.024	+ 0.6430	− 0.6410	+ 0.6420	−2.0	+ 3.1	137	152.816	1402.0015
Do	137–P_{10}	1.167	− 1.8507	+ 1.8509	− 1.8508	−0.2	+ 2.9	P_{10}	153.983	1400.1507
Do	P_{10}–138	1.183	+11.3422	−11.3444	+11.3433	+2.2	+ 5.1	138	155.166	1411.4940
Do	138–139	1.022	+12.3863	−12.3862	+12.3862	−0.1	+ 5.0	139	156.188	1423.8802
Do	139–140	1.120	+14.0272	−14.0249	+14.0260	−2.3	+ 2.7	140	157.308	1437.9062
Aug. 26–27	140–141	1.077	− 0.4365	+ 0.4350	− 0.4358	+1.5	+ 4.2	141	158.385	1437.4704
Aug. 27–27	141–142	1.184	− 7.0827	+ 7.0819	− 7.0823	+0.8	+ 5.0	142	159.569	1430.3881
Do	142–143	1.139	+ 1.9171	− 1.9169	+ 1.9170	−0.2	+ 4.8	143	160.708	1432.3051
Do	143–144	1.173	− 7.3953	+ 7.3927	− 7.3940	+2.6	+ 7.4	144	161.881	1424.9111
Do	144–145	1.260	+ 8.5200	− 8.5228	+ 8.5214	+2.8	+10.2	145	163.141	1433.4325
Do	145–146	1.061	+ 4.3095	− 4.3086	+ 4.3090	−0.9	+ 9.3	146	164.202	1437.7415
Do	146–Q_{10}	1.118	− 8.6213	+ 8.6205	− 8.6209	+0.8	+10.1	Q_{10}	165.320	1429.1206
Aug. 28–28	Q_{10}–147	1.122	−15.6756	+15.6775	−15.6766	−1.9	+ 8.2	147	166.442	1413.4440
Do	147–148	1.389	−14.7280	+14.7282	−14.7281	−0.2	+ 8.0	148	167.831	1398.7159
Do	148–R_{10}	1.382	−11.2233	+11.2262	−11.2248	−2.9	+ 5.1	R_{10}	169.213	1387.4911
Do	R_{10}–149	1.415	−10.2636	+10.2685	−10.2637	−2.6	+ 2.5	149	170.628	1377.2274
Aug. 29–30	R_{10}–149	1.415	−10.2612	+10.2615						
Aug. 28–28	149–150	1.147	− 2.4311	+ 2.4296	− 2.4304	+1.5	+ 4.0	150	171.775	1374.7970
Do	150–151	1.320	− 4.4414	+ 4.4439	− 4.4426	−2.5	+ 1.5	151	173.095	1370.3544
Do	151–152	1.015	− 7.3303	+ 7.3288	− 7.3296	+1.5	+ 3.0	152	174.110	1363.0248
Do	152–153	1.447	− 5.4230	+ 5.4206	− 5.4218	+2.4	+ 5.4	153	175.557	1357.6030
Aug. 29–29	153–S_{10}	1.149	− 0.5656	+ 0.5685	− 0.5670	−2.9	+ 2.5	S_{10}	176.706	1357.0360
Do	S_{10}–154	1.209	− 1.0233	+ 1.0270	− 1.0252	−3.7	− 1.2	154	177.915	1356.0108
Do	154–155	1.129	− 6.5939	+ 6.5939	− 6.5939	0.0	− 1.2	155	179.044	1349.4169
Aug. 29–28	155–156	1.165	− 8.9735	+ 8.9716	− 8.9726	+1.9	+ 0.7	156	180.200	1340.4443
Aug. 29–29	156–157	1.198	− 6.8566	+ 6.8554	− 6.8560	+1.2	+ 1.9	157	181.407	1333.5883
Do	157–158	1.146	− 6.6473	+ 6.6495	− 6.6484	−2.2	− 0.3	158	182.553	1326.9399
Do	158–159	1.145	− 3.2814	+ 3.2789	− 3.2802	+2.5	+ 2.2	159	183.698	1323.6597
Aug. 30–30	159–160	1.078	− 1.6055	+ 1.6070	− 1.6062	−1.5	+ 0.7	160	184.776	1322.0535
Do	160–T_{10}	1.495	+ 3.4016	− 3.4064	+ 3.4040	+4.8	+ 5.5	T_{10}	186.271	1325.4575
Do	T_{10}–161	1.132	− 0.1042	+ 0.1034	− 0.1038	+0.8	+ 6.3	161	187.403	1325.3537
Do	161–162	1.114	+ 2.1939	− 2.1963	+ 2.1951	+2.4	+ 8.7	162	188.517	1327.5488
Do	162–163	1.027	+ 3.9711	− 3.9709	+ 3.9710	−0.2	+ 8.5	163	189.544	1331.5198
Aug. 31–31	163–164	1.321	+ 4.9048	− 4.9050	+ 4.9049	+0.2	+ 8.7	164	190.865	1336.4247
Do	164–165	1.033	+ 2.2998	− 2.3006	+ 2.3002	+0.8	+ 9.5	165	191.898	1338.7249
Do	165–U_{10}	0.989	+ 0.9918	− 0.9915	+ 0.9916	−0.3	+ 9.2	U_{10}	192.887	1339.7165
Do	U_{10}–166	1.040	+ 4.7387	− 4.7359	+ 4.7373	−2.8	+ 6.4	166	193.927	1344.4538
Do	166–167	1.136	+ 2.2993	− 2.3026	+ 2.3010	+3.3	+ 9.7	167	195.063	1346.7548
Do	167–168	1.332	− 4.0720	+ 4.0759	− 4.0740	−3.9	+ 5.8	168	196.395	1342.6808
Aug. 31, Sept. 1	168–169	1.188	− 1.6220	+ 1.6252	− 1.6236	−3.2	+ 2.6	169	197.583	1341.0572
Sept. 1–1	169–170	1.138	+ 2.6970	− 2.6995	+ 2.6982	+2.5	+ 5.1	170	198.721	1343.7554
Do	170–171	1.239	+ 1.9552	− 1.9556	+ 1.9554	+0.4	+ 5.5	171	199.960	1345.7108
Do	171–V_{10}	1.074	+ 4.2243	− 4.2235	+ 4.2239	−0.8	+ 4.7	V_{10}	201.034	1349.9347
Sept. 1–2	V_{10}–172	1.141	+10.9882	−10.9876	+10.9879	−0.6	+ 4.1	172	202.175	1360.9226
Sept. 2–2	172–173	1.282	+ 8.6585	− 8.6612	+ 8.6604	+1.7	+ 5.8	173	203.457	1369.5830
Do	173–174	1.144	+ 3.4905	− 3.4914	+ 3.4910	+0.9	+ 6.7	174	204.601	1373.0740
Do	174–175	1.261	− 1.5667	+ 1.5640	− 1.5654	+2.7	+ 9.4	175	205.862	1371.5086
Sept. 13–13	175–176	0.561	− 5.5739	+ 5.5722	− 5.5730	+1.7	+11.1	176	206.423	1365.9356
Do	176–W_{10}	0.924	− 3.3049	+ 3.3042	− 3.3046	+0.7	+11.8	W_{10}	207.347	1362.6310
Sept. 12–12	176–X_{10}	1.111	+ 3.9260	− 3.9317	+ 3.9289	+4.2	+15.3	X_{10}	207.534	1369.8645
Sept. 13–13	176–X_{10}	1.111	+ 3.9277	− 3.9302						
Sept. 12–12	X_{10}–Y_{10}	0.800	+ 8.1908	− 8.1901	+ 8.1904	−0.7	+14.6	Y_{10}	208.334	1378.0549
Do	Y_{10}–177	1.239	+ 6.8279	− 6.8264	+ 6.8272	−1.5	+13.1	177	209.573	1384.8821
Sept. 11–11	177–178	1.133	+ 1.7516	− 1.7539	+ 1.7528	+2.3	+15.4	178	210.706	1386.6349
Do	178–Z_{10}	1.197	+ 0.4621	− 0.4641	+ 0.4631	+2.0	+17.4	Z_{10}	211.903	1387.0980
Do	Z_{10}–179	1.649	+ 9.2927	− 9.2898	+ 9.2912	−2.9	+14.5	179	213.552	1396.3892
Do	179–A_{11}	1.133	+ 8.9098	− 8.9093	+ 8.9096	−0.5	+14.0	A_1,	214.685	1405.2988
Do	A_{11}–180	0.752	+ 4.6038	− 4.6027	+ 4.6032	−1.1	+12.9	180	215.437	1409.9020
Sept. 8–6	180–181	0.747	+ 8.1766	− 8.1721	+ 8.1756	−1.6	+11.3	181	216.184	1418.0776
Sept. 13–13	180–181	0.747	+ 8.1762	− 8.1774						
Sept. 8–6	181–182	1.189	+14.9945	−14.9907	+14.9926	−3.8	+ 7.5	182	217.373	1433.0702
Do	182–183	1.091	+14.5334	−14.5336	+14.5335	+0.2	+ 7.7	183	218.464	1447.6037
Sept. 8–8	183–I_3	0.714	+ 9.9736	− 9.9705	+ 9.9720	−3.1	+ 4.6	I_3	219.178	1457.5757
Do	I_3–184	0.514	+ 4.5540	− 4.5552	+ 4.5546	+1.2	+ 5.8	184	219.692	1462.1303
Sept. 8–6	184–185	1.092	+ 2.8152	− 2.8164	+ 2.8158	+1.2	+ 7.0	185	220.784	1464.9461
Do	185–186	1.215	+ 0.1954	− 0.1974	+ 0.1964	+2.0	+ 9.0	186	221.999	1465.1425
Sept. 7–7	186–J_3	1.045	+ 1.9219	− 1.9249	+ 1.9234	+3.0	+12.0	J_3	223.044	1467.0659
Do	J_3–187	0.952	− 2.3162	+ 2.3132	− 2.3147	+3.0	+15.0	187	223.996	1464.7512
Sept. 6–7	187–188	1.107	+ 0.4453	− 0.4525	+ 0.4499	+4.2	+19.2	188	225.103	1465.2011
Sept. 7–8	187–188	1.107	+ 0.4503	− 0.4516						
Sept. 6–7	188–189	0.847	+ 1.5376	− 1.5384	+ 1.5380	+0.8	+20.0	189	225.950	1466.7391
Sept. 7–7	189–K_3	0.712	− 0.1124	+ 0.1124	− 0.1124	0.0	+20.0	K_3	226.662	1466.6267
Do	K_3–190	1.049	+ 1.6573	− 1.6552	+ 1.6562	−2.1	+17.9	190	227.711	1468.2829
Sept. 6–7	190–191	1.154	+ 0.6836	− 0.6840	+ 0.6838	+0.4	+18.3	191	228.865	1468.9667

Results of leveling, Brigham, Utah, to Beowawe, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. R.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1911.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
Sept. 9-7	191–L_3	1.043	− 0.0558	+ 0.0548	− 0.0553	+1.0	+19.3	L_3	229.908	1468.9114
Sept. 9-9	L_3–M_3	1.211	+ 2.3125	− 2.3145	+ 2.3135	+2.0	+21.3	M_3	231.119	1471.2249
Do	M_3–192	1.368	+ 3.2863	− 3.2859	+ 3.2861	−0.4	+20.9	192	232.487	1474.5110
Do	192–N_3	0.754	+ 2.3382	− 2.3369	+ 2.3376	−1.3	+19.6	N_3	233.241	1476.8486
Do	N_3–O_3	1.739	+ 8.6578	− 8.6571	+ 8.6574	−0.7	+18.9	O_3	234.980	1485.5060
Sept. 9-14	O_3–P_3	0.110	− 0.0067	+ 0.0058	− 0.0066	+0.3	+19.2	P_3	235.090	1485.4994
Sept. 14-14	O_3–P_3	0.110	− 0.0067	+ 0.0070						
Do	P_3–193	1.352	+ 7.8885	− 7.8918	+ 7.8901	+3.3	+22.5	193	236.442	1493.3895
Do	193–194	1.034	+ 6.6240	− 6.6258	+ 6.6249	+1.8	+24.3	194	237.476	1500.0144
Do	194–Q_3	1.292	+16.4304	−16.4335	+16.4320	+3.1	+27.4	Q_3	238.768	1516.4464
Do	Q_3–195	1.234	+11.3662	−11.3666	+11.3664	+0.4	+27.8	195	240.002	1527.8128
Do	195–196	1.172	+13.3076	−13.3105	+13.3090	+2.9	+30.7	196	241.174	1541.1218
Do	196–R_3	1.360	+18.3972	−18.4000	+18.3986	+2.8	+33.5	R_3	242.534	1559.5204
Sept. 15-15	R_3–197	1.215	+13.4313	−13.4305	+13.4309	−0.8	+32.7	197	243.749	1572.9513
Do	197–198	1.172	+13.3380	−13.3423	+13.3402	+4.3	+37.0	198	244.921	1586.2915
Do	198–S_3	1.237	+17.4624	−17.4601	+17.4612	−2.3	+34.7	S_3	246.158	1603.7527
Do	S_3–199	1.145	+12.0540	−12.0562	+12.0551	+2.2	+36.9	199	247.303	1615.8078
Do	199–200	1.131	+14.7454	−14.7467	+14.7460	+1.3	+38.2	200	248.434	1630.5538
Sept. 16-16	200–T_3	1.429	+18.4028	−18.4068	+18.4048	+4.0	+42.2	T_3	249.863	1648.9586
Do	T_3–201	1.186	+12.5411	−12.5431	+12.5421	+2.0	+44.2	201	251.049	1661.5007
Sept. 16-18	201–202	1.124	+13.4927	−13.4936	+13.4932	+0.8	+45.0	202	252.173	1674.9939
Sept. 18-18	201–202	1.124	+13.4930	.....						
Sept. 16-16	202–203	1.030	+13.2371	−13.2331						
Sept. 18-19	202–203	1.030	+13.2346	−13.2375	+13.2356	−0.7	+44.3	203	253.203	1688.2295
Sept. 19-19	202–203	1.030	+13.2363	.....						
Sept. 16-18	203–U_3	1.272	+17.4607	−17.4617	+17.4612	+1.0	+45.3	U_3	254.475	1705.6907
Sept. 18-18	U_3–204	1.107	+14.0745	−14.0725	+14.0735	−2.0	+43.3	204	255.582	1719.7642
Do	204–205	1.132	+12.7202	−12.7286	+12.7239	+5.0	+48.3	205	256.714	1732.4881
Do	204–205	1.132	+12.7226	−12.7243						
Do	205–206	1.131	+12.2456	−12.2430						
Sept. 19-19	205–206	1.131	.....	−12.2437	+12.2445	−2.2	+46.1	206	257.845	1744.7326
Sept. 18-18	206–207	0.989	+12.0727	−12.0740	+12.0734	+1.3	+47.4	207	258.834	1756.8060
Do	207–208	1.106	+14.6130	−14.6154	+14.6142	+2.4	+49.8	208	259.940	1771.4202
Sept. 19-19	208–V_3	0.691	+ 9.5153	− 9.5146	+ 9.5150	−0.7	+49.1	V_3	260.631	1780.9352
Do	V_3–209	1.274	+15.2193	−15.2165	+15.2179	−2.8	+46.3	209	261.905	1756.1531
Sept. 20-20	209–W_3	1.386	+ 8.7892	− 8.7863	+ 8.7878	−2.9	+43.4	W_3	263.291	1804.9409
Do	W_3–X_3	1.180	+ 4.5775	− 4.5775	+ 4.5775	0.0	+43.4	X_3	264.471	1809.5184
Do	X_3–210	1.208	+ 8.2619	− 8.2596	+ 8.2608	−2.3	+41.1	210	265.679	1817.7792
Do	210–211	1.138	+ 7.9429	− 7.9442	+ 7.9436	+1.3	+42.4	211	266.817	1825.7228
Oct. 12-12	211–Y_3	0.568	+ 5.0420	− 5.0400	+ 5.0410	−2.0	+40.4	Y_3	267.385	1830.7638
Oct. 12-11	Y_3–212	1.096	+11.9147	−11.9155	+11.9151	+0.8	+41.2	212	268.481	1842.6789
Do	212–Z_3	1.306	+ 7.2487	− 7.2510	+ 7.2498	+2.3	+43.5	Z_3	269.787	1849.9287
Do	Z_3–213	0.956	− 1.4950	+ 1.4933	− 1.4942	+1.7	+45.2	213	270.743	1848.4345
Do	213–214	0.685	+ 0.0651	− 0.0679	+ 0.0665	+2.8	+48.0	214	271.428	1848.5010
Do	214–A_4	0.995	+ 3.0139	− 3.0119	+ 3.0129	−2.0	+46.0	A_4	272.423	1851.5139
Oct. 10-11	A_4–215	1.196	+ 4.0099	− 4.0051	+ 4.0077	−3.0	+43.0	215	273.619	1855.5216
Oct. 11-11	A_4–215	1.196	+ 4.0085	− 4.0073						
Oct. 10-11	215–216	1.217	+ 1.0121	− 1.0102	+ 1.0112	−1.9	+41.1	216	274.836	1856.5328
Do	216–B_4	0.998	+ 2.4372	− 2.4338	+ 2.4355	−3.4	+37.7	B_4	275.834	1858.9683
Oct. 9-11	B_4–217	1.053	+ 3.4181	− 3.4193	+ 3.4187	+1.2	+38.9	217	276.887	1862.3870
Do	217–218	1.216	+ 4.1818	− 4.1792	+ 4.1805	−2.6	+36.3	218	278.103	1866.5675
Do	218–219	1.135	+ 3.8629	− 3.8604	+ 3.8616	−2.5	+33.8	219	279.238	1870.4291
Oct. 11-11	219–C_4	1.551	+ 4.5242	− 4.5242	+ 4.5242	0.0	+33.8	C_4	280.789	1874.9533
Oct. 9-10	C_4–220	0.748	− 0.9731	+ 0.9722	− 0.9727	+0.9	+34.7	220	281.537	1873.9806
Oct. 10-8	220–221	1.216	− 2.2333	+ 2.2386	− 2.2360	−4.5	+30.2	221	282.753	1871.7446
Oct. 11-10	220–221	1.216	− 2.2342	+ 2.2380						
Oct. 10-8	221–D_4	1.266	+ 1.1550	− 1.1567	+ 1.1558	+1.7	+31.9	D_4	284.019	1872.9004
Oct. 8-8	D_4–222	1.249	− 4.3837	+ 4.3835	− 4.3836	+0.2	+32.1	222	285.268	1868.5168
Do	222–223	1.400	+ 1.0490	− 1.0501	+ 1.0496	+1.1	+33.2	223	286.668	1869.5664
Oct. 8-7	223–224	1.234	+ 2.0865	− 2.0887	+ 2.0876	+2.2	+35.4	224	287.902	1871.6540
Do	224–225	1.132	− 1.6183	+ 1.6156	− 1.6170	+2.7	+38.1	225	289.034	1870.0370
Do	225–226	1.133	+ 4.5777	− 4.5773	+ 4.5775	−0.4	+37.7	226	290.167	1874.6145
Do	226–E_4	1.145	+ 1.2201	− 1.2203	+ 1.2202	+0.2	+37.9	E_4	291.312	1875.8347
Sept. 28-28	E_4–227	1.292	− 5.3534	+ 5.3524	− 5.3529	+1.0	+38.9	227	292.604	1870.4818
Do	227–F_4	1.034	− 3.7600	+ 3.7622	− 3.7611	−2.2	+36.7	F_4	293.638	1866.7207
Do	F_4–228	0.843	− 2.6560	+ 2.6512	− 2.6530	+2.9	+39.6	228	294.481	1864.0677
Oct. 7-7	F_4–228	0.843	− 2.6530	+ 2.6519						
Sept. 28-28	228–229	1.132	− 2.3218	+ 2.3209	− 2.3214	+0.9	+40.5	229	295.613	1861.7463
Do	229–G_4	1.051	− 1.2055	+ 1.2049	− 1.2052	+0.6	+41.1	G_4	296.664	1860.5411
Sept. 28-29	G_4–230	0.993	− 4.5654	+ 4.5630	− 4.5642	+2.4	+43.5	230	297.657	1855.9769
Sept. 29-29	230–231	0.625	− 1.3392	+ 1.3399	− 1.3396	−0.7	+42.8	231	298.282	1854.6373
Do	231–232	1.217	+ 1.0484	− 1.0459	+ 1.0472	−2.5	+40.3	232	299.499	1855.6845
Do	232–233	1.215	+ 2.1954	− 2.1954	+ 2.1954	0.0	+40.3	233	300.714	1857.8799
Do	233–234	1.218	+ 3.8995	− 3.9042	+ 3.9008	+2.5	+42.8	234	301.932	1861.7807
Do	233–234	1.218	+ 3.8997	− 3.9000						
Do	234–H_4	1.311	+ 4.4229	− 4.4239	+ 4.4234	+1.0	+43.8	H_4	303.243	1866.2041
Sept. 29-30	H_4–235	1.218	− 0.4912	+ 0.4912	− 0.4912	0.0	+43.8	235	304.461	1865.7129
Do	235–236	1.218	+ 0.1420	− 0.1467	+ 0.1444	+1.3	+45.1	236	305.679	1865.8573
Do	235–236	1.218	+ 0.1454	− 0.1432						
Sept. 30-30	236–237	1.310	+ 3.2085	− 3.2085	+ 3.2085	0.0	+45.1	237	306.989	1869.0658
Do	237–238	1.316	+ 5.1676	− 5.1645	+ 5.1660	−3.1	+42.0	238	308.305	1874.2318
Do	238–I_4	1.058	+ 3.2694	− 3.2679	+ 3.2686	−1.5	+40.5	I_4	309.363	1877.5004
Oct. 2-2	I_4–239	0.970	− 8.1658	+ 8.1653	− 8.1656	+0.5	+41.0	239	310.333	1869.3348
Do	239–240	1.255	−16.8891	+16.8904	−16.8898	−1.3	+39.7	240	311.588	1852.4450
Do	240–241	1.312	−17.0690	+17.0664	−17.0677	+2.6	+42.3	241	312.900	1835.3773
Oct. 2-Sept. 30	241–J_4	1.200	−15.9948	+15.9913	−15.9930	+3.5	+45.8	J_4	314.100	1819.3843
Sept. 30-Oct. 2	J_4–242	0.726	− 5.7078	+ 5.7052	− 5.7065	+2.6	+48.4	242	314.826	1813.6778
Oct. 2-Sept. 30	242–243	1.010	− 9.5822	+ 9.5786	− 9.5804	+3.6	+52.0	243	315.836	1804.0974
Do	243–244	1.196	−14.4381	+14.4351	−14.4366	+3.0	+55.0	244	317.032	1789.6608

Results of leveling, Brigham, Utah, to Beowawe, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. R.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1911.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
Oct. 2-Sept. 29	244–K_4	1.089	−12.8173	+12.8157	−12.8165	+1.6	+56.6	K_4	318.121	1776.8443
Do	K_4–{S. P. B. M. 5803.200}	0.914	− 8.0485	+ 8.0472	− 8.0478	+1.3	+57.9	{S. P. B. M. 5803.200}	319.035	1768.7965
Sept. 27-27	{S. P. B. M. 5803.200}–245	1.204	−15.2525	+15.2514	−15.2520	+1.1	+59.0	245	320.239	1753.5445
Do	245–L_4	1.114	−13.6658	+13.6582	−13.6607	+3.8	+62.8	L_4	321.353	1739.8838
Sept. 30-Oct. 2	245–L_4	1.114	−13.6595	+13.6594						
Sept. 27-27	L_4–246	1.193	−16.5263	+16.5242	−16.5252	+2.1	+64.9	246	323.546	1723.3586
Do	246–M_4	1.183	− 8.1865	+ 8.1873	− 8.1869	−0.8	+64.1	M_4	323.729	1715.1717
Do	M_4–N_4	0.048	− 0.0640	+ 0.0643	− 0.0642	−0.3	+63.8	N_4	323.777	1715.1075
Do	N_4–247	1.486	− 0.5494	+ 0.5497	− 0.5496	−0.3	+63.5	247	325.263	1714.5579
Do	247–O_4	1.010	− 2.9426	+ 2.9431	− 2.9428	−0.5	+63.0	O_4	326.273	1711.6151
Do	O_4–P_4	1.620	− 2.6224	+ 2.6217	− 2.6220	+0.7	+63.7	P_4	327.893	1708.9931
Do	P_4–248	1.247	− 2.3685	+ 2.3717	− 2.3701	−3.2	+60.5	248	329.140	1706.6230
Oct. 3-3	248–Q_4	1.943	− 1.5955	+ 1.5957	− 1.5956	−0.2	+60.3	Q_4	331.083	1705.0274
Do	Q_4–249	1.275	− 6.7766	+ 6.7781	− 6.7774	−1.5	+58.8	249	332.358	1698.2500
Do	249–250	1.216	− 4.3174	+ 4.3215	− 4.3194	−4.1	+54.7	250	333.574	1693.9306
Do	250–251	1.153	− 4.6228	+ 4.6256	− 4.6242	−2.8	+51.9	251	334.727	1689.3064
Do	251–252	1.214	− 4.7727	+ 4.7743	− 4.7735	−1.6	+50.3	252	335.941	1684.5329
Do	252–253	1.091	− 4.1223	+ 4.1206	− 4.1214	+1.7	+52.0	253	337.032	1680.4115
Do	253–R_4	0.797	− 3.2998	+ 3.2975	− 3.2986	+2.3	+54.3	R_4	337.829	1677.1129
Oct. 3-4	R_4–{S. P. B. M. 5483.658}	1.043	− 3.8903	+ 3.8868	− 3.8886	+3.5	+57.8	{S. P. B. M. 5483.658}	338.872	1673.2243
Oct. 4-4	{S. P. B. M. 5483.658}–254	1.419	− 5.5783	+ 5.5784	− 5.5784	−0.1	+57.7	254	340.291	1667.6459
Do	254–255	1.194	− 4.5609	+ 4.5637	− 4.5623	−2.8	+54.9	255	341.485	1663.0836
Do	255–256	1.134	− 4.4741	+ 4.4726	− 4.4734	+1.5	+56.4	256	342.619	1658.6102
Do	256–257	1.093	− 4.0916	+ 4.0886	− 4.0901	+3.0	+59.4	257	343.712	1654.5201
Do	257–258	1.094	− 4.2600	+ 4.2610	− 4.2605	−1.0	+58.4	258	344.806	1650.2596
Do	258–259	1.254	− 4.7446	+ 4.7434	− 4.7440	+1.2	+59.6	259	346.060	1645.5156
Do	259–S_4	0.454	− 1.3706	+ 1.3720	− 1.3713	−1.4	+58.2	S_4	346.514	1644.1443
Oct. 5-5	S_4–260	1.096	− 4.8539	+ 4.8558	− 4.8548	−1.9	+56.3	260	347.610	1639.2895
Do	260–261	1.216	− 4.8953	+ 4.8944	− 4.8948	+0.9	+57.2	261	348.826	1634.3947
Do	261–262	1.134	− 2.2207	+ 2.2235	− 2.2221	−2.8	+54.4	262	349.960	1632.1726
Do	262–T_4	0.969	− 1.1546	+ 1.1592	− 1.1562	−2.9	+51.5	T_4	350.929	1631.0164
Oct. 6-6	262–T_4	0.969	− 1.1548	+ 1.1561						
Oct. 5-5	T_4–263	1.134	− 1.4564	+ 1.4560	− 1.4562	+0.4	+51.9	263	352.063	1629.5602
Do	263–U_4	1.828	− 3.8368	+ 3.8350	− 3.8359	+1.8	+53.7	U_4	353.891	1625.7243
Oct. 6-6	U_4–264	1.129	− 3.6749	+ 3.6748	− 3.6748	+0.1	+53.8	264	355.020	1622.0495
Do	264–265	1.071	− 2.2035	+ 2.2055	− 2.2045	−2.0	+51.8	265	356.091	1619.8450
Do	265–266	1.134	− 2.0381	+ 2.0392	− 2.0386	−1.1	+50.7	266	357.225	1617.8064
Do	266–267	1.612	− 1.9049	+ 1.9031	− 1.9040	+1.8	+52.5	267	358.837	1615.9024
Oct. 6-15	267–V_4	0.547	− 2.0633	+ 2.0637	− 2.0635	−0.4	+52.1	V_4	359.384	1613.8389
Oct. 15-15	V_4–268	1.484	− 1.5179	+ 1.5143	− 1.5161	+3.6	+55.7	268	360.868	1612.3228
Do	268–269	1.045	− 2.3227	+ 2.3224	− 2.3226	+0.3	+56.0	269	361.913	1610.0002
Do	269–270	1.044	+ 0.7454	− 0.7450	+ 0.7452	−0.4	+55.6	270	362.957	1610.7454
Oct. 14-15	270–271	0.805	− 2.8692	+ 2.8675	− 2.8684	+1.7	+57.3	271	363.762	1607.8770
Oct. 14-14	271–272	1.215	− 2.2084	+ 2.2075	− 2.2080	+0.9	+58.2	272	364.977	1605.6690
Do	272–273	1.215	− 2.2836	+ 2.2807	− 2.2822	+2.9	+61.1	273	366.192	1603.3868
Do	273–274	1.487	− 1.2744	+ 1.2781	− 1.2762	−3.7	+57.4	274	367.679	1602.1106
Do	274–275	1.433	− 2.4785	+ 2.4766	− 2.4776	+1.9	+59.3	275	369.112	1599.6330
Do	275–276	1.283	− 1.2316	+ 1.2319	− 1.2318	−0.3	+59.0	276	370.395	1598.4012
Do	276–277	0.936	− 2.8656	+ 2.8683	− 2.8670	−2.7	+56.3	277	371.331	1595.5342
Do	277–278	1.147	− 1.4568	+ 1.4546	− 1.4557	+2.2	+58.5	278	372.478	1594.0785
Do	278–W_4	1.423	+ 0.3763	− 0.3785	+ 0.3774	+2.2	+60.7	W_4	373.901	1594.4559
Oct. 16-16	W_4–279	1.491	− 5.9367	+ 5.9364	− 5.9366	+0.3	+61.0	279	375.392	1588.5193
Do	279–280	1.226	− 0.8445	+ 0.8440	− 0.8442	+0.5	+61.5	280	376.618	1587.6751
Do	280–281	1.289	− 2.3539	+ 2.3526	− 2.3532	+1.3	+62.8	281	377.907	1585.3219
Do	281–X_4	1.224	+ 0.7396	− 0.7388	+ 0.7392	−0.8	+62.0	X_4	379.131	1586.0611
Do	X_4–282	1.170	− 3.1209	+ 3.1220	− 3.1214	−1.1	+60.9	282	380.301	1582.9397
Do	282–283	1.104	− 1.7392	+ 1.7361	− 1.7376	+3.1	+64.0	283	381.405	1581.2021
Do	283–284	1.028	− 1.5923	+ 1.5933	− 1.5928	−1.0	+63.0	284	382.433	1579.6093
Do	284–285	0.834	+ 0.0314	− 0.0328	+ 0.0321	+1.4	+64.4	285	383.267	1579.6414
Oct. 17-17	285–Y_4	0.172	+ 0.3424	− 0.3431	+ 0.3428	+0.7	+65.1	Y_4	383.439	1579.9842
Oct. 20-20	Y_4–286	0.874	− 1.4552	+ 1.4559	− 1.4556	−0.7	+64.4	286	384.313	1578.5286
Do	286–287	1.097	− 3.5787	+ 3.5824	− 3.5806	−3.7	+60.7	287	385.410	1574.9480
Do	287–288	1.090	− 2.2296	+ 2.2311	− 2.2303	−1.5	+59.2	288	386.500	1572.7178
Do	288–289	1.174	− 2.4414	+ 2.4456	− 2.4435	−4.2	+55.0	289	387.674	1570.2742
Do	289–Z_4	1.111	+ 1.7163	− 1.7137	+ 1.7150	−2.6	+52.4	Z_4	388.785	1571.9892
Oct. 21-21	Z_4–A_5	1.179	− 1.6455	+ 1.6441	− 1.6448	+1.4	+53.8	A_5	389.964	1570.3444
Do	A_5–290	1.056	− 0.7892	+ 0.7841	− 0.7872	+4.1	+57.9	290	391.020	1569.5572
Do	A_5–290	1.056	.....	+ 0.7861						
Oct. 23-21	290–291	1.305	− 4.5402	+ 4.5461	− 4.5418	−2.1	+55.8	291	392.325	1565.0154
Oct. 23-23	290–291	1.305	− 4.5414	+ 4.5397						
Oct. 23-21	291–B_5	1.209	− 0.5745	+ 0.5757	− 0.5751	−1.2	+54.6	B_5	393.534	1564.4403
Oct. 23-23	B_5–292	1.046	− 3.9125	+ 3.9116	− 3.9120	+0.9	+55.5	292	394.580	1560.5283
Do	292–293	1.130	− 1.9870	+ 1.9847	− 1.9858	+2.3	+57.8	293	395.710	1558.5425
Do	293–294	1.133	+ 3.6706	− 3.6726	+ 3.6716	+2.0	+59.8	294	396.843	1562.2141
Oct. 23-24	294–295	1.134	− 0.8928	+ 0.8928	− 0.8928	0.0	+59.8	295	397.977	1561.3213
Oct. 24-24	295–296	0.529	− 4.9191	+ 4.9160	− 4.9178	+2.4	+62.2	296	398.506	1556.4035
			− 4.9188	+ 4.9172						
Do	296–297	1.093	− 2.8903	+ 2.8891	− 2.8897	+1.2	+63.4	297	399.599	1553.5138
Do	297–C_5	1.135	− 1.9427	+ 1.9387	− 1.9407	+4.0	+67.4	C_5	400.734	1551.5731
Do	C_5–298	1.708	+ 3.1304	− 3.1279	+ 3.1292	−2.5	+64.9	298	402.442	1554.7023
Do	298–D_5	1.486	− 8.1607	+ 8.1652	− 8.1630	−4.5	+60.4	D_5	403.928	1546.5393
Oct. 24-25	D_5–299	1.059	− 1.4375	+ 1.4367	− 1.4371	+0.8	+61.2	299	404.987	1545.1022
Oct. 25-25	299–300	0.730	+ 1.1518	− 1.1524	+ 1.1521	+0.6	+61.8	300	405.717	1546.2543
Do	300–E_5	1.158	+ 1.5885	− 1.5892	+ 1.5888	+0.7	+62.5	E_5	406.875	1547.8431
Do	E_5–F_5	1.096	− 3.7920	+ 3.7945	− 3.7932	−2.5	+60.0	F_5	407.971	1544.0499
Oct. 25-26	F_5–G_5	1.056	− 3.5257	+ 3.5280	− 3.5268	−2.3	+57.7	G_5	409.027	1540.5231

Results of leveling, Brigham, Utah, to Beowawe, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. R.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1911.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
Oct. 25-25	G_5-301	1.205	+ 0.6262	− 0.6232	+ 0.6247	−3.0	+54.7	301	410.232	1541.1478
Do	301-302	1.219	− 4.4353	+ 4.4338	− 4.4346	+1.5	+56.2	302	411.451	1536.7132
Do	302-H_5	0.907	− 0.6312	+ 0.6283	− 0.6298	+2.9	+59.1	H_5	412.358	1536.0834
Do	H_5-303	1.216	− 0.9647	+ 0.9628	− 0.9638	+1.9	+61.0	303	413.574	1535.1196
Oct. 25-26	303-304	1.219	− 1.3286	+ 1.3284	− 1.3285	+0.2	+61.2	304	414.793	1533.7911
Do	304-I_5	0.807	− 0.7961	+ 0.7954	− 0.7958	+0.7	+61.9	I_5	415.600	1532.9953
Oct. 26-26	I_5-J_5	2.012	− 2.8384	+ 2.8379	− 2.8382	+0.5	+62.4	J_5	417.612	1530.1571
Do	J_5-305	1.215	− 0.7290	+ 0.7286	− 0.7288	+0.4	+62.8	305	418.827	1529.4283
Do	305-K_5	1.583	− 2.8098	+ 2.8108	− 2.8103	−1.0	+61.8	K_5	420.410	1526.6180
Do	K_5-306	1.185	− 3.7441	+ 3.7417	− 3.7429	+2.4	+64.2	306	421.595	1522.8751
Do	306-307	1.194	− 0.1237	+ 0.1243	− 0.1240	−0.6	+63.6	307	422.789	1522.7511
Oct. 28-28	307-L_5	1.038	+ 3.4648	− 3.4651	+ 3.4650	+0.3	+63.9	L_5	423.827	1526.2161
Do	L_5-308	1.051	− 4.8499	+ 4.8503	− 4.8504	−0.9	+63.0	308	424.878	1521.3657
Do	308-309	1.318	− 2.7773	+ 2.7749	− 2.7764	+2.9	+65.9	309	426.196	1518.5893
Oct. 28-27	309-M_5	1.071	− 2.1646	+ 2.1644	− 2.1645	+0.2	+66.1	M_5	427.267	1516.4248
Oct. 27-27	M_5-310	1.257	− 0.1935	+ 0.1958	− 0.1946	−2.3	+63.8	310	428.524	1516.2302
Do	310-311	1.113	− 1.1289	+ 1.1288	− 1.1288	+0.1	+63.9	311	429.637	1515.1014
Do	311-N_5	0.866	+ 0.2275	− 0.2246	+ 0.2260	−2.9	+61.0	N_5	430.503	1515.3274
Do	N_5-312	1.174	− 0.2368	+ 0.2375	− 0.2372	−0.7	+60.3	312	431.677	1515.0902
Do	312-O_5	1.344	− 1.2427	+ 1.2380	− 1.2409	+3.0	+63.3	O_5	433.021	1513.8493
Oct. 30-30	312-O_5	1.344	− 1.2422	+ 1.2409						
Oct. 27-30	O_5-P_5	0.570	− 1.5432	+ 1.5438	− 1.5435	−0.6	+62.7	P_5	433.591	1512.3058
Oct. 30-30	P_5-Q_5	0.977	− 2.0149	+ 2.0140	− 2.0144	+0.9	+63.6	Q_5	434.568	1510.2914
Nov. 1-1	Q_5-R_5	0.708	− 1.5248	+ 1.5196	− 1.5225	+2.6	+66.2	R_5	435.276	1508.7689
Do	Q_5-R_5	0.708	− 1.5228	+ 1.5229						
Oct. 30	R_5-313	1.178	− 3.9112	+ 3.9081	− 3.9096	+3.1	+69.3	313	436.454	1504.8593
Oct. 30-30	313-314	0.875	− 0.3608	+ 0.3604	− 0.3606	+0.4	+69.7	314	437.329	1504.4987
Oct. 30-31	314-S_5	1.263	− 6.1738	+ 6.1719	− 6.1728	+1.9	+71.6	S_5	438.592	1498.3259
Oct. 31-31	S_5-315	1.218	− 0.5666	+ 0.5639	− 0.5652	+2.7	+74.3	315	439.810	1497.7607
Do	315-316	1.215	− 2.1441	+ 2.1394	− 2.1407	+1.0	+75.3	316	441.025	1495.6200
Nov. 2-2	315-316	1.215	− 2.1384	+ 2.1410						
Oct. 31-31	316-317	1.180	− 1.0604	+ 1.0588	− 1.0596	+1.6	+76.9	317	442.205	1494.5604
Do	317-T_5	1.204	− 2.3531	+ 2.3498	− 2.3514	+3.3	+80.2	T_5	443.409	1492.2090
Do	T_5-318	1.099	+ 0.8354	− 0.8414	+ 0.8396	+2.0	+82.2	318	444.508	1493.0486
			+ 0.8419	− 0.8399						
Oct. 31-Nov. 2	318-319	1.218	− 3.6317	+ 3.6345	− 3.6331	−2.8	+79.4	319	445.726	1489.4155
Nov. 2-2	319-U_5	0.915	− 2.3154	+ 2.3170	− 2.3162	−1.6	+77.8	U_5	446.641	1487.0993
Do	U_5-320	1.170	+ 1.1616	− 1.1658	+ 1.1637	+4.2	+82.0	320	447.811	1488.2630
Nov. 3-3	320-V_5	1.135	− 3.4481	+ 3.4466	− 3.4474	+1.5	+83.5	V_5	448.946	1484.8156
Do	V_5-321	1.125	+ 0.3423	− 0.3441	+ 0.3432	+1.8	+85.3	321	450.071	1485.1588
Do	321-322	1.128	− 2.8622	+ 2.8615	− 2.8618	+0.7	+86.0	322	451.199	1482.2970
Do	322-323	1.134	− 1.2173	+ 1.2184	− 1.2178	−1.1	+84.9	323	452.333	1481.0792
Do	323-324	1.133	− 2.0310	+ 2.0282	− 2.0296	+2.8	+87.7	324	453.466	1479.0496
Do	324-325	1.131	− 0.2677	+ 0.2693	− 0.2685	−1.6	+86.1	325	454.597	1478.7811
Do	325-326	1.130	− 1.1182	+ 1.1194	− 1.1188	−1.2	+84.9	326	455.727	1477.6623
Do	326-327	1.130	− 1.7050	+ 1.7038	− 1.7044	+1.2	+86.1	327	456.857	1475.9579
Nov. 4-4	327-W_5	1.412	− 0.0330	+ 0.0339	− 0.0334	−0.9	+85.2	W_5	458.269	1475.9245
Do	W_5-328	1.215	+ 0.1362	− 0.1330	+ 0.1346	−3.2	+82.0	328	459.484	1476.0591
Do	328-329	1.216	− 1.2987	+ 1.2966	− 1.2976	+2.1	+84.1	329	460.700	1474.7615
Do	329-330	1.215	− 2.1364	+ 2.1355	− 2.1360	+0.9	+85.0	330	461.915	1472.6255
Do	330-331	1.052	− 1.9905	+ 1.9935	− 1.9920	−3.0	+82.0	331	462.967	1470.6335
Do	331-332	1.198	− 1.2392	+ 1.2446	− 1.2412	−3.2	+78.8	332	464.165	1469.3923
Do	331-332	1.198	− 1.2400	+ 1.2410						
Nov. 6-6	332-X_5	0.790	− 0.5964	+ 0.5962	− 0.5963	+0.2	+79.0	X_5	464.955	1468.7960
Do	X_5-333	1.278	− 4.2556	+ 4.2583	− 4.2570	−2.7	+76.3	333	466.233	1464.5390
Do	333-334	1.214	− 1.2240	+ 1.2205	− 1.2222	+3.5	+79.8	334	467.447	1463.3168
Do	334-335	1.218	+ 0.1044	− 0.1032	+ 0.1038	−1.2	+78.6	335	468.665	1463.4206
Do	335-336	1.208	− 4.0076	+ 4.0035	− 4.0056	+4.1	+82.7	336	469.873	1459.4150
Do	336-337	1.218	− 4.1509	+ 4.1494	− 4.1502	+1.5	+84.2	337	471.091	1455.2648
Do	337-Y_5	1.183	− 0.4290	+ 0.4306	− 0.4298	−1.6	+82.6	Y_5	472.274	1454.8350
Do	Y_5-338	1.107	− 2.1292	+ 2.1303	− 2.1298	−1.1	+81.5	338	473.381	1452.7052
Nov. 7-7	338-339	1.219	− 4.6948	+ 4.6968	− 4.6958	−2.0	+79.5	339	474.600	1448.0094
Do	339-340	1.217	− 1.5940	+ 1.5950	− 1.5945	−1.0	+78.5	340	475.817	1446.4149
Do	340-341	1.214	− 2.0886	+ 2.0916	− 2.0901	−3.0	+75.5	341	477.031	1444.3248
Do	341-342	1.134	− 0.7464	+ 0.7494	− 0.7479	−3.0	+72.5	342	478.165	1443.5769
Do	342-Z_5	0.910	− 1.9546	+ 1.9556	− 1.9551	−1.0	+71.5	Z_5	479.075	1441.6218
Do	Z_5-343	1.135	− 2.0079	+ 2.0073	− 2.0076	+0.6	+72.1	343	480.210	1439.6142
Do	343-344	1.218	− 1.8545	+ 1.8570	− 1.8558	−2.5	+69.6	344	481.428	1437.7584
Nov. 8-8	344-345	1.218	− 1.6848	+ 1.6853	− 1.6850	−0.5	+69.1	345	482.646	1436.0734
Do	345-346	1.189	− 2.0433	+ 2.0437	− 2.0435	−0.4	+68.7	346	483.835	1434.0299
Do	346-347	1.118	− 1.5324	+ 1.5322	− 1.5323	+0.2	+68.9	347	484.953	1432.4976
Do	347-A_6	0.361	− 0.3037	+ 0.3025	− 0.3031	+1.2	+70.1	A_6	485.314	1432.1945
Do	A_6-B_6	0.113	− 0.3501	+ 0.3501	− 0.3501	0.0	+70.1	B_6	485.427	1431.8444
Do	B_6-C_6	0.798	− 1.5218	+ 1.5253	− 1.5236	−3.5	+66.6	C_6	486.225	1430.3208

BEOWAWE TO MARMOL, NEV.

This section was run between July 18 and October 25, 1912.

Precise level No. 7 and rods V and W were used for the entire line. The lengths of these rods at 0° C. as determined by the instrument division of this Survey are as follows: June 17, 1912, rod V, 3.0004 meters, rod W, 3.0004 meters; January 25, 1913, rod V, 2.9999 meters, rod W, 3.0001 meters.

These measurements indicate a shortening of the rods. The field measurements confirm this shortening and show it to have taken place between June 26 and August 5. For the remainder of the period of leveling the rods maintained practically a constant length. In the computation the mean length of the rods on July 16, 3.00019 meters or an excess of 0.06 millimeter per meter was used for the leveling done previous to August 5. For the remainder of the season the mean length of the rods given by the office measures of January 25, 1913, 3.0000 meters was used.

The index error of rod V was −0.5 millimeter; of rod W, −0.2 millimeter.

The new determination of the differences of elevation between the three bench marks recovered at Beowawe showed that they had not been disturbed since their establishment in 1911.

The elevations in the following table depend on an elevation of 1431.8444 meters for bench mark B_6 at Beowawe as determined by the line from Brigham, Utah, to Beowawe, Nev.

Results of leveling, Beowawe to Marmol, Nev.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. B_6.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1912.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
								A_6	−0.135	1432.1937
July 18–18	A_6–B_6	0.135	−0.3491	+0.3495	−0.3493	−0.4	−0.4	B_6	0.000	1431.8444
Do	B_6–C_5	0.789	−1.5274	+1.5270	−1.5272	+0.4	+0.4	C_5	0.789	1430.3172
Do	C_5–1	0.999	−1.8911	+1.8925	−1.8918	−1.4	−1.0	1	1.788	1428.4254
Do	1–2	1.125	−1.3749	+1.3706	−1.3724	+2.5	+1.5	2	2.913	1427.0530
Do	1–2	1.125	−1.3723	+1.3716						
Do	2–3	1.206	−1.1577	+1.1579	−1.1578	−0.2	+1.3	3	4.119	1425.8952
July 18–19	3–4	1.206	−2.0437	+2.0428	−2.0432	+0.9	+2.2	4	5.325	1423.8520
Do	4–5	1.290	−1.5143	+1.5113	−1.5128	+3.0	+5.2	5	6.615	1422.3392
Do	5–G_6	0.902	−1.9620	+1.9632	−1.9626	−1.2	+4.0	G_5	7.517	1420.3766
Do	G_6–6	1.006	−0.6080	+0.6079	−0.6080	+0.1	+4.1	6	8.523	1419.7686
July 19–19	6–7	1.103	−1.3225	+1.3219	−1.3222	+0.6	+4.7	7	9.626	1418.4464
Do	7–8	1.124	−1.6507	+1.6498	−1.6502	+0.9	+5.6	8	10.750	1416.7962
Do	8–9	1.121	−1.3476	+1.3478	−1.3477	−0.2	+5.4	9	11.871	1415.4485
July 20–19	9–10	1.163	−1.6051	+1.6047	−1.6049	+0.4	+5.8	10	13.034	1413.8436
Do	10–11	1.082	−1.7709	+1.7744	−1.7726	−3.5	+2.3	11	14.116	1412.0710
Do	11–12	1.125	−1.2406	+1.2405	−1.2406	+0.1	+2.4	12	15.241	1410.8304
Do	12–H_6	1.036	−0.2412	+0.2425	−0.2418	−1.3	+1.1	H_6	16.277	1410.5886
July 20–20	H_6–13	1.121	−4.1594	+4.1587	−4.1590	+0.7	+1.8	13	17.398	1406.4296
Do	13–14	1.126	−2.2427	+2.2437	−2.2432	−1.0	+0.8	14	18.524	1404.1864
Do	14–15	1.104	−1.6818	+1.6790	−1.6804	+2.8	+3.6	15	19.628	1402.5060
Do	15–16	1.125	−1.7674	+1.7665	−1.7670	+0.9	+4.5	16	20.753	1400.7390
Do	16–17	1.125	−0.4100	+0.4141	−0.4108	−3.1	+1.4	17	21.878	1400.3282
July 22–22	16–17	1.125	−0.4086	+0.4107						
July 20–20	17–18	1.024	−0.2910	+0.2889	−0.2900	+2.1	+3.5	18	22.902	1400.0382
July 22–22	18–19	1.288	−1.3721	+1.3709	−1.3715	+1.2	+4.7	19	24.190	1398.6667
Do	19–I_6	1.185	−1.4885	+1.4833	−1.4864	+3.1	+7.8	I_6	25.375	1397.1803
Do	19–I_6	1.185	−1.4875	+1.4865						
Do	I_6–20	0.752	−1.6296	+1.6313	−1.6304	−1.7	+6.1	20	26.127	1395.5499
Do	20–21	0.984	+0.6259	−0.6275	+0.6267	+1.6	+7.7	21	27.111	1396.1766
July 23–22	21–22	0.967	−2.2144	+2.2148	−2.2146	−0.4	+7.3	22	28.078	1393.9620
Do	22–23	1.021	+2.9731	−2.9722	+2.9726	−0.9	+6.4	23	29.099	1396.9346
Do	23–24	1.020	+1.3330	−1.3334	+1.3332	+0.4	+6.8	24	30.119	1398.2678
July 23–23	24–25	1.029	−6.0975	+6.0973	−6.0974	+0.2	+7.0	25	31.148	1392.1704
Do	25–26	1.038	−3.6270	+3.6215	−3.6252	+0.7	+7.7	26	32.186	1388.5452
Do	25–26	1.038	−3.6240	+3.6280						
Do	26–27	1.021	−1.5292	+1.5280	−1.5286	+1.2	+8.9	27	33.207	1387.0166
Do	27–J_6	1.004	+1.4908	−1.4923	+1.4916	+1.5	+10.4	J_6	34.211	1388.5082
July 23–24	J_6–28	1.192	−3.9227	+3.9208	−3.9218	+1.9	+12.3	28	35.403	1384.5864
Do	28–29	1.125	+1.3726	−1.3696	+1.3711	−3.0	+9.3	29	36.528	1385.9575
July 24–24	29–30	0.777	−2.3373	+2.3336	−2.3354	+3.7	+13.0	30	37.305	1383.6221
Do	30–31	1.125	−0.2468	+0.2454	−0.2461	+1.4	+14.4	31	38.430	1383.3760
Do	31–32	1.125	+0.5726	−0.5743	+0.5734	+1.7	+16.1	32	39.555	1383.9494
Do	32–33	1.124	−1.2085	+1.2094	−1.2090	−0.9	+15.2	33	40.679	1382.7404
Do	33–34	1.124	−1.3278	+1.3256	−1.3267	+2.2	+17.4	34	41.803	1381.4137
Do	34–K_6	1.123	−1.3321	+1.3322	−1.3322	−0.1	+17.3	K_6	42.926	1380.0815
July 24–25	K_6–35	1.210	−1.4185	+1.4176	−1.4180	+0.9	+18.2	35	44.136	1378.6635
Do	35–36	1.124	−1.1976	+1.1959	−1.1968	+1.7	+19.9	36	45.260	1377.4667
Do	36–37	1.124	+0.3991	−0.3998	+0.3994	+0.7	+20.6	37	46.384	1377.8661
Do	37–38	1.126	−0.4584	+0.4617	−0.4600	−3.3	+17.3	38	47.510	1377.4061
Do	38–39	1.126	+0.2049	−0.2087	+0.2068	+3.8	+21.1	39	48.636	1377.6129
July 25–25	39–40	0.779	−0.5602	+0.5608	−0.5605	−0.6	+20.5	40	49.415	1377.0524
Do	40–41	1.125	−1.1615	+1.1586	−1.1600	+2.9	+23.4	41	50.540	1375.8924
Do	41–42	1.086	−1.2503	+1.2494	−1.2498	+0.9	+24.3	42	51.626	1374.6426
Do	42–I_6	1.276	−0.3158	+0.3155	−0.3156	+0.3	+24.6	I_6	52.902	1374.3270
July 25–26	I_6–43	0.798	−0.4839	+0.4831	−0.4835	+0.8	+25.4	43	53.700	1373.8435
Do	43–44	1.125	−1.9993	+2.0000	−1.9996	−0.7	+24.7	44	54.825	1371.8439
July 26–26	44–M_6	1.066	+0.5912	−0.5843	+0.5875	−3.0	+21.7	M_6	55.891	1372.4314
July 27–27	44–M_6	1.066	+0.5867	−0.5878						
July 26–26	M_6–45	1.073	−1.1621	+1.1693	−1.1663	−4.6	+17.1	45	56.964	1371.2651
Do	M_6–45	1.073	−1.1660	+1.1680						
Do	45–46	1.069	−1.2074	+1.2084	−1.2079	−1.0	+16.1	46	58.033	1370.0572
Do	46–47	1.124	+0.6065	−0.6073	+0.6069	+0.8	+16.9	47	59.157	1370.6641
Do	47–48	1.123	+1.0821	−1.0844	+1.0832	+2.3	+19.2	48	60.280	1371.7473

Results of leveling, Beowawe to Marmol, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. B_6.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1912.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
July 26-27	48–N_6	0.746	+1.2548	−1.2530	+1.2539	−1.8	+17.4	N_6	61.026	1373.0012
July 27-27	N_6–49	1.117	−0.2214	+0.2218	−0.2216	−0.4	+17.0	49	62.143	1372.7796
Do	49–50	1.125	+0.1333	−0.1300	+0.1316	−3.3	+13.7	50	63.268	1372.9112
Do	50–51	1.125	+1.7874	−1.7847	+1.7860	−2.7	+11.0	51	64.393	1374.6972
Do	51–52	1.104	+1.3936	−1.3923	+1.3930	−1.3	+ 9.7	52	65.497	1376.0902
Do	52–53	1.083	−0.4026	+0.4054	−0.4040	−2.8	+ 6.9	53	66.580	1375.6862
Do	53–54	1.074	−2.2988	+2.3013	−2.3000	−2.5	+ 4.4	54	67.654	1373.3862
July 27-29	54–O_6	0.592	−0.1409	+0.1417	−0.1413	−0.8	+ 3.6	O_6	68.246	1373.2449
July 29-29	O_6–55	1.111	+0.5560	−0.5562	+0.5561	+0.2	+ 3.8	55	69.357	1373.8010
Do	55–56	1.123	+3.4737	−3.4727	+3.4732	−1.0	+ 2.8	56	70.480	1377.2742
Do	56–57	1.083	−3.4914	+3.4911	−3.4912	+0.3	+ 3.1	57	71.563	1373.7830
Do	57–58	1.081	−1.4976	+1.4977	−1.4976	−0.1	+ 3.0	58	72.644	1372.2854
July 30-29	58–59	1.382	+2.3364	−2.3344	+2.3354	−2.0	+ 1.0	59	74.026	1374.6208
Do	59–60	1.082	+0.5804	−0.5790	+0.5797	−1.4	− 0.4	60	75.108	1375.2005
Do	60–P_6	1.079	−1.7192	+1.7232	−1.7200	−1.6	− 2.0	P_6	76.187	1373.4805
July 30-30	60–P_6	1.079	−1.7192	+1.7183						
Do	P_6–61	1.171	−3.9086	+3.9071	−3.9078	+1.5	− 0.5	61	77.358	1369.5727
Do	61–Q_6	1.080	−3.6357	+3.6342	−3.6350	+1.5	+ 1.0	Q_6	78.438	1365.9377
July 30-31	Q_6–62	1.071	−3.0360	+3.0348	−3.0354	+1.2	+ 2.2	62	79.509	1362.9023
Do	62–63	1.126	−4.0346	+4.0341	−4.0344	+0.5	+ 2.7	63	80.635	1358.8679
July 31-31	63–64	1.125	−0.7076	+0.7068	−0.7072	+0.8	+ 3.5	64	81.760	1358.1607
Do	64–65	1.571	−5.3582	+5.3571	−5.3576	+1.1	+ 4.6	65	83.331	1352.8031
Do	65–R_6	0.593	−4.2825	+4.2863	−4.2842	−1.9	+ 2.7	R_6	83.924	1348.5189
Aug. 1-1	65–R_6	0.593	−4.2840	+4.2839						
July 31-31	R_6–66	1.163	−0.7238	+0.7225	−0.7232	+1.3	+ 4.0	66	85.087	1347.7957
Do	66–67	1.225	−1.3032	+1.3009	−1.3020	+2.3	+ 6.3	67	86.312	1346.4937
July 31-Aug. 1	67–68	1.127	−0.9519	+0.9514	−0.9514	−1.0	+ 5.3	68	87.439	1345.5423
Aug. 1-1	68–69	1.189	−1.4796	+1.4824	−1.4810	−2.8	+ 2.5	69	88.628	1344.0613
Do	69–S_6	0.742	−1.2718	+1.2734	−1.2726	−1.6	+ 0.9	S_6	89.370	1342.7887
Do	S_6–70	0.386	+0.4468	−0.4477	+0.4472	+0.9	+ 1.8	70	89.756	1343.2359
Do	70–71	1.078	−1.0533	+1.0525	−1.0529	+0.8	+ 2.6	71	90.834	1342.1830
Do	71–72	1.067	−0.5510	+0.5490	−0.5500	+2.0	+ 4.6	72	91.901	1341.6330
Do	72–73	1.127	−0.7044	+0.7038	−0.7041	+0.6	+ 5.2	73	93.028	1340.9289
Do	73–74	1.211	−0.6717	+0.6695	−0.6706	+2.2	+ 7.4	74	94.239	1340.2583
Aug. 1-2	74–75	0.623	−0.3847	+0.3829	−0.3838	+1.8	+ 9.2	75	94.862	1339.8745
Aug. 2-2	75–76	1.227	−1.0456	+1.0437	−1.0446	+1.9	+11.1	76	96.089	1338.8299
Do	76–77	1.127	−0.9627	+0.9618	−0.9622	+0.9	+12.0	77	97.216	1337.8677
Do	77–T_6	0.369	−1.2920	+1.2909	−1.2914	+1.1	+13.1	T_6	97.585	1336.5763
Do	T_6–78	1.150	−0.5194	+0.5155	−0.5174	+3.9	+17.0	78	98.735	1336.0589
Do	78–79	1.127	−1.0880	+1.0898	−1.0889	−1.8	+15.2	79	99.862	1334.9700
Do	79–80	1.126	−0.8732	+0.8748	−0.8740	−1.6	+13.6	80	100.988	1334.0960
Aug. 2-7	80–81	1.124	−0.3924	+0.3910	−0.3917	+1.4	+15.0	81	102.112	1333.7043
Aug. 7-7	81–82	1.600	−0.2458	+0.2440	−0.2449	+1.8	+16.8	82	103.712	1333.4594
Do	82–U_6	1.149	−0.7518	+0.7545	−0.7532	−2.7	+14.1	U_6	104.861	1332.7062
Do	U_6–83	1.067	+0.7525	−0.7511	+0.7518	−1.4	+12.7	83	105.928	1333.4580
Do	83–84	1.083	−0.6881	+0.6894	−0.6888	−1.3	+11.4	84	107.011	1332.7692
Do	84–V_6	1.152	+0.4374	−0.4390	+0.4382	+1.6	+13.0	V_6	108.163	1333.2074
Aug. 8-8	V_6–85	0.483	−0.7578	+0.7584	−0.7581	−0.6	+12.4	85	108.646	1332.4493
Do	85–86	1.082	−0.1218	+0.1220	−0.1219	−0.2	+12.2	86	109.728	1332.3274
Do	86–87	1.104	−3.2598	+3.2612	−3.2605	−1.4	+10.8	87	110.832	1329.0669
Do	87–88	1.047	+0.3359	−0.3331	+0.3345	−2.8	+ 8.0	88	111.879	1329.4014
Do	88–89	1.115	−0.3311	+0.3334	−0.3322	−2.3	+ 5.7	89	112.994	1329.0692
Do	89–90	1.124	−0.4178	+0.4156	−0.4167	+2.2	+ 7.9	90	114.118	1328.6525
Aug. 8-9	90–91	1.131	−1.8144	+1.8167	−1.8156	−2.3	+ 5.6	91	115.249	1326.8369
Aug. 9-9	91–92	0.719	−0.5895	+0.5893	−0.5894	+0.2	+ 5.8	92	115.968	1326.2475
Do	92–W_6	0.845	+0.4355	−0.4361	+0.4358	+0.6	+ 6.4	W_6	116.813	1326.6833
Do	W_6–93	1.455	+3.9316	−3.9321	+3.9318	+0.5	+ 6.9	93	118.268	1330.6151
Do	93–94	1.058	+4.5694	−4.5663	+4.5678	−3.1	+ 3.8	94	119.326	1335.1829
Do	94–X_6	1.033	+1.4438	−1.4441	+1.4440	+0.3	+ 4.1	X_6	120.359	1336.6269
Aug. 9-10	X_6–95	1.108	−1.3363	+1.3338	−1.3350	+2.5	+ 6.6	95	121.467	1335.2919
Do	95–96	1.130	−6.0717	+6.0692	−6.0704	+2.5	+ 9.1	96	122.597	1329.2215
Aug. 10-10	96–97	1.061	−4.9844	+4.9824	−4.9834	+2.0	+11.1	97	123.658	1324.2381
Do	97–98	1.148	−1.7314	+1.7324	−1.7319	−1.0	+10.1	98	124.806	1322.5062
Do	98–99	1.149	−1.3970	+1.3981	−1.3976	−1.1	+ 9.0	99	125.955	1321.1086
Do	99–100	1.276	−1.7297	+1.7277	−1.7287	+2.0	+11.0	100	127.231	1319.3799
Do	100–Y_6	1.109	−1.5888	+1.5878	−1.5883	+1.0	+12.0	Y_6	128.340	1317.7916
Aug. 12-12	Y_6–101	1.131	−0.6166	+0.6169	−0.6168	−0.3	+11.7	101	129.471	1317.1748
Do	101–102	1.169	+4.9369	−4.9380	+4.9374	+1.1	+12.8	102	130.640	1322.1122
Do	102–103	1.093	−0.3814	+0.3800	−0.3807	+1.4	+14.2	103	131.733	1321.7315
Do	103–104	1.021	+0.8988	−0.8974	+0.8981	−1.4	+12.8	104	132.754	1322.6296
Do	104–105	1.023	−1.9309	+1.9275	−1.9292	+3.4	+16.2	105	133.777	1320.7004
Do	105–106	1.023	−1.1643	+1.1646	−1.1644	−0.3	+15.9	106	134.800	1319.5360
Aug. 12-13	106–107	1.074	−0.0976	+0.0993	−0.0984	−1.7	+14.2	107	135.874	1319.4376
Do	107–108	1.149	−2.7148	+2.7104	−2.7118	+0.7	+14.9	108	137.023	1316.7258
Aug. 13-13	107–108	1.149	−2.7094	+2.7124						
Aug. 12-13	108–Z_6	1.207	−3.9799	+3.9795	−3.9797	+0.4	+15.3	Z_6	138.230	1312.7461
Aug. 13-13	Z_6–109	0.922	−2.0116	+2.0120	−2.0118	−0.4	+14.9	109	139.152	1310.7343
Aug. 14-13	109–110	0.965	−0.4894	+0.4896	−0.4895	−0.2	+14.7	110	140.117	1310.2448
Do	110–111	1.123	+0.0239	−0.0300	+0.0272	+2.3	+17.0	111	141.240	1310.2720
Aug. 14-14	110–111	1.123	+0.0281	−0.0266						
Do	111–112	1.162	+3.5673	−3.5689	+3.5681	+1.6	+18.6	112	142.402	1313.8401
Do	112–113	1.242	+4.4194	−4.4208	+4.4201	+1.4	+20.0	113	143.644	1318.2602
Do	113–114	1.264	+0.9549	−0.9580	+0.9564	+3.1	+23.1	114	144.908	1319.2166
Do	114–115	1.234	−0.9820	+0.9807	−0.9814	+1.3	+24.4	115	146.142	1318.2352
Do	115–A_7	1.006	−2.3329	+2.3286	−2.3308	+4.3	+28.7	A_7	147.148	1315.9044
Aug. 15-15	A_7–116	1.050	+5.9959	−5.9949	+5.9954	−1.0	+27.7	116	148.198	1321.8998
Do	116–117	1.128	−3.1033	+3.1041	−3.1037	−0.8	+26.9	117	149.326	1318.7961
Do	117–118	1.149	−0.5484	+0.5488	−0.5486	−0.4	+26.5	118	150.475	1318.2475
Do	118–119	1.074	−1.1178	+1.1193	−1.1186	−1.5	+25.0	119	151.549	1317.1289
Do	119–120	1.092	−3.5743	+3.5779	−3.5761	−3.6	+21.4	120	152.641	1313.5528
Do	120–121	1.090	−0.6069	+0.6086	−0.6078	−1.7	+19.7	121	153.731	1312.9450

Results of leveling, Beowawe to Marmol, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. B_6.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1912.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
Aug. 15–16	121–122	0.752	−0.6695	+0.6715	−0.6705	−2.0	+17.7	122	154.483	1312.2745
Aug. 16–16	122–B_7	1.433	−2.5391	+2.5414	−2.5402	−2.3	+15.4	B_7	155.916	1309.7343
Do	B_7–123	1.089	+0.2796	−0.2806	+0.2801	+1.0	+16.4	123	157.005	1310.0144
Do	123–124	1.022	−1.5328	+1.5338	−1.5333	−1.0	+15.4	124	158.027	1308.4811
Do	124–125	1.151	−0.4518	+0.4554	−0.4536	−3.6	+11.8	125	159.178	1308.0275
Do	125–126	1.111	+0.2099	−0.2074	+0.2086	−2.5	+ 9.3	126	160.289	1308.2361
Do	126–127	1.093	−0.7147	+0.7153	−0.7150	−0.6	+ 8.7	127	161.382	1307.5211
Aug. 16–17	127–128	1.093	+0.5837	−0.5868	+0.5852	+3.1	+11.8	128	162.475	1308.1063
Aug. 17–17	128–129	1.023	+4.1021	−4.1000	+4.1010	−2.1	+ 9.7	129	163.498	1312.2073
Do	129–C_7	1.127	+5.4827	−5.4778	+5.4807	−3.4	+ 6.3	C_7	164.625	1317.6880
Aug. 19–19	129–C_7	1.127	+5.4820	−5.4803						
Aug. 17–17	C_7–130	1.074	+2.8736	−2.8701	+2.8718	−3.5	+ 2.8	130	165.699	1320.5598
Do	130–131	1.136	−0.6556	+0.6564	−0.6560	−0.8	+ 2.0	131	166.835	1319.9038
Do	131–132	1.077	−2.1108	+2.1142	−2.1125	−3.4	− 1.4	132	167.912	1317.7913
Do	132–133	1.123	−4.5630	+4.5653	−4.5642	−2.3	− 3.7	133	169.035	1313.2271
Aug. 17–19	133–134	1.165	−4.6106	+4.6101	−4.6104	+0.5	− 3.2	134	170.200	1308.6167
Aug. 19–19	134–135	1.128	+2.5103	−2.5099	+2.5101	−0.4	− 3.6	135	171.328	1311.1268
Do	135–D_7	1.010	−3.3043	+3.3043	−3.3043	0.0	− 3.6	D_7	172.338	1307.8225
Do	D_7–136	1.049	+3.6160	−3.6175	+3.6168	+1.5	− 2.1	136	173.387	1311.4393
Do	136–137	1.030	−2.2695	+2.2730	−2.2723	−1.4	− 3.5	137	174.417	1309.1670
Aug. 20	136–137	1.030	−2.2738	.....						
Aug. 19–19	137–138	1.109	−4.3987	+4.4022	−4.4004	−3.5	− 7.0	138	175.526	1304.7666
Aug. 20–20	138–139	1.150	−0.4110	+0.4098	−0.4104	+1.2	− 5.8	139	176.676	1304.3562
Do	139–140	1.076	+0.0652	−0.0610	+0.0631	−4.2	−10.0	140	177.752	1304.4193
Aug. 20–21	140–141	1.092	+4.2895	−4.2850	+4.2872	−1.9	−11.9	141	178.844	1308.7065
Aug. 22–22	140–141	1.092	+4.2868	−4.2876						
Aug. 21–21	141–E_7	1.217	+1.7726	−1.7723	+1.7724	−0.3	−12.2	E_7	180.061	1310.4789
Do	E_7–142	1.151	−3.8634	+3.8684	−3.8654	−4.4	−16.6	142	181.212	1306.6135
Aug. 22–22	E_7–142	1.151	−3.8630	+3.8667						
Aug. 21–21	142–143	1.056	−4.2296	+4.2337	−4.2316	−4.1	−20.7	143	182.268	1302.3819
Do	143–144	1.092	−4.4124	+4.4128	−4.4126	−0.4	−21.1	144	183.360	1297.9693
Do	144–145	1.091	−1.1839	+1.1797	−1.1818	+4.2	−16.9	145	184.451	1296.7875
Aug. 21–22	145–146	1.038	+1.2921	−1.2919	+1.2920	−0.2	−17.1	146	185.489	1298.0795
Aug. 22–22	146–147	0.985	−2.9454	+2.9465	−2.9460	−1.1	−18.2	147	186.474	1295.1335
Do	147–F_7	0.528	+0.7161	−0.7173	+0.7167	+1.2	−17.0	F_7	187.002	1295.8502
Do	F_7–148	1.145	+2.4605	−2.4601	+2.4603	−0.4	−17.4	148	188.147	1298.3105
Aug. 23–23	148–149	1.102	−4.6630	+4.6616	−4.6623	+1.4	−16.0	149	189.249	1293.6482
Do	149–150	1.163	−3.1999	+3.2005	−3.2002	−0.6	−16.6	150	190.412	1290.4480
Do	150–151	1.139	−1.4830	+1.4836	−1.4833	−0.6	−17.2	151	191.551	1288.9647
Do	151–152	1.092	+1.0622	−1.0608	+1.0615	−1.4	−18.6	152	192.643	1290.0262
Do	152–G_7	1.043	−2.8917	+2.8956	−2.8936	−3.9	−22.5	G_7	193.686	1287.1326
Aug. 24–24	G_7–153	1.123	−4.4009	+4.4024	−4.4016	−1.5	−24.0	153	194.809	1282.7310
Do	153–154	1.093	−2.1886	+2.1906	−2.1896	−2.0	−26.0	154	195.902	1280.5414
Do	154–155	1.093	−2.2233	+2.2229	−2.2231	+0.4	−25.6	155	196.995	1278.3183
Do	155–156	1.090	−1.5668	+1.5708	−1.5688	−4.0	−29.6	156	198.085	1276.7495
Do	156–157	1.057	−0.2252	+0.2270	−0.2261	−1.8	−31.4	157	199.142	1276.5234
Aug. 24–26	157–158	1.071	−0.2439	+0.2457	−0.2448	−1.8	−33.2	158	200.213	1276.2786
Aug. 26–26	158–H_7	0.592	+1.9917	−1.9923	+1.9920	+0.6	−32.6	H_7	200.805	1278.2706
Do	H_7–159	1.083	+0.7198	−0.7174	+0.7186	−2.4	−35.0	159	201.888	1278.9892
Do	159–160	1.092	+2.4203	−2.4185	+2.4194	−1.8	−36.8	160	202.980	1281.4086
Do	160–161	1.033	+0.3713	−0.3714	+0.3714	+0.1	−36.7	161	204.013	1281.7800
Aug. 26–28	161–162	1.005	+4.0300	−4.0269	+4.0284	−3.1	−39.8	162	205.018	1285.8084
Aug. 28–28	162–163	1.126	+4.4149	−4.4129	+4.4139	−2.0	−41.8	163	206.144	1290.2223
Do	163–164	1.061	+3.0460	−3.0441	+3.0450	−1.9	−43.7	164	207.205	1293.2673
Do	164–165	1.130	−4.5058	+4.5054	−4.5056	+0.4	−43.3	165	208.335	1288.7617
Do	165–166	1.145	−0.5874	+0.5892	−0.5883	−1.8	−45.1	166	209.480	1288.1734
Do	166–167	1.092	−0.5722	+0.5691	−0.5706	+3.1	−42.0	167	210.572	1287.6028
Sept. 5–5	167–168	0.987	+1.5791	−1.5792	+1.5792	+0.1	−41.9	168	211.559	1289.1820
Do	168–I_7	0.864	+0.5005	−0.4987	+0.4996	−1.8	−43.7	I_7	212.423	1289.6816
Do	I_7–169	0.765	−2.6095	+2.6098	−2.6096	−0.3	−44.0	169	213.188	1287.0720
Do	169–170	0.913	+0.9245	−0.9241	+0.9243	−0.4	−44.4	170	214.101	1287.9963
Do	170–171	1.059	+4.1060	−4.1051	+4.1056	−0.9	−45.3	171	215.160	1292.1019
Do	171–172	1.075	+1.1651	−1.1675	+1.1663	+2.4	−42.9	172	216.235	1293.2682
Do	172–173	1.207	+4.8255	−4.8235	+4.8245	−2.0	−44.9	173	217.442	1298.0927
Sept. 10–10	173–174	0.655	+1.9798	−1.9789	+1.9794	−0.9	−45.8	174	218.097	1300.0721
Do	174–J_7	1.191	+3.6638	−3.6607	+3.6622	−3.1	−48.9	J_7	219.288	1303.7343
Do	J_7–175	0.592	+3.5901	−3.5892	+3.5896	−0.9	−49.8	175	219.880	1307.3239
Do	175–176	1.210	−2.2699	+2.2695	−2.2697	+0.4	−49.4	176	221.090	1305.0542
Do	176–177	1.208	−4.8292	+4.8280	−4.8286	+1.2	−48.2	177	222.298	1300.2256
Do	177–178	1.144	−4.4991	+4.4975	−4.4983	+1.6	−46.6	178	223.442	1295.7273
Sept. 10–11	178–K_7	0.374	−1.9342	+1.9345	−1.9344	−0.3	−46.9	K_7	223.816	1293.7929
Do	K_7–179	1.168	+0.9521	−0.9510	+0.9516	−1.1	−48.0	179	224.984	1294.7445
Do	179–180	1.207	−0.1227	+0.1210	−0.1218	+1.7	−46.3	180	226.191	1294.6227
Do	180–L_7	1.178	+0.9295	−0.9287	+0.9291	−0.8	−47.1	L_7	227.369	1295.5518
Sept. 11–11	L_7–181	0.808	+1.4951	−1.4945	+1.4948	−0.6	−47.7	181	228.177	1297.0466
Do	181–182	1.041	+0.6502	−0.6504	+0.6503	+0.2	−47.5	182	229.218	1297.6969
Do	182–M_7	0.932	−2.2268	+2.2295	−2.2282	−2.7	−50.2	M_7	230.150	1295.4687
Do	M_7–N_7	1.096	−1.6638	+1.6610	−1.6624	+2.8	−47.4	N_7	231.246	1293.8063
Do	N_7–183	0.967	+1.7460	−1.7468	+1.7464	+0.8	−46.6	183	232.213	1295.5527
Sept. 11–12	183–184	1.059	+3.7325	−3.7316	+3.7320	−0.9	−47.5	184	233.272	1299.2847
Sept. 12–12	184–O_7	1.192	+0.0600	−0.0607	+0.0604	+0.7	−46.8	O_7	234.464	1299.3451
Do	O_7–185	0.798	−3.6194	+3.6214	−3.6204	−2.0	−48.8	185	235.262	1295.7247
Do	185–186	0.912	−3.3681	+3.3680	−3.3680	+0.1	−48.7	186	236.174	1292.3567
Do	186–P_7	1.022	−2.8886	+2.8917	−2.8902	−3.1	−51.8	P_7	237.196	1289.4665
Do	P_7–187	0.111	−1.5662	+1.5654	−1.5659	+0.6	−51.2	187	237.307	1287.9006
Sept. 13–13	P_7–187	0.111	−1.5662	+1.5658						
Sept. 3–12	187–188	1.164	−4.0052	+3.9971	−4.0002	+4.9	−46.3	188	238.471	1283.9004
Sept. 12–13	187–188	1.164	−4.0002	+3.9985						

Results of leveling, Beowawe to Marmol, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. B_6.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1912.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
Sept. 3	188–189	1.081	−4.6136	(1)	−4.6102	+2.3	−44.0	189	239.552	1279.2902
Sept. 12–13	188–189	1.081	−4.6091	+4.6091						
Sept. 12	189–190	1.084	(1)	+4.5544	−4.5539	−3.0	−47.0	190	240.636	1274.7363
Sept. 13–13	189–190	1.084	−4.5524	+4.5564						
Sept. 3–12	190–191	1.154	−3.7517	+3.7505	−3.7511	+1.2	−45.8	191	241.790	1270.9852
Do	191–192	1.020	−2.8950	+2.8921	−2.8936	+2.9	−42.9	192	242.810	1268.0916
Do	192–Q_7	0.445	−1.1388	+1.1387	−1.1388	+0.1	−42.8	Q_7	243.255	1266.9528
Sept. 7–9	Q_7–193	1.354	−0.6220	+0.6150	−0.6194	+4.4	−38.4	193	244.609	1266.3334
Sept. 13–13	Q_7–193	1.354	−0.6211	+0.6193						
Sept. 7–9	193–194	1.025	+2.1304	−2.1400	+2.1350	+6.1	−32.3	194	245.634	1268.4684
Sept. 9–9	193–194	1.025	+2.1334	−2.1359						
Sept. 7–9	194–195	1.023	−4.6511	+4.6505	−4.6508	+0.6	−31.7	195	246.657	1263.8176
Do	195–196	0.914	−3.2336	+3.2311	−3.2324	+2.5	−29.2	196	247.571	1260.5852
Do	196–197	1.096	−4.3969	+4.3988	−4.3978	−1.9	−31.1	197	248.667	1256.1874
Do	197–198	1.097	−4.5496	+4.5461	−4.5478	+3.5	−27.6	198	249.764	1251.6396
Do	198–R_7	0.562	−2.6440	+2.6444	−2.6442	−0.4	−28.0	R_7	250.326	1248.9954
Do	R_7–199	0.978	−2.6070	+2.6093	−2.6082	−2.3	−30.3	199	251.304	1246.3872
Do	199–200	1.076	−4.4128	+4.4201	−4.4180	−2.8	−33.1	200	252.380	1241.9692
Sept. 9–9	199–200	1.076	−4.4204	+4.4188						
Sept. 7–9	200–201	1.133	−4.7911	+4.7921	−4.7916	−1.0	−34.1	201	253.513	1237.1776
Sept. 9–9	201–202	0.914	−3.2653	+3.2659	−3.2656	−0.6	−34.7	202	254.427	1233.9120
Do	202–203	1.153	−4.8945	+4.8934	−4.8940	+1.1	−33.6	203	255.580	1229.0180
Sept. 7–7	203–204	1.479	−4.9788	+4.9789	−4.9788	−0.1	−33.7	204	257.059	1224.0392
Sept. 13–14	204–S_7	0.509	−3.4568	+3.4584	−3.4576	−1.6	−35.3	S_7	257.568	1220.5816
Sept. 14–14	S_7–205	1.176	−0.5375	+0.5341	−0.5358	+3.4	−31.9	205	258.744	1220.0458
Do	205–206	1.021	−2.0262	+2.0273	−2.0268	−1.1	−33.0	206	259.765	1218.0190
Do	206–T_7	1.024	−1.2848	+1.2869	−1.2858	−2.1	−35.1	T_7	260.789	1216.7332
Do	T_7–U_7	0.915	−0.7933	+0.7927	−0.7930	+0.6	−34.5	U_7	261.704	1215.9402
Do	U_7–207	1.127	−1.2404	+1.2409	−1.2406	−0.5	−35.0	207	262.831	1214.6996
Do	207–208	1.095	−2.1071	+2.1058	−2.1064	+1.3	−33.7	208	263.926	1212.5932
Do	208–V_7	1.038	−1.0383	+1.0375	−1.0379	+0.8	−32.9	V_7	264.964	1211.5553
Sept. 6–6	V_7–209	1.064	−1.2286	+1.2253	−1.2270	+3.3	−29.6	209	266.028	1210.3283
Do	209–210	1.188	−2.4752	+2.4742	−2.4747	+1.0	−28.6	210	267.216	1207.8536
Do	210–211	1.173	−1.6800	+1.6787	−1.6794	+1.3	−27.3	211	268.389	1206.1742
Do	211–212	1.172	−1.5742	+1.5742	−1.5742	0.0	−27.3	212	269.561	1204.6000
Do	212–213	1.268	+0.5333	−0.5342	+0.5338	+0.9	−26.4	213	270.829	1205.1338
Sept. 16–16	213–W_7	0.532	−1.8853	+1.8853	−1.8853	0.0	−26.4	W_7	271.361	1203.2485
Do	W_7–214	1.124	−1.6945	+1.6951	−1.6948	−0.6	−27.0	214	272.485	1201.5537
Do	214–215	1.114	−1.7965	+1.7937	−1.7951	+2.8	−24.2	215	273.599	1199.7586
Do	215–216	1.020	+0.0979	−0.0998	+0.0988	+1.9	−22.3	216	274.619	1199.8574
Do	216–217	1.147	−2.3073	+2.3086	−2.3080	−1.3	−23.6	217	275.766	1197.5494
Sept. 6–16	217–218	1.092	−0.7300	+0.7271	−0.7286	+2.9	−20.7	218	276.858	1196.8208
Sept. 16–16	218–219	1.094	−2.5886	+2.5847	−2.5862	+0.5	−20.2	219	277.952	1194.2346
Sept. 17–17	218–219	1.094	−2.5841	+2.5871						
Sept. 16–17	219–X_7	0.653	−0.3203	+0.3212	−0.3208	−0.9	−21.1	X_7	278.605	1193.9138
Sept. 17–17	X_7–220	1.134	−1.1678	+1.1678	−1.1678	0.0	−21.1	220	279.739	1192.7460
Do	220–221	1.023	+2.6086	−2.6073	+2.6080	−1.3	−22.4	221	280.762	1195.3540
Do	221–222	1.087	+1.7589	−1.7590	+1.7590	+0.1	−22.3	222	281.849	1197.1130
Do	222–223	1.022	−0.3349	+0.3356	−0.3352	−0.7	−23.0	223	282.871	1196.7778
Do	223–224	1.090	−3.3961	+3.3943	−3.3952	+1.8	−21.2	224	283.961	1193.3826
Do	224–225	1.090	+2.4267	−2.4264	+2.4266	−0.3	−21.5	225	285.051	1195.8092
Do	225–Y_7	0.345	+1.5125	−1.5140	+1.5132	+1.5	−20.0	Y_7	285.396	1197.3224
Do	Y_7–226	1.095	−0.1651	+0.1672	−0.1662	−2.1	−22.1	226	286.491	1197.1562
Sept. 17–18	226–227	0.546	−0.8048	+0.8039	−0.8044	+0.9	−21.2	227	287.037	1196.3518
Sept. 18–18	227–228	1.093	+4.1821	−4.1827	+4.1824	+0.6	−20.6	228	288.130	1200.5342
Do	228–229	1.077	−3.0319	+3.0300	−3.0310	+1.9	−18.7	229	289.207	1197.5032
Do	229–230	1.093	−0.1881	+0.1921	−0.1901	−4.0	−22.7	230	290.300	1197.3131
Do	230–Z_7	0.578	+0.2067	−0.2070	+0.2068	+0.3	−22.4	Z_7	290.878	1197.5199
Do	Z_7–231	1.161	−2.5947	+2.5943	−2.5945	+0.4	−22.0	231	292.039	1194.9254
Sept. 19–19	231–232	1.084	−1.8549	+1.8566	−1.8558	−1.7	−23.7	232	293.123	1193.0696
Do	232–233	1.123	+0.0670	−0.0631	+0.0650	−3.9	−27.6	233	294.246	1193.1346
Do	233–234	1.123	+0.0613	−0.0614	+0.0614	+0.1	−27.5	234	295.369	1193.1960
Do	234–235	1.082	−0.4123	+0.4142	−0.4132	−1.9	−29.4	235	296.451	1192.7828
Do	235–A_8	1.049	+0.8079	−0.8041	+0.8060	−3.8	−33.2	A_8	297.500	1193.5888
Sept. 19–20	A_8–236	0.924	+0.0357	−0.0344	+0.0350	−1.3	−34.5	236	298.424	1193.6238
Sept. 20–20	236–237	1.122	+0.0606	−0.0592	+0.0599	−1.4	−35.9	237	299.546	1193.6837
Do	237–238	1.118	−2.0199	+2.0177	−2.0188	+2.2	−33.7	238	300.664	1191.6649
Do	238–239	1.084	−3.0219	+3.0263	−3.0238	−1.7	−35.4	239	301.748	1188.6411
Sept. 21–21	238–239	1.084	−3.0239	+3.0229						
Sept. 20–20	239–240	1.083	−1.0357	+1.0348	−1.0352	+0.9	−34.5	240	302.831	1187.6059
Do	240–241	0.898	−1.1427	+1.1438	−1.1432	−1.1	−35.6	241	303.729	1186.4627
Sept. 20–21	241–242	1.099	−0.7426	+0.7445	−0.7436	−1.9	−37.5	242	304.828	1185.7191
Sept. 21–21	242–243	1.202	−0.4717	+0.4727	−0.4722	−1.0	−38.5	243	306.030	1185.2469
Do	243–244	1.203	−0.5772	+0.5776	−0.5774	−0.4	−38.9	244	307.233	1184.6695
Do	244–B_8	0.847	+1.2909	−1.2888	+1.2898	−2.1	−41.0	B_8	308.080	1185.9593
Do	B_8–245	1.097	+3.5358	−3.5384	+3.5371	+2.6	−38.4	245	309.177	1189.4964
Do	245–246	1.210	−0.4054	+0.4031	−0.4042	+2.3	−36.1	246	310.387	1189.0922
Sept. 23–23	246–247	1.117	+0.4064	−0.4062	+0.4063	−0.2	−36.3	247	311.504	1189.4985
Do	247–248	1.124	−1.4319	+1.4300	−1.4310	+1.9	−34.4	248	312.628	1188.0675
Do	248–249	1.184	−1.9903	+1.9906	−1.9904	−0.3	−34.7	249	313.812	1186.0771
Do	249–250	1.082	+1.4090	−1.4079	+1.4084	−1.1	−35.8	250	314.894	1187.4855
Do	250–251	1.082	−2.1471	+2.1475	−2.1473	−0.4	−36.2	251	315.976	1185.3382
Do	251–252	0.774	−1.4105	+1.4097	−1.4101	+0.8	−35.4	252	316.750	1183.9281
Sept. 24–24	252–C_8	0.690	+0.0610	−0.0636	+0.0623	+2.6	−32.8	C_8	317.440	1183.9904
Do	C_8–253	0.929	−0.4038	+0.4016	−0.4027	+2.2	−30.6	253	318.369	1183.5877
Sept. 25–25	253–254	1.100	−0.7773	+0.7767	−0.7770	+0.6	−30.0	254	319.469	1182.8107
Do	254–255	1.101	+1.1231	−1.1232	+1.1232	+0.1	−29.9	255	320.570	1183.9339
Do	255–256	1.099	+1.1464	−1.1441	+1.1452	−2.3	−32.2	256	321.669	1185.0791
Do	256–D_8	1.142	+0.3237	−0.3234	+0.3236	−0.3	−32.5	D_8	322.811	1185.4027

[1] Rejected in field.

Results of leveling, Beowawe to Marmol, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. B_6.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1912.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
Sept. 25–26	D_6–257	1.101	+0.2330	−0.2316	+0.2323	−1.4	−33.9	257	323.912	1185.6350
Sept. 26–26	257–258	0.982	+0.3870	−0.3868	+0.3869	−0.2	−34.1	258	324.894	1186.0219
Do	258–259	1.079	+0.2606	−0.2620	+0.2613	+1.4	−32.7	259	325.973	1186.2832
Do	259–E_6	0.807	+2.8492	−2.8483	+2.8488	−0.9	−33.6	E_6	326.780	1189.1320
Do	E_6–260	1.044	+3.9296	−3.9290	+3.9293	−0.6	−34.2	260	327.824	1193.0613
Sept. 30–30	260–261	0.950	+0.0110	−0.0099	+0.0104	−1.1	−35.3	261	328.774	1193.0717
Do	261–262	1.101	−4.2127	+4.2118	−4.2122	+0.9	−34.4	262	329.875	1188.8595
Do	262–F_6	0.862	−0.1376	+0.1401	−0.1388	−2.5	−36.9	F_6	330.737	1188.7207
Sept. 30–Oct. 1	F_6–263	1.080	+0.0859	−0.0874	+0.0866	+1.5	−35.4	263	331.817	1188.8073
Do	263–264	1.081	+0.8930	−0.8932	+0.8931	+0.2	−35.2	264	332.898	1189.7004
Do	264–G_6	0.509	+0.2457	−0.2436	+0.2446	−2.1	−37.3	G_6	333.407	1189.9450
Do	G_6–265	1.160	+1.5332	−1.5339	+1.5336	+0.7	−36.6	265	334.567	1191.4786
Oct. 1–1	265–266	0.869	+3.1794	−3.1787	+3.1790	−0.7	−37.3	266	335.436	1194.6576
Do	266–267	1.083	+4.2149	−4.2114	+4.2132	−3.5	−40.8	267	336.519	1198.8708
Do	267–H_6	1.182	+0.1546	−0.1558	+0.1552	+1.2	−39.6	H_6	337.701	1199.0260
Do	H_6–268	1.318	+4.6527	−4.6512	+4.6520	−1.5	−41.1	268	339.019	1203.6780
Do	268–269	1.165	+0.4021	−0.4014	+0.4018	−0.7	−41.8	269	340.184	1204.0798
Oct. 1–2	269–270	1.185	+1.6998	−1.6977	+1.6988	−2.1	−43.9	270	341.369	1205.7786
Do	270–271	1.243	+2.7519	−2.7521	+2.7520	+0.2	−43.7	271	342.612	1208.5306
Do	271–272	1.207	+0.0693	−0.0713	+0.0703	+2.0	−41.7	272	543.819	1208.6009
Do	272–273	1.209	−0.1477	+0.1459	−0.1468	+1.8	−39.9	273	345.028	1208.4541
Do	273–274	1.208	+2.9402	−2.9403	+2.9402	+0.1	−39.8	274	346.236	1211.3943
Oct. 2–2	274–I_6	0.997	−0.1520	+0.1500	−0.1510	+2.0	−37.8	I_6	347.233	1211.2433
Do	I_6–275	1.375	+0.4836	−0.4847	+0.4842	+1.1	−36.7	275	348.608	1211.7275
Do	275–J_6	1.203	+4.5023	−4.5029	+4.5026	+0.6	−36.1	J_6	349.811	1216.2301
Do	J_6–276	1.098	+1.6505	−1.6493	+1.6499	−1.2	−37.3	276	350.909	1217.8800
Oct. 2–3	276–277	1.118	−0.1074	+0.1066	−0.1070	+0.8	−36.5	277	352.027	1217.7730
Do	277–278	1.104	+3.1041	−3.1045	+3.1043	+0.4	−36.1	278	353.131	1220.8773
Do	278–K_6	0.487	−0.4508	+0.4510	−0.4509	−0.2	−36.3	K_6	353.618	1220.4264
Do	K_6–279	1.116	−0.3264	+0.3259	−0.3262	+0.5	−35.8	279	354.734	1220.1002
Do	279–L_6	0.476	−0.3600	+0.3601	−0.3600	−0.1	−35.9	L_6	355.210	1219.7402
Oct. 3–3	L_6–280	0.830	+3.3050	−3.3019	+3.3034	−3.1	−39.0	280	356.040	1223.0436
Do	280–281	1.089	+4.3018	−4.2997	+4.3008	−2.1	−41.1	281	357.129	1227.3444
Do	281–282	1.083	+3.7991	−3.7972	+3.7982	−1.9	−43.0	282	358.212	1231.1426
Do	282–283	1.084	+3.5958	−3.5995	+3.5976	+3.7	−39.3	283	359.296	1234.7402
Do	283–284	1.084	+2.2793	−2.2807	+2.2800	+1.4	−37.9	284	360.380	1237.0202
Do	284–M_6	0.748	+0.4864	−0.4899	+0.4882	+3.5	−34.4	M_6	361.128	1237.5084
Do	M_6–285	1.130	+3.3607	−3.3622	+3.3614	+1.5	−32.9	285	362.258	1240.8698
Oct. 4–4	285–286	1.087	+1.6196	−1.6231	+1.6214	+3.5	−29.4	286	363.345	1242.4912
Do	286–N_6	0.709	−0.0919	+0.0907	−0.0913	+1.2	−28.2	N_6	364.054	1242.3999
Do	N_6–287	1.132	−1.3081	+1.3088	−1.3084	−0.7	−28.9	287	365.186	1241.0915
Do	287–O_6	1.115	+0.0407	−0.0392	+0.0400	−1.5	−30.4	O_6	366.301	1241.1315
Do	O_6–288	1.123	+0.2393	−0.2390	+0.2392	−0.3	−30.7	288	367.424	1241.3707
Do	288–P_6	0.512	−0.1431	+0.1425	−0.1428	+0.6	−30.1	P_6	367.936	1241.2279
Do	P_6–289	1.137	+5.0789	−5.0772	+5.0780	−1.7	−31.8	289	369.073	1246.3059
Do	289–290	1.125	+4.9205	−4.9193	+4.9199	−1.2	−33.0	290	370.198	1251.2258
Do	290–291	1.125	+3.7272	−3.7272	+3.7272	0.0	−33.0	291	371.323	1254.9530
Do	291–Q_6	0.895	+2.6394	−2.6404	+2.6399	+1.0	−32.0	Q_6	372.218	1257.5929
Oct. 5–5	Q_6–292	1.202	+5.6800	−5.6788	+5.6794	−1.2	−33.2	292	373.420	1263.2723
Do	292–R_6	1.503	+1.3733	−1.3729	+1.3731	−0.4	−33.6	R_6	374.923	1264.6454
Do	R_6–S_6	0.211	+0.7100	−0.7106	+0.7105	+0.2	−33.4	S_6	375.134	1265.3559
Oct. 8–8	R_6–S_6	0.211	+0.7107	−0.7107						
Do	S_6–293	1.072	−0.0376	+0.0364	−0.0370	+1.2	−32.2	293	376.206	1265.3189
Do	293–294	0.843	+3.7718	−3.7738	+3.7728	+2.0	−30.2	294	377.049	1269.0917
Do	294–295	1.104	−0.7978	+0.7961	−0.7970	+1.7	−28.5	295	378.153	1268.2947
Do	295–296	1.082	−0.6251	+0.6232	−0.6242	+1.9	−26.6	296	379.235	1267.6705
Do	296–297	1.023	−0.1263	+0.1256	−0.1260	+0.7	−25.9	297	380.258	1267.5445
Oct. 11–11	297–298	0.926	+0.1266	−0.1241	+0.1254	−2.5	−28.4	298	381.184	1267.6699
Do	298–T_6	1.017	+0.4292	−0.4293	+0.4292	+0.1	−28.3	T_6	382.201	1268.0991
Oct. 11–10	T_6–299	1.071	−0.4275	+0.4274	−0.4274	+0.1	−28.2	299	383.272	1267.6717
Do	299–300	1.211	−0.0756	+0.0733	−0.0744	+2.3	−25.9	300	384.483	1267.5973
Do	300–U_6	1.174	+0.2751	−0.2777	+0.2764	+2.6	−23.3	U_6	385.657	1267.8737
Oct. 11–12	U_6–V_6	1.151	−0.3968	+0.3975	−0.3972	−0.7	−24.0	V_6	386.808	1267.4765
Do	V_6–W_6	0.685	+1.9120	−1.9121	+1.9120	+0.1	−23.9	W_6	387.493	1269.3885
Do	W_6–301	1.187	+1.5703	−1.5661	+1.5682	−4.2	−28.1	301	388.680	1270.9567
Do	301–302	1.120	+3.3442	−3.3459	+3.3450	+1.7	−26.4	302	389.800	1274.3017
Do	302–303	1.102	+3.0731	−3.0743	+3.0737	+1.2	−25.2	303	390.902	1277.3754
Do	303–304	1.095	+3.9718	−3.9722	+3.9720	+0.4	−24.8	304	391.997	1281.3474
Oct. 12–12	304–X_6	1.221	+4.4013	−4.4048	+4.4030	+3.5	−21.3	X_6	393.218	1285.7504
Do	X_6–Y_6	0.358	+1.1893	−1.1915	+1.1904	+2.2	−19.1	Y_6	393.576	1286.9408
Do	Y_6–305	0.970	+1.7324	−1.7358	+1.7341	+3.4	−15.7	305	394.546	1288.6749
Do	305–306	1.169	+2.1631	−2.1628	+2.1630	−0.3	−16.0	306	395.715	1290.8379
Do	306–Z_6	1.090	+2.9149	−2.9131	+2.9140	−1.8	−17.8	Z_6	396.805	1293.7519
Oct. 14–14	Z_6–307	1.139	+1.6843	−1.6850	+1.6846	+0.7	−17.1	307	397.944	1295.4365
Do	307–308	1.144	+3.3973	−3.3967	+3.3970	−0.6	−17.7	308	399.088	1298.8335
Do	308–309	1.168	+4.8118	−4.8144	+4.8131	+2.6	−15.1	309	400.256	1303.6466
Do	309–310	1.208	+1.8463	−1.8474	+1.8468	+1.1	−14.0	310	401.464	1305.4934
Do	310–311	1.207	+2.1971	−2.1959	+2.1965	−1.2	−15.2	311	402.671	1307.6899
Do	311–A_9	1.205	+1.3108	−1.3150	+1.3129	+4.2	−11.0	A_9	403.876	1309.0028
Oct. 15–15	A_6–312	0.876	+0.7762	−0.7804	+0.7792	+2.3	− 8.7	312	404.752	1309.7820
Do	A_9–312	0.876	+0.7799	−0.7802						
Do	312–313	0.709	+2.4352	−2.4342	+2.4347	−1.0	− 0.7	313	405.461	1312.2167
Oct. 15	313–314	1.116	+0.7876	(1)	+0.7888	−0.1	− 9.8	314	406.577	1313.0055
Oct. 15–15	313–314	1.116	+0.7901	−0.7887						
Do	314–315	1.105	+3.6812	−3.6795	+3.6804	−1.7	−11.5	315	407.682	1316.6859
Oct. 16	315–316	1.121	+4.7191	(1)	+4.7206	+0.8	−10.7	316	408.803	1321.4065
Oct. 16–16	315–316	1.121	+4.7214	−4.7210						
Do	316–317	0.722	+2.7134	−2.7133	+2.7134	−0.1	−10.8	317	409.525	1324.1199
Do	317–318	1.164	+4.3666	−4.3697	+4.3682	+3.1	− 7.7	318	410.689	1328.4881
Do	318–B_9	1.193	+5.0811	−5.0813	+5.0812	+0.2	− 7.5	B_9	411.882	1333.5693

[1] Rejected in field.

Results of leveling, Beowawe to Marmol, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. B_6.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1912.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
Oct. 18–16	B_9–319	0.615	+1.7493	−1.7495	+1.7494	+0.2	− 7.3	319	412.497	1335.3187
Do	319–320	1.179	+0.0859	−0.0853	+0.0856	−0.6	− 7.9	320	413.676	1335.4043
Oct. 18–17	320–321	1.022	+0.2040	−0.2059	+0.2050	+1.9	− 6.0	321	414.698	1335.6093
Do	321– C_9	0.546	+2.0437	−2.0442	+2.0440	+0.5	− 5.5	C_9	415.244	1337.6533
Do	C_9–D_9	0.957	+0.1522	−0.1477	+0.1502	−0.1	−5.6	D_9	416.201	1337.8035
Oct. 18–18	C_9– D_9	0.957	+0.1484	−0.1526						
Oct. 18–17	D_9– E_9	0.875	+1.3681	−1.3672	+1.3676	−0.9	− 6.5	E_9	417.076	1339.1711
Do	E_9– F_9	1.428	−0.1245	+0.1280	−0.1262	−3.5	−10.0	F_9	418.504	1339.0449
Oct. 18–19	F_9–322	1.088	−1.0706	+1.0670	−1.0688	+3.6	− 6.4	322	419.592	1337.9761
Do	322–323	1.069	+0.0729	−0.0744	+0.0736	+1.5	− 4.9	323	420.661	1338.0497
Do	323–324	1.040	+1.1721	−1.1727	+1.1724	+0.6	− 4.3	324	421.701	1339.2221
Do	324–325	1.138	+3.1615	−3.1639	+3.1627	+2.4	− 1.9	325	422.839	1342.3848
Do	325– G_9	1.428	+5.0325	−5.0367	+5.0346	+4.2	+ 2.3	G_9	424.267	1347.4194
Oct. 19–19	G_9–326	0.622	+5.8441	−5.8489	+5.8456	+2.0	+ 4.3	326	424.889	1353.2650
Do	G_9–326	0.622	+5.8450	−5.8442						
Do	326–327	1.042	+7.8000	−7.8022	+7.8011	+2.2	+ 6.5	327	425.931	1361.0661
Do	327–328	1.098	+4.4328	−4.4332	+4.4330	+0.4	+ 6.9	328	427.029	1365.4991
Do	328–329	1.145	+2.2538	−2.2542	+2.2540	+0.4	+ 7.3	329	428.174	1367.7531
Oct. 21–21	329– H_9	0.378	+1.9823	−1.9808	+1.9816	−1.5	+ 5.8	H_9	428.552	1369.7347
Oct. 21	H_9–330	1.086	(1)	−2.8219	+2.8234	−1.2	+ 4.6	330	429.638	1372.5581
Oct. 21–21	H_9–330	1.086	+2.8240	−2.8237						
Do	330– I_9	0.284	+15.9842	−15.9846	+15.9844	+0.4	+ 5.0	I_9	429.922	1388.5425
Do	I_9–331	1.157	−17.3154	+17.3181	−17.3168	−2.7	+ 2.3	331	431.079	1371.2257
Oct. 22–23	331–332	1.123	+ 7.0444	− 7.0418	+ 7.0431	−2.6	− 0.3	332	432.203	1378.2688
Oct. 22–22	332–333	1.132	+ 4.9893	− 4.9872	+ 4.9882	−2.1	− 2.4	333	433.334	1383.2570
Do	333–334	1.124	+ 4.5129	− 4.5134	+ 4.5132	+0.5	− 1.9	334	434.458	1387.7702
Do	334–335	1.123	+ 7.3748	− 7.3725	+ 7.3736	−2.3	− 4.2	335	435.581	1395.1438
Do	335–336	1.123	+ 6.0237	− 6.0210	+ 6.0224	−2.7	− 6.9	336	436.704	1401.1662
Do	336–337	1.100	+ 7.6743	− 7.6746	+ 7.6744	+0.3	− 6.6	337	437.804	1408.8406
Do	337– J_9	0.874	+ 6.6342	− 6.6354	+ 6.6348	+1.2	− 5.4	J_9	438.678	1415.4754
Oct. 22–23	J_9–338	1.138	+ 3.6595	− 3.6570	+ 3.6582	−2.5	− 7.9	338	439.816	1419.1336
Do	338–339	0.738	+ 4.9243	− 4.9244	+ 4.9244	+0.1	− 7.8	339	440.554	1424.0580
Do	339–340	1.038	+ 7.6448	− 7.6394	+ 7.6425	−2.6	−10.4	340	441.592	1431.7005
Oct. 24–25	339–340	1.038	+ 7.6428	− 7.6429						
Oct. 23–23	340–341	1.060	+16.9772	−16.9745	+16.9758	−2.7	−13.1	341	442.652	1448.6763
Do	341–342	1.079	+12.0908	−12.0871	+12.0890	−3.7	−16.8	342	443.731	1460.7653
Do	342–343	1.079	− 0.3077	+ 0.3047	− 0.3062	+3.0	−13.8	343	444.810	1460.4591
Do	343– K_9	0.299	− 1.0305	+ 1.0325	− 1.0315	−2.0	−15.8	K_9	445.109	1459.4276
Do	K_9–344	1.083	+ 8.7852	− 8.7879	+ 8.7866	+2.7	−13.1	344	446.192	1468.2142
Oct. 23–25	344– L_9	0.599	+ 9.3999	− 9.4019	+ 9.4009	+2.0	−11.1	L_9	446.791	1477.6151
Oct. 25–25	L_9–345	1.080	+15.9649	−15.9637	+15.9643	−1.2	−12.3	345	447.871	1493.5794
Do	345–346	1.018	+ 7.8586	− 7.8649	+ 7.8608	+2.9	− 9.4	346	448.889	1501.4402
Do	345–346	1.018	+ 7.8600	− 7.8596						
Do	346–347	1.025	+ 3.3272	− 3.3327	+ 3.3302	+3.6	− 5.8	347	449.914	1504.7704
Do	346–347	1.025	+ 3.3297	− 3.3312						
Do	347– E_6	1.016	+ 6.6865	− 6.6867	+ 6.6866	+0.2	− 5.6	E_6	450.930	1511.4570
Do	E_6– F_6	0.105	− 0.4397	+ 0.4403	− 0.4400	.....	.....	E_6	451.035	1511.8970

[1] Rejected in field.

SAN FRANCISCO, CAL., TO MARMOL, NEV.

This section was run between March 7 and July 12, 1912.

Precise level No. 10 was used until April 19 and precise level No. 7 for the remainder of the period of leveling. Rods CC and DD were used until July 3, and rods V and W for the remainder of the period of leveling.

The lengths of rods CC and DD at 0° C as determined by the instrument division of this Survey are as follows: January 12, 1912, rod CC, 3.0008 meters, rod DD, 3.0012 meters; March 5, 1913, rod CC, 3.0011 meters, rod DD, 3.0015 meters.

Both the office and field measurements of the rods show a lengthening. It is assumed that the lengthening was gradual and distributed uniformly over the period between the office measurements. Because of the peculiar profile of this line, which is comparatively level for the first 270 kilometers, rising gradually 2100 meters in the next 170 kilometers and then falling a little in the remaining 56 kilometers, the mean length of the rods, 3.0011 meters, or an excess of 0.37 millimeter per meter, on June 9, which is the mean date of the period of the leveling up the ineline, was used in the computations. The index correction of rod CC was −0.3 millimeter; of rod DD, −0.2 millimeter.

The lengths of rods V and W, their index correction, and the mean length used in the computation are given in connection with the line Beowawe to Marmol, Nev. (See p. 13.)

The elevations in the table following depend on an elevation of 48.5590 meters for bench mark 635 at San Francisco. This elevation was furnished by the engineer of that city.

Results of leveling, San Francisco, Cal., to Marmol, Nev.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. City 635.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1912.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
								City 635	0.000	48.5590
Mar. 8–8	City 635–City 640.	0.332	+10.8331	−10.8347	+10.8339	+1.6	+ 1.6	City 640	0.332	59.3929
Mar. 7–7	City 640–1	1.579	[1] +10.2259	−10.2344						
Do	City 640–1	1.579	+10.2378	−10.2305	+10.2342	−3.6	− 2.0	1	1.911	69.6271
Mar. 8–8	City 640–1	1.579	+10.2342	−10.2324						
Mar. 7–7	1–City 386	0.260	−10.9667	+10.9679	−10.9673	−1.2	− 3.2	City 386	2.171	58.6598
Mar. 7–8	1–2	1.123	[2] +14.2231	[2] −14.2226	+14.2366	+2.8	+ 0.8	2	3.034	83.8637
Mar. 9–9	1–2	1.123	+14.2352	−14.2380						
Mar. 8	2–3	0.472	.....	[2] − 7.0531	+ 7.0364	−2.1	− 1.3	3	3.506	90.9001
Mar. 9–9	2–3	0.472	+ 7.0375	− 7.0354						
Mar. 8–8	3–City 418	0.279	+ 3.8753	− 3.8719	+ 3.8726	−1.4	− 2.7	City 418	3.785	94.7727
Mar. 9–8	3–4	0.950	− 8.9111	+ 8.9137	− 8.9124	−2.6	− 3.9	4	4.456	81.9877
Mar. 11–9	4–5	0.996	−10.9755	+10.9753	−10.9754	+0.2	− 3.7	5	5.452	71.0123
Do	5–6	1.057	−11.0882	+11.0890	−11.0886	−0.8	− 4.5	6	6.509	59.9237
Do	6–7	1.112	−11.7090	+11.7115	−11.7102	−2.5	− 7.0	7	7.621	48.2135
Mar. 11–11	7–8	0.980	− 9.4753	+ 9.4792	− 9.4751	−2.6	− 9.6	8	8.601	38.7384
Mar. 12–12	7–8	0.980	− 9.4722	+ 9.4737						
Mar. 11–11	8–W_6	1.283	−11.8540	+11.8545	−11.8542	−0.5	−10.1	W_6	9.884	26.8842
Do	W_6–9	1.278	−12.4919	+12.4915	−12.4917	+0.4	− 9.7	9	11.162	14.3925
Mar. 11–12	9–10	1.201	− 5.6283	+ 5.6255	− 5.6269	+2.8	− 6.9	10	12.363	8.7656
Mar. 12–13	10–11	1.214	− 0.2409	+ 0.2419	− 0.2414	−1.0	− 7.9	11	13.577	8.5242
Mar. 13–13	11–X_6	1.433	− 0.3837	+ 0.3816	− 0.3826	+2.1	− 5.8	X_6	15.010	8.1416
Do	X_6–12	0.900	− 3.5610	+ 3.5586	− 3.5598	+2.4	− 3.4	12	15.910	4.5818
Do	12–13	1.209	− 1.5980	+ 1.5953	− 1.5966	+2.7	− 0.7	13	17.119	2.9852
Do	13–14	1.208	+ 1.9631	− 1.9651	+ 1.9641	+2.0	+ 1.3	14	18.327	4.9493
Mar. 13–14	14–Y_6	1.215	+ 0.6689	− 0.6684	+ 0.6686	−0.5	+ 0.8	Y_6	19.542	5.6179
Do	Y_6–15	1.209	− 2.6883	+ 2.6898	− 2.6890	−1.5	− 0.7	15	20.751	2.9289
Do	15–16	1.196	+ 0.3098	− 0.3090	+ 0.3094	−0.8	− 1.5	16	21.947	3.2383
Do	16–Z_6	1.911	+ 6.0721	− 6.0676	+ 6.0698	−4.5	− 6.0	Z_6	23.858	9.3081
Mar. 14–14	Z_6–17	0.828	− 0.8345	+ 0.8313	− 0.8329	+3.2	− 2.8	17	24.686	8.4752
Do	17–A_7	1.324	− 0.6006	+ 0.5998	− 0.6002	+0.8	− 2.0	A_7	26.010	7.8750
Do	A_7–B_7	0.608	+ 0.4744	− 0.4736	+ 0.4740	−0.8	− 2.8	B_7	26.618	8.3490
Do	B_7–18	1.183	− 5.0244	+ 5.0237	− 5.0240	+0.7	− 2.1	18	27.801	3.3250
Mar. 15–16	18–19	1.818	+ 0.0874	− 0.0883	+ 0.0878	+0.9	− 1.2	19	29.619	3.4128
Do	19–C_7	0.640	+ 3.5754	− 3.5729	+ 3.5742	−2.5	− 3.7	C_7	30.259	6.9870
Do	C_7–20	1.212	− 3.7290	+ 3.7251	− 3.7270	+3.9	+ 0.2	20	31.471	3.2600
Do	20–21	1.047	+ 8.4523	− 8.4498	+ 8.4510	−2.5	− 2.3	21	32.518	11.7110
Mar. 15–18	21–D_7	0.642	− 1.1010	+ 1.1005	− 1.1008	+0.5	− 1.8	D_7	33.160	10.6102
Mar. 18–18	D_7–22	0.133	+ 0.1657	− 0.1644	+ 0.1650	−1.3	− 3.1	22	33.293	10.7752
Mar. 16–18	22–23	1.200	− 5.5414	+ 5.5469	− 5.5428	−1.7	− 4.8	23	34.493	5.2324
Mar. 19–19	22–23	1.200	− 5.5427	+ 5.5405						
Mar. 16–18	23–E_7	0.779	+ 2.6145	− 2.6089	+ 2.6129	−1.8	− 6.6	E_7	35.272	7.8453
Mar. 18–18	23–E_7	0.779	+ 2.6131	− 2.6151						
Do	E_7–24	1.042	− 2.5497	+ 2.5496	− 2.5496	+0.1	− 6.5	24	36.314	5.2957
Do	24–25	1.210	+ 1.4465	− 1.4445	+ 1.4455	−2.0	− 8.5	25	37.524	6.7412
Do	25–F_7	1.186	− 2.8658	+ 2.8667	− 2.8662	−0.9	− 9.4	F_7	38.710	3.8750
Mar. 19–19	F_7–26	1.229	+ 1.3710	− 1.3709	+ 1.3710	−0.1	− 9.5	26	39.939	5.2460
Do	26–27	1.149	+ 4.1720	− 4.1722	+ 4.1721	+0.2	− 9.3	27	41.088	9.4181
Do	27–28	1.078	+ 3.9389	− 3.9392	+ 3.9390	+0.3	− 9.0	28	42.166	13.3571
Do	28–29	1.103	+ 4.0046	− 4.0039	+ 4.0042	−0.7	− 9.7	29	43.269	17.3613
Do	29–G_7	1.000	+ 4.1683	− 4.1672	+ 4.1678	−1.1	−10.8	G_7	44.269	21.5291
Do	G_7–30	1.198	− 0.3221	+ 0.3272	− 0.3247	−1.3	−12.1	30	45.467	21.2044
Mar. 20–20	G_7–30	1.198	− 0.3260	+ 0.3234						
Mar. 19–20	30–H_7	0.209	+ 1.2058	− 1.2053	+ 1.2052	−0.4	−12.5	H_7	45.676	22.4096
Mar. 20–20	30–H_7	0.209	+ 1.2049	− 1.2048						
Do	H_7–I_7	0.737	− 3.4879	+ 3.4866	− 3.4872	+1.3	−11.2	I_7	46.413	18.9224
Do	I_7–31	1.231	− 5.6291	+ 5.6313	− 5.6302	−2.2	−13.4	31	47.644	13.2922
Do	31–J_7	1.303	− 3.2822	+ 3.2837	− 3.2830	−1.5	−14.9	J_7	48.947	10.0092
Do	J_7–32	1.203	− 0.6039	+ 0.6049	− 0.6044	−1.0	−15.9	32	50.150	9.4048
Mar. 21–22	32–33	1.184	+ 2.3001	− 2.3008	+ 2.3004	+0.7	−15.2	33	51.334	11.7052
Do	33–34	1.207	+ 1.5911	− 1.5894	+ 1.5902	−1.7	−16.9	34	52.541	13.2954
Do	34–35	1.176	+ 3.4509	− 3.4484	+ 3.4496	−2.5	−19.4	35	53.717	16.7450
Mar. 22–22	35–36	0.980	+ 3.2123	− 3.2102	+ 3.2112	−2.1	−21.5	36	54.697	19.9562
Do	36–K_7	1.215	+ 3.6975	− 3.6940	+ 3.6958	−3.5	−25.0	K_7	55.912	23.6520
Do	K_7–37	1.231	+ 6.4901	− 6.4849	+ 6.4884	−3.8	−28.8	37	57.143	30.1404
Do	K_7–37	1.231	+ 6.4905	− 6.4881						
Do	37–38	1.010	+ 0.0238	− 0.0227	+ 0.0232	−1.1	−29.9	38	58.153	30.1636
Mar. 22–23	38–39	1.210	+ 0.2760	− 0.2740	+ 0.2750	−2.0	−31.9	39	59.363	30.4386
Do	39–L_7	0.922	− 0.6402	+ 0.6349	− 0.6384	+3.5	−28.4	L_7	60.285	29.8002
Do	39–L_7	0.922	− 0.6400	+ 0.6382						
Do	L_7–40	0.893	− 2.6563	+ 2.6521	− 2.6542	+4.2	−24.2	40	61.178	27.1460
Do	40–41	1.209	− 4.3090	+ 4.3081	− 4.3086	+0.9	−23.3	41	62.387	22.8374
Do	41–M_7	1.217	− 2.4186	+ 2.4191	− 2.4188	−0.5	−23.8	M_7	63.604	20.4186
Mar. 23–25	M_7–42	1.161	− 2.7803	+ 2.7807	− 2.7805	−0.4	−24.2	42	64.765	17.6381
Mar. 25–25	42–43	0.886	+ 0.7627	− 0.7626	+ 0.7626	−0.1	−24.3	43	65.651	18.4007
Do	43–44	1.282	+ 0.2308	− 0.2353	+ 0.2330	+4.5	−19.8	44	66.933	18.6337
Do	44–45	1.208	+ 1.9892	− 1.9911	+ 1.9902	+1.9	−17.9	45	68.141	20.6239
Do	45–N_7	1.215	+ 2.3723	− 2.3735	+ 2.3729	+1.2	−16.7	N_7	69.356	22.9968
Do	N_7–46	1.495	+ 1.7125	− 1.7116	+ 1.7120	−0.9	−17.6	46	70.851	24.7088
Do	46–47	1.238	+ 1.9634	− 1.9618	+ 1.9626	−1.6	−19.2	47	72.089	26.6714
Do	47–48	0.935	+ 0.5922	− 0.5936	+ 0.5929	+1.4	−17.8	48	73.024	27.2643
Mar. 25–27	48–O_7	0.371	+ 0.2058	− 0.2061	+ 0.2060	+0.3	−17.5	O_7	73.395	27.4703
Mar. 27–27	O_7–P_7	0.513	+ 2.4294	− 2.4295	+ 2.4294	+0.1	−17.4	P_7	73.908	29.8997
Do	P_7–49	0.473	− 1.9530	+ 1.9520	− 1.9525	+1.0	−16.4	49	74.381	27.9472
Do	49–50	1.126	− 5.1876	+ 5.1885	− 5.1880	−0.9	−17.3	50	75.507	22.7592
Do	50–51	1.201	− 1.6339	+ 1.6358	− 1.6348	−1.9	−19.2	51	76.708	21.1244
Do	51–52	1.072	− 1.6914	+ 1.6911	− 1.6912	+0.3	−18.9	52	77.780	19.4332
Do	52–Q_7	0.814	+ 1.2002	− 1.1952	+ 1.1972	−1.9	−20.8	Q_7	78.594	20.6304
Mar. 28–28	52–Q_7	0.814	+ 1.1962	− 1.1974						

[1] Rejected.

[2] Rejected, T. B. M. was disturbed.

Results of leveling, San Francisco, Cal., to Marmol, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. City 635.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1912.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
Mar. 27–27	Q_7–53	1.173	− 3.6132	+ 3.6139	− 3.6136	−0.7	−21.5	53	79.767	17.0168
Do	53–54	1.210	− 4.0062	+ 4.0051	− 4.0056	+1.1	−20.4	54	80.977	13.0112
Mar. 28–29	54–55	1.209	− 2.5567	+ 2.5592	− 2.5580	−2.5	−22.9	55	82.186	10.4532
Do	55–56	1.206	− 3.6482	+ 3.6491	− 3.6486	−0.9	−23.8	56	83.392	6.8046
Mar. 28–28	56–57	1.208	− 2.5831	+ 2.5839	− 2.5835	−0.8	−24.6	57	84.600	4.2211
Do	57–R_7	0.369	+ 1.0033	− 1.0021	+ 1.0027	−1.2	−25.8	R_7	84.969	5.2238
Do	R_7–58	1.210	− 1.2081	+ 1.2088	− 1.2084	−0.7	−26.5	58	86.179	4.0154
Do	58–59	1.207	+ 0.9164	− 0.9119	+ 0.9140	−2.8	−29.3	59	87.386	4.9294
Do	58–59	1.207	+ 0.9145	− 0.9134						
Do	59–S_7	0.544	− 0.1319	+ 0.1319	− 0.1319	0.0	−29.3	S_7	87.930	4.7975
Do	S_7–60	1.114	+ 4.1285	− 4.1300	+ 4.1292	+1.5	−27.8	60	89.044	8.9267
Mar. 29–29	60–61	1.185	+ 4.5842	− 4.5817	+ 4.5830	−2.5	−30.3	61	90.229	13.5097
Do	61–T_7	0.707	− 0.6871	+ 0.6890	− 0.6880	−1.9	−32.2	T_7	90.936	12.8217
Do	T_7–62	1.166	+ 1.6192	− 1.6206	+ 1.6199	+1.4	−30.8	62	92.102	14.4416
Do	62–63	1.131	− 3.2012	+ 3.2034	− 3.2023	−2.2	−33.0	63	93.233	11.2393
Do	63–U_7	0.418	− 1.4416	+ 1.4433	− 1.4424	−1.7	−34.7	U_7	93.651	9.7969
Do	U_7–64	1.253	+ 0.4049	− 0.4064	+ 0.4056	+1.5	−33.2	64	94.904	10.2025
Mar. 30–30	64–V_7	1.739	+11.1458	−11.1411	+11.1434	−4.7	−37.9	V_7	96.643	21.3459
Do	V_7–65	1.188	− 4.3567	+ 4.3586	− 4.3576	−1.9	−39.8	65	97.831	16.9883
Do	65–66	1.207	+ 0.9260	− 0.9248	+ 0.9254	−1.2	−41.0	66	99.038	17.9137
Do	66–67	1.126	+ 5.0201	− 5.0224	+ 5.0212	+2.3	−38.7	67	100.164	22.9349
Do	67–W_7	1.233	+ 2.7526	− 2.7505	+ 2.7516	−2.1	−40.8	W_7	101.397	25.6865
Mar. 30–Apr. 3	W_7–X_7	0.802	+ 0.7394	− 0.7405	+ 0.7400	+1.1	−39.7	X_7	102.199	26.4265
Apr. 3–3	X_7–68	0.564	+ 4.1073	− 4.1071	+ 4.1072	−0.2	−39.9	68	102.763	30.5337
Do	68–69	0.976	+ 3.6692	− 3.6692	+ 3.6692	0.0	−39.9	69	103.739	34.2029
Do	69–Y_7	1.044	+ 3.7097	− 3.7090	+ 3.7094	−0.7	−40.6	Y_7	104.783	37.9123
Do	Y_7–Z_7	1.374	+13.1407	+13.1419	+13.1413	+1.2	−39.4	Z_7	100.157	51.0536
Do	Z_7–70	1.159	+ 7.0093	− 7.0078	+ 7.0086	−1.5	−40.9	70	107.316	58.0622
Do	70–71	1.040	+ 1.1614	− 1.1576	+ 1.1595	−3.8	−44.7	71	108.356	59.2217
Do	71–72	1.264	+ 4.8815	− 4.8806	+ 4.8810	−0.9	−45.6	72	109.620	64.1027
Apr. 3–4	72–73	0.729	+ 2.5542	− 2.5567	+ 2.5554	+2.5	−43.1	73	110.349	66.6581
Apr. 4–4	73–A_8	0.920	+ 2.0893	− 2.0892	+ 2.0892	−0.1	−43.2	A_8	111.269	68.7473
Do	A_8–74	0.886	+ 7.4457	− 7.4385	+ 7.4437	−4.6	−47.8	74	112.155	76.1910
Do	A_8–74	0.886	+ 7.4462	− 7.4444						
Do	74–75	1.132	+ 2.8282	− 2.8267	+ 2.8274	−1.5	−49.3	75	113.287	79.0184
Do	75–76	1.078	+ 3.9885	− 3.9881	+ 3.9883	−0.4	−49.7	76	114.365	83.0067
Do	76–77	1.196	+ 4.0809	− 4.0800	+ 4.0804	−0.9	−50.6	77	115.561	87.0871
Do	77–B_8	1.230	+ 5.1480	− 5.1486	+ 5.1483	+0.6	−50.0	B_8	116.791	92.2354
Apr. 5–5	B_8–78	1.456	+ 9.6497	− 9.6516	+ 9.6500	+1.9	−48.1	78	118.247	101.8860
Do	78–79	1.123	+ 1.5385	− 1.5387	+ 1.5386	+0.2	−47.9	79	119.370	103.4246
Do	79–C_8	1.123	− 0.9066	+ 0.9041	− 0.9054	+2.5	−45.4	C_8	120.493	102.5192
Do	C_8–80	1.113	+ 8.2545	− 8.2538	+ 8.2542	−0.7	−46.1	80	121.606	110.7734
Do	80–81	1.274	− 0.1424	+ 0.1455	− 0.1440	−3.1	−49.2	81	122.880	110.6294
Apr. 6–6	81–D_8	0.313	+ 1.4208	− 1.4209	+ 1.4208	+0.1	−49.1	D_8	123.192	112.0502
Do	D_8–82	1.172	+ 1.5674	− 1.5690	+ 1.5682	+1.6	−47.5	82	124.365	113.6184
Do	82–83	1.124	+ 2.2307	− 2.2336	+ 2.2322	+2.9	−44.6	83	125.489	115.8506
Do	83–84	1.127	+ 3.9372	− 3.9336	+ 3.9354	−3.6	−48.2	84	126.616	119.7860
Do	84–85	1.187	+ 8.1550	− 8.1498	+ 8.1500	−2.8	−51.0	85	127.803	127.9366
Apr. 8–8	84–85	1.187	+ 8.1490	− 8.1486						
Apr. 8–6	85–E_8	1.223	+12.4868	−12.4876	+12.4872	+0.8	−50.2	E_8	129.026	140.4238
Apr. 8–8	E_8–86	0.657	− 0.6095	+ 0.6084	− 0.6090	+1.1	−49.1	86	129.683	139.8148
Do	86–F_8	1.245	+ 8.8431	− 8.8405	+ 8.8418	−2.6	−51.7	F_8	130.928	148.6566
Do	F_8–87	1.143	+ 6.8521	− 6.8504	+ 6.8512	−1.7	−53.4	87	132.071	155.5078
Do	87–88	1.108	+ 6.4809	− 6.4794	+ 6.4802	−1.5	−54.9	88	133.179	161.9880
Apr. 8–9	88–G_8	1.242	+ 1.7316	− 1.7316	+ 1.7316	0.0	−54.9	G_8	134.421	163.7196
Apr. 8–8	G_8–89	1.100	+ 3.3844	− 3.3828	+ 3.3836	−1.6	−56.5	89	135.521	167.1032
Do	89–90	1.150	+ 3.1742	− 3.1759	+ 3.1750	+1.7	−54.8	90	136.671	170.2782
Do	90–91	1.219	+10.5388	−10.5341	+10.5364	−4.7	−59.5	91	137.890	180.8146
Apr. 9–12	91–H_8	1.330	+14.4720	−14.4677	+14.4698	−4.3	−63.8	H_8	139.220	195.2844
Do	H_8–92	1.118	+ 9.4587	− 9.4618	+ 9.4602	+3.1	−60.7	92	140.338	204.7446
Do	92–I_8	1.391	+13.5292	−13.5267	+13.5280	−2.5	−63.2	I_8	141.729	218.2726
Do	I_8–93	1.469	+ 3.6803	− 3.6782	+ 3.6792	−2.1	−65.3	93	143.198	221.9518
Do	93–94	0.592	+ 2.8298	− 2.8315	+ 2.8305	+2.0	−63.3	94	143.790	224.7823
Apr. 12–12	94–J_8	0.211	+ 0.7348	− 0.7340	+ 0.7344	−0.8	−64.1	J_8	144.001	225.5167
Do	J_8–K_8	0.705	− 6.2892	+ 6.2891	− 6.2892	+0.1	−64.0	K_8	144.706	219.2275
Do	K_8–95	1.028	−12.0916	+12.0928	−12.0922	−1.2	−65.2	95	145.734	207.1353
Do	95–96	1.121	−10.8607	+10.8617	−10.8612	−1.0	−66.2	96	146.855	196.2741
Apr. 13–13	96–97	1.202	−11.2386	+11.2380	−11.2383	+0.6	−65.0	97	148.057	185.0358
Do	97–L_8	0.554	− 5.0093	+ 5.0051	− 5.0080	+3.7	−61.9	L_8	148.611	180.0278
Do	97–L_8	0.554	− 5.0104	+ 5.0071						
Do	L_8–98	1.039	− 9.4438	+ 9.4447	− 9.4440	−1.5	−63.4	98	149.650	170.5838
Apr. 15	L_8–98	1.039	− 9.4425	.....						
Apr. 13–13	98–99	1.194	−10.6230	+10.6267	−10.6248	−3.7	−67.1	99	150.844	159.9590
Apr. 15–15	99–M_8	1.096	− 9.5505	+ 9.5572	− 9.5538	+3.3	−63.8	M_8	151.940	150.4002
Do	M_8–100	1.001	−10.4644	+10.4663	−10.4654	−1.9	−65.7	100	152.941	139.9348
Do	100–101	1.081	− 8.0848	+ 8.0848	− 8.0848	0.0	−65.7	101	154.022	131.8500
Do	101–N_8	0.296	− 2.9304	+ 2.9297	− 2.9300	+0.7	−65.0	N_8	154.318	128.9200
Do	N_8–102	1.043	−10.0936	+10.0888	−10.0907	+2.0	−63.0	102	155.361	118.8293
Do	N_8–102	1.043	−10.0898	+10.0906						
Do	102–103	1.019	− 7.5155	+ 7.5131	− 7.5143	+2.4	−60.6	103	156.380	111.3150
Do	103–O_8	0.457	− 4.1878	+ 4.1868	− 4.1873	+1.0	−59.6	O_8	156.837	107.1277
Apr. 16–16	O_8–104	1.098	−10.9322	+10.9323	−10.9322	−0.1	−59.7	104	157.935	96.1955
Do	104–105	1.023	− 9.6601	+ 9.6605	− 9.6603	−0.4	−60.1	105	158.958	86.5352
Do	105–106	1.041	− 8.7558	+ 8.7574	− 8.7566	−1.6	−61.7	106	159.999	77.7786
Do	106–107	1.013	− 8.7952	+ 8.7941	− 8.7946	+1.1	−60.6	107	161.012	68.9840
Do	107–108	1.077	− 9.2931	+ 9.2880	− 9.2922	+1.6	−59.0	108	162.089	59.6918
Apr. 17–22	107–108	1.077	− 9.2928	+ 9.2947						
Apr. 16–16	108–109	1.150	−11.3777	+11.3723	−11.3742	+5.1	−53.9	109	163.239	48.3176
Apr. 17–22	108–109	1.150	−11.3757	+11.3710						
Apr. 16–16	109–110	1.021	−10.1971	+10.1943	−10.1957	+2.8	−51.1	110	164.260	38.1219
Apr. 22–20	110–P_8	0.633	− 6.7351	+ 6.7367	− 6.7359	−1.6	−52.7	P_8	164.893	31.3860

Results of leveling, San Francisco, Cal., to Marmol, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. City 635.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1912.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
Apr. 22–20	P_8–111	1.237	−10.1176	+10.1165	−10.1170	+1.1	−51.6	111	166.130	21.2690
Do	111–112	1.023	− 0.7618	+ 0.7604	− 0.7611	+1.4	−50.2	112	167.153	20.5079
Do	112–113	1.092	+ 0.2179	− 0.2197	+ 0.2188	+1.8	−48.4	113	168.245	20.7267
Do	113–Q_8	0.947	− 2.6977	+ 2.6937	− 2.6958	+2.7	−45.7	Q_8	169.192	18.0309
Apr. 22–22	113–Q_8	0.947	− 2.6965	+ 2.6952						
Do	Q_8–R_8	0.226	+ 0.3136	− 0.3150	+ 0.3143	+1.4	−44.3	R_8	169.418	18.3452
Apr. 23–23	R_8–S_8	0.530	− 1.8366	+ 1.8372	− 1.8369	−0.6	−44.9	S_8	169.948	16.5083
Apr. 22–23	S_8–114	1.061	− 1.7307	+ 1.7310	− 1.7308	−0.3	−45.2	114	171.009	14.7775
Do	114–115	1.138	− 1.4898	+ 1.4871	− 1.4884	+2.7	−42.5	115	172.147	13.2891
Apr. 23–23	115–116	1.372	− 2.1728	+ 2.1777	− 2.1772	−3.5	−46.0	116	173.519	11.1119
Do	115–116	1.372	− 2.1779	+ 2.1801						
Do	116–T_8	1.076	− 4.2565	+ 4.2593	− 4.2579	−2.8	−48.8	T_8	174.595	6.8540
Do	T_8–U_8	1.665	− 0.6066	+ 0.6035	− 0.6050	+3.1	−45.7	U_8	176.260	6.2490
Apr. 23–24	U_8–117	1.262	+ 0.3594	− 0.3578	+ 0.3586	−1.6	−47.3	117	177.522	6.6076
Apr. 24–24	117–118	0.453	+ 0.0233	− 0.0226	+ 0.0230	−0.7	−48.0	118	177.975	6.6306
Do	118–119	1.137	+ 0.0150	− 0.0148	+ 0.0149	−0.2	−48.2	119	179.112	6.6455
Do	119–120	1.076	+ 0.2071	− 0.2061	+ 0.2066	−1.0	−49.2	120	180.188	6.8521
Do	120–V_8	1.090	+ 1.4484	− 1.4443	+ 1.4464	−4.1	−53.3	V_8	181.278	8.2985
Do	V_8–121	0.917	− 0.9363	+ 0.9397	− 0.9380	−3.4	−56.7	121	182.195	7.3605
Do	121–122	1.086	− 0.4040	+ 0.4075	− 0.4058	−3.5	−60.2	122	183.281	6.9547
Apr. 24–25	122–123	1.165	+ 0.3224	− 0.3209	+ 0.3216	−1.5	−61.7	123	184.446	7.2763
Apr. 25–25	123–124	1.019	− 0.2339	+ 0.2348	− 0.2344	−0.9	−62.6	124	185.465	7.0419
Do	124–W_8	1.161	− 0.8437	+ 0.8451	− 0.8444	−1.4	−64.0	W_8	186.626	6.1975
Do	W_8–X_8	0.057	+ 0.6757	− 0.6750	+ 0.6754	−0.7	−64.7	X_8	186.683	6.8729
Do	X_8–125	0.424	− 0.8107	+ 0.8110	− 0.8108	−0.3	−65.0	125	187.107	6.0621
Do	125–126	1.120	+ 0.0560	− 0.0529	+ 0.0544	−3.1	−68.1	126	188.227	6.1165
Do	126–127	1.246	+ 0.3931	− 0.3904	+ 0.3918	−2.7	−70.8	127	189.473	6.5083
Do	127–Y_8	1.206	− 0.6049	+ 0.6039	− 0.6044	+1.0	−69.8	Y_8	190.679	5.9039
Do	Y_8–Z_8	0.796	+ 1.0498	− 1.0541	+ 1.0513	+1.4	−68.4	Z_8	191.475	6.9552
Apr. 26–26	Y_8–Z_8	0.796	+ 1.0515	− 1.0498						
Apr. 25–26	Z_8–128	1.205	− 0.6251	+ 0.6215	− 0.6233	+3.6	−64.8	128	192.680	6.3319
Apr. 26–26	128–129	1.497	− 0.3924	+ 0.3892	− 0.3908	+3.2	−61.6	129	194.177	5.9411
Apr. 26–25	129–A_9	0.998	− 0.5369	+ 0.5335	− 0.5352	+3.4	−58.2	A_9	195.175	5.4059
Apr. 26–26	A_9–B_9	0.402	− 1.1243	+ 1.1239	− 1.1241	+0.4	−57.8	B_9	195.577	4.2818
Do	B_9–C_9	1.140	+ 1.0349	− 1.0325	+ 1.0337	−2.4	−60.2	C_9	196.717	5.3155
Do	C_9–130	0.720	+ 0.1614	− 0.1611	+ 0.1612	−0.3	−60.5	130	197.437	5.4767
Do	130–131	1.182	+ 1.3602	− 1.3579	+ 1.3590	−2.3	−62.8	131	198.619	6.8357
Apr. 26–27	131–132	1.208	− 0.3486	+ 0.3467	− 0.3476	+1.9	−60.9	132	199.827	6.4881
Apr. 27–27	132–133	0.761	+ 0.2381	− 0.2365	+ 0.2373	−1.6	−62.5	133	200.588	6.7254
Do	133–D_9	1.210	− 0.7269	+ 0.7292	− 0.7280	−2.3	−64.8	D_9	201.798	5.9974
Do	D_9–E_9	0.098	+ 1.0869	− 1.0878	+ 1.0874	+0.9	−63.9	E_9	201.896	7.0848
Do	E_9–134	1.024	− 0.6442	+ 0.6440	− 0.6441	+0.2	−63.7	134	202.920	6.4407
Apr. 27–29	134–135	1.144	− 0.0168	+ 0.0191	− 0.0180	−2.3	−66.0	135	204.064	6.4227
Apr. 29–29	135–F_9	1.357	− 0.1506	+ 0.1501	− 0.1504	+0.5	−65.5	F_9	205.421	6.2723
Do	F_9–G_9	0.936	+ 2.2894	− 2.2881	+ 2.2888	−1.3	−66.8	G_9	206.357	8.5611
Do	G_9–136	1.203	− 0.5212	+ 0.5190	− 0.5201	+2.2	−64.6	136	207.560	8.0410
Do	136–137	1.209	+ 0.7608	− 0.7597	+ 0.7602	−1.1	−65.7	137	208.769	8.8012
Do	137–138	1.106	+ 0.7170	− 0.7144	+ 0.7157	−2.6	−68.3	138	209.875	9.5169
Do	138–H_9	0.325	− 0.7757	+ 0.7748	− 0.7752	+0.9	−67.4	H_9	210.200	8.7417
Apr. 30–29	H_9–I_9	1.326	+ 1.4461	− 1.4468	+ 1.4462	+3.1	−64.3	I_9	211.526	10.1879
Apr. 30–30	H_9–I_9	1.326	+ 1.4433	− 1.4487						
Apr. 29–29	I_9–139	1.245	+ 0.7568	− 0.7529	+ 0.7548	−3.9	−68.2	139	212.771	10.9427
Apr. 29–30	139–140	1.209	+ 0.4095	− 0.4081	+ 0.4088	−1.4	−69.6	140	213.980	11.3515
Apr. 30–30	140–141	1.127	+ 0.6241	− 0.6210	+ 0.6226	−3.1	−72.7	141	215.107	11.9741
Do	141–J_9	0.068	− 0.3881	+ 0.3885	− 0.3883	−0.4	−73.1	J_9	215.175	11.5858
Do	141–142	1.125	+ 0.3588	− 0.3579	+ 0.3584	−0.9	−73.6	142	216.232	12.3325
Do	142–143	1.105	+ 0.8472	− 0.8463	+ 0.8468	−0.9	−74.5	143	217.337	13.1793
Do	143–144	1.106	+ 0.4596	− 0.4595	+ 0.4596	−0.1	−74.6	144	218.443	13.6389
Do	144–145	1.024	+ 0.4184	− 0.4204	+ 0.4194	+2.0	−72.6	145	219.467	14.0583
May 1–2	145–K_9	0.405	− 0.0825	+ 0.0826	− 0.0826	−0.1	−72.7	K_9	219.872	13.9757
Do	K_9–146	1.189	+ 1.7296	− 1.7295	+ 1.7296	−0.1	−72.8	146	221.061	15.7053
May 1–1	146–L_9	1.055	+ 0.1364	− 0.1367	+ 0.1366	+0.3	−72.5	L_9	222.116	15.8419
Do	L_9–147	1.181	+ 4.1447	− 4.1458	+ 4.1452	+1.1	−71.4	147	223.297	19.9871
Do	147–148	1.167	− 2.7217	+ 2.7282	− 2.7272	−5.1	−76.5	148	224.464	17.2599
May 2–2	147–148	1.167	− 2.7256	+ 2.7312						
May 2	147–148	1.167	− 2.7266	.....	.....	.....	.....	.....	.....	.....
May 1–1	148–M_9	0.365	− 1.0375	+ 1.0359	− 1.0367	+1.6	−74.9	M_9	224.829	16.2232
Do	M_9–149	1.122	+ 0.4806	− 0.4832	+ 0.4819	+2.6	−72.3	149	225.951	16.7051
May 1–2	149–150	1.072	− 0.6293	+ 0.6347	− 0.6323	−2.6	−74.9	150	227.023	16.0728
May 3–3	149–150	1.072	− 0.6327	+ 0.6324						
May 2–2	150–151	1.127	− 0.5167	+ 0.5196	− 0.5182	−2.9	−77.8	151	228.150	15.5546
Do	151–N_9	0.644	− 0.0836	+ 0.0807	− 0.0822	+2.9	−74.9	N_9	228.794	15.4724
Do	N_9–O_9	0.804	− 0.5800	+ 0.5806	− 0.5803	−0.6	−75.5	O_9	229.598	14.8921
May 2–3	O_9–152	1.124	− 0.2770	+ 0.2797	− 0.2784	−2.7	−78.2	152	230.722	14.6137
May 3–3	152–153	1.253	+ 0.3961	− 0.3952	+ 0.3956	−0.9	−79.1	153	231.975	15.0093
Do	153–154	1.167	− 3.2235	+ 3.2263	− 3.2249	−2.8	−81.9	154	233.142	11.7844
Do	154–155	1.165	+ 2.5043	− 2.5029	+ 2.5036	−1.4	−83.3	155	234.307	14.2880
Do	155–P_9	1.116	− 0.2230	+ 0.2236	− 0.2233	−0.6	−83.9	P_9	235.423	14.0647
May 6–6	P_9–156	1.041	+ 1.1967	− 1.1978	+ 1.1972	+1.1	−82.8	156	236.464	15.2619
Do	156–157	1.124	− 1.4195	+ 1.4217	− 1.4206	−2.2	−85.0	157	237.588	13.8413
Do	157–158	1.134	− 0.9970	+ 0.9948	− 0.9959	+2.2	−82.8	158	238.722	12.8454
Do	158–159	1.123	+ 1.0675	− 1.0689	+ 1.0682	+1.4	−81.4	159	239.845	13.9136
May 6–7	159–Q_9	0.972	− 0.6024	+ 0.6025	− 0.6024	−0.1	−81.5	Q_9	240.817	13.3112
May 7–7	Q_9–160	1.161	− 2.1576	+ 2.1583	− 2.1580	−0.7	−82.2	160	241.978	11.1532
Do	160–161	1.105	+ 0.3417	− 0.3462	+ 0.3448	+1.7	−80.5	161	243.083	11.4980
May 9–9	160–161	1.105	+ 0.3461	− 0.3450						
May 7–7	161–162	1.145	+ 0.1271	− 0.1273	+ 0.1272	+0.2	−80.3	162	244–228	11.6252
Do	162–163	1.098	+ 0.5866	− 0.5878	+ 0.5872	+1.2	−79.1	163	245.326	12.2124
Do	163–164	1.124	+ 1.1539	− 1.1572	+ 1.1556	+3.3	−75.8	164	246.450	13.3680
May 7–10	164–165	1.143	+ 1.8150	− 1.8138	− 1.8144	−1.2	−77.0	165	247.593	15.1824
May 10–10	165–R_9	0.372	− 0.8676	+ 0.8648	− 0.8653	+1.8	−75.2	R_9	247.965	14.3171
Do	165–R_9	0.372	− 0.8649	+ 0.8641						

Results of leveling, San Francisco, Cal., to Marmol, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. City 635.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1912.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
May 10-10	R_9-166	0.797	− 0.3208	+ 0.3185	− 0.3196	+2.3	−72.9	166	248.762	13.9975
Do	166-167	1.163	+ 0.7143	− 0.7149	+ 0.7146	+0.6	−72.3	167	249.925	14.7121
Do	167-168	1.124	+ 0.7090	− 0.7052	+ 0.7071	−3.8	−76.1	168	251.049	15.4192
Do	168-169	1.204	− 0.6267	+ 0.6221	− 0.6255	+3.8	−72.3	169	252.253	14.7937
May 11-11	168-169	1.204	− 0.6280	+ 0.6250						
May 10-11	169-S_9	1.276	+ 0.4048	− 0.4047	+ 0.4048	−0.1	−72.4	S_9	253.529	15.1985
Do	S_9-170	1.118	− 1.5941	+ 1.5917	− 1.5929	+2.4	−70.0	170	254.647	13.6056
May 11-11	170-171	0.536	− 0.1397	+ 0.1434	− 0.1418	−3.2	−73.2	171	255.183	13.4638
Do	170-171	0.536	− 0.1408	+ 0.1433						
Do	171-172	1.124	− 0.7087	+ 0.7112	− 0.7100	−2.5	−75.7	172	256.307	12.7538
Do	172-173	1.164	− 0.5540	+ 0.5538	− 0.5539	+0.2	−75.5	173	257.471	12.1999
May 13-11	173-T_9	1.097	− 0.8306	+ 0.8305	− 0.8301	+1.0	−74.5	T_9	258.568	11.3698
May 13	173-T_9	1.097	.....	+ 0.8288						
May 13-13	T_9-174	0.419	+ 0.9336	− 0.9347	+ 0.9342	+1.1	−73.4	174	258.987	12.3040
Do	174-175	1.152	+ 0.5358	− 0.5309	+ 0.5328	−2.4	−75.8	175	260.139	12.8368
Do	174-175	1.152	+ 0.5322	− 0.5323						
Do	175-176	1.430	− 0.4521	+ 0.4519	− 0.4520	+0.2	−75.6	176	261.569	12.3848
Do	176-177	0.925	− 0.0137	+ 0.0100	− 0.0118	+3.7	−71.9	177	262.494	12.3730
Do	177-178	1.236	− 0.0328	+ 0.0317	− 0.0322	+1.1	−70.8	178	263.730	12.3408
May 14-13	178-U_9	1.281	− 1.2735	+ 1.2717	− 1.2726	+1.8	−69.0	U_9	265.011	11.0682
May 14-14	U_9-179	0.755	+ 1.3613	− 1.3626	+ 1.3620	+1.3	−67.7	179	265.766	12.4302
May 15-14	179-180	1.146	− 0.0301	+ 0.0293	− 0.0297	+0.8	−66.9	180	266.912	12.4005
Do	180-181	1.674	+ 0.5849	− 0.5867	+ 0.5858	+1.8	−65.1	181	268.586	12.9863
Do	181-V_9	1.414	+ 2.2413	− 2.2408	+ 2.2410	−0.5	−65.6	V_9	270.000	15.2273
May 15-15	V_9-182	1.281	− 0.2640	+ 0.2596	− 0.2618	+4.4	−61.2	182	271.281	14.9655
Do	182-183	1.239	− 0.1783	+ 0.1780	− 0.1782	+0.3	−60.9	183	272.520	14.7873
Do	183-184	1.150	− 1.0837	+ 1.0851	− 1.0844	−1.4	−62.3	184	273.670	13.7029
Do	184-185	0.670	− 0.4063	+ 0.4060	− 0.4062	+0.3	−62.0	185	274.340	13.2967
Do	185-186	0.568	+ 0.3017	− 0.3021	+ 0.3019	+0.4	−61.6	186	274.908	13.5986
Do	186-W_9	0.431	− 1.4147	+ 1.4151	− 1.4149	−0.4	−62.0	W_9	275.339	12.1837
May 16-16	W_9-187	0.879	+ 1.2158	− 1.2173	+ 1.2166	+1.5	−60.5	187	276.218	13.4003
Do	187-188	1.063	− 1.8684	+ 1.8689	− 1.8686	−0.5	−61.0	188	277.281	11.5317
Do	188-189	1.126	+ 2.6630	− 2.6661	+ 2.6646	+3.1	−57.9	189	278.407	14.1963
Do	189-190	1.165	+ 0.6263	− 0.6234	+ 0.6248	−2.9	−60.8	190	279.572	14.8211
Do	190-191	1.123	− 0.3541	+ 0.3533	− 0.3537	+0.8	−60.0	191	280.695	14.4674
Do	191-X_9	0.516	+ 1.4658	− 1.4657	+ 1.4658	−0.1	−60.1	X_9	281.211	15.9332
Do	X_9-192	1.209	+ 2.1297	− 2.1284	+ 2.1290	−1.3	−61.4	192	282.420	18.0622
Do	192-193	1.117	+ 3.4555	− 3.4557	+ 3.4556	+0.2	−61.2	193	283.537	21.5178
May 16-17	193-194	0.864	+ 1.3824	− 1.3833	+ 1.3828	+0.9	−60.3	194	284.401	22.9006
May 17-17	194-195	1.206	+ 3.9729	− 3.9760	+ 3.9744	+3.1	−57.2	195	285.607	26.8750
Do	195-196	1.242	+ 4.8325	− 4.8353	+ 4.8339	+2.8	−54.4	196	286.849	31.7089
Do	196-197	1.116	+ 4.4840	− 4.4826	+ 4.4833	−1.4	−55.8	197	287.965	36.1922
Do	197-198	1.123	+ 4.2233	− 4.2209	+ 4.2221	−2.4	−58.2	198	289.088	40.4143
Do	198-199	1.204	+ 4.7555	− 4.7582	+ 4.7568	+2.7	−55.5	199	290.292	45.1711
Do	199-200	1.196	+ 4.0077	− 4.0105	+ 4.0091	+2.8	−52.7	200	291.488	49.1802
May 17-18	200-Y_9	0.836	− 1.4141	+ 1.4173	− 1.4157	−3.2	−55.9	Y_9	292.324	47.7645
May 18-18	Y_9-201	1.151	− 1.4445	+ 1.4463	− 1.4454	−1.8	−57.7	201	293.475	46.3191
Do	201-202	1.083	− 1.3679	+ 1.3692	− 1.3686	−1.3	−59.0	202	294.558	44.0505
Do	202-Z_9	0.855	− 0.3080	+ 0.3068	− 0.3074	+1.2	−57.8	Z_9	295.413	44.6431
Do	Z_9-203	1.179	− 2.7074	+ 2.7029	− 2.7074	+3.1	−54.7	203	296.592	41.9357
May 21-21	Z_9-203	1.179	− 2.7104	+ 2.7087						
May 18-21	203-204	1.370	+ 4.9220	− 4.9215	+ 4.9218	−0.5	−55.2	204	297.962	46.8575
May 21-21	204-A_{10}	0.686	+ 1.9622	− 1.9617	+ 1.9620	−0.5	−55.7	A_{10}	298.648	48.8195
Do	A_{10}-205	1.115	+ 3.7930	− 3.7961	+ 3.7946	+3.1	−52.6	205	299.763	52.6141
Do	205-B_{10}	0.708	+ 0.0432	− 0.0478	+ 0.0440	+1.5	−51.1	B_{10}	300.471	52.6581
May 22-22	205-B_{10}	0.708	+ 0.0432	− 0.0416						
May 21-21	B_{10}-206	1.139	+ 6.5651	− 6.5696	+ 6.5682	+1.6	−49.5	206	301.610	59.2263
May 22-22	B_{10}-206	1.139	+ 6.5697	− 6.5684						
May 21-21	206-207	1.165	+ 5.4990	− 5.4973	+ 5.4982	−1.7	−51.2	207	302.775	64.7245
May 23-23	207-208	0.381	+ 0.2591	− 0.2594	+ 0.2592	+0.3	−50.9	208	303.156	64.9837
Do	208-209	1.064	+ 5.1238	− 5.1204	+ 5.1221	−3.4	−54.3	209	304.220	70.1058
May 25-23	209-210	1.012	+ 5.5770	− 5.5800	+ 5.5785	+3.0	−51.3	210	305.232	75.6843
May 23-24	210-C_{10}	0.806	+ 1.0782	− 1.0778	+ 1.0780	−0.4	−51.7	C_{10}	306.038	76.7623
Do	C_{10}-211	1.093	+16.7259	−16.7270	+16.7264	+1.1	−50.6	211	307.131	93.4887
Do	211-212	1.042	+ 1.4817	− 1.4820	+ 1.4818	+0.3	−50.3	212	308.173	94.9705
Do	212-213	1.118	+12.6253	−12.6273	+12.6263	+2.0	−48.3	213	309.291	107.5968
Do	213-214	1.110	+14.3317	−14.3304	+14.3310	−1.3	−49.6	214	310.401	121.9278
May 24-24	214-215	1.341	+13.8172	−13.8179	+13.8176	+0.7	−48.9	215	311.742	135.7454
Do	215-216	1.187	+20.0855	−20.0885	+20.0870	+3.0	−45.9	216	312.929	155.8324
Do	216-217	1.201	+24.4965	−24.4963	+24.4964	−0.2	−46.1	217	314.130	180.3288
Do	217-218	1.179	+23.7184	−23.7194	+23.7189	+1.0	−45.1	218	315.309	204.0477
May 24-27	218-219	1.100	+21.8112	−21.8115	+21.8114	+0.3	−44.8	219	316.409	225.8591
May 27-27	219-220	1.182	+23.9550	−23.9530	+23.9540	−2.0	−46.8	220	317.591	249.8131
Do	220-221	1.092	+25.9405	−25.9374	+25.9390	−3.1	−49.9	221	318.683	275.7521
Do	221-D_{10}	1.135	+21.6887	−21.6871	+21.6879	−1.6	−51.5	D_{10}	319.818	297.4400
Do	D_{10}-222	0.328	+ 4.5922	− 4.5919	+ 4.5920	−0.3	−51.8	222	320.146	302.0320
Do	222-223	0.999	+25.0851	−25.0853	+25.0852	+0.2	−51.6	223	321.145	327.1172
May 28-28	223-224	1.082	+23.7269	−23.7248	+23.7258	−2.1	−53.7	224	322.227	350.8430
Do	224-225	1.200	+24.0176	−24.0183	+24.0180	+0.7	−53.0	225	323.427	374.8610
Do	225-226	1.150	+16.5361	−16.5372	+16.5366	+1.1	−51.9	226	324.577	391.3976
Do	226-227	1.156	+ 6.9047	− 6.9039	+ 6.9043	−0.8	−52.7	227	325.733	398.3019
Do	227-228	1.166	+12.3755	−12.3708	+12.3776	+2.4	−50.3	228	326.899	410.6795
Do	227-228	1.166	+12.3773	−12.3777						
May 28-29	228-E_{10}	0.423	+ 3.5623	− 3.5609	+ 3.5616	−1.4	−51.7	E_{10}	327.322	414.2411
Do	E_{10}-229	0.943	+ 9.9482	− 9.9498	+ 9.9490	+1.6	−50.1	229	328.265	424.1901
Do	229-230	1.070	+12.4583	−12.4610	+12.4596	+2.7	−47.4	230	329.335	436.6497
Do	230-231	0.848	+17.5067	−17.5073	+17.5070	+0.6	−46.8	231	330.183	454.1567
May 29-29	231-232	1.219	+21.7155	−21.7159	+21.7157	+0.4	−46.4	232	331.402	475.8724
Do	232-233	1.248	+17.8177	−17.8129	+17.8166	−3.9	−50.3	233	332.650	493.6890
May 30-30	232-233	1.248	+17.8193	−17.8162						
May 29-29	233-234	1.121	+ 1.6038	− 1.6041	+ 1.6040	+0.3	−50.0	234	333.771	495.2930
Do	234-235	1.116	+17.3709	−17.3679	+17.3694	−3.0	−53.0	235	334.887	512.6624

Results of leveling, San Francisco, Cal., to Marmol, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. City 635.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1912.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
May 29–31	235–236	1.171	+13.5697	−13.5748	+13.5728	+2.3	−50.7	236	336.058	526.2352
May 31–31	235–236	1.171	+13.5735	−13.5730						
May 30–30	236–237	1.116	+ 7.4743	− 7.4757	+ 7.4750	+1.4	−49.3	237	337.174	533.7102
Do	237–F_{10}	0.688	+ 1.4563	− 1.4561	+ 1.4562	−0.2	−49.5	F_{10}	337.862	535.1664
Do	F_{10}–238	1.120	+11.3428	−11.3450	+11.3439	+2.2	−47.3	238	338.982	546.5103
Do	238–G_{10}	1.071	+22.7227	−22.7222	+22.7224	−0.5	−47.8	G_{10}	340.053	569.2327
Do	G_{10}–239	1.154	+19.9707	−19.9680	+19.9694	−2.7	−50.5	239	341.207	589.2021
May 31–31	239–240	1.134	+22.6956	−22.6968	+22.6962	+1.2	−49.3	240	342.341	611.8983
Do	240–241	1.024	+21.2278	−21.2266	+21.2272	−1.2	−50.5	241	343.365	633.1255
Do	241–242	1.099	+21.9504	−21.9545						
June 3–3	241–242	1.099	+21.9523	−21.9542	+21.9529	+3.0	−47.5	242	344.464	655.0784
May 31–31	242–243	1.180	+23.6097	−23.6128	+23.6112	+3.1	−44.4	243	345.644	678.6896
Do	243–244	1.119	+15.6731	−15.6788						
June 3–3	243–244	1.119	+15.6773	−15.6761	+15.6763	+2.2	−42.2	244	346.763	694.3659
Do	244–245	1.195	− 0.7227	+ 0.7229	− 0.7228	−0.2	−42.4	245	347.958	693.6431
Do	245–246	1.003	+ 0.0813	− 0.0802	+ 0.0808	−1.1	−43.5	246	348.961	693.7239
Do	246–247	0.976	+ 1.3804	− 1.3791	+ 1.3798	−1.3	−44.8	247	349.937	695.1037
Do	247–H_{10}	0.386	+ 4.6663	− 4.6672	+ 4.6668	+0.9	−43.9	H_{10}	350.323	699.7705
June 4–4	H_{10}–248	1.128	− 4.3546	+ 4.3563	− 4.3554	−1.7	−45.6	248	351.451	695.4151
Do	248–249	1.118	+ 6.4256	− 6.4228	+ 6.4242	−2.8	−48.4	249	352.569	701.8393
Do	249–250	1.102	+16.4008	−16.4031	+16.4020	+2.3	−46.1	250	353.671	718.2413
Do	250–251	1.098	+11.4355	−11.4378	+11.4366	+2.3	−43.8	251	354.769	729.6779
Do	251–I_{10}	0.761	+ 6.4652	− 6.4652	+ 6.4652	0.0	−43.8	I_{10}	355.530	736.1431
June 4–5	I_{10}–252	1.076	− 2.1380	+ 2.1353	− 2.1366	+2.7	−41.1	252	356.606	734.0065
June 5–5	252–253	1.139	− 4.0866	+ 4.0875	− 4.0870	−0.9	−42.0	253	357.745	729.9195
Do	253–J_{10}	1.005	+ 2.1232	− 2.1237	+ 2.1234	+0.5	−41.5	J_{10}	358.750	732.0429
June 5–6	J_{10}–254	0.885	+17.5293	−17.5279	+17.5286	−1.4	−42.9	254	359.635	749.5715
June 6–6	254–255	1.154	+22.1958	−22.1943	+22.1950	−1.5	−44.4	255	360.789	771.7665
Do	255–256	1.183	+25.4462	−25.4439	+25.4450	−2.3	−46.7	256	361.972	797.2115
Do	256–257	1.079	+21.4982	−21.4977	+21.4980	−0.5	−47.2	257	363.051	818.7095
Do	257–258	1.190	+22.6055	−22.6054	+22.6054	−0.1	−47.3	258	364.241	841.3149
Do	258–259	1.152	+14.0240	−14.0218	+14.0229	−2.2	−49.5	259	365.393	855.3378
Do	259–260	1.179	+22.6599	−22.6609	+22.6604	+1.0	−48.5	260	366.572	877.9982
Do	260–261	0.886	+15.4772	−15.4789	+15.4780	+1.7	−46.8	261	367.458	893.4762
June 6–7	261–262	0.965	+11.1318	−11.1309	+11.1314	−0.9	−47.7	262	368.423	904.6076
June 7	262–263	1.159	(1)	−22.2113						
June 8–8	262–263	1.159	+22.2132	−22.2103	+22.2120	−2.4	−50.1	263	369.582	926.8196
June 7–7	263–264	1.097	+22.9247	−22.9180						
June 8–8	263–264	1.097	+22.9228	−22.9209	+22.9216	−4.4	−54.5	264	370.679	949.7412
June 7–7	264–K_{10}	0.884	+17.3219	−17.3204	+17.3212	−1.5	−56.0	K_{10}	371.563	967.0624
Do	K_{10}–265	1.078	+15.0453	−15.0510						
June 8–8	K_{10}–265	1.078	+15.0498	−15.0496	+15.0490	+2.7	−53.3	265	372.641	982.1114
June 7–8	265–266	0.914	+ 4.4092	− 4.4114	+ 4.4103	+2.2	−51.1	266	373.555	986.5217
June 8–8	266–267	1.101	+22.0597	−22.0596	+22.0596	−0.1	−51.2	267	374.656	1008.5813
Do	267–268	1.092	+22.3830	−22.3805	+22.3818	−2.5	−53.7	268	375.748	1030.9631
Do	268–269	1.088	+23.0163	−23.0179	+23.0171	+1.6	−52.1	269	376.836	1053.9802
June 8–10	269–270	0.497	+10.3424	−10.3426	+10.3425	+0.2	−51.9	270	377.333	1064.3227
June 10–10	270–271	1.093	+24.1956	−24.1932	+24.1944	−2.4	−54.3	271	378.426	1088.5171
Do	271–272	1.092	+24.4290	−24.4237						
Do	271–272	1.092	+24.4301	−24.4295	+24.4281	−3.0	−57.3	272	379.518	1112.9452
Do	272–L_{10}	0.944	+22.1225	−22.1230	+22.1228	+0.5	−56.8	L_{10}	380.462	1135.0680
Do	L_{10}–273	1.038	+19.2222	−19.2178						
June 13–14	L_{10}–273	1.038	+19.2189	−19.2224	+19.2204	−0.5	−57.3	273	381.500	1154.2884
June 10–14	273–274	0.837	+18.5748	−18.5706						
June 14–14	273–274	0.837	+18.5746	−18.5742	+18.5736	−2.3	−59.6	274	382.337	1172.8620
June 13–14	274–275	1.289	+28.1738	−28.1714	+28.1726	−2.4	−62.0	275	383.626	1201.0346
Do	275–276	1.295	+28.3798	−28.3749						
June 14–14	275–276	1.295	+28.3803	−28.3786	+28.3784	−3.2	−65.2	276	384.921	1229.4130
June 13	276–277	1.299	+28.9543	(1)						
June 15–15	276–277	1.299	+28.9555	−28.9548	+28.9548	−0.1	−65.3	277	386.220	1258.3678
June 13–14	277–278	1.291	+28.5796	−28.5774	+28.5785	−2.2	−67.5	278	387.511	1286.9463
Do	278–279	1.295	+28.7109	−28.7124	+28.7116	+1.5	−66.0	279	388.806	1315.6579
Do	279–M_{10}	1.437	+31.1632	−31.1613	+31.1622	−1.9	−67.9	M_{10}	390.243	1346.8201
June 15–15	M_{10}–280	0.986	+21.4629	−21.4656	+21.4642	+2.7	−65.2	280	391.229	1368.2843
Do	280–281	0.944	+20.9333	−20.9350	+20.9342	+1.7	−63.5	281	392.173	1389.2185
June 17–17	281–282	0.260	+ 5.7555	− 5.7564	+ 5.7560	+0.9	−62.6	282	392.433	1394.9745
June 15–15	282–283	1.002	+20.9079	−20.9059	+20.9069	−2.0	−64.6	283	393.435	1415.8814
Do	283–N_{10}	0.681	+14.1001	−14.0992	+14.0996	−0.9	−65.5	N_{10}	394.116	1429.9810
June 17–17	N_{10}–284	1.006	+18.9429	−18.9410	+18.9420	−1.9	−67.4	284	395.122	1448.9230
Do	284–285	0.997	+20.3287	−20.3245						
June 18–18	284–285	0.997	+20.3284	−20.3278	+20.3274	−2.4	−69.8	285	396.119	1469.2504
June 17–17	285–286	0.999	+20.8690	−20.8709	+20.8700	+1.9	−67.9	286	397.118	1490.1204
Do	286–287	0.998	+20.8402	−20.8397	+20.8400	−0.5	−68.4	287	398.116	1510.9604
Do	287–288	0.987	+21.2308	−21.2328	+21.2318	+2.0	−66.4	288	399.103	1532.1922
Do	288–289	0.996	+18.2097	−18.2075	+18.2086	−2.2	−68.6	289	400.099	1550.4008
June 18–18	289–290	1.000	+16.9239	−16.9264	+16.9252	+2.5	−66.1	290	401.099	1567.3260
Do	290–291	0.993	+16.2778	−16.2781	+16.2780	+0.3	−65.8	291	402.092	1583.6040
Do	291–O_{10}	0.300	+ 5.0827	− 5.0816	+ 5.0822	−1.1	−66.9	O_{10}	402.392	1588.6862
Do	O_{10}–292	1.013	+14.9183	−14.9223	+14.9203	+4.0	−62.9	292	403.405	1603.6065
Do	292–293	1.079	+19.6415	−19.6422	+19.6418	+0.7	−62.2	293	404.484	1623.2483
Do	293–294	1.000	+17.9413	−17.9428	+17.9420	+1.5	−60.7	294	405.484	1641.1903
June 18–20	294–295	0.225	+ 3.8387	− 3.8395	+ 3.8391	+0.8	−59.9	295	405.709	1645.0294
June 20–20	295–296	0.220	+ 4.1097	− 4.1094	+ 4.1096	−0.3	−60.2	296	405.929	1649.1390
Do	296–297	1.141	+20.5586	−20.5625	+20.5606	+3.9	−56.3	297	407.070	1669.6996
Do	297–298	1.183	+21.1530	−21.1519	+21.1524	−1.1	−57.4	298	408.253	1690.8520
Do	298–299	1.144	+20.9799	−20.9779	+20.9789	−2.0	−59.4	299	409.397	1711.8309
Do	299–300	1.054	+ 8.8671	− 8.8677	+ 8.8674	+0.6	−58.8	300	410.451	1720.6983
Do	300–301	1.182	+15.6842	−15.6835	+15.6838	−0.7	−59.5	301	411.633	1736.3821
June 21–20	301–302	1.073	+17.0593	−17.0577	+17.0585	−1.6	−61.1	302	412.706	1753.4406
June 21–21	302–303	1.089	+15.5451	−15.5458	+15.5454	+0.7	−60.4	303	413.795	1768.9860

[1] Rejected in field.

Results of leveling, San Francisco, Cal., to Marmol, Nev.—Continued.

Date.	From B. M. to B. M.	Distance in kilometers.	Difference of elevation.			Discrepancy.		Designation of B. M.	Distance from B. M. City 635.	Observed elevation above mean sea level.
			Forward line.	Backward line.	Mean.	Partial.	Total accumulated.			
1912.			*m.*	*m.*	*m.*	*mm.*	*mm.*		*km.*	*m.*
June 21-21	303-304	1.183	+20.1214	−20.1206	+20.1210	−0.8	−61.2	304	414.978	1789.1070
Do	304-P_{10}	1.100	+16.1330	−16.1363	+16.1346	+3.3	−57.9	P_{10}	416.078	1805.2416
Do	P_{10}-305	1.097	+16.0222	−16.0258	+16.0240	+3.6	−54.3	305	417.175	1821.2656
June 22-22	305-306	1.060	+14.8408	−14.8434	+14.8421	+2.6	−51.7	306	418.235	1836.1077
Do	306-307	1.099	+16.7968	−16.7967	+16.7968	−0.1	−51.8	307	419.334	1852.9045
Do	307-308	1.221	+18.9571	−18.9571	+18.9571	0.0	−51.8	308	420.555	1871.8616
Do	308-309	1.228	+17.1302	−17.1325	+17.1314	+2.3	−49.5	309	421.783	1888.9930
Do	309-310	1.158	+18.8207	−18.8250	+18.8228	+4.3	−45.2	310	422.941	1907.8158
June 24-24	310-311	1.124	+18.3130	−18.3123	+18.3126	−0.7	−45.9	311	424.065	1926.1284
Do	311-312	1.216	+19.2307	−19.2303	+19.2305	−0.4	−46.3	312	425.281	1945.3589
Do	312-313	1.117	+18.2481	−18.2483	+18.2482	+0.2	−46.1	313	426.398	1963.6071
Do	313-314	1.081	+17.3217	−17.3199	+17.3208	−1.8	−47.9	314	427.479	1980.9279
June 26-26	314-Q_{10}	0.289	+ 3.8663	− 3.8670	+ 3.8666	+0.7	−47.2	Q_{10}	427.768	1984.7945
Do	Q_{10}-315	0.862	+12.3061	−12.3063	+12.3062	+0.2	−47.0	315	428.630	1997.1007
Do	315-316	1.106	+14.1021	−14.1038	+14.1030	+1.7	−45.3	316	429.736	2011.2037
Do	316-317	1.143	+16.2331	−16.2352	+16.2342	+2.1	−43.2	317	430.879	2027.4379
Do	317-318	1.083	+16.3500	−16.3478	+16.3489	−2.2	−45.4	318	431.962	2043.7868
Do	318-319	1.038	+15.1519	−15.1536	+15.1528	+1.7	−43.7	319	433.000	2058.9396
June 27-27	319-320	1.330	+22.7926	−22.7964	+22.7945	+3.8	−39.9	320	434.330	2081.7341
Do	320-321	1.083	+19.1857	−19.1846	+19.1852	−1.1	−41.0	321	435.413	2100.9193
Do	321-R_{10}	1.149	+21.9775	−21.9771	+21.9773	−0.4	−41.4	R_{10}	436.562	2122.8966
Do	R_{10}-322	0.779	+11.3078	−11.3077	+11.3078	−0.1	−41.5	322	437.341	2134.2044
Do	322-323	0.996	− 9.7794	+ 9.7794	− 9.7794	0.0	−41.5	323	438.337	2124.4250
June 27-29	323-324	0.932	−15.7318	+15.7284	−15.7301	+3.4	−38.1	324	439.269	2108.6949
June 28	324-325	1.091	−19.3325	(1)	} −19.3293	+4.2	−33.9	325	440.360	2089.3656
June 29-29	324-325	1.091	−19.3304	+19.3272						
June 28-28	325-326	1.219	−20.2618	+20.2679	} −20.2667	−5.0	−38.9	326	441.579	2069.0989
Do	325-326	1.219	−20.2667	+20.2706						
Do	326-327	1.123	−18.6381	+18.6388	−18.6384	−0.7	−39.6	327	442.702	2050.4605
Do	327-328	0.662	−11.2852	+11.2819	−11.2836	+3.3	−36.3	328	443.364	2039.1769
July 1-1	328-329	1.041	−18.4714	+18.4737	−18.4726	−2.3	−38.6	329	444.405	2020.7043
Do	329-S_{10}	0.969	−15.1132	+15.1162	−15.1147	−3.0	−41.6	S_{10}	445.374	2005.5896
Do	S_{10}-330	0.648	−11.8867	+11.8874	−11.8870	−0.7	−42.3	330	446.022	1993.7026
Do	330-331	0.842	−14.4711	+14.4709	−14.4710	+0.2	−42.1	331	446.864	1979.2316
Do	331-332	1.040	−17.8235	+17.8225	−17.8230	+1.0	−41.1	332	447.904	1961.4086
July 6-6	332-333	0.523	− 7.4008	+ 7.4004	− 7.4006	+0.4	−40.7	333	448.427	1954.0080
Do	333-334	0.821	−14.4426	+14.4431	−14.4428	−0.5	−41.2	334	449.248	1939.5652
Do	334-T_{10}	0.679	−11.4040	+11.4052	−11.4046	−1.2	−42.4	T_{10}	449.927	1928.1606
July 2-2	T_{10}-335	0.505	− 8.3629	+ 8.3632	− 8.3630	−0.3	−42.7	335	450.432	1919.7976
Do	335-336	0.989	−16.9016	+16.9004	−16.9010	+1.2	−41.5	336	451.421	1902.8966
Do	336-337	0.958	−10.6400	+10.6404	} −10.6404	−0.8	−42.3	337	452.379	1892.2562
July 3	336-337	0.958	.....	+10.6413						
July 3-3	337-338	1.027	− 7.9882	+ 7.9877	− 7.9880	+0.5	−41.8	338	453.406	1884.2682
Do	338-339	0.900	− 8.0324	+ 8.0325	− 8.0324	−0.1	−41.9	339	454.306	1876.2358
July 3-2	339-340	1.066	−14.8053	+14.8087	−14.8070	−3.4	−45.3	340	455.372	1861.4288
Do	340-341	1.060	−16.9283	+16.9304	−16.9294	−2.1	−47.4	341	456.432	1844.4994
Do	341-342	0.963	−18.2706	+18.2699	−18.2702	+0.7	−46.7	342	457.395	1826.2292
Do	342-343	1.061	−18.0310	+18.0318	−18.0314	−0.8	−47.5	343	458.456	1808.1978
Do	343-344	0.981	−17.4063	+17.4053	−17.4058	+1.0	−46.5	344	459.437	1790.7920
Do	344-U_{10}	1.123	−16.8868	+16.8883	−16.8876	−1.5	−48.0	U_{10}	460.560	1773.9044
July 5-5	U_{10}-345	1.178	−12.4227	+12.4284	} −12.4258	−2.3	−50.3	345	461.738	1761.4786
July 6-6	U_{10}-345	1.178	−12.4267	+12.4255						
July 5-5	345-346	1.071	−10.0166	+10.0172	−10.0169	−0.6	−50.9	346	462.809	1751.4617
Do	346-347	1.106	− 3.5131	+ 3.5142	− 3.5136	−1.1	−52.0	347	463.915	1747.9481
Do	347-348	1.144	− 5.4759	+ 5.4744	− 5.4752	+1.5	−50.5	348	465.059	1742.4729
Do	348-349	1.178	− 9.8161	+ 9.8139	− 9.8150	+2.2	−48.3	349	466.237	1732.6579
Do	349-350	1.079	− 6.1066	+ 6.1060	−6.1063	+0.6	−7.74	350	467.316	1726.5516
Do	350-351	1.080	− 9.2335	+ 9.2333	− 9.2334	+0.2	−47.5	351	468.396	1717.3182
Do	351-352	1.080	− 5.1659	+ 5.1647	− 5.1653	+1.2	−46.3	352	469.476	1712.1529
July 8-8	352-V_{10}	0.756	− 2.1912	+ 2.1929	− 2.1920	−1.7	−48.0	V_{10}	470.232	1709.9609
Do	V_{10}-353	1.090	− 8.9193	+ 8.9200	− 8.9199	−0.2	−48.2	353	471.322	1701.0410
Do	353-354	1.083	− 8.7450	+ 8.7467	− 8.7458	−1.7	−49.9	354	472.405	1692.2952
Do	354-355	1.080	− 5.9497	+ 5.9522	− 5.9510	−2.5	−52.4	355	473.485	1686.3442
Do	355-356	1.032	− 6.1358	+ 6.1386	− 6.1372	−2.8	−55.2	356	474.517	1680.2070
Do	356-357	1.080	− 4.0053	+ 4.0013	− 4.0033	+4.0	−51.2	357	475.597	1676.2037
Do	357-358	1.080	− 4.0098	+ 4.0113	− 4.0106	−1.5	−52.7	358	476.677	1672.1931
Do	358-359	1.076	− 3.2569	+ 3.2599	− 3.2584	−3.0	−55.7	359	477.753	1668.9347
July 9-9	359-360	1.141	− 8.8346	+ 8.8326	− 8.8336	+2.0	−53.7	360	478.894	1660.1011
Do	360-361	1.080	− 8.3375	+ 8.3369	− 8.3372	+0.6	−53.1	361	479.974	1651.7639
Do	361-W_{10}	1.019	− 2.8024	+ 2.8023	− 2.8024	+0.1	−53.0	W_{10}	480.993	1648.9615
Do	W_{10}-362	1.094	−14.9729	+14.9727	−14.9728	+0.2	−52.8	362	482.087	1633.9887
Do	362-363	1.061	− 5.5120	+ 5.5131	− 5.5126	−1.1	−53.9	363	483.148	1628.4761
July 9	363-364	1.009	(1)	+13.3447	} −13.3422	−1.6	−55.5	364	484.157	1615.1339
July 10-10	363-364	1.009	−13.3414	+13.3414						
July 9-9	364-365	1.088	−13.0748	+13.0783	−13.0766	−3.5	−59.0	365	485.245	1602.0573
July 10-10	365-366	1.080	− 7.9983	+ 8.0026	} − 7.9997	−2.6	−61.6	366	486.325	1594.0576
July 11-11	365-366	1.080	− 7.9984	+ 7.9995						
July 10-10	366-367	0.964	− 9.4670	+ 9.4675	− 9.4672	−0.5	−62.1	367	487.289	1584.5904
Do	367-368	1.038	− 7.5637	+ 7.5627	− 7.5632	+1.0	−61.1	368	488.327	1577.0272
July 10-11	368-X_{10}	0.602	− 3.9117	+ 3.9136	− 3.9126	−1.9	−63.0	X_{10}	488.929	1573.1146
July 11-11	X_{10}-369	1.079	− 6.8315	+ 6.8310	− 6.8312	+0.5	−62.5	369	490.008	1566.2834
Do	369-370	1.224	−10.5289	+10.5302	−10.5296	−1.3	−63.8	370	491.232	1555.7538
Do	370-371	0.818	− 5.1045	+ 5.1039	− 5.1042	+0.6	−63.2	371	492.050	1550.6496
Do	371-372	0.714	− 5.7014	+ 5.7000	− 5.7007	+1.4	−61.8	372	492.764	1544.9489
Do	372-Y_{10}	0.894	−11.0127	+11.0118	−11.0122	+0.9	−60.9	Y_{10}	493.658	1533.9367
July 12-12	Y_{10}-373	1.128	− 9.1245	+ 9.1264	− 9.1254	−1.9	−62.8	373	494.786	1524.8113
Do	373-D_6	0.828	−10.0122	+10.0141	−10.0132	−1.9	−64.7	D_6	495.614	1514.7981
Do	D_6-E_6	0.921	− 2.3403	+ 2.3422	− 2.3412	−1.9	−66.6	E_6	496.535	1512.4569
Do	E_6-F_6	0.103	− 0.4395	+ 0.4398	− 0.4396	−0.3	−66.9	F_6	496.638	1512.0173

[1] Rejected in field.

RATE OF PROGRESS.

The average rates of progress for the two seasons were 73 miles per month in 1911 and 77.4 miles per month in 1912. The maximum progress in any one calendar month was 88 miles in 1911 and 87 miles in 1912. The average monthly progress for 28 seasons of precise leveling, as shown on page 30 of Special Publication No. 18, is 69.5 miles. The rates of progress for the two seasons leveling on the San Francisco-Brigham line are, respectively, 5 and 11 per cent greater than that average value.

The maximum rates of progress attained in precise leveling by this survey in recent years are given on pages 14 and 15 of Precise Leveling in the United States, 1903–1907, and page 30 of Special Publication No. 18.

COST OF LEVELING.

The cost per mile of leveling during the season of 1911 was $14.09 ($8.75 per kilometer) while the cost of the leveling during the season of 1912 was $10.73 per mile ($6.67 per kilometer). The average cost per mile for the whole line was $11.90. This is in close agreement with the average cost for a number of seasons of leveling, which as stated on page 31 of Special Publication No. 18 is $11.10.

The lower unit cost of the work in 1912 was due largely to the use of the motor velocipede car which made the rate of progress more rapid, to the longer season, and to the absence of heavy transportation charges on equipment at the beginning and end of the season. The places at which it was possible to get hotel accommodations for the party were closer together than in 1910. The increased experience of the observer, who was also the chief of party, was no doubt an additional factor.

The above figures represent the actual cost of the leveling, including the establishment of the bench marks, with the exception of the cost of the instruments and stationery. It includes the transportation to and from the field paid by the Government and all wages and salaries, including those of the chief of party and recorder. The salary of the chief of party was charged to the leveling for the whole period during which he was engaged upon work incidental to the leveling, including the time spent in travel to and from the field, the time spent in preparing for the field, and in completing field reports, records, and computations at the end of the season. One-eleventh has been added to the salary actually paid the chief of party during the time he was connected with the leveling, to take account of the fact that the Government pays its permanent employees 12 months' salary for 11 months' work upon an average.

In view of the unfavorable character of the country and the steep grades encountered, especially on the western end of the line, the cost of the work must be considered very satisfactory.

ORGANIZATION OF PARTY.

The party consisted of the chief, who made all of the observations, and 5 hands. One of these recorded the observations, 2 were rodmen, 1 held the sunshade, and 1 the wind shield.

The equipment was practically the same as that used on previous lines. During the greater part of the season of 1911 two hand-driven velocipede cars were used to transport the party to and from the work and during the actual leveling. For several weeks at the end of the first season and during the entire season of 1912, one hand-driven velocipede car and one motor-driven velocipede car were used.

During the first season the members of the party lived mostly in tents. At all except one of the headquarters they were able to obtain their meals at hotels, and thus they avoided the necessity of running their own mess. In 1912 it was possible to secure hotel accommodations, both quarters and meals, throughout the season.

For a detailed account of the usual organization and equipment and also the management of a precise leveling party, see pages 14 to 17 of Special Publication No. 18.

CONNECTIONS WITH OTHER LEVELING.

The western end of the leveling was started from four bench marks established by the engineering department of the city of San Francisco. The elevation of those marks had been determined by precise leveling from the tidal bench marks near the tidal station at the Presidio.

At a number of places connections were made with bench marks of the United States Geological Survey. The bench marks of the Southern Pacific Railway were connected with the new leveling whenever practicable, and when of a substantial character were used instead of setting new permanent bench marks.

Except in the case of the city bench marks in San Francisco all those of previous leveling with which connections were made, were given the United States Coast and Geodetic Survey designation letter followed by the initials of the organization which established the mark.

AGREEMENT OF ELEVATIONS AT BRIGHAM, UTAH.

The 1912 special adjustment of the level net, which is reported on in Special Publication No. 18, fixed the standard elevation of bench mark R at Brigham, Utah, as 1309.1505 meters, while the elevation of this mark, as given by the observed and unadjusted leveling from San Francisco, was 1309.1684 meters. The difference between the observed and standard elevations is only 0.0179 meter.

The theoretically best value for bench mark R at Brigham, as determined by the 1912 adjustment, is 1309.1510 meters. This differs 0.0174 meter from the observed value.

These agreements are so close that it is certain that the addition of this new line to the net in a new adjustment would change the elevations very little from those resulting from the 1912 special and general adjustments.

CIRCUIT CLOSURES.

The most severe test of the accuracy of the new line is the closing errors of the two circuits of which it forms a part. The unadjusted leveling in the loop Seattle-Brigham-San Francisco has a closing error of 0.2360 meter. The correction which would close this circuit of 2911 kilometers is 0.081 millimeter per kilometer.

The closing error of the loop San Diego-Brigham-San Francisco, as given by the unadjusted levels, is 0.2612 meter. The correction which would close this circuit of 3027 kilometers is 0.086 millimeter per kilometer.

These corrections per kilometer are very small and compare most favorably with the smallest corrections per kilometer to close circuits, as shown on pages 72 and 73 of Special Publication No. 18.

CORRECTION APPLIED.

The line from San Francisco to Brigham was adjusted to the fixed elevations at those two places. The elevation at the former place was referred to mean sea level as zero and that at the latter was the standard elevation from the 1912 special adjustment. A correction of only 0.0125 millimeter per kilometer was necessary to make the line fit the fixed elevations.

PROBABLE AND SYSTEMATIC ERRORS.

On page 88 of Special Publication No. 18 is given the resolution adopted by the International Geodetic Association in 1912 in regard to leveling of high precision. The resoultion gives the following formulas with which to compute the accidental and systematic errors of leveling.

For the probable accidental error, η_r, in the case of a set of lines, whether or not they form circuits,

$$\eta_r^2 = \frac{1}{9}\left[\frac{\Sigma d^2}{\Sigma L} - \frac{\Sigma r^2}{(\Sigma L)^2}\Sigma\frac{s^2}{L}\right].$$

For the probable systematic error, σ_r, in the case of a set of lines not forming a net,

$$\sigma_r^2 = \frac{1}{9\Sigma L}\Sigma\frac{s^2}{L}.$$

L denotes the length of an unconnected line, or the length of the side of a polygonal circuit in the case of a net;

ΣL, the aggregate length of the set of lines, or of the net under consideration;

Δ, the discrepancy between the results of the two runnings between consecutive bench marks;

r, the distance between these two bench marks;

s, the entire systematic discrepancy between the results of the two runnings, either for a whole line or for the side of a circuit.

To obtain the s the process given by Lallemand in his "Nivellement de haute précision," page 713, was used. The accumulated discrepancy was plotted as ordinate against the distance in kilometers from an initial bench mark as abscissa. The line connecting these points gave a somewhat irregular line which, nevertheless, showed, as a rule, a tendency to a fairly well-defined slope. A straight line was drawn by eye to represent as nearly as possible the tendency of the irregular line, and was tested to see whether the area between the irregular line and the straight line, lying above the latter, was equal to the area between the two lines and below the straight line. After a straight line was finally adopted the difference between the two ordinates corresponding to the two ends of the line of levels gave the value of s.

The following table gives the values of the terms in the above formulas for each of the sections of the line from San Francisco to Brigham and also for the entire line.

Section.	Length of line L.	Systematic discrepancy s.	Number of sections N.	$\Sigma\Delta^2$	Σr^2	$\frac{s^2}{L}$
	km.	*mm.*				
Brigham to Beowawe	486	+73	435	1896	563	11.0
Beowawe to Marmol	451	−33	434	1584	486	2.4
Marmol to San Francisco	497	−25	483	1926	545	1.3
Total	1434	.....	1352	5406	1594	14.7

$$\eta_r^2 = 1/9\left[\frac{5406}{1434} - \frac{1594}{(1434)^2}\times 14.7\right] = 1/9[3.770 - 0.011] = 0.418$$

$$\eta_r = \pm 0.646$$

$$\sigma_r^2 = \frac{14.7}{9\times 1434} = 0.001139$$

$$\sigma_r = \pm 0.034$$

The probable accidental error per kilometer for the whole line $\eta_r = \pm 0.646$ millimeter.

The probable systematic error per kilometer for the whole line $\sigma_r = \pm 0.034$ millimeter.

These errors indicate an accuracy much greater than that barely necessary for leveling of high precision which is given by the International Geodetic Association as a probable accidental error per kilometer of 1 millimeter and a probable systematic error per kilometer of ± 0.2 millimeter.

INSTRUMENTS USED.

The leveling instruments used were like the adopted model which is described in detail on pages 200 to 211 of Appendix 3 of the Report for 1903. A brief description of it, with two views, is given on page 7 of Special Publication No. 18.

The regular type of self-reading rods was used. These are described on pages 415 and 416 of Appendix 8 of the Report for 1899. They are graduated to centimeters and on only one face.

The rods were standardized in the United States Coast and Geodetic Survey office, both before and after each field season, and they were also measured by an especially designed tape

at frequent intervals in the field. This tape and the way it is used are described on page 31 of this publication. The measurements in the field are sufficiently exact to indicate whether the rods maintain their lengths or actually change, and the amount of the change, if any.

GENERAL INSTRUCTIONS FOR PRECISE LEVELING.

The leveling was done in accordance with the following general instructions for precise leveling. These are also given on pages 8 to 12 of Special Publication No. 18, of the United States Coast and Geodetic Survey.

1. Except when specific instructions are given to proceed otherwise, all lines are to be leveled independently in both the forward and backward directions.

2. The distance between successive permanent bench marks shall nowhere exceed 15 kilometers. There shall be no portion of the line 100 kilometers long in which there are not at least 20 permanent bench marks. No permanent bench mark is to be counted in considering these limits unless it is adequately described, nor shall both of two bench marks be counted if they are placed so near to one another and in such similar conditions of exposure as to be likely to be destroyed at the same time. The preceding statements refer to all permanent bench marks with which the leveling is directly connected, regardless of whether they are new bench marks or old ones established by other organizations. The above-stated limits are to be regarded as extreme lower limits. It is desired that the number of bench marks shall, in general, greatly exceed that just necessary to keep within the limits. A good example to emulate is a line run in New York State, in 1902, on which the average distance between bench marks was 2.5 kilometers. It is desired, also, that the bench marks in each general locality shall belong, in part, to each of several classes, such as bolts or other marks on buildings, squares cut or bolts or disks set in railroad masonry, such as bridge piers, water tanks, etc., stone posts, and iron-pipe bench marks.

3. The line of levels is to be broken by temporary bench marks into sections from 1 to 2 kilometers long, except where special conditions make shorter sections advisable.

4. Temporary bench marks should be established in places where they will be free from disturbance by the track hands working along the road or by materials unloaded from cars. This is especially important when the temporary bench mark is expected to hold the line for any considerable time. It is believed, however, that an undetected error caused by disturbance of the bench mark will be exceedingly rare, when two points, one set-up of the instrument apart, are used for holding the line.

5. At each city along the line, the leveling should be connected with at least two stable bench marks which are connected with the city datum. Connection should also be made with all stable bench marks of other organizations which may be found along the route.

6. In general, the top of rail of the railroad track should be used as the rod support. However, footpins should be carried along during the progress of the work, and they should be used whenever a train is known to be approaching or when there are special reasons for supposing the rail not to be in a sufficiently stable condition.

7. When elevations and descriptions of bench marks established by a railroad (over which a line is to be run) are furnished to this office with a request by the officials of the road to have the precise leveling done by this Survey connected with them, as many of the railroad bench marks will be incorporated in our line of levels as can be done without greatly delaying its progress. The railroad bench marks which are of a permanent nature are to be treated in the same manner as new permanent bench marks established by the precise leveling party. If the permanent bench marks of the railroad are chiefly of the same general type they must not be given full weight in deciding whether there are enough bench marks in any section of the line. (See paragraph 2.) Bench marks of the railroad which are not of permanent character may be determined by extra foresights, as in the manner provided for determining the height of rail in front of a railroad station. (See paragraph 10.) It will not be necessary to connect the precise leveling with the railroad bench marks which are in places not easily accessible. It will not be necessary to connect with each railroad bench mark where they are less than 1 kilometer apart. The benefits derived from connecting a line of precise leveling with railroad bench marks are: (*a*) That time is gained by having some permanent bench marks already established; (*b*) the elevations of the railroad bench marks resulting from the connection with precise leveling are of great value to the railroad concerned; and, (*c*) as the work progresses, a check is obtained on gross mistakes which might escape notice, by comparing the elevations furnished by the railroad with those by the precise leveling party.

8. All old bench marks are to be called by their old names or numbers and are to be described fully by quoting the old description, if one is available, and by making additions or corrections to it.

9. All new bench marks are to be designated by capital letters with numerical subscripts after the alphabet has been exhausted in each State.

10. The elevation of the top of the railroad rail in front of each railroad station along the line of levels is to be determined with a check. This may be done by using the point on the rail as a rod support in either the regular forward or backward running of the line, or by taking an extra foresight to it on both the backward and forward runnings, or by taking extra foresights to it from two instrument stations near it in one of the runnings of the line.

11. When it is desirable to get the elevations by means of which to compare the line of levels with the profile of the railroad, such elevations may be gotten by single readings on the rod held on top of the rail opposite water tanks and over bridges and culverts. Such structures are usually shown on the railroad profiles.

12. It is desirable that the backward measurement on each section should he made under different atmospheric conditions from those which occur on the forward measurement. It is especially desirahle to make the backward measurement in the afternoon if the forward measurement was made in the forenoon, and vice versa. The observer is to secure as much difference of conditions hetween the forward and backward measurements as is possible without materially delaying the work for that purpose.

13. On all sections upon which the forward and hackward measures differ in millimeters by more than $4.0\sqrt{K}$ (in which K is the distance in kilometers leveled hetween adjacent hench marks) hoth the forward and hackward measures are to be repeated until the difference hetween two such measures falls within the limit. No one of the questioned measures is to he used with a new measure in order to get this agreement.

14. If any measure over a section gives a result differing by more than 6 millimeters from the mean of all the measures over that section, this measure shall be rejected. No rejection shall be made on account of a residual smaller than 6 millimeters unless there is some other good reason for suspecting an error in this particular measure, and in such cases the reason for rejection must be fully stated in the record.

15. Whenever a mistake, such as a misreading of 1 decimeter or 1 meter, or an interchange of sights (the backsight being recorded as a foresight), is discovered in any measure after its completion and the necessary correction applied, such measure may he retained, provided there are at least two other measures over the same section which are not suhject to any such uncertainty. Provided, further, that when it is found that the mistake was made on the last instrument station of the second running of a section and it is corrected on the same day and before beginning work on an adjacent section, such measure may he retained and no further measures of the section are to he required on account of the mistake.

16. The program of ohservation at each station is to he as follows:

Set up and level the instrument. Read the three lines of the diaphragm as seen projected against the front (or rear) rod, each reading being taken to the nearest millimeter (estimated), and the huhhle heing held continuously in the middle of the tuhe (i. e., hoth ends reading the same). As soon as possible thereafter read the three lines of the diaphragm as seen projected against the rear (or front) rod, estimating to millimeters as hefore, and holding the buhble continuously in the middle of the tube.

17. At each rod station the thermometer in the rod is to be read to the nearest degree centigrade and the temperature recorded.

18. At stations of odd numbers the backsight is to be taken hefore the foresight, and at even stations the foresight is to be taken hefore the hacksight. As the same rod is held on a rod station for both the fore and hack sights, the effect of this is that the same rod is read first at each set-up, it being the rod used for the backsight at the first instrument station.

19. The difference in length between a foresight and the corresponding hacksight must not exceed 10 meters. The difference is to be made as small on each pair of sights as is feasible hy the use of good judgment without any expenditure of time for this particular purpose.

20. The recorder shall keep a record of the rod intervals subtended hy the extreme lines of the diaphragm on each hacksight, together with their continuous sum between each two contiguous hench marks (temporary or permanent). A similar record shall be kept for the foresights. The two continuous sums shall he kept as nearly equal as is feasible without the expenditure of extra time for that purpose, hy setting the instrument heyond (or short of) the middle point between the hack and front rods. The two continuous sums for a section shall not be allowed to differ hy more than a quantity corresponding to a distance of 20 meters.

21. Once during each day of ohservation the error of the level should be determined in the regular course of the leveling and recorded in a separate opening of the record hook as follows: The ordinary ohservations at an instrument station heing completed, transcribe the last foresight reading as part of the error determination, call up the hack rod and have it placed ahout 10 meters hack from the instrument, read the rod, move the instrument to a position about 10 meters hehind the front rod, read the front rod and then the back rod. (The two instrument stations are hetween the two rod points.) The rod readings must be taken with the huhhle in the middle of its tuhe. The required constant C to he determined, namely, the ratio of the required correction to any rod reading to the corresponding subtended interval, is

$$C=\frac{(\text{sum of near rod readings})-(\text{sum of distant rod readings})}{(\text{sum of distant rod intervals})-(\text{sum of near rod intervals})}.$$

The total correction for curvature and refraction must he applied to the sum of the distant rod readings hefore using it in this formula. The level should not be adjusted if C is less than 0.005. If C is hetween 0.005 and 0.010 the ohserver is advised not to adjust the level, hut if C exceeds 0.010 the adjustment must he made. If a new adjustment of the level is made, C should at once be redetermined. It is desirable to have the determination of level error made under the usual conditions as to length of sight, character of ground, elevation of line of sight ahove ground, etc. The adjustment of the instrument to reduce C must he made hy moving the level vial, not by moving the reticle.

22. Notes for future use in studying leveling errors shall he inserted in the record, indicating the time of heginning and ending the work of each section, the weather conditions, especially as to cloudiness and wind, and whether each section of the line is run toward or away from the sun. Such other notes should he made as promise to he of value in studying errors.

23. The instrument shall he shaded from the direct rays of the sun, hoth during the ohservations and when moving from station to station.

24. The maximum length of sight shall he 150 meters, and the maximum is to be attained only under the most favorable conditions.

25. At the beginning and end of the season, and at least twice each month during the progress of the leveling, the 3-meter interval between metallic plugs on the face of each level rod shall be measured carefully with a steel tape, which shall be kept continuously with the party during the season for that purpose only. The temperatures shown by the thermometer inserted in the rod and by the thermometer attached to the tape at the time of each of these measures must be recorded. The purpose of these measures is to detect changes in the length of the rods and not to determine the absolute lengths. The absolute lengths are determined at the office between field seasons.

26. The tape furnished by the office for measurement of the rods is a piece of steel tape about 3.1 meters long, having near one end a fine line graduation and about 3 meters from it (at the other end of the tape) a series of fine millimeter graduations on a steel rule riveted to the tape. With this special form of tape the measurement of a rod should be made somewhat as follows: The rod should be supported at about the 0.85 meter and 2.45 meter points only (approximately quarter points) to get the least bending of the rod for any two-support system. In making the measurement the singlo line should bo made to coincide with the fine line on the silver plug nearest the bottom of the rod and the reading should be made at the line on the silver plug at the top of the rod. It is possible to estimate the half tenths of millimeters on the rule which is attached to the tape. The tape should be placed on the face of the rod in such a way that the edge of the tape from which the steel rule does not project coincides with the edge of the face of the rod nearest the meter marks of the rod. Care must be taken that the two edges coincide closely in order that the tape may always assume exactly the same position. The end of the tape at the foot of the rod should be clamped firmly to the rod after the line on the tape and that on the plug have been made to coincide. The tape should then be smoothed down by the hand to make it lie perfectly flat on the face of the rod. With the hand lifted and, consequently, no tension on the tape, the reading should be made from the rule attached to the tape near the upper or top end of the rod.

27. The field computations and abstracts are to be kept up as the work progresses. As soon as each book of the original record is out of use it is to be sent to the office by registered mail. The corresponding abstracts must be retained until an acknowledgment of the receipt of the original record at the office has been received.

28. No duplicates of the original records are to be made except of the descriptions of bench marks, of which duplicates in the form of carbon copies are to be made. At least once during each month such carbon copies as have accumulated are to be sent to the inspector of geodetic work.

29. At least once each month, during the progress of the leveling, a test must be made of the adjustment of the rod levels, and a statement should be inserted in the record showing the manner in which the test was made, whether the error was found to be outside the limit stated below, and whether an adjustment was made. With the bubble of the level rod held at the center, the deviation from the vertical of the plane intersecting the center of the face of the rod throughout its length and normal to the face of the rod, must be determined. The deviation from the vertical of the plane coinciding with the face of the rod must also be determined. If the deviation from the vertical exceeds 10 millimeters on a 3-meter length of the rod, the rod level must be adjusted.

30. On the left-hand page of the record the number of each instrument station at which the instrument is not set up in tho railroad track is to be included in parentheses. Similarly, on the right-hand page of the record the designating letter for the foresight rod (V, W, etc.) shall be inclosed in parentheses, if said rod is not supported on the railroad rail. If the length of any portion of the level line run off the railroad is 25 meters or more greater than the railroad distance between the points of departure from and return to the railroad, then the distance along the track between these two points must be shown in the record. The purpose of theso requirements is to furnish the office a means of detecting blunders in the leveling, by plotting the level line on the profile of the railroad.

31. When it is expected that the forward and backward runnings of the line are to be completed up to any one place, the elevation at that place should be held by two points, established at least one set-up of the instrument apart. When the loveling is continued from or to such a pair of points, the instrument should be set up between them and readings of the rod taken on each point. The same arrangement of points should be used at the completed end or ends of any detached portion of the line of levels. Either one of the two points may be used for carrying along the elevation, with the other used only as a check against mistakes in reading the rod, or a disturbance of one or both of them. The records should show clearly which one of the two points was used to carry the elevation, and it is believed that it is good policy to use the same point (backward or forward) in each case as far as may be practicable. It is believed that by employing this method no mistake of a meter or a decimoter made in reading the rod, held on a bench mark, will escape dctection.

32. As far as possible all the permanent bench marks should be in the main line of levels and not on spur or branch lines. One of tho exceptions to this rule is where the line runs several miles off the railroad to tho mark of a triangulation station. In such a caso the spur, or branch line, is the more economical way of doing the work and will be satisfactory. Whenever a permanent bench mark is established by means of a spur, or branch line, which has only one set-up, the forward and backward lines of the spur or branch should be run at different times of a day or on different days, if practicable. If it should be necessary to have the two runnings made ono immediately after the other, the height of the instrument should be materially changed to make the second measure.

33. Except in rare cases, the permanent bench marks should be established before or during the first running of the line. It is believed to be inadvisable to delay tho tying in of the permanent bench marks until after the line has been run, oven in only one direction. When it is impracticable to establish a permanent bench mark before or

during the first measurement of tbe line, an acceptable manner of tying in the permanent bench mark or including it in tbe main line of levels is to establish a temporary bench mark on both sides of tbe proposed location of the permanent bench mark and to leave the distance between tbem unleveled until the permanent bench mark has been set. The arrangement of tbe temporary bench marks establisbed for this purpose should be similar to that described in tbe latter part of paragrapb 31 of tbese instructions. This would provide for two points, tbe difference in elevation between whicb are known, on each side of the permanent bencb mark and tbe distance between tbe two pairs of points makes a section in tbe main line of levels. A diagram showing the arrangement of the stakes and the permanent bench mark is sbown below:

——O——×——O——×——□——×——O——×——O——

The positions of the instrument are shown by ×, the positions of the temporary bench marks by O, and tbe position of the permanent bencb mark by □.

34. Chiefs of party should keep the length of sigbt great enough to make it necessary to do a moderate amount of rerunning. If an observer is extremely cautious and confines all his observations to sigbts sufficiently short to insure easy reading of the rod, it is possible to work montb after montb with almost no rerunning, but tbe progress will be slow. On the otber hand, it is certain that an attempt to take sights of the limiting length, 150 meters, at all times would lead to a very large amount of rerunning and the progress would not be rapid. It is believed tbat the maximum speed consistent with the required degree of accuracy will be secured by continually keeping the lengtb of sight such that tbe amount of rerunning will be from 5 to 15 per cent. An extremely small percentago of rerunning would indicate an excess of caution on the part of the observer. Tbe occurrence of a moderate amount of rerunning is due largely to an attempt on tbe part of the observer to obtain the maximum progress consistent with the required degree of accuracy and not to inability to secure such observations that little or no rerunning would be necessary. Observers have found a convenient rule in fixing tbe length of sigbt to be to sborten the sigbts whenever tbe upper and lower thread intervals subtended on the rod are found to differ frequently by more than a selected limit. Eacb observer sbould fix tbe limit from his own experience by noting the relation between sucb a provisional limit and tbe amount of rerunning found to be necessary while using it. Such a rule is based upon the idea that the additional errors whicb are encountered when the lengtb of sight is increased are, in the main, those due to the increasing accidental errors in reading tbe rods.

35. It is not tbought advisable to state definitely in these instructions the allowable limit on the rate of divergence between the forward and backward lines, but this should be kept small.

36. Tbe record and tho preliminary or field computation of precise levels must conform to the examples given on pages 22 to 26 of Special Publication No. 18, except that in the computation shown on page 25 tho five corrections for curvature and refraction, level, index, lengtb of rod, and temperature are not to be applied in the field.

37. Sbould tbe experience of a chief of party indicate to him tbat a change or changes in these instructions would facilitate tbe work in the field, he is urged to communicate witb tbis office regarding sucb cbanges.

38. When cases arise which are not provided for by tbese general instructions or by specific instructions, tbe chief of party will uso his own judgment in the matter.

Following the general instructions in Special Publication No. 18 there are given some explanations of them which, it is believed, need not be repeated here.

STUDY OF ERRORS.[1]

The errors in leveling are shown by the difference between the backward and forward runnings of the sections, the accumulated discrepancy of the line, and by the closing errors of the circuits. None of these, however, shows exactly what error may be present in any section of a line.

Constant errors due to erroneous values for the rod lengths and to undetected changes in rod lengths during the season are known to be small and may be considered negligible.

The constant or systematic errors due to changes in the elevation of rod supports between the forward and backward readings are very small. The rod support is usually the top of the rail of the railroad, the exact place used for the rod point being marked with keel or some similar substance. Wooden stakes are used as temporary bench marks. Wooden stakes or metal pins are used as the rod support for the short time when a train is known to be approaching or when the line is being run through a town or village. Metal plates are no longer used as rod supports. Country roads are used only on spur lines out to triangulation stations or to bench marks of other organizations which are not on railroads, with which it is desired to make connections.

[1] The subject, errors in leveling, is discussed at length by Charles Lallemand in "Nivellement de Haute Précision" in the Encyclopédie des Travaux Publics, Paris et Liège, 1912.

It is possible to have appreciable errors due to the careless work of a rodman who might not place the rod in exactly the same position for the two sights, but it is believed that the effect of this would be largely accidental.

It seems probable that unequal temperatures in different parts of the instrument can have only slight effect on the leveling. All parts of the instrument except the wooden tripod are shielded from the sun during the observations and while moving forward from one instrument station to another. The instrument is constructed of an alloy of nickel and iron which has a very low coefficient of expansion, only 0.000004 per degree Centigrade, and unequal heating of the different parts should have very little effect in distorting the instrument. Temperature effects are still further minimized by having the level vial set into the barrel of the telescope very close to the line of sight.

The principal sources of accidental errors are believed to be: (*a*) Poor estimation of the millimeters in reading the rod; (*b*) reading the rod before the bubble has come to rest; (*c*) rapid changes in the vertical refraction.

The principal sources of systematic error are probably: (*a*) Slow changes in the vertical refraction; (*b*) difference in the amount of the vertical refraction on the two sights on steep grades; (*c*) other atmospheric conditions which possibly depend upon the direction of the running, the time of day, whether the sky is clear or cloudy, and whether it is calm or windy.

Some of the errors may be systematic in their effect on a single running of a line of levels, but the mean of two runnings over the same line under different conditions may minimize or entirely eliminate the effect.

The effect of a gradual change in the vertical refraction is practically eliminated from even a single line by observing the back sight first at one station and the foresight first at the next station, and so on. It is impossible to eliminate the systematic errors of leveling from a single difference between two bench marks, but the method of procedure in the field is designed to make the effect of the systematic errors on any line or large section of it largely accidental.

It is believed that the value of the accumulated difference between the forward and backward runnings does not give a definite value of the systematic error in a section of leveling. This will be discussed later. (See p. 42.)

It is not easy to discover in the results of leveling the effect of any one condition or set of conditions when only two runnings of a line have been made. In order to do this with any degree of certainty, a line should be run many times, under many different conditions of weather, and with the sun at various azimuths.

INVESTIGATION OF SYSTEMATIC ERRORS.

A number of miles of leveling have been run in the United States over steep grades on which the errors of leveling seem to be greater, on an average, than those usually obtained when running over level ground. The observers of the United States Coast and Geodetic Survey, during a number of years past, have kept a record of the time of the runnings of the different sections, with the weather conditions at the time the observations were made. Five lines of the leveling by this Survey have been selected for a study of the possible relations between the errors of leveling and the conditions of weather, the time of observations, and the grade. They are:

No.	Line.	Distance.	Direction of progress.	Average length of section.
		Kilometers.		*Kilometers.*
1	San Francisco, Cal., to Marmol, Nev.	497	Eastward.	0.8
2	Beowawe to Marmol, Nev.	451	Westward.	0.9
3	Brigham, Utah, to Beowawe, Nev.	486	...do.....	0.8
4	Butte to Devon, Mont.	461	Northward	0.8
5	Pocatello, Idaho, to Butte, Mont.	415	...do.....	1.1

The grades on some portions of these lines are as great as 2½ per cent, or a change in elevation of 25 meters in 1 kilometer. The leveling over the above lines was, as usual, divided into sections which vary in length from something less than 1 kilometer to about 2 kilometers. Each section is run over twice, in opposite directions, and if the two differences in the elevations of the ends of a section do not agree in millimeters within the amount represented by $4.0\sqrt{K}$, where K is the length of the section in kilometers, one or more additional runnings are made.

The data for the United States Coast and Geodetic Survey leveling do not give any clear idea as to the relation between the accidental errors and the conditions under which the work is done, for the observers are directed to make their lengths of sight at all times as long as possible, provided only that they shall never exceed 150 meters and that the difference in millimeters between the two runnings of a section shall not be greater than $4.0\sqrt{K}$. It seems reasonable to suppose that with the same length of sight on cloudy and on clear days, the accidental errors would be much smaller on the former, while under the actual condition of running when the cloudy-day sights are 150 meters and the clear-day sights only about half that length the accidental errors will be approximately the same. There remain the systematic errors which may be investigated.

The subject of constant and systematic errors in precise leveling is an old one which has been discussed by many writers of different countries. Most of these errors are of such small amounts that it is difficult to separate them from the accidental errors. It is believed that the largest systematic errors are found in leveling over steep grades, and that the errors are functions of (1) the time of day, (2) the amount of sunshine, (3) the strength of wind, and (4) possibly the direction of the running, forward or backward, or toward or away from the sun.

It being impracticable to investigate the relations between the size and sign of the discrepancy between the results of the two runnings of the sections and the many different grades, the leveling has been separated into only two classes: First, those sections with grades exceeding 10 meters,[1] and, second, the remainder of the sections. The following table gives the average grades for the lines of leveling under consideration:

Lines.	Mean grade per section.		
	For sections with grades greater than 10 meters.	For sections with grades less than 10 meters.	For all sections.
	Meters.	*Meters.*	*Meters.*
San Francisco to Marmol	17	3	8
Beowawe to Marmol	15	2	2
Brigham to Beowawe	14	3	5
Butte to Devon	18	5	9
Pocatello to Butte	19	4	8
Mean of all lines	16.6	3.4	6.4

RELATIONS BETWEEN THE DISCREPANCY AND THE TIMES OF RUNNING.

The instructions issued to the observers direct that the two runnings of a section shall be made at different times of the day, if practicable. The following table gives the average discrepancies for the sections with the two runnings at the same time of the day and also for those which have one running in the morning and the other in the afternoon. In this discussion the direction of the line or sections is not considered. It is only the difference in the elevation of the ends of a section which is taken into account. The letter P stands for afternoon and A for morning. If the value for P–A is positive, it shows that the difference in elevation between the two bench marks is greater by the afternoon than by the morning leveling.

The values for the sections which have both runnings made at the same time of the day are given for purposes of comparison with those sections run both in the morning and the afternoon. Only the average value without regard to sign can be given for the A–A and P–P sections.

[1] On this and the following pages, the grades are named by the difference in elevation of the two ends of the separate sections. As the average length of these sections is roughly about 1 kilometer, a grade of 10 meters as given here corresponds approximately to a 1 per cent grade.

Table 1.

SECTIONS WITH GRADE EXCEEDING 10 METERS PER SECTION.

	San Francisco to Marmol.	Beowawe to Marmol.	Brigham to Beowawe.	Butte to Devon.	Pocatello to Butte.	All lines.
Number of sections	64	None.	53	37	34	188
P–A, total, positive	+135.3	.....	+136.0	+103.8	+121.3	+496.4
Mean discrepancy	+ 2.11	.....	+ 2.57	+ 2.81	+ 3.57	+ 2.64
Number of sections	65	3	24	28	24	144
P–A, total, negative	−131.0	−7.6	− 52.0	− 67.6	− 82.2	−340.4
Mean discrepancy	− 2.02	−2.53	− 2.17	− 2.41	− 3.42	− 2.36
Number of sections	129	3	77	62	61	332
Mean discrepancy	2.06	2.5	2.44	2.76	3.34	2.52
Accumulated discrepancy	+ 4.3	−7.6	+ 84.0	+ 36.2	+ 39.1	+156.0
Mean accumulation per section	+ 0.03	−2.53	+ 1.09	+ 0.58	+ 0.64	+ 0.47
Number of sections	75	2	26	53	49	205
A–A and P–P, total	166.4	3.1	51.5	146.8	112.6	480.4
Mean discrepancy	2.22	1.6	1.98	2.77	2.30	2.34

SECTIONS WITH GRADE LESS THAN 10 METERS PER SECTION.

Number of sections	160	174	193	160	74	761
P–A, total, positive	+336.1	+321.9	+431.9	+314.3	+240.9	+1645.1
Mean discrepancy	+ 2.10	+ 1.85	+ 2.24	+ 1.96	+ 3.26	+ 2.16
Number of sections	102	164	156	137	70	629
P–A, total, negative	−171.3	−301.5	−303.6	−307.1	−194.3	−1277.8
Mean discrepancy	− 1.68	− 1.84	− 1.95	− 2.24	− 2.78	− 2.03
Number of sections	262	338	349	297	144	1390
Mean discrepancy	1.94	1.84	2.11	2.09	3.02	2.10
Accumulated discrepancy	+164.8	+ 20.4	+128.3	+ 7.2	+ 46.6	+ 367.3
Mean accumulation per section	+ 0.63	+ 0.06	+ 0.37	+ 0.02	+ 0.32	+ 0.26
Number of sections	144	168	135	131	124	702
A–A and P–P, total	275.8	299.4	266.1	304.4	328.9	1474.6
Mean discrepancy	1.92	1.78	1.97	2.32	2.65	2 10

ALL SECTIONS.

Number of sections	224	174	246	194	111	949
P–A, total, positive	+471.4	+321.9	+567.9	+418.1	+362.2	+2141.5
Mean discrepancy	+ 2.10	+ 1.85	+ 2.31	+ 2.16	+ 3.26	+ 2.25
Number of sections	167	167	180	165	94	773
P–A, total, negative	−302.3	−309.1	−355.6	−374.7	−276.5	−1618.2
Mean discrepancy	− 1.81	− 1.85	− 1.98	− 2.27	− 2.94	− 2.09
Number of sections	391	341	426	359	205	1722
Mean discrepancy	1.98	1.85	2.17	2.21	3.12	2.18
Accumulated discrepancy	+169.1	+ 12.8	+212.3	+ 85.7	+ 43.4	+ 523.3
Mean accumulation per section	+ 0.43	+ 0.04	+ 0.50	+ 0.24	+ 0.21	+ 0.30
Number of sections	219	170	161	184	173	907
A–A and P–P, total	442.2	302.5	317.6	451.2	441.5	1955.0
Mean discrepancy	2.02	1.78	1.97	2.45	2.55	2.16

As stated above there is no standard length of sight and therefore the sizes of the mean differences without regard to sign between the two runnings for the sections of different grade may have little significance, but with the sign considered the size and the sign of the differences of P–A are of great importance in indicating whether there may be systematic errors present.

For the steep sections positive values of P–A predominate, there being 188 positive and 144 negative. Four of the five lines of levels have the positive sign for the total accumulated discrepancy and the mean accumulated discrepancy per section varies from +0.03 to +1.09 millimeters. The line which gives a negative value has only 3 sections with one running in the morning and the other in the afternoon and may be disregarded. The mean accumulated discrepancy per section for all the lines combined is +0.47 millimeter. Even the sections with grades less than 10 meters show a positive mean accumulated discrepancy for each line with an average accumulated discrepancy of +0.26 for all the five lines taken together. This value is only 55 per cent as great as the values for the steep sections.

On the steep sections the mean difference without regard to sign for the P–A sections is 2.52 millimeters, while it is 2.34 millimeters for the mean of the P–P and A–A sections. This shows

a closer agreement between the differences in elevation obtained by two runnings at the same time of day than at different times. There is no such difference in the mean values for those sections with low grades.

Taken as a whole, the 1722 P–A sections indicate that on an average the afternoon running will give a greater difference in elevation between two bench marks than will the morning running. This average value for P–A is +0.30 millimeter for bench marks averaging about 1.0 kilometer apart.

On page 20 of the Fourth General Adjustment of the Precise Level Net in the United States it is stated that there probably is a systematic difference between the morning and afternoon runnings of a section on steep slopes. The following paragraph on the subject is quoted from that report:

> There is a possibility of an accumulated discrepancy being produced by refraction on lines having steep grades. If the conditions in regard to refraction be the same on the two runnings of a line, there would be no divergence from that cause; but it is probable that the refraction is different on the higher sight than the lower one and that this difference changes during the day as the relative temperatures of the ground and air vary. The refraction on the higher sight (up the slope) is no doubt different in the morning with a rising temperature from what it is in the afternoon with a falling temperature, while the lower sight (down the slope) which comes well above the surface of the ground will not vary so much between the forenoon and afternoon. Consequently, if the observer systematically leveled forward early in the day and backward late in the day, refraction might cause an accumulated discrepancy. If it does, there should be a change of sign in the discrepancy when the program is reversed by leveling backward in the morning and forward in the afternoon. Also, without a change of program a change of sign should occur after passing a summit or the lowest point in a valley.

It is the author's opinion that the afternoon running gives on an average a difference which is closer to the truth than the morning running. In the afternoon the temperatures of the ground and the air are more nearly the same and a layer of air of uniform density should be concentric or nearly so with the sea-level surface. If this is true the refraction on the front and back sights should be about the same. The leveling of the United States Coast and Geodetic Survey is seldom done after 5 o'clock in the afternoon. So the afternoon running is not materially affected by the abnormal refraction of the late afternoon when a line of sight on a grade would pass through layers of colder and denser air which would tend to be concentric with the surface of the ground. In the late afternoon the earth cools more rapidly than the air and the air near the earth's surface becomes colder than the air above and consequently denser than normal.

In the morning on a clear day the air is receiving heat from the earth's surface. This decreases the density of the air close to the ground, which forms layers which tend to be concentric with the surface of the ground rather than with the sea-level surface. (The air near the earth is of course not at rest but tends to rise, owing to the decreased density.) It may be assumed that the line of sight to the observer from the rod held down the grade is not affected abnormally while the sight to the rod held up the grade is usually close to the ground and must pass through the layers of decreased density near the earth's surface. This sight would be less refracted than the one down the grade and therefore the morning running would give too small a difference between the zeros of the rods sighted on from one station. It is the writer's belief that, other things being equal, a line of levels run over steep grades in two directions in the afternoon, from noon to about one hour before sundown, will give results closer to the truth than levels with both runnings in the forenoon or with one leveling in the forenoon and the other in the afternoon. It is believed that this also applies to leveling over slopes of moderate grade.

The following table is similar to the one shown above, except that the data are given for only those sections which had both runnings in the sunshine:

Table 2.

SECTIONS WITH GRADE EXCEEDING 10 METERS PER SECTION.

	San Francisco to Marmol.	Beowawe to Marmol.	Brigham to Beowawe.	Butte to Devon.	Pocatello to Butte.	All lines.
Number of sections	31	None.	46	22	32	131
P-A, total, positive	+ 67.6	.....	+110.3	+ 76.0	+104.7	+ 358.6
Mean discrepancy	+ 2.18	.....	+ 2.40	+ 3.45	+ 3.27	+ 2.74
Number of sections	28	3	20	18	18	87
P-A, total, negative	− 58.2	− 7.6	− 40.9	− 43.8	− 52.5	− 203.0
Mean discrepancy	− 2.08	− 2.5	− 2.04	− 2.43	− 2.92	− 2.33
Number of sections	59	3	66	40	50	218
Mean discrepancy	2.13	2.5	2.29	3.00	3.14	2.58
Accumulated discrepancy	+ 9.4	− 7.6	+ 69.4	+ 32.2	+ 52.2	+ 155.6
Mean accumulation per section	+ 0.16	− 2.5	+ 1.05	+ 0.80	+ 1.04	+ 0.71
Number of sections	27	2	20	35	43	127
A-A and P-P, total	62.6	3.1	39.7	99.0	91.1	295.5
Mean discrepancy	2.32	1.6	1.98	2.83	2.12	2.33

SECTIONS WITH GRADE LESS THAN 10 METERS PER SECTION.

Number of sections	100	134	116	121	58	529
P-A, total, positive	+202.9	+249.4	+253.5	+248.4	+186.6	+1140.8
Mean discrepancy	+ 2.03	+ 1.86	+ 2.18	+ 2.05	+3.22	+ 2.15
Number of sections	57	119	110	111	59	456
P-A, total, negative	−106.0	−206.1	−200.9	−261.5	−161.0	− 935.5
Mean discrepancy	− 1.86	− 1.73	− 1.83	− 2.36	− 2.73	− 2.05
Number of sections	157	253	226	232	117	985
Mean discrepancy	1.97	1.80	2.01	2.19	2.97	2.11
Accumulated discrepancy	+ 96.9	+ 43.3	+ 52.6	− 13.1	+ 25.6	+ 205.3
Mean accumulation per section	+ 0.62	+ 0.17	+ 0.23	− 0.06	+ 0.22	+ 0.21
Number of sections	64	168	141	95	102	570
A-A and P-P, total	104.2	299.4	277.9	221.4	289.5	1192.4
Mean discrepancy	1.63	1.78	1.97	2.33	2.84	2.09

ALL SECTIONS.

Number of sections	131	134	162	143	90	660
P-A, total, positive	+270.5	+249.4	+363.8	+324.4	+291.3	+1499.4
Mean discrepancy	+ 2.06	+ 1.86	+ 2.25	+ 2.27	+ 3.24	+ 2.27
Number of sections	85	122	130	129	77	543
P-A, total, negative	−164.2	−213.7	−241.8	−305.3	−213.5	−1138.5
Mean discrepancy	− 1.93	− 1.75	− 1.86	− 2.37	− 2.77	− 2.10
Number of sections	216	256	292	272	167	1203
Mean discrepancy	2.01	1.81	2.07	2.32	3.02	2.19
Accumulated discrepancy	+106.3	+ 35.7	+122.0	+ 19.1	+ 77.8	+ 360.9
Mean accumulation per section	+ 0.49	+ 0.14	+ 0.42	+ 0.07	+ 0.47	+ 0.30
Number of sections	91	170	161	130	145	697
A-A and P-P, total	166.8	302.5	317.6	320.4	380.6	1487.9
Mean discrepancy	1 83	1.78	1.97	2.46	2.62	2.14

As before, the afternoon runnings give on an average greater differences in elevation between the ends of sections than the morning runnings. But on steep grades the all-sunshine results give a mean accumulated discrepancy of P–A of +0.71 millimeter per section while the value was only +0.47 millimeter where no account was taken of clear or cloudy weather. This seems to bear out the theory stated above that the afternoon runnings give results closer to the truth than the morning runnings. If it were cloudy in the morning the difference between the morning and afternoon results should agree more closely than if the morning running were in sunshine.

The data for the sections having low grades indicate the same results for the all-sunshine runnings as for the runnings with sunshine or clouds disregarded.

RELATION BETWEEN ERRORS OF LEVELING AND CLEAR AND CLOUDY SKY.

The following table gives data for the leveling done under different conditions of the sky and also for the sections which have both runnings in sunshine or both in cloudy weather.

The sections are again divided into two groups according to their grades. First, those for which the difference in elevation of their ends exceeds 10 meters and, second, those with differences less than 10 meters.

As was stated on page 34, it is difficult or impossible to notice any relations between the accidental errors and the weather conditions, as there is no fixed length of sight. But the data in the tables given below should indicate whether there are any relations between systematic errors and the degree of clearness of the sky. The letter "C" stands for clouds and "S" for sunshine or clear.

Table 3.

SECTIONS WITH GRADE EXCEEDING 10 METERS PER SECTION.

	San Francisco to Marmol.	Beowawe to Marmol.	Brigham to Beowawe.	Butte to Devon.	Pocatello to Butte.	All lines.
Number of sections	28	None.	8	10	10	56
C–S, total, positive	+ 54.6	.....	+ 30.7	+ 23.4	+ 50.5	+159.2
Mean discrepancy	+ 1.95	.....	+ 3.84	+ 2.34	+ 5.05	+ 2.84
Number of sections	28	None.	4	6	7	45
C–S, total, negative	− 53.9	.....	− 4.7	− 9.2	− 17.3	− 85.1
Mean discrepancy	− 1.92	.....	− 1.18	− 1.53	− 2.47	− 1.89
Number of sections	56	None.	12	16	17	101
Mean discrepancy	1.94	.....	2.95	2.04	3.99	2.42
Accumulated discrepancy	+ 0.7	.....	+ 26.0	+ 14.2	+ 33.2	+ 74.1
Mean accumulation per section	+ 0.01	.....	+ 2.17	+ 0.89	+ 1.95	+ 0.73
Number of sections	55	None.	10	15	None.	80
C–C, total	101.9	.....	27.6	33.1	.....	162.6
Mean discrepancy	1.85	.....	2.76	2.21	.....	2.03
Number of sections	93	3	36	60	93	285
S–S, total	207.7	7.6	69.6	169.0	248.3	702.1
Mean discrepancy	2.23	2.53	1.93	2.82	2.67	2.46

SECTIONS WITH GRADE LESS THAN 10 METERS PER SECTION.

Number of sections	46	58	69	24	20	217
C–S, total, positive	+ 83.6	+134.4	+160.6	+ 40.4	+ 54.1	+473.1
Mean discrepancy	+ 1.82	+ 2.32	+ 2.33	+ 1.68	+ 2.70	+ 2.18
Number of sections	74	55	62	24	13	228
C–S, total, negative	−160.6	− 92.1	−137.3	− 51.4	− 40.9	−482.3
Mean discrepancy	− 2.17	− 1.68	− 2.21	− 2.14	− 3.15	− 2.12
Number of sections	120	113	131	48	33	445
Mean discrepancy	2.04	2.00	2.27	1.91	2.88	2.15
Accumulated discrepancy	− 77.0	+ 42.3	+ 23.3	− 11.0	+ 13.2	− 9.2
Mean accumulation per section	− 0.64	+ 0.37	+ 0.18	− 0.23	+ 0.40	− 0.02
Number of sections	56	39	51	46	12	204
C–C, total	96.2	56.1	95.6	88.4	29.8	366.1
Mean discrepancy	1.72	1.44	1.87	1.92	2.48	1.79
Number of sections	240	362	347	290	220	1459
S–S, total	458.9	646.2	695.8	635.7	626.9	3063.5
Mean discrepancy	1.91	1.78	2.00	2.19	2.85	2.10

ALL SECTIONS.

Number of sections	74	58	77	34	30	273
C–S, total, positive	+138.2	+134.4	+191.3	+ 63.8	+104.6	+632.3
Mean discrepancy	+ 1.87	+ 2.32	+ 2.48	+ 1.88	+ 3.49	+ 2.32
Number of sections	102	55	66	30	20	273
C–S, total, negative	−214.5	− 92.1	−142.0	− 60.6	− 58.2	−567.4
Mean discrepancy	− 2.10	− 1.68	− 2.15	− 2.02	− 2.91	− 2.08
Number of sections	176	113	143	64	50	546
Mean discrepancy	2.00	2.00	2.33	1.94	3.26	2.20
Accumulated discrepancy	− 76.3	+ 42.3	+ 49.3	+ 3.2	+46.4	+ 64.9
Mean accumulation per section	− 0.43	+ 0.37	+ 0.35	+ 0.05	+ 0.93	+ 0.12
Number of sections	111	39	61	61	12	284
C–C, total	198.1	56.1	123.2	121.5	29.8	528.7
Mean discrepancy	1.78	1.44	2.02	1.99	2.48	1.86
Number of sections	333	365	383	350	313	1744
S–S, total	666.6	653.8	765.3	804.7	875.2	3765.6
Mean discrepancy	2.00	1.79	2.00	2.30	2.80	2.16

In each of the lines considered the running of a section with steep grade, when the sky was cloudy, gave on an average a difference in elevation greater than the running when the sky was clear. There are 101 sections of steep slopes or grades on which the two runnings of a section were made, one in sunshine and the other with a cloudy sky. The mean accumulated discrepancy is +0.73 millimeter.

There seems to be no tendeney toward an aeeumulation of C–S (eloudy minus sunshine) for those seetions having grades less than 10 meters per section. The total discrepancy with regard to sign for 445 sueh sections is only −9.2 millimeters or −0.02 millimeter per section.

It is the general belief among geodesists that the leveling under a cloudy sky is practically free from systematic errors resulting from atmospheric conditions. Therefore it would appear that the leveling under a clear sky eauses the observed differences in elevation on steep grades to be too small.

In the following table are given data for the steep sections which had one running in elear and the other in eloudy weather, but the data are arranged in two groups, one where the running in sunshine was made in the morning called (S A), while the other has the running in sunshine made in the afternoon (S P):

Table 4.

SECTIONS WITH GRADE EXCEEDING 10 METERS PER SECTION.

	San Francisco to Marmol.	Beowawe to Marmol.	Brigham to Beowawe.	Butte to Devon.	Pocatello to Butte.	All lines.
Number of sections	13	.....	6	3	4	26
C–SA, total, positive	+22.3	.....	+25.2	+ 6.9	+20.4	+74.8
Number of sections	21	.....	3	3	3	30
C–SA, total, negative	−44.8	.....	− 3.7	− 5.8	− 7.0	−61.3
Number of sections	15	.....	2	7	6	30
C–SP, total, positive	+32.3	.....	+ 5.5	+16.5	+30.1	+84.4
Number of sections	7	.....	1	3	4	15
C–SP, total, negative	− 9.1	.....	− 1.0	− 3.4	−10.3	−23.8
C–SA, accumulation per section	− 0.66	.....	+ 2.39	+ 0.18	+ 1.91	+ 0.24
C–SP, accumulation per section	+ 1.05	.....	+ 1.50	+ 1.31	+ 1.98	+ 1.34

SECTIONS WITH GRADE LESS THAN 10 METERS PER SECTION.

Number of sections	24	24	44	13	19	124
C–SA, total, positive	+42.4	+55.6	+109.9	+20.8	+29.1	+257.8
Number of sections	33	33	29	13	8	116
C–SA, total, negative	−66.9	−57.3	− 59.7	−24.1	−23.6	−231.6
Number of sections	22	34	25	11	11	103
C–SP, total, positive	+41.2	+78.8	+ 50.7	+19.4	+25.0	+215.1
Number of sections	41	22	33	11	5	112
C–SP, total, negative	−93.7	−34.8	− 87.6	−27.3	−17.3	−260.7
C–SA, accumulation per section	− 0.43	− 0.03	+ 0.69	− 0.13	+ 0.18	+ 0.11
C–SP, accumulation per section	− 0.83	+ 0.79	− 0.64	− 0.36	+ 0.48	− 0.21

ALL SECTIONS.

Number of sections	91	57	82	32	34	296
C–SA, accumulation per section	− 0.52	− 0.03	+ 0.87	− 0.07	+ 0.56	+ 0.13
Number of sections	85	56	61	32	26	260
C–SP, accumulation per section	− 0.34	+ 0.79	− 0.53	+ 0.16	+ 1.06	+ 0.06

In the above table it is shown that the cloudy running gave on an average a larger value for the differenee in elevation on steep grades than the running in sunshine. If, as was stated above, it is assumed that the cloudy running is free from systematic error, then on an average the afternoon running in sunshine gave a smaller differenee in elevation than the morning running in sunshine. Contrary to what might be expected from the data in a previous table, the value of C–SA for one of the lines is negative. All of the other values for C–SA are positive, as is the ease with the values of C–SP.

The average aeeumulated values of C–SA and C–SP for the sections with low grade are small, +0.11 millimeter per section in the former and −0.21 millimeter per section in the latter. These sections are quite numerous as compared with the number of steep sections, and should no doubt be given some considcration before coming to a decision as to whether the morning or afternoon runnings in sunshine give the larger differenees.

The third section of the above table gives the average accumulated discrepancy per section for 296 (C–SA) and for 260 (C–SP) sections, without regarding the amount of the grade. The average (C–SA) value is +0.13 millimeter per section and the average (C–SP) value is only +0.06 millimeter per section. This evidence is weak but it agrees with the conclusion expressed on page 36, that the afternoon running in sunshine gives a greater difference than a forenoon running in sunshine.

The data in the following table were prepared with the view of investigating possible relations between the systematic errors in leveling and the wind and calm during the observations. In the table C stands for calm and W for wind. The strength of the wind, whether strong, moderate, or light, is not considered.

Table 5.

SECTIONS WITH GRADE EXCEEDING 10 METERS PER SECTION.

	San Francisco to Marmol.	Beowawe to Marmol.	Brigham to Beowawe.	Butte to Devon.	Pocatello to Butte.	All lines.
Number of sections	20	1	12	9	21	63
C–W, total, positive	+41.2	+2.7	+22.6	+25.9	+47.6	+140.0
Mean discrepancy	+ 2.06	+2.7	+ 1.88	+ 2.88	+ 2.27	+ 2.22
Number of sections	25	None.	21	14	15	75
C–W, total, negative	−56.1	.....	−53.2	−34.4	−56.1	−199.8
Mean discrepancy	− 2.24	.....	− 2.53	− 2.46	− 3.74	− 2.66
Number of sections	45	1	33	23	36	138
Mean discrepancy	2.16	2.7	2.30	2.62	2.88	2.46
Accumulated discrepancy	−14.9	+2.7	−30.6	− 8.5	− 8.5	− 59.8
Mean accumulation per section	− 0.33	+2.7	− 0.93	− 0.37	− 0.24	− 0.43
Number of sections	129	4	10	62	31	236
C–C, total	262.6	8.0	10.6	164.5	91.6	537.3
Mean discrepancy	2.04	2.0	1.06	2.65	2.95	2.28
Number of sections	28	None.	64	31	57	180
W–W, total	62.6	.....	159.7	96.1	167.1	485.5
Mean discrepancy	2.24	.....	2.49	3.10	2.93	2.70

SECTIONS WITH GRADE LESS THAN 10 METERS PER SECTION.

Number of sections	46	81	64	50	36	277
C–W, total, positive	+ 74.6	+140.5	+136.6	+111.4	+ 91.2	+554.3
Mean discrepancy	+ 1.62	+ 1.73	+ 2.14	+ 2.23	+ 2.53	+ 2.00
Number of sections	74	82	93	60	36	345
C–W, total, negative	−155.9	−149.3	−221.0	−116.9	−114.3	−757.4
Mean discrepancy	− 2.11	− 1.82	− 2.38	− 1.95	− 3.18	− 2.20
Number of sections	120	163	157	110	72	622
Mean discrepancy	1.92	1.78	2.28	2.08	2.85	2.11
Accumulated discrepancy	− 81.3	− 8.8	− 84.4	− 5.5	− 23.1	−203.1
Mean accumulation per section	− 0.68	− 0.05	− 0.54	− 0.05	− 0.32	− 0.33
Number of sections	151	195	134	245	113	838
C–C, total	265.3	369.5	259.4	533.6	302.6	1,730.4
Mean discrepancy	1.76	1.89	1.94	2.18	2.68	2.06
Number of sections	134	148	193	85	83	643
W–W, total	261.7	256.8	390.6	173.5	259.8	1,342.4
Mean discrepancy	1.95	1.74	2.02	2.04	3.13	2.09

ALL SECTIONS.

Number of sections	66	82	76	59	57	340
C–W, total, positive	+115.8	+143.2	+159.2	+137.3	+138.8	+694.3
Mean discrepancy	+ 1.75	+ 1.75	+ 2.10	+ 2.33	+ 2.44	+ 2.04
Number of sections	99	82	114	74	51	420
C–W, total, negative	−212.0	−149.3	−274.2	−151.3	−170.4	−957.2
Mean discrepancy	− 2.14	− 1.82	− 2.41	− 2.04	− 3.34	− 2.28
Number of sections	165	164	190	133	108	760
Mean discrepancy	1.99	1.78	2.28	2.17	2.86	2.17
Accumulated discrepancy	− 96.2	− 6.1	−115.0	− 14.0	− 31.6	−262.9
Mean accumulation per section	− 0.58	− 0.04	− 0.61	− 0.11	− 0.29	− 0.35
Number of sections	280	199	144	307	144	1,074
C–C, total	527.9	377.5	270.0	698.1	394.2	2,267.7
Mean discrepancy	1.89	1.90	1.88	2.27	2.74	2.11
Number of sections	162	148	257	116	140	823
W–W, total	324.3	256.8	550.3	269.6	426.9	1,827.9
Mean discrepancy	2.00	1.74	2.14	2.32	3.05	2.22

The sections are again divided into two classes, first those having differences in elevation between the ends of more than 10 meters, and second those sections having a difference in elevation of less than 10 meters. The above table shows that each of the groups of sections has a minus sign for the accumulated value of (C–W), calm minus wind. (There is only one steep section for the second line.) For the steep sections, 138 in number, the accumulated value per section is −0.43 millimeter. On the low-grade sections the mean value of the accumulated discrepancy is −0.33 millimeter per section. The mean value for all sections regardless of the grade is −0.35 millimeter per section.

These facts show that the running in wind gave a greater difference in elevation than a running during calm. The conclusion that this is a general rule might not be justified for other factors enter the case. All of the lines are in the western portion of the United States where it is usually more windy in the afternoon than in the morning. Calm is infrequent there in the afternoon. Therefore the value of C–W would be somewhat confused with the value of P–A.

If both runnings are made in the forenoon or both in the afternoon, then the values of C–W should be practically free from the effect of the time of day. In the following table there are given the data for such sections the amount of grade not being considered:

Table 6.

ONLY SUCH SECTIONS AS HAVE RUNNINGS IN BOTH DIRECTIONS EITHER IN THE MORNING OR IN THE AFTERNOON.

	San Francisco to Marmol.	Beowawe to Marmol.	Brigham to Beowawe.	Butte to Devon.	Pocatello to Butte.	All lines.
Number of sections	20	16	16	14	19	85
C–W, total, positive	+32.7	+35.6	+22.4	+42.4	+44.1	+177.2
Mean discrepancy	+ 1.64	+ 2.22	+ 1.40	+ 3.03	+ 2.32	+ 2.08
Number of sections	27	20	12	13	18	90
C–W, total negative	−68.3	−40.9	−29.6	−29.2	−54.3	−222.3
Mean discrepancy	− 2.53	− 2.04	− 2.47	− 2.25	− 3.02	− 2.47
Number of sections	47	36	28	27	37	175
Accumulated discrepancy	−35.6	− 5.3	− 7.2	+13.2	−10.2	− 45.1
Mean accumulation per section	− 0.76	− 0.15	− 0.26	+ 0.49	− 0.28	− 0.26

The value of C–W in the above table is practically free from the effect of the time of day and also that of cloudy or clear weather. It appears then that the mean accumulated value of C–W is −0.26 millimeters per section. This makes the difference in elevation obtained from the running in wind greater than the difference obtained in calm. There are no data collected as to whether the size of C–W is a function of the steepness of the grade.

There are 495 sections, each of which had one running in the morning and one running in the afternoon with both runnings made during calm. These sections should have values for P–A which are free from the effect of calm and wind. The data for these sections are shown below:

Table 7.

ONLY SUCH SECTIONS AS WERE RUN IN BOTH DIRECTIONS DURING CALM.

	San Francisco to Marmol.	Beowawe to Marmol.	Brigham to Beowawe.	Butte to Devon.	Pocatello to Butte.	All lines.
Number of sections	88	55	44	33	39	259
P–A, total, positive	+177.6	+112.0	+73.0	+119.4	+121.5	+603.5
Mean discrepancy	+ 2.02	+ 2.04	+ 1.66	+ 3.62	+ 3.12	+ 2.33
Number of sections	69	62	43	29	33	236
P–A, total, negative	−122.1	−119.7	−75.6	− 86.5	− 93.6	−497.5
Mean discrepancy	− 1.77	− 1.93	− 1.76	− 2.98	− 2.84	− 2.11
Number of sections	157	117	87	62	72	495
Accumulated discrepancy	+ 55.5	− 7.7	− 2.6	+ 32.9	+ 27.9	+106.0
Mean accumulation per section	+ 0.35	− 0.07	− 0.03	+ 0.53	+ 0.39	+ 0.21

The above values for the accumulated discrepancy P–A are no doubt somewhat affected by cloudy and clear weather, for in general the forenoons are somewhat more free from clouds than the afternoons, but it is believed that this effect is small. The value of P–A for the accumulated discrepancy is +0.22 millimeter per section. The afternoon running gives a larger value for the difference in elevation between the ends of a section than the morning running. The steepness of the grade has not been considered as there were so few P–A sections on steep grades which were run only in calm weather. But it is worthy of note that the three lines, the first, fourth, and fifth, which have the greatest mean grade per section (see p. 34), have the largest values of P–A (both in calm). The second and third lines have accumulated values of the discrepancy of C–W of only −0.07 and −0.03 millimeter. Therefore the conclusion may be drawn that the size of P–A, free from the effects of calm or wind, is a function of the grade.

If it is assumed that the running in wind is free from error, then the data for the sections shown below should give an indication as to whether an afternoon or forenoon running of a section will give the greater difference in elevation.

		mm.
Number of sections 256, total positive value	(C–W) A	+499.2
Number of sections 330, total negative value	(C–W) A	−759.0
Number of sections 94, total positive value	(C–W) P	+221.7
Number of sections 87, total negative value	(C–W) P	−182.3
Mean accumulated discrepancy per section	(C–W) A	− 0.44
for	(C–W) P	+ 0.22

The term (C–W) A represents calm minus wind, with the calm running in the forenoon, while (C–W) P is the same, except that the calm running is in the afternoon.

The indications in the above table are that the difference in elevation from the calm running in the forenoon is too small and from the calm running in the afternoon too great. This bears out the conclusion stated on page 36 that the afternoon running gave a greater difference than the forenoon running.

RELATION BETWEEN THE ERRORS OF LEVELING AND THE FORWARD AND BACKWARD RUNNINGS OF A LINE.

The values of B–F in the following table represent the difference in elevation between the ends of the sections as given by the two runnings, one forward and one backward. When the section is up grade in the line of progress the difference between the two runnings B–F is positive if the backward running gives a greater difference between the two ends than the forward running. The value is negative if the forward running gives the greater difference.

If the section is down grade in the line of progress the value of B–F is positive, if the backward running gives the smaller difference in elevation between the ends of the section, and is negative when it gives the larger difference. In general B–F is positive if the backward running gives the higher elevation above sea level for the bench mark at the forward end of the section.

In the following table are given data regarding the accumulated value of B–F for the five lines considered in this investigation.

Table 8.

SECTIONS WITH GRADE EXCEEDING 10 METERS PER SECTION.

	San Francisco to Marmol.	Beowawe to Marmol.	Brigham to Beowawe.	Butte to Devon.	Pocatello to Butte.	All lines.
Number of sections	100	2	60	72	66	300
B–F, total, positive	+207.8	+3.1	+145.3	+248.3	+188.3	+792.8
Mean discrepancy	+ 2.08	+1.6	+ 2.42	+ 3.45	+ 2.85	+ 2.64
Number of sections	100	3	45	43	42	233
B–F, total, negative	−220.1	−7.6	−103.2	− 85.7	−125.3	−541.9
Mean discrepancy	− 2.20	−2.5	− 2.29	− 1.99	− 2.98	− 2.33
Number of sections	200	5	105	115	108	533
Mean discrepancy	2.14	2.14	2.37	2.90	2.90	2.50
Accumulated discrepancy	− 12.3	−4.5	+ 42.1	+162.6	+ 63.0	+250.9
Accumulation per section	− 0.06	−0.9	+ 0.40	+ 1.41	+ 0.58	+ 0.47

SECTIONS WITH GRADE LESS THAN 10 METERS PER SECTION.

Number of sections	186	251	240	231	124	1032
B–F, total, positive	+356.8	+460.1	+520.1	+501.4	+374.2	+2212.6
Mean discrepancy	+ 1.92	+ 1.83	+ 2.17	+ 2.17	+ 3.02	+ 2.14
Number of sections	222	254	242	217	145	1080
B–F, total, negative	−429.5	−453.2	−480.8	−457.5	−397.3	−2218.3
Mean discrepancy	− 1.93	− 1.78	− 1.99	− 2.11	− 2.74	− 2.05
Number of sections	408	505	482	448	269	2112
Mean discrepancy	1.93	1.81	2.08	2.14	2.87	2.09
Accumulated discrepancy	− 72.7	+ 6.9	+ 39.3	+ 43.9	− 23.1	− 5.7
Mean accumulation per section	− 0.18	+ 0.01	+ 0.08	+ 0.10	− 0.09	0.00

The large accumulations occurred on steep grades, though the evidence is not conclusive that this accumulation is of the same sign. Of the five lines, the one from Beowawe to Marmol should be ignored, for it has only five sections with steep grades. Of the other four lines, one has an accumulated value of −0.06 millimeter per section for B–F, while the other three have accumulated values ranging from +0.40 to +1.41 millimeters. The mean of all steep sections for the five lines is +0.47 millimeter. This indicates a large systematic error on steep grades.

The remainder of the sections which have low grades show no systematic error in the accumulated values of B–F. Two of the values are negative and three positive, while the largest one is −0.18 millimeter and the mean for the 2112 sections of all lines is 0.00 millimeter. The program followed by the observers seems to avoid troublesome accumulation of error on low grades, but not so on the steep grades.

The difference between the two runnings of a line can not alone disclose any systematic errors due to the azimuth of the line, for there would be no systematic effect from that cause on one running which should not be present on the other. There may possibly be a systematic error which is a function of the azimuth of the line, but this would be shown only by the errors of closure of the loops.

CONCLUSIONS.

The above discussion (pp. 32 to 43) seems to make justifiable the following conclusions:

1. The average size of the discrepancy between the difference in elevation determined twice under different conditions does not give a clear idea of the magnitude of the accidental errors which may be produced by certain conditions, as the custom is to make the length of sight as great as the conditions will permit. Therefore the extra length of sight may offset otherwise favorable conditions and give a large difference between two runnings of a section.

2. For sections run twice under different conditions the average accumulated value of the discrepancy is greater for the sections with steep grades than with low grades, the direction of the running being ignored and only the actual difference in elevation between the ends of a section being considered.

3. On all grades, but more especially the steep ones, the difference in elevation determined in the afternoon is on an average greater than that determined in the forenoon.

4. On an average, a running during wind gives a greater difference in elevation than one during calm. The amount of this difference is somewhat greater for the steep than for the low grades.

5. On an average a running when the sky is cloudy gives a larger difference in elevation between two points, on a steep grade, than a running while the sun is shining. For low grades there is practically no difference, on an average, between the runnings under the two conditions.

6. On steep grades the average accumulated value of the backward minus the forward (B–F) running is positive. There is no accumulation for the low sections considered as one group.

7. For steep grades (about 10 meters per kilometer) the probability is that the afternoon running gives, on an average, a result closer to the truth than the forenoon running. The afternoon running should be ended sometime before sundown. The running in wind probably gives results on an average closer to the truth than a running in calm.

While the data in the tables make the above conclusions justifiable, yet, owing to the fact that there are so many conditions to be considered, it is impracticable to obtain at present any reliable numerical values for the effect of any given atmospheric condition or set of conditions.

It is believed that, other things being equal, the running in the afternoon (if not within about an hour of sunset) gives, on an average, more accurate results than the forenoon running; also that, other things being equal, a running in wind is more accurate, on an average, than one in calm; and, other things being equal, a running with a cloudy sky will be more accurate, on an average, than one in sunshine. Hence, the ideal condition would be an afternoon with a moderate wind and a cloudy sky.

It is believed that the mere fact of running backward or forward has no real effect on the result of a running, as the value of B–F may vary in sign for different lines and even for different parts of a single line.

As data accumulate it may be possible to determine accurately the effect of certain weather conditions and a correction might then be applied to the leveling. With our present knowledge it seems safe to follow such a program as that now used in the United States Coast and Geodetic Survey. On level ground or ground with low grades the observer need not be so particular in regard to the relation between the weather conditions and the separate runnings provided the two runnings of a section are made on different days, to meet the requirements of the International Geodetic Association; but on a steep slope it is best not to make observations in the early morning or the late afternoon; the reading of a wire on the rod should never be less than about two decimeters; and whenever part of a day must be taken for setting bench marks or computing, the forenoon should be used for that work and the afternoon for leveling, rather than the reverse.

As was stated on page 22 of Special Publication No. 18, it is not believed that the accumulated value of B–F (backward minus forward) gives any accurate indication of the systematic error which may be expected in a line of levels. Let it be assumed that on an average the afternoon running gives a greater difference in elevation than the forenoon running. Then, if the line is on a long steep grade, the accumulated value of B–F may be very small if each section has the two runnings in the forenoon or both in the afternoon, while the accumulated value of B–F will probably be large if all of one running is made in the forenoon and all of the other running is made in the afternoon. In each case the actual accumulated systematic error would be the same.

STANDARD ELEVATIONS.

The following list gives the standard elevation, in meters and feet above mean sea level, of each bench mark on the precise level line Brigham, Utah, to San Francisco, Cal.

Elevations of permanent bench marks.

Place.	Designation of bench mark.	Standard elevation.		Place.	Designation of bench mark.	Standard elevation.	
		Meters.	Feet.			Meters.	Feet.
Brigham, Utah	R	1309.150	4295.103	Deeth, Nev.	U_4	1626.022	5334.707
Do	J_9	1313.399	4309.043	Natchez, Nev	V_4	1614.139	5295.721
Do	K_9	1352.930	4438.738	Halleck, Nev	W_4	1594.771	5232.178
Honeyville, Utah	L_9	1301.032	4268.469	Elburz, Nev	X_4	1586.379	5204.645
Dewey, Utah	T	1317.551	4322.665	Near Elburz, Nev	Y_4	1580.299	5184.698
Near Corinne, Utah	M_9	1287.547	4224.227	Ryndon, Nev	Z_4	1572.304	5158.467
Corinne, Utah	N_9	1289.016	4229.047	Near Ryndon, Nev	A_5	1570.662	5153.080
Near Corinne, Utah	O_9	1290.421	4233.656	Osino, Nev	B_5	1564.760	5133.717
Near Balfour, Utah	P_9	1293.550	4243.922	Coin, Nev	C_5	1551.898	5091.519
Balfour, Utah	Q_9	1294.273	4246.294	Near Elko, Nev	D_5	1546.867	5075.013
Near Hansen, Utah	R_9	1289.823	4231.694	Do	E_5	1548.173	5079.298
Hansen, Utah	S_9	1290.815	4234.949	Elko, Nev	F_5 (U. S. G. S.)	1544.382	5066.860
Near Hansen, Utah	T_9	1295.596	4250.635	Do	G_5	1540.855	5055.288
Blue Creek, Utah	U_9	1301.447	4269.831	Near Elko, Nev	H_5	1536.418	5040.731
Near Blue Creek, Utah	V_9	1323.993	4343.800	Near Avenel, Nev	I_5	1533.332	5030.607
Kolmar, Utah	W_9	1333.590	4375.286	Avenel, Nev	J_5	1530.494	5021.296
Surbon, Utah	X_9	1391.661	4565.808	Near Avenel, Nov	K_5	1526.957	5009.691
Promontory, Utah	Y_9	1494.255	4902.402	Near Moleen, Nev	L_5	1526.558	5008.382
Near Promontory, Utah	Z_9	1484.824	4871.460	Moleen, Nev	M_5	1516.769	4976.266
Do	A_{10}	1441.217	4728.393	Near Moleen, Nev	N_5	1515.674	4972.674
Rozel, Utah	B_{10}	1400.062	4593.370	Near Tonka, Nev	O_5	1514.198	4967.831
Near Rozel, Utah	C_{10}	1398.971	4589.791	Tonka, Nev	P_5	1512.654	4962.766
Near Lake, Utah	D_{10}	1325.579	4349.004	Near Tonka, Nev	Q_5	1510.640	4956.158
Lake, Utah	E_{10}	1284.236	4213.364	Near Vivian, Nev	R_5	1509.118	4951.165
Near Lake, Utah	F_{10}	1287.202	4223.095	Vivian, Nev	S_5	1498.672	4916.893
Monument, Utah	G_{10}	1288.232	4226.474	Carlin, Nev	T_5	1492.558	4896.834
Near Monument, Utah	H_{10}	1292.478	4240.405	Near Carlin, Nov	U_5	1487.450	4880.075
Do	I_{10}	1287.070	4222.662	Tyrol, Nev	V_5	1485.169	4872.592
Near Kelton, Utah	J_{10}	1286.080	4219.414	Palisade, Nev	W_5	1476.289	4843.458
Kelton, Utah	K_{10}	1286.750	4221.612	Gerald, Nev	X_5	1469.163	4820.079
Near Kelton, Utah	L_{10}	1326.236	4351.159	Harney, Nev	Y_5	1455.204	4774.282
Near Peplin, Utah	M_{10}	1384.143	4541.142	Cluro, Nev	Z_5	1441.991	4730.932
Ombey, Utah	N_{10}	1436.620	4713.311	Beowawe, Nev	A_6	1432.562	4699.997
Near Romola, Utah	O_{10}	1404.126	4606.703	Do	B_6	1432.212	4698.849
Do	P_{10}	1400.376	4594.400	Do	C_6	1430.688	4693.849
Near Terrace, Utah	Q_{10}	1429.349	4689.456	Ladoga, Nev	G_6	1420.740	4661.211
Terrace, Utah	R_{10}	1387.724	4552.891	Farrel, Nev	H_6	1410.945	4629.075
Near Terrace, Utah	S_{10}	1357.271	4452.980	Mosel, Nev	I_6	1397.537	4585.086
Bovine, Utah	T_{10}	1325.698	4349.394	Argenta, Nev	J_6	1388.867	4556.641
Near Bovine, Utah	U_{10}	1339.962	4396.192	Rosny, Nev	K_6	1380.447	4529.016
Near Umbria Junction, Utah.	V_{10}	1350.182	4429.722	Battle Mountain, Nev.	L_6	1374.690	4510.129
Lucin, Utah	W_{10}	1362.878	4471.376	Near Battle Mountain, Nev.	M_6	1372.793	4503.905
Near Umbria Junction, Utah.	X_{10}	1370.114	4495.116	Pfute, Nev	N_6	1373.358	4505.759
Do	Y_{10}	1378.304	4521.986	Mote, Nev	O_6	1373.594	4506.533
Do	Z_{10}	1387.348	4551.658	Valmy, Nev	P_6	1373.821	4507.278
Gartney, Utah	A_{11}	1405.550	4611.375	Near Valmy, Nev	Q_6	1366.276	4482.524
Near Tecoma, Nev	I_3	1457.827	4782.887	Stonehouse, Nev	R_6	1348.853	4425.362
Tecoma, Nev	J_3	1467.322	4814.039	Herrin, Nev	S_6	1343.121	4406.556
Near Tecoma, Nev	K_3	1466.885	4812.605	Iron Point, Nev	T_6	1336.901	4386.150
Do	L_3	1469.172	4820.108	Comus, Nev	U_6	1333.025	4373.433
Akbar, Nev	M_3	1471.488	4827.707	Near Preble, Nev	V_6	1333.524	4375.070
Near Montello, Nev	N_3	1477.112	4846.158	Near Golconda, Nev	W_6 (S. P.)	1327.004	4353.679
Montello, Nev	O_3	1485.769	4874.560	Golconda, Nev	X_6	1336.950	4386.310
Do	P_3	1485.765	4874.547	Eglon, Nev	Y_6	1318.108	4324.493
Banvard, Nev	Q_3	1516.712	4976.079	Tule, Nev	Z_6	1313.059	4307.928
Noble, Nev	R_3	1559.786	5117.398	Winnemucca, Nev	A_7	1316.225	4318.315
Ullin, Nev	S_3	1604.021	5262.526	Benin, Nev	B_7	1310.059	4298.085
Wright, Nev	T_3	1649.229	5410.845	Rose Creek, Nev	C_7	1318.017	4324.194
Loray, Nev	U_3	1705.966	5596.990	Lamar, Nev	D_7	1308.160	4291.855
Omar, Nev	V_3	1781.219	5843.883	Cosgrave, Nev	E_7	1310.824	4300.595
Cobre, Nev	W_3	1805.230	5922.659	Dodon, Nev	F_7	1296.202	4252.623
Do	X_3	1809.808	5937.678	Mill City, Nev	G_7	1287.488	4224.033
Near Cobre, Nev	Y_3	1831.050	6007.370	Imlay, Nev	H_7	1278.626	4194.959
Valley Pass, Nev	Z_3	1850.212	6070.237	Humboldt, Nev	I_7	1290.045	4232.423
Near Valley Pass, Nev	A_4	1851.795	6075.431	Valery, Nev	J_7	1304.104	4278.548
Icarus, Nev	B_4	1859.244	6099.870	Near Valery, Nev	K_7 (S. P.)	1294.168	4245.949
Near Icarus, Nev	C_4	1875.226	6152.304	Near Rye Patch, Nev	L_7 (S. P.)	1295.933	4251.740
Pequop, Nev	D_4	1873.173	6145.568	Rye Patch, Nev	M_7	1295.850	4251.468
Fenelon, Nev	E_4	1876.107	6155.194	Near Rye Patch, Nev	N_7 (S. P.)	1294.190	4246.022
Near Holborn, Nev	F_4	1866.993	6125.293	Near Zola, Nev	O_7 (S. P.)	1299.730	4264.198
Holborn, Nev	G_4	1860.817	6105.030	Zola, Nev	P_7	1289.856	4231.803
Anthony, Nev	H_4	1866.485	6123.626	Oreana, Nev	Q_7	1267.348	4157.957
Moor, Nev	I_4	1877.788	6160.709	Woolsey, Nev	R_7	1249.396	4099.060
Cedar, Nev	J_4	1819.671	5970.037	Kodak, Nev	S_7	1220.988	4005.853
Kaw, Nev	K_4	1777.134	5830.480	Near Lovelocks, Nev	T_7	1217.142	3993.240
Near Wells, Nev	L_4	1740.174	5709.221	Do	U_7	1216.350	3990.642
Wells, Nev	M_4	1715.462	5628.145	Lovelocks, Nev	V_7	1211.967	3976.262
Do	N_4	1715.397	5627.932	Perth, Nev	W_7	1203.666	3949.027
Near Wells, Nev	O_4	1711.902	5616.465	Granite Point, Nev	X_7	1194.333	3918.408
Do	P_4	1709.278	5607.856	Toulon, Nev	Y_7	1197.746	3929.605
Alazon, Nev	Q_4	1705.310	5594.838	Toy, Nev	Z_7	1197.949	3930.271
Near Tnlasco, Nev	R_4	1677.398	5503.263	Miriam, Nev	A_8	1194.025	3917.397
Near Nardi, Nev	S_4	1644.437	5395.124	Near Huxley, Nev	B_8	1186.403	3892.391
Near Deeth, Nev	T_4	1631.314	5352.069	Parran, Nev	C_8	1184.441	3885.953
				Near Desert, Nev	D_8 (S. P.)	1185.857	3890.599

Elevations of permanent bench marks—Continued.

Place.	Designation of bench mark.	Standard elevation.		Place.	Designation of bench mark.	Standard elevation.	
		Meters.	Feet.			Meters.	Feet.
Near Desert, Nev.	E_8	1189.596	3902.866	Near Acampo, Cal.	N_9	15.468	50.748
Upsal, Nev.	F_8 (S. P.)	1189.186	3901.521	Do.	M_9 (U. S. G. S.)	16.219	53.212
Do.	G_8	1190.412	3905.543	Lodi, Cal.	L_9	15.838	51.962
Near Falais, Nev.	H_8 (S. P.)	1199.499	3935.356	Near Lodi, Cal.	K_9 (U. S. G. S.)	13.972	45.840
Massie, Nev.	I_8	1211.720	3975.451	Pearson, Cal.	J_9 (U. S. G. S.)	11.582	37.999
Do.	J_8	1216.708	3991.816	Near Hammer, Cal.	I_9	10.184	33.412
Hazen, Nev.	K_8 (S. P.)	1220.908	4005.596	Do.	H_9 (U. S. G. S.)	8.738	28.668
Do.	L_8	1220.222	4003.345	Near El Pinal, Cal.	G_9	8.558	28.077
Patna, Nev.	M_8	1237.988	4061.632	Near Stockton, Cal.	F_9 (U. S. G. S.)	6.269	20.568
Near Patna, Nev.	N_8 (S. P.)	1242.878	4077.676	Stockton, Cal.	E_9	7.081	23.232
Argo, Nev.	O_8 (S. P.)	1241.610	4073.515	Do.	D_9	5.994	19.665
Do.	P_8	1241.706	4073.830	Near Stockton, Cal.	C_9	5.312	17.428
Luva, Nev.	Q_8	1258.071	4127.521	Near French Camp, Cal.	B_9 (U. S. G. S.)	4.278	14.035
Fernley, Nev.	R_8	1265.124	4150.661	Do.	A_9	5.402	17.723
Do.	S_8 (U. S. G. S.)	1265.834	4152.990	Do.	Z_8	6.952	22.808
Gilpin, Nev.	T_8	1268.580	4162.000	Near Lathrop, Cal.	Y_8	5.900	19.357
Derby, Nev.	U_8 (S. P.)	1268.354	4161.258	Lathrop, Cal.	X_8	6.870	22.539
Near Derby, Nev.	V_8 (S. P.)	1267.957	4159.956	Do.	W_8 (U. S. G. S.)	6.194	20.321
Do.	W_8 (S. P.)	1269.869	4166.229	Near Lathrop, Cal.	V_8	8.295	27.215
Thisbe, Nev.	X_8 (S. P.)	1286.231	4219.909	Near Banta, Cal.	U_8	6.246	20.492
Do.	Y_8 (S. P.)	1287.423	4223.820	Banta, Cal.	T_8 (U. S. G. S.)	6.851	22.477
Clark, Nev.	Z_8 (S. P.)	1294.236	4246.173	Tracy, Cal.	S_8 (U. S. G. S.)	16.505	54.150
Near Ditho, Nev.	A_9 (S. P.)	1309.489	4296.215	Do.	R_8	18.342	60.177
Hafed, Nev.	B_9	1334.058	4376.822	Do.	Q_8	18.028	59.147
Near Vista, Nev.	C_9 (S. P.)	1338.144	4390.227	Near Tracy, Cal.	P_8 (U. S. G. S.)	31.383	102.962
Do.	D_9 (S. P.)	1338.292	4390.713	Midway, Cal.	O_8 (U. S. G. S.)	107.125	351.459
Do.	E_9 (S. P.)	1339.658	4395.195	Near Midway, Cal.	N_8	128.917	422.955
Vista, Nev.	F_8	1339.532	4394.781	Near Cayley, Cal.	M_8	150.397	493.427
Sparks, Nev.	G_9	1347.906	4422.255	Near Altamont, Cal.	L_8	180.025	590.632
Reno, Nev.	H_9	1370.224	4495.477	Do.	K_8	219.224	719.237
Do.	I_9 (U. S. G. S.)	1389.031	4557.179	Altamont, Cal.	J_8 (U. S. G. S.)	225.513	739.871
Lawton, Nev.	J_9	1415.966	4645.549	Near Altamont, Cal.	I_8	218.270	716.107
Near Verdi, Nev.	K_9	1459.919	4789.751	Near Livermore, Cal.	H_8	195.282	640.688
Verdi, Nev.	L_9 (S. P.)	1478.104	4849.413	Do.	G_8	163.717	537.128
Marmol, Nev.	F_8	1511.948	4960.449	Livermore, Cal.	F_8 (U. S. G. S.)	148.655	487.712
Do.	E_8	1512.388	4961.893	Near Livermore, Cal.	E_8	140.422	460.701
Near Marmol, Nev.	D_8	1514.731	4969.580	Radum, Cal.	D_8	112.049	367.614
Calvada, Cal.	Y_{10}	1533.870	5032.372	Pleasanton, Cal.	C_8	102.518	336.344
Mystic, Cal.	X_{10}	1573.053	5160.925	Verona, Cal.	B_8	92.234	302.604
Iceland, Cal.	W_{10}	1648.909	5409.796	Brightside, Cal.	A_8	68.746	225.544
Near Prosser Creek, Cal.	V_{10}	1709.909	5609.926	Farwell, Cal.	Z_7 (U. S. G. S.)	51.053	167.496
Truckee, Cal.	U_{10}	1773.860	5819.739	Near Niles, Cal.	Y_7	37.912	124.383
Tunnel, Cal.	T_{10}	1928.122	6325.847	Niles, Cal.	X_7	26.426	86.699
Near Eder, Cal.	S_{10}	2005.548	6579.869	Do.	W_7	25.686	84.271
Summit, Cal.	R_{10}	2122.855	6964.733	Irvington, Cal.	V_7	21.345	70.029
Near Spruce, Cal.	Q_{10}	1984.753	6511.644	Near Warmsprings, Cal.	U_7	9.796	32.139
Cisco, Cal.	P_{10}	1805.200	5922.560	Warmsprings, Cal.	T_7	12.821	42.064
Emigrant Gap, Cal.	O_{10}	1588.645	5212.079	Near Warmsprings, Cal.	S_7	4.797	15.738
Blue Canyon, Cal.	N_{10}	1429.947	4691.418	Near Milpitas, Cal.	R_7	5.223	17.136
Orel, Cal.	M_{10}	1346.788	4418.587	Near Wayne, Cal.	Q_7	20.630	67.684
Towle, Cal.	L_{10}	1135.040	3723.877	San Jose, Cal.	P_7 (U. S. G. S.)	29.900	98.097
Gold Run, Cal.	K_{10}	967.036	3172.684	Do.	O_7	27.470	90.124
Near Wirt, Cal.	J_{10}	732.022	2401.642	Santa Clara, Cal.	N_7	22.997	75.449
Colfax, Cal.	I_{10}	736.123	2415.097	Lawrence, Cal.	M_7	20.419	66.991
Lander, Cal.	H_{10}	699.753	2295.773	Sunnyvale, Cal.	L_7	29.800	97.769
Near Clippergap, Cal.	G_{10}	569.220	1867.516	Mountain View, Cal.	K_7	23.652	77.598
Do.	F_{10}	535.154	1755.751	Mayfield, Cal.	J_7	10.009	32.838
East Auburn, Cal.	E_{10}	414.232	1359.026	Palo Alto, Cal.	I_7	18.922	62.080
Near New Castle, Cal.	D_{10}	297.432	975.825	Near Palo Alto, Cal.	H_7	22.410	73.523
Near Rocklin, Cal.	C_{10}	76.756	251.824	Menlo Park, Cal.	G_7	21.529	70.633
Near Roseville, Cal.	B_{10}	52.652	172.742	Redwood City, Cal.	F_7	3.875	12.713
Roseville, Cal.	A_{10}	48.814	160.151	San Carlos, Cal.	E_7	7.846	25.741
Near Antelope, Cal.	Z_9 (U. S. G. S.)	44.638	146.450	Belmont, Cal.	D_7	10.610	34.810
Antelope, Cal.	Y_9	47.759	156.689	Beresford, Cal.	C_7	6.987	22.923
Near Benall, Cal.	X_9	15.928	52.257	San Mateo, Cal.	B_7	8.349	27.392
Elvas, Cal.	W_9	12.179	39.957	Do.	A_7	7.875	25.837
Brighton, Cal.	V_9	15.222	49.941	Burlingame, Cal.	Z_6	9.308	30.538
Near Florin, Cal.	U_9 (U. S. G. S.)	11.063	36.296	Millbrae, Cal.	Y_6	5.618	18.432
Do.	T_9 (U. S. G. S.)	11.365	37.287	San Bruno, Cal.	X_6	8.142	26.713
Elk Grove, Cal.	S_9 (U. S. G. S.)	15.194	49.849	Holy Cross, Cal.	W_6	26.885	88.205
McConnell, Cal.	R_9 (U. S. G. S.)	14.313	46.959	San Francisco, Cal.	City 418	94.789	310.987
Need, Cal.	Q_9	13.307	43.658	Do.	City 386	58.661	192.457
Galt, Cal.	P_9 (U. S. G. S.)	14.061	46.132	Do.	City 640	59.391	194.852
Jahant, Cal.	O_9 (U. S. G. S.)	14.888	48.845	Do.	City 635	48.559	159.314

Elevations of top of rail in front of railroad stations.

Place.	Standard elevation.	
	Meters.	Feet.
Brigham, Utah	1312.89	4307.37
Corinne, Utah	1289.51	4230.67
Promontory, Utah	1491.61	4903.57
Kelton, Utah	1287.50	4224.07
Peplin, Utah	1349.91	4428.83
Ombey, Utah	1437.28	4715.48
Romola, Utah	1410.32	4627.02
Lucin, Utah	1363.26	4472.63
Tecoma, Nev	1465.25	4807.24
Ulin, Nev	1601.93	5255.83
Wright, Nev	1647.75	5405.99
Loray, Nev	1712.54	5618.56
Omar, Nev	1779.95	5839.72
Cobre, Nev	1804.05	5918.79
Valley Pass, Nev	1850.39	6070.82
Icarus, Nev	1861.01	6105.66
Pequop, Nev	1872.41	6143.07
Moor, Nev	1878.50	6163.05
Cedar, Nev	1819.49	5969.44
Kaw, Nev	1777.38	5831.29
Wells, Nev	1715.26	5627.48
Alazon, Nev	1703.91	5590.24
Tulasco, Nev	1680.11	5512.16
Starr, Nev	1675.92	5498.41
Nardl, Nev	1648.91	5409.80
Deeth, Nev	1627.46	5339.42
Natchez, Nev	1613.59	5293.92
Rasld, Nev	1603.16	5259.70
Halleck, Nev	1593.04	5226.50
Elbnrz, Nev	1585.55	5201.93
Ryndon, Nev	1571.64	5156.29
Osino, Nev	1563.91	5130.93
Coin, Nev	1553.27	5096.02
Elko, Nev	1541.86	5058.59
Avenel, Nev	1530.54	5021.45
Moleen, Nev	1518.85	4983.09
Tonka, Nev	1511.19	4957.96
Vivian, Nev	1498.88	4917.58
Carlin, Nev	1493.98	4901.50
Tyrol, Nev	1486.11	4875.68
Palisado, Nev	1476.35	4843.66
Gerald, Nev	1468.55	4818.07
Harney, Nev	1455.43	4775.02
Cluro, Nev	1441.86	4730.50
Beowawe, Nev	1430.53	4693.33
Farrel, Nev	1409.94	4625.78
Mosel, Nev	1397.05	4583.49
Argenta, Nev	1386.59	4549.17
Battle Mountain, Nev	1374.65	4510.00
Valmy, Nev	1373.77	4507.11
Stonehouse, Nev	1355.65	4447.66
Herrin, Nev	1343.43	4407.57
Iron Point, Nev	1338.05	4389.92
Comus, Nev	1334.31	4377.65
Golconda, Nev	1337.42	4387.85
Tule, Nev	1317.46	4322.37
Winnemucca, Nev	1320.27	4331.59
Cosgrave, Nev	1310.29	4298.84
Mill City, Nev	1287.98	4225.65
Imlay, Nov	1278.03	4193.00
Humboldt, Nev	1290.62	4234.31
Rye Patch, Nev	1296.23	4252.71
Oreana, Nev	1266.84	4156.29
Woolsey, Nev	1248.63	4096.55
Granite Point, Nev	1195.18	3921.19
Toulon, Nev	1197.95	3930.27
Toy, Nev	1197.59	3929.09
Ocala, Nev	1186.93	3894.12
Huxley, Nev	1190.32	3905.24
Parran, Nev	1184.25	3885.33
Desert, Nev	1186.98	3894.28
Upsal, Nev	1190.89	3907.11
Falais, Nev	1204.92	3953.14
Massle, Nev	1212.17	3976.93
Hazen, Nev	1222.16	4009.70
Argo, Nev	1243.23	4078.83
Fernley, Nev	1266.09	4153.83
Derby, Nev	1268.39	4161.38
Tbisbe, Nev	1275.75	4185.52
Clark, Nev	1296.46	4253.47
Ditho, Nev	1311.74	4303.60
Hafed, Nev	1333.73	4375.75
Vista, Nev	1339.58	4394.94
Sparks, Nev	1347.80	4421.91
Reno, Nev	1369.70	4493.76
Mogul, Nev	1443.64	4736.34
Calvada, Cal	1536.47	5040.90
Floriston, Cal	1620.65	5317.08
Wickes, Cal	1632.37	5355.53
Boca, Cal	1685.73	5530.60
Winsted, Cal	1743.90	5721.45
Truckee, Cal	1772.76	5816.13
Tunnel, Cal	1950.36	6398.81
Eder, Cal	2011.74	6600.18
Lake View, Cal	2068.15	6785.26
Summit, Cal	2121.73	6961.04
Soda Springs, Cal	2056.93	6748.44
Spruce, Cal	1991.76	6534.63
Troy, Cal	1940.73	6367.21
Tamarack, Cal	1888.51	6195.89
Cisco, Cal	1806.99	5928.43
Crystal Lake, Cal	1754.89	5757.50
Yuba Pass, Cal	1711.02	5613.57
Smart, Cal	1630.99	5351.01
Emigrant Gap, Cal	1588.29	5210.91
Fulda, Cal	1531.61	5024.96
Blue Canyon, Cal	1428.88	4687.92
Orel, Cal	1343.78	4408.72
Midas, Cal	1262.63	4142.48
Gorge, Cal	1190.00	3904.19
Towle, Cal	1125.20	3691.59
Alta, Cal	1097.87	3601.93
Dutch Flat, Cal	1033.32	3390.15
Gold Run, Cal	982.47	3223.32
Magra, Cal	883.62	2899.01
Caporn, Cal	809.61	2656.20
Wirt, Cal	744.30	2441.92
Colfax, Cal	735.22	2412.13
Lander, Cal	695.70	2282.48
New England Mills, Cal	694.23	2277.65
Applegate, Cal	614.13	2014.86
Clippergap, Cal	535.52	1756.95
Bowman, Cal	492.89	1617.09
Nestor, Cal	426.78	1400.19
Auburn, Cal	413.45	1356.46
Flint, Cal	397.09	1302.79
Zeta, Cal	356.84	1170.73
Newcastle, Cal	291.14	955.18
Penryn, Cal	189.68	622.31
Loomis, Cal	120.36	394.88
Rocklin, Cal	74.75	245.24
Roseville, Cal	48.51	159.15
Antelope, Cal	49.04	160.89
Walerga, Cal	32.59	106.92
Benali, Cal	15.40	50.52
Brighton, Cal	15.29	50.16
Polk, Cal	13.07	42.88
Davis, Cal	12.66	41.54
Florin, Cal	12.36	40.55
Grabam, Cal	12.32	40.42
Sibeck, Cal	12.91	42.36
Elk Grove, Cal	15.26	50.07
McConnell, Cal	14.33	47.01
Arno, Cal	11.77	38.62
Need, Cal	12.82	42.06
Galt, Cal	14.41	47.28
Forest Lake, Cal	15.12	49.61
Acampo, Cal	17.21	56.46
Lodi, Cal	15.71	51.54
Mettler, Cal	13.93	45.70
Armstrong, Cal	12.87	42.22
Pearson, Cal	12.22	40.09
Raclmo, Cal	11.62	38.12
Castle, Cal	10.40	34.12
Jarn, Cal	8.98	29.46
El Pinal, Cal	7.52	24.67
Stockton, Cal	5.93	19.46
Hislop, Cal	6.81	22.34
French Camp, Cal	6.26	20.54
Lathrop, Cal	6.76	22.18
Banta, Cal	8.29	27.20
Tracy, Cal	17.81	58.43
Ellis, Cal	22.12	72.57
Midway, Cal	108.61	356.33
Altamont, Cal	225.08	738.45
Ulmar, Cal	169.74	556.89
Livermore, Cal	147.39	483.56
Eliot, Cal	113.93	373.79
Remillard, Cal	112.84	370.21
Radum, Cal	109.90	360.56
Pleasanton, Cal	106.99	351.02
Verona, Cal	92.18	302.43
Sunol, Cal	79.55	260.99
Brightside, Cal	63.65	208.83
Mayborg, Cal	58.98	193.50
Farwell, Cal	49.81	163.42
Alston, Cal	40.62	133.27
Niles, Cal	25.81	84.68
Irvington, Cal	10.02	32.87
Warmsprings, Cal	13.30	43.64
Milpitas, Cal	6.04	19.82
San Jose, Cal	27.77	91.11
Santa Clara, Cal	23.01	75.49
Sunnyvale, Cal	29.89	98.06
Mountain View, Cal	24.32	79.79
Castro, Cal	17.96	58.92
Palo Alto, Cal	19.11	62.70
Menlo Park, Cal	20.56	67.45
Fair Oaks, Cal	16.07	52.72
San Carlos, Cal	7.56	24.80
Beresford, Cal	7.18	23.56
San Mateo, Cal	7.66	25.13
Burlingame, Cal	8.89	29.17
Milbrae, Cal	3.49	11.45
San Bruno, Cal	7.86	25.79

DESCRIPTIONS OF BENCH MARKS.[1]

GENERAL NOTES DESCRIBING DIFFERENT FORMS AND MARKINGS OF BENCH MARKS.

NOTE 1.—This type of bench mark is the red metal disk designed by the Coast and Geodetic Survey, lettered "U. S. Coast and Geodetic Survey, B. M. $250 fino or imprisonment for disturbing this mark." The disk is 3 inches in diameter, with a 3-inch tenon upon the back for setting it, and is set in cement flush with a horizontal or vertical surface. In the latter case a horizontal mark cut on it, or the horizontal mark of a cross, is the bench mark.

NOTE 2.—This type of bench mark has the same lettering as that referred to in note 1, and is a 3-inch red metal cap, somewhat curved, screwed upon a 4-foot or 4½-foot iron pipe set in the ground and usually cemented at the base, from 4 to 6 inches being exposed above the ground. The base of the pipe is split and spread to a diameter of about a foot. For placing the foot of the level rod accurately a square or a small circle was cut in outline in the center of the cap.

NOTE 11.—The bottom of hole about 25 millimeters square and about 4 to 5 millimeters deep, cut in the top of a stone or cement post about 4 feet long and with rectangular top from 4 to 8 inches on a side, projecting about 6 inches from the ground. The top of the post is lettered "U. S. B. M." Limestone posts are used between Holland and New Braunfels, Tex., and black lava posts between Pocatello and Owyhee, Idaho.

NOTE 11A.—A red metal disk, like that described in note 1, set in the top of a stone or cement post about 4 feet long and with a rectangular top from 4 to 8 inches on a side, projecting about 6 inches from the ground.

NOTE 17.—A 3-inch aluminum or bronze disk [1] lettered "U. S. Geological Survey B. M. $250 fine or imprisonment for disturbing this mark. Elevation above sea — feet. Datum —." Each disk is stamped with the approximate elevation in feet and a letter or letters to indicate the datum plane. This elevation and the datum letter or letters usually form the name by which the bench mark is designated in this publication.

NOTE 18.—This type of bench mark has the same lettering as that referred to in note 17, and is a 3-inch aluminum or bronze cap riveted upon a 3-inch iron pipe, set in the ground, 5 to 6 inches being exposed above the ground. A cross cut in the center of the top is the bench mark.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN BRIGHAM, UTAH, AND BEOWAWE, NEV., 1911.

R.—At *Brigham, Boxelder County, Utah,* 15 meters south of the second road crossing north of the station, in a field west of the tracks, inside and 0.6 meter from the fence, about halfway between mile poles 21 and 22 and about 1.5 meters above the level of the tracks. Note 11.*

J_9.—At *Brigham, Boxelder County, Utah,* about 100 meters south of the Oregon Short Line Railroad station, in the top surface of the northwest stone pillar of the railroad water tank. Note 1.*

K_9.—At *Brigham, Boxelder County, Utah,* in the eastern vertical face of the south side of the stone steps leading to the west entrance of the Boxelder County Courthouse, about 1.5 meters above the ground. Note 1.*

L_9.—At *Honeyville, Boxelder County, Utah,* in the west face of the concrete foundation of the Oregon Short Line Railroad station, directly beneath the telegraph operator's window and just behind the semaphore tower, about 0.2 meter above the platform. Note 1.*

T.—At *Dewey, Boxelder County, Utah,* 180 meters south of the depot, on the right of way of the Oregon Short Line Railroad, 15 meters east of the main tracks. Note 11.*

M_9.—Near *Corinne, Boxelder County, Utah,* about 4 telegraph poles west of mile pole 3 on the right of way of the Brigham-Corinne cut-off, 14 meters south of the tracks, 1.2 meters north of the south line fence, about 1.5 meters below the track. Note 11.*

N_9.—At *Corinne, Boxelder County, Utah,* directly south of the middle of the freight station, 42.4 meters west of the west end of the old passenger station, 18.7 meters south of the Southern Pacific Railway main track, one-half meter north of the south line fence, and about 0.6 meter below the track. Note 11.*

O_9.—Near *Corinne, Boxelder County, Utah,* between the tenth telegraph pole east of Southern Pacific mile pole 806 and the south line fence 1 meter north of the latter, 150 meters east of the small bridge that crosses the irrigation ditch at the point where the right of way narrows, 14.3 meters south of the tracks. Note 2.*

P_9.—Between *Corinne* and *Balfour, Boxelder County, Utah,* about 1½ telegraph poles east of mile pole 804, 50 meters east of the whistle post, at the road crossing, on the Southern Pacific right of way one-half meter north of the south line fence and 14.8 meters south of the track. Note 2.*

Q_9.—At *Balfour, Boxelder County, Utah,* about 7 telegraph poles west of mile pole 801, 98 meters east of the westernmost of the two switch stands at the west end of the siding, on the right of way of the Southern Pacific Railway, one-half meter north of the south line fence, 14.8 meters south of the main track and about 1 meter above it. Note 2.*

R_9.—Near *Hansen, Boxelder County, Utah,* about 2 telegraph poles east of mile pole 798 on the right of way of the Southern Pacific Railway, 0.9 meter south of the north line fence, 14.3 meters north of the track, and about 1.2 meters above it. Note 11.*

S_9.—At *Hansen, Boxelder County, Utah,* about midway between the ends of the siding, one-half telegraph pole west of the pole that carries the station sign (795.7 miles), in the line of the telegraph poles, 13 meters south of the Southern Pacific main track. Note 11.*

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[1] Any person who finds that one of the bench marks here described is disturbed, or that the description is not in accordance with the facts, is requested to notify the Superintendent of the United States Coast and Geodetic Survey, Washington, D. C.

* See above.

T_9.—Near *Hansen, Boxelder County, Utah*, about 2 telegraph poles west of mile pole 793 on the right of way of the Southern Pacific Railway, 8.9 meters north of the south line fenee, and 5.8 meters south of the railway track. Note 2.*

U_9.—At *Blue Creek, Boxelder County, Utah*, situated on the right of way of the Southern Pacific Railway, opposite the water tank, 14.8 meters west of the west end of the pumping station, 10 meters north of the south line fenee, 12.2 meters south of the southernmost siding, 24.5 meters south of the main track. Note 11.*

V_9.—Near *Blue Creek*, and *Kolmar, Boxelder County, Utah*, about 4 telegraph poles east of milo pole 790, on the Southern Pacific Railway right of way, 0.8 meter north of the south line fence, 14.4 meters south of the railway track. Note 2.*

W_9.—At *Kolmar, Boxelder County, Utah*, about 0.2 telegraph pole south of the pole that earries the station sign (789.1 miles), on the right of way of the Southern Pacifie Railway, 6.7 meters east of the west line fenee, 32.2 meters west of the main track of the Southern Paeifie Railway. Note 11.*

X_9.—At *Surbon, Boxelder County, Utak*, about 2 telegraph poles north of the pole that carries the station sign (786.1 miles), 6.2 meters west of the east line fenee, on the right of way of the Southern Pacifie Railway, 4 meters east of the main track. Note 11.*

Y_9.—At *Promontory, Boxelder County, Utah*, on the Southern Pacific right of way, on a line joining tho west end of the railway station with the east edge of the door to the United States post offiee, 45.1 meters north of the main track, 4.2 meters south of the north line fenee, 48.7 meters from the northwest eorner of the station house. Note 11.*

Z_9.—Near *Promontory, Boxelder County, Utah*, at mile pole 778 on the right of way of the Southern Pacifie Railway, 0.7 meter north of the south line fenee, 15 meters south of the track, and about 1.2 meters below it. Note 2.*

A_{10}.—Near *Promontory, Boxelder County, Utah*, between Promontory and Rozel, on the right of way of the Southern Pacifie Railway, 3 telegraph poles east of mile pole 775, 8.1 meters north of the south line fenee, and about 1.8 meters above the track. Note 2.*

B_{10}.—At *Rozel, Boxelder County, Utah*, on the Southern Pacifie Railway, right of way, 46 meters east of the east end of the water tank, 14.6 meters south of the main track, 0.8 meter north of the south line fenee. Note 11.*

C_{10}.—Near *Rozel, Boxelder County, Utah*, one-half meter south of mile pole 770, on the right of way of the Southern Pacific Railway, 15.4 meters south of the main traek. Note 2.*

D_{10}.—Near *Lake, Boxelder County, Utah*, 1.42 meters north of mile pole 766, on the right of way of the Southern Pacifie Railway, 10.8 meters south of the track, and about 1.5 meters below it. Note 2.*

E_{10}.—At *Lake, Boxelder County, Utah*, 1.8 meters north of mile pole 763, on the right of way of the Southern Pacific Railway, 15.4 meters south of the main track, and about 0.6 meter below it. Note 11.*

F_{10}.—Near *Lake, Boxelder County, Utah*, 1.5 meters north of the fourth telegraph pole east of mile pole 759, on the right of way of the Southern Pacific Railway, 13.2 meters south of the traek. Note 2.*

G_{10}.—At *Monument, Boxelder County, Utah*, at the west end of the siding on the right of way of the Southern Pacifie Railway, 0.8 meter south of the seventh telegraph pole west of the pole that earries the station sign, 10.8 meters north of the track. Note 11.*

H_{10}.—Near *Monument, Boxelder County, Utah*, on the Southern Paeifie Railway right of way, 1.1 meters south of mile pole 752, 19.5 meters south of the track, and about 1.5 meters below it. Note 2.*

I_{10}.—Near *Monument, Boxelder County, Utah*, 1.2 meters north of mile pole 748, on the right of way of the Southern Pacifie Railway, 14.3 meters south of the traek, and about 1 meter below it. Note 11.*

J_{10}.—Near *Kelton, Boxelder County, Utah*, 1 meter north of the seventh telegraph pole west of mile pole 744 on the Southern Pacifie Railway right of way, 14.5 meters south of the track, and about 1 meter above it. Note 2.*

K_{10}.—At *Kelton, Boxelder County, Utah*, 36 meters east of the east end of the Southern Pacific freight station, 29.6 meters north of the main track. Note 1.*

L_{10}.—Near *Kelton, Boxelder County, Utah*, 1 meter east of a telegraph pole on the right of way of the Southern Pacifie Railway and direetly aeross the track from mile pole 736, 22.8 meters west of the track. Note 11.*

M_{10}.—Near *Peplin, Boxelder County, Utah*, in the vertieal side of the deep eut 2 telegraph poles east of mile pole 733, 25 meters west of the east end of the eut, 1.5 meters above the track, and 2 meters south of it. Note 1.*

N_{10}.—At *Ombey, Boxelder County, Utah*, 1 meter northwest of mile pole 730, 14.8 meters southeast of the Southern Pacific Railway main track, 30 meters northeast of the switch stand at the northeast end of the wye, 48.4 meters northeast of the semaphore. Note 2.*

O_{10}.—Near *Romola, Boxelder County, Utah*, about one-half mile west of the station sign, 6 telegraph poles east of mile pole 724, 16.1 meters south of the Southern Pacifie Railway track, 1 meter north of a telegraph post, 40 meters east of a whistle post. Note 2.*

P_{10}.—Near *Romola, Boxelder County, Utah*, on the right of way of the Southern Pacifie Railway, south of the track, about 1 meter north of mile pole 719. Note 2.*

Q_{10}.—Near *Terrace, Boxelder County, Utah*, 1.3 meters north of mile pole 712 on the right of way of the Southern Pacifie Railway, 13.7 meters south of the track, and about 1.2 meters above it. Note 2.*

R_{10}.—At *Terrace, Boxelder County, Utah*, in the northeast eorner of the brick structure of the machine shop, about 1.5 meters above tho ground. Note 1.*

S_{10}.—Near *Terrace, Boxelder County, Utah*, 1 meter north of mile pole 705 on the Southern Pacifie Railway right of way, 14.7 meters south of the track. Note 2.*

* See p. 48.

T_{10}.—At *Bovine, Boxelder County, Utah*, on the Southern Pacific Railway right of way about 1.4 telegraph poles east of mile pole 699 and on the opposite side of the track, 36.8 meters west along the track of the section car house, 14.1 meters north of the main track. Note 2.*

U_{10}.—Near *Bovine, Boxelder County, Utah*, on the right of way of the Southern Pacific Railway, 1.2 meters north of mile pole 695, 14.6 meters south of the track. Note 2.*

V_{10}.—Near *Umbria Junction, Boxelder County, Utah*, 0.9 meter north of mile pole 690, 14.5 meters south of the Southern Pacific Railway track. Note 2.*

W_{10}.—At *Lucin, Boxelder County, Utah*, in the top of the southern one of the two westernmost stone pillars under the water tank. Note 1.*

X_{10}.—About one-half mile east of *Umbria Junction, Boxelder County, Utah*, between the old Terrace line of the Southern Pacific Railway and the Lucin Cut-off, 1.4 meters east of the old-line telegraph pole that stands about 75 meters northeast of the whistle post at the crossing on the main line, 53.2 meters north of the eastbound main track, about 45 meters north of the westbound main track and 20.6 meters south of the old Terrace line. Note 11.*

Y_{10}.—Near *Umbria Junction, Boxelder County, Utah*, 0.6 meter north of the sixth telegraph pole east of mile pole 679, about one-fourth mile west of the junction; at the west end of the cut that runs west from the junction point; 15.7 meters north of the eastbound track of the Southern Pacific Railway and about 0.6 meter above it. Note 11.*

Z_{10}.—Near *Umbria Junction, Boxelder County, Utah*, 0.9 meter north of mile pole 677, 14.3 meters north of the eastbound track of the Southern Pacific Railway. Note 2.*

A_{11}.—At *Gartney, Boxelder County, Utah*, directly opposite the station sign, 59.7 meters south of the eastbound track of the Southern Pacific Railway, 0.9 meter north of the south line fence. Note 11.*

I_3.—Near *Tecoma, Elko County, Nev.*, in the north side of the granite post which marks the boundary between the States of Utah and Nevada, 19.2 meters south of the Southern Pacific Railway eastbound track. Note 1.*

J_3.—At *Tecoma, Elko County, Nev.*, about two-fifths of a mile east of the Southern Pacific Railway station; 6 telegraph poles east of mile pole 670, opposite the east post of a rail-rack; 15.3 meters south of the eastbound track, 0.8 meter north of a telegraph pole. Note 11.*

K_3.—Near *Tecoma, Elko County, Nev.*, 73.2 meters south of mile pole 668, 59.8 meters south of the eastbound main track of the Southern Pacific Railway, 1.3 meters north of the south line fence. Note 11.*

L_3.—Near *Tecoma, Elko County, Nev.*, situated 47 meters north from mile pole 666, 56.3 meters north from the westbound track of the Southern Pacific Railway, 0.9 meter south of the north line fence. Note 2.*

M_3.—At *Akbar, Elko County, Nev.*, about 9 telegraph poles east of mile pole 665 with two semaphore towers in range, 60.2 meters south of the Southern Pacific Railway main track, 1 meter north of the south line fence. Note 11.*

N_3.—About one mile east of *Montello, Elko County, Nev.*, 47 meters north of mile pole 664, 56.5 meters north of eastbound line of the Southern Pacific Railway, 100 meters east of cattle guard, 1 meter south of the north line fence. Note 2.*

O_3.—At *Montello, Elko County, Nev.*, in the top surface of the western one of the two northernmost stone pillars under the water tank. Note 1.*

P_3.—At *Montello, Elko County, Nev.*, in the southeast corner of the grass plat in front of the Southern Pacific Hotel, about 1 meter from the corner. Note 11.*

Q_3.—At *Banvard, Elko County, Nev.*, in line with the west side of the section house, 60 meters north of the eastbound track of the Southern Pacific Railway, 1.3 meters south of the north line fence. Note 11.*

R_3.—At *Noble, Elko County, Nev.*, directly opposite the station sign on the northwest side of the Southern Pacific Railway track at the rear of the signal tender's dwelling; about 1 meter southeast of the northwest line fence. Note 11*.

S_3.—At *Ullin, Elko County, Nev.*, directly opposite the station sign in a fence corner 59.2 meters northwest of the eastbound line of the Southern Pacific Railway, 7 telegraph poles northeast of mile pole 656. Note 11.*

T_3.—At *Wright, Elko County, Nev.*, 43 meters northwest of mile pole 654, 57.7 meters northwest of the Southern Pacific Railway track, 1.2 meters southeast of the northwest line fence. Note 11.*

U_3.—At *Loray, Elko County, Nev.*, opposite the yellow dwelling house of the section foreman, 1 telegraph pole west of section car house 46, 6 telegraph poles east of mile pole 652, 60.3 meters north of the Southern Pacific Railway main track, 0.9 meter south of the north line fence. Note 11.*

V_3.—At *Omar, Elko County, Nev.*, 0.6 meter north of the eleventh telegraph pole east of mile pole 647, 5.6 meters north of the station sign, 15.0 meters north of the main track of the Southern Pacific Railway. Note 11.*

W_3.—At *Cobre, Elko County, Nev.*, 0.9 meter northeast of the fourth telegraph pole northwest of the railway station, 14.2 meters northeast of the main track of the Southern Pacific Railway, about 100 meters northwest of the freight station. Note 11.*

X_3.—At *Cobre, Elko County, Nev.*, 0.9 meter northeast of mile pole 645, 14.4 meters northeast of the Southern Pacific Railway and about 1 meter below the track. Note 2.*

Y_3.—Near *Cobre, Elko County, Nev.*, 7 telegraph poles east of mile pole 643, the top of an iron spike in the top of the north headwall of culvert No. 643A.

Z_3.—At *Valley Pass, Elko County, Nev.*, situated 1 meter south of the first telegraph pole east of the Southern Pacific Railway station, about 15 meters south of the track and within the turning wye. Note 11.*

A_4.—Near *Valley Pass, Elko County, Nev.*, about 3.7 telegraph poles east of the mile pole 640, 75 meters west of the crossing, 29.3 meters north of the Southern Pacific Railway track, 1.4 meters south of the north line fence. Note 2.*

* See p. 48.

B_4.—At *Icarus, Elko County, Nev.*, 44 meters north of mile pole 638, 60 meters north of the main line of the Southern Pacific Railway, 1.2 meters south of the north line fence. Note 11.*

C_4.—Near *Icarus, Elko County, Nev.*, 50 meters west of the mile pole 635, on the east slope of a hill at the east end of a deep cut, 28.9 meters north of the Southern Pacific Railway track, and about on the level with the track near the set-off stand, 0.9 meter south of the north line fence. Note 2.*

D_4.—At *Pequop, Elko County, Nev.*, in front of the section hands' quarters, 1 meter north of mile pole 633, 10 meters west of section car house No. 44. Note 11.*

E_4.—At *Fenelon, Elko County, Nev.*, about 30 meters east of the Southern Pacific Railway station (628.4), 59.5 meters north of the main track. Note 11.*

F_4.—Near *Holborn, Elko County, Nev.*, 2 telegraph poles east of mile pole 627, 28 meters north of the Southern Pacific Railway track, 0.9 meter south of the north line fence. Note 2.*

G_4.—At *Holborn, Elko County, Nev.*, 40 meters east of section car house No. 43, 17.1 meters north of the main track of the Southern Pacific Railway, 0.8 meter north of a white telegraph pole which is 2 telegraph poles east of the station sign. Note 11.*

H_4.—At *Anthony, Elko County, Nev.*, directly opposite the station sign, 6 telegraph poles west of the water tank, 29.9 meters south of the Southern Pacific Railway main track, 1.2 meters north of the south line fence. Note 11.*

I_4.—At *Moor, Elko County, Nev.*, about 10 meters west of the Southern Pacific Railway station, 1 meter north of a white telegraph pole, 15 meters north of the main track, and about 1.5 meters below it. Note 11.*

J_4.—At *Cedar, Elko County, Nev.*, 35 meters east of the station sign, about 2 telegraph poles east and 0.7 meter north of mile pole 614, 16.8 meters north of the Southern Pacific Railway track. Note 11.*

K_4.—At *Kaw, Elko County, Nev.*, 1 meter north of mile pole 612, 10.5 meters north of the Southern Pacific Railway main track. Note 11.*

L_4.—Two miles east of *Wells, Elko County, Nev.*, 0.9 meter north of mile pole 610, 10 meters north of the Southern Pacific Railway track. Note 11.*

M_4.—At *Wells, Elko County, Nev.*, 1 meter north of the telegraph pole opposite the east end of the Southern Pacific Railway station, 12 meters north of main track. Note 11.*

N_4.—At *Wells, Elko County, Nev.*, in the western one of the two northernmost concrete pillars under the Southern Pacific Railway water tank. Note 1.*

O_4.—Near *Wells, Elko County, Nev.*, on the east slope of a hill at the east end of a deep cut, 3 telegraph poles west of mile pole 607, 65.5 meters north of the Southern Pacific Railway track, 1.3 meters south of the north line fence. Note 2.*

P_4.—Near *Wells, Elko County, Nev.*, at mile pole 606, 1 meter south of the north line fence, 27.7 meters north of the Southern Pacific Railway track, and about 1.5 meters below it. Note 2.*

Q_4.—At *Alazon, Elko County, Nev.*, 4.4 telegraph poles east of Southern Pacific Railway mile pole 604, one-quarter mile west of the station sign, 28 meters north of the track, 32.4 meters north of Western Pacific Railway track; and 0.9 meter south of the north line fence. Note 11.*

R_4.—Near *Tulasco, Elko County, Nev.*, on the Southern Pacific Railway and near *Starr*, on the Western Pacific Railway at Southern Pacific mile pole 600, 4½ telegraph poles west of Western Pacific mile pole 709, 29.1 meters south of the Western Pacific track, 33.5 meters south of the Southern Pacific Railway track, 1.3 meters north of the south line fence. Note 11.*

S_4.—Near *Nardi, Elko County, Nev.*, one-half mile west of the west end of the siding, 12 telegraph poles west of Southern Pacific mile pole 595, 18 telegraph poles west of Western Pacific mile pole 704, 75 meters west of signal tower 5948, and 27.9 meters north of the Southern Pacific track, 32.3 meters north of the Western Pacific track, and 0.9 meter south of north line fence. Note 11.*

T_4.—About 1 mile east of *Deeth, Elko County, Nev.*, about 200 meters west of the point where the Southern Pacific Railway begins to separate from the Western Pacific Railway, 3 telegraph poles west of Southern Pacific mile pole 592, 7 telegraph poles west of Western Pacific mile pole 701, 4.3 meters south of Southern Pacific track, 5.6 meters north of the Western Pacific track. Note 2.*

U_4.—At *Deeth, Elko County, Nev.*, about one-half mile west of the Southern Pacific Railway station, 35 meters east of the west end of the siding, 0.7 meter south of the first telegraph pole east of signal tower 590.5, 15.5 meters south of the main track. Note 2.*

V_4.—At *Natchez, Elko County, Nev.*, 4 telegraph poles east of mile pole 587 in range with signal towers 5871 and 5872, 17.4 meters south of the Southern Pacific Railway track; 1.7 meters south of the south line fence, outside the right of way. Note 2.*

W_4.—At *Halleck, Elko County, Nev.*, 106 meters north of the Southern Pacific main track, 1.6 meters south of the north line fence, in range with the east gable of the railway station and about 1.5 meters above the track. Note 11.*

X_4.—At *Elburz, Elko County, Nev.*, 2.8 meters north of mile pole 575, 18.9 meters north of the Southern Pacific Railway track, 20 meters west of section car house No. 38. Note 11.*

Y_4.—Near *Elburz, Elko County, Nev.*, in the face of the rock at the east end of tunnel No. 5, north of the Southern Pacific Railway track, and about 0.6 meter above it. Note 1.*

Z_4.—At *Ryndon, Elko County, Nev.*, 100 meters east of the station, 12 meters south of the Southern Pacific Railway track, 10 meters north of the Western Pacific Railway track, 1 meter west of a telegraph pole. Note 11.*

* See p. 48.

A_5.—Near *Ryndon, Elko County, Nev.*, in the top surfaco of tho west abutment of Southern Pacific Railway bridge No. 25 over Humboldt River, 300 meters east of tunnel No. 3, south of the track. Note 1.*

B_5.—At *Osino, Elko County, Nev.*, 50.7 meters east of section car house No. 36, 0.9 meter east of a telegraph pole, 30.3 meters north of the Southern Pacific main track. Note 11.*

C_5.—At *Coin, Elko County, Nev.*, 6.8 meters north of Southern Pacific Railway mile pole 562, 21 meters north of the Southern Pacific main track, about one-quarter mile northeast of Western Pacific mile pole 670. Note 11.*

D_5.—About 2 miles east of *Elko, Elko County, Nev.*, 11.8 meters north of mile pole 560, 23.5 meters north of Southern Pacific Railway track, 1.5 meters south of the fence. Note 2.*

E_5.—About three-fourths of a mile east of *Elko, Elko County, Nev.*, 8 telegraph poles east of mile pole 558, 58.8 meters north of the Southern Pacific Railway track, 1.1 meters south of the north line fence, and about 100 meters east of the cattle guard. Note 11.*

F_5 (U. S. G. S.).—At *Elko, Elko County, Nev.*, in the top surface, at the west end of the lower step leading to the south entrance of the Elko County courthouse; a cross marks the exact point. Note 17.*

G_5.—At *Elko, Elko County, Nev.*, 50 meters east of signal tower 567.3 at the west end of the Southern Pacific siding, about one-half mile west of the railway station, 12.7 meters north of the track, and 1.3 meters north of a telegraph pole. Note 11.*

H_5.—About 3 miles west of *Elko, Elko County, Nev.*, 1.2 meters north of Southern Pacific Railway mile pole 555, 15.5 meters north of the track. Note 2.*

I_5.—Near *Avenel, Elko County, Nev.*, 1.2 meters north of mile pole 553, and 15.6 meters north of the Southern Pacific Railway track. Note 2.*

J_5.—At *Avenel, Elko County, Nev.*, 75 meters east of the station sign, 30 meters west of the crossing, 58.7 meters south of the Southern Pacific Railway main track, and 2.6 meters north of the fence. Note 11.*

K_5.—Near *Avenel, Elko County, Nev.*, 49 meters north of mile pole 550, 64 meters north of Southern Pacific Railway tracks, and 1.9 meters south of the north line fence. Note 2.*

L_5.—Near *Moleen, Elko County, Nev.*, 34 meters north of mile pole 548, 48.3 meters north of the Southern Pacific Railway track, 1.3 meters south of the north line fence. Note 2.*

M_5.—At *Moleen, Elko County, Nev.*, 3 telegraph poles west of mile pole 546, opposite the station sign, 1 meter north of the south line fence, 61.3 meters south of the Southern Pacific Railway main track. Note 11.*

N_5.—Near *Moleen, Elko County, Nev.*, in the top surface of the west abutment of Southern Pacific Railway bridge No. 24 over Humboldt River, north of the track. Note 1.*

O_5.—Near *Tonka, Elko County, Nev.*, at mileage distance 542.6, in the top surface of the west abutment of bridge No 21 over Humboldt River, south of the track. It is the top of an iron pin.

P_5.—At *Tonka, Elko County, Nev.*, 3.1 meters north of mile pole 542, 22.4 meters north of the Southern Pacific Railway main track, 39.2 meters south of the north line fence. Note 11.*

Q_5.—Near *Tonka, Elko County, Nev.*, in the top surface of the west abutment of Southern Pacific Railway bridge No. 20 over Humboldt River, south of the track. It is the top of an iron bolt.

R_5.—Near *Vivian, Elko County, Nev.*, in the top surface of the east abutment of bridge No. 19 over Humboldt River, south of the track. It is the top of an iron bolt.

S_5.—At *Vivian, Elko County, Nev.*, 65.9 meters south of the station sign, on the right of way of the Southern Pacific Railway, 59.6 meters south of the main track, 1.4 meters north of the line fence between the Southern Pacific Railway and the Western Pacific Railway, 16.3 meters north of the Western Pacific track, 9.3 telegraph poles east of Western Pacific mile pole 647, 2.8 telegraph poles west of Southern Pacific mile pole 539. Note 11.*

T_5.—At *Carlin, Elko County, Nev.*, in the grass plot halfway between the Southern Pacific Hotel and the Southern Pacific Railway station, 1 meter south of the front fence. Note 11.*

U_5.—About 2 miles west of *Carlin, Elko County, Nev.*, 100 meters west of crossing 534A, 41 meters north of mile pole 534, 56 meters north of the Southern Pacific Railway track, 1.7 meters south of the north line fence. Note 11.*

V_5.—At *Tyrol, Eureka County, Nev.*, approximately at mile pole 532.6, 7.5 meters east of the station sign, 13.7 meters east of the Southern Pacific Railway main track, 1.4 meters west of the east line fence.

W_5.—At *Palisade, Eureka County, Nev.*, 75 meters west of the west end of Southern Pacific Railway bridge No. 16 over Humboldt River, 30 meters east of tunnel No. 1, 13.7 meters north of the track, 14.5 meters south of the north line fence, 1 meter east of a telegraph pole. Note 11.*

X_5.—At *Gerald, Eureka County, Nev.*, near the fence corner at the west end of the siding, 8 telegraph poles west of the station sign, 29.2 meters south of the Southern Pacific Railway track, 1 meter from the south line fence. Note 11.*

Y_5.—At *Harney, Eureka County, Nev.*, 2.4 telegraph poles east of mile pole 518, 6.6 poles west of the station sign, 30 meters north of the Southern Pacific Railway track, 0.6 meter south of the fence. Note 11.*

Z_5.—At *Cluro, Eureka County, Nev.*, 3.3 telegraph poles east of the station sign and of Southern Pacific Railway mile pole 514, 5.3 meters south of the second telegraph pole west of the Western Pacific Railway mile pole 623, 26.8 meters north of the Southern Pacific track, 34.5 meters south of the north line fence, and 19.1 meters south of the Western Pacific track. Note 11.*

A_6.—At *Beowawe, Eureka County, Nev.*, in the top surface of the concrete base of signal tower 510.1 at the east end of the siding. Note 1.*

*See p. 48.

B_6.—At *Beowawe, Eureka County, Nev.*, in the top surface of the concrete foundation (center pier) of the Western Pacific Railway water tank. Note 1.*

C_6.—At *Beowawe, Eureka County, Nev.*, 25 meters west of the west end of the Southern Pacific Railway station, 26 meters south of the Western Pacific Railway track, 19.8 meters north of the Southern Pacific track. Note 11.*

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G_6.—At *Ladoga, Eureka County, Nev.*, 0.3 mile east of the station sign, 75 meters east of mile pole 504, and 19 meters south of the Southern Pacific Railway track. Note 11.*

H_6.—At *Farrel, Eureka County, Nev.*, 120 meters east of the station sign, 10 meters east of section tool house No. 29, and 24 meters north of the Southern Pacific Railway track. Note 11.*

I_6.—At *Mosel, Lander County, Nev.*, 100 meters east of the station sign, 90 meters west of mile pole 493, 0.8 meter north of the south line fence, and 60 meters south of the Southern Pacific Railway track. Note 11.*

J_6.—At *Argenta, Lander County, Nev.*, 100 meters east of the west point of the Southern Pacific Railway siding, 1.5 meters north of the south line fence and opposite a white-painted frame ranch dwelling house. Note 11.*

K_6.—At *Rosny, Lander County, Nev.*, 30 meters east of the station sign, 1.5 meters south of Southern Pacific Railway mile pole 482. Note 11.*

L_6.—At *Battle Mountain, Lander County, Nev.*, on the southwestern one of the four central concrete pillars under the Southern Pacific Railway water tank, 50 meters west of the station. Note 1.*

M_6.—About 1.5 miles northwest of *Battle Mountain, Lander County, Nev.*, at Southern Pacific Railway mile pole 474, 51.5 meters north of the track, 9.1 meters south of the north line fence. Note 11.*

N_6.—At *Piute, Humboldt County, Nev.*, at the station sign, at Southern Pacific Railway mileage 470.8, 36.6 meters south of the track, 25.2 meters north of the south line fence. Note 11A.*

O_6.—At *Mote, Humboldt County, Nev.*, at the station sign, at Southern Pacific Railway mileage 466.3, 56.2 meters north of the track, 4.9 meters south of the north line fence. Note 11A.*

P_6.—At *Valmy, Humboldt County, Nev.*, on top of the concrete subbase of the southeastern one of the four central pillars under the Southern Pacific Railway water tank. Note 1.*

Q_6.—1.3 miles west of *Valmy, Humboldt County, Nev.*, 9 meters north of mile pole 460, 28 meters north of the Southern Pacific Railway track, 33 meters south of the north line fence. Note 11A.*

R_6.—0.3 mile west of *Stonehouse, Humboldt County, Nev.*, on top of the south headwall of concrete culvert No. 456C over Humboldt River, 3.2 meters south of the Southern Pacific Railway track, and about 1.5 meters below it. Note 1.*

S_6.—At *Herrin, Humboldt County, Nev.*, 60 meters west of the east end of the siding, 28 meters west of a yellow building, 1.4 meters north of a red building, 27.4 meters south of the Southern Pacific Railway track. Note 11A.*

T_6.—At *Iron Point, Humboldt County, Nev.*, 100 meters east of mile pole 448, 18 meters west and 36 meters north of the Southern Pacific Railway station, 60 meters north of the track, 0.7 meter south of the north line fence. Note 11A.*

U_6.—At *Comus, Humboldt County, Nev.*, 11.2 meters west of the section tool house, 17.6 meters north of the Southern Pacific Railway track, 0.5 meter south of the north line fence. Note 11A.*

V_6.—Near *Preble, Humboldt County, Nev.*, on the top surface of the east abutment of Southern Pacific Railway bridge No. 441 C, which is bridge No. 3 over Humboldt River, 2 meters north of the track. Note 1.*

W_6 (S. P.).—Near *Golconda, Humboldt County, Nev.*, in the top surface of the west abutment of Southern Pacific Railway bridge No. 2 over Humboldt River, north of the track. The bench mark is the top of a round-headed iron bolt. The stone is marked on top with the railroad's value of the elevation, 4348.238 feet.

X_6.—At *Golconda, Humboldt County, Nev.*, on the northwestern one of the concrete pillars under the Southern Pacific Railway water tank, 100 meters west of the station, 50 meters south of the track. Note 1.*

Y_6.—At *Eglon, Humboldt County, Nev.*, 41.7 meters north of the Southern Pacific Railway track, 29.2 meters north of mile pole 429, 1 meter south of the north line fence. Note 11A.*

Z_6.—At *Tule, Humboldt County, Nev.*, 250 meters west of mile pole 423, 100 meters east of the west point of the siding, 29 meters south of the Southern Pacific Railway track, 27 meters north of the south line fence, opposite the derailing switch to the spur, and in line with the telegraph poles. Note 11A.*

A_7.—At *Winnemucca, Humboldt County, Nev.*, in the foundation of the Humboldt County courthouse, to the left of the entrance on Bridge Street. Note 1.*

B_7.—At *Benin, Humboldt County, Nev.*, opposite the station sign, at Southern Pacific Railway mileage 412.2, 60.4 meters south of the track, 1.1 meters north of the south fence. Note 11A.*

C_7.—At *Rose Creek, Humboldt County, Nev.*, 36.4 meters south of the south side in line with the west side of the station, 45 meters south of the Southern Pacific Railway track, 0.9 meter north of the fence. Note 11A.*

D_7.—At *Lamar, Humboldt County, Nev.*, 0.2 mile east of the station sign, 40 meters north of mile pole 402, 59.2 meters north of the Southern Pacific Railway track, 1.3 meters north of the fence. Note 11A.*

E_7.—At *Cosgrave, Humboldt County, Nev.*, south of the Southern Pacific Railway water tank, 30 meters south of the track, 0.7 meter north of the south line fence. Note 11A.*

F_7.—At *Dodon, Humboldt County, Nev.*, 4 telegraph poles west of mile pole 393, opposite the station sign, 59.8 meters south of the Southern Pacific Railway track, 1.6 meters north of the south fence. Note 11A.*

* See p. 48.

G_7.—At *Mill City, Humboldt County, Nev.*, 175 meters west of the Southern Pacific Railway station, in the second line of telegraph poles, 0.6 meter east of the east fence around a yellow frame building, 37.6 meters south of the track. Note 11A.*

H_7.—At *Imlay, Humboldt County, Nev.*, on the top of the northeastern concrete pillar under the Southern Pacific Railway water tank. Note 1.*

I_7.—At *Humboldt, Humboldt County, Nev.*, on the south side of the concrete foundation under the yellow-painted building of the Southern Pacific Railway, opposite the water tank, about 75 meters west of the station, 25 meters north of the track. Note 1.*

J_7.—At *Valery, Humboldt County, Nev.*, 300 meters east of the station sign, 200 meters west of mile pole 373, 60 meters north of the track, 1.0 meter south of the north line fence, 4.0 meters east of a gate in the fence. Note 11A.*

K_7 (S. P.).—3 miles west of *Valery, Humboldt County, Nev.*, at railroad mileage 369.9, in the top surface of the south headwall of the culvert under the eastbound line of the Southern Pacific Railway. It is the top of a round-headed iron bolt and constitutes a bench mark of the Southern Pacific Railway.

L_7 (S. P.).—1.7 miles east of *Rye Patch, Humboldt County, Nev.*, at railroad mileage 367.7, south of the track, on the top surface of the east concrete abutment of the small bridge under the eastbound line of the Southern Pacific Railway. It is the top of a round-headed iron bolt and constitutes a bench mark of the Southern Pacific Railway.

M_7.—At *Rye Patch, Humboldt County, Nev.*, 30 meters north of mile pole 366, 49 meters north of the Southern Pacific Railway track, 35 meters south of the line fence, 20 meters east of the freight house. Note 11A.*

N_7 (S. P.).—0.6 mile west of *Rye Patch, Humboldt County, Nev.*, at railroad mileage 365.4, in the top surface of the south headwall of concrete culvert No. 365C. It is the top of a round-headed iron bolt and constitutes a Southern Pacific Railway bench mark.

O_7 (S. P.).—2 miles east of *Zola, Humboldt County, Nev.*, in the top surface of the south headwall of culvert No. 363C. It is the top of a round-headed iron bolt and constitutes a Southern Pacific Railway bench mark.

P_7.—0.3 mile east of *Zola, Humboldt County, Nev.*, at railroad mileage 361.7, 46 meters south of the Southern Pacific Railway track, 1 meter north of the south line fence. Note 11A.*

Q_7.—At *Oreana, Humboldt County, Nev.*, at railroad mileage 357.9, on the top surface of the southeastern one of the four central pillars under the Southern Pacific Railway water tank. Note 1.*

R_7.—At *Woolsey, Humboldt County, Nev.*, at railroad mileage 353.6, 150 meters west of the east end of the siding, on the top surface of the south headwall of stone culvert 353D, 10 meters south of the Southern Pacific Railway track, and about 1 meter below it. Note 1.*

S_7.—At *Kodak, Humboldt County, Nev.*, opposite the station sign, on the south side of the Southern Pacific Railway track, 100 meters west of mile pole 349, 1 meter north of the south line fence. Note 11A.*

T_7.—2.5 miles east of *Lovelocks, Humboldt County, Nev.*, 0.5 meter north of mile pole 347, 16.5 meters north of the Southern Pacific Railway track. Note 11A.*

U_7.—2 miles east of *Lovelocks, Humboldt County, Nev.*, at railroad mileage 346.4, on the south end of the east abutment of Southern Pacific Railway bridge 346B over the irrigation canal. Note 1.*

V_7.—At *Lovelocks, Humboldt County, Nev.*, 50 meters east of the station, on the north side of the northwestern one of the concrete pillars under the Southern Pacific Railway water tank, 60 meters south of the track. Note 1.*

W_7.—At *Perth, Humboldt County, Nev.*, opposite the station sign at railroad mileage 340.5 in the second line of telegraph poles, 30 meters south of the Southern Pacific Railway track. Note 11A.*

X_7.—At *Granite Point, Humboldt County, Nev.*, 20 meters west of mile pole 336, at the edge of a hummock, 100 meters west of the section foreman's house, 60 meters north of the Southern Pacific Railway track, 2.5 meters south of the line fence. Note 11A.*

Y_7.—At *Toulon, Humboldt County, Nev.*, at railroad mileage 331.8, 11.4 meters north of the station sign, 18.5 meters north of the Southern Pacific Railway track, in the first line of telegraph poles. Note 11A.*

Z_7.—At *Toy, Humboldt County, Nev.*, 30 meters west of the station, 28.5 meters north of the Southern Pacific Railway track, 0.9 meter outside of the west fence inclosing the section foreman's house, 9.6 meters north of the southwest angle of the inclosure. Note 11A.*

A_8.—At *Miriam, Churchill County, Nev.*, 6.6 meters east of the station, at railroad mileage 324.2, 29 meters south of the Southern Pacific Railway track, 0.8 meter west of a telegraph pole in the second line of poles. Note 11A.*

B_8.—1 mile east of *Huxley, Churchill County, Nev.*, at mileage 317.6 of the Southern Pacific Railway, on the east abutment of bridge 317A. Note 1.*

C_8.—At *Parran, Churchill County, Nev.*, on the south side of the southwest concrete pillar under the Southern Pacific Railway water tank. Note 1.*

D_8 (S. P.).—1.5 miles east of *Desert, Churchill County, Nev.*, at railroad mileage 308.4, in the top surface of the concrete abutment of the small Southern Pacific Railway bridge. It is the top of a round-headed bolt and constitutes a Southern Pacific Railway bench mark.

E_8.—0.9 mile west of *Desert, Churchill County, Nev.*, 1 meter north of mile pole 306, 18.8 meters north of the Southern Pacific Railway track, 50 meters east of the "distant" signal. Note 11A.*

F_8 (S. P.).—At *Upsal, Churchill County, Nev.*, at Southern Pacific Railway mileage 303.6, 200 meters east of the 1 mile sign at the east side of Upsal, in concrete culvert No. 303A. It is the top of a round-headed iron bolt and constitutes a Southern Pacific Railway bench mark.

* See p. 48.

G_8.—At *Upsal, Churchill County, Nev.*, 150 meters west of the station, on the top surface of the east abutment of the small Southern Pacific Railway bridge No. 301A, 2 meters south of the track and about 0.6 meter below it. Note 1.*

H_8 (S. P.).—1.2 miles east of *Falais, Churchill County, Nev.*, in the top surface of the west concrete abutment of the small Southern Pacific Railway bridge 299A. It is the top of a round-headed iron bolt and constitutes a Southern Pacific Railway bench mark.

I_8.—At *Massie, Churchill County, Nev.*, at Southern Pacific Railway mileage 293.2, 0.3 mile east of the east end of the siding, on the top surface of the east abutment to bridge 293A. Note 1.*

J_8.—At *Massie, Churchill County, Nev.*, at Southern Pacific Railway mileage 291.7, 0.3 mile west of the west end of the siding, on the top surface of the east abutment to Southern Pacific Railway bridge 291A. Note 1.*

K_8 (S. P.).—At *Hazen, Churchill County, Nev.*, 100 meters east of the east end of the siding, on the top surface of the east abutment of Southern Pacific Railway bridge 289A. It is the top of a round-headed iron bolt and constitutes a Southern Pacific Railway bench mark.

L_8.—At *Hazen, Churchill County, Nev.*, 0.3 mile east of the station, in the southeast concrete pillar under the Southern Pacific Railway water tank, 50 meters north of the track. Note 1.*

M_8.—At *Patna, Churchill County, Nev.*, at railroad mileage 284.7, 0.1 mile west of the section foreman's house, on the top of the west concrete abutment of the small Southern Pacific Railway bridge 284B. Note 1.*

N_8 (S. P.).—In *Lyon County*, 1.1 miles west of *Patna, Churchill County, Nev.*, at railroad mileage 282.8, in the top surface of the west abutment of small Southern Pacific Railway bridge 282C. It is the top of a round-headed iron bolt and constitutes a Southern Pacific Railway bench mark.

O_8 (S. P.).—0.5 mile east of *Argo, Lyon County, Nev.*, at railroad mileage 281.4, in the east concrete abutment to bridge 281B. It is the top of a round-headed iron bolt and constitutes a Southern Pacific Railway bench mark.

P_8.—At *Argo, Lyon County, Nev.*, 0.1 mile east of the station sign, at railroad mileage 280.5, 11.3 meters east of the derailing switch, 30.7 meters north of the Southern Pacific Railway track, and 0.4 meter south of the north line fence. Note 11A.*

Q_8.—At *Luva, Lyon County, Nev.*, at railroad mileage 277.8, 4 meters east of the station sign, 29.5 meters north of the Southern Pacific Railway track, 1 meter south of the north line fence, and 16 meters west of the point of the branch line. Note 11A.*

R_8.—At *Fernley, Lyon County, Nev.*, at railroad mileage 276.1, 16 meters west of the Southern Pacific Railway station, 59 meters north of the track, 0.8 meter south of the north line fence. The station is soon to be moved about 0.3 mile to the westward. Note 11A.*

S_8. (U. S. G. S.).—At *Fernley, Lyon County, Nev.*, 200 meters west of the Southern Pacific Railway station, 60 meters west of mile pole 276, 3 meters south of the track, on the south headwall of a concrete culvert. The station is soon to be moved about 0.3 mile to the westward. Note 17* not stamped.

T_8.—At *Gilpin, Washoe County, Nev.*, 150 meters west of the Southern Pacific Railway water tank, 200 meters east of the station sign, and 15.7 meters south of the track. Note 11A.*

U_8 (S. P.).—At *Derby, Washoe County, Nev.*, at railroad mileage 269.5, in the top surface of the west abutment of Southern Pacific Railway bridge No. 13 over the Truckee River. It is the top of a round-headed iron bolt and constitutes a Southern Pacific Railway bench mark.

V_8 (S. P.).—0.6 mile west of *Derby, Washoe County, Nev.*, at railroad mileage 268.7, in the top surface of the east abutment of Southern Pacific Railway bridge No. 12 over the Truckee River. It is the top of a round-headed iron bolt and constitutes a Southern Pacific Railway bench mark.

W_8 (S. P.).—1 mile west of *Derby, Washoe County, Nev.*, at railroad mileage 268.2, in the top surface of the east abutment of Southern Pacific Railway bridge No. 11 over the Truckee River. It is the top of a round-headed iron bolt and constitutes a Southern Pacific Railway bench mark.

X_8 (S. P.).—At *Thisbe, Washoe County, Nev.*, at railroad mileage 264.7, 0.2 mile west of the Derby Dam of the United States Reclamation Service, in the top surface of the east concrete abutment of Southern Pacific Railway bridge No. 10 over the Truckee River which goes under the bridge from north to south. It is the top of a round-headed iron bolt and constitutes a Southern Pacific Railway bench mark.

Y_8 (S. P.).—At *Thisbe, Washoe County, Nev.*, 0.5 mile west of the Derby Dam of the United States Reclamation Service at railroad mileage 264.5, in the top surface of the east abutment of Southern Pacific Railway bridge No. 9 over the Truckee River. The river goes under the bridge from south to north. It is the top of a round-headed iron bolt and constitutes a bench mark of the Southern Pacific Railway.

Z_8 (S. P.).—At *Clark, Storey County, Nev.*, 100 meters east of the east end of the siding, in the top surface of the west concrete abutment of Southern Pacific Railway bridge No. 8 over the Truckee River. It is the top of a round-headed iron bolt and constitutes a railroad bench mark.

A_9 (S. P.).—One-half mile east of *Ditho, Washoe County, Nev.*, at railroad mileage 258.1, in the top surface of the east abutment of Southern Pacific Railway bridge No. 7 over the Truckee River. It is the top of a round-headed iron bolt and constitutes a railroad bench mark.

B_9.—At *Hafed, Washoe County, Nev.*, at railroad mileage 253.1, 40 meters east of the station sign, 29.4 meters south of the Southern Pacific Railway track, on top of a large black bowlder 3 meters high. Note 1.*

C_9 (S. P.).—Near *Vista, Washoe County, Nev.*, at railroad mileage 251, on the top surface of the east abutment of Southern Pacific Railway bridge No. 6 over the Truckee River. It is the top of a round-headed iron bolt and constitutes a railroad bench mark.

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* See p. 48.

D_9 (S. P.).—In *Storey County*, 1.4 miles east of *Vista, Washoe County, Nev.*, on the west abutment of the small Southern Pacific Railway bridge 250B. It is the top of a round-headed iron bolt and constitutes a railroad bench mark.

E_9 (S. P.).—In *Storey County*, 0.6 mile east of *Vista, Washoe County, Nev.*, at railroad mileage 249.8, on the top surface of the east abutment of Southern Pacific Railway bridge No. 5 over the Truckee River. It is the top of a round-headed iron bolt and constitutes a railroad bench mark.

F_9.—At *Vista, Washoe County, Nev.*, 10.6 meters south of mile pole 249, 25.2 meters south of the Southern Pacific Railway track, 0.2 mile west of the station sign, in the angle formed by the fence at the grade crossing with the south line fence, northwest of the highway. Note 11A.*

G_9.—At *Sparks, Washoe County, Nev.*, at railroad mileage 246.3, 250 meters west of the Southern Pacific Railway station, in the angle formed by the high board fence at the grade crossing, 1 meter from fence corner, 14.9 meters north of the track. Note 11A.*

H_9.—At *Reno, Washoe County, Nev.*, a brass plate 2 by 4 inches in the granite top of the north balustrade of the east entrance to the city hall. The elevation marked on top is 96.72 feet above the zero of the city system of levels.

I_9 (U. S. G. S.).—At *Reno, Washoe County, Nev.*, on the main building of the Nevada State University in the side of the northeast corner stone. Note 17* stamped 4554.817.

J_9.—At *Lawton, Washoe County, Nev.*, 0.3 mile east of the Southern Pacific Railway station, 120 meters east of mile pole 238, on top of a large brown bowlder 1.5 meters high, 15 meters north of the westbound track. Note 1.*

K_9.—2 miles east of *Verdi, Washoe County, Nev.*, at mileage 234.1 on the old line of the Southern Pacific Railway, on the east abutment of Southern Pacific Railway bridge No. 4 on the Truckee River. Note 1*.

L_9 (S. P.).—At *Verdi, Washoe County, Nev.*, the top of the western inside base bolt of signal tower 2329, which is the "distant" signal for the east end of Verdi siding. It constitutes a Southern Pacific Railway bench mark.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN MARMOL, NEV., AND SAN FRANCISCO, CAL., 1912.

F_6.—At *Marmol, Washoe County, Nev.*, at Southern Pacific Railway mileage 230.5, in the cow pasture opposite a large red building, 75 meters south of the track, 20 meters west of the east pasture fence, 7 meters north of the south pasture fence, 100 meters east of bench mark E_6, in the top of a black bowlder. The bench mark is the top of a round-headed iron bolt.

E_6.—At *Marmol, Washoe County, Nev.*, at Southern Pacific Railway mileage 230.5, in the cow pasture opposite a large red building, 65 meters south of the track, 60 meters east of the west pasture fence, 10 meters north of the south pasture fence, on the top of a large bowlder. Note 1.*

D_6.—About 0.6 mile southwest of *Marmol, Washoe County, Nev.*, on the top of the east abutment of the Southern Pacific Railway bridge over the Truckee River. Note 1.*

Y_{10}.—At *Calvada, Sierra County, Cal.*, 5 meters west of the California-Nevada State line, on the top of the north headwall of the stone culvert under the Southern Pacific Railway tracks, and about 1.2 meters below them. Note 1.*

X_{10}.—At *Mystic, Nevada County, Cal.*, 65 meters east of the Southern Pacific Railway station, at railroad mileage 225.8, on the top of the concrete culvert under the track. Note 1.*

W_{10}.—At *Iceland, Nevada County, Cal.*, on the top of the east stone abutment of Southern Pacific Railway bridge No. 220G over the Truckee River. Note 1.*

V_{10}.—Near *Prosser Creek, Nevada County, Cal.*, 0.5 mile west along the Southern Pacific Railway track from the bridge over Prosser Creek, on top of a large volcanic bowlder. Note 1.*

U_{10}.—At *Truckee, Nevada County, Cal.*, 30 meters west of the Southern Railway passenger station, on the top surface of the northwestern one of the four central pillars under the water tank, about 1.2 meters above the rail. Note 1.*

T_{10}.—At *Tunnel, Placer County, Cal.*, 0.4 mile east of the Southern Pacific Railway station (tunnel 13), 150 meters east of the east end of the snowshed, on the top of the south headwall of stone culvert No. 201F, under the track. Note 1.*

S_{10}.—About ¼ mile east of *Eder, Placer County, Cal.*, 15 meters west of Southern Pacific Railway mile pole 198, 100 meters west of the east end of the siding, in the snowshed on the inside of the stone retaining wall, about 1 meter above the track. Note 1.*

R_{10}.—At *Summit* (*Donner* post office), *Placer County, Cal.*, on the front wall of the concrete Southern Pacific Railway station, between two front windows, about 1.2 meters above the track. Note 1.*

Q_{10}.—0.5 mile west of *Spruce, Nevada County, Cal.*, on the top of the granite abutment of the Southern Pacific bridge, south of the track, and about 0.6 meter below it. Note 1.*

P_{10}.—At *Cisco, Placer County, Cal.*, on top of a large bowlder 50 meters west of the Southern Pacific Railway Station, 10 meters north of the snowshed, about 1.5 meters below the track. Note 1.*

O_{10}.—At *Emigrant Gap, Placer County, Cal.*, on top of a large flat bowlder 3 meters east of the Southern Pacific Railway station, 2 meters outside of the snowshed on the south side of the track, and about 0.6 meter above the track. Note 1.*

N_{10}.—At *Blue Canyon, Placer County, Cal.*, on the face of the concrete drinking fountain, at the Southern Pacific Railway station, about 1.2 meters above the track. Note 1.*

M_{10}.—At *Orel, Placer County, Cal.*, 200 meters east of the Southern Pacific Railway station, on the top surface of the central concrete pillar under the water tank, about 0.3 meter above the track. Note 1.*

* See p. 48.

L_{10}.—At *Towle, Placer County, Cal.*, 0.3 milo east of the Southern Pacific Railway station, 90 meters east of milo pole 158, on the top of a bowlder 1 meter high, 20 meters north of the track, and about 1.5 meters above it. Note 1.*

K_{10}.—At *Gold Run, Placer County, Cal.*, 0.6 mile west of tho Southern Pacific Railway passenger station, on the top surface of the south headwall of concrete culvert No. 152D, under the Southern Pacific track, 3.2 meters south of the track, and about 0.6 meter below it. Note 1.*

J_{10}.—0.3 mile southwost of *Wirt, Placer County, Cal.*, on the top of the east concrete abutment to Southorn Pacific Railway bridge, about 0.6 meter below the track. Note 1.*

I_{10}.—At *Colfax, Placer County, Cal.*, on the top surface of the concrete slab in front of the drinking fountain at the Nevada County exhibit. Note 1.*

H_{10}.—At *Lander, Placer County, Cal.*, on top of the central concrete pillar under the Southern Pacific Railway watcr tank, 4½ meters abovo the track. Noto 1.*

G_{10}.—One mile northeast of *Clippergap, Placer County, Cal.*, about 1.2 meters from the east end of tunnel O of the westbound line of tho Southcrn Pacific Railway, on tho south stone wall, 0.6 meter above the top of the rail. Noto 1.*

F_{10}.—0.2 mile cast of the Southern Pacific Railway station at *Clippergap, Placer County, Cal.*, on top of tho old foundation of tho watcr tank (now removed), about 0.5 metcr below the top of the rail. Note 1.*

E_{10}.—At *East Auburn, Placer County, Cal.*, opposite the Southern Pacific Railway passenger and freight station, on the old line (now the westbound line) of the Southern Pacific Railway, on the eastern one of the two northwestern concrete pillars under the water tank, about 1 meter above tho top of the rail. Note 1.*

D_{10}.—About 0.2 mile east of *Newcastle, Placer County, Cal.*, at the west end of the Southern Pacific Railway tunnel, north of the track, on the top surface of the bottom stone of tho tunnel, 0.3 meter above the track. Note 1.*

C_{10}.—About 0.5 mile east of *Rocklin, Placer County, Cal.*, on the west side of the concrete bridgo of the Southern Pacific Railway, which carries the eastbound track over the westbound track; north of the westbound track and about 1 meter above it, about 0.46 meter from the north edge of the pier, and 1.5 meters above the ground. Noto 1.*

B_{10}.—Near *Roseville, Placer County, Cal.*, about 0.8 mile east of tho Southern Pacific Railway station, on the top surfaco of the granite abutment at the east end of Southern Pacific Railway bridge 107D, on the south side of track, and about 0.5 meter below it. Note 1.*

A_{10}.—At *Roseville, Placer County, Cal.*, on the top surface of the concrete base of signal tower 1067, 70 meters west of the Southern Pacific Railway station; 10 metcrs north of the track, and about 0.6 metcr above it. Note 1.*

Z_9 (U.S.G.S.).—About 2 miles northeast of *Antelope, Sacramento County, Cal.*, at a highway crossing, north of the Southern Pacific Railway track, 7 meters south of the north line fence, 1.6 metcrs from a fence located 18 meters north of the track, and about 3 moters above the track. Note 18,* stamped 146.

Y_9.—At *Antelope, Sacramento County, Cal.*, 90 mcters west of the Southern Pacific Railway station, on the top surface of the north headwall of the stone culvert under the Southern Pacific tracks, about 1.2 meters below the track. Note 1.*

X_9.—1.2 miles northeast of *Benali, Sacramento County, Cal.*, on the top surface of the stone abutment at the east end of the Southern Pacific Railway steel bridge No. 96C, about 0.6 meter below the track. Note 1.*

W_9.—At *Elvas, Sacramento County, Cal.*, at mile pole 92, 0.4 mile north of Elvas tower, on the top of the south concrete abutment of the Southern Pacific Railway steel bridge over the American River, east of tho track, and 2.5 meters below the top of the rail. Note 1.*

V_9.—At *Brighton, Sacramento County, Cal.*, 100 meters east of the station, on the top surface of the southwestern one of the four pillars under the Southern Pacific Railway water tank, about 3.4 meters above the ground. Note 1.*

U_9 (U. S. G. S.).—About 0.8 mile north of *Florin, Sacramento County, Cal.*, at mile pole 130, on the right of way of the Southern Pacific Railway, east of the track; 0.5 meter west of the east fence line. Note 18* stamped "36 B."

T_9 (U. S. G. S.).—About 3 miles south of *Florin, Sacramento County, Cal.*, at Southcrn Pacific Railway mile pole 126, north of the highway crossing, east of the track, 10 meters south of the angle of the fence. Noto 18* stamped "37 B."

S_9 (U. S. G. S.).—At *Elk Grove, Sacramento County, Cal.*, at the southwest corner formed by the Southern Pacific right of way with the main street of Elk Grove, west of the track, opposite the north end of the Southern Pacific Railway station between two poles set about 2.5 meters apart. Note 18* stamped "49 B."

R_9 (U. S. G. S.).—At *McConnell, Sacramento County, Cal.*, 0.2 meter northeast of the northeast corner of the small house, between the Southern Pacific Railway track and the county road. Note 18* stamped "46 B."

Q_9.—At *Need, Sacramento County, Cal.*, 375 meters south of the station sign, 30 meters south of mile pole 115, on the top of the north concrete abutment to the Southern Pacific Railway bridge, about 0.3 meter below the track. Note 1.*

P_9. (U. S. G. S.).—At *Galt, Sacramento County, Cal.*, on the right of way of the Southern Pacific Railway, in line with the north end of the railway station; 13.1 meters west of the main line, 0.6 meter from the northwest corner of the grass park. Note 18* stamped "46 B."

O_9 (U. S. G. S.).—At *Jahant, San Joaquin County, Cal.*, 8 meters south of mile pole 108, on the Southern Pacific Railway right of way, at crossing 107F; 0.9 meter north of the north highway fence, 11.3 meters east of the track. Note 18* stamped "48 B."

N_9.—1 mile north of *Acampo, San Joaquin County, Cal.*, on the top surface of the north concrete abutment of Southern Pacific Railway bridge No. 107D, about 0.6 meter below the top of the rail. Note 1.*

* See p. 48.

M_9 (U. S. G. S.).—1 mile south of *Acampo, San Joaquin County, Cal.*, at crossing 105A, in the north margin of the road, 16 meters east of the Southern Pacific Railway track, 6.4 meters south of the north crossing fence. Note 18* stamped "53 B."

L_9.—At *Lodi, San Joaquin County, Cal.*, 200 meters north of the Southern Pacific Railway station in the east face of the northeast pillar under the water tank. Note 1.*

K_9 (U. S. G. S.).—1½ miles south of *Lodi, San Joaquin County, Cal.*, 75 meters south along the track from mile pole 102, in the edge of a cultivated field, 16.3 meters east of the Southern Pacific Railway track, 0.9 meter east of the fence corner at the crossing north of the road, about 1.2 meters below the track. Note 18* stamped "45 B."

J_9 (U. S. G. S.).—At *Pearson, San Joaquin County, Cal.*, 7.7 meters north along the track from mile pole 99 on the right of way of the Southern Pacific Railway, 0.3 meter west of the east line fence, 4.8 meters east of the track, and about 1 meter below it. Note 18* stamped "37 B."

I_9.—1.2 miles north of *Hammer, San Joaquin County, Cal.*, at railroad mileage 96.8, in the west headwall of concrete culvert 96B, under the Southern Pacific Railway track. Note 1.*

H_9 (U. S. G. S.).—One-half mile north of *Hammer, San Joaquin County, Cal.*, 11.8 meters north along the track from mile pole 96, on the right of way of the Southern Pacific Railway, 0.8 meter west of the east line fence, 15 meters east of track, and about 1 meter below it. Note 18* stamped "28 B."

G_9.—0.8 mile north of *El Pinal, San Joaquin County, Cal.*, in the north abutment of bridge 93A, west of the Southern Pacific Railway track, about 0.6 meter below the top of the rail. Note 1.*

F_9 (U. S. G. S.).—About 2 miles north of *Stockton, San Joaquin County, Cal.*, 10 meters north along the track from mile pole 93, 0.5 meter west of the east line fence on the right of way of the Southern Pacific Railway, 15.7 meters east of the track, and about 1 meter below it. Note 18* stamped "20 B."

E_9.—At *Stockton, San Joaquin County, Cal.*, in the Western Pacific Railway station, in the west side of the southwest pillar of the portico at the south end. Note 1.*

D_9.—At *Stockton, San Joaquin County, Cal.*, in the top of the concrete curbing around a palm tree, in the passageway between the Southern Pacific Railway waiting room and baggage room. Note 1.*

C_9.—About 2 miles south of *Stockton, San Joaquin County, Cal.*, in the east headwall of concrete culvert No. 87B under the Southern Pacific Railway track, 140 meters north of the Western Pacific Railway crossing, about 0.6 meter below the track. Note 1.*

B_9 (U. S. G. S.).—About 1 mile north of *French Camp, San Joaquin County, Cal.*, 0.6 meter east of Southern Pacific Railway mile pole 87, 1 meter below the track. Note 18* stamped "15 B." This bench mark of the United States Geological Survey, the position of which was originally published as 8 feet south of mile post 88, was found washed out and relocated as described above.

A_9.—About 0.7 mile north of *French Camp, San Joaquin County Cal.*, at railroad mileage 86.7, on the east headwall of concrete culvert No. 86C of the Southern Pacific Railway, about 0.6 meter below the track. Note 1.*

Z_8.—Near *French Camp, San Joaquin County, Cal.*, in the east headwall of concrete culvert 84A under the Southern Pacific Railway track. Note 1.*

Y_8 (U. S. G. S.).—Near *Lathrop, San Joaquin County, Cal.*, 40 meters south along the track from Southern Pacific Railway mile pole 84, 0.6 meter south of the north highway fence at the crossing, 11.5 meters east of the Southern Pacific northbound track. Note 18* stamped "19 B."

X_8.—At *Lathrop, San Joaquin County, Cal.*, 100 meters north of the Southern Pacific Railway station in the southeast pillar of the water tank. Note 1.*

W_8 (U. S. G. S.).—At *Lathrop, San Joaquin County, Cal.*, about 75 meters north of the Southern Pacific Railway station, west of the tracks, at the fence line, 15 meters south of the water tank. Note 18* stamped "20 B."

V_8.—Near *Lathrop, San Joaquin County, Cal.*, at railroad mileage 78.1, at the west end of the viaduct leading to the west end of the Southern Pacific Railway bridge 78B over the San Joaquin River, on the top surface of the bearing stone of the northwest pier, about 1.8 meters below the top of the rail. Note 1.*

U_8.—1 mile northeast of *Banta, San Joaquin County, Cal.*, in the top surface of the east abutment to Southern Pacific Railway bridge 74C, south of the track. Note 1.*

T_8 (U. S. G. S.).—At *Banta, San Joaquin County, Cal.*, opposite mile pole 74 on the Southern Pacific Railway right of way, 250 meters east of the Southern Pacific station. Note 18* stamped "22.121."

S_8. (U. S. G. S.).—At *Tracy, San Joaquin County, Cal.*, about 0.3 mile east of the Southern Pacific Railway station 2 meters north of mile pole 71, 0.3 meter south of the line fence on the right of way of the Southern Pacific Railway. Note 18* stamped "53.927."

R_8.—At *Tracy, San Joaquin County, Cal.*, 150 meters east of the Southern Pacific Railway station, in the top surface of the southwest concrete pillar under the water tank. Note 1.*

Q_8.—At *Tracy, San Joaquin County, Cal.*, 75 meters west of the Southern Pacific Railway station, in the north face of the northwest concrete pillar under the water tank. Note 1.*

P_8 (U. S. G. S.).—Near *Tracy, San Joaquin County, Cal.*, 10 meters along the track east of mile pole 68, on the Southern Pacific Railway right of way, 1 meter from the south line fence, about 1 meter below the track. Note 18* stamped "102.656".

O_8 (U. S. G. S.).—At *Midway, Alameda County, Cal.*, about 1.5 meters east of mile pole 63, about 150 meters east of the station on the south side of the track on the Southern Pacific Railway right of way. Note 18* stamped "351.341."

*See p. 48.

N_8.—Near *Midway, Alameda County, Cal.*, in the concrete base of Southern Pacific Railway signal tower 625. Note 1.*

M_8.—Near *Cayley, Alameda County, Cal.*, 100 meters west of Southern Pacific Railway mile pole 60, 125 meters of the east end of Cayley siding, in the face of a rocky cut, about 1.2 meters above the track. Note 1.*

L_8.—Near *Altamont, Alameda County, Cal.*, at Southern Pacific railway mileage 57.9, on the north side at the east entrance to Southern Pacific tunnel No. 1, about 0.2 meter from the end of tunnel and 1 meter above the track. Note 1.*

K_8.—One-half mile east of *Altamont, Alameda County, Cal.*, on the south abutment to the Western Pacific Railway crossing over the Southern Pacific track, about 1 meter above the Southern Pacific track. Note 1.*

J_8 (U. S. G. S.).—At *Altamont, Alameda County, Cal.*, about 60 meters east of the Southern Pacific Railway station, between the Southern Pacific main track and the county pike, abreast of the derailing switch to the siding. Note 18* stamped "739.899."

I_8.—Near *Altamont, Alameda County, Cal.*, at Southern Pacific Railway mileage 53.7, on the south headwall of Southern Pacific culvert 53G, about 0.6 meter below the track. Note 1*.

H_8.—Near *Livermore, Alameda County, Cal.*, at Southern Pacific Railway mileage 52.2, on the north abutment of the overhead crossing of the Western Pacific Railway over the Southern Pacific Railway, about 1.2 meters above the Southern Pacific track. Note 1.*

G_8.—About 2 miles east of *Livermore, Alameda County, Cal.*, at Southern Pacific mileage 49.1 on the south abutment of the overhead crossing of the Western Pacific Railway over the Southern Pacific Railway, about 1 meter above the Southern Pacific track. Note 1.*

F_8 (U. S. G. S.).—At *Livermore, Alameda County, Cal.*, on the Farmers' Union Building, which is the large building just east of the Southern Pacific Railway station, north of the track, in the south side wall at the southeast corner of the building. Note 17* stamped "488."

E_8.—About 1 mile west of *Livermore, Alameda County, Cal.*, south of Southern Pacific Railway bridge No. 45A, north of the highway, about 30 meters east of the water tank, on top of the wall to the west abutment of the highway bridge. Note 1.*

D_8.—At *Radum, Alameda County, Cal.*, about 1 mile east of *Pleasanton*, 0.1 mile east of the signal tower, on the east abutment of the Southern Pacific Railway concrete bridge No. 42A, south of the track, and about 3 meters east of the derailing switch. Note 1.*

C_8.—At *Pleasanton, Alameda County, Cal.*, ¼ mile west of the Southern Pacific Railway station, on the south headwall of highway culvert at Southern Pacific Railway bridge 40C, about 3 meters north of the track and 0.18 meter above the top of the rail. Note 1.*

B_8.—At *Verona, Alameda County, Cal.*, 90 meters west of the Southern Pacific Railway station, 23 meters east of the highway crossing, in the west abutment of the Western Pacific Railway overhead crossing, about 6 meters from the east edge of the abutment and 0.6 meter above the Southern Pacific track. Note 1.*

A_8.—At *Brightside, Alameda County, Cal.*, about 200 meters east of the station at mileage 34.9 on the Southern Pacific Railway, north of the track on the east abutment of the Western Pacific Railway bridge over Alameda Creek. Note 1.*

Z_7 (U. S. G. S.).—At *Farwell, Alameda County, Cal.*, about 60 meters east of the Southern Pacific Railway station, 12 meters north of the track. Note 18* stamped "167.099."

Y_7.—About 1 mile east of *Niles, Alameda County, Cal.*, east of the track, on the north end of Southern Pacific Railway bridge No. 30D over Alameda Creek. Note 1.*

X_7.—At *Niles, Alameda County, Cal.*, about 60 meters west of the railway station, on the southern one of the two easternmost pillars under the wooden water tank. Note 1.*

W_7.—At *Niles, Alameda County, Cal.*, one-half mile south of the railway station, about 9 meters north of the crossing of the Southern Pacific and Western Pacific Railways, east of the track, on top of rock abutment of Southern Pacific Railway bridge over the river. Note 1.*

V_7.—At *Irvington, Alameda County, Cal.*, about 90 meters north of the Southern Pacific Railway station, on the west headwall of culvert under the tracks. Note 1.*

U_7.—Near *Warmsprings, Alameda County, Cal.*, on the west headwall of culvert 34E under the Southern Pacific Railway track. Note 1.*

T_7.—At *Warmsprings, Alameda County, Cal.*, about 90 meters north of the Southern Pacific Railway station, on the west headwall of culvert 36B under the crossing of the track and the highway. Note 1.*

S_7.—Near *Warmsprings, Alameda County, Cal.*, in the west headwall of culvert 38A under the Southern Pacific Railway track, and about 0.6 meter below it. This benchmark has probably been destroyed or moved. Note 1.*

R_7.—Near *Milpitas, Santa Clara County, Cal.*, at Southern Pacific Railway mileage 39.9, in the top surface of the west headwall of the culvert under the county road, about 24 meters east of the track and about 1 meter above the county road. Note 1.*

Q_7.—Near *Wayne, Santa Clara County, Cal.*, at mileage 43.9 of the Southern Pacific Railway, in the top of the south abutment to bridge 43G, east of the track and about 0.5 meter below it. Note 1.*

P_7 (U. S. G. S.).—At *San Jose, Santa Clara County, Cal.*, on the north balustrade of the east entrance to the Hall of Records, about 1.5 meters above the ground. Note 17* stamped "98 S. F."

* See p. 48.

O_7.—At *San Jose, Santa Clara County, Cal.*, just west of the Southern Pacific Railway station, south of the tracks, in the northwestern one of the four central pillars under the Southern Pacific water tank. Note 1.*

N_7.—At *Santa Clara, Santa Clara County, Cal.*, north of Southern Pacific Railway station, in the south end of the large grass park. Note 11A.*

M_7.—At *Lawrence, Santa Clara County, Cal.*, opposite the Southern Pacific Railway station, on the right of way, 40.9 meters north of the track, 1.9 meters from the line fence, 8.9 meters west of the road fence. Note 11A.*

L_7.—At *Sunnyvale, Santa Clara County, Cal.*, in the east end of the grass park which lies northwest of the Southern Pacific Railway station. Note 11A.*

K_7.—At *Mountain View, Santa Clara County, Cal.*, north of the Southern Pacific Railway station, in the south side of the northern one of the two circular grass parks. Note 11A.*

J_7.—At *Mayfield, Santa Clara County, Cal.*, in the south end of the small grass park, north of the Southern Pacific Railway station, and west of the track. Note 11A.*

I_7.—At *Palo Alto, Santa Clara County, Cal.*, in the north end of the small grass park east of the Southern Pacific Railway, and south of University Avenue. Note 11A.*

H_7.—In *San Mateo County* near *Palo Alto, Santa Clara County, Cal.*, west of the track, on the top surface of the stone abutment at the north end of the Southern Pacific Railway bridge over San Francisquito Creek, which forms the boundary between San Mateo and Santa Clara Counties. Note 1.*

G_7.—At *Menlo Park, San Mateo County, Cal.*, on the opposite side of the alley from the Oak Grove Villa Hotel, in the top of a concrete sphere on a corner post, about 1.2 meters above the ground. Note 1.*

F_7.—At *Redwood City, San Mateo County, Cal.*, north of the Southern Pacific Railway station, in the north corner of the triangular grass park. Note 11A.*

E_7.—At *San Carlos, San Mateo County, Cal.*, On the Southern Pacific Railway station, in the east side of the eastern stone post that supports the roof over the passage way, about 0.23 meter above the pavement. Note 1.*

D_7.—At *Belmont, San Mateo County, Cal.*, north of the Southern Pacific Railway station, in the south end of the grass park, midway between the rail and the fence. Note 11A.*

C_7.—At *Beresford, San Mateo County, Cal.*, about 300 meters north of the Southern Pacific Railway station, in the concrete foundation of signal tower 202, west of the track. Note 1.*

B_7.—At *San Mateo, San Mateo County, Cal.*, in the top of the concrete wall at the east entrance to the small park at the Southern Pacific Railway passenger station, about 0.3 meter north of the north pillar. Note 1.*

A_7.—At *San Mateo, San Mateo County, Cal.*, on Ellsworth Avenue about one-half mile north of the Southern Pacific Railway station, in the south side of the F. A. M. building, about 3 meters from the southeast corner and about 1 meter above the ground. Note 1.*

Z_6.—At *Burlingame, San Mateo County, Cal.*, in the foundation on the east side of the Southern Pacific Railway station, in front of the ticket window, about 0.15 meter above the pavement. Note 1.*

Y_6.—At *Millbrae, San Mateo County, Cal.*, in the east wall of the power substation, about 1 meter from the northeast corner and about 1.5 meters above the brick pavement. Note 1.*

X_6.—At *San Bruno, San Mateo County, Cal.*, about 15 meters northeast of the Southern Pacific Railway station, the top of the southern inside base bolt of signal tower 108.

W_6.—At *Holy Cross, San Mateo County, Cal.*, north of the stone building at the entrance to Holy Cross Cemetery, between the Southern Pacific Railway track and the street, on the eastern side of a large conical rock, on the east side of the fountain. Note 1.*

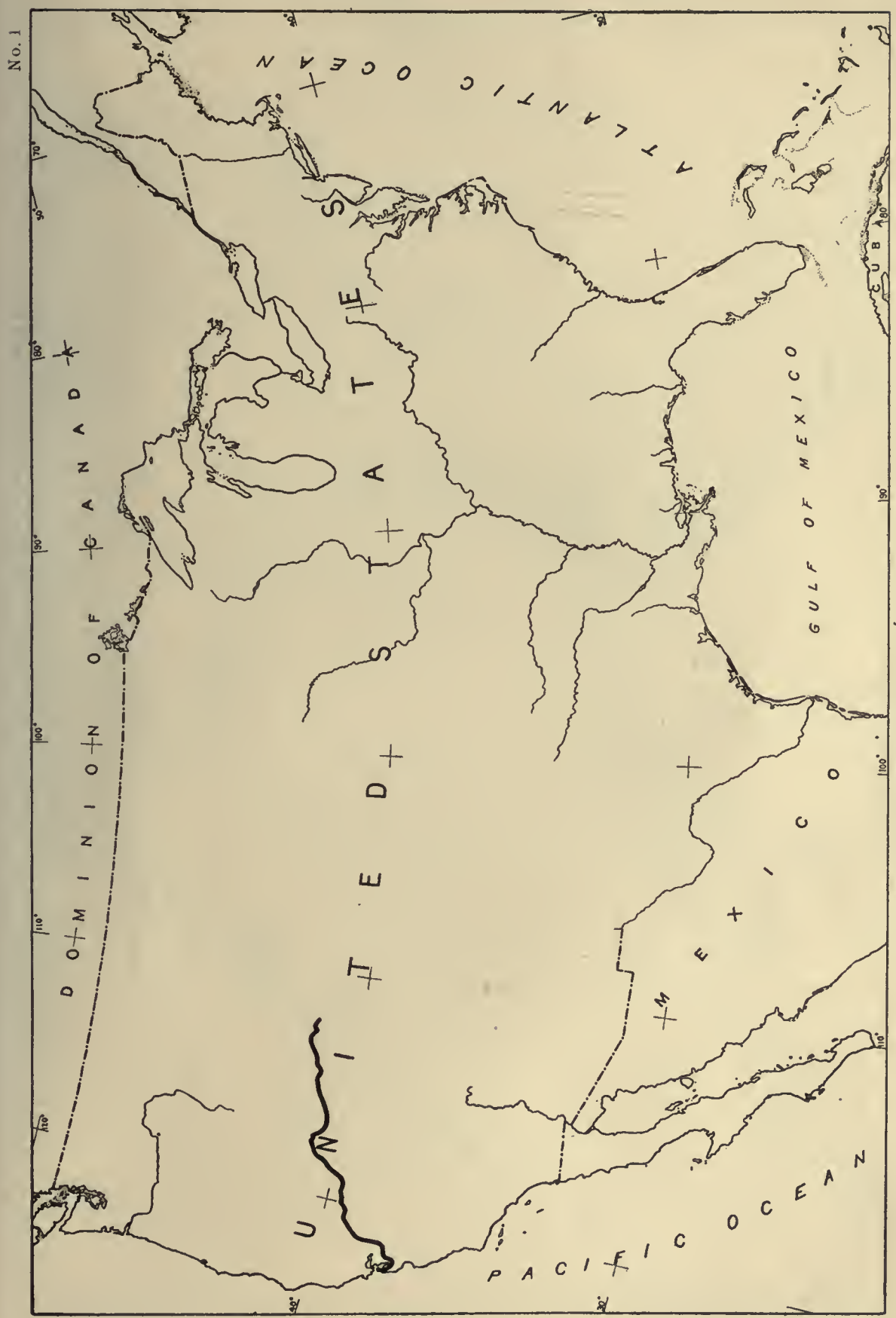
City 418.—At *San Francisco, San Francisco County, Cal.*, on the north side of Sickles Avenue about 35 meters west of Huron Avenue and just to the left of the entrance to No. 110 Sickles Avenue. The bench mark is a cross on the cement surface at the west end of an iron gateway.

City 386.—At *San Francisco, San Francisco County, Cal.*, on the south side of Ocean Avenue about 12 meters east of San Jose Avenue. The bench mark is a cross at the west end of the bottom step to the side entrance to a saloon.

City 640.—At *San Francisco, San Francisco County, Cal.*, at the intersection of San Jose, Circular, and Joost Avenues. The bench mark is a cross at the southeast corner rail guard around the Southern Pacific Railway gate post, about 1 meter above the ground.

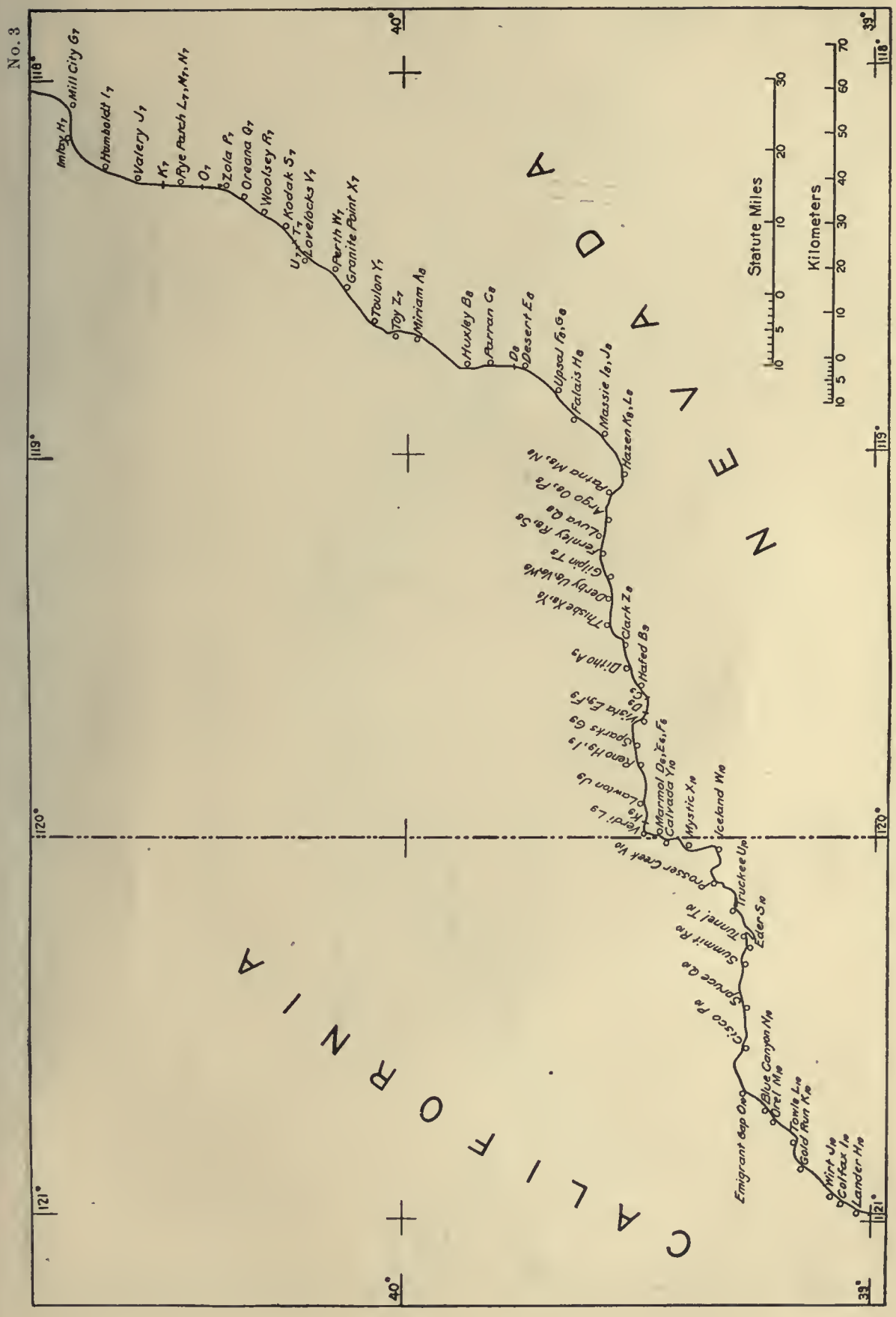
City 635.—At *San Francisco, San Francisco County, Cal.*, on the north side of Bosworth Street opposite Lyell Street. The bench mark is a cross on the head of an iron spike embedded in the top of the dome at the east end of the east concrete retaining wall at the entrance to the culvert under the Southern Pacific Railway viaduct.

* See p. 48.



INDEX MAP SHOWING GENERAL LOCATION OF THE LEVELING

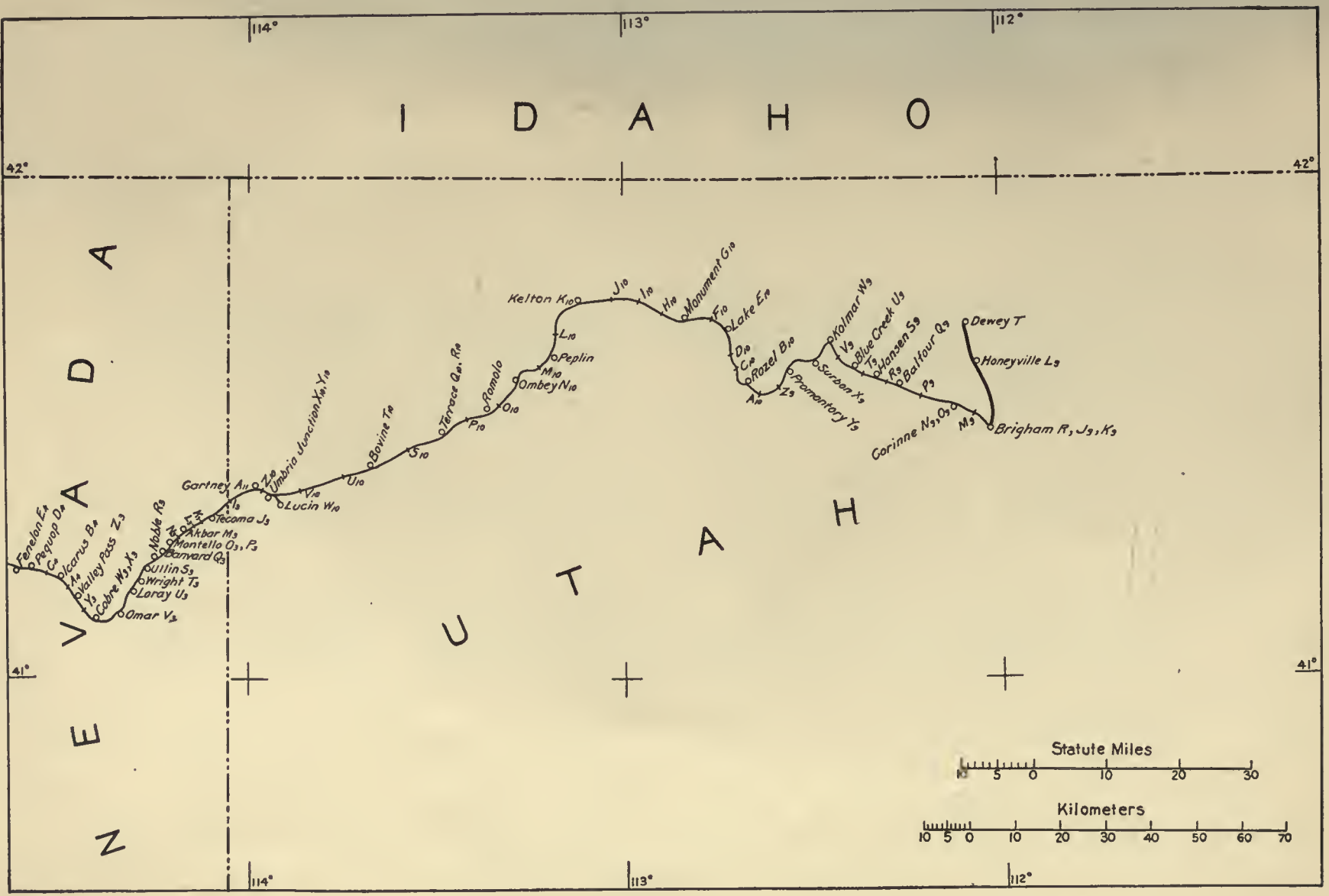
LOCATION OF BENCH MARKS BETWEEN SAN FRANCISCO AND CLIPPERGAP, CAL.



LOCATION OF BENCH MARKS BETWEEN CLIPPERGAP, CAL., AND DODEN, NEV.

LOCATION OF BENCH MARKS BETWEEN DODEN AND FENELON, NEV.

53167°—14——5



LOCATION OF BENCH MARKS BETWEEN FENELON, NEV., AND BRIGHAM, UTAH.

INDEX TO ELEVATIONS AND DESCRIPTIONS OF BENCH MARKS.

[Alpbabetical under each State.]