12-1-1918

Report of the State Highway Engineer and State Engineer of New Mexico for the Fifth and Sixth Fiscal Years, December 1, 1916, to November 30, 1918

James A. French

REPORT OF

STATE HIGHWAY ENGINEER

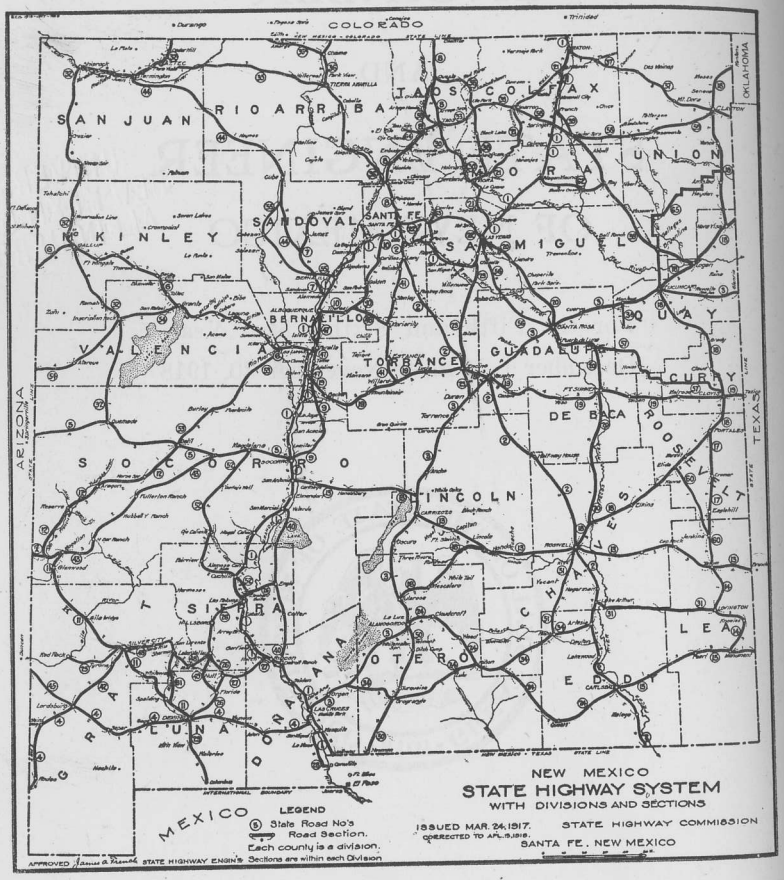
AND

STATE ENGINEER

OF NEW MEXICO

For the Fifth and Sixth Fiscal Years
December 1, 1916, to November 30, 1918

JAMES A. FRENCH
State Highway Engineer
State Engineer



JAMES A. FRENCH
STATE HIGHWAY ENGINEER
STATE ENGINEER

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PART ONE

STATE HIGHWAY ENGINEER

PART TWO.

STATE ENGINEER.

Santa Fe, New Mexico,
December 1, 1918.

Sir:

Transmitted herewith is my biennial report as State Engineer for the biennium ending November 30, 1918.

Respectfully,

JAMES A. FRENCH,
State Engineer.

To His Excellency, Washington E. Lindsey, Governor of New Mexico.

INTRODUCTION.

The report covers the work directed by the Legislature of the State of New Mexico to be carried out under the State Engineer during the two fiscal years December 1, 1916, to November 30, 1918, and other work that was in progress before December 1, 1916, and to be continued.

There is quoted herewith for your information the authority granted by the various legislatures, citing the several acts directing the work of the office.

Chapter 49, Laws of 1907: An Act to Conserve and Regulate the Use and Distribution of the Waters of New Mexico; to Create the Office of Territorial Engineer. Approved March 18, 1907.

Chapter 68, Laws of 1909: An act providing for the gaging of streams to encourage irrigation. Approved March 17, 1909.

Chapter 102, Laws of 1909. An Act creating the Carey Act Land Board. Approved March 18, 1909.

Chapter 32, Laws of 1912: An act providing for the gaging of streams, investigations for pumping and underground waters. Approved June 8, 1912.

Chapter 23, Laws of 1913: An act to provide for the paving of certain streets at the seat of government. Approved March 12, 1913.

Chapter 85, Laws of 1913: An act providing for the digging of wells on state lands. Approved March 14, 1913.

Chapter 80, Laws of 1913: An act providing additional funds for Hydrographic Surveys under the irrigation laws of 1907. Approved March 17, 1913.

Chapter 15, Laws of 1915: An act appropriating funds for the improvement of the Rio Grande. Approved February 26, 1915.

Chapter 87, Laws of 1915: An act to amend sections two and three of Chapter 23, Laws of 1913. Santa Fe street paving.

Chapter 71, Laws of 1917: An act to appropriate money for surveys and investigations of lands in the Rio Grande valley. Approved March 13, 1917.

Chapter 102, Laws of 1917: An act defining surveying and licensing surveyors. Approved March 13, 1917.

Chapter 107, Laws of 1917: An act creating the Rio Grande Commission. Approved March 12, 1917.

RECOMMENDATIONS.

(Sec. 5671, 1915 Codification.)

Lack of Complete Records.

It has been found that the lack of complete records of actual users of the natural waters of this State is becoming serious. Numerous investors have been to this office with proposals for development, dependent on conclusive data as to the total amount of water being diverted and applied to a beneficial use from the stream or system in question. They procured from this office the data in detail from March 19, 1907, but any reliable information as to the actual use being made by appropriators initiating their claims prior to that date is impossible to be obtained from any records in the State. Of course, the law provides a means to the end by authorizing the making of hydrographic surveys and adjudication suits through the courts. Although this means is satisfactory when applied, it is too expensive a procedure to employ until a system is settled up, and invariably over-appropriated. The State is not and will not be for some time to come, financially able to appropriate sufficient funds to survey all the stream systems of the State. What good is a decree based upon the doctrine of prior appropriation going to be on these streams unless the whole drainage is surveyed and all the users made parties? Even after the funds are available, a number of years will pass before the technical data can be procured for the courts.

Conflict Without Full Records.

The user under old rights and the future development of the State demands a remedy until such time as the rights have been adjudicated. Especially have the Spanish-American users been anxious to record their rights so as to be protected from future encroachments. As it is, the State Engineer, having no knowledge of their rights, may approve a subsequent application to appropriate water from a stream already totally appropriated by prior users, not of record. In case of the Spanish-American user, he seldom sees the publication notices printed in connection with an application for permit, and, therefore, has been brought to realize that protection lies in having his rights properly of record.

The said demands will be served by adding the following amendment, in black-faced type, to Sec. 5671, 1915:

"Sec. 18. The State Engineer shall make *rules and reg-*

ulations and prescribe forms for the filing of record rights acquired to the use of the natural waters of the state initiated prior to March 19th,* 1907, and shall make hydrographic surveys and investigations of each stream system and source of water supply in the state, beginning with those most used for irrigation, and obtaining and recording all available data for the determination, development and adjudication, of water supply of the State—including the location and survey of suitable sites for dams and resevoirs and the determination of the approximate water supply, capacity and cost of each. He shall be authorized to co-operate with the agencies of the United States engaged in similar surveys and investigations, and in the construction of works for the development and use of water supply of the state, expending for such purposes *any moneys earned under the provisions of Section* 5662 *and* any money available for the work of his office, and may accept and use in connection with the operations of his department the results of the agencies of the United States.''

**Subject to the Approval of Board of Water Commissioners.*

One regulation that ought to be established under such a law would be that the State Engineer should send an engineer from this office at State expense to locate accurately the point of diversion, measure the capacity of the ditch or ditches, and get such other technical data as could not be furnished by the party filing the rights of record. This would give an old right as valuable a standing of record as that of an applicant granted permit under the irrigation law. This system was employed by Wyoming in getting of record their old Territorial rights, and has proven very satisfactory; in fact, Wyoming enjoys the reputation of having settled the majority of state water appropriations without litigation.

(Section 5674, 1915 Codification.)

Under said section, when a suit is brought, as provided for through the courts, the attorneys often disagree as to the meaning of the provision:

> ''The costs of such suit shall include the fees of witnesses, the taking of depositions and the fees of officers for serving the process *and together with the costs on the behalf of the State.''*

It has been held that the costs on behalf of the State include the costs and expenses of the hydrographic survey, but in the La Luz and Fresnal case, now before the court, it was contended by counsel for the defendant that the sum of $7,000 for the expense of the hydrographic survey should not be included and

charged pro-rata, according to their construction of the law. This contention has held the case up for four years, and the State has not been getting the benefit of that amount, which should have been refunded some time ago for further investigation of the State's use of water by survey. Such a technicality should be remedied and is serious enough to require conclusive attention of the Legislature this coming session. The operation of the total provisions of the hydrographic survey act is and will continue to be retarded so long as there remains a question as to the construction of the statute on this point.

The following addition, in black-faced type, ought to clear up the question:

> ''The costs of such suit shall include the fees of witnesses, the taking of depositions and the fees of the officers for serving process and together with the *expenses of the hydrographic survey and* costs on behalf of the State.''

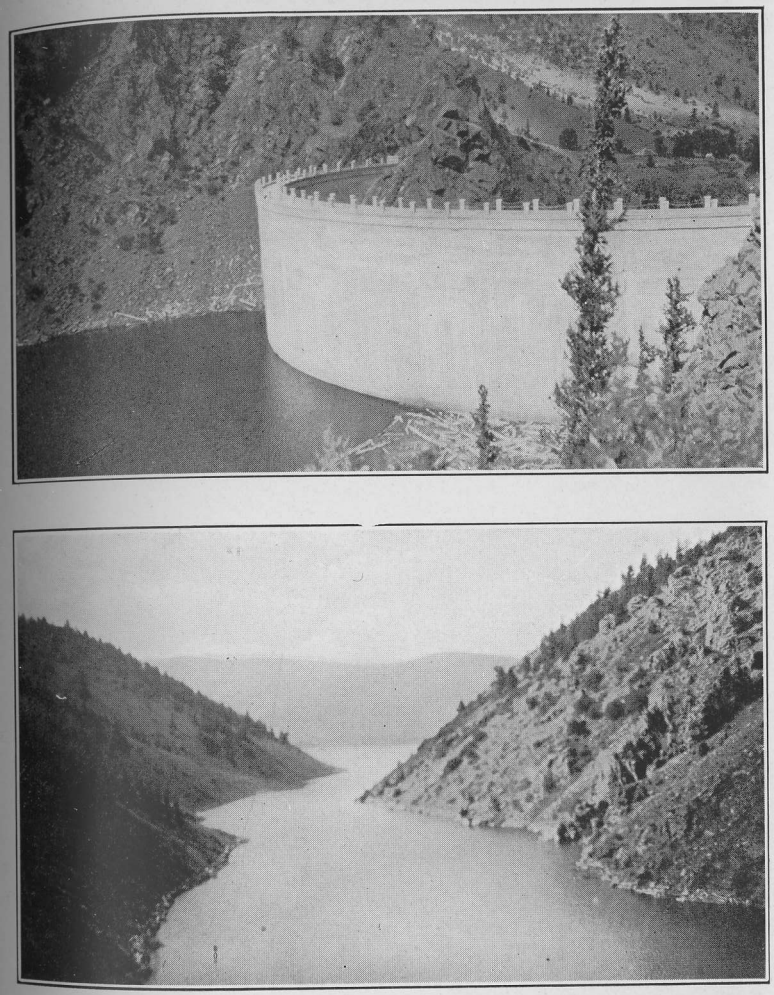
Employes.

The water right department of this office has grown and extended its operations according to authority given under the law, to such bounds that the need of an engineer is becoming serious. The appropriators in good faith, are not getting the service necessary to the working out of the irrigation law in detail. For example, the parties who have been granted permits are now coming in rapidly with their final proofs, and asking for the inspection and report as provided and required by law, to the end that their final certificates and licenses may be granted. As it is, the office has to authorize some private engineer to make the inspection, oftentimes a party with very little idea of what is required by the law, who reports on the project and charges the applicant quite a sum for his services. It can be seen that the interests of the state cannot be wholly safeguarded by one paid by the party for whom the report is being made. The report has to be taken as the basis for issuing the license to appropriate the public waters of New Mexico, and the engineer making the report and inspection should be from the State Engineer's office as the law intended. There being no appropriation for such an engineer, the applicants cannot be held up on their licenses, so the inspection has to be made at the least cost to the appropriator by the safest means at hand.

Such an engineer would be subject, when not employed in the pursuit of his initial requirements, to the State Engineer's orders and, therefore, could be used for any work in his line, such as inspector on large construction works that might be a menace to public life and safety, if allowed to be put in improperly; one qualified to examine and pass on plans and specifica-

tions for storage dams and the like, and be subject to call at any time to report on the feasibility of sites for dams and reservoirs and the determination of the approximate water supply, capacity and cost of each, and such other duties as may require his supervision and inspection.

Recommendation is therefore made that the item of $2,400 for salary of an Assistant Engineer, as submitted in the budget to the Governor on December 5, 1918, be approved, to take effect immediately, or for the Seventh, Eighth and Ninth Fiscal Years. It is also urgently recommended that the increases of salary for the chief clerk and stenographer as submitted in the above mentioned budget be approved.



EAGLE NEST DAM AND RESERVOIR.

Built by the Cimarron Land Company for the impounding of 100,000 acre-feet of water to be used in the irrigation of about 70,000 acres of land located in Colfax County, New Mexico.
The dam is 140 feet high.

IRRIGATION.

Under the Irrigation Act, Chapter 49, Laws of 1907, applications for water permits declined somewhat, owing to the conditions brought about by the war.

Filings.

The record of applications for permit to appropriate the public waters during the period December 1, 1916, to December 1, 1918, shows a total of 62 filed, of which 22 have been canceled. Out of the 40 still standing there are 21 pending, 19 having already been granted a permit to construct their works and apply the water to a beneficial use towards completing their appropriations. Also, 34 previously pending applications for permit have been approved.

Of the said 62 applications, 40 were filed for irrigation purposes, and in the event they are totally developed the cultivation of 36,054 acres will result. Their total appropriation calls for 73,912 acre-feet of water.

1907 to 1916.

The records of this office, since the initiation of the office in 1907, show filings in good standing totaling 326,731 acres proposed to be irrigated, which estimate their requirements at 1,176,734 acre-feet of water. Of the said acreage, 71,477 acres have been granted licenses to appropriate an equivalent of 244,352 acre-feet of water, delivered on the land for their cultivation, or an average duty of 3.41 acre-feet for each acre irrigated, on a basis of eight months' use per annum.

Lapsed Filings.

The records also show quite a number of filings having lapsed during previous administrations, without action being taken at the time of lapse. The majority were left of record without sufficient information to justify the subsequent administration in canceling them, which necessitated the procuring of evidence for the files to substantiate an adverse action. To date 543 such filings have been canceled, which represented an estimated total appropriation of 44,140 cubic feet per second of water, enough, on the basis of the duty above given to cultivate 7,003,546 acres of land. The said total reverted to the public, subject to appropriation for beneficial uses. This policy of keeping the records clear is being insisted upon, to the end that no material number of lapsed permits are allowed

to remain of record to the detriment of the rights of the public or prospective appropriators in the natural waters within the limits of the State of New Mexico. In fact, the revised rules and regulations of May 1, 1918, Section 51, as approved by the Board of Water Commissioners, requires the State Engineer to cancel any and all of such permits or applications thirty days after date of such lapse or abandonment.

Irrigation Progress.

Irrigation progress has not been so marked of late, but the future is bright for the diversion of capital back into this line of investment. The projects of standing have all been looking closely to their rights, and in consequence, the record shows quite a number of applications for extension of time, of which 64 completed the record in compliance with the law and regulations by being granted permits. All projects previously reported on have been active, with the exception of the Fort Sumner project. The United States Rio Grande project has been the most active, the Elephant Butte dam having been completed and dedicated. The other large projects deserving mention at this time are by the Springer Land & Irrigation Company, which is nearly completed, known as the Eagle's Nest project. The Board of Trustees of the town of Las Vegas, or Las Vegas project, partially completed; the Costilla Estates Development Company, or Costilla project, which is over half completed; the Lake Charette Land & Irrigation Company, a Carey Act project, which is nearly in shape to deliver water; and the City of Raton, a municipal development, which has been in full operation for some time.

From present indication the large body of arid State land in Taos county, under option originally to the Red River Land and Water Company, is now in line to become valuable as farming land. The interest of C. L. Ballard, assignee of the water appropriation, has taken over the project and are now making extensive investigations toward completing the filing, to the end that they be allowed to start construction work in the near future.

Power Projects.

As previously stated, a number of the applications were filed for the development of hydro-electric power and for mining and milling purposes. The progress in this field has not been so marked the last two years, projects for the total development of 56,675 horse-power having been filed on and are complying with the requirements of the office and the completion of financing.

Protests and Hearings.

Testimony was taken in connection with a number of cases called up on protest and all disposed of according to the findings of this office. It should be noted that the majority of such findings or actions were not carried to the Board of Water Commissioners on appeal, but were allowed to stand as decided.

Six other protests are pending to be called for hearing in the near future.

The rule, Secs. 59 and 60 of the Manuel of Rules and Regulations, requiring the deposit of fees in advance sufficient to cover the costs and expenses incurred by the office for holding the hearing, has worked out satisfactorily. In order to protect the parties in making advance deposits, they are now required to file affidavits guaranteeing their payments of such costs or expenses as might accrue and be payable to the prevailing party.

Miscellaneous.

Besides the necessary detail to be closely followed in keeping the records required of this office in accordance with the law and the rules and regulations, quite a large correspondence taken care of maps and plans and specifications checked for acceptance, copies of all public records and negatives and blueprints of maps, filings of old appropriations accepted and filed for record, water master reports checked and approved for the consideration of the County Commissioners and the usual other routine necessary in its administration, this office acts in an advisory capacity for the Board of Water Commissioners and the Carey Act Land Board.

In passing it might be well to state that a complete revision of the Rules and Regulations as provided for by statute was compiled and printed in a form followed by legal practice with cross reference to every section of the Code and Manual so indicated as to make it easy to refer to and follow up in order every point involved in any question presented under Chap. CXIV, 1915 Code, the 1917 Session Laws and other sections of the statute regulating the appropriation and use of the Public Waters of the State New Mexico.

The work in this department has been in charge of Mr. A. S. Kirkpatrick, who resigned recently to take a position with the Chino Copper Company, Hurley, New Mexico.

Herewith a statement showing total receipts, refunds, earned fees, unearned fees in bank and statement of Hydrographic Survey Fund in State Treasury November 30, 1918.

IRRIGATION FEES ACCOUNT.

Balance with The First National Bank of Santa Fe, 12-1-16....		$3,299.82
Receipts:		
Applications	$5,775.80	
Interest	227.15	$6,002.95
Disbursements		
Refunds (unearned fees)	$ 937.15	
Earned fees	1,832.20	$2,769.35
Balance (includes both interest and unearned fees) with The First National Bank of Santa Fe, 11-30-18		$6,533.42

Hydrographic Fund with State Treasurer is shown on statement following.

HYDROGRAPHIC SURVEY FUND.

Fifth Fiscal Year.

Balance, December 1, 1916	$3,723.75	
Receipts	1,718.35	$5,442.10
Disbursements		500.00
Balance, November 30, 1917		$4,942.10

Sixth Fiscal Year.

Balance, December 1, 1917	$4,942.10	
Receipts	113.85	$5,055.95
Disbursements		500.00
Balance, November 30, 1918		$4,555.95

HYDROGRAPHIC SURVEY WORKING FUND.

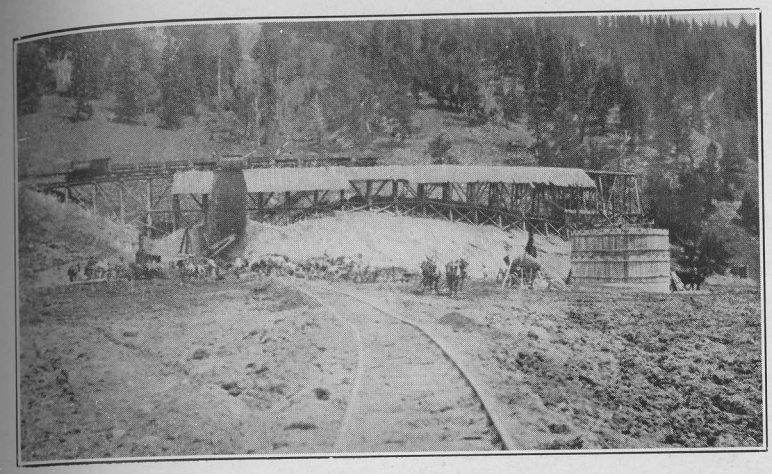
Fifth Fiscal Year.

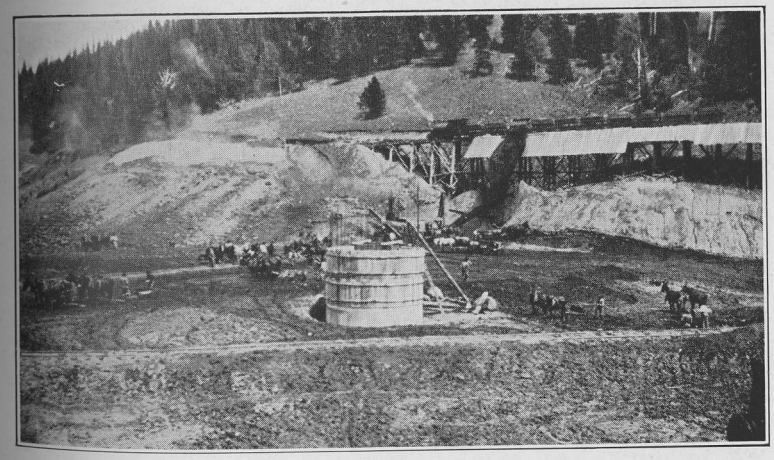
Balance, December 1, 1916	$ 23.38	
Auditor Warrant	500.00	
Interest	2.82	$526.20
Disbursements		$421.01
Balance, November 30, 1917		$105.19

Sixth Fiscal Year.

Balance, December 1, 1917	$105.19	
Auditor Warrant	500.00	
Interest	2.26	$607.45
Disbursements		303.99
Balance, November 30, 1918		$303.46

Above *working* fund is deposited with the First National Bank of Santa Fe, New Mexico. The *regular* fund is with the State Treasurer and the status of same is shown on preceding statement.





Two views showing construction work in progress during 1918 on the Costilla Reservoir of the Costilla Estates Development Co.

STREAM GAGING.

On November 30, 1916, the date of the last biennial report, there was a balance in the stream gaging fund of $1,428.64. At that time the State was maintaining sixty-five gaging stations and had five field hydrographers. During the fifth and sixth fiscal years we have had, in addition to the engineer in charge of the work, from three to five hydrographers beside a stenographer and clerk. The office records of run-off have been kept up to within a month to six weeks at all times.

At the end of the calendar year 1917 the State was maintaining sixty-two gaging stations, and during 1918 we have discontinued one station and established one.

For 1917 we published run-off records for seventy-one gaging stations; through courtesy of the State Engineer of Colorado the records for the Rio Grande at Del Norte and Lobatos; through the United States Reclamation Service the records for the Pecos at Dayton, and the Rio Grande at San Marcial, and through the U. S. Geological Survey the record of the Pecos at Carlsbad.

The compilation of run-off records on all streams in the State from 1888-1915 was delayed in proof-reading and the report was made from 1888-1917, re-assembled and re-edited, and printed in 1918. We have printed the reports for 1916 and 1917 and the 1918 report is practically up to date and should go to the printer early in 1919. These reports are for the calendar year and there is a great demand by the public libraries throughout the country, by consulting engineers and state engineers, and everyone interested in irrigation and water power development for them.

We have been able to reduce the hydrographers' travel expense by having the hydrographer use his own car at ten cents per mile in making the stations on the Pecos and in the northeast corner of the State, and by contracting with an auto driver for the trip in the San Juan Basin, and have been able to make every station once a month except for some unavoidable delay. By visiting the gaging stations oftener we are able to keep a clear relation established between the gage height and discharge and to account for any shift in the channel or change in the shape of the curve.

The results from our stream gaging work have been satisfactory and we feel that the published records are reliable and can be depended upon as accurate to the degree such records can attain.

This work has been in charge of Assistant Engineer Robt. L. Cooper, who was assisted by Hydrographers Clyde Walters, H. A. Howell, John E. Powers, Eugene Griffin, E. C. Harvey, J. D. Walker, E. C. Stout, Wayne Laws and W. N. Evans. Miss Vivian Redding has been stenographer and clerk during the two fiscal years. Mr. R. L. Cooper was succeeded by Clyde Walters on November 1, 1918.

The following financial statement is for the Fifth and Sixth Fiscal Years:

STREAM GAGING FUND.

Fifth Fiscal Year.

Balance December 1, 1916	$ 1,428.64	
Annual Appropriation	15,000.00	
Refunds on Scrip, Etc.	312.55	$16,741.19
Paid by Vouchers		16,701.80
Balance November 30, 1917		$ 39.39

Sixth Fiscal Year.

Balance December 1, 1917	$ 39.39	
Annual Appropriation	15,000.00	
Refunds on Scrip, Salary, Etc.	328.28	$15,397.67
Paid by Vouchers		$14,965.21
Balance November 30, 1918		$ 432.46

CAREY ACT LAND BOARD.

Under the Territorial Laws of 1909, the State accepted the conditions of Section 4 of the Act of Congress entitled: "An Act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1895, and for other purposes," approved August 18, A. D. 1894, together with all the grants of land to the State of New Mexico under the provisisions of the aforesaid Act. The selection, management and disposal of the land is vested in the Carey Act Land Board.

The organization of the Carey Act Land Board for the State of New Mexico is provided in the New Mexico statutes and consists of the Governor, Commissioner of Public Lands and State Engineer. The Governor is the chairman; the Commissioner of Public Lands, secretary, and the State Engineer, member. The Attorney General is the legal advisor to the Board.

The stated meetings of the Board are on the second Wednesday of each month and any two members of the Board constitute a quorum for the transaction of any and all business. The chairman has the power to call special meetings whenever in his judgment the public good requires the same to be done.

CAREY ACT LAND BOARD.

(By FRED MULLER, Its Secretary.)

Introduction.

Although the statute requires an annual report to be made by the Carey Act Land Board, the business of the said Board has not heretofore seemed to warrant the issuance and publication of such reports. For the past year, however, the Board has been called upon to exercise its functions to some extent, inasmuch as applications for lands by settlers have been received, together with the moneys required by law to be paid in connection therewith. Moreover, the irrigation project being constructed to irrigate the lands segregated under the provisions of the Carey Act is nearing completion, and the expiration of the time allowed for reclaiming the lands withdrawn by the Department of the Interior for the benefit of the Territory and State is not far distant. The Board is therefore called upon to give some attention to the details of the administration of the Carey Act laws and regulations.

Lands Segregated.

Only one withdrawal for Carey Act purposes has been made so far in the State. This is a body of land in several disconnected tracts in southern Colfax County, comprising in all an area of 7,533.79 acres, and situated in townships 23 north, ranges 20, 21 and 22 east, and townships 24 north, ranges 21 and 22

east. These lands have been approved by the Commissioner of the General Land Office under the application for segregation submitted on behalf of the Territory of New Mexico in 1909. There has recently been an adjustment of the lands applied for to conform to the subdivisions of the plat of the official survey, as to that portion of the segregated area which was unsurveyed when withdrawn. The only lands remaining in an uncertain status is a portion of Section 32, Township 24 North, Range 22 East, which the Commissioner of the General Land Office has sought to except from the withdrawal and to consider as common school land. The matter has been appealed by the Clerk of the Board to the Secretary of the Interior, and it is confidently believed that the Carey Act segregation as to this particular land will be directed by the Department to remain intact, the grounds of such appeal being the priority of the segregation over the grant of the sections numbered 32 to the State for common school purposes.

Irrigation Works.

The Irrigation Works being constructed for the purpose of irrigating the segregated lands consist of diversion and storage dams, and intake and outlet canals and ditches on rather an elaborate scale. The company under contract for the construction of the works is the Colmor Irrigation and Land Company, of Colmor, New Mexico, of which Mr. E. M. Traylor is Secretary and Mr. W. H. Wolff is President. A report made by Mr. R. L. Cooper, a representative of the Office of the State Engineer, during the past year indicated that fair progress is being made in the construction of the said irrigation system.

Upon petition submitted in due form, and upon representations made by the secretary of the said company, the Board, at a special meeting held March 25, 1918, granted an extension of time to the said irrigation company, whereby it was allowed until January 1, 1921, to complete its irrigation works and to apply the water to beneficial use. A bond satisfactory in form and amount was thereupon required by the Board of the said company, which was duly filed and approved by the Clerk and Secretary of the Board.

Application of Settlers.

There have been filed with the Board applications of thirty-two settlers or prospective settlers for lands segregated under the application of the Territory above referred to, and proposed to be irrigated by the system being constructed by the Colmor Irrigation and Land Company. Each application has been accompanied by the lawful fees and purchase moneys, and also by a duplicate or triplicate copy of the irrigation contract existing between the applicant and the irrigation company. The

total acreage of the lands thus applied for is 3,571.42 acres, and thirty-one of the said applications have been finally allowed and certificate of location issued. One application remains suspended and undisposed of, but is in process of being cancelled and closed out under direction of the Board. The total area of lands for which thirty-one certificates of location have been issued is 3,571.42 acres, and the area covered by the suspended application just mentioned is 160 acres.

Appointment of Clerk.

The Board appointed Mr. Charles B. Barker as its Clerk and, unsolicited, voted him a salary of Ten Dollars per month from and after February 12, 1918, the date of his appointment. He had theretofore attended to the business of the Board without official title and without compensation.

Expenses.

Although the fees and purchase moneys received by the Board are by statute made available for its legitimate expenses, the business so far has been carried on with practically no expense. As will be seen in the financial statement below, the only expense charged for the past year is the Clerk's salary, and it is not expected that the expense for the next year will exceed greatly that amount. It is probable that a field examination by a representative of the Board may be required some time during the coming year, and that a few books, blanks, and supplies of stationery may be required. The money in the fund held by the State Treasurer is available, however, for such expenditures, without further action by the legislature.

Miscellaneous.

The Board is not in a position to recommend the State's Carey Act lands to prospective settlers. Each settler must examine the lands and the irrigation scheme, and decide for himself whether he wants to apply for the segregated lands. Copies of the laws and regulations, however, will be furnished on request. The Board has approved the form of contract required to be entered into between the settler and the irrigation company, and believes that it affords the settler the maximum protection possible under the law. Description by legal subdivision will be furnished by the Clerk of the Board of such withdrawn lands as remain unapplied for as shown by the records in his office, but information concerning the progress of the reclamation and irrigation of the lands will have to be secured from an examination on the ground.

Financial statement follows.

CAREY ACT FUND.

Receipts.

Fees paid by 32 applicants for lands	$ 32.00	
Payment of first half of purchase price on lands applied for (25 cents per acre)	894.02	$926.02

Disbursements.

Refund to one applicant on account excess purchase moneys paid	$ 10.00	
Salary of Clerk (from Feb. 12, 1918)	95.00	
Fee and purchase money on suspended application which remains undisposed of to date	41.00	146.00
Balance with State Treasurer		$780.02

STREET PAVING AT SEAT OF GOVERNMENT.

An Act by the Legislature of 1915, Chapter 87 Laws of 1915, to amend Sections 2 and 3 of Chapter 23 of the Laws of 1913, provided for a change in the petition of the former act, "by the Capitol Custodian Committee in behalf of the Capitol grounds and one private owner of abutting property on each, shall be deemed a petition in full compliance with Section 3 of Chapter 22 of the 1913 Laws."

There appeared to be no popular movement by the abutting property owners for this improvement and, war conditions prevailing, it was thought advisable not to push this paving.

The following table gives a statement of this fund and shows the balance in the hands of the State Treasurer:

Appropriated by State	$13,000.00
Paid out by State	2,692.50
Balance in Fund	$10,307.50

See pages 53-54 Second Biennial Report of State Engineer.

STATE WELLS.

On November 30th, 1916, Well No. 1, Section 8, Township 8 North, Range 13 East; No. 2, Section 8, Township 8 North, Range 14 East, and No. 3, Section 30, Township 10 North, Range 12 East, were completed and a contract had been made with the Keehn Brothers for drilling Well No. 4 in Section 15, Township 9 North, Range 11 East. The date of this contract was November 18, 1916. Well No. 4 was completed and tested early in March, 1917. This well is 575 feet deep and was tested to thirty gallons per minute.

On March 5, 1917, a contract was drawn for drilling a well as close to Well No. 1 as it was possible to set the rig, this well to go 800 feet in depth, and on the same day an agreement was drawn between the State Engineer and Ballard and Armstrong whereby Ballard and Armstrong agreed to furnish casing at the well as ordered by the State Engineer. This well, which is called Well No. 1-A, was drilled to a depth of 804 feet and tested May 3, 1917, to nine gallons per minute.

A complete summary of the accomplishment with the $15,000.00 is as follows: There were five wells drilled—No. 1, 610 to 620 feet deep, went under pump to 1½ gallons per minute; Well No. 2, 532 feet deep, dry; Well No. 3, 1,280 feet deep, tested and pumped to 15 gallons per minute; Well No. 4, 575 feet deep, tested and pumped to 30 gallons per minute; Well No. 1-A, 804 feet deep, tested and pumped to 9 gallons per minute. Well No. 3 was not cased and during the present year has caved in the red beds at about three hundred feet and at the bottom. The well was not cased because the people who had the State land leased were very anxious to have the two other wells drilled, and had we cased this well we could only have drilled one other.

In figuring the cost of these wells the office expense was divided pro rata to the five wells in proportion to the cost of the well. Wells Nos. 1 and 1-A are considered as one well and the cost of the four wells is as follows:

WELL NO. 1 AND 1-A.		
Contract price, engineering and superivision	$5,163.96	
Office expense and geologist's report pro rata	120.43	
		$ 5,284.39
WELL NO. 2.		
Contract price, engineering and supervision	$1,525.42	
Office expense and geologist's report, pro rata	35.59	
		1,561.01
WELL NO. 3.		
Contract price, engineering and supervision	$5,457.36	
Office expense and geologist's report, pro rata	127.30	
		5,584.66
WELL NO. 4.		
Contract price, engineering and supervision	$2,511.33	
Office expense and geologist's report, pro rata	58.61	
		2,569.94
Total		$15,000.00

DRILLER'S LOG OF WELL NO. 1-A.

Surface	to	3	feet	*Clay.*
3 feet	to	93	feet	*Yellow sandstone.*
93 feet	to	113	feet	*Red sandstone.*
113 feet	to	153	feet	*Red clay.*
153 feet	to	168	feet	*Red shale.*
168 feet	to	190	feet	*Red sandstone.*
190 feet	to	240	feet	*Red clay.*
240 feet	to	270	feet	*Red sandstone, soft.*
270 feet	to	350	feet	*Red clay.*
350 feet	to	354	feet	*Red sandstone, hard.*
354 feet	to	384	feet	*Red sandstone, soft.*
384 feet	to	429	feet	*Red clay.*
429 feet	to	444	feet	*Red shale.*
444 feet	to	469	feet	*Red sandstone.*
469 feet	to	499	feet	*Red clay.*
499 feet	to	555	feet	*Red sandstone.*
555 feet	to	610	feet	*Red clay (little water).*
610 feet	to	622	feet	*Blue limestone.*
622 feet	to	627	feet	*Blue soapstone.*
627 feet	to	640	feet	*Yellow sandstone.*
640 feet	to	685	feet	*White sandstone.*
685 feet	to	741	feet	*Gray sandstone.*
741 feet	to	751	feet	*Blue soapstone.*
751 feet	to	767	feet	*Gray sandstone.*
767 feet	to	775	feet	*Red sandstone.*
775 feet	to	785	feet	*Light red sandstone.*
785 feet	to	797	feet	*Red shale.*
797 feet	to	804	feet	*Light red sandstone.*

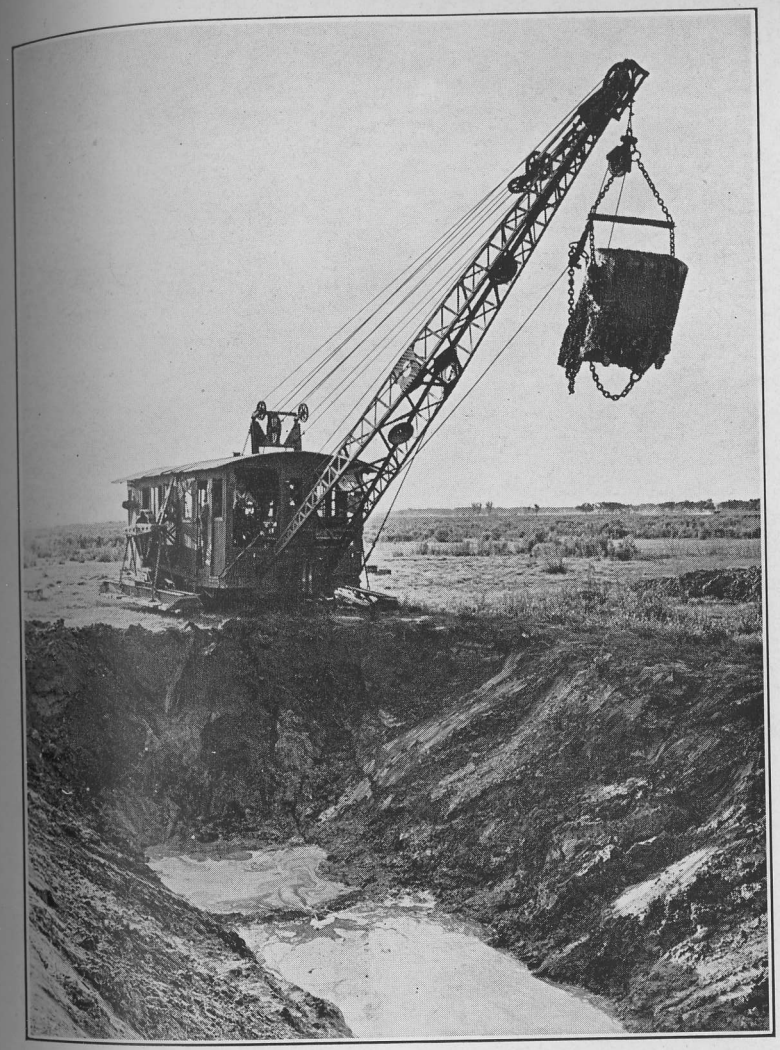
DRILLER'S LOG OF WELL NO. 4.

Surface to	10	feet	*Clay.*
10 feet to	30	feet	*Boulders.*
30 feet to	160	feet	*Yellow sandstone.*
160 feet to	180	feet	*Red sandstone.*
180 feet to	280	feet	*Red clay.*
280 feet to	315	feet	*Red sandstone.*
315 feet to	340	feet	*Red clay.*
340 feet to	380	feet	*Red sandstone.*
380 feet to	400	feet	*Red clay.*
400 feet to	430	feet	*Red shale.*
430 feet to	445	feet	*Red sandstone.*
445 feet to	465	feet	*Red clay.*
465 feet to	513	feet	*Blue limestone.*
513 feet to	533	feet	*Yellow sandstone, hard.*
533 feet to	543	feet	*Yellow sandstone, soft.*
543 feet to	575	feet	*Yellow sandstone, hard.*

STATE WELL FUND.

Fifth and Sixth Fiscal Years.

Balance December 1, 1916	$5,245.59
Paid by Vouchers	5,245.59
Balance November 30, 1918	None



A DRAGLINE EXCAVATOR

At work constructing drains for the draining of lands under the Carlsbad project of the U. S. Reclamation Service, Carlsbad, New Mexico. Project Manager, L. E. Foster says with regard to drainage on this project:

"Seepage conditions have shown a marked improvement during the past few years, due to the concrete lined sections of the Main Canal and the construction of drains. Good results have been obtained from the construction of all drains and good crops are now growing on a large percentage of the area formerly rendered unfit for cultivation, due to seepage and the necessity for drainage."

REPORT ON RIO GRANDE DRAINAGE INVESTIGATIONS

The Rio Grande is confined within a narrow box canon from the New Mexico-Colorado state line to Embudo. From this point it passes through the Espanola Valley to Buckman, where it enters the deep and tortuous White Rock Canon. Emerging from this canon near the Indian Village of Cochiti it traverses for one hundred and fifty miles the highly productive Middle Rio Grande Valley which terminates at San Marcial, the head of the Elephant Butte Reservoir. The storage basin of this reservoir extends from near San Marcial to the dam, a distance of over forty miles. Below the dam to the New Mexico-Texas state line the river passes through several fertile and highly developed valleys.

Under the act of the State Legislature providing for the investigation of the valley as it crosses the state, all portions are eliminated except the Middle Rio Grande Valley, either because there is little or no valley areas susceptible of reclamation or because the areas are already adequately covered by surveys and investigations carried on by the United States Reclamation Service, which is the case with all that area between Elephant Butte Dam and the New Mexico-Texas state line.

In passing through the Middle Rio Grande Valley the most striking feature is the immense areas of swamp land and tracts given over to grazing or the cutting of a limited amount of second or third rate native hay, and large areas that do not seem to offer sufficient prospect of returns to warrant the clearing and cultivation. Under the more favorable conditions, intensely cultivated fields showing magnificent yields of diversified crops tend only to emphasize the deplorable effect of an ever rising water table. In its silent but persistent process it has all but driven agriculture from one of the most promising valleys in the southwest. With fine soil, good climate and adequate water for irrigation easy of application, it lies almost idle in spite of a crying need for food stuffs and the great demand for auxiliary feed that is necessary for the herds that are grazed throughout the adjacent territories.

Practically every land owner in the valley is conscious of the limitations that are placed upon him as to the choice of crops to be grown and the areas of his land that he may use, and there must be ever present the question as to whether con-

ditions are remaining about the same or gradually growing worse.

Scope of Survey.

The entire valley under consideration has been covered by a topographic survey. Practically all that portion from the upper end to the canon below La Joya was made by plane table and from that point to the lower end was made by transit stadia. Levels were run throughout the length of the valley and based on the bench marks established by the U. S. Geological Survey and the U. S. Coast and Geodetic Survey which are referred to mean sea level. The field work has been carried on from the railroad as a base. The resulting map, consisting of 34 sheets and made to a scale of 1000 feet to the inch, shows the land classifications, roads, railroads, towns, settlements, schools, churches, river channels, public survey monuments where found, and two foot contours in the bottom land and five or ten foot contours on the side slopes.

Over the principal areas there has been established, and monthly readings kept, on a system of test wells which have also been referred to the sea level datum. These wells were sunk from six to twelve feet, depending on conditions, and a log of the material penetrated was recorded. The well casings were made of two inch galvanized iron pipe cut and rolled from No. 27 gauge sheets, perforated along one side with ¼ inch holes spaced six inches apart. In the top of this pipe was fitted a turned wooden plug held in place by a screw in one side. Elevation of the top of each pipe was taken and also a bench mark established at each for use in case the well should be disturbed. Each well was given a number corresponding to the mile on the railroad within which it falls and in addition the wells within a given mile were numbered consecutively from one up. It was attempted to place a line of wells along the center of each area, approximately paralleling the valley and spaced one-half mile apart, and every two miles up and down the valley, a cross line from the river to the hills spaced one-half mile apart. As accessibility is a very important feature to be considered, both for the installation and the subsequent monthly readings, wells were placed on or near roads as far as possible, even at the expense of the general plan of distribution.

Besides monthly readings over all the wells there have been certain sets selected on which daily readings and readings every two hours were taken over a certain period to show intermediate fluctuations between the regular readings.

Location and General Description.

The Middle Rio Grande Valley of New Mexico in this report is considered to extend from the mouth of White Rock Canon in Sandoval County to just below San Marcial in Socorro County, and between these two points extends through Bernalillo and Valencia Counties. It occupies parts of the following townships: 15 and 16 north of Range 5 east; 12, 13 and 14 north of Range 4 east; 7 to 13 north both inclusive of Range 3 east; 3 to 11 north, both inclusive of Range 2 east; 6 south to 5 north, both inclusive of Range 1 east; and 1 south to 7 south, both inclusive of Range 1 west, all of the New Mexico Principal Meridian.

The principal towns within the valley are as follows: Bernalillo, county seat of Sandoval County, located 18 miles north of Albuquerque with a population of approximately 1000; Albuquerque, county seat of Bernalillo County, the largest city of New Mexico, and by far the most important industrial center of the area, is located 44 miles south of White Rock Canon and 105 miles north of San Marcial, estimated population, 18,000; Los Lunas, county seat of Valencia County, twenty miles south of Albuquerque, estimated population 900; Belen, important railroad point, where Belen cutoff of Santa Fe System crosses the branch from Isleta to El Paso, located 31 miles south of Albuquerque, estimated population 2000; Socorro, county seat of Socorro County and important distributing point for large territory to the west, 76 miles south of Albuquerque, estimated population 1800; San Antonio, agricultural center and distributing point for Carthage coal district, estimated population 500; San Marcial, railroad division point located 105 miles south of Albuquerque and at the head of Elephant Butte Reservoir, estimated population 1200.

All these points are on the Santa Fe railroad, the main line of which leaves the valley just below the Indian village of Isleta and the El Paso branch traverses the valley from that point southward. Besides quite a large number of small agricultural villages scattered throughout the valley there are in the northern part, the Indian villages of Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia and Isleta with a total population of about 3000. The total population of the valley excluding the Indians, is estimated at 40,000, of which a large percent is of Spanish descent. Agriculture is the principal industry of the valley, though stock raising and mining are important industries in the adjacent country contributory to the valley. The entire area is provided with good schools and many good roads are built and others are being continually improved, so that all parts are rapidly becoming easily access-

ible. With a railroad traversing its entire length, there is no part of the valley that is not within reasonable reach of these facilities.

Unlike most western irrigated districts, portions of this valley were being irrigated and farmed by the Indians when the Spanish explorers first entered it in the early part of the sixteenth century. The settlers from Mexico who followed after its exploration built additional ditches and the process of building community ditches for some certain area or settlement has resulted in the present almost chaotic network of canals or "Acequias," heading sometimes very close together, paralleling, crossing and recrossing, each with but one object in view, that of carrying water to a certain small area or settlement. In most cases these ditches, through long years of use and the annual removal of sediment that is deposited in them, have built up great embankments on either side and oftimes the bottom of the ditches themselves have raised from year to year till they are far above the adjacent fields.

As a whole, it may be said that the methods of irrigation in the valley are in a very crude state, notwithstanding the fact it is one of the oldest irrigated districts in the United States. In some cases the same old ditches and largely the same old methods are being used today that were used hundreds of years ago. Because they were built long before there were any laws or regulations to govern, there are almost no records of the amount of water they divert or the acreage they serve, but practically all observers agree that more water is used than is necessary and also that too much water is used for the best results. The border or check system is by far the most prevalent throughout, in spite of its many undesirable points.

Practically none of the adjacent mesa lands or side slopes have been brought under water, which would necessarily require very much greater units and very heavy expenditures. The community ditch is kept in repair by the labor or money contributed by the users themselves under the supervision of the "mayordomo," who is elected by them for that purpose, and it is also his duty to see to the equitable distribution of the water to the users, prorated according to the number of acres each has under cultivation. Diversion is made without any wiers or dams during times of sufficient water, but as the water in the river begins to recede it becomes necessary to construct temporary control works, either with brush and rock, or in the sand, in order to get water into the ditches. These, with a rise in the river, are usually destroyed and must be reconstructed when the water again goes down. This process may be repeated four or five times in a season, and each time the

users under that particular ditch are called out from their farm duties to do the work.

CLIMATE

The valley ranges in elevation from 5245 feet above mean sea level at the upper end to 4455 feet at the lower end with the heavier gradients immediately below White Rock Canon. The climate is arid with an average of from 30 to 40 days each year with precipitation and a very high percentage of sunshine. The average annual precipitation varies from 7.59 inches at Albuquerque to 11.09 inches at Socorro. The snow fall is very light, averaging each year 7.6 inches near Los Lunas and 9.3 inches at Socorro. The humidity is low and tends to mitigate very materially the effect of temperature upon the human body. Especially during the spring and early summer there is a very strong wind movement through the valley, generally from the south. This wind movement, the low humidity and the high percentage of sunshine produce a high rate of evaporation.

Following are tables showing mean precipitation, temperatures and killing frosts for those points within the valley from which records are available:

MEAN PRECIPITATION

	Bernalillo.		Albuquerque.		Los Lunas.		Socorro.	
Lgth. of Record (yrs)	11	6	40	23	28	23	28	21
	Amount.	Days.	Amount.	Days.	Amount.	Days.	Amount.	Days.
January	0.56	2	0.44	3	0.65	2	0.46	3
February	0.28	2	0.31	3	0.44	2	0.46	3
March	0.49	2	0.23	2	0.49	2	0.55	3
April	0.26	2	0.54	3	0.70	2	0.81	4
May	0.88	2	0.40	3	0.71	2	0.40	3
June	0.35	3	0.74	3	0.62	2	0.54	3
July	1.30	7	1.25	6	1.27	4	1.92	9
August	0.86	8	1.22	7	1.09	4	1.49	8
September	1.64	7	0.80	4	1.25	4	1.76	6
October	0.97	4	0.76	3	0.95	2	1.43	4
November	0.38	3	0.46	2	0.43	1	0.51	3
December	0.48	1	0.44	2	0.49	2	0.76	3
Annual	8.45	43	7.59	41	9.09	29	11.09	52

TEMPERATURES—ALBUQUERQUE

	Years.	Years.	Years.	Years.	Years.	Years.
Length of Record	33	18	18	18	18	22
	Mean.	Mean. Max.	Mean. Min.	Highest.	Lowest.	Wind.
January	33.8	48.1	22.3	70	−4	N
February	39.3	53.1	27.0	78	−10	NW
March	47.2	63.3	33.4	89	12	W
April	55.7	71.2	40.8	89	12	S
May	64.7	78.8	48.6	95	30	S
June	73.4	89.1	57.8	104	37	S
July	77.1	90.4	62.1	104	44	S
August	75.3	88.4	60.6	99	45	S
September	67.8	81.8	53.4	97	30	S
October	56.6	71.0	41.5	86	24	S
November	43.3	58.0	30.1	78	7	S
December	34.4	47.7	22.2	69	3	N
Annual	55.7	70.1	41.6	104	−10	S

TEMPERATURES—LOS LUNAS

	Years.	Years.	Years.	Years.	Years
Length of Record	26	22	23	28	22
	Mean.	Mean Max.	Mean Min.	Highest.	Lowest.
January	32.3	48.2	19.0	73	−20
February	38.3	54.1	22.3	79	−11
March	46.6	63.6	29.7	87	8
April	55.9	73.3	37.9	92	10
May	63.5	81.9	46.1	98	24
June	72.5	92.1	52.3	104	27
July	76.8	92.9	59.2	105	40
August	73.9	90.3	56.8	105	35
September	66.2	82.5	48.6	96	25
October	53.8	70.5	36.3	94	19
November	42.1	55.9	25.0	77	5
December	33.2	47.6	17.5	74	−25
Annual	54.6	71.1	37.6	105	−25

TEMPERATURES—SOCORRO

	Years.	Years.	Years.	Years.	Years.	Years.
Length of Record	25	20	20	22	21	19
	Mean.	Mean Max.	Mean Min.	Highest.	Lowest.	Wind.
January	37.9	52.7	23.6	76	−13	N
February	43.1	58.1	26.6	79	1	N
March	49.7	65.7	32.7	91	10	S
April	57.6	74.4	40.3	94	15	S
May	65.8	83.8	47.4	102	28	S
June	75.4	93.4	56.9	108	40	S
July	77.4	92.3	61.8	108	42	S
August	75.9	91.2	59.8	106	45	S
September	69.1	85.6	51.7	99	27	SE
October	58.0	74.4	39.4	95	16	N
November	45.7	62.9	28.9	86	6	N
December	36.2	51.4	21.2	70	−16	N
Annual	57.6	73.8	40.9	108	−16	S

KILLING FROSTS

Station.	Length of Record Years.	Av. Date First in Autumn.	Av. Date Last in Spring.	Average Growing Season.	Earliest in Autumn.	Latest in Spring.
Bernalillo	6	Oct. 25	April 18	189	Sept. 16	May 13
Albuquerque	23	Oct. 23	April 16	191	Sept. 17	May 1
Los Lunas	24	Oct. 19	April 16	186	Sept. 22	May 13
Socorro	22	Oct. 19	April 14	198	Sept. 27	May 1
Espanola	20	Oct. 9	April 27	165	Sept. 12	May 31
Santa Fe	43	Oct. 18	April 25	176	Sept. 25	May 18

LAND

Topography.

As is implied, the Rio Grande is the principal river of the areas under consideration, and it winds its way from one side of the valley to the other for the entire distance of 150 miles, measured along the thread of the valley. The valley is skirted on either side by bluffs backed sometimes with extensive mesa land, but more often with broken and hilly country. There are a few inflowing streams, all of which are dry for great portions of the year. The more important of these are the Rio Santa Fe, entering the river from the east near the upper end, Rio Jemez from the west five miles above Bernalillo, Rio Puerco from the west 20 miles below Belen, and the Rio Salado from the west, just above San Acacia, or 17 miles above Socorro. The valley floor is quite uniform and varies from a few hundred feet to a full five miles in width. Usually the river banks and sometimes the river itself is higher than the land directly opposite and near to the marginal hills. In many places there are old river channels, now either cultivated or overgrown with vegetation. There are some areas of hummocky sand dunes which constitute the greatest departure from the uniformity of the valley floor. The gradient to the southward is practically the same as that of the river and for different stretches is as follows:

From.	To	Dist. in Miles	Diff. in Elev. Ft.	Feet per Mile.
White Rock Can.	San Felipe	17.7	133.2	7.52
San Felipe	Albuquerque	27.0	160.3	5.93
Albuquerque	La Joya Can.	56.0	266.0	4.74
La Joya Can.	San Acacia	5.5	23.4	4.27
San Acacia	M. P. 1000	36.5	182.5	5.00
M. P. 1000	M. P. 1007	7.0	27.6	3.94
White Rock Can.	M. P. 1007	149.5	793.2	5.30

Soil.

The classes of soil, its depth and fertility are probably best shown by data contained in "Soil Survey of the Middle Rio Grande Valley, New Mexico," published by the Bureau of Soils of the U. S. Department of Agriculture. The area covered by this soil survey is 67 percent of the area now under consideration and the area not covered in that report is very similar and the same conditions may be taken as holding good there. The following is tabulated from that report:

Soil Class.	Acres.	% of Whole.	Average Depth.	Fertility.
Gila fine sandy loam	46,336	26.4	21 in.	Fertile when drained.
Anthony gravelly sand	24,576	14.0	72 in.	Fertile for early crops.
Gila loam	24,384	13.9	72 in.	Fertile.
River wash	18,688	10.7	.....	Medium.
Gila clay	14,272	8.1	60 in.	Fertile.
Gila clay loam	11,584	6.6	.....	Fertile.
Anthony fine sand	11,072	6.3	72 in.	Medium.
Anthony sand	10,944	6.2	72 in.	Fertile for early truck, peaches and cherries.
Anthony silty clay loam	4,160	2.4	12 in.	Fertile.
Anthony fine sandy loam	2,944	1.7	54 in.	Fertile.
Gila sand	2,752	1.6	33 in.	Medium.
Brazito fine sand	2,048	1.2	.....	Medium.
Tijeras fine sand	1,600	0.9	13 in.	Very fertile.

Land Areas.

The total gross area of the valley, as determined by the survey, including all areas from the foot of the slopes as nearly as may be determined, is 206,012 acres, classified as follows:

Cultivated (Class I)	40,063 acres
Cultivated (Class II)	8,732 acres
Alkali and Salt Grass	51,977 acres
Swamp	6,517 acres
Timber	37,594 acres
River and River Wash	27,536 acres
Other Valley	33,593 acres
Total	206,012 acres

In Cultivated (Class I) of this classification is included all areas that are being cultivated and, by a superficial examination, do not show that crops are being impaired by a too high water table. It does not mean that the land is not suffering from a high water table or even endangered, nor that it will grow all crops without injury, but that there are no surface indications of a shallow soil.

In Cultivated (Class II) are included those cultivated areas which do show indications of a high water table either by evident saturated soil or the presence of alkali or by affected crops.

In Alkali and Salt Grass are included those areas which are not being farmed, have visible quantities of alkali or are overgrown with salt grass. It is usual that such areas have the water table within a very few inches of the surface and during periods of high water table it may be at, or even above, the ground surface.

The Swamp areas are those that have the ground water exposed and are indicated by the water surface, marsh and rushes. This class is very closely related to Salt Grass and Alkali areas as the two may oscillate to a certain extent with

fluctuations of the ground water within the same year or from year to year.

The Timbered areas are those overgrown with timber or brush, usually cottonwoods, willows, or thorn bushes.

In the River and River Wash areas are those actually occupied by the river or the washed channels through which the water flows at a higher river stage. These areas are usually free from vegetation and consist of washed sand or gravel.

In the Other Valley areas are included all lands that do not come under the other classifications and may be sand wastes or sand dunes or sage brush either above or below ditches, and village or town areas.

Ownership.

Practically all land titles originate in Land Grants by the Spanish Government during their occupation of this territory, either to the Indians or the Spaniards. Large portions of these grants have been parceled out to individuals (much less so in the case of the Indians than others) and subdivided among successive heirs till now the lands, as a rule, are held in a very large number of small irregular tracts. On the other hand, there is now a consolidating process in which individuals are buying up contiguous parcels to form a farm of practical size, but there are comparatively few real large holdings.

In some cases Indians hold land outside, and others hold land inside Indian Grants, usually by adverse possession. From the southern boundary of the Isleta Indian Grant to the northern end of the valley, to which district the Indian Grants are confined, the total valley area is 80,100 acres. Of this total 43,200 acres or 54 percent lies within the boundaries of Indian Grants, and is comparable to the amount actually held by the Indians.

Values.

Land values through the valley are difficult to determine for general classes, but basing an estimate on values assigned by the Interstate Commerce Commission, the following values may be taken:

Good cultivated and improved	$100.00 to $125.00
Cultivated but affected by seep	50.00 to 60.00
Alkali and Salt Grass	10.00 to 25.00
Swamp	10.00 to 20.00
Timber or Bosque	15.00 to 25.00

Just how much the threatening water table cuts down the value of good land is difficult to determine, but it is conserva-

tive to say that good land with all possibility of a high or injurious water table removed would be worth from $125.00 to $150.00.

Results of Tests.

Following is given a table showing by districts the average depths from ground surface to water bearing material and the average depths from ground surface to water table by months, and includes most of the records collected for these purposes:

District.	Average Depth to Sand.	Average Depth to Water Table								
		Mar.	Apr.	May.	Jun.	July.	Aug.	Sep.	Oct.	Nov.
Bernalillo	1.6	4.17	3.03	2.47	2.82	2.78	3.90	3.95	4.05	3.31
Corrales	4.5	....	....	2.30	2.65	3.08	3.69	3.80	3.68	3.06
Albuquerque	3.3	2.81	2.94	2.49	2.76	2.96	3.68	4.11	3.83	3.34
Atrisco	...	2.33	2.87	2.02	2.34	2.55	2.75	2.93	2.79	2.49
Peralta	2.5	2.20	2.23	2.81	2.25	2.79	3.54	3.74	3.73	3.08
Belen	3.4	....	....	1.22	2.52	2.82	3.38	3.80	3.55	3.17
Lemitar	3.0	....	....	....	....	2.80	3.64	3.70	4.54	3.69
Socorro	3.9	....	....	....	....	1.95	2.55	3.33	3.94	2.44
San Marcial	1.9	....	....	....	....	....	....	3.23	4.17	2.38
Val Verde	0.0	....	....	....	....	....	....	5.53	6.30	5.76
Barr	2.7	....	....	1.14	1.20	1.52	2.70	2.72	2.44	1.25
All Districts	3.0	2.59	2.77	2.05	2.45	2.79	3.25	3.65	3.69	2.97

The records in the preceding table cover only a period of from three to nine months, and it is not known whether this is a normal year. However, it will be noted that in all instances the high point of the curve comes at the first of May and the low point for Barr, Belen, Atrisco, Peralta, Albuquerque and Corrales Districts comes on Sept. 1st, and all others, including the curve for "All Districts," comes Oct. 1st.

The form of the curves have a remarkable similarity, but the extreme variations extend from 0.91 of a foot in the Atrisco District to 2.58 feet in the Belen District.

On a set of 127 wells read on the first of May,

1918, the average depth to water was.....1.98 feet
The average for the same wells Sept. 1st was.....3.65 feet
Average fall of ground water for period.....1.67 feet

In the following table is given results of readings on a set of 150 wells on May 1st, 1918, and the same wells again Sept. 1st of the same year, showing the percent of the total number of wells for the given depths below the surface:

Depth to Water.	May 1st, 1918.	Sept. 1st, 1918.
Less than 1 ft.	19.7%	0.0%
Less than 2 ft.	56.4	8.3
Less than 3 ft.	76.8	30.9
Less than 4 ft.	92.5	58.9
Less than 5 ft.	95.2	76.7
Less than 6 ft.	95.9	88.6
Less than 7 ft.	98.6	92.8
Less than 8 ft.	99.3	96.4
Less than 9 ft.	100.0	98.3
Less than 10 ft.	100.0	100.0

On May 1st 92.5 percent of the tests showed the ground water to be less than 4 feet below the surface with the average depth for those tests of 1.85 feet, and the remaining 7.5 percent showed the water between four and nine feet below the surface with an average of 5.96 feet. The average depth for all these wells on May 1st was 2.16 feet, while on Sept. 1st it was 3.99 feet, a fall of 1.83 feet.

The percentages of these tests may not be taken as exactly representing the percentages of areas having those given conditions, but, after eliminating the river area and the area within the Val Verde District, which is the only one in which the ground waters are not at all serious, and applying the percentages to the remaining area of 173,000 acres, it would indicate that in the Rio Grande Valley on May 1st of this year there were 160,000 acres in which the ground water was from 0 to 4 feet below the surface with an average of 1.85 feet; that there was 13,000 acres in which the depth to water varied from 4 to 9 feet with an average of 5.96 feet, and that the average depth to water over the entire 173,000 acres was 2.16 feet; that on Sept. 1st the water table had dropped 1.83 feet and was at that time an average of 3.99 feet below the surface.

In the nine-day period from Aug. 12th to 20th there was maintained on a set of wells just north of Albuquerque short interval readings. These wells consisted of one line extending from the river to the marginal hills and another line crossing this at about right angles up and down the valley. These readings show a distinct daily fluctuation of from one to three-tenths of a foot. This daily cycle has its high point in the forenoon at 8 o'clock and its low point at about 4 in the afternoon. Also, a rainstorm on the afternoon of the 14th affected nearly all readings on the following morning, three or four from one to two days later, and one or two wells not at all. All effects of this rain had apparently passed entirely in three to four days.

Natural Units.

The Rio Grande, in its meandering course through the valley, by successive contacts with the bluffs on one side and then on the other, divides the valley proper into areas, which, in some respects, constitute natural drainage units. These are drainage units in the sense that it is possible to drain the area contained within them with no consideration of other portions of the valley except those that have to do with the river itself. There may be exceptions to this when it becomes more economical or more effectual to carry a main outlet drain

from one such unit to another by an inverted siphon or by a deep cut through high ground.

Studies of the manner and the direction of flow of the ground water as revealed by elevations of its surface at different points, indicate that at least the greater part of it flows out under a given area from the river itself. Tracing it, as nearly as is possible with the limited number of test wells that have been installed, it flows down the valley, and at the same time outward toward the hills, and on reaching the more or less impervious materials that underlie these hills there appears to be a piling up or a flow along the margin of the valley.

That portion of the flow which has not been dissipated either through evaporation, or by respiration in the plant life of the valley and possibly through escape in pervious strata under the hills, would naturally flow again into the river when the river takes a bend across this flow or when it is crowded back by the river and the hills again coming together.

This theory is entirely borne out by the tests that have been made and the profiles of the water table across the valley, showing the gradient downward from the river almost to the hills and there a sudden mounting. Also at the lower end of a unit and sometimes at other places the water table near the hills is found higher than directly opposite and near the river, showing a flow from the ground water to the river.

The general fluctuations in the ground water appear to follow somewhat the stage of the river and are appreciably affected by the periods of high evaporation, and abnormal local rises due to temporary surface water disappear within a few days after the cause is removed. There is strong evidence of high places in the water table due to long continued water in ditches or small reservoirs, and variations from the uniform surface are usually traceable to some surface condition of this kind.

As already stated, the greatest source of the ground water under the valley is from direct percolation through the pervious substrata from the river. Other sources are: Over irrigation, careless handling of irrigation water such as the breaking of ditches and allowing water to waste into unused areas when not needed, percolation from irrigation canals, the number of which is greatly in excess of that necessary to irrigate the areas requiring it; direct precipitation which is almost negligible, and surface drainage from adjacent areas.

The possible methods by which a lower water table may be attained are, first, the lowering of the river by straightening, confining to one channel, and the elimination of all possible diversions and obstructions; second, in connection with irrigation, eliminating all possible canals, preventing waste of water and restricting its use to that which is necessary for the best results, and third, the removal of ground water by a system of open and closed drains and by pumping.

Because of the excessive cost, and the many difficulties presented in the absolute control of the river in such a channel, it is considered impracticable to attempt a made channel throughout the length of the valley. Were not the cost of excavation alone prohibitive, the provision of safeguards against excessive scouring, both laterally and in depth to insure diversion, would be very costly undertakings.

There are claims, and with some evidence to bear them out, that the river is very slowly and gradually increasing its elevation. This can be at least partially overcome by the elimination of divided channels, which reduce the velocity and consequently the sediment-carrying capacity of the water. Also the numerous brush and rock diversions tend to deposit large quantities of sediment, sometimes only temporarily, it is true, but even if apparently all taken out during a heavy flood, it is more likely that it is only distributed as the flood waters are usually carrying their maximum amount of sediment without taking on more.

One acre foot of water may be taken, with some degree of accuracy, as representing three acre feet of ground water. Losses in irrigation canals, over irrigation and needless waste become important factors in augmenting the volume of ground water under an area, raising its surface that much nearer to the ground elevation, and, either with or without drainage, must be reckoned with. Without drainage it must find its way by natural flow back to the river or be removed by evaporation or plant respiration. With drainage there must be provided that much greater capacity to care for the additional water.

Being unable to keep injurious amounts of ground water out of an area, it becomes necessary to remove it by a system of drains or by pumping. Pumping might be practicable on smaller areas and especially if the water so pumped could be applied directly for irrigation. But a constant lowering of the water table must be obtained. The growing crop roots will not penetrate into the saturated soil, and if they reach a certain depth when the water table is low only to be flooded for a period of time by a higher table, the result is drowning.

Development of Plans.

In formulating plans for the drainage of the Rio Grande

Valley the first, and probably the most important consideration is assigning the river to a certain channel and the provision of means whereby it may be absolutely kept within that channel, in order that it may not find a new course, thus destroying or rendering useless any system that has been constructed. And in this consideration must also be taken the arrest, as far as possible, of the process of sedimentation.

A more or less permanent river control program should be adopted, and it should include annual improvements to keep all protection works in good condition. Methods of diversion from the river, as now practiced, are dangerous, as most ditches are without adequate control, and seldom have substantial headgates which can be depended upon to properly function during times of extreme floods. Properly planned and protected headgates should be required on all ditches, and in cases where several diversions occur near together, arrangements should be made to use a common headwork, and distribution of water made to the several canals after diversion is affected, thus removing the multiplied expense and menace. To go even further and consolidate the many duplicating canals, while it is extremely desirable from many points of view, and it is hoped in time it may be accomplished, is an undertaking of considerable expense, and one that should receive careful study and planning. It has its bearing on plans for drainage as well as on the conservation of water, and has in it the possibility of a great reduction in annual maintenance charges, and insurance against failure of diversion at times when water is greatly needed by crops.

In considering the main outlet drains, it is at once apparent that they must approximately parallel the river. With this determined, it is then to consider their location. The first consideration is efficiency, that is, they must be placed where, with respect to the sources of the underflow and the character of the substrata, they will render the greatest service to the areas involved. Also in this connection there must be considered the type of drains, values of land traversed, structures necessary and defacement of the country if open drains are to be used.

The conclusion has already been reached that by far the greater part of the ground water flows from the river through the pervious substrata. It is proposed that main open drains be constructed as near the river as practicable and approximately parallel to it, from the lower end of the natural units till they reach the bluffs at the upper end. These ditches will act as intercepting drains, carrying a large portion of the water

that would otherwise flow out under the areas, through their channels to the river at the lower end. This will have the effect, for the areas between the drains and the hills, of lowering the river till its water level is the same as that in the drains.

These main outlet drains should have their outfall at an elevation even higher than high water in the river. This will give some margin in case there should be some raising of the river bed through sedimentation, and also will prevent the depositing of sediment in the drains due to back water when the river is in high stage. By following near the river, they will not only effectually act as intercepting drains, but it will usually be possible to locate them on unimproved land, there will be less damage by cutting off fragments of property, there will be fewer structures, and defacement will be more or less removed from view.

The water will enter these drains from the river side and there will be a tendency toward a flow from the drains outward toward the hills and down the valley, but at a much greater depth, and should its gradient be less than that of the valley, thus allowing it to approach nearer to the ground surface, or should there be an excess of water applied at distances too great for it to percolate naturally to them, it will become necessary to install laterals which will carry the excess back to the main drains.

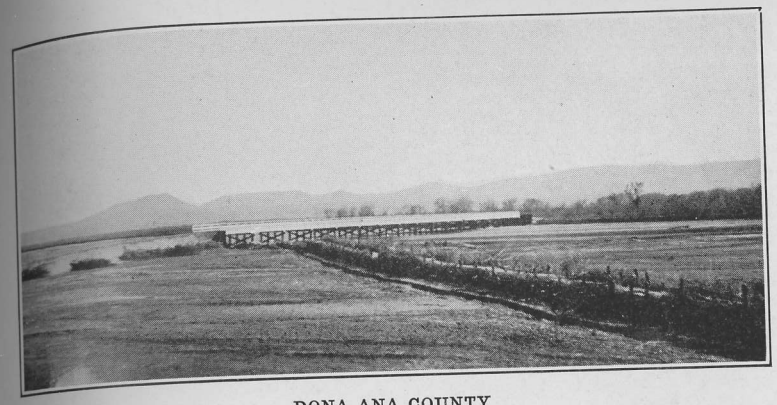
Inasmuch as these laterals will cross improved land, roads and ditches, they should be closed tile drains, and extend to the marginal hills, but up the valley sufficiently to provide the necessary grade. They may even be extended along the base of the hills up the valley in order to tap a known source of underground water. These laterals will intercept the underflow as it moves down the valley, whether it is the result of irrigation or comes from subterranean springs or is possibly due to surface drainage from adjacent areas. With the proper control and restrictions on the use of irrigation water and other preventive measures that have been pointed out, it is believed the number of these lateral drains will be quite limited, but their frequency can best be determined by the continued study of the action of the water table after the main outlet drains have been constructed. It is possible to conceive of conditions, under which, because of extreme width of areas from the river to the hills or the ground surface near the hills being so much lower than the river, it might be impossible to provide sufficient grade to the laterals as suggested, in which case it would become necessary to construct secondary outlet drains, branching from the first or main drain near the lower

end of the units but following near the hills, and extending up only so far as the conditions make it necessary. In most cases these could be made open drains without the objections pointed out for open drains above. It is more economical to have fewer long laterals than a greater number of shorter ones since each lateral must necessarily traverse areas near the main outlet into which it empties that are already adequately drained by it. Consequently these secondary drains and the number of laterals are to be held down so long as all parts of the areas can be cared for in any other way.

Water Developed.

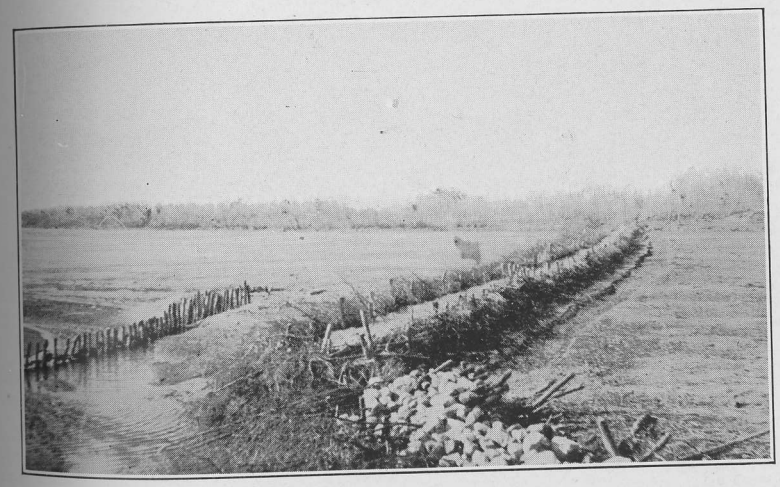
In order to arrive at the amount of water that may be developed by a system of drains in the valley, reference is had to a seepage investigation of the Rio Grande, made by the State Engineer, covering the period from October 20th to 30th, 1913, and described in the report on the Surface Water Supply of New Mexico for that year. In this investigation it was found that there was an absolute loss due to seepage alone of 296.9 second feet between Pena Blanca and San Marcial, or practically two second feet per mile of valley. It will be noted that this result was obtained at a time when the river was at a gradual falling stage, and also quite near a mean stage for the year. Under this condition it would be expected that the seepage loss would be less than if it had been at a rising or constant stage, for the reason that the ground water in the areas immediately adjacent to the river was higher in comparison, due to the previous high water. Also the seepage loss is relatively higher for a higher stage of the river due to the increased head, but more especially due to the increased wetted area. With these points in mind it is safe to assume that the average seepage loss for the year is not less than the figure obtained in this investigation. The average loss of 296.9 second feet is equivalent to approximately 216,000 acre feet in one year's time.

This loss is divided into two elements, that which is evaporated directly from the river surface, and that which percolates out under the valley floor and does not find its way back into the river. This latter is lost in evaporation from the exposed water table and in plant respiration, and possibly, though not very likely, in flow into pervious substrata away from the valley. Assuming an average river surface between these two points of 18,000 acres and an annual evaporation from a free water surface of 5 feet, there would be lost in this way 90,000 acre feet of water, leaving an absolute loss by percolation of 126,000 acre feet. But this is not all the water that is lost in



DONA ANA COUNTY

Salem Bridge over Rio Grande. Showing willow brush mat with loose rock top. River control or bridge protection, north end Salem Bridge built in 1917, service very satisfactory.



DONA ANA COUNTY

Showing north approach to Salem Bridge over Rio Grande, protected by willow and rock basket, also willow brush mat with loose rock top, river control or bridge protection.

the valley. Certain portions of the water from all sources that help to make up the ground water are also lost. Important among these elements are the seepage losses of the canals and the excess water applied to the land. It is not likely that all water now lost could be saved by a drainage system, but with the water table so lowered that there would be but little evaporation, and plant respiration would be largely confined to water that is applied by irrigation for that purpose, it would seem conservative to estimate that at least something like the 126,000 acre feet would be developed.

To reach the conclusion that it is entirely feasible to drain the Middle Rio Grande Valley, it is first necessary to establish the fact that it is physically possible to do so. The surveys and studies that have been carried on, and the practical plans that have been outlined in this report, establish the fact that it is possible to construct a system of drains that will effectually and permanently lower the water table throughout the areas where it is applied. But, for it to be feasible, drainage must be accomplished at a cost much less than the benefits that will result from it. It is then necessary to obtain the probable cost of construction and the probable amount of benefits that will result with as great a degree of accuracy as is possible at this time.

ESTIMATED COST

(Tentative.)

The following table gives for each district, the cost of drainage, the total number of acres, the estimated number of acres that will receive full benefit, the cost per acre of the gross area and the cost per acre for full benefit:

District.	Cost of Drainage.	Total Acres.	Cost per Acre of Total Area.	Acres of Full Benefit.	Cost per Acre for Full Benefit.
Bernalillo	$ 189,553	9,118	$20.79	8,000	$23.70
Corrales	72,933	3,422	21.31	2,738	26.63
Albuquerque	291,893	14,631	19.95	12,800	22.80
Barr	80,023	3,696	21.65	2,931	27.30
Atrisco	253,136	15,255	16.50	12,000	21.10
Peralta	320,505	20,858	15.37	15,200	21.09
Belen	395,875	24,097	16.43	18,000	21.99
San Juan	149,301	8,159	18.30	6,040	24.72
San Francisco	135,414	7,412	18.27	5,600	24.18
Lemitar	121,785	8,338	14.60	6,000	20.30
Socorro	316,420	19,156	16.52	15,126	20.92
All Districts	$2,326,837	134,143	$17.34	104,435	$22.28

The above table is given for the purpose of showing the estimated cost of drainage in the eleven districts so far worked out. The estimates for the remaining districts should approximate the same average costs and will probably bring the total acreage to 145,000 acres. It gives a very close estimate of the probable final cost per acre.

The complete report of the whole drainage project is nearing completion and will be published in its entirety with the topographic maps in a separate volume, probably early in February, 1919. The final estimates of costs, estimates of benefits, conclusion, summary and recommendations will be given in full in the final complete report.

PRESENT STATUS.

Through general agitation and discussion, the landowners in some large measure are awakening to the absolute necessity of drainage in the Rio Grande Valley if it is to be much more than a general grazing area.

The system of test wells that has been installed in this work should be extended and monthly reading continued by some agency that is in a position to do so. The water table readings are valuable principally in proportion to the length of time over which they are taken. They would, if continued, be valuable to any agency that undertakes a more extensive survey or even the construction of drain systems in this area. An especial study should also be made to determine the possibility and feasibility of consolidating the present irrigation canals in the valley and conserving the use of water under them.

At this time the drainage project between White Rock Canyon and San Marcial has been incorporated in the program of reclamation and drainage by the U. S. Reclamation Service under the proposed department bill of the Secretary of the Interior.

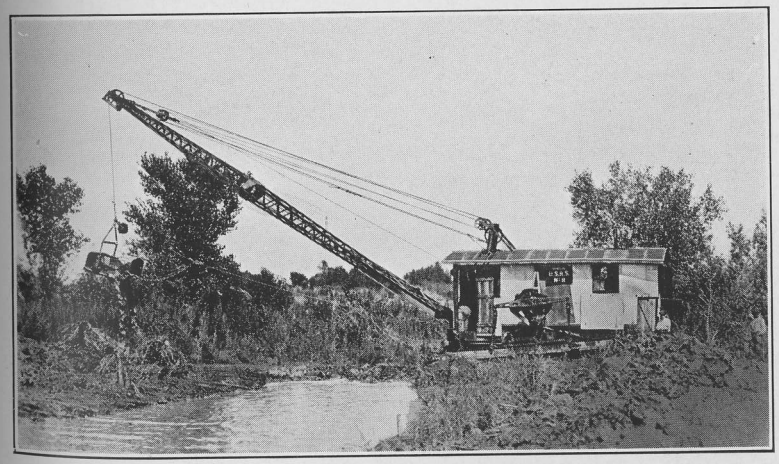
It is recommended that the budget item of $5,000 for the seventh fiscal year be granted to carry on the readings of the well elevations in the valley.

RIO GRANDE DRAINAGE FUND.

Fifth and Sixth Fiscal Years.

Amount of Appropriation	$25,000.00	
Refunded for Scrip Books	61.16	$25,061.16
Paid by Vouchers		22,985.44
Balance November 30, 1918		$ 2,075.72

A Dragline Excavator constructing the "Nemexas" drainage canal on the Rio Grande project of the U. S. Reclamation Service.



A Dragline Excavator, on the Rio Grande project of the U. S. Reclamation Service, at work building the "Park" Drainage Canal.

SANTA FE AND CHICO RICO HYDROGRAPHIC SURVEYS.

The legislative session of 1913 made an appropriation of $15,000.00 out of the Water Reservoirs Income Fund (for irrigation purposes) for the hydrographic surveys.

Two surveys were undertaken—one in Colfax County on the Chico Rico Drainage, involving the water supply of the City of Raton; the other in Santa Fe County on the Santa Fe Creek Drainage, involving the water supply of the City of Santa Fe.

Chico Rico.

The Chico Rico hydrographic survey was begun in October, 1913, with the object of collecting the information necessary to an adjudication of water rights in that basin. The records of this office contained several conflicting claims to water for irrigation purposes, and information had been received that the Town of Raton, through its council, was about to begin the construction of a water works system to replace the privately owned plant then serving the town. As the value of both these enterprises was dependent on the control of the water supply and as irrigation rights would necessarily have to be considered along with domestic rights, it was clear that the question of ownership would soon come up for settlement. The municipal plant was completed and put into operation in 1915, and the case is now in the courts for settlement.

The situation is complicated by the fact that all water not used for domestic purposes has been filed on for irrigation and, while the business of this department under the law is limited to the consideration of the amount and permanency of the supply and to the feasibility and economy of proposed plans for applying it to beneficial use, the question of the relative values of water for irrigation and domestic use, and for each under different conditions, is sure to arise in this case. It was therefore believed necessary, in order that the proper authorities may be prepared to treat all phases of the question, carry out the investigations in considerable detail and to make certain studies which might at first thought seem unnecessarily minute. It is evident that in this instance a cursory examination would be misleading rather than helpful and might easily result in injustice. Furthermore, it was assumed that the adjudication, when made, would cover the entire basin as it is a fact well known that in any stream system where all the water has been filed on and claims have begun to conflict, no adjudication is complete and permanent that does not apply to the entire stream system.

It is assumed that the adjudication will aim at the following results:

(a) That the supply for the Town of Raton shall be assured as to quantity and quality beyond reasonable doubt.

(b) The fixing of a fair pecuniary value, aside from construction costs, on such supply.

(c) The determination of the amount of water remaining for other uses after the needs of the town have been satisfied.

(d) The definition as to ownership and boundaries of all lands entitled to irrigation water.

(e) The determination of the economic duty of water for irrigation.

(f) The listing of water rights and owners, in terms of quantity of water and area of irrigable land, in order of priority.

(g) The appointment of a water master after an adjudication, whose duty shall be to see that all water is distributed in conformity with the court decree.

The survey was accordingly conducted so as to obtain, with respect to the subjects listed below, the information contained in detail in the following report:

(1) *Water Supply*—Sources, drainage areas, Weather Bureau statistics, run-off at controlling points, comparison of precipitation and run-off as to various watersheds, average per cent of run-off for several watersheds, probably minimum run-off, ratio of run-off from different watersheds, capacity and effect of storage reservoirs, seepage gains and losses, evaporation losses.

(2) *Topography of Irrigated Lands*—Contour elevations, areas of various crops, source of water supply, streams, ditches, pipe lines, reservoirs, gaging stations, roads, land lines, etc.

(3) *Use of Water*—Methods and results of irrigation in 1914. Effect of rains. Gross duty and net duty of irrigation water outside of Raton. Duty of water for city irrigation. Requirements for domestic use in Raton.

(4) *Conclusions*—Probable range of supply. Supply for Raton. Amount remaining for distribution among irrigators (a) probably permanent, (b) probably intermittent, (c) additional storage. Probable economic duty. Total area irrigable from assured supply. Area of uncertain supply.

Chico Rico Hydrographic Survey Expenditures to November 30, 1918:

First Fiscal Year	$1,703.78
Second Fiscal Year	5,877.22
Third Fiscal Year	1,589.08
Fourth Fiscal Year	470.46
Fifth Fiscal Year	6.23
Sixth Fiscal Year	.....
Total	$9,646.77

Santa Fe.

The Santa Fe River Hydrographic Survey report has been delayed owing to the fact that the assistant engineer who had immediate direction of the work resigned his position to take up private work with the understanding that the assembling of the report would be given attention from time to time when opportunity presented itself. After a couple years waiting, the data was turned over to Lee S. Miller, assistant engineer at Santa Fe, and the report is practically complete and now being typewritten. This report will be given to the Attorney General by the first of the year, with request to bring suit against all parties concerned for final adjudication.

Santa Fe River Hydrographic Survey Expenditures to November 30, 1918:

First Fiscal Year	$ 1,748.43
Second Fiscal Year	5,782.13
Third Fiscal Year	1,391.67
Fourth Fiscal Year	592.79
Fifth Fiscal Year	414.78
Sixth Fiscal Year	303.99
Total	$10,233.79

RIO GRANDE IMPROVEMENT.

On November 30, 1916, the date of the last biennial report, there was a balance in this fund from the appropriation made in Senate Bill No. 27, 1915 Session Laws, approved February 26, 1915. The 1917 Legislature made no appropriation for this fund, due to an oversight, although at that time there was about $14,000.00 in the treasury available for appropriation for this purpose, so that during 1917 and 1918 we have endeavored to use the funds on hand in maintaining structures already built or for emergency work.

A brief resume of the work done during the years 1917 and 1918 is as follows:

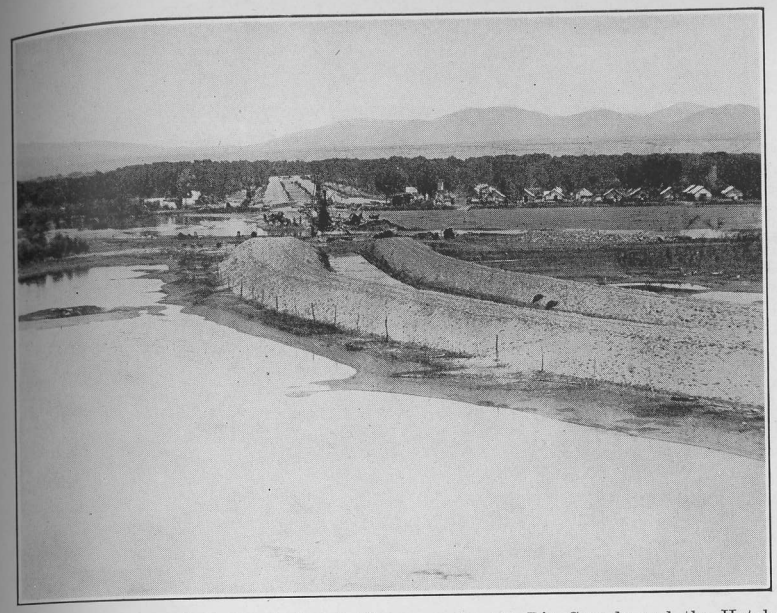
In May, 1917, the dike built at Sausal in 1916 was partially washed away, due to the fact that the Los Garcias ditch heading was put right through the dike. No work was attempted on the repair of this dike in 1917. In 1918, at the request of Mr. Decidero Sanchez y Baca of Sausal, Mr. Harvey made an investigation of the condition of the dike and reported on April 18, 1918, that it would be useless to attempt any repair unless pile construction were used.

At the request of Mr. Eugene Kempenich of Peralta, in a letter dated May 24, 1917, we had Mr. Harvey investigate the advisability of building an auxiliary earth dike to the pile breakwater opposite the Valencia church, and on June 30, 1917, we made a contract with Mr. Jose G. Chavez of Valencia, agreeing to pay him $100.00 for building an earth dike of such dimensions and at such location as Mr. Harvey should direct, and upon recommendation of Mr. Harvey, Mr. Chavez was paid the final payment upon completion of this dike on December 7, 1917.

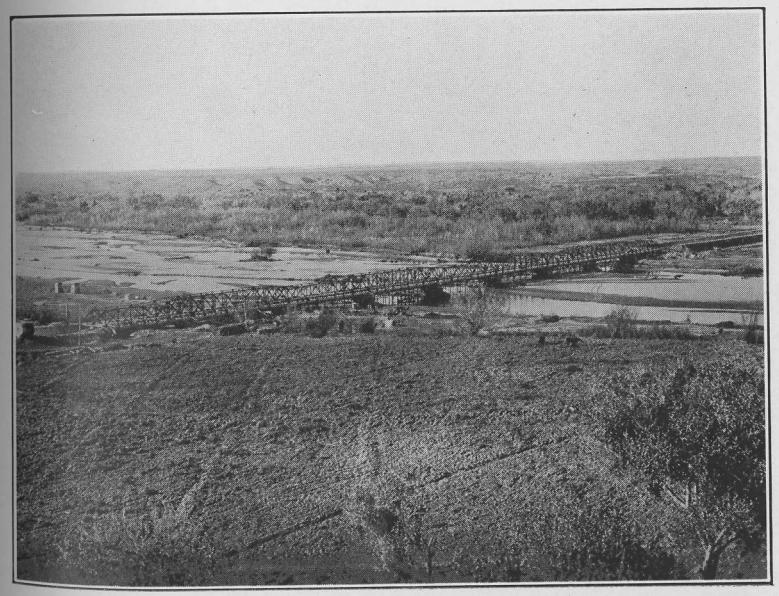
On March 20, 1917, we received a request from Mr. Paul Kempenich of Peralta to look into the design of the headgate of the Acequia de Medio, which the ditch owners thought too small. Mr. Harvey went to investigate, and on April 6, 1917, reported that the gate would carry up to the capacity of the ditch.

However, the owners of this ditch must have changed their diversion, for upon request of Mr. Kempenich in December, 1917, Mr. Harvey went to examine the pile breakwater above the head of this ditch, and reported that this ditch ran right through the bank end of one of the breakwaters. These breakwaters were filled with brush by force account, under direction of Mr. Harvey, and the work was completed February 27, 1918. At the request of this office the heading of the Acequia de la Media was changed back to old location to avoid danger to these breakwaters.

Upon petition from land owners on the east bank of the Rio



A view of the Garfield Canal, Hatch Siphon under the Rio Grande and the Hatch Canal on the Rio Grande project of the U. S. Reclamation Service.



A view of the Garfield Flume which carries the Garfield Canal irrigation water over the Rio Grande on the Rio Grande project of the U. S. Reclamation Service.

Grande below Round Mountain, we allowed $250.00 for temporary protection, under Elfego Gomez, foreman, and this work was done in November and December, 1917.

There was some office expense charged to this fund and also a portion of the expense of publishing the second biennial report.

RIO GRANDE IMPROVEMENT FUND.

Fifth and Sixth Fiscal Years.

Balance December 1, 1916	$1,243.13	
By Sundry Refunds	25.75	
Interest	9.40	$1,278.28
Paid by Vouchers		656.50
Balance November 30, 1918		$ 621.78

RIO GRANDE PROJECT DRAINAGE AND IRRIGATION WORK.

(Contributed by L. M. Lawson, Project Manager, U. S. R. S.)

The formation of two irrigation districts under the Rio Grande project during the winter of 1917-1918, embracing a large majority of the irrigable acreage of the original project in the States of New Mexico and Texas, made possible the execution of contracts between these districts and the United States Reclamation Service for providing distribution and drainage systems.

The original project plans contemplated the construction of storage, diversion and principal carriage works for the delivery of water to existing community canals. In common, however, with most irrigated districts, and particularly similar to those where storage works made water for irrigating purposes available throughout the season, the necessity for proper distribution and delivery of the irrigation supply, as well as a drainage system to remove excess water applied to the soils, became apparent.

Following the formation of the Elephant Butte Irrigation District for lands in New Mexico, and the El Paso Water Improvement District No. 1 for lands in Texas, a contract was negotiated and executed for extensive lateral and drainage construction. Plans for the former contemplated the assumption by the Government of control of community canals, through transfer of these properties, their reconstruction, and extension to include new lands.

To accomplish the better delivery of water to individuals, including its measurement on the acre-foot basis, practically all the large community canals of the project have now been transferred by deed to the Government for operation and reconstruction. The object of this merger and cessation of community ditch operations, which was practically unanimously voted by the water users, was for the purpose of placing the control in the hands of one central organization. This action on the part of the water users and irrigation districts that have voted for the construction of laterals and distributaries throughout the project, will have considerable effect on the use of water and curtail to a large extent the excessive irrigations, to which the large area now seeped and water-logged is due.

A comprehensive drainage plan has been formulated, which contemplates the construction of approximately 316 miles of open drains, involving the excavation by dragline machines of over fifteen million cubic yards. These open drains vary in bottom width from 10 to 30 feet, and the average depth is approximately 9 feet.

The necessity for this drainage work is apparent because of the large percentage of lands in the Mesilla and El Paso Valleys of the project which are now in various stages of seeped condition. Sixty-six per cent of the total area of land in the Mesilla Valley during the past year had ground water within four feet or less of the surface. In the El Paso Valley, sixty-nine per cent of the total area of 46,000 acres was in the same condition. The total crop value produced on the project would have been materially lessened over previous years had not the prevailing war prices increased the unit value.

To combat this serious menace and safeguard the farming interests, there has been assembled on the project a large fleet of dragline excavators, which, operating night and day, are relieving the situation and making possible the cultivation of areas which have become waterlogged. At present, eleven of these machines are being operated on this drainage work, of which one is a contract machine and ten are owned and operated by the U. S. Reclamation Service. It is expected to increase this number by two additional machines within the next two months.

Besides the actual excavation work, a large construction force is engaged upon the work of providing the numerous bridges, flumes and culverts, and it is estimated that over five million board feet of lumber will be required for these features.

In addition to the lateral and drainage work on the project, the construction work for providing main canals for detached areas is still in progress. During the spring of 1918 the Percha Diversion dam, located on the Rio Grande approximately midway between Elephant Butte dam and Rincon, was completed and put in commission. This concrete structure provides for the diversion of water to the main canal passing through the Arrey, Garfield, Hatch and Rincon districts. Three crossings of the Rio Grande are included in this location. The Garfield crossing of steel flume has been constructed and is in commission. The next crossing, north and west of Hatch, called the Hatch Siphon, which has recently been completed, is a reinforced concrete tube, six feet in diameter, under the bed of the Rio Grande.

To carry irrigation water from the Hatch side of the river to the Rincon district, construction work is now in progress on what is known as the Rincon Siphon, located just below the Santa Fe railroad bridge in the vicinity of Rincon.

The appropriation for Rio Grande project work for the fiscal year beginning July 1, 1918, amounted to over a million and a quarter dollars, the largest appropriation for any reclamation project for this fiscal year. It can reasonably be expected that

following appropriations will be sufficient for the completion of the contemplated works within the near future, and that irrigation and drainage facilities will be provided that will guarantee to lands of the Rio Grande project a successful future.

During the past year, when the entire southern and western countries have experienced unprecedented drouth conditions, the storage of water made possible by the Elephant Butte dam has provided sufficient water for all irrigation demands throughout the project and the crop production, which would otherwise have been of very small amount, has returned large revenues to the water users of the project.

POWER DEVELOPMENT.

New Mexico-Colorado.

Supplementary.

Independent project, but would have a control upon the regulation of flow of water to the Albuquerque Valley Irrigation Project and storage of developed drainage water from San Luis Valley.

General Description.

Description.

Even in a preliminary way, surveys have never been made concerning this project, but from many years of investigation work for the U. S. Reclamation Service and for the State of New Mexico upon the Rio Grande, I wish to point out certain known and unknown physical conditions familiar to me and submit this information for your consideration. The proposed drainage and new irrigation in the middle Rio Grande Valley is closely related to the proposed drainage in the San Luis Valley, Colorado, and the water supply to the Elephant Butte Project. Colorado, New Mexico, Texas and Mexico all having uses of the waters of the Rio Grande, the ultimate development problems of this stream are many, both physical and legal. The solution of the problem is beyond the agencies of the States involved if the best results are to be accomplished considering the whole Rio Grande scheme. With three States involved it is an interstate project, and with Mexico involved it becomes international. There is only one agency capable of solving the whole scheme, viz: the U. S. Reclamation Service.

Four great physical problems are involved: First, the irrigation and drainage in the San Luis Valley; second, the proposed power development (call this the State Line Project); third, the drainage and new irrigation in the Albuquerque Valley, and fourth, the protection of the water supply to the Elephant Butte Project.

Location.

On the Rio Grande close to the Colorado-New Mexico State line, Conehos County, Colorado. Public domain west abutment; Costillo Estate (Grant) east abutment. Purchase of right of way probable.

No Development.

Visited dam site in 1910-11 and referred to in my report to the Director U. S. R. S. Located at head of box canyon, 7,360 feet elevation above sea level. A dam 135 feet high is possible, but probably not necessary. Top of dam 600 feet long, and 200 feet at stream bed. (Figures from actual measurement.) Capacity for storage at this height 1,500,000 acre feet. I believe that such a large dam is not necessary, nor could such

a big storage be utilized, but this is about the maximum of the cross section of the dam and is mentioned to show the immense storage capacity for so small a dam.

Stream Flow.

From the runoff as determined at the Labatos gaging station, within four miles of the dam site, the record shows a mean annual runoff of approximately 660,000 acre feet for a period of eighteen years.

The record is as follows:

Year.	Runoff in Acre Feet.	
1900	362,304	(last half year)
1901	312,341	
1902	173,528	
1903	642,607	
1904	259,181	
1905	1,096,000	
1906	929,700	
1907	1,454,000	
1908	378,200	
1909	943,135	
1910	567,408	
1911	973,000	
1912	830,632	
1913	335,000	(estimated)
1914	640,000	
1915	471,000	
1916	732,000	
1917	727,000	

This makes a total of 11,827,000 acre feet for the eighteen years or 657,000 acre feet annually.

No estimate made for seepage from proposed drainage in San Luis Valley.

It is probable a dam less than 100 feet high would give all the storage required.

Canals, Etc.

From the dam, a canal seventy miles long at the most would be required to the proposed power plant somewhere above Embudo Railroad Station. The dam location elevation, 7,360 feet. Proposed power station elevation, 5,900 feet. Hydraulic head, 1,200 feet.

On a basis of 1,000 second-foot canal and a 1,000 foot head at power station, would give approximately 90,000 H. P.

Power House.

Somewhere above Embudo Station.

Estimate of Cost.

Dam and reservoir	$2,000,000
Canal	2,000,000
Transmission lines	2,000,000
Total	$6,000,000

Cost estimates are mere guesses.

Power for new irrigation, reserve storage, regulation of the water supply, municipal, mining and manufacturing, would enter into the project.

The building of this proposed power dam is vital to the regulation of the stream flow for further irrigation development in the Albuquerque Valley and the storage of the return waters from the proposed drainage of some 600,000 acres of land in the San Luis Valley, which drainage project is incorporated in the program of the Secretary of the Interior.

This project will be submitted for consideration to the Secretary of the Interior for incorporation into the proposed reclamation and drainage plan of the Secretary. It has been suggested by the Chief of Construction of the U. S. Reclamation Service that I submit further information than previously submitted.

SURVEYORS' LICENSE LAW.

Under the Act Defining Surveying and Licensing Surveyors, approved March 13, 1917, a Board of Examining Surveyors was appointed September 14, 1917, by the Governor. The Board first met and organized October 17, 1917, and in accordance with Section 3 of the Act the State Engineer became Secretary of the Board. The other two members appointed were Mr. Pitt Ross of Albuquerque and Mr. Lee S. Miller of Santa Fe. Mr. Miller was elected President of the Board.

At the meeting of October 18, 1917, thirty-four applications were examined and approved. A number of other applications, more or less complete, were set aside until further or more complete information could be procured concerning the applicants.

From time to time meetings were called and held for the purpose of passing upon applicants' petitions.

To date there are ninety-two licenses in force; three have lapsed; three refused, and one applicant failed to complete his application. One application was revoked.

The Board at a meeting held November 30, 1918, passed a resolution recommending the repeal of the law, owing to its many inconsistencies and the impracticability of justly enforcing it. Evidently the law was intended that a license granted a surveyor would become a recommendation as to his ability. It acts otherwise, as any three licensed surveyors' recommendation is sufficient for the granting of a license by the Examining Board. In other words, anyone, whether engineer, surveyor, chainman or rodman, must and can become a Licensed Surveyor in the State.

The financial statement follows:

SURVEYORS' LICENSE FUND.

Fifth and Sixth Fiscal Years.

Receipts	$480.00
Disbursements	263.39
Balance November 30, 1918	$216.61

LICENSED SURVEYORS OF NEW MEXICO

(Corrected to February 28, 1919)

No.	1—Pitt Ross	Albuquerque
No.	2—Lee S. Miller	Santa Fe
No.	3—James A. French	Santa Fe
No.	4—N. Howard Thorpe	Santa Fe
No.	5—William H. Herrick	Socorro
No.	6—Frank Grygla (deceased).	
No.	7—J. L. Wells	Lordsburg
No.	8—A. C. Loveless	Clayton
No.	9—Guy Howard Palmes	Cimarron
No.	10—Bart A. Nymeyer	Carlsbad
No.	11—Charles F. Holly	Aztec
No.	12—Jonas H. Trimmer	Miami
No.	13—Jay Turley	Santa Fe
No.	14—Rolla W. Russell	Magdalena
No.	15—Charles B. Barker	Santa Fe
No.	16—C. B. Morgan	Deming
No.	17—Hugh M. Neighbor	Magdalena
No.	18—J. W. March	Santa Fe
No.	19—R. L. Cooper	Santa Fe
No.	20—Paul B. Moore	Magdalena
No.	21—Clyde Walters	Santa Fe
No.	22—B. C. Broome	Santa Fe
No.	23—E. Norris Hobart	Santa Fe
No.	24—Elwood Albright	Santa Fe
No.	25—L. J. Charles	Santa Fe
No.	26—J. W. Lewis	Carlsbad
No.	27—S. W. Almy	Deming
No.	28—J. P. Adams	Santa Fe
No.	29—W. H. Vauchelet	Roswell
No.	30—G. E. Moffett	Alamogordo
No.	31—W. R. Eccles	Roswell
No.	32—W. G. Turley	Velarde
No.	33—William Harris	Silver City
No.	34—Edmund Ross	Albuquerque
No.	35—John R. Darnell	Portales
No.	36—J. B. Franzini	East Las Vegas
No.	37—Saturnino Gutierrez	Magdalena
No.	38—C. L. Carter	Portales

No. 39—W. R. Smythe ..... Raton
No. 40—O. H. B. Turner ..... Raton
No. 41—W. A. Wilson ..... Roswell
No. 42—J. C. McKee ..... Hanover
No. 43—John H. Walker ..... Santa Fe
No. 44—E. M. Fenton ..... Albuquerque
No. 45—C. E. Johnson ..... Silver City
No. 46—James French ..... San Mateo
No. 47—M. W. Bushman ..... Silver City
No. 48—Will Benson ..... Artesia
No. 49—H. V. B. Smith ..... Santa Rosa
No. 50—Arthur F. Fraker ..... Clayton
No. 51—C. B. Sampson ..... Las Cruces
No. 52—Frank Herrmann ..... Santa Fe
No. 53—Terrell Bartlett ..... San Antonio, Texas
No. 54—L. O. Marden ..... Santa Fe
No. 55—J. H. Caldwell ..... Santa Fe
No. 56—G. S. Willhoite ..... Gallup
No. 57—Chas. W. Devendorf ..... Santa Fe
No. 58—Jas. C. Harvey ..... Los Lunas
No. 59—F. L. Cox ..... Silver City
No. 60—Charles M. Boren ..... Albuquerque
No. 61—E. D. Mason ..... Tyrone
No. 62—E. J. Hall ..... Albuquerque
No. 63—J. D. Walker ..... Santa Fe
No. 64—Lee C. Daves ..... Albuquerque
No. 65—Vincent K. Jones ..... East Las Vegas
No. 66—L. N. Jones ..... Alamogordo
No. 67—A. S. Kirkpatrick ..... Hurley
No. 68—Revoked.
No. 69—A. H. Harvey ..... Carrizozo
No. 70—W. L. Rider ..... Carrizozo
No. 71—H. E. Stansbury ..... Tucumcari
No. 72—T. H. Seay ..... Silver City
No. 73—C. A. Brown ..... Tucumcari
No. 74—H. H. Miller ..... Farmington
No. 75—J. F. Ortiz ..... Tres Piedras
No. 76—George H. Pradt ..... Laguna
No. 77—Lapsed.
No. 78—Lapsed.
No. 79—V. L. Sullivan ..... Fort Stockton, Texas
No. 80—Albert D. Bryant ..... Los Cerrillos
No. 81—C. R. Dwire ..... Taos
No. 82—L. O. Turner ..... Las Vegas
No. 83—Lapsed.
No. 84—Guy S. Exon ..... Pojuaque
No. 85—P. T. Wrigley ..... Raton
No. 86—R. Creasy Master ..... Ramah
No. 87—S. E. Wood ..... Gallup
No. 88—George E. Briggs ..... Springer
No. 89—Frederick Hiltscher ..... Hillsboro
No. 90—George W. King ..... San Marcial
No. 91—L. M. Carl ..... Columbus
No. 92—W. C. Davidson ..... Roswell
No. 93—C. L. Nichols ..... Magdalena
No. 94—Oscar Dobbs ..... Clovis
No. 95—Mill Sanderson ..... Gallup
No. 96—Manuel A. Sanchez ..... Mora
No. 97—Chas. A. May ..... Carlsbad
No. 98—N. V. Cook ..... Lakewood
No. 99—Jas. H. Batchelder, Jr. ..... Socorro
No. 100—Chas. V. Shearer ..... Mineral Hill
No. 101—H. W. Stoneham ..... Lovington
No. 102—Waldemar M. Ervin ..... Magdalena
No. 103—Geo. M. Neel ..... Santa Fe
No. 104—Kenneth A. Heron ..... Chama
No. 105—Lucius Dills ..... Santa Fe
No. 106—Fred G. Carscallen ..... Watrous
No. 107—A. F. Schramm ..... Silver City
No. 108—B. H. Calkins ..... Albuquerque

RIO GRANDE COMMISSION.

Under Chapter 107 of the Laws of 1917, the Rio Grande Commission was created. Hon. H. J. Hagerman of Roswell, and Hon. W. S. Hopewell of Albuquerque were appointed by the Governor as members of the Commission, the Act itself providing that the State Engineer become a member.

At the first meeting of the Commission, on May 3, 1917, Col. Hopewell was elected President, and the State Engineer, James A. French, Secretary of the Commission.

At a special meeting held January 3, 1918, it was decided that the Commission should go to Washington to confer with Senators and Representatives relative to a donation of public land, the proceeds of the sale of which were to be used in the drainage construction of the Rio Grande Valley. Col. Hopewell and the State Engineer visited Washington during the latter part of February and early March, 1918, and had many interviews before the departments relating to drainage on the Rio Grande.

Detail of the study and results of the drainage are given under the head of Report on the Middle Rio Grande Valley as a Drainage Project.

At the request of the Chief Engineer of the U. S. Reclamation Service, the Drainage Report was submitted to a conference of engineers held in Denver, and I am advised by letter of October 22nd that the Drainage Report was incorporated in the program to be presented to the Secretary of the Interior, who is now preparing plans to assist the returning soldiers from France to labor and homes by an immense plan of drainage and reclamation.

RIO GRANDE COMMISSION FUND.

Fifth and Sixth Fiscal Years.

Appropriation	$2,500.00
Disbursements	1,117.55
Balance November 30, 1918	$1,382.45