INDEX.

Summary of Applications Made between December 1, 1916, and November 30, 1918.

DOMESTIC AND MUNICIPAL.

DRAINAGE AREA	No. of Applications.	Water Applied For.	
		Cu. Ft. Per Sec.	Acre Feet.
Bear River	6	9.65	
Colorado River	6	1,523.01	
Great Salt Lake	5	2.40	
Green River	19	4.87	
Sevier River	9	2.01	
Utah Lake-Jordan River	8	10.88	
Weber River	3	0.31	
Totals	56	1,553.13	

MISCELLANEOUS.

DRAINAGE AREA	No. of Applications.	Water Applied For.	
		Cu. Ft. Per Sec.	Acre Feet.
Bear River	0		
Colorado River	2	9.55	
Great Salt Lake	2	8.01	
Green River	4	14.00	
Sevier River	4	18.00	
Utah Lake-Jordan River	5	19.25	
Weber River	1	40.00	
Totals	18	108.81	

Summary of Applications Made between December 1, 1916, and November 30, 1918.

STOCK WATERING.

DRAINAGE AREA	No. of Applications.	Water Applied For.	
		Cu. Ft. Per Sec.	Acre Feet.
Bear River	0		
Colorado River	25	2.93	
Great Salt Lake	5	0.80	
Green River	73	4.42	167.00
Sevier River	36	2.83	
Utah Lake-Jordan River	10	1.09	
Weber River	1	0.02	
Totals	150	12.09	167.00

MINING.

DRAINAGE AREA	No. of Applications.	Water Applied For.	
		Cu. Ft. Per. Sec.	Acre Feet.
Bear River	0		
Colorado River	9	46.00	550
Great Salt Lake	11	35.60	
Green River	9	42.76	
Sevier River	14	17.90	
Utah Lake-Jordan River	14	46.05	
Weber River	1	2.00	
Totals	58	190.31	550

Summary of Applications Made between December 1, 1916, and November 30, 1918.

IRRIGATION.

DRAINAGE AREA	No. of Applications	Water Applied For		Area to Be Irrigated.
		Cu. Ft. Per Sec.	Acre Feet	
Bear River	20	101.07		10,982.02
Colorado River	102	561.88	106,070.00	49,707.00
Great Salt Lake	43	207.63	3,700.00	19,970.87
Green River	259	2,098.63	215,368.00	237,422.52
Utah Lake-Jordan River	29	289.80	8,025.00	77,520.01
Sevier River	63	236.07	35,117.00	43,075.00
Weber River	13	28.93		1,568.10
Totals	529	3,524.01	701,794.17	440,245.52

POWER.

DRAINAGE AREA	No. of Applications	Water Applied For		Horse Power to be Generated.
		Cu. Ft. Per Sec.	Acre Feet	
Bear River	1	110.00		792.00
Colorado River	1	3.00		30.00
Great Salt Lake	10	154.00		4,257.00
Green River	10	5,675.00	174,000.00	120,857.00
Sevier River	14	541.00		14,878.00
Utah Lake-Jordan River	11	322.50	500.00	21,128.00
Weber River	0			
Totals	47	6,805.50	174,500.00	161,942.00

STREAM MEASUREMENT FUND.

Co-operative work with the United States Geological Survey for the purpose of measuring the streams of the State as provided by Chapter 56, Laws of Utah, 1913. Appropriations and expenditures have been as follows:

Balance available in Federal Fund, December 1, 1916	$ 1,533.80	
Federal allotment for Stream Measurement Work July 1, 1917, to June 30, 1919, inclusive	10,000.00	
Refund from scrip books and Congressional increase in salary compensation	243.32	
Total Federal allotment		$11,777.12
Gauging streams December 1, 1916, to November 30, 1918, inclusive		9,643.65
Balance available December 1, 1918		$ 2,133.47
Balance available in Stream Measurement Fund, December 1, 1916	$ 548.94	
Appropriation made by Legislature for Stream Measurement Work, 1917-1918	10,000.00	
By cash (J. Fewson Smith)	17.10	
Total State Appropriation for Stream Measurement Work		$10,566.04
Amount reverted to State Treasury at end of 1915-1916 biennium	.11	
Expenditure for Stream Measurement Work from December 1, 1916, to November 30, 1918, inclusive	9,942.65	
Total amount spent from State Appropriations		9,942.76
Balance in Stream Measurement Fund December 1, 1918		$ 623.28
Total amount expended from Federal and State Funds for the period, December 1, 1916, to November 30, 1918, inclusive		$19,586.41

IRRIGATION CONTINGENT FUND.

For the necessary irrigation contingent expenses for the years 1917-1918, there was appropriated the sum of $30,000. Expenditures up to November 30, 1918, inclusive, have been as follows:

Maintenance of the State Engineer's office for assistants, stenographers, draftsmen, copyist, filing clerk, and for supplies and property purchased	$23,358.71
For traveling expenses	218.28
For stream measurements	3,664.05
For irrigation districts	279.34
For State Council of Defense	29.17
Total	$27,549.55

From the above expenditures the following amounts have been refunded to the Irrigation Contingent Fund:

From the Sevier River water users	$ 505.32
From State Council of Defense	29.17
From Mapleton Irrigation District	81.63
From Springville Irrigation District	86.18
From Water Rights Commission	2.40
Total	$ 704.70

STATE ENGINEER'S CONTINGENT FUND.

For the contingent expenses, supplies, and necessary traveling expenses of the State Enigneer for the years 1917-1918, there was appropriated the sum of $1,600.00. Expenditures to November 30, 1918, inclusive, have been as follows:

Supplies, reference books, repairs and gasoline for State automobile	$ 894.32
Traveling expenses	255.35
Total	$ 1,149.67

THE FOLLOWING TABLES SHOW THE FEES COLLECTED AND THE DISBURSEMENTS OF THE VARIOUS FUNDS APPROPRIATED FOR THE 1917-1918 BIENNIUM.

FEES.

The fee register of the State Engineer's office for the period December 1, 1916, to November 30, 1918, inclusive, shows the sources of revenue to be as follows:

For examining and filing applications	$10,008.27
For recording and approving applications	2,075.00
For examining and filing notices of protest	501.00
For examining and filing written proofs of appropriation, and maps to accompany same	1,380.00
For issuing certificates of appropriation	308.00
For examining and filing plans and specifications	226.82
For examining and filing affidavits	1,756.00
For making search of records	78.25
For making certified copies	617.80
For making blue prints	49.50
For filing and recording papers of assignment	496.30
For making examinations in the field	70.00
For miscellaneous purposes	212.15
For interest on deposits from January 1, 1918, to November 30, 1918, inclusive	12.15
	$17,791.24
Refunds on Certificate Fees	3.00
Total	$17,788.24

General.

Period of Use	Days Used	Miles Traveled	GASOLINE Gals. Used	GASOLINE Miles per Gal.	OIL Gals. Used	OIL Miles per Gal.
Apr. 12, 1916 to Nov. 30, 1918	500	31,000	1,863	16.7	138	225

Costs.

	Gas, Oils and Grease	Labor, Storage and Repairs	Tires	Extras	Operating Cost	Including Cost of Car
	$831.92	$505.10	$601.90	$69.75	$2,011.67	$2,463.67
Cost per Mile	$0.027	$0.016	$0.019	$0.002	$0.065	$0.079

of obtaining data during the fiscal year ending June 30, 1918, as shown by the following table, reflects the general increase in the cost of all kinds of work:

Cost per month's record:	1915	1916	1917	1918
	$13.88	$13.35	$13.35	$15.53

Stream-flow records more or less complete have been obtained at 133 stations on Utah streams during the biennium ending November 30, 1918. Of these stations 80 were equipped with water-stage recorders and 53 with staff gauges.

The Sevier River Hydrographic Investigation is a co-operative undertaking between this department, the State Board of Land Commissioners, the Water Resources Branch of the U. S. Geological Survey and the water users on the Sevier River for the purpose of securing a reliable and continuous record of the flow in said river, the diversions therefrom, the amount of water stored in the various reservoirs, return flow at various points along the river, etc. This investigation was started in 1913 and has been continued since. For the purpose of carrying on this investigation the river system is divided into three divisions. Division No. 1 includes the east and south forks of the river and extends from the headwaters of these forks to the Piute Reservoir. Division No. 2 extends from the Piute Reservoir to the confluence of the Sevier and San Pitch Rivers, while Division No. 3 embraces the remainder of the river. The territory from the headwaters to the Rocky Ford Reservoir is in charge of Mr. J. J. Sanford, with headquarters at Richfield, Utah, while the rest of the river is in charge of Mr. E. A. Porter, who also acts as court commissioner for the Higgins Decree. The records secured from this investigation are compiled at the end of each irrigation season. They may be obtained either at the State Engineer's office or at the office of the Water Resources Branch of the U. S. Geological Survey. Five years continuous records have to date been obtained under this investigation. These records constitute a basis that is invaluable in determining the relation of the various water rights on the river.

Mr. Sanford, in connection with his work, used a Ford automobile in going to and from the various gauging stations in his territory. This machine was purchased on April 12, 1916, at a cost of $466.75. The following tables show the cost of operating the same since that date:

logical Survey through twenty-five years' experience in this work all over the United States have been closely followed, and the stream-measurement work in Utah is an integral part of a comprehensive study of the water-resources of the whole country. A first-class stream-measurement station should be equipped with the following standard equipment:

(1) Water-stage recorder costing from $50 to $150, the price depending on the type, and the selection of the type depending on the availability of an observer, the character of record desired, and the behavior of the stream.

(2) A shelter constructed of concrete or timber to house the recorder and costing from $50 to $150 or more, the type and cost depending on location, climatic conditions, and length of time that station will probably be in operation. A base station should be made a permanent installation.

(3) A cable and car to provide for making current-meter measurements. This structure should also be permanent and should be established at the most favorable point. The cost depends largely upon the span, varying from $25 on small streams to several hundred dollars where heavy galvanized, steel cable and framed towers must be used. Concrete dead-men are necessary at many stations and advisable for permanent stations.

(4) An artificial control to insure permanence of stage-discharge relation is desirable and economical for stations on many streams and on some streams is necessary. The cost of such a control varies within wide limits, being cheap for a simply constructed weir on small streams, and expensive—possibly $1,000—for a reinforced concrete weir on large streams.

To these items must be added the cost of obtaining gauge readings, which varies from $25 to $125 a year, the amount depending on the distance the observer has to travel; visits by engineers to make current-meter measurements, check up the water-stage recorder, and keep the equipment in shape; and the cost of assembling and interpreting the data and its final publication. The annual report of the Salt Lake district for the fiscal year ending June 30, 1918, showed the cost of collecting and preparing stream-flow data for publication to be $15.53 per month's record. This cost is made up of the following items: Operation and maintenance, construction, office work, top cost, and non-expendable property, but does not include the cost of supervision and publication by the Washington office. The cost

Co-operative stream-measurement fund:		
State of Utah	$9,925.55	
U. S. Geological Survey	9,633.04	
Total		$19,558.59*a*
U. S. Reclamation Service		1,491.06
U. S. Indian Service		2,220.88
Sevier River Investigation (*b*) (includes co-operation from State Engineer's contingent fund, State Board of Land Commissioners, Otter Creek Reservoir Company, and water users of Sevier River above Piute Reservoir)		6,318.92
State Engineer's contingent fund, Uintah Basin		659.51
State Board of Land Commissioners, Panguitch Lake		38.40
State Board of Land Commissioners, Sevier River and East Fork Sevier River special construction		905.15
State Board of Land Commissioners, Fish Creek		135.82
Logan River Investigation		31.34
Private Co-operation		87.10
Total		$31,446.77

a Of this total, $17,558.59 was expended through district office for collection of data, and $2,000 through Washington office for supervision, reviewing, editing and publication of data.

b Does not include cost of data furnished for Sevier River investigation by the Water Commissioner for lower Sevier River.

The general policy has been to use the regular stream-measurement fund of the State of Utah and the allotment from the United States Geological Survey to gradually build up a system of base stations equipped to obtain continuous records and to cover the State impartially. These base stations on important streams are supplemented by many stations on tributaries to these streams or on smaller creeks in different basins. The base stations are invaluable in studying the flow of the shorter time or intermittent records at the supplementary stations and should be equipped with modern instruments, as the use of the simple staff gauges on which many of them depend has led to their location at points determined by the availability of observers and not by the conditions favoring accuracy of discharge measurements and permanence of stage-discharge relation.

The standard methods developed by the United States Geo-

officials, large industrial concerns, members of the County Councils of Defense and others.

In view of the comprehensive nature of the work, the mass of detail required in accordance with instructions received from time to time from the War Department, the cost of the survey to date has been extremely light. A statement of expenses for the work from September 24, 1917, to December 1, 1918, is given below:

Salaries	$4,547.14
Office Supplies	260.58
Transportation and Field Expenses	396.04
Blue Prints	29.24
Total	$5,233.00

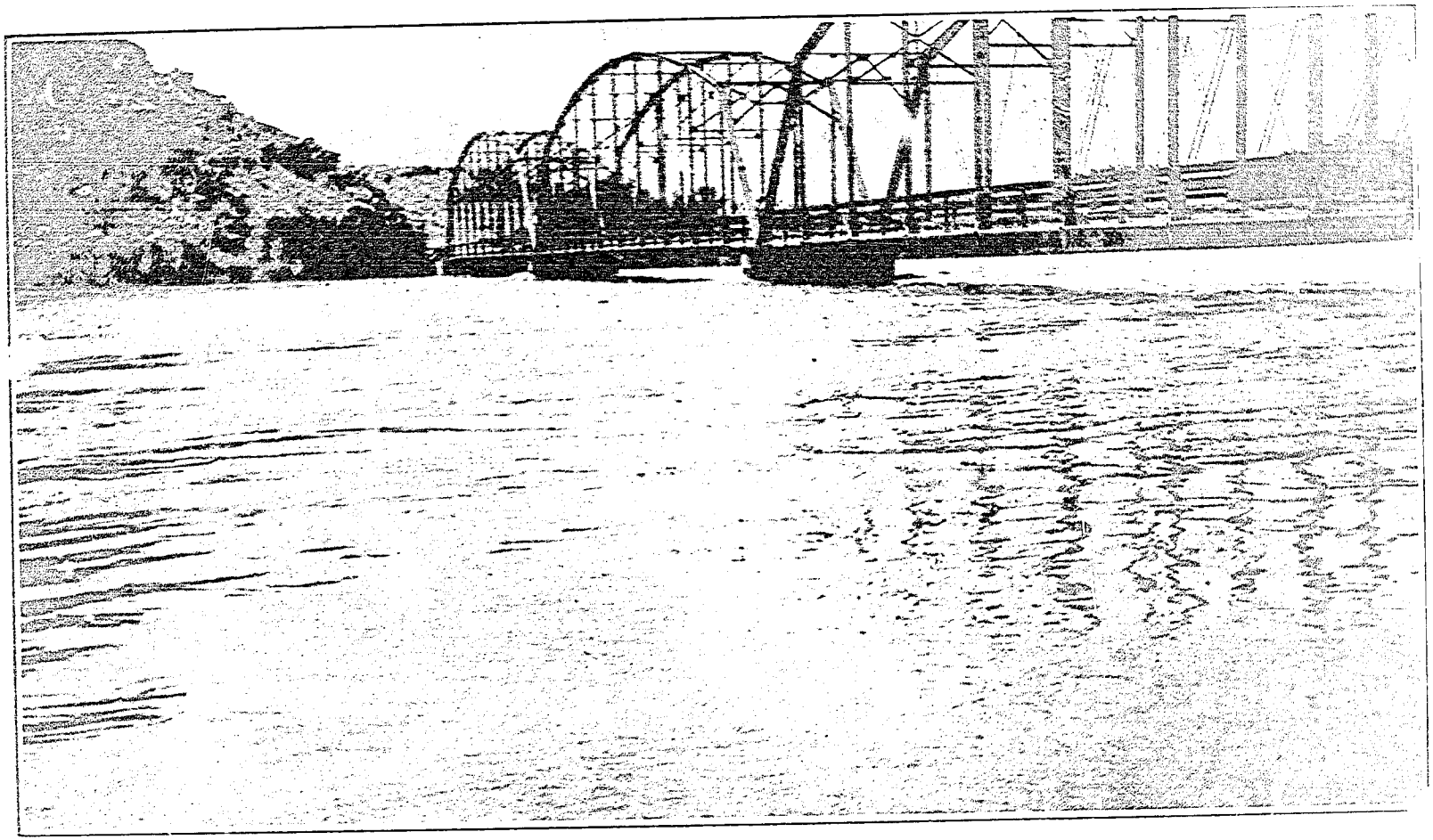
This makes an average cost per square mile of thirty-seven (37c) cents.

CHAPTER VII.

STATEMENT REGARDING HYDROMETRIC WORK CARRIED ON IN CO-OPERATION WITH THE UNITED STATES GEOLOGICAL SURVEY BY A. B. PURTON, DISTRICT ENGINEER.

Stream measurement work in Utah during the past two years has been continued under co-operative agreements between the State Engineer and the United States Geological Survey that have been fully outlined in previous Reports of the State Engineer. The work has been extended and much valuable information has been obtained through additional co-operation furnished by the State Board of Land Commissioners, by many canal companies, and by private corporations or individuals. A very striking example of this assistance is found in the valuable records that are being obtained relative to the water resources of Sevier River Basin.

Expenditures for the biennium ending November 30, 1918, have been as follows:



Green River near Moab, Utah, at flood stage.

and described in detail, necessitating personal measurements by employees of this department to ascertain the locations of excessive grades, curves, etc. Detailed descriptions of bridges of more than 20-foot span, together with sketches and photographs of the same, are included in the reports.

The reports also call for a complete survey of all industries in each quadrangle; their nature and number, together with the man power, or number of employees in each, and their nationalities. The population of cities and towns within the areas mapped, the principal industries in each, transportation facilities, lines of communication, water and fuel supply, number and dimensions of buildings that might be of use during military operations, kind and quantity of supplies on hand, and, in fact, any information that might appear in the judgment of the reporting officer of military value, are given.

Up to December 1, 1918, sixty-three (63) quadrangle reports have been completed and forwarded in duplicate to the War Department. Each report was accompanied by a progressive military map of the area being reported on showing the locations by a system of numbers of points of vulnerability and other features desired by the War Department. The territory so far covered by the survey under the supervision of the State Engineer comprises approximately 13,923 square miles, the quadrangles being embraced in Box Elder, Cache, Weber, Davis, Salt Lake, Tooele, Utah, Juab and Millard Counties. There remain ninety-two (92) quadrangles yet to be reported on; however, the greater portion of the territory embraced in these quadrangles being in outlying districts. Field work has been completed in the most important or congested districts within these unreported areas.

With the completion of each individual report, the boundaries of the area mapped were checked with an index map furnished by the War Department, thus insuring accuracy as to locations, etc. The reports range in length from 10 to 143 typewritten pages, legal size, exclusive of Progressive Military Maps, bridge sketches and photographs. A copy of each report is on file in this office.

While information on roads, trails and bridges, and other important features was secured by personal surveys made by this office, valuable assistance was rendered by the engineering departments of the various railroads, telephone and telegraph companies, power companies, mining companies, State and County

CHAPTER VI.

MILITARY SURVEY OF UTAH FOR UNITED STATES WAR DEPARTMENT.

By E. C. PENROSE, Special Agent.

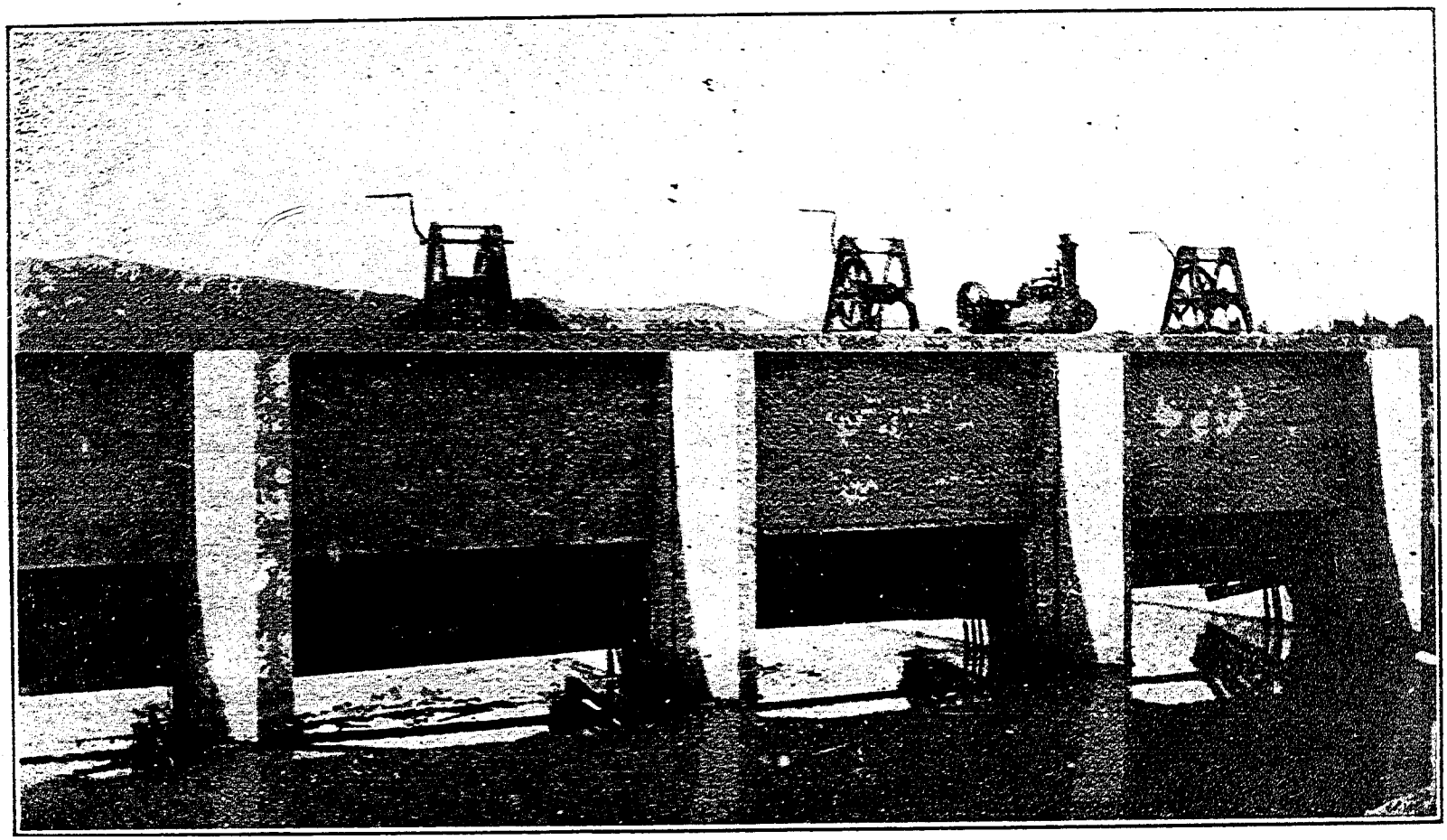
In August, 1917, the State was called upon by the Federal Government to complete the preparation of special military Reconnaissance Reports and Progressive Military Maps of the State of Utah for the information of the War Department. The responsibility of financing the work was assumed by the State Council of Defense, and at a meeting of the organization held August 23, 1917, a recommendation was adopted requesting His Excellency, Governor Simon Bamberger, to have the survey made. Upon receipt of the recommendation, the Governor ordered the work done.

Up to that time approximately fifty-five (55) per cent of the State had been surveyed by the Forest Service under the direction of the Forester of District No. 4. When the work was taken over by the State, in September, 1917, Mr. E. C. Penrose was appointed Special Agent, with two assistants, in charge of the survey under the supervision of the State Engineer.

The State was theoretically divided into zones, or quadrangles, of 15 minutes of latitude by 15 minutes of longitude, the same covering areas of about 13 miles in width and 17 miles in length. A separate report is made on each quadrangle as the field work is completed and is accompanied by a special map of the zone reported upon. The reports contain data regarding physical conditions, natural resources, etc., which might be required by a commander of troops assigned to military operations within a quadrangle.

Each quadrangle report contains detailed information on topographical features, description of the terrain, etc., locations of commanding positions, sections of land suitable for aeroplane landings, observation points, camp sites, climatic data, health and sanitary conditions, locations and descriptions of rivers and streams, lakes and ponds, springs and wells, reservoirs and water tanks, transportation facilities including railroads, stage lines, automobiles and their passenger capacity, etc., lines of communication—telephone and telegraph—power lines and substations.

An important feature of the Reconnaissance Reports is the information desired by the War Department on roads, trails and bridges. Each road and trail is treated as a separate unit



PIUTE AND SEVIER VALLEY CANAL DIVERSION DAM ON SEVIER RIVER.
Upstream view of headgates, showing radial gates in raised position.

extension and staked the line out on the ground. On August 5 the State Board of Land Commissioners entered into a contract with Mr. A. C. Nielson, Jr., of Ephraim, for the construction of this extension.

The canal prism for this extension is four feet wide on the bottom with side slopes of one and one-half to one and is constructed on a grade of .0006. The entire extension is in cut section. The contractor began work soon after entering into the contract and completed the same on November 18, 1918. The entire work was done under the supervision of the State Engineer. A total of 21,716 cubic yards of material was excavated, of which sixty per cent was earth and forty per cent cemented gravel or hardpan. The contract price for the removal of this material was 23 cents per cubic yard. What few structures are repaired in connection with the operation of this extension will probably be installed next spring under Force Account. This extension is officially known as Canal Extension No. 5, and it will probably be the last extension of the Piute Canal, as the amount of good land to the north of Jap Wash that can be reclaimed is so small that its reclamation would not warrant the cost of a further extension.

In September, 1918, the State Board of Land Commissioners requested the State Engineer to report on the feasibility of irrigating the land in Antelope Valley with Piute Reservoir water, also the tract of desert land lying east of the town of Gunnison, and to that end authorized that the necessary surveys be made. Antelope Valley lies east of the town of Monroe and comprises approximately six thousand acres of very fertile land. To irrigate this valley will require the construction of a canal on the east side of the Sevier River and diverting from said river at some point above the town of Sevier. The land to the east of the town of Gunnison can probably be reached best by enlarging and extending the present Monroe-Rocky Ford Canal. A surveying party is at the present time in the field making the necessary preliminary surveys. As soon as these surveys are completed and platted a report on the feasibility and practicability of irrigating these two tracts of land will be submitted to the State Board of Land Commissioners for consideration.

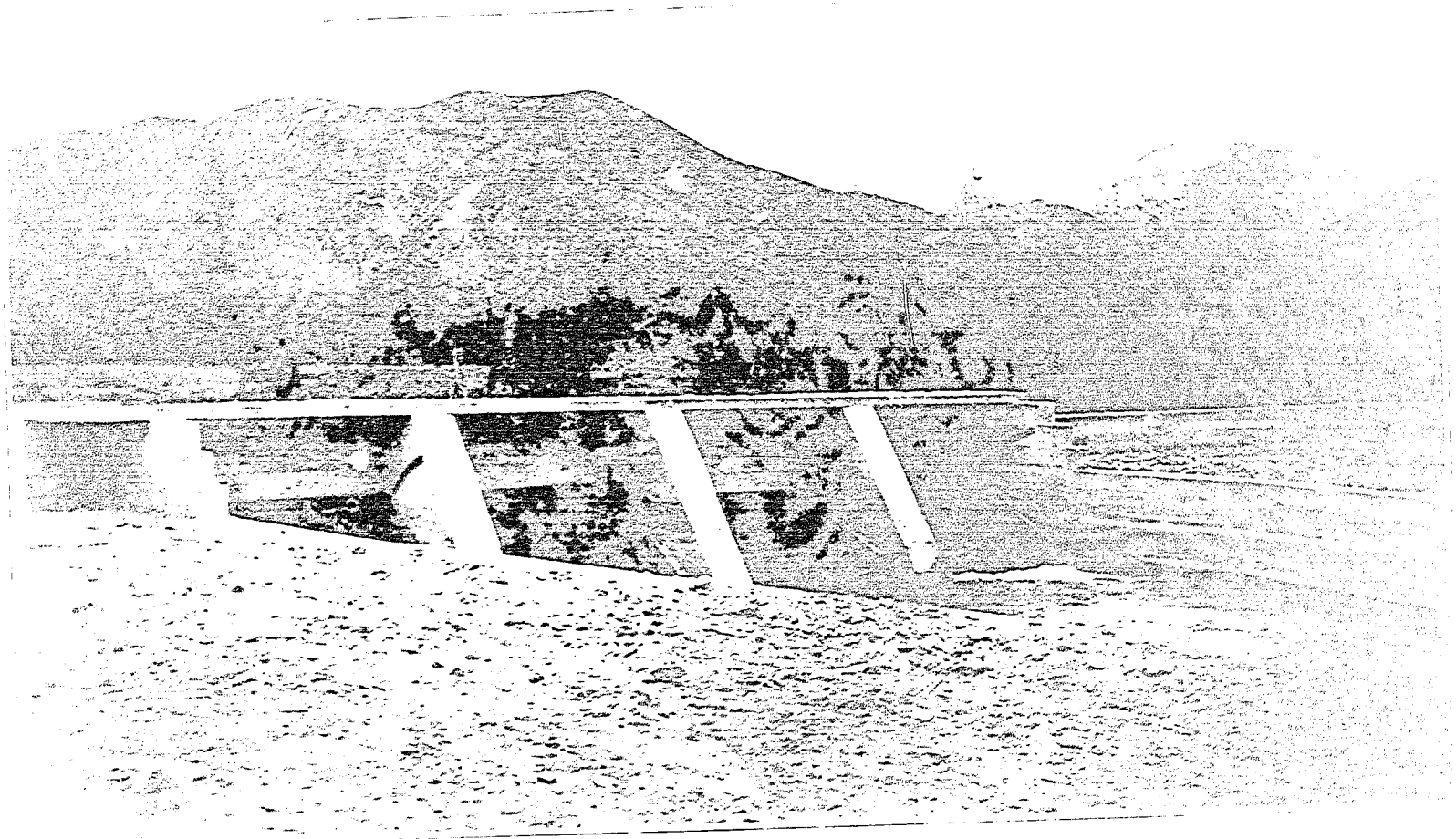
Mr. H. S. Kerr is the field engineer in charge of all construction and improvement work on this project.

both banks for several hundred feet were constructed to prevent the river from cutting around the dam. The winding nature of the river below the new dam necessitated straightening the channel for a distance of about one-fourth of a mile. This was accomplished by constructing a ditch sufficiently wide and deep to start the water flowing, allowing the water to cut the channel to the grade and size required. The construction of the dam was done by force account under the supervision of the State Engineer. It required approximately nine months to complete the structure, the delay being due to a lack of help. The cost of the completed structure amounted to $16,500.

Improvement work on the canal system during the past two years was limited on account of war conditions. Several sections of the canal considered somewhat dangerous were improved. The most important of these changes was the re-location and construction of 1,300 feet of canal about two miles southwest of the city of Richfield. This change cost approximately $2,800. Other improvements consisted mainly in strengthening the present banks, repairing canal structures, and installing such additional structures as are required for the proper maintenance and operation of the canal. All this improvement work was done as the result of a report on the condition of the canal system submitted by the State Engineer to the State Board of Land Commissioners in May, 1917. There still remains considerable improvement work to be done in order to put the canal system in first-class condition.

The Piute Canal crosses the Denmark Wash by means of a flume. This flume is thirty-four feet long, rests on concrete abutments, and in addition is supported by two trestle bents eighteen feet high. On June 15, 1918, a heavy rainstorm occurred on the headwaters of this wash, which resulted in a flood and the damaging of this flume to the extent that the water had to be drained out of the canal and the flume repaired. The flood took out the trestle bents under the center of the flume and damaged the east concrete abutment. On account of the shortage of help it took several weeks to repair the structure, although such temporary repairs were made immediately after the flood that the water was not out of the canal over two days.

In July, 1918, the State Board of Land Commissioners authorized a three-mile extension of the Piute Canal from its then existing terminal northward to the Jap Wash west of the town of Fayette, in Sanpete County. Immediately thereafter the State Engineer prepared an estimate of the cost of this



PIUTE AND SEVIER VALLEY CANAL DIVERSION DAM ON SEVIER RIVER
Downstream view of headgates, showing radial gates in closed position

In addition, a concrete control was constructed across the river at each station to insure uniform conditions for the measurement of the flow of water.

As a precautionary measure against activities of alien enemies, guards were maintained on the dam within the past two years during the time the reservoir was filled with water. Proper housing for these guards and the illumination of the dam at night were taken care of by the State Engineer.

During the 1917 irrigation season a total of 60,000 acre-feet of water was stored in the reservoir, and during the 1918 irrigation season a total of 56,800 acre-feet was stored. The storing of water in the reservoir is under the supervision of the State Engineer.

Canal System.

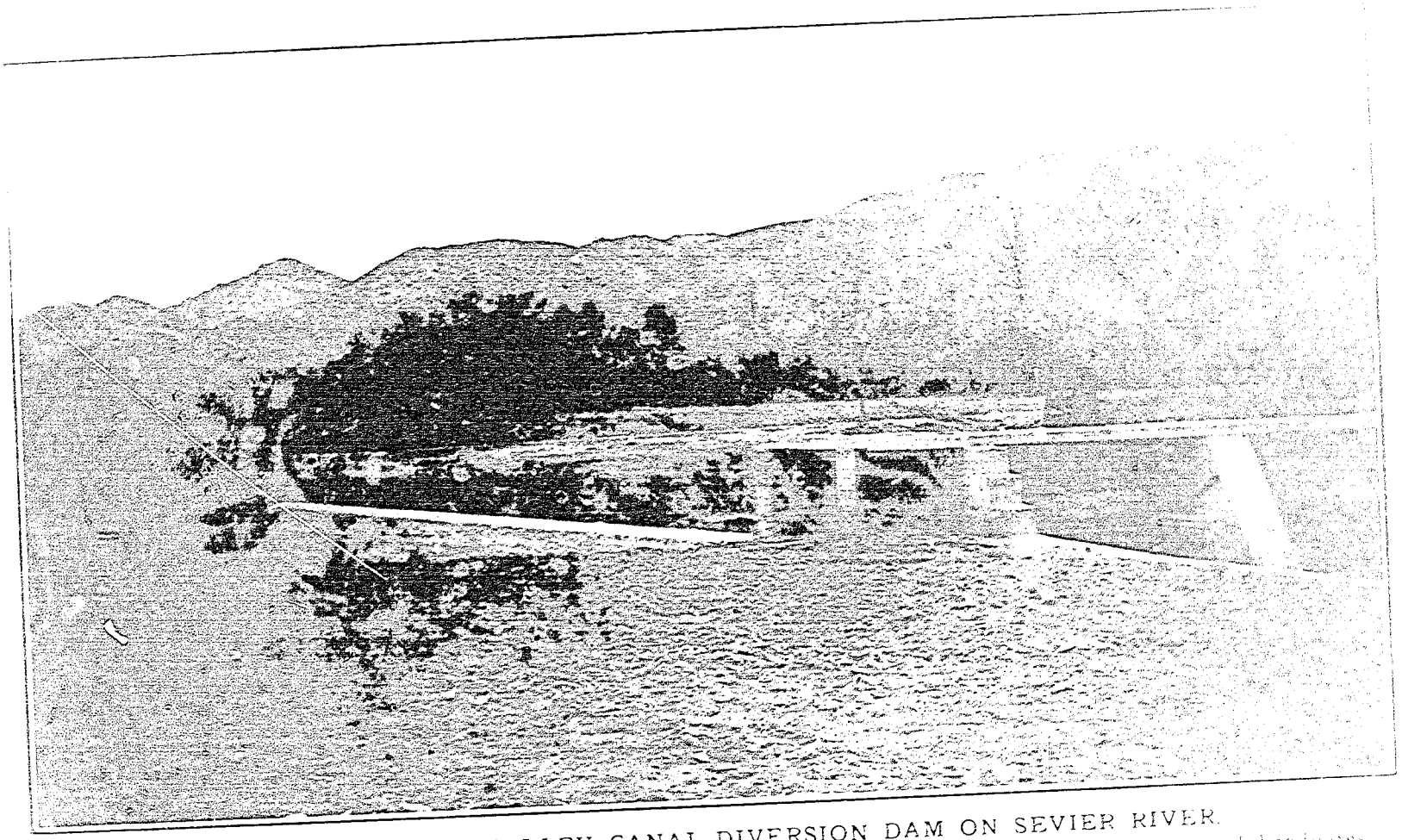
Under the terms of the agreement with the Sevier Valley Canal Company for the enlargement of its canal, the State obligated itself to construct a permanent and adequate diversion dam at the head of the Sevier Valley Canal to serve the purposes of both the canal company and the State. Plans and specifications for such a structure were prepared by this office in the fall of 1917. Part of the excavation was done that fall, but the construction of the dam proper was not begun until February, 1918. The dam is a concrete structure of the combination spillway and headgate type, and is equipped with steel radial gates. It is located 1,200 feet upstream from the old point of diversion. The spillway has an Ogee section, is eighty feet long, and has its crest seven feet above the bottom of the river and one-half foot above the top of the headgate openings. The radial gates are four in number, each four feet high by six feet wide, and operate by hand.

The gates were designed for a maximum capacity of 900 second-feet, which is in excess of the present demands, but, on account of the fact that there is a possibility of consolidating the canals on the west side of the river and such a consolidation will mean the further enlargement of the Sevier Valley Canal and also the enlargement of the Piute extension, it was deemed advisable to design these gates of a capacity equivalent to the combined capacities of all the canals on the west side of the river.

The canal for a distance of two hundred feet below the headgates has been lined with concrete. Concrete wing walls carried down well below the bed of the river and extending along

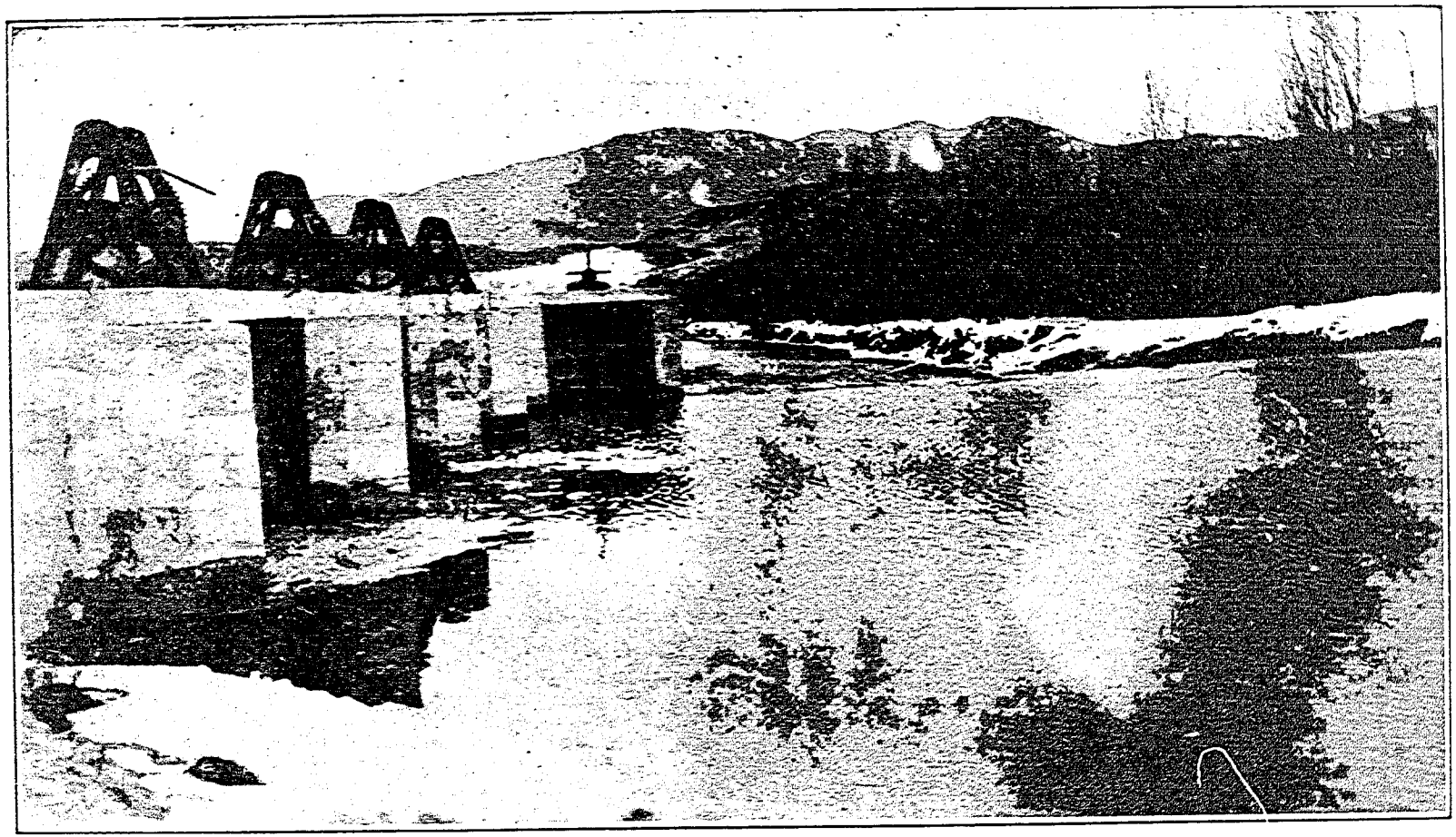
well was sunk through the dam at the lower third of the downstream slope to stream bed, and a ditch constructed along the entire lower toe to collect the water seeping through the dam and convey the same over a measuring weir. Daily records have been obtained since then of the depth of water in the saturation well and the amount of seepage water passing over the measuring weir. A seepage curve has been plotted from these records. This curve shows that the seepage through the dam and the degree of saturation of the dam vary directly as the depth of water behind the dam. The relation between the depth of water in the reservoir and the amount seeping through the dam has been practically constant for the different years, being 1.10 second-feet for a reservoir depth of 65 feet. The same relation holds true with reference to the depth of water in the saturation well, this being 21 feet for a reservoir depth of 65 feet. The result of this study has led to the conclusion that water may safely be stored behind the dam, as at present constructed, only up to a depth of 65 feet, which corresponds to an average capacity of 60,000 acre-feet. As at present constructed the dam has an upstream slope of approximately two and a half horizontal to one vertical and a downstream slope varying from two and thirty-three hundredths to two and eighty-nine hundredths horizontal to one vertical. To make the dam safe in order to store the maximum amount of water for which it was designed, the downstream slope should be increased to three and one-half horizontal to one vertical and a loose rock-fill added to the lower toe to act as an anchorage. Surveys and estimates have been made upon the foregoing basis and submitted to the State Board of Land Commissioners. To make this improvement it will require approximately 80,000 cubic yards of earth-fill and 7,500 cubic yards of rock-fill. The estimated cost of placing this material is $68,000. In view of the fact that to date it has been deemed advisable to store water only up to sixty-five per cent of the maximum capacity of the reservoir, this additional expenditure would, in my opinion, be well warranted.

During the past year permanent gauging stations were established on the South Fork and the East Fork of the Sevier River just above the backwater contour of the Piute Reservoir, for the purpose of keeping an accurate record of the flow of water into the reservoir. Prior to this time temporary gauging stations were maintained on these forks. Each station is equipped with a Stevens automatic water stage recorder, properly housed.



PIUTE AND SEVIER VALLEY CANAL DIVERSION DAM ON SEVIER RIVER.

Upstream view of completed structure before water was turned in, showing spillway and portion of headgates.



PIUTE AND SEVIER VALLEY CANAL DIVERSION DAM ON SEVIER RIVER.
Downstream view of completed structure, with gates closed and water passing over spillway.

CHAPTER V.

PIUTE PROJECT.

In 1908, the State of Utah through the State Board of Land Commissioners, in accordance with Title 75, Chapter 3, Compiled Laws of Utah, 1907, began the construction of the Piute Irrigation Project for the purpose of reclaiming and irrigating 35,000 acres of desert land situated in Sevier and Sanpete Counties. The project consists of a reservoir of 93,000 acre-feet capacity, known as the Piute Reservoir, located on the Sevier River in Township 29 South, Range 3 West, and a canal system approximately sixty miles long. The dam is an earthen structure of the hydraulic-fill type, and is 96 feet high. The water is stored in the reservoir during the spring and non-irrigation season. It is released from the reservoir during the irrigation season and allowed to flow down the river for a distance of twenty-five miles to the intake of the Sevier Valley Canal, located in Section 27, Township 25 South, Range 4 West, where it is recovered and conveyed to the lands under the project. The first twenty miles of the canal system is an enlargement of the Sevier Valley Canal. The construction on the project up to December 1, 1916, has been quite thoroughly covered in the previous Biennial Reports of the State Engineer. This chapter will be confined entirely to the work done on the project during the past two years.

Reservoir Dam.

In draining the reservoir in the fall of 1916 it was found that two of the three cast iron headgates controlling the water in the reservoir were damaged. One of these gates had its entire lower end for a height of eight inches broken off, and the other was cracked through the body. The exact cause of the damage is not known, although it is surmised that the gates may have been damaged either by being struck by boulders drawn through the outlet tunnel by the draft of the water or from vibration caused by the high head under which the gates operate. The damaged gates were replaced with new gates in January, 1917. The new gates were constructed of cast steel, as this material is able to resist shock and vibration better than cast iron. An extra gate was cast at the same time and stored at the reservoir for emergency use.

Since January, 1915, a systematic study has been made of the behavior of the Piute Dam. For this purpose a saturation

List of Plans and Specifications for Dams on File in the State Engineer's Office—Continued

Name of Dam	Stream Located on	Maximum Height Feet	Capacity of Reservoir, Acre Feet	Date Approved	By Whom Approved	Remarks
Skutempah Res. & Irr. Co. Dam..	Skutempah Creek	30	666	Dec. 19, 1913	W. D. Beers	
Strawberry Project Res. Dam...	Strawberry River	70.5	282,000	Nov. 29, 1913	W. D. Beers	Were not approved.
Summit Creek Irr. & Canal Co. Reservoir Dam	Summit Creek	43	700			
Ten Mile Wash Reservoir Dam, property of Chas. Brown.....	Ten Mile Wash	18	1,751	Oct. 26, 1906	Caleb Tanner	
Three Creeks Reservoir Dam, Sevier Valley Canal Co.....	Three Creeks	25	183			Filed Feb. 20, 1900; never approved.
Trial Lake Reservoir Dam, Union Reservoir Co.	Head of Provo River...	40.68	2,298	Mar. 25, 1914	W. D. Beers	
Tropic & East Fork Irr. Co. Reservoir Dam	East Fork Sevier River.	35	No record		R. C. Gemmell	
Twin Lakes Reservoir Dam, Salt Lake City Corporation.	Big Cottonwood Creek..	69	897	Sept. 2, 1914	W. D. Beers	
Utah Agricultural College Power Dam	Logan River	28			Caleb Tanner	
Wall Lake Reservoir Dam, Union Reservoir Co.	Head of Provo River...	34.57	2,900	Mar. 25, 1914	W. D. Beers	
Warren Irrigation Co. Res. Dam..	Weber River	12	No record	Sept. 7, 1916	W. D. Beers	
Washington Lake Reservoir Dam, Union Reservoir Co.	Head of Provo River ..	42.8	3,309	Mar. 25, 1914	W. D. Beers	
Whelan Reservoir Dam.....	Unnamed Draw.....	14.25	20	Mar. 19, 1912	Caleb Tanner	
White Mesa Canal Co. Res. Dam..	Off natural stream. Water supply derived from Recapture Wash Creek	16	15	Oct. 4, 1917	G. F. McGonagle	
White Pine Reservoir Dam, Parley's Park Land & Water Co...	White Pine Creek.....	16	322	April 8, 1903	A. F. Doremus	
Woodruff Creek Reservoir Dam..	North Fork of Woodruff Creek	39	188	Oct. 16, 1901	A. F. Doremus	

Note.—A number of the dams listed above have never been built, and their construction is now practically abandoned.

List of Plans and Specifications for Dams on File in the State Engineer's Office—Continued

Name of Dam.	Stream Located on.	Maximum Height Feet.	Capacity of Reservoir Acre-Feet.	Date Approved	By Whom Approved	Remarks.
Otter Creek Reservoir Dam, Otter Creek Reservoir Co.	Otter Creek	45	53,000	No record	R. C. Gemmell	No plans on file. For description see first and second biennial reports of the State Engineer.
Park Livestock Co. Res. Dam	Pot Creek	50	5,505	Sept. 1, 1909	Caleb Tanner	
Peeteetneet Canyon Dam of Payson City	Peeteetneet Canyon	19.5	No record	Oct. 29, 1898	R. C. Gemmell	No plans on file.
Perkins, Nephi O., Res. Dam	Unnamed wash. Water supply derived from Pace and Dugout Creeks	24	230	Feb. 26, 1917	G. F. McGonagle	
Range Creek Reservoir Dam, Utah Fuel Co.	Range Creek	73	290	April 12, 1908	Caleb Tanner	
Red Pine Lake Reservoir Dam, Little Cottonwood Water Co.	Little Cottonwood Creek	43	578	Sept. 7, 1916	W. D. Beers	
Red Pine Lake Reservoir Dam, Parley's Park Land & Water Co.	Red Pine Lake	11.9	42	April 8, 1903	A. F. Doremus	
Robinson Tanner Reservoir Dam	Off natural stream. Water supply derived from seepage or waste water	22	No record	April 1, 1916	W. D. Beers	
Rocky Ford Reservoir Co. Dam	Sevier River	30	2,115	Oct. 23, 1902	A. F. Doremus	
Rocky Ford Reservoir Dam, Delta Land & Water Co.	Beaver River	68	25,270	Mar. 9, 1914	W. D. Beers	
Sandridge Res. & Canal Co. Dam	Off natural stream. Water supply derived from San Pitch River and Cottonwood Creek	23	80	Sept. 1, 1899	R. C. Gemmell	
Sevier Bridge Reservoir Dam	Sevier River	60	104,000	Dec. 5, 1903	A. F. Doremus	
Sevier Bridge Reservoir Dam, enlarged.	Sevier River	90	250,000	Nov. 11, 1913	W. D. Beers	Original design.
		93	250,000	Mar. 25, 1915	W. D. Beers	Revised design.
Sevier River Land & Water Co. Diversion Dam	Sevier River	23		Feb. 27, 1913	Caleb Tanner	
Sheep Valley Reservoir Dam, Manti Live Stock Co.	Dry wash	36.7	482	Aug. 8, 1914	W. D. Beers	

List of Plans and Specifications for Dams on File in the State Engineer's Office—Continued

Name of Dam.	Stream Located on.	Maximum Height Feet.	Capacity of Reservoir Acre-Feet.	Date Approved	By Whom Approved	Remarks.
Lake Phoebe-Mary Reservoir Dam, Salt Lake City Corporation	Lakes Phoebe and Mary	85	975	Aug. 18, 1913	W. D. Beers	
Lake Blanch Reservoirs Nos. 1, 2, and 3, Brown & Sanford Irrigation Company	Little Cottonwood Canyon	13, 15, 12 respt.	68, 28, 43 respt.			Filed; never approved.
Lake View Reservoir Dam, Lake View Reservoir & Canal Co.	Clay Creek			Sept. 7, 1916	W. D. Beers	
Lewis, A. B., Power Dam	Beaver Creek	75	935	June 9, 1902	A. F. Doremus	
Logan River Diversion Dam	Logan River	12		Aug. 19, 1908	Caleb Tanner	No specifications on file.
Logan River Power Co. Dam	Logan River	27.5		Oct. 6, 1903	A. F. Doremus	Filed; never approved.
Lost Creek Irr. Co. Res. Dam	Lost Creek	19.5	398			
Lower Joe's Valley Res. Dam	North Fork Cottonwood Creek		99,100			Plan of reservoir site only.
Lyman Res. & Irr. Co. Res. Dam	Middle Fork, Black Fork River	26	427	Sept. 1, 1915	W. D. Beers	
Mammoth Reservoir Dam, Irrigated Lands Company	Gooseberry Creek	100 125	26,800	May 5, 1903	A. F. Doremus	Filed; never approved.
Melville Irr. Co. Diversion Dam	Sevier River	32		April 30, 1908	Caleb Tanner	Washed out.
Melville Irr. Co. and Oasis Land & Irr. Co. Diversion Dam	Sevier River	28.2		Aug. 7, 1909	Caleb Tanner	
Miller, Louis T., Reservoir Dam	Branch of Blue Creek	33	275	Mar. 31, 1914	W. D. Beers	
Miller's Flat Reservoir Dam	Jordan Creek	171	23,200			File for record only; no specifications.
Mountain Dell Reservoir Dam, Salt Lake City Corporation	Parley's Creek	105	915	Jan. 13, 1916	W. D. Beers	
North Cottonwood Lake Res. Dam	North Cottonwood Canyon	23.4	33	Aug. 31, 1901	A. F. Doremus	

List of Plans and Specifications for Dams on File in the State Engineer's Office—Continued

Name of Dam.	Stream Located on.	Maximum Height Feet.	Capacity of Reservoir Acre-Feet.	Date Approved	By Whom Approved	Remarks.
Gordon Reservoir Dam, property of H. H. Redd, Chas. Redd, and O. I. Lewis	Off natural stream. Water supply derived from Spring Creek	38	2,500	May 4, 1918	G. F. McGonagle	
Grand Canyon Power Co., Reservoir Dam	Green River	116	33,000	Jan. 17, 1908	Caleb Tanner	Rejected by Caleb Tanner.
Grand Valley Fruit & Water Co. Reservoir Dams	Cottonwood Creek	83	24,800			
		76	24,800	Jan. 21, 1910	Caleb Tanner	Revised design.
Grass Valley Reservoir Dam, New Castle Reclamation Co.	Grass Valley Creek	100	26,650	July 21, 1915	W. D. Beers	
Green River Irrigation Dist. Diversion Dam	Green River	12				Filed for record only.
Gunnison Bend Reservoir Dam	Sevier River	26	10,000	Mar. 7, 1899	R. C. Gemmell	
Gunnison High Line Canal Co. Reservoir Dam	Nine Mile Creek	30.4	1,519	No record	R. C. Gemmell	
Gunnison Irrigation Co., Reservoir Dam	San Pitch River	40		No record	R. C. Gemmell	No capacity given.
Hercules Power Reservoir Dam, Grand Valley Fruit & Water Co.	Grand River	160	13,000	Feb. 15, 1911	Caleb Tanner	Specifications rejected.
Holmes Creek Reservoir Dam, Holmes Creek Irrigation Co.	Holmes Creek	50	816	April 10, 1903	A. F. Doremus	
Huntington Canal & Reservoir Association Dam	Huntington Creek	75	2,122	April 22, 1908	Caleb Tanner	
Irrigated Lands Company Diversion Dam	Price River	18				Filed; never approved.
Jordan Narrows Diversion Dam	Jordan River	16		Dec. 11, 1914	W. D. Beers	
Jones, F. I. & Sons. Company Reservoir Dam	East Canyon Draw	25	1,435	Sept. 8, 1916	W. D. Beers	
Kays Creek Irrigation Company. Reservoir Dam	Snow Creek	55	937	Feb. 28, 1914	W. D. Beers	
		40	351	Nov. 24, 1914	W. D. Beers	
Kaysville Irrigation Company. Reservoir Dam	South Fork, Holmes Creek	43.4	266	April 16, 1914	W. D. Beers	
		15	905	Feb. 1, 1899	R. C. Gemmell	
Koosharem Irrigation Company. Reservoir Dam	East Fork, Otter Creek	29	3,858	Aug. 13, 1917	G. F. McGonagle	Enlarged design.

List of Plans and Specifications for Dams on File in the State Engineer's Office—Continued

Name of Dam.	Stream Located on.	Maximum Height Feet.	Capacity of Reservoir Acre-Feet.	Date Approved	By Whom Approved	Remarks.
Deseret Live Stock Co., Reservoir Dam No. 2	Saleratus Creek	17	140	Aug. 21, 1907	Caleb Tanner	
Deseret Live Stock Co., Reservoir Dam No. 3	Saleratus Creek	15	120			Filed Nov. 25, 1915. never approved.
Deseret Irrigation Company, Diversion Dam	Sevier River	18		Feb. 2, 1903	A. F. Doremus	
Dry Creek Reservoir, Canal & Irrigation Co., Reservoir Dam.	Off natural stream. Water supply derived from Dry Creek	26	475	Dec. 11, 1905	Caleb Tanner	
Dry Creek Reservoir & Irrigation Co., Reservoir Dam	Dry Creek	34.75	173	Mar. 7, 1914	W. D. Beers	
East Canyon Creek Reservoir Dam, Davis and Weber Counties Canal Co.	East Canyon Creek	93		Aug. 15, 1898	R. C. Gemmell	Original design.
		100	12,826	Oct. 13, 1903	A. F. Doremus	Enlarged design.
		150	27,300	Nov. 24, 1915	W. D. Beers	New arch dam.
East Park Reservoir Dam	East Fork Little Brush Creek	22	1,299	May 1, 1902	A. F. Doremus	Original design.
		23	1,300	Sept. 7, 1916	W. D. Beers	Revised design.
Echo Reservoir Dam, Weber Reservoir, Power & Irrigation Co.	Weber River	63.25	15,900	Mar. 14, 1905	A. F. Doremus	
Erickson, John A., Reservoir Dam	Deep Creek	37	321	Dec. 7, 1912	Caleb Tanner	
Farnsworth Canal & Reservoir Co. Dams:						
Dam No. 1	Unnamed Lake	18	363	Feb. 14, 1917	G. F. McGonagle	
Dam No. 2	Island Lake	15	944	Feb. 14, 1917	G. F. McGonagle	
Dam No. 3	Duck Lake	15	3,725	Feb. 14, 1917	G. F. McGonagle	
Dam No. 4	Unnamed Lake	18	468	Feb. 14, 1917	G. F. McGonagle	
Fisher Vallet Reservoir Dams, Nos. 1 and 2, property of R. S. Saunders	Beaver Creek	32	77			Filed for record only.
		18	38			
Fool Creek Reservoir Dam	Fool Creek	18	No record	May 15, 1901	R. C. Gemmell	
Forsythe Reservoir Dam, Fremont Irrigation Co.	Fremont River	66	3,419	May 25, 1905	Caleb Tanner	
Geyser Reservoir Dam, Paradox Valley Irrigation Co.	Geyser Creek	50	1,530	June 19, 1908	Caleb Tanner	

List of Plans and Specifications for Dams on File in the State Engineer's Office

Name of Dam.	Stream Located on.	Maximum Height Feet.	Capacity of Reservoir Acre-Feet.	Date Approved	By Whom Approved	Remarks.
Anderson, Nephi and Niels M., Reservoir Dam	Off natural stream. Water supply derived from Red Hills Creek.	16	56	Sept. 12, 1918	G. F. McGonagle	
Anderson, Wm. P., Reservoir Dam	Blue Creek	43	1,460	Aug. 28, 1905	Caleb Tanner	
Bailey, Peter, Reservoir Dam	Vega Creek	15.6	205	May 25, 1915	W. D. Beers	
Bastian Reservoir Dam	Kings Meadow Canyon.	17	41	Feb. 10, 1911	Caleb Tanner	
Bear Wallow Reservoir Dam	North Cottonwood Canyon	27.4	58	Aug. 31, 1901	A. F. Doremus	
Big Elk Lake Reservoir Dam, Washington Irrigation Co.	Boulder Creek	29	871	Nov. 27, 1914	W. D. Beers	
		35	1,780			Original design; filed, never approved.
Blue Creek Reservoir Co. Dam	Blue Creek	45	2,770	Feb. 17, 1917	G. F. McGonagle	Enlarged design.
Box Elder Creek Reservoir Dam, Brigham City Conservation Co.	Box Elder Creek	68				
		45	2,800	Sept. 7, 1916	W. D. Beers	Two dams on reserv.
Booby Hole Reservoir Dam, property of J. C. Maginnis	Booby Hole Creek	18	200			Were not approved.
Buckhorn Land Co. Reservoir Dam	Off natural stream. Water supply derived from Huntington Creek	61	25,898	Nov. 15, 1913	W. D. Beers	
Cleveland Canal & Argicultural Companies, Reservoir Dam	Huntington Creek	40	2,315	Nov. 8, 1905	Caleb Tanner	
Cobble Creek Reservoir Dam, Ogden River Reservoir Co.	South Fork of Ogden River	100	4,960	July 30, 1912	Caleb Tanner	Original design.
		50	509	Sept. 23, 1912	Caleb Tanner	Revised design.
Columbus Consolidated Mining Company Power Dam	Little Cottonwood	13		Dec. 10, 1903	A. F. Doremus	Diversion dam.
Deep Creek Reservoir Dam, Curlew Land Co. (Also known as the Curlew Res. Dam)	Upper Deep Creek	30	5,400	Aug. 12, 1907	Caleb Tanner	
Delta Land & Water Co. and Melville Irrigation Co., Diversion Dam	Sevier River	24		No record	Caleb Tanner	
Deseret Live Stock Co., Reservoir Dam No. 1	Saleratus Creek	13.4	140			Filed Nov. 25, 1915; never approved.

the lower toe of the dam will constitute the outlet tunnel. A spillway and wasteway consisting of an open cut 20 feet wide on top with a crest elevation 5 feet below the top of the dam are also provided for.

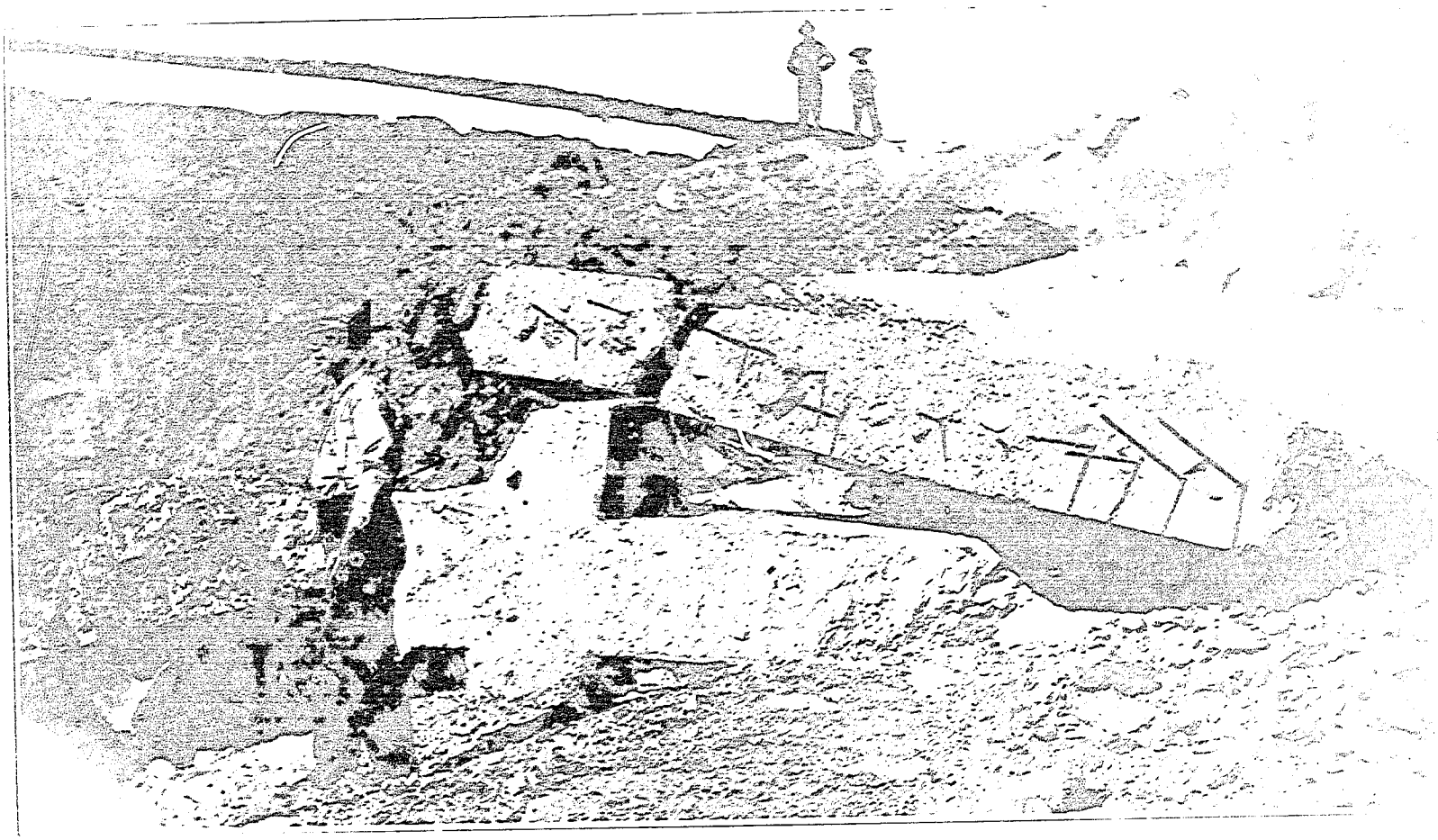
In addition to the dam an earth embankment 1,018 feet long having a maximum height of 18 feet is required at the southwest end of the reservoir site. This embankment is to be of similar construction as the main dam.

The plans and specifications were returned for modification on February 2, 1917, and were approved on February 26, 1917.

White Mesa Canal Company Reservoir Dam.

This proposed structure is to be located on a natural swale in Section 15, Township 36 South, Range 22 East, Salt Lake Base and Meridian. The water supply will be derived from Recapture Wash Creek and conveyed by means of a supply canal approximately 9 miles long to the reservoir. The dam is to be an earthen structure 16 feet high, 684 feet long on top, with an upstream and downstream slope of 3 to 1 and 2 to 1, respectively. The specifications call for the dam to be built of red clay. The water in the reservoir will be controlled by means of an 8-inch outlet pipe and an 8-inch valve gate attached to the upper end of the pipe. The gate valve will be operated from a trestle extending out into the reservoir. A spillway 4 feet wide is provided for in the supply canal immediately below the dam. The dam will impound a maximum of 15 acre-feet of water.

The plans and specifications were submitted on September 26, 1917. They were approved on October 4, 1917.



MAMMOTH DAM.
Sections of concrete core wall deposited over dam site at time of failure.

Range 1 East, Salt Lake Base and Meridian. The company has for years maintained an earthen structure 22 feet high at this point. The enlarged dam is to be 29 feet high, 2,050 feet long on top with an upstream and a downstream slope of 2½ to 1 and 2 to 1 respectively. The plan proposed for enlarging the original dam is to place an earth fill on the downstream side underlaying the same with an 8-inch tile drain system to collect and carry off any seepage water that may find its way through the dam or foundation. The dam is designed to have a minimum freeboard height of 6 feet.

The water in the reservoir will be controlled by means of a concrete tunnel 2 feet square equipped at its upper end with a slide gate stem following the slope of the upstream face to the top of the dam. In addition a spillway 18 feet wide, 8 feet deep and equipped with flash boards is provided for.

The enlarged reservoir will have a maximum capacity of 3,858 acre-feet at which stage it will cover 401 acres.

The plans and specifications were returned for modification on March 3, 1917, and again on August 13, 1917. They were approved November 1, 1917.

Nephi O. Perkins Reservoir Dam.

On January 22, 1917, Mr. Nephi O. Perkins submitted plans and specifications for a reservoir dam to be built in connection with his application file No. 5039 to appropriate water for irrigation purposes. The reservoir site is located on an unnamed wash in Section 15, Township 14 South, Range 12 East, Salt Lake Base and Meridian, and will have a maximum capacity of 230 acre-feet. The water supply will be derived from Pace and Dugout Creeks and conveyed by an artificial channel to the reservoir.

The plans and specifications call for an earthen structure having a maximum height of 24 feet, a top length of 284 feet, with an upstream and a downstream slope of 3 to 1 and 2 to 1, respectively. The dam will rest on the natural surface of the ground, and is to have a puddle core wall extending into the foundation 4 feet to a solid shale formation. A 4-foot-by-4-foot concrete shaft containing the hoisting mechanism for the outlet gate is to be constructed through the upstream portion of the dam at a distance of 35 feet from the upstream toe. A 12-inch corrugated iron pipe leading from the reservoir to the shaft and a 12-inch-by-12-inch concrete culvert leading from the shaft to

outlet of the lake. The reservoir will have a capacity of 3,725 acre-feet above the bottom of the outlet tunnel.

Dam No. 4.

This dam is to be located at the outlet of an unnamed lake which has a surface area of 23 acres. The dam is to be 18 feet high, 245 feet long on top and is similar in design to Dam No. 1, with the exception that the spillway is to be only 10 feet wide. The bottom of the outlet tunnel is to be 5 feet below the natural outlet of the lake. The reservoir will have a capacity of 468 acre-feet above the bottom of the outlet tunnel.

Plans and specifications for these dams were approved February 14, 1917.

Gordon Reservoir Dam.

Plans and specifications for the Gordon Reservoir Dam were submitted March 14, 1918. The damsite is located at the mouth of a natural basin in the West half of Section 33, Township 32 South, Range 24 East, Salt Lake Base and Meridian. The reservoir will have a capacity of 2,500 acre-feet of water. The water supply will be derived from Spring Creek and conveyed to the reservoir by means of a supply canal. The dam is to be an earthen structure 38 feet high, 820 feet long on top with a puddle core wall passing through its upstream third and extending down to bedrock. Bedrock is 5 feet below the natural surface of the ground. The upstream face of the dam is to be on a slope of 3 to 1, and the downstream face is on a slope of 2 to 1. A rock fill 10 feet high is to constitute the lower toe of the dam.

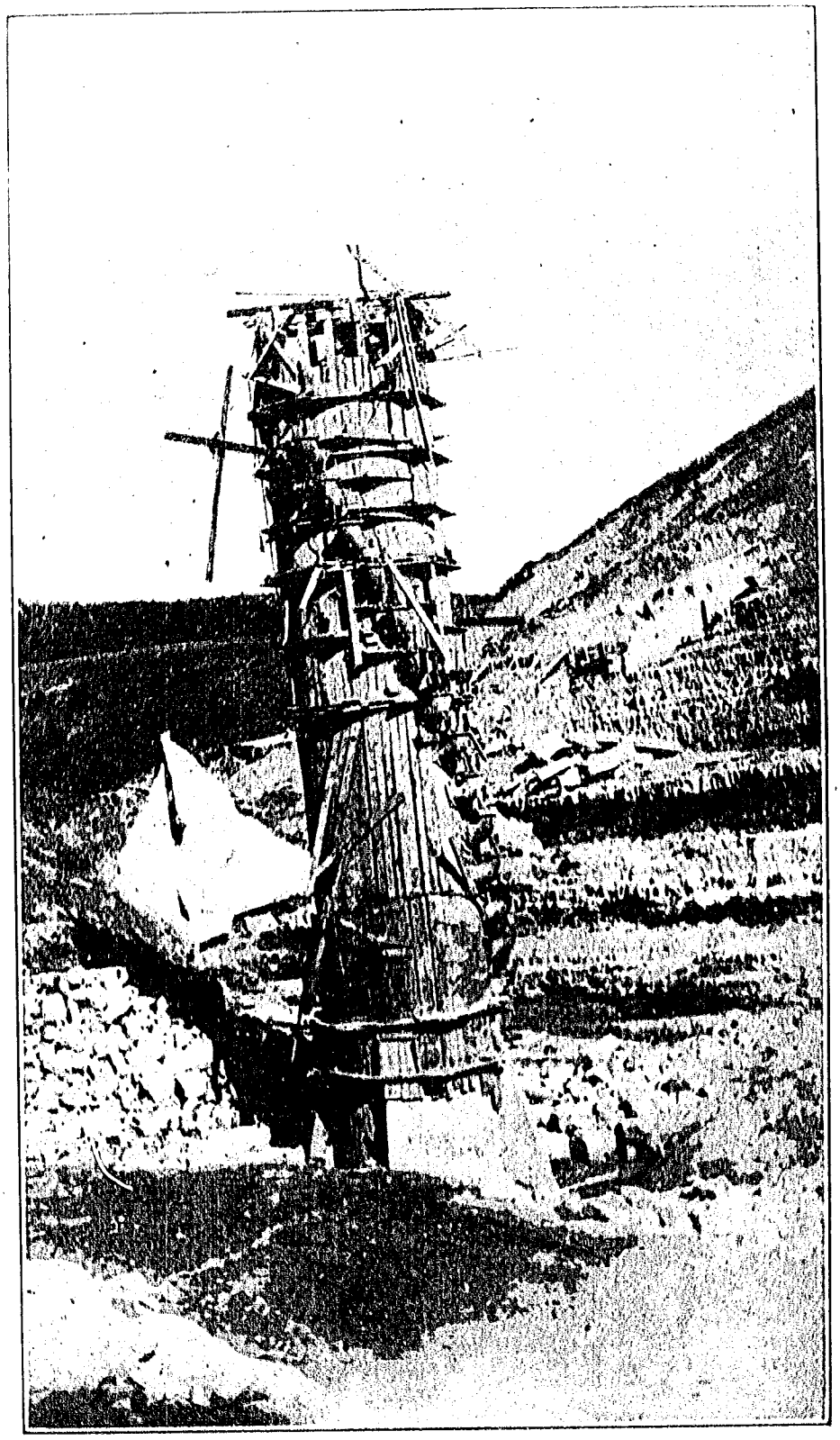
The plans provide that a trench 3 feet wide be cut through the ledge rock, forming the north abutment of the dam, to act as an outlet channel for the reservoir. This trench will be bulkheaded at the center with a masonry core wall through which a 12-inch pipe is to pass, terminating at the lower side in a 12-inch valve. A spillway 10 feet deep and 16 feet wide is to be constructed through the ledge rock at the north end of the dam.

The plans and specifications were approved May 4, 1918.

Koosharem Irrigation Company's Reservoir Dam.

The Koosharem Irrigation Company on February 17, 1917, filed plans and specifications for the enlargement of its reservoir dam, located on Otter Creek, in Section 30, Township 25 South,

MAMMOTH DAM.
Portion of temporary spillway remaining intact after failure.



MAMMOTH DAM.
Intake tower at upstream toe of wrecked dam.

Farnsworth Canal and Reservoir Company Dams.

The Farnsworth Canal and Reservoir Company is planning to utilize for storage purposes a chain of four lakes situated on an unnamed fork of the West Fork of Lake Fork Creek in Sections 5 and 6, Township 2 North, Range 6 West, and Section 1, Township 2 North, Range 7 West, Uintah Special Meridian, by damming up the outlets of these lakes and tapping the same below their present natural outlets. In line with this plan the Company submitted on February 9, 1917, plans and specifications of the dams it intends to build at the outlets of these lakes.

Dam No. 1.

This dam is to be located at the outlet of an unnamed lake which has a surface area of 27 acres. The dam proposed is of the Loose Rock Type with an earthen fill on the upstream side to make it impervious. The dam is to be 18 feet high and 700 feet long on top. The downstream face of the rock fill is to be on a slope of 1½ to 1, the upstream face on a slope of 1 to 1, with the upstream face of the earth fill on a slope of 3 to 1. An outlet tunnel consisting of a 36-inch corrugated iron pipe terminating at the upper end in a 36-inch slide gate is to be constructed 3 feet below the natural outlet of the lake. The slide gate will be operated from a trestle extending out into the reservoir. A spillway 20 feet wide having its crest 4 feet below the top of the dam is provided for. This reservoir will have a maximum storage capacity of 363 acre-feet above the bottom of the outlet tunnel.

Dam No. 2.

This dam is to be located at the outlet of Island Lake, which covers a surface area of 46.7 acres. The dam is to be 15 feet high, 320 feet long on top and is similar in design to Dam No. 1. The bottom of the outlet tunnel is to be 7 feet below the natural outlet of the lake. The reservoir will have a maximum capacity of 944 acre-feet above the bottom of the outlet tunnel.

Dam No. 3.

This dam is to be located at the outlet of Duck Lake which covers a surface area of 177 acres. The dam is to be 15 feet high, 381 feet long on top, and is similar in design to Dam No. 1. The bottom of the outlet tunnel is to be 10 feet below the natural

The reservoir will have a maximum capacity of 56 acre-feet. The water supply will be derived from Red Hills Creek and conveyed to the reservoir by means of a supply canal approximately 3,300 feet long.

Plans and specifications were returned for modification on August 28, 1917, and were approved September 12, 1917.

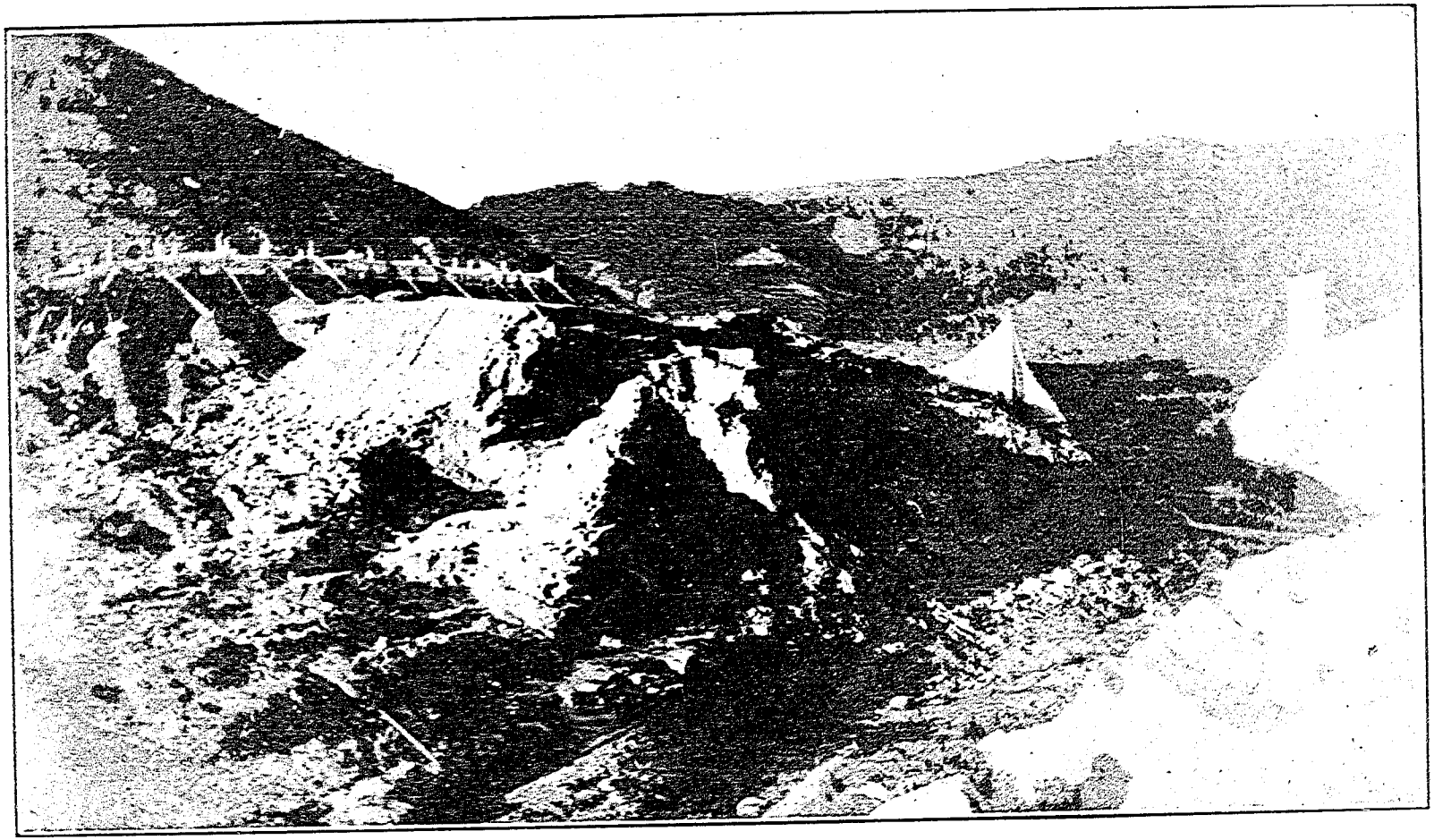
Blue Creek Irrigation Company Reservoir Dam.

This structure is the property of the Blue Creek Irrigation Company, successor in interest to the Promontory Curlew Land Company. The latter company in 1904 built a dam 36 feet high across Blue Creek in Section 6, Township 12 North, Range 5 West, Salt Lake Base and Meridian, impounding therewith 1,780 acre-feet of water. On April 4, 1916, the present company filed plans and specifications for permission to raise this structure to 45 feet in height.

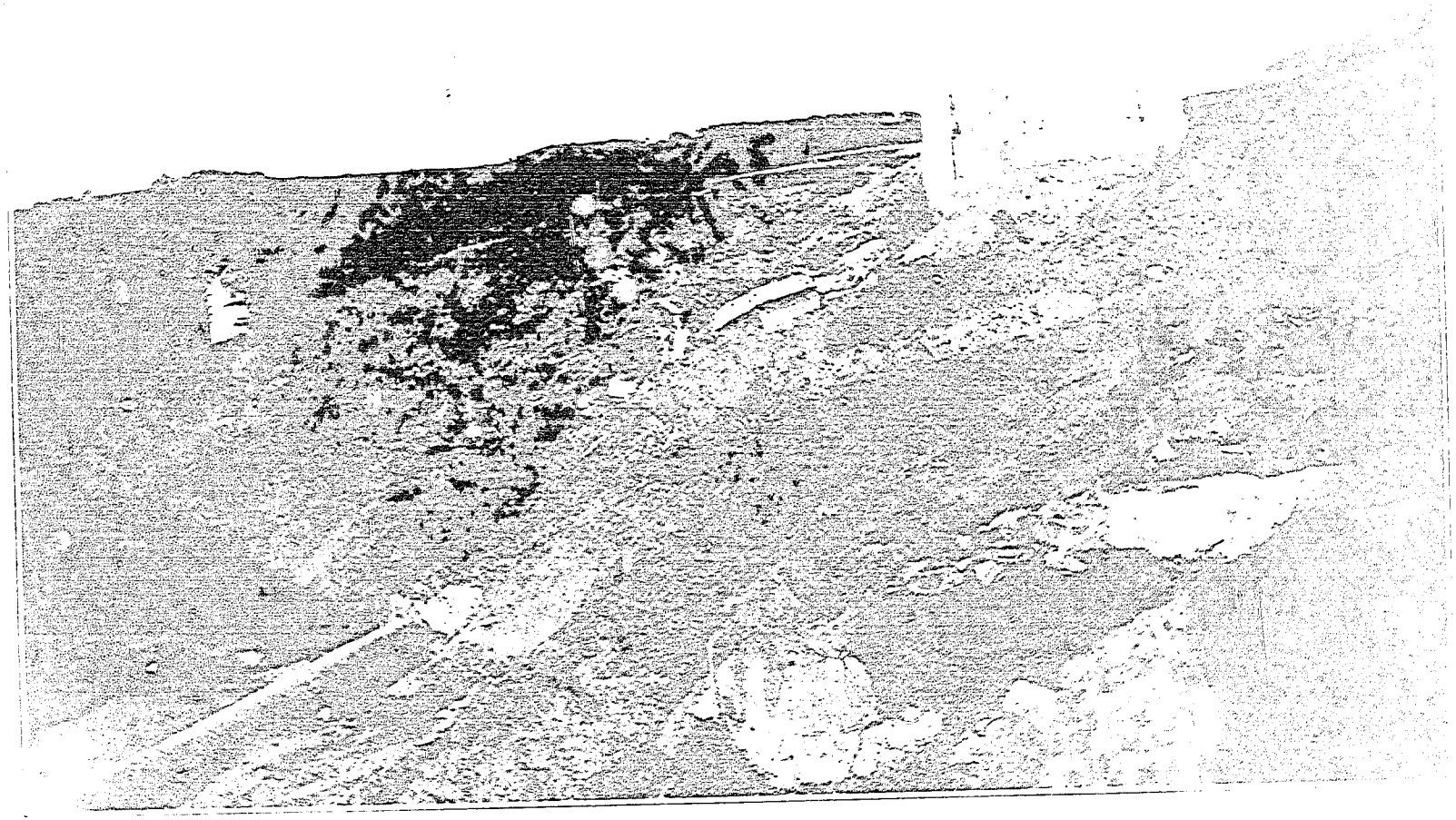
The enlarged structure is 2,400 feet long, 1,800 feet of which averages 7 feet in height. The raising of the dam was accomplished by steepening the upstream and the downstream slopes starting at a point one-third of the height from the bottom of the dam. The slope of the upstream face of the finished structure varies from 3 to 1 at the bottom, 2 to 1 at the top, and of the downstream face from 2 to 1 at the bottom to 1½ to 1 at the top. The dam has a top width of 15 feet and a minimum freeboard height of 8 feet.

The water in the reservoir is controlled by means of an intake tower and a concrete outlet pipe 4 feet in diameter. The intake tower is constructed of concrete and is located at the upstream toe of the dam. The water enters the tower through a series of seven iron cast elbows each 30 inches in diameter, equipped with flap gate valves. These elbows are set at different heights in a spiral formation and the flap gate valves are operated by means of a differential hoist mounted on a circular track supported on top of the tower. A wooden trestle leads from the top of the dam to the tower. A natural "hogback" at the north end of the dam rising to within 8 feet of the top of the dam serves as a wasteway. The enlarged reservoir has a maximum capacity of 2,770 acre-feet, at which stage it inundated 140 acres of land.

Plans and specifications were approved February 17, 1917, and the raising of the dam has since been completed.



MAMMOTH DAM.
Upstream view of North end of dam after failure, showing location of temporary spillway.



MAMMOTH DAM.

Upstream view of south end of dam after failure, showing intake tower, outlet tunnel and part of concrete [illegible]

money sufficient to pay the expenses of the examination, and in case the application appears to him not to have been justified, he may cause the whole or part of such expenses to be paid out of such deposit. In case the request appears to the State Engineer to have been justified, he may require the owner of the works to pay the whole or any part of the expenses of such examination."

Under these provisions of the law there were checked and approved during the past two years plans and specifications for ten dams and examinations made of several existing structures. In addition the State Engineer made an investigation of the failure of the Mammoth Reservoir Dam. His report of this investigation is found elsewhere in this report. The plans and specifications passed on were all analyzed in accordance with the fundamental principles of design and construction that are today recognized by conservative engineers. While economy was taken into consideration whenever alterations in designs were required, the first and foremost consideration was safety and it was with this end in view that modifications were requested.

A brief description of the dams for which plans and specifications were approved during the past two years follows, and at the end of the chapter is given a list of all dams for which plans and specifications have been filed since the creation of the State Engineer's office.

Nephi and Niels M. Anderson Reservoir Dam.

On August 28, 1917, Nephi and Niels M. Anderson submitted plans and specifications for a reservoir dam to be built in connection with their application file No. 5982 to appropriate water for irrigation purposes. The reservoir site is situated in Section 23, Township 13 South, Range 3 East, Salt Lake Base and Meridian. Here a small dam 8 feet in height has been maintained for several years. This dam is to be replaced by a new dam 16 feet high and 503 feet long on top. The new dam is to be built of a heavy clay loam with an upstream slope of 2 to 1 and a downstream slope of 1¼ to 1. An 8-inch galvanized iron outlet pipe with a steel slide gate attached to the upper end and a wasteway 4 feet wide by 2 feet deep will control the water in the reservoir. In addition to the new dam an embankment having a maximum height of less than 10 feet and a length of 498 feet will be required at the east end of the reservoir site.

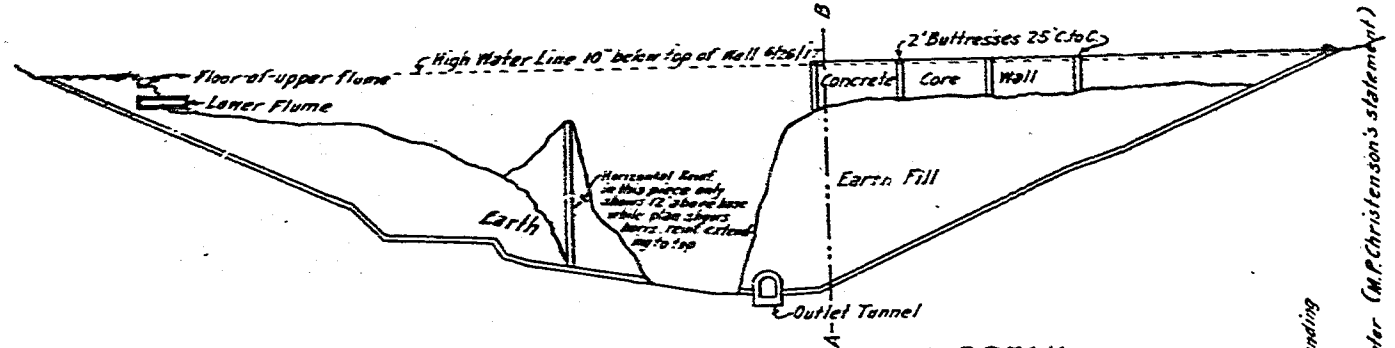
CHAPTER IV.

RESERVOIR DAMS.

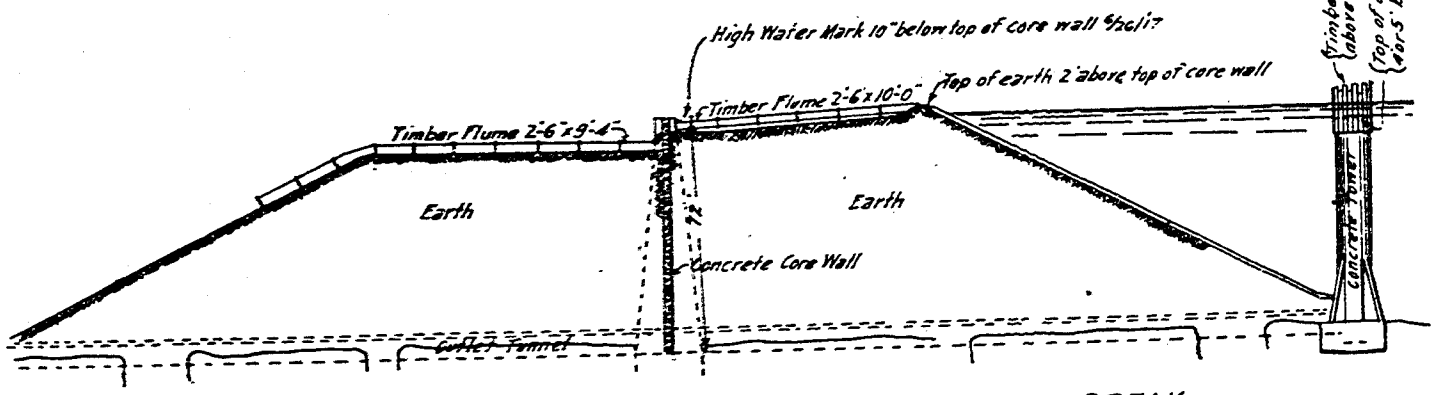
Sections 1268 and 1269, Compiled Laws of Utah, 1907, provide for the examination and approval by the State Engineer of the plans and specifications of all reservoir dams to be built within the State over a certain height, also for the examination of any existing reservoir dam. These sections read as follows:

"Section 1268. *Must examine plans of dams exceeding five feet in height, and inspect dams.* Duplicate plans, drawings, and specifications for any dam above five feet in height, across the natural channel of a running stream, or of any other dam intended to retain water above ten feet in height, shall be submitted to the State Engineer for his approval, who shall examine such plans, drawings and specifications, and, if he approves the same, he shall return one copy of each such plans, drawings, and specifications, with his approval, to the party or parties submitting the same, and file the other in his office. If the State Engineer disapproves any of such plans, drawings, or specifications, he shall return the same, with his reasons for such disapproval. The State Engineer shall have authority to keep an inspector on any such dam during the construction thereof, and to see that the work is done in accordance with the plans, drawings, and specifications, and the State Engineer may require the parties constructing the same to make any additions or alterations during the construction which he considers necessary for the security of the work, the safety of persons, or the protection of property. Any person, corporation, or association beginning the construction of any such dam before the plans, drawings, and specifications shall have been submitted to and approved by the State Engineer, or proceeding with such work in the absence of an inspector appointed by said engineer, or who shall fail to comply with any of the requirements made by him in pursuance of this section, shall be guilty of a misdemeanor."

"Section 1269. *Id. Dam or works examined, when.* Should any person, corporation, or association residing on or owning land in the neighborhood of any completed dam or diverting works, apply to the State Engineer in writing, requesting an examination of such dam or works, the State Engineer may order an examination thereof. Before doing so, he may require the applicant for such examination to deposit a sum of

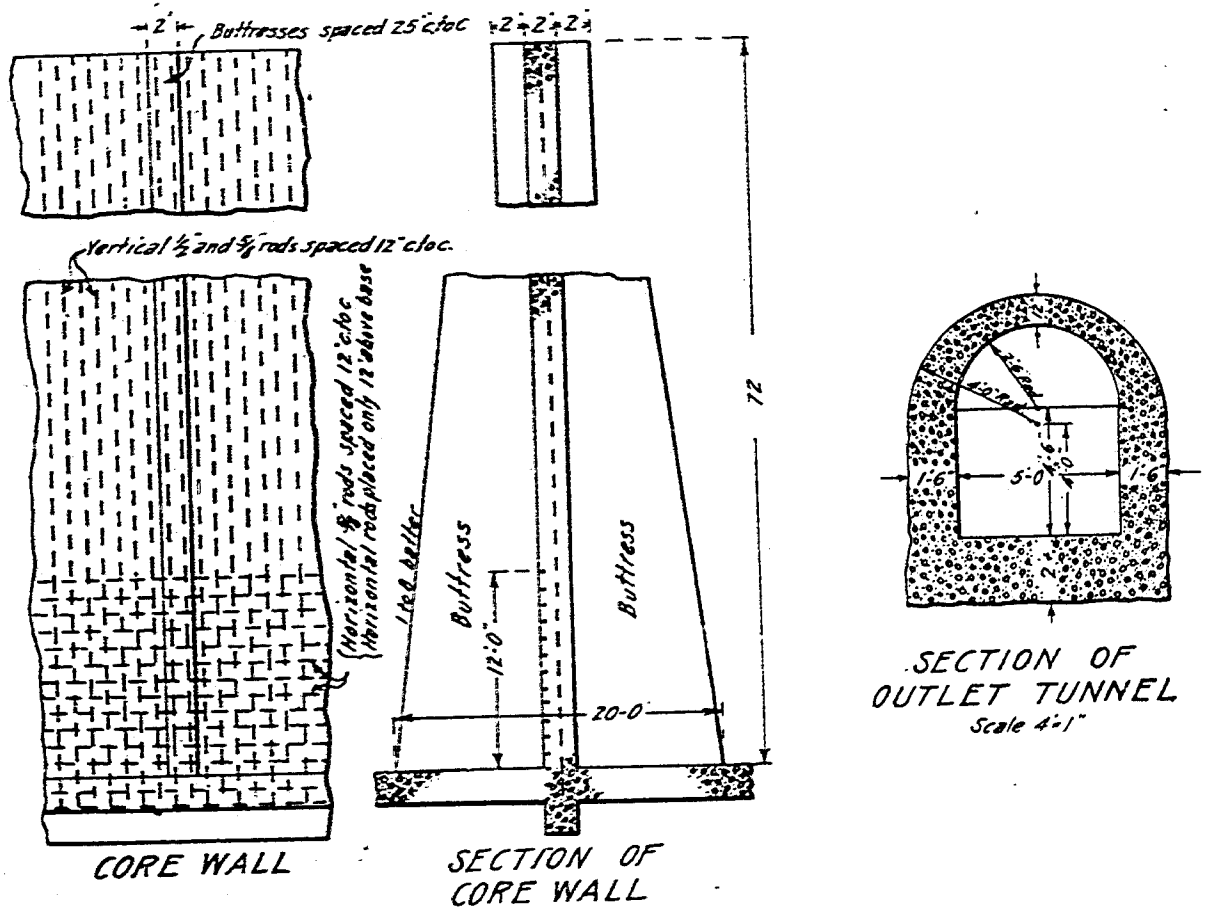


UPSTREAM VIEW OF DAM AFTER BREAK
Scale 40=1'



SECTION A-B SHOWING CONDITIONS BEFORE BREAK
Scale 40=1'

MAMMOTH RESERVOIR DAM



MAMMOTH RESERVOIR DAM.
Details of Core Wall and Outlet Tunnel.

11:00 a. m. and went to lunch at the bunkhouse, about a thousand feet distant. On his return, two hours later, the water had broken through the earth dyke along the side of the temporary flume, had filled the intervening space between the dyke and the core wall, and a section of the core about five feet high and thirty feet in length had fallen outward, allowing the water to pour through this breach onto the earth-fill forming the lower half of the dam. As the earth washed away, leaving the core unsupported, sections of the core continued to fall until seventy-five per cent of the dam had gone out and the reservoir emptied.

I am advised by Superintendent Christensen that there was no unusual flood condition on the day of the break; that the level of the reservoir was stationary, or, if anything, falling slightly; that no water was passing through the flume; that he had nailed three six-inch boards across the upper end of the flume forming a bulkhead eighteen inches high, and that the water level was four inches below the top of the bulkhead.

A review of the situation shows that this dam failed, first, because the flume portion of the spillway was improperly and inadequately constructed; second, because the horizontal reinforcement in the core wall had been stopped twelve feet above the base instead of being carried to the top of the core; third, the first section of core wall to fail sheared off at a point five feet below the top, indicating that the bond between the older section of the wall and the five-foot raise made last year was not what it should have been; fourth, because the management deliberately permitted the level of the water in the reservoir to rise to within ten inches of the top of the core wall contrary to all precedent and against all engineering practice.

If the water level had been maintained five feet below the top of the core wall the dam would still be intact.

There is absolutely no evidence to indicate that the dam was tampered with by outside parties.

Maps, photographs and drawings are herewith attached.

Respectfully submitted,

(Signed) G. F. McGONAGLE,
State Engineer.

July 7, 1917.

area of 12,115 acres, the elevation at the dam being 8,600 feet above sea level.

The waters impounded in the reservoir flowed down Gooseberry Creek, thence into Fish Creek in Pleasant Valley a few miles below Scofield, thence into the Price River near Colton, and thence down the Price River to the company's diversion dam between Helper and Price. From the diversion dam the waters were carried in the company's main canal for a distance of about twelve miles and used for the irrigation of about 20,000 acres of land lying south and east of Price.

On June 27th, H. S. Kleinschmidt, representing the Engineering News-Record, J. L. Rhead, engineer of the Piute project, and I proceeded to the dam, took numerous measurements and photographs of the wrecked structure, and, after remaining there over night, arrived back at Fairview the next day, or June 28th.

We then interviewed M. P. Christensen, who was in charge of the dam for the company, and Andrew Hall, watchman at the dam at the time of the break.

I find the following to be the facts in the case:

The concrete wall was raised five feet in the fall of 1916.

The earth-fill was about five feet below the top of the core wall on the upstream side and ten feet below the top on the downstream side.

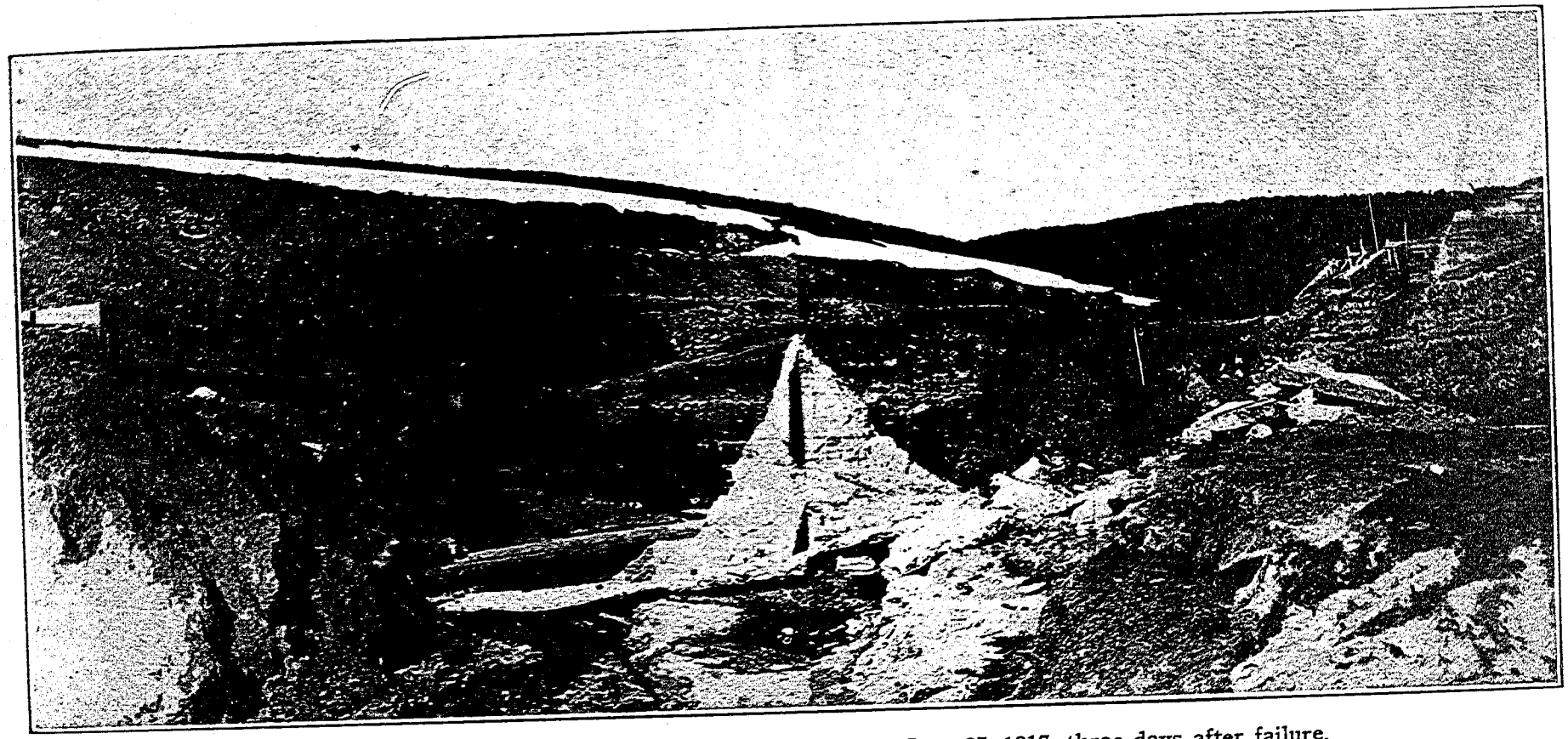
The top width of the dam was 160 feet and the top length about 440 feet, the unusual top width being caused by the fact that the company expected to raise the dam about fifty feet to a total height of 125 feet. The core wall was located on the axis of the dam.

At the junction of the upstream slope and the top of the dam an earth dyke had been erected eighty feet upstream from the core and parallel to it, the top of this dyke being two feet higher than the top of the core.

The water in the dam was two feet ten inches below the top of the earth dyke, or ten inches below the top of the core wall.

A wooden flume had been constructed, extending from the dyke to a rectangular notch in the core, the flume being two feet six inches deep, ten feet wide, and eighty feet in length, this flume being intended to carry flood waters from the dyke to the core wall, thence over a vertical drop of six feet six inches into a temporary wooden spillway butted against the lower side of core. This flume was laid through the earth dyke without any bulkheads or cut-off walls.

On Sunday, June 24th, Watchman Hall left the dam at



Downstream view of Mammoth Dam as it appeared on June 27, 1917, three days after failure.

and caused the shutdown of all coal mines in this district, as they depended entirely on the Denver & Rio Grande Railroad Company to furnish cars for moving the coal.

The records of my office show that early in 1903 the predecessors in interest of the Price River Irrigation Company filed with the then State Engineer, for his approval, plans and specifications for a dam 100 feet high, to be constructed at the site of the present dam. These plans and specifications were approved on May 5, 1903. Some time in 1908 the company filed plans and specifications for enlarging the dam to 115 in height. These plans and specifications were never approved by the State Engineer, and they were returned to the company in 1912. On October 26, 1914, a new set of plans and specifications, to raise the dam to 125 feet in height, were filed. At the time these plans were submitted the dam had been built to a height of 67 feet but had not been built in accordance with the original plans for the 100-foot dam approved in 1903. At the time of failure of the dam these revised plans and specifications had not received the approval of the State Engineer. As late as the latter part of April, 1917, the then State Engineer, Mr. W. D. Beers, had a conference with Messrs. T. R. Cutler, George A. Smith, W. A. Wheelon and George Austin, relative to the necessity of making certain changes in the design of the enlarged structure which the State Engineer demanded be made before he would approve the plans and specifications.

At the request of Governor Bamberger, I made a field investigation of the failure of the dam on June 27, 1917, and submitted the following report to him:

Report on the Failure of the Mammoth Dam.

The Mammoth Dam is situated on the southwest quarter of Section 6, Township 13 South, Range 6 East, twelve miles east of Fairview, Utah, and is owned by the Price River Irrigation Company of Salt Lake City. The officers of the company are:

George Austin ..... President
George A. Smith ..... Secretary
T. R. Cutler,
Mark Austin,
Ira D. Wines,
Thomas Austin,
J. H. Leautand, ... Directors
J. C. Wheelon ..... Chief Engineer

The dam was approximately 72 feet in height, of earth construction, with a concrete core wall founded on bedrock.

The reservoir covered an area of 349 acres with a watershed

CHAPTER III.

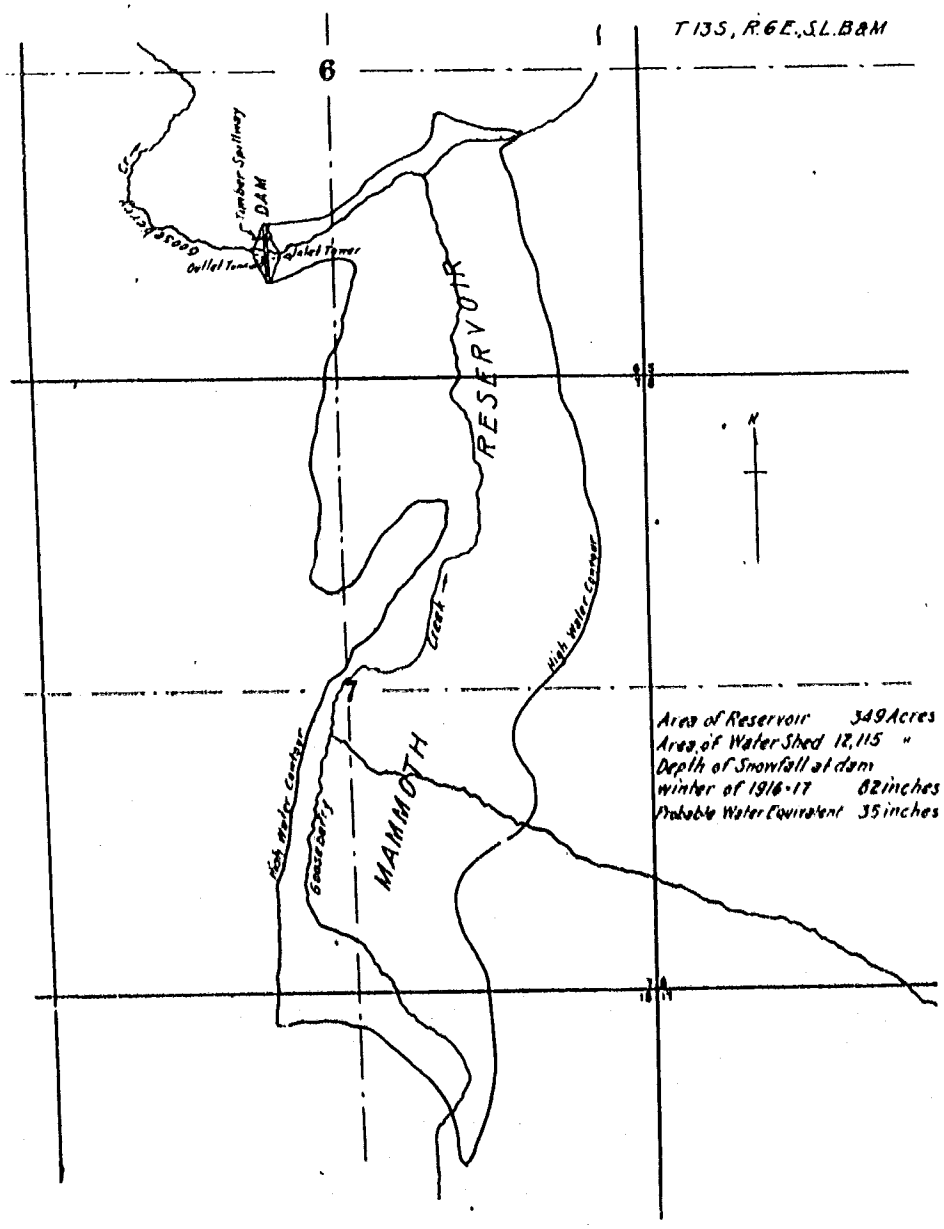
FAILURE OF THE MAMMOTH DAM.

On the afternoon of June 24, 1917, the Mammoth Reservoir Dam, located on Gooseberry Creek in Section 6, Township 13 South, Range 6 East, failed, releasing 11,000 acre-feet of water. This water rushed in a huge flood down Gooseberry Creek into Fish Creek, thence down Fish Creek into Price River, thence down Price River into Green River, wrecking everything in its course. As a result of this failure, the dam was completely destroyed and untold damage was done to property along the path of the flood.

The dam was the property of the Price River Irrigation Company and was used to store water to supplement the low water flow of Price River for the irrigation of lands under the company's project southwest of the City of Price. It was in process of construction at the time of failure and had reached a height of 72 feet. The dam was an earth-fill structure, with a concrete core wall founded on bed-rock and was designed for a maximum height of 125 feet.

The water in the reservoir was controlled by means of a circular outlet tower located at the upstream toe of the dam. This tower was equipped with four 12-inch sluice gates and eighteen one-fourth bend cast iron inlets each twelve inches in diameter. These inlets were located in a spiral around the tower. No footbridge or adequate operating platform had been constructed and access to the tower was had by means of a raft. The tower was connected to an arched concrete outlet tunnel five feet wide by six feet high, passing through the body of the dam. At the time of failure no spillway had been built; a temporary wooden flume ten feet wide by two and a half feet deep served the purposes of a spillway.

The damage caused by the flood resulting from this failure was enormous. In Price River Canyon the main line of the Denver & Rio Grande Railroad Company was washed out for many miles, while on the Scofield Branch of this road eleven miles of roadbed was destroyed. It required several weeks to rebuild the main line to the extent where trains could be operated over it again. It is estimated that the loss to the Denver & Rio Grande Railroad Company alone amounted to over $500,000. In addition to this, the flood did considerable damage to the homes of coal miners residing in the canyon and around Helper



MAMMOTH RESERVOIR SITE.

water to be stored behind said dam in excess of 60,000 acre-feet, as I think this is the maximum amount that can safely be stored behind the dam in its present condition. The dam should be strengthened to the point where it will be absolutely safe for storing the maximum amount of water for which it was originally designed. It is estimated that this will require an expenditure of approximately $70,000. Such an expenditure is justified in view of the fact that it will make available an additional storage of 33,000 acre-feet at a cost of less than $2.50 per acre-foot. The State Board of Land Commissioners informs me that it has not the necessary money in the Irrigation Fund to do this work. I therefore recommend that the coming legislature pass such laws as may be necessary to provide sufficient funds to strengthen the dam to the point where it will be safe to store the full amount of water for which it was designed.

Many of the persons who have filed applications with this office to appropriate water come within the Draft Law of the Federal Government. Those that have been inducted into the service cannot comply with the provisions of the Irrigation Law relating to the appropriation of water and a number of these have requested extensions of time within which to complete their appropriations. Under the present law the State Engineer's authority to grant extensions of time within which to complete appropriations does not cover delays of this nature. It is only justice to these persons that their requests should be granted, and I therefore recommend that the coming legislature pass a law empowering the State Engineer to grant extensions of time to applicants inducted into the Federal Service equivalent to the time that they are in the service.

The following is an estimate of the funds necessary for the expenses of the State Engineer's office for the next biennium, and I recommend that the funds be provided:

Irrigation Contingent Fund	$30,300
State Engineer Contingent Fund	1,500
State Institution Survey Fund	500
Stream Measurement Fund	10,000
Total	$42,300

CHAPTER II.

RECOMMENDED LEGISLATION.

In the last two Biennial Reports of the State Engineer attention was called to the unsatisfactory conditions existing throughout the State with respect to water rights and certain recommendations were made for remedying these conditions. In line with these recommendations the 1917 legislature passed a law creating the Water Rights Commission. It is the duty of this Commission to make a careful and complete investigation of the conditions existing throughout the State with respect to irrigation and water rights, with a view of ascertaining what changes in the present irrigation and water right laws are desirable and expedient, and to that end prepare a bill covering the adjudication, appropriation, and administration of water rights within this State, for introduction in the Thirteenth Session of the Legislature.

In accordance with the foregoing provision the Water Rights Commission has practically completed the draft of the bills which it proposes to introduce in the coming legislature. These bills include the adjudication, appropriation, and administration of all public waters of the State, also the revision of the Irrigation District Law and of the Drainage District Law.

As State Engineer I have, on a number of occasions, met with the Commission while in session and have discussed and advised with it on matters pertaining to these bills. I have personally gone over and studied carefully each and every provision of these bills, and have come to the conclusion that the principles underlying them are correct and will remedy the conditions now existing. I most heartily endorse these bills as now drafted for introduction in the Thirteenth Legislature and sincerely hope that they be enacted into laws.

The Piute Dam was completed to its present state in 1914. As the dam stands today it has a maximum height of 95 feet and a maximum impounding capacity of 93,000 acre-feet. Since it has been brought into service its behavior has been closely studied. The results of these studies are given in Chapter V of this report. These results, taking into consideration the profile of the dam, have demonstrated to my mind that it is not safe to impound water behind the dam to its maximum capacity. As State Engineer under the authority given me by Sections 1268 and 1269, Compiled Laws of Utah, 1907, I will not allow the

proximately 40,000 acres of rich agricultural land. The water allotment survey was made in September 1917 and on an average of 1 acre-foot of water was allotted to each acre of land. Part of the land embraced in the district has a partial water supply derived from Chalk Creek, Meadow Creek, Pine Creek and from artesian wells. The district contemplates securing the additional water from the Sevier River Land & Water Company and has voted a $1,250,000 bond issue for this purpose.

In organizing these districts it was found that the present law was impractical and defective in several respects. These defects have been called to the attention of the Water Rights Commission, and the amendments to this law which said commission will propose to the coming legislature will remedy these defects.

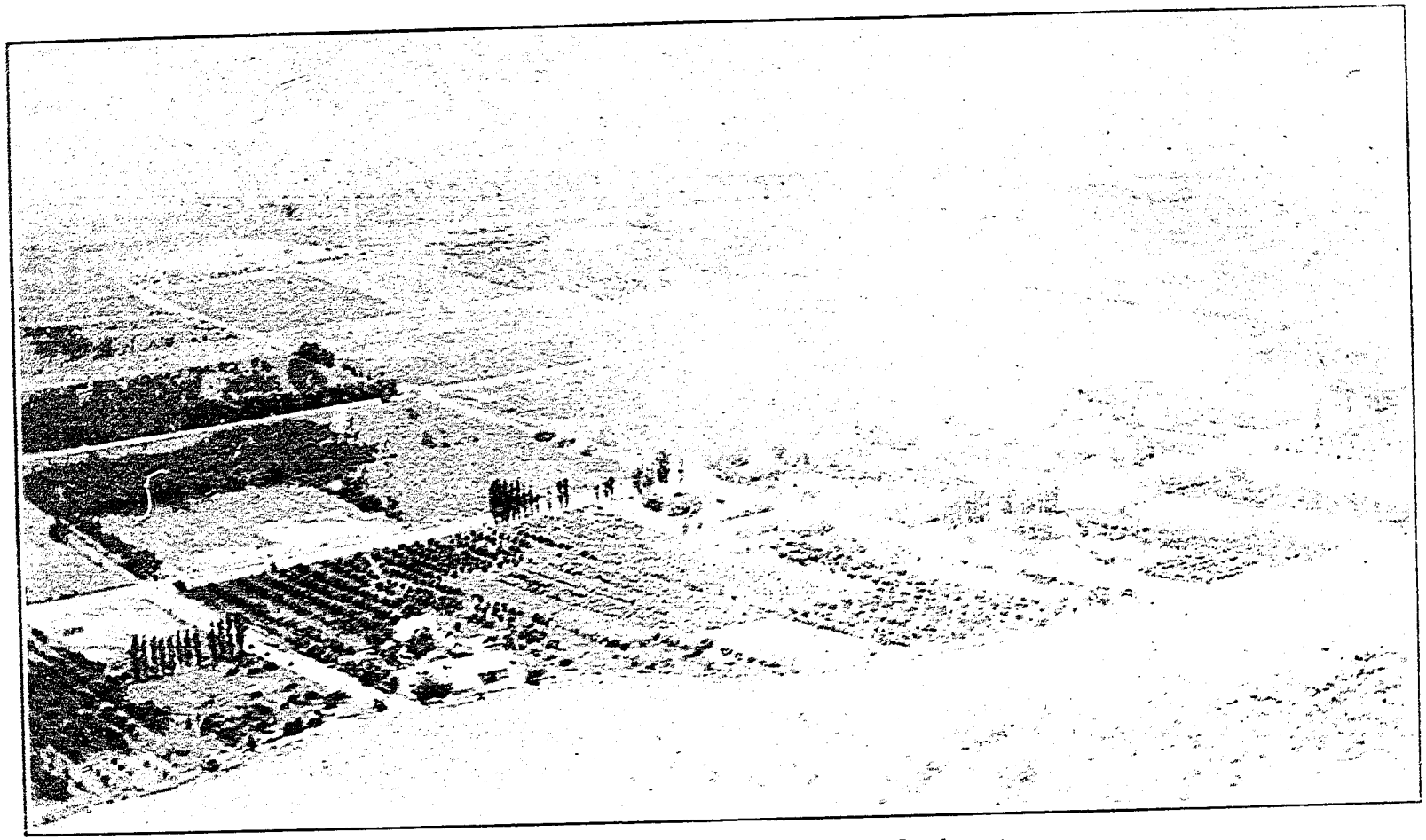
The Colorado River system is one of the greatest natural resources of the West and is of untold value to the States through which it flows. While sporadic efforts have been made in the past looking toward the control and utilization of this river system no concerted efforts have so far been made by the States tributary to it. During the past three months an organization has been perfected in this State by a number of its leading citizens with a view of interesting the Federal Government in the development of this river system as a means for providing homes and employment for thousands of returned soldiers. One of the purposes of this organization is to induce the other States tributary to the Colorado River system to create similar organizations so that a concerted and unified effort may be made to induce Congress to authorize the Federal Government to undertake this work. As a member of the aforesaid organization the State Engineer has given considerable time and attention to this movement and has collected data and prepared maps for use in promulgating this undertaking. The control and utilization of this river system is such a gigantic task that no agency except the Federal Government can undertake it. As a matter of fact, the Government through the President and the Secretary of the Interior has already signified its interest in this matter, and it is hoped that the present efforts of Utah and her sister States may result in Congress making the necessary appropriations for undertaking this work.

right is determined and sufficient additional water allotted to properly irrigate it. The fact that the law requires that water shall be allotted to each 40-acre tract or smaller in separate ownership necessitates that an abstract of ownership of all lands within the proposed district be first prepared. This is generally secured from the County Recorder's records. Where a proposed district embraces land that already has a partial water right experience during the past two years has shown that it is often difficult to determine the nature and extent of those rights due primarily to a lack of proper records and water measurements. After the water survey and allotment of water is completed a report showing the amount of water allotted to each tract of land is submitted to the County Commissioners, who then set a date for a hearing at which time any land owner may petition to have his allotment increased or decreased or to be included or excluded from the district. The water allotment made by the State Engineer as modified by the County Commissioners on petition becomes the basis on which all future district assessments are made.

During the past two years three irrigation districts were organized under the present irrigation law, namely, the Mapleton Irrigation District, the Springville Irrigation District, and the Pahvant Irrigation District. The Mapleton Irrigation District is located in Utah County and embraces the town of Mapleton. Practically all lands under this district have a partial water supply derived from Hobble Creek. For the additional water supply the district entered into a contract with the United States Reclamation Service to furnish the same from the Strawberry Reservoir. The water allotment survey for this district embraces 418 separate tracts of land, and a total of 6,081 acre-feet of water was allotted to these tracts. This district has been in successful operation for over a year.

The Springville Irrigation District joins the Mapleton Irrigation District, and embraces the town of Springville. Like the Mapleton District, the majority of the lands embraced in this district have a partial water supply derived from Hobble Creek, the additional water being secured from the Strawberry Reservoir by purchase through the United States Reclamation Service. Water for 567 separate tracts of land was allotted under this district, the total amount allotted being 2,465 acre-feet. This district has been in operation for the past year.

The Pahvant Irrigation District is located in Millard County just west of the town of Fillmore. This district embraces ap-



View of La Verkin Bench looking Northwest.

tion of the various dams throughout the State an arrangement has been perfected with Mr. L. F. Kneipp, District Forester, whereby his department co-operates with this office in so far as dams on the Forest Reserve are concerned. Blank forms are furnished each forest ranger, upon which he reports all conditions affecting the safety of each dam over ten feet in height in his territory. Reports are sent in every week or two during the storing period, depending upon how often the ranger covers his territory. The storing period is generally from May 1 to July 1 of each year. These reports as soon as received are closely studied, and if any one reveals an apparent weakness in any dam an examination of the dam is immediately made to determine its safety to store water. By means of this system the State Engineer can keep in touch with the condition of most of the dams in the State as a majority of them are on the Forest Reserves.

In August, 1917 the State was called on to complete the military survey of the State of Utah started by the War Department at the time the United States entered the European war. Prior to that time this work was carried on by the Forest Department that had up to that time surveyed about fifty per cent of the State. The State in taking over this work assigned the task of completing the survey to the State Engineer's office while the State Council of Defense assumed the responsibility of financing it. A special force was organized to carry on this work and Mr. E. C. Penrose placed in charge under the direction of the State Engineer. This survey is being made along lines outlined by the War Department and is quite comprehensive. Chapter VI of this report describes in detail the nature and extent of the work done under this survey since it was turned over to this department.

The present Irrigation District Law was passed by the 1917 legislature. This law provides that whenever a petition for the organization of an irrigation district is submitted to the County Commissioners of the county in which the proposed district is situated the County Commssioners shall request the State Engineer to make a water survey and allotment of water for the lands in the proposed district and it then becomes the duty of the State Engineer to have such survey made. The survey consists in determining the amount of water required to properly irrigate each 40-acre tract or smaller tract of land in separate ownership embraced in the proposed district. In case any tract already has a partial water right the nature and extent of such

The State Engineer is also a member of the Executive Committee of the Highway Transport Committee of Utah. This committee was organized as a war measure to bring the crops and other resources of the State to market centers.

During the past two years plans and specifications for ten dams were submitted to this office for approval. These were carefully checked with a view of protecting life and property below the dams. Whenever plans and specifications for any dam were found to depart from what is today considered conservative dam construction or the stability of any dam proposed appeared questionable, the plans and specifications were returned with a statement as to what alterations would have to be made before they would be approved. A detailed description of the plans and specifications checked and approved during the past two years will be found in Chapter IV of this report. In addition to the plans and specifications so checked an examination of the failure of the Mammoth Dam was made, also several existing structures examined. The failure of the Mammoth Dam is the subject of a special chapter of this report.

In examining the dam of Huntington Canal and Reservoir Association located on Huntington Creek, at the time the company was making alterations in this structure it was found that the outlet tunnel consisted of a wooden pipe made of native lumber. The company was required to remove this pipe and to put in a permanent outlet tunnel before any more water was allowed to be stored behind the dam. In removing the pipe it was found to be in a badly decayed condition and a serious hidden menace to the safety of the dam. The company has since put in a galvanized corrugated pipe for an outlet tunnel.

The Doxford Canal Company in years past maintained a small dam on Doxford Creek in Sevier County. Several years ago this dam failed, washing out the Forest Service Road in Doxford Canyon, also damaging the water system of the town of Monroe. Last summer the company rebuilt the dam without first getting plans and specifications approved by the State Engineer. Complaints reached this office that the rebuilt dam was not safe whereupon an investigation was made. This investigation disclosed that fact that the dam as reconstructed is not safe, and the company was notified that it would not be allowed to store water behind the dam until it filed plans and specifications with this office and the dam rebuilt in accordance with the approved plans and specifications.

For the purpose of keeping in closer touch with the condi-

Dinosaur quarry near Jensen. View shows vertebra imbedded in the rock.

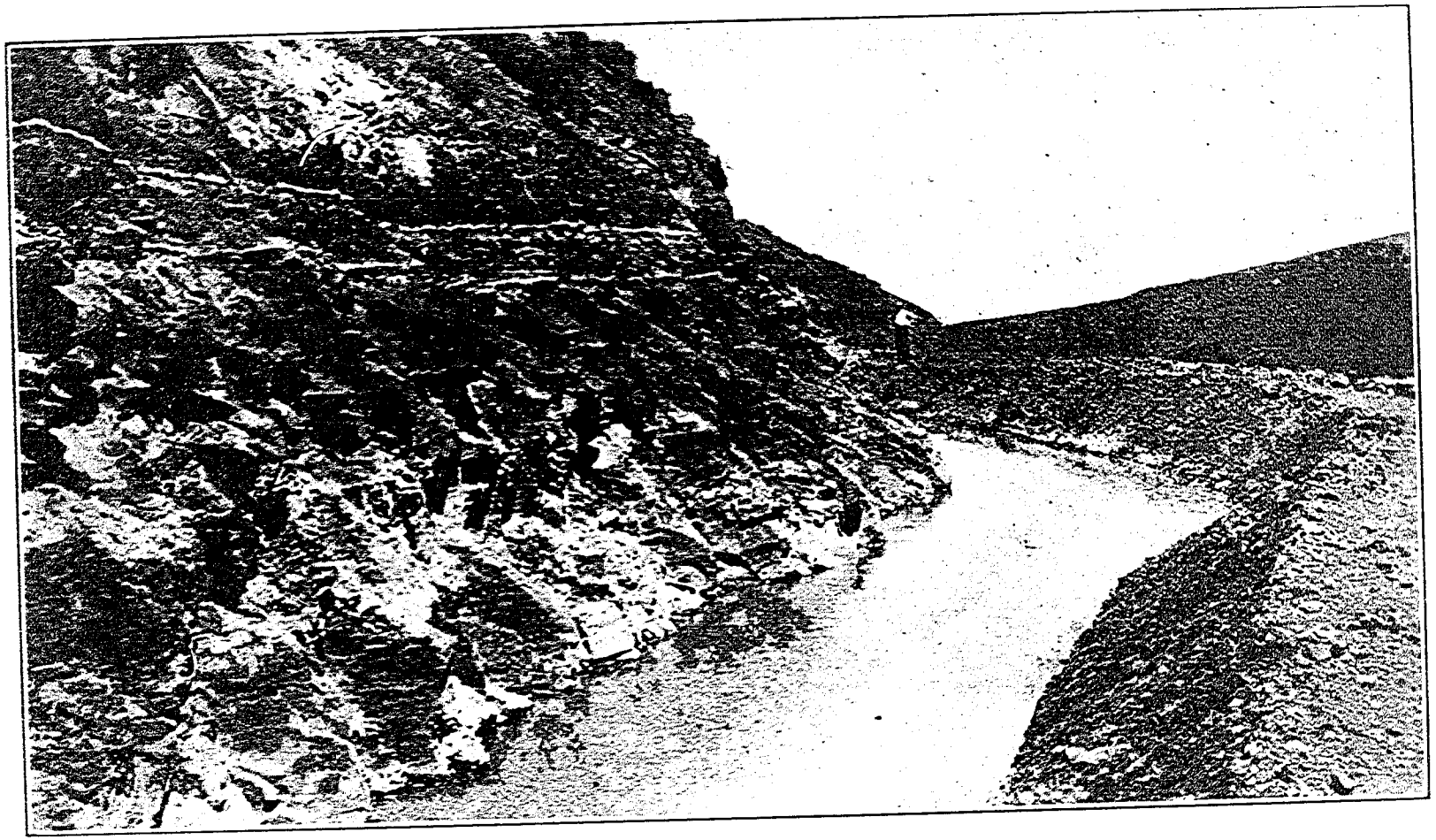
to appropriate water file No. 5319 was prepared. This required a field survey to secure the necessary data for the map, profile and drawings which must accompany the written proof. In addition services were rendered to the department on several other matters of minor importance. For the State Fish and Game Department a design of a standard fishway over dams was prepared.

In September 1918 a dispute arose between Wasatch and Utah Counties as to the location of the county boundary line at Soldier Summit. The statutes define this portion of the county line to be along the summit of the range of mountains east of the headwaters of Hobble and Spanish Fork Creeks to a point where the White River and Spanish Fork road crossed the summit in 1880, thence south to the line between townships 10 and 11. The point where the said wagon road crossed the summit in 1880 is not on a section line and the two counties to facilitate assessing property agreed, in the past, to call the nearest section line the boundary line and to assess property to that line. Within the past two years the Denver & Rio Grande Railroad Company moved its division point from Helper to Soldier Summit and land in that vicinity has increased in value. Since then Wasatch County claims that the boundary line agreed on is not the true boundary line, while Utah County claims that it is. The matter was put up to the State Engineer to decide. The point where the said road crossed the summit in 1880 is definitely known and the State Engineer ruled that this point locates the boundary line between the two counties at Soldier Summit regardless of any agreement that the said counties may have entered into in the past.

The State Engineer is a member of the State Road Commission. The duties of this commission have been greater and more extensive during the past two years than at any time since the organization of this department. This is due partly to the fact that the last legislature authorized a bond issue of two million dollars for road construction and partly to Federal Road aid. In addition the Lincoln Highway Association is spending through the State Road Commission $125,000 on the Lincoln Highway over the Salt Lake Desert. The State Engineer being the only engineer member of the State Road Commission, the highways of the State during the past two years have taken up the greater portion of his time. Accomplishments in the way of State road construction during the past two years will be found in the Biennial Report of the State Road Commission.

State Board of Land Commissioners for water from the Piute project to irrigate desert land entries would not be considered evidence of a sufficient water supply such as the Desert Land Act contemplated. On investigation it was found that this ruling was based on a report of the water supply of the Piute project made by a Carey Act inspector of the General Land Office. The Carey Act inspector cited in his report that under normal conditions he found the State could expect under its filings to appropriate water only to the extent of 25,000 acre-feet and that, inasmuch as it contemplated irrigating 30,000 acres of land under this project, the water supply was deficient. Neither the State Board of Land Commissioners nor the State Engineer was consulted by the Carey Act inspector in preparing his report. As soon as the State Board of Land Commissioners became aware of this ruling, the matter was taken up with the Commissioner of the General Land Office, with the result that the order was suspended for a period of ninety days pending the preparation and submittal of a water supply report by the board. The State Engineer was then instructed to prepare a report showing the nature and extent of the Piute project rights and with what degree of certainty these rights could be fulfilled. It took approximately three months to prepare this report, which required a hydrographic analysis of the entire Sevier River. The conclusion arrived at in this report was that the State could by virtue of its water filings expect with reasonable certainty to fill its reservoir to the extent of 93,000 acre-feet. On completion of this report it was submitted to the General Land Office, who sent the Carey Act inspector out to make a supplemental report. The Carey Act inspector in his supplemental report found that on a basis of three acre-feet of water per acre of land the State had sufficient water to irrigate 20,000 acres of land. This is an increase of one hundred forty per cent over his first report. To date no confirmation of this supplemental report has been received from the General Land Office. While the Carey Act inspector in his supplemental report increased the amount of water available for the Piute project by virtue of its filings from 25,000 acre-feet to 60,000 acre-feet, this office still maintains that the Piute project can realize a total of 93,000 acre-feet under its filings.

The engineering service rendered by this department to other State institutions during the past two years was confined to the State Prison and the State Fish and Game Department. For the State Prison proof of appropriation on its application



Typical view of Santa Clara Bench Canal in Washington County.

On the Piute project the work done consisted of repairing the reservoir outlet gates, building a diversion dam at the head of the Sevier Valley canal, extending the Piute canal, besides strengthening the canal in places and doing other maintenance work. In drawing down the reservoir in the fall of 1916, it was found that two of the three gates controlling the water in the reservoir were damaged. These damaged gates were replaced in January, 1917, by new cast steel gates.

The water for the Piute project is diverted through the Sevier Valley canal, which the State enlarged. One of the conditions in the agreement for right of way through this canal was that the State construct an adequate and substantial diverting dam across the Sevier River at the point of diversion. A concrete structure was built at this point during the past year. This structure was designed for a total diverting capacity of 900 second-feet and cost approximately $16,500. In a later chapter of this report the design and construction of this dam is gone into in more detail.

A three-mile extension was constructed at the end of the present terminus of the Piute canal during the past year. This work was done by contract and involved the moving of approximately 22,000 yards of material at a total cost of $5,431.06. The work was completed on the 18th day of November, 1918.

A flood in June, 1918, damaged the Denmark wash flume to the extent that it could not be used without repair. The trestle bent supporting the flume in the center was washed away and one of the concrete abutments damaged. The flume was temporarily repaired so as to maintain the operation of the canal and was later on permanently repaired. The water was not out of the canal to exceed two days.

During the past two years the canal was relocated in several places in order to make it safer and at other points the banks were strengthened. A number of wooden structures, measuring devices and lateral outlet gates were also replaced during this period.

An investigation is now being made to determine the feasibility and practicability of supplying Piute Reservoir water to the land embraced in Antelope Valley, also to the land lying to the east of Gunnison, Utah. A surveying party is at the present time in the field on this work.

In January, 1918, the attention of the State Board of Land Commissioners was called to the fact that the General Land Office at Washington, D. C., had ruled that a contract with the

For purposes of this investigation the river is divided into three districts. The upper two districts and the upper half of the middle district are in charge of an engineer of the Water Resources Branch of the United States Geological Survey, while the lower half of the middle district and the lower district are in charge of the water commissioner appointed by the court under the Higgins decree. The importance of this investigation is inestimable, as it will undoubtedly be the basis of a future readjudication of the entire river. The report on the water supply for the Piute project, discussed further on in this chapter, is an example of the importance of this investigation. Chapter VII of this report describes in detail the nature and extent of this work.

The co-operative work carried on with the United States Reclamation Service covers the Duchesne River and its tributaries, also Fish Creek, a tributary of Price River. The purpose of this work is to determine if the amount of unappropriated water in these streams is sufficient to justify the Reclamation Service considering these streams suitable for further Federal reclamation projects. Mr. J. L. Lytel, project manager of the Strawberry Reclamation Project, is handling this work for the Reclamation Service. The co-operative work with the United States Indian Bureau is for the purpose of securing more extensive stream flow records of the streams within the basin, and incidentally aiding the Federal water commissioner in distributing the water of these streams.

The State Engineer is by law the supervising engineer for the State Board of Land Commissioners, and as such it is his duty to render all engineering services required by said board and to supervise such construction work as said board may undertake. During the past two years the work for the State Board of Land Commissioners was confined entirely to the Hatchtown and Piute projects.

On the Hatchtown project the investigation of the feasibility and practicability of rebuilding the Hatchtown storage unit, which investigation was started during the previous biennium, was completed and submitted to the Land Board. Since submitting this report the State Engineer has conferred with said board from time to time with respect to this matter, and has made such supplemental reports and examinations as said board requested. The board finally decided to abandon this project and make equitable allowance to the settlers under the same.

Cliff dwelling near Kanab.

to secure a record of stream flow of all the streams within the State. Within the past two years it has been found difficult with this fund to even maintain the stations previously established on account of increased cost of water stage records, equipment and increased salary of Government hydrographers. Even the gauge readers, who generally are persons living within the vicinity of gauging stations, have in a number of cases asked for increased pay for reading staff gauges. It appears evident that a larger appropriation will have to be made for this work in order to properly maintain the stations already established, to say nothing about getting stream flow records on streams heretofore not included in the co-operative stream hydrographic survey.

There have been maintained during the past two years on the various streams of the State 133 gauging stations. Of these 80 are equipped with automatic water stage recorders, the rest with ordinary staff gauges. All records obtained from these gauging stations are on file in the State Engineer's office, also in the office of the Water Resources Branch of the United States Geological Survey, Room 421 Federal Building. These records give the gauge height and daily discharge in second-feet and the monthly and yearly discharge in acre-feet. The time over which records are obtained each year differs for the various stations. Some stations are closed down during the winter on account of ice interference, others where the record is of importance primarily for irrigation are operated only during the irrigation season, while those recording the natural flow of the important streams are maintained the year around.

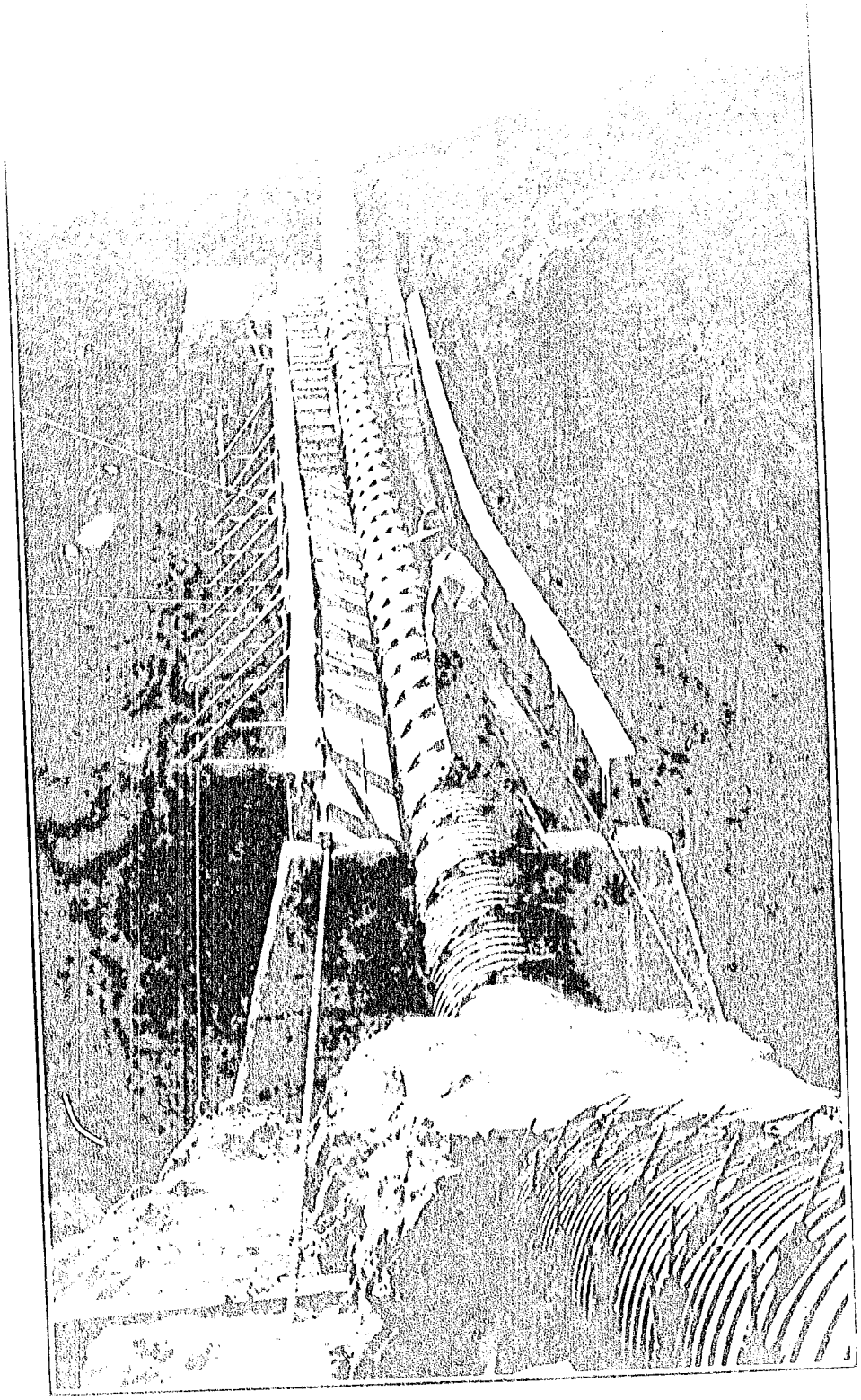
In addition to co-operating with the United States Government on stream measurement work, this office also co-operated during the past biennium with the water users on the Sevier River, the United States Reclamation Service, and the United States Indian Bureau. The special hydrographic investigation of the Sevier River was started in 1913 and continued ever since. During the past two years $6,318.92 was spent on this investigation, the greater part of this cost being borne by the water users. Until two years ago the canal companies diverting from said river in the vicinity of Panguitch refused to co-operate in this investigation and the cost of getting a record of the diversion of these canals was borne by this office. However, in the spring of 1917 the district court on appeal by the State Engineer ordered these canal companies to co-operate in this investigation and bear their pro rata cost of the expense.

written proof must be sworn to by the appropriator, also by two disinterested witnesses, one of whom shall be the engineer who prepared the maps, profile and drawings, that the work represented on the proof has actually been constructed on the ground and the water put to the beneficial use set forth. The engineer must further swear that the maps, profile and drawings represent correctly the diverting system as constructed.

Of the 858 applications to appropriate water filed during the past biennium, the granting of 176 was protested. During this same period 216 protested applications were disposed of. In most of these cases a field investigation of the premises involved was made before a decision was rendered.

In connection with the disposal of protested applications, it is the policy of this office whenever practicable to first make a field investigation of the premises involved before rendering a decision. Such investigations often disclose facts vital to the questions in dispute which are not set forth in the affidavits in support or in rebuttal to protests. Furthermore, such investigations often have the effect of bringing contesting parties to a compromise when all the facts become known and their relation to the appropriation in question explained. Protested applications are not taken up for final disposition as soon as protested, but at such times as circumstances will permit. As a rule, action on such applications is delayed until several have accumulated from the same locality, when a field trip is planned and all parties interested are notified when a representative of the State Engineer's office will be in the vicinity for that purpose. By this method delays in getting the contesting parties together are almost invariably eliminated, thus saving time and expense. Often as high as three or four counties are embraced in one field trip, and the premises of ten to twenty contested applications examined.

One of the important functions of this office is the securing of stream flow data of the various streams within the State. Since 1909 this work has been carried on in conjunction with the Water Resources Branch of the United States Geological Survey under a co-operative agreement whereby the United States Government appropriates for stream measurement purposes within this State an amount equal to the amount appropriated by the State legislature for the same purpose. The last legislature appropriated $10,000 for this work, making a total of $20,000 available for the work during the past biennium. Past experience has shown that it is impossible with this fund



30-inch syphon and suspension bridge over Ash Creek at Toquerville. Part of John L. Sevy's private irrigation project

issued. The total revenue from these applications, proofs, certificates and other fees incidental to water appropriations amounted to $17,788.24.

In the Ninth and Tenth Biennial Reports of the State Engineer the method of procedure for appropriating water was thoroughly discussed; it is therefore not deemed advisable to restate this procedure in the present report. Persons interested in the routine procedure for appropriating water are referred to Chapter I of the Ninth and Tenth Biennial Reports of the State Engineer.

Of the 229 proofs of appropriation submitted during the past biennium practically all were returned for correction; in fact, most of them were returned several times. Relative to these proofs the law provides that when it appears to the satisfaction of the State Engineer that a proof has been perfected in accordance with the application and the water applied for has been put to a beneficial use, he shall issue a Certificate of Appropriation setting forth therein the nature, extent and priority of the appropriation, which certificate shall be made of record in the county recorder's office of the county in which the appropriation is made. Such a certificate or title when once issued is good as against the State, and the State cannot thereafter question the appropriator's right unless the certificate was secured by fraud or misrepresentation. It is for this reason that proofs of appropriation are so carefully checked.

A proof of appropriation consists of two parts, the written proofs and the maps, profile and drawings. The written proof is made out on a blank furnished by this office, and contains a detailed description of the diverting system and the use to which the water has been put. The maps, profile and drawings are in the nature of an exhibit to the written proof and must delineate the diverting system. The written proof and the maps, profile and drawings must show the size, grade and alignment of all main ditches and the amount of water claimed to have been appropriated, together with the details of the measurement of the water. From these data the capacity of the diverting system is checked against the amount of water claimed to have been appropriated. Where the proof of appropriation covers water for irrigation purposes both the written proof and the maps must set forth the land area actually reclaimed, and in case the same does not constitute full legal subdivisions it must be described by metes and bounds. The law provides further that a reputable hydraulic engineer prepare the maps, profile and drawings. The

CHAPTER I.

SCOPE OF WORK.

Probably at no time in the history of the State Engineer's office have the duties of this department been so varied and of such moment to the development of the State as during the past two years. This is due partly to the present war conditions and partly to legislation enacted by the last legislature. In addition to the regular routine duties of this office, such problems as co-operating with the Federal Government in providing homes and employment for returning soldiers, co-operating with the Reclamation Service looking to the control and utilization of the Colorado River and its tributaries, the organization of irrigation districts, the preparation of special military reconnaissance reports and progressive military maps of the State for the United States War Department, and the increased activity in State road construction due to State and Federal aid, have demanded the attention of the State Engineer. These problems besides taking up the time of the State Engineer have entailed considerable extra office work. In the succeeding chapters of this report a more detailed description is given of the nature and extent of this work.

The routine duties of this office have also increased during the past two years. While there has been a falling off in new applications filed to appropriate water, proofs of appropriation on filings made in years past have been submitted in increasing numbers. The checking of each proof to see that the water claimed to have been appropriated was actually put to beneficial use and that the appropriator is entitled to a certificate of appropriation entails considerable work. For the State Board of Land Commissioners, the investigation as to the feasibility of rebuilding the Hatchtown Dam was completed, a concrete diversion dam was constructed at the head of the Piute Canal, and the canal extended for a distance of three miles. These various duties, together with the checking of plans and specifications for dams, investigating the failure of the Mammoth Dam, deciding county boundary line disputes, etc., give an insight into the nature and extent of the work of this department for the past two years.

During the past biennium 858 applications to appropriate water were filed. During this same period 229 proofs of appropriation were submitted and 355 certificates of appropriation

projects the State Engineer has, so far, done all the engineering work, supervised all construction, and prepared all estimates. This, at times, required the employment of as high as six or eight field assistants.

The State Engineer is a member of the State Road Commission, and has been since its creation in 1909. Considerable of his time is taken up in the fulfilling of his duties as a member of this commission. In 1917 the legislature passed the present Irrigation District Law. This law requires the State Engineer to make a water survey and allotment of water for each district organized under it. Such a survey and allotment of water requires a determination of the nature and extent of all existing water rights each 40-acre tract under the district has, also how much more water each tract requires to properly irrigate it.

When the office of State Engineer was first created an office consisting of a single room was secured in the Constitution Building. This was later on increased to several rooms. In 1907 the office quarters were moved to the "old" Commercial Club building on West Temple Street. As the volume of business increased these office quarters soon became too small, so in 1911 the office was moved to the Felt Building. Here it remained until November, 1915, when it was moved to the Capitol Building, where it is now located on the fourth floor, consisting of five large rooms and a vault.

During the past twenty years that the office of the State Engineer has been in existence it has grown from a one-roomed office, employing no assistants, to an office which today occupies a floor space of approximately 2,600 square feet and employs a force of fifteen people composed mainly of engineers, clerks and stenographers. From this it is evident that the duties of the State Engineer have increased from year to year, and at present are many and exacting.

The following list gives the names, together with their terms of office, of the men who have acted as State Engineer since the creation of the office:

Willard Young, May, 1897, to July, 1898.
Robert C. Gemmel, July, 1898, to June, 1901.
A. F. Doremus, June, 1901, to March, 1905.
Caleb Tanner, March, 1905, to March, 1913.
W. D. Beers, March, 1913, to May 1, 1917.
G. F. McGonagle, May 1, 1917, to date.

ELEVENTH BIENNIAL REPORT

— OF THE —

STATE ENGINEER

FOR THE YEARS 1917 AND 1918

OFFICE HISTORY.

The office of State Engineer was created in 1897, primarily for the purpose of aiding in the adjudication of water rights; however, the legislature, in specifying the duties of the State Engineer, gave him no control over the water supply of the State. It confined his duties to the examination and approval of plans and specifications for dams, inspection of dams reported to be unsafe, and to act in an engineering capacity for the State Board of Land Commissioners. In 1901 the legislature enlarged the duties of the State Engineer. He was authorized to make measurements, and keep records of the flow of the various streams throughout the State, and later laws permit him to co-operate with the United States government in this respect. This legislature, furthermore, provided for the creation of water districts, and the distribution of water by commissioners appointed by the County Commissioners, and the State Engineer was given supervision over these Commissioners and required to instruct them in the measurement of water. With a few exceptions the Boards of County Commissioners failed to appoint water commissioners, and this part of the law became inoperative.

In 1903 the present irrigation law was passed. Under this law the State Engineer is required to make hydrographic surveys of the various streams of the State, bring action in the courts to adjudicate the water rights on any river system of which a hydrographic survey has been made, divide the State into water districts and supervise the distribution of water within these districts; also, to receive, record, pass on and approve applications for the unappropriated water of the State, and, upon satisfactory showing that the law has been complied with, issue certificates of appropriation.

In 1907 the State Board of Land Commissioners started the construction of the Hatchtown project, and the following year began the construction of the Piute project. On both of these

LIST OF OFFICERS AND EMPLOYEES.

STATE ENGINEER'S DEPARTMENT.

G. F. McGonagle	State Engineer
C. J. Ullrich	General Assistant
J. L. Rhead (resigned)	Field Engineer, Piute Project
H. S. Kerr	Field Engineer, Piute Project
E. S. Borgquist (resigned)	Draftsman and Engineer
Earl Manning (resigned)	Draftsman and Engineer
H. H. Hitchcock (resigned)	Draftsman and Engineer
H. E. Robinson (resigned)	Draftsman and Engineer
T. F. Jackson	General Clerk
C. F. Balka (resigned)	General Clerk
C. W. Oxley	Bookkeeper
Edith Bennion (resigned)	Bookkeeper
May Nash	Stenographer
Mattie S. Mitchell	Filing Clerk and Stenographer
Lila Folsom	Stenographer
Agness Brown (resigned)	Stenographer
Eleanor Clawson	Copyist
Eve M. Hodson	Special Agent
E. C. Penrose	Stenographer and Draftswoman
Bess O'Melveny	Draftsman
C. M. Goodliffe	

WATER RESOURCES BRANCH OF THE U. S. GEOLOGICAL SURVEY.

(Under Co-operative Agreement with States.)

C. C. Jacobs (resigned)	District Engineer
A. B. Purton	District Engineer
L. W. Jordan	Assistant Engineer
J. J. Sanford	Assistant Engineer
W. E. Dickinson	Junior Engineer
J. N. Bines (resigned)	Junior Engineer
E. S. Borgquist (resigned)	Field Assistant
R. P. Flagel (resigned)	Field Assistant
Ruby Christensen	Stenographer

LIST OF ILLUSTRATIONS.

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LETTER OF TRANSMITTAL.

SALT LAKE CITY, UTAH, November 30, 1918.

To the Honorable Simon Bamberger, Governor of Utah.

SIR: In accordance with the provisions of Section 1265, Compiled Laws of Utah, 1907, I have the honor to submit herewith the Eleventh Biennial Report of the State Engineer covering the work of this department for the past two years.

Respectfully,

G. F. McGONAGLE,
State Engineer.

Cliff dwelling near Kanab.

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ELEVENTH BIENNIAL REPORT

of the

STATE ENGINEER

to the

GOVERNOR OF UTAH

1917-1918

PRESS OF
THE F. W. GARDINER CO.
SALT LAKE