No. 141, Original

In the

SUPREME COURT OF THE UNITED STATES

STATE OF TEXAS,

Plaintiff,

v.

STATE OF NEW MEXICO and
STATE OF COLORADO,

Defendants.

OFFICE OF THE SPECIAL MASTER

APPENDIX OF EVIDENCE IN SUPPORT OF STATE OF TEXAS'S NOTICE OF MOTION AND MOTION FOR PARTIAL SUMMARY JUDGMENT; MEMORANDUM OF POINTS AND AUTHORITIES IN SUPPORT THEREOF FEDERAL RULE OF CIVIL PROCEDURE 56

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APPENDIX OF EVIDENCE

Index No.	Description	Bates Beginning	Bates Ending
1	Declaration of Robert Brandes, P.E., Ph.D., and Attachments 1-3	TX_MSJ_000001	TX_MSJ_000016
2	**Attachment 1:** Resume	TX_MSJ_000017	TX_MSJ_000021
3	**Attachment 2:** National Resources Committee, Regional Planning: Part VI-The Rio Grande Joint Investigation in the Upper Rio Grande Basin in Colorado, New Mexico, and Texas 1936-1937, published in February 1938 (JIR)	TX_MSJ_000022	TX_MSJ_000600
4	**Attachment 3:** 2001 Report of the Rio Grande Compact Commission	TX_MSJ_000601	TX_MSJ_000656
5	Declaration of William R. Hutchison, Ph.D., P.E., P.G., and Attachments 1-4	TX_MSJ_000657	TX_MSJ_000669
6	**Attachment 1:** Resume	TX_MSJ_000670	TX_MSJ_000688
7	**Attachment 2:** Groundwater Modeling Experience in Texas	TX_MSJ_000689	TX_MSJ_000690
8	**Attachment 3:** Groundwater Modeling Experience Outside of Texas	TX_MSJ_000691	TX_MSJ_000692
9	**Attachment 4:** DataAnn sheet of Excel file named Ferguson Rebuttal_revised 9-15-20	TX_MSJ_000693	TX_MSJ_000695
10	Declaration of Staffan W. Schorr and Attachment 1	TX_MSJ_000696	TX_MSJ_000699
11	**Attachment 1:** Resume	TX_MSJ_000700	TX_MSJ_000703
12	Declaration of Theresa C. Barfield and Exhibits 1-2	TX_MSJ_000704	TX_MSJ_000705
13	**Exhibit 1:** State of New Mexico's Objections and Witness Designations to the United States' Notice of Rule 30(b)(6) Deposition and to State of Texas's Cross-Notice, 9/10/2020	TX_MSJ_000706	TX_MSJ_000728
14	**Exhibit 2:** State of New Mexico's Objections and Supplemental Responses to the State of Texas's First Set of Requests for Admission to the State of New Mexico	TX_MSJ_000729	TX_MSJ_000756

APPENDIX OF EVIDENCE

Index No.	Description	Bates Beginning	Bates Ending
15	Deposition Excerpts of John D'Antonio, 6/24/2020	TX_MSJ_000757	TX_MSJ_000788
16	Deposition Excerpts of John D'Antonio, 6/25/2020	TX_MSJ_000789	TX_MSJ_000812
17	Exhibit 3 to John D'Antonio Deposition 6/25/2020: Active Water Resources Management in the Lower Rio Grande (8/19/2005)	TX_MSJ_000813	TX_MSJ_000833
18	Deposition Excerpts of John D'Antonio, 6/26/2020	TX_MSJ_000834	TX_MSJ_000853
19	Deposition Excerpts of John D'Antonio, 8/14/2020	TX_MSJ_000854	TX_MSJ_000887
20	Deposition Excerpts of Peggy Barroll, 2/5/2020	TX_MSJ_000888	TX_MSJ_000925
21	Deposition Excerpts of Peggy Barroll, 2/6/2020	TX_MSJ_000926	TX_MSJ_000943
22	Deposition Excerpts of Peggy Barroll, 8/7/2020	TX_MSJ_000944	TX_MSJ_000959
23	Deposition Excerpts of Peggy Barroll, Rule 30(b)(6), 10/21/2020	TX_MSJ_000960	TX_MSJ_000988
24	Deposition Excerpts of Gary Esslinger, 8/18/2020	TX_MSJ_000989	TX_MSJ_001022
25	Intentionally Left Blank	TX_MSJ_001023	TX_MSJ_001050
26	Deposition Excerpts of Jorge Garcia, 2/6/2019	TX_MSJ_001051	TX_MSJ_001074
27	Deposition Excerpts of Estevan Lopez, 7/6/2020	TX_MSJ_001075	TX_MSJ_001097
28	Deposition Excerpts of Estevan Lopez, 7/7/2020	TX_MSJ_001098	TX_MSJ_001122
29	Deposition Excerpts of Estevan Lopez, Rule 30(b)(6), 9/18/2020	TX_MSJ_001123	TX_MSJ_001176
30	Deposition Excerpts of Ryan Serrano, 2/26/2019	TX_MSJ_001177	TX_MSJ_001242

APPENDIX OF EVIDENCE

Index No.	Description	Bates Beginning	Bates Ending
31	Exhibit 69 to Deposition of Ryan Serrano 2/26/20: Mesilla Valley Administrative Area Guidelines for Review of Water Right Applications, 1/5/1999	TX_MSJ_001243	TX_MSJ_001266
32	Deposition Excerpts of Ryan Serrano, 4/17/2019	TX_MSJ_001267	TX_MSJ_001288
33	Deposition Excerpts of Herman Settemeyer, 7/30/2020	TX_MSJ_001289	TX_MSJ_001312
34	Deposition Excerpts of Cheryl Thacker, 4/18/2019	TX_MSJ_001313	TX_MSJ_001343
35	Deposition Excerpts of Cheryl Thacker, 9/18/2020	TX_MSJ_001344	TX_MSJ_001393
36	Exhibit 1 to Deposition of Cheryl Thacker, 9/18/2020: Well Metering Requirements (Effective March 2006)	TX_MSJ_001394	TX_MSJ_001423
37	Deposition Excerpts of Adrienne Widmer, 2/5/2019	TX_MSJ_001424	TX_MSJ_001453
38	Exhibit 58 to Deposition of Adrienne Widmer, 2/5/2019: City of Las Cruces 40-Year Water Development Plan (April 2017)	TX_MSJ_001454	TX_MSJ_001531
39	Deposition Excerpts of Lee Wilson, 7/23/2020	TX_MSJ_001532	TX_MSJ_001550
40	Exhibit 2 to Deposition of Lee Wilson, 7/23/2020: State of New Mexico's Disclosure of Rebuttal Expert Witness	TX_MSJ_001551	TX_MSJ_001573
41	Figure 1: The Rio Grande basin	TX_MSJ_001574	TX_MSJ_001574
42	Figure 2: The Upper Rio Grande basin	TX_MSJ_001575	TX_MSJ_001575
43	Figure 3: Groundwater wells in New Mexico in 1938	TX_MSJ_001576	TX_MSJ_001576
44	Figure 4: Groundwater wells in New Mexico in 2020	TX_MSJ_001577	TX_MSJ_001577
45	Figure 5: Map of Rio Grande Project	TX_MSJ_001578	TX_MSJ_001578
46	Figure 6: Table 90 of the JIR	TX_MSJ_001579	TX_MSJ_001579
47	Figure 7: Illustration of a Gaining Stream (from Winter and others, 1988)	TX_MSJ_001580	TX_MSJ_001580

APPENDIX OF EVIDENCE

Index No.	Description	Bates Beginning	Bates Ending
48	Figure 8: Illustration of a Losing Stream (from Winter and others, 1988)	TX_MSJ_001581	TX_MSJ_001581
49	Figure 9: Illustration of a Disconnected Stream (from Winter and others, 1988)	TX_MSJ_001582	TX_MSJ_001582
50	Figure 10: Schematic of Rio Grande Groundwater System Interaction Prior to Development of Groundwater Pumping in Ricon and Mesilla basins	TX_MSJ_001583	TX_MSJ_001583
51	Figure 11: Schematic of Rio Grande and Groundwater System Interaction After Development of Groundwater Pumping in Rincon and Mesilla basins	TX_MSJ_001584	TX_MSJ_001584
52	Declaration of Scott Miltenberger, Ph.D., and Attachments 1-2 **Attachment 1:** Resume **Attachment 2:** Library of Documents Referenced in Scott A. Miltenberger Declaration (*Documents in the Library are hyperlinked in footnotes*)	TX_MSJ_001585	TX_MSJ_006491

Dated: November 5, 2020

Respectfully submitted,

s/ Stuart L. Somach

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Tab 52
Continued

area as has taken place in the past.

It is believed free operation of reservoirs in the Conejos area can be made without disturbing conditions reflected by the schedule. The principal need for reservoirs in this area is for seasonal regulation and not for carry-over storage. There would not result large accrued debits over a period of years by withholding substantial amounts of flood water in the reservoirs.

The lands irrigated from the Conejos River are situated along the river, or in such a position that return flow from those lands reaches and will continue to reach either the Conejos or the Rio Grande. It is believed with proper regulation of the Conejos, water consumption in the area might actually be less than at present, due to reduction in incidental evaporation.

OTHER PROVISIONS

Sump Drain. On page 12 in the agreement under "Other Limitations" appears this paragraph:

> "In event any works are constructed after 1937 for the purpose of delivering water into the Rio Grande from the Closed Basin in San Luis Valley, Colorado shall be credited with the amount of such water delivered, provided the proportion of sodium ions is less than 45% of the total positive ions in that water".

This has the effect of preventing Colorado from receiving credit for any water delivered to the river from the "sump" area proper, including water from San Luis Lake, since the sodium ions in the water of the sump area in general exceed 60% of the total positive ions in the water. The positive ions in the water of Soda Lake, one of the lakes that would be drained through the sump drain, are 100% sodium. While there is some question about the toxity of certain salts, yet there is no question about the

undesirability of the presence of sodium ions in irrigation water.

Since the question of the quality of water in the basin has been raised in a major way in connection with the Texas-New Mexico suit, it is felt that under no circumstances will Colorado be able to prevail upon the lower states to credit Colorado with water that is definitely poor water for irrigation purposes.

The above provision in the agreement will not prevent Colorado from getting credit for any water brought to the river from the "Closed Basin" immediately west of the sump proper, including water from Sand Creek, which now flows into San Luis Lake.

The first proposal of the Texas member of the committee included one similar to the above, and in addition, provided that any credits to Colorado would be reduced by three acre-feet for each ton of salt increase above 80,000 tons per year at Lobatos. This would have had the effect of preventing Colorado from accumulating any credits whatever, particularly under reservoir operation since it will be impossible for Colorado to operate reservoirs in accordance with present plans without increasing somewhat the salt content at the stateline.

After considerable discussion, the Texas member finally agreed that there should be no provisions whatsoever as to limitations of credits because of increased salt content at the stateline, and the writer agreed that no credit would be allowed to Colorado for poison water imported from the "Dead Area", the criterion being the limitation of sodium ions to 45% of the total positive ions. The following is quoted from a letter from Mr. Scofield regarding this matter:

"As I understand the objective of the quoted statement,

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I think it is fully justified by conditions in the Rio Grande Project, as well as in the Middle Valley, and not unfair to Colorado. I take it that the objective is not to prevent Colorado from constructing the Sump Drain or from discharging into the river any drainage water having a sodium percentage above 45. It is rather that because water having a higher sodium percentage is less desirable for irrigation use it is proposed not to allow credit for such contributions. I think the objective here involved is sound in principle and for its application at the head of the basin I do not believe the value of 45 percent is too low".

Normal Release from Elephant Butte Reservoir.

On page 9 of the agreement the normal release from Elephant Butte Reservoir was described as follows:

"Normal Release from Elephant Butte - is an average of 800,000 acre-feet per annum out of Elephant Butte Reservoir, adjusted for any gain or loss in usable water resulting from the operation of any reservoir below Elephant Butte; provided that this amount shall be reduced or increased by two-thirds of any change in aggregate diversions and loss to Mexico between Courchesne gaging station and the lowest point of diversion to lands of Rio Grande Project. In determining the amount of such change, the average annual diversion and loss to Mexico from 1928 to 1937, inclusive, shall be used as a basis."

The fixing of this item constituted one of the most difficult phases of the problem. The 800,000 acre-feet modified in accordance with the above provision is not out of line with the assumptions made by the engineers of the National Resources Committee as to proper releases from Elephant Butte, discussed on pages 291-304, inclusive, of Volume I of the Joint Report. The diversion requirements were estimated by two different methods. One method is summarized in Table 95 on page 302 of the Report, which indicates a total reservoir release of 773,000 acre-feet. By another analysis, a total demand on Elephant Butte Reservoir of 736,000 acre-feet was arrived at, the details of which are

given on page 303. In commenting on the results of the two analyses the report states as follows:

> "This demand on the reservoir of 736,000 acre-feet lacks 37,000 acre-feet of agreement with the corresponding demand of 773,000 acre-feet as derived in the previous analysis. If, in the 773,000 acre-feet derivation, no increase had been made in the mean net diversion figure of 564,000 acre-feet in accordance with the ratio of 145,000 acres, as the irrigated acreage of complete development, to 136,000 acres, the 7-year mean of irrigated acreage, the resulting summation for the demand on the reservoir would have been 737,000 acre-feet; a demand practically identical with that derived by the integration method using the Bureau of Agricultural Engineering estimates of unit consumption. Notwithstanding the implication of the foregoing, and in view of the fact that between 144,000 and 145,000 acres were actually irrigated in 1929, 1930, and 1931, and more than 142,000 in 1926 and 1928, it was considered that the required remand on the reservoir of 773,000 acre-feet should be used as a conservative estimate."

The 773,000 acre-feet is predicated upon the reduction of deliveries to Mexico to the Treaty provision of 60,000 acre-feet. This is explained on pages 291-292 of the Joint Report as follows:

> "Diversion Demand. The demand upon Elephant Butte Reservoir to be assured for the Elephant Butte-Ft. Quitman Section was considered to be that required by Rio Grande Project and fulfillment of the Mexican Treaty obligation under the conditions which will prevail upon completion of the American Diversion Dam and extension to it of Franklin Canal, a project now under construction. By this development the 60,000 acre-feet required to be delivered to the Mexican Canal will be released to the river below the new dam so that it may be diverted as at present by the International dam. All other river water (except local flood waters) will be diverted to Franklin Canal by the American Dam and carried to a point below the International dam where the water for Riverside, Hansen, and Tornillo canal headings will be spilled back to the river. Under this arrangement the Mexican diversion at the International dam will be definitely limited to 60,000 acre-feet, and, assuming that the estimates of diversions by Mexico in the past as given in Table 89 are reasonably correct, this means an average annual saving of about 70,000 acre-feet. In the section from Juarez to Tornillo Bridge there is another Mexican canal, San Augustine,

which heads above the Hansen and Tornillo headings and which will, therefore, still be in a position to divert from the river. It is a small canal, however, compared to the Acequia Madre at the International dam. The present opportunity for diversions by other Mexican canals at lower river points will not be changed, but any diversions below Tornillo Heading are from wastes and return waters. As the new arrangement makes no change in the delivery of water to Tornillo Heading via the river channel into which drainage is discharged above the heading, no change in the quality of the water diverted at this heading is to be anticipated."

Attention is called to the statement that by means of the new American Dam and Canal there will be an average annual saving of about 70,000 acre-feet of water in the deliveries to Mexico. If such a saving were made the normal release from Elephant Butte by the terms of the provisions contained in the engineers' agreement would become 800,000 acre-feet, minus two-thirds of 70,000 acre-feet, or about 753,000 acre-feet. This is 20,000 acre-feet less than assumed in the Joint Report as required, based upon the same assumptions as to deliveries to Mexico.

It is almost exactly the mean of the values arrived at in the Joint Report by the two methods of analysis, or the mean between 773,000 and 736,000 acre-feet.

There is no assurance that there will be a material reduction in diversions and loss to Mexico although it is reasonable to assume that an attempt will be made through the operation of the American Dam and Canal to limit deliveries to the treaty quantity of 60,000 acre-feet. However, the Mexican Government has constructed a riverside drain along the river in the Juarez area, which discharges into the old San Augustine Canal, the river heading of which has been abandoned. The effect of this drain upon the loss of water from the river is not known. It

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would be physically possible to increase the capacity of the Franklin Canal, which would permit of the abandonment of the River-side and Tornillo headings. In this way, Mexico could not encroach upon the water supply for the project. However, such a development would be expensive, the estimated cost of which varies between wide limits.

There is a difference of opinion also as to what the diversions and loss to Mexico from 1928-1937 were. Therefore, the fixing of the base figure of diversions for that period is one which was not done by the committee of engineers. It might be possible to analyze all existing data and decide upon a base value which would be used as a measure for future operation. It is understood that two new river stations are to be established between Courchesne and the Tornillo canal, which will permit of a more accurate determination of diversions and loss of water to Mexico. The operation of such stations over a period of years might make it easier to interpret past records, facilitating the determination of diversions and losses to Mexico for the period 1928-1937.

Attention is called to the fact that if diversions and losses to Mexico were increased, releases from Elephant Butte Reservoir under the terms of the agreement could be increased by two-thirds of the increase in diversions to Mexico. It seems that this is a fair provision in that the project should not be required out of current releases to take care of all increase in diversions to Mexico, if there be such increases.

Under the suggested provisions it does not seem logical that the project water users would be interested in seeing

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diversions to Mexico increase, because under such an arrangement there would be less water for the project than if the diversions were decreased, the water supply for the project being increased by one-third of any reduction in deliveries to Mexico and being reduced by one-third of any increase in such deliveries.

Attention is called to the fact that in the event of increased diversions to Mexico, one-third of such increase would be taken care of concurrently from project water, but under the suggested provisions no increase in deliveries by Colorado at the stateline would be required. In other words, Colorado would not be obligated to supply concurrently one-third of the increased diversions to Mexico, nor would the area in New Mexico above Elephant Butte Reservoir. The balance of the increased diversions to Mexico would come out of Elephant Butte spill, which might affect slightly, the increased uses of water that can be made in Colorado and New Mexico under the provisions of the agreement.

On the other hand, if the diversions and loss to Mexico are decreased, Colorado can concurrently reduce its delivery at the stateline by one-third of the decrease in such diversions and losses, or can receive credit concurrently for one-third of this quantity. This is taken care of by the last paragraph on page 12 of the agreement, which reads as follows:

> "In the event that the normal release from Elephant Butte is modified by any change in the amount of diversions and loss to Mexico, Colorado and New Mexico shall share equally therein, and the accrued credits or debits of each shall be adjusted annually by an amount equal to one-third of such change in diversions and loss to Mexico."

If the provision permitting Texas to call for debit water

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when the stage of Elephant Butte reservoir drops below 400,000 acre-feet is modified, as recommended hereinafter, the only time from 1890 to 1937 when Colorado would have benefited materially by a designated normal release from Elephant Butte reservoir smaller than 800,000 acre-feet, would have been in 1897 and 1898. Had the designated normal release been 750,000 acre-feet and diversions to Mexico had been as at present, Colorado would have had in storage unencumbered at the end of 1898 about 250,000 acre-feet of water available for consumption during the succeeding period of drought.

Had the designated normal release been 775,000 acre-feet this amount of unencumbered stored water would have been reduced to about 150,000 acre-feet and had the normal release been 800,000 acre-feet the full 250,000 acre-feet in storage in Wagon Wheel Gap reservoir would have belonged to Elephant Butte reservoir. The same situation could arise again during such a period as 1924 to the time of next spill from Elephant Butte reservoir, although it would not have occurred between 1924 and 1937.

Release of Stored Water To Take Care of Accrued Debits.

On page 12 in the engineers' agreement the following paragraph appears under "Other Limitations":

> "Neither Colorado, nor New Mexico, shall increase the amount of water in storage in reservoirs constructed since 1929 whenever there is less than 400,000 acre-feet of water in storage available for use in the Rio Grande project, and if this minimum stage is reached on January first of any year Colorado and New Mexico shall each release on demand, at the greatest rate practicable, water from reservoirs in an amount equal to the total debit of each which was caused by storage of water in reservoirs."

While this provision in principle was proposed by the

writer, both in his confidential memorandum of September 22, 1937, and in the proposal made by Colorado at Santa Fe, yet it is believed there should be some modification and clarification of the provision. The theory of the entire plan is to permit the accumulation of flood water in reservoirs above Elephant Butte Reservoir and the use of such water so long as this water otherwise would spill from Elephant Butte Reservoir. The whole plan was designed to permit the consumption of a portion of the present surplus water above Elephant Butte without adversely affecting the project below the reservoir.

The provisions of the agreement permit the accumulation of debits without limit so long as there is sufficient water in storage to supply those debits. In other words, when debits accrue by virtue of storage operation above the Elephant Butte Reservoir such debits constitute Elephant Butte water stored in upstream reservoirs.

The provision quoted above was designed to protect the lands under Elephant Butte Reservoir from shortage in water supply by withholding water which otherwise would have been stored in Elephant Butte. However, it appears to the writer at this time that the provision as written might, at times, make for waste of water and be contrary to the major premise upon which the plan embodied in the agreement was designed.

For example, Elephant Butte might drop below 400,000 acre-feet on January first of a certain year, and yet be able to supply during that year and succeeding years the normal release from the reservoir and finally, during a series of high years, spill. If, in the meantime, water equal to accrued debits from upstream

reservoirs had been released, such water would have the effect of increasing Elephant Butte spill and could not be regained by the reservoirs above Elephant Butte. The retaining in reservoirs above Elephant Butte of water which otherwise would be stored in that reservoir would be an advantage to the basin in that the loss of water by evaporation in those reservoirs would be less than in Elephant Butte.

It would appear that so long as such water is held available for release in case it is actually needed to insure the normal release from Elephant Butte Reservoir, this should provide sufficient insurance against injury by upstream operation.

It is recommended, therefore, that the provision quoted above be given further consideration, with an idea of so modifying it as to provide for releases of water only in sufficient amount to insure delivery during individual years of normal release from Elephant Butte Reservoir - the release of water, of course, not to exceed accrued debits.

RECOMMENDATIONS.

The following recommendations are directed mainly at changes in the text of the agreement, in some instances for purposes of clarification, and in others to bring the provisions of the agreement more in line with the intent behind present compact negotiations.

1. It is recommended that the allowable limit of accrued credits and debits in delivery of water at Lobatos, due to natural causes, be changed to 200,000 acre-feet.

2. The provision requiring release of debit water by upstream reservoirs in the event storage in Elephant Butte drops

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below 400,000 acre-feet should be changed to provide release of water only when necessary, and only in sufficient amounts to insure the normal release from Elephant Butte.

3. There should be fixed a base value to represent 1928 to 1937 delivery and loss of water to Mexico. Unless an amount substantially equal to that estimated by the engineers of the National Resources Committee for the period 1930 to 1936 can be agreed upon, the designated normal release from Elephant Butte Reservoir should be revised downward.

Colorado is more interested in substantial reductions in deliveries to Mexico from which can be obtained definite concurrent credits, than in material reduction of releases from Elephant Butte reservoir, the benefit from which would be uncertain and infrequent.

4. In connection with paragraph (c) on page 9 of the agreement there is a question whether or not Elephant Butte water users should not assume all losses which might accrue by the operation of Caballo Reservoir. Substantial benefit will be derived by them in the reduction in project construction cost repayments through the relinquishing to the Federal Government of all rights to power generated by virtue of Caballo Reservoir. Substantial flood control benefit will also accrue. Due to these benefits if Caballo causes a loss of water such loss should come out of the project supply.

5. Insert "actual" after "total" in first line, top of page 11 and after "minimum" in fourth line; insert "in that year" at the end of the second paragraph.

6. The first and second paragraphs under "Limitation of

Credits" on page 11 need clarification. As written, the provision might be interpreted to mean that only that part of credit accruals exceeding 100,000 acre-feet in the case of Colorado and 200,000 acre-feet in the case of New Mexico could be applied to offset debits caused by storage in reservoirs. The intent of the provision is that total credit accruals in whatever amount may be used for that purpose.

7. As a part of the definition of "Normal Release from Elephant Butte" there should be added some such provision as the following:

> "Water released from Elephant Butte Reservoir for the generation of power, which is not stored in a project reservoir for subsequent release for irrigation purposes shall be considered a part of the normal release."

8. It would be desirable to establish some criterion to determine possible changes in use between Lobatos and Otowi Bridge. Possibly a curve showing the relationship on a five year progressive mean basis of the flow at Lobatos, plus the Colorado at Questa, plus the Chama, to the flow at Otowi would serve this purpose. Such a curve would not form the basis for a schedule of delivery of water but would be used to determine any gradual increase in consumption that might take place in New Mexico above Otowi Bridge.

9. In the first line of the last paragraph on page 11 the word "actual" should be substituted for "unusable" and should be inserted before "spill" in the last line.

If, during a certain period, releases were greater than normal, eliminating spill which would otherwise have occurred under normal release, then under the definition of "unusable spill", and

the above cited paragraph as it now reads, upstream credits would be reduced by the amount of the spill which would have occurred under the normal releases. This would be unfair since the project would have received the benefit of the credit water through releases greater than normal.

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APPENDICES

TX_MSJ_005176

EXTRACTS FROM

"RESUME OF THE PROBLEM CONCERNING THE RIO GRANDE ABOVE FORT QUITMAN, TEXAS, BY R. J. TIPTON, JANUARY, 1935"

RESUME OF THE PROBLEM
CONCERNING THE RIO GRANDE ABOVE FORT QUITMAN, TEXAS

By R. J. Tipton

January, 1935

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The Problem

The Rio Grande River is an interstate and international stream, the use of which concerns the citizens of the States of Colorado, New Mexico, Texas, and the Republic of Mexico. The waters of the river above Fort Quitman, Texas, are largely consumed by irrigation in the three states and Mexico, only about 14 percent of the total production of the basin escaping from the basin unconsumed. A portion of the water, which passes out of the basin, consists of unusable return flow and unusable flood peaks, resulting from cloudbursts on the side streams below the Elephant Butte Reservoir.

According to the last (1930) United States census, about 550,000 acres of land are irrigated in Colorado on the Rio Grande and its tributaries, about 380,000 acres in New Mexico, and about 79,400 acres in Texas above Fort Quitman. About 171,000 acres of the land irrigated in New Mexico and Texas above Fort Quitman are under the Elephant Butte Reservoir. In addition, some 25,000 to 40,000 acres are irrigated in the Republic of Mexico by the water which is delivered to Mexico at the international dam at El Paso, under the Treaty which provides for delivery of 60,000 acre-feet per annum to Mexico.

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A small portion of the New Mexico development, no doubt, was initiated at a very early date by the Indians, or other aborigines living in the Rio Grande basin. A small portion of the Texas development began prior to 1890, as evidenced by the fact that the 1890 census report refers to a large ditch heading at El Paso and extending for some distance below, for the purpose of irrigating lands in that region. However, the major portion of the development in New Mexico and Texas took place after the construction of the Elephant Butte Reservoir was completed in the year 1915.

The first irrigation development in Colorado on the Rio Grande by white men was initiated in the early 1850's. Practically all of the large development was made between 1880 and 1890. Only two or three small canal systems, which irrigate in the aggregate less than 40,000 acres, have been constructed since that time. Practically all of these more recently constructed systems involved the consolidation of a number of older ditches. The reason that no recent major irrigation development has taken place in the San Luis Valley is because all of the streams of the Valley were over-appropriated by water rights initiated prior to 1890. This fact is mentioned in the early census reports. Immediately after the large development was made in the San Luis Valley in the 1880's, it became evident that reservoirs were necessary in order to control the water supplies and protect the water users against severe water shortages. However, due to a low cycle of runoff, which ovvurred in the 1890's, which brought to a head the difficulties between the Republic of Mexico and the United States over the Rio Grande, an embargo was placed upon

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the river in 1896 which prevented reservoir construction on the Rio Grande, both in Colorado and New Mexico, by the refusal of the Government to grant rights-of-way over public lands for the construction of such reservoirs. However, the Government did construct the Elephant Butte Reservoir, with capacity of 2,600,000 acre-feet, for the stated purpose of enabling the United States to deliver the 60,000 acre-feet per annum to Mexico, provided for in a Treaty which was signed in 1907.

As a part of the Elephant Butte Reservoir project, the Rio Grande reclamation project was initiated to use surplus waters stored and made available by the Reservoir. It was originally contemplated that 154,000 acres of land would be irrigated by this project, but the area has been increased by the addition of the so-called Tornillo unit, so at present the irrigated area in the project is about 162,000 acres. The Hudspeth District of about 13,000 acres also has been developed since 1925 to use waste waters from the Rio Grande project.

The major problem concerning the uses of the river, so far as Colorado is concerned, is the same as it was in the 1890's, viz., the provision of sufficient storage capacity to make the flow of the stream parallel with the irrigation demand for the lands that are now irrigated and for which the irrigation works were provided prior to 1890. The construction of such necessary storate as has been indicated was impossible, due to the embargo that was placed upon the river until such embargo was lifted in 1925. However, since that time, the construction of reservoirs on the Rio Grande in Colorado has been vigorously resisted by the States of New Mexico and Texas, the representatives

TX_MSJ_005180

of these states feeling that major reservoir development in Colorado would deplete the flow of the stream to such an extent as to jeopardize the water supply of the lands that are irrigated in New Mexico and Texas. The representatives of these states have alleged also that depletion of the water supplies of the river by increased use in Colorado, since the initiation of the Elephant Butte Reservoir, has already progressed to the point that severe shortages would occur on the Rio Grande project during cycles of low stream flow. During past compact negotiations, the representatives of New Mexico and Texas have insisted that the state line outflow, as it existed during these negotiations, should not be changed in any way by the Colorado water users. They not only insist that the yearly flow should remain the same, but that monthly regimen should not be disturbed. However, these representatives have conceded that increased uses of water could be made in Colorado in an amount equal to water which might be recovered to the stream by future drainage development. No increased uses of water in Colorado can be made under present conditions without more storage development, and such development necessarily would have to be in a substantial amount as compared with the additional amount of water that would be made available for use. It has been the position of the representatives of Colorado that the required major reservoir development could be made on the Rio Grande in Colorado to equalize the water that is now being used, and that this would not result in any substantial increased depletion of the flow across the state line, and that the reservoir construction in conjunction with drainage

TX_MSJ_005181

development might make for an increased flow at the state line.

The stream flow records indicate that from 1890 to 1934, inclusive, the average annual water production in the San Luis Valley was about 1,560,000 acre-feet, about 240,000 acre-feet of which originate in the so-called Closed Basin, and about 1, 320,000 acre-feet originate in the Live Area. Consumptive use studies conducted by the state indicate that the consumptive use in the San Luis Valley, by lands that are artificially drained, is about 1.3 acre-feet per acre. Assuming 550,000 acres of land to be irrigated in the region, about 760,000 acre-feet of water per annum is beneficially consumed. Depletion studies indicate that the mean annual flow at the state line, under present conditions of development for a period such as 1890 to 1934, would be about 470,000 acre-feet. Therefore, of the 1,560,000 acre-feet of total water production in the Valley, 1,230,000 acre-feet are accounted for by beneficial consumptive use, and outflow across the state line, leaving 330,000 acre-feet of water that is non-beneficially consumed, a portion of which would be recoverable by drainage construction. A portion of the undue consumption results from the method of irrigation that it is necessary to practice in the San Luis Valley, due to the lack of proper storage facilities to make the flow parallel with the demand. It is on account of the above facts that it has been felt that provision of proper storage facilities in the San Luis Valley coupled with necessary drainage construction would not result in increased consumption of water in the Valley.

TX_MSJ_005182

However, it is evident that the operation of large reservoirs in the Valley necessarily would result in a material change in the yearly outflow at the State Line, although over a period of years the mean flow might not be materially changed. In order that reservoirs should be effective, flood flows in wet years must be stored and, in some cases, carried over for a period of years to take care of deficiencies that otherwise would result in years of low flow. The State Line outflow by this process would be depleted in years of high flow, but would be augmented during years of low flow. Such operation should not be materially detrimental to the water supply for the lands under the Elephant Butte Reservoir, except possibly during protracted periods of drouth.

Due to the interstate and international controversies over the uses of the waters of the Rio Grande, which have prevented the construction of necessary reservoirs in the San Luis Valley, the lands irrigated there, the development of which was made prior to 1890, must depend upon the run of the streams for their water supply, as a result of which seasonal water shortages occur practically every year and severe annual shortages occur frequently. The recurrence of a cycle of low runoff such as prevailed from 1890 to 1904 would mean the temporary abandonment of a substantial portion of the irrigation development in the San Luis Valley, and the migration of some of the irrigators of the Valley, the same as happened during the latter portion of the 1890-1904 period of low runoff. On the other hand, the Elephant Butte Reservoir, with a capacity of 2,600,000 acre-feet was constructed by

TX_MSJ_005183

the United States Government to provide a perfect water supply year after year for lands, the irrigation of which commenced long after the development of the lands in the San Luis Valley. The most pessimistic investigator, using the most conservative methods of calculation, can find but two years from 1894 to date when a shortage in the water supply for the lands under the Elephant Butte Reservoir would have occurred. From the standpoint of equity, it would seem the Colorado development should be placed on a parity with the New Mexico and Texas development, so far as an assured dependable supply of water is concerned, particularly since the former development is senior to the major protion of the latter. It appears also that the water could be properly regulated for the Colorado lands without materially affecting the water supply for the downstream land.

The interstate problem in the San Luis Valley concerns in general only the Rio Grande above Alamosa, and the Conejos River and its tributaries, and the Closed Basin insofar as water from it can be made tributary to the Rio Grande. The waters of the southwest area, viz., the Trinchera, Culebra, and Costilla basins are largely consumed, and the streams in that area in general have adequate reservoir development. While some minor storage development will be necessary on some of the streams of the Closed Basin, particularly if the present predominating crop of native hay in that area is changed to high priced row crops, such development will not affect interstate relations, since the Closed Basin contributes no water to the Rio Grande, Alamosa River and La Jara Creek are fully developed so far as reservoirs are concerned. Therefore, the only reservoir development in the San Luis Valley, that would affect

TX_MSJ_005184

the flow across the State Line, would be on the Rio Grande proper and on the Conejos, where it is most needed. Also the Rio Grande, plus the Conejos River proper, produces 73% of the total water originating in the Live Area, and the flow of the Rio Grande and Conejos, and its tributaries, accounts for 83% of the flow across the State Line.

The following discussion gives the conclusions of the studies that have been made to date, covering some of the above points, including -

1. Depletion of water supplies by irrigation development in the San Luis Valley;

2. Necessary reservoir development in the San Luis Valley;

3. Effect of Reservoir development in the San Luis Valley on the water supply for the lands under the Elephant Butte Reservoir;

4. Consumptive use in the San Luis Valley, and probable production of future drains;

5. Conejos River;

6. Difficulties in connection with the consummation of a plan of development for the San Luis Valley.

TX_MSJ_005185

NOTE:

There follows in the original text twenty-eight pages of discussion of the foregoing subjects, accompanied by eight tables. Only the discussion of the last subject is submitted herein in full.

With respect to the other subjects, the following conclusions were reached:

Depletion of Water Supplies by Irrigation Development in the San Luis Valley.

(a) Depletion increased rapidly from 1890 to 1901 and then declined due to the low water supply during that period.

(b) The water supply began to increase in 1905 but resumption of development lagged behind several years.

(c) Depletion in the Live Area reached an estimated peak of 911,000 acre-feet in the period 1924 to 1930. Since that time depletion has decreased, due to the declining water supply.

(d) No records of the runoff of the Rio Grande are available prior to 1890. Therefore, no estimate can be made of depletion prior to that date. If the runoff was high the depletion may have approached the present amount.

Necessary Reservoir Development in the San Luis Valley.

(a) The minimum annual diversion requirement between Del Norte and Alamosa was estimated at 600,000 acre-feet, if properly regulated.

(b) Water supply was inadequate either in quantity or seasonal distribution, or both, for each year of record, 1890 to 1904, to supply such a requirement. Seasonal shortages varying from 9,000 acre-feet to 417,000 acre-feet occurred.

(c) To provide a regulated seasonal supply of 600,000 acre-feet

TX_MSJ_005186

for each year, 1890 to 1934, would require 1,300,000 acre-feet of reservoir capacity.

(d) Wagon Wheel Gap Reservoir, with a capacity of 1,000,000 acre-feet, plus existing reservoirs, would take care of the above requirement for all years except 1901, 1902, and 1904, when shortages of 9,000 acre-feet, 375,000 acre-feet, and 157,000 acre-feet would have occurred.

Effect of Reservoir Development in the San Luis Valley on the Water Supply for the Lands Under the Elephant Butte Reservoir.

It was concluded from detailed analyses that:

> "The major reservoir development necessary on the Rio Grande in the San Luis Valley could be made without materially affecting the water supply of the Elephant Butte Reservoir, and this is particularly true if drainage development were made in conjunction with the reservoir development. The drainage development together with the reservoir development would make for a better water supply to the Elephant Butte, even though over a long period of years the mean annual outflow at the state line remained the same. This is true because the outflow during years of low water supply at the present time would be increased by the increased drainage return, and such drainage return would be fairly constant, because the diversions would be uniform from year to year."

Effect of Reservoir Development in the San Luis Valley on the Water Supplies for the Middle Rio Grande Conservancy District.

It was concluded that the necessary reservoir development in the San Luis Valley would not adversely affect the water supply of the Middle Rio Grande Conservancy District, but probably would improve it. The effect of reservoir and drainage development in the San Luis Valley would be to reduce the flow of water in April, May, and June which, at present, is high and considerably in excess of the requirements of the Middle Rio Grande lands, and to increase the supply in July, August, and September, during which time it is deficient at present. During years of low water supply, such as 1901, 1931, and

TX_MSJ_005187

1934, under the proposed development in the San Luis Valley, the entire flow during the irrigation season, subject to use by the Middle Rio Grande area, will be improved.

The above conclusions were supported by detailed tables showing the estimated water supply for the Middle Rio Grande before and after the proposed development in the San Luis Valley, and showing also the operation of El Vado Reservoir under these two conditions.

Consumptive Use in the San Luis Valley, and Probable Production of Future Drains.

It was concluded that the consumptive use of river water in the San Luis Valley on well drained lands is 1.2 acre-feet per acre and that about 300,000 acre-feet of water per year is being non-beneficially consumed by evaporation, a portion of which is subject to recovery to the river by drainage construction.

It was concluded that the probable water recovery that would result from the construction of the sump drain, prior to the construction of the drainage works to connect with such a drain, would range between 30,000 and 50,000 acre-feet per year.

Conejos River

It was concluded that the present rate of consumption in the Conejos area is about 2.58 acre-feet per acre and that this high indicated consumption is due to the distorted manner in which this water is used. It was concluded that with proper reservoir operation the lands now irrigated could be adequately watered, and there would be no increased depletion of the watered supply stream but probably an accretion.

There follows the original text covering the last subject.

TX_MSJ_005188

Difficulties in Connection with the Consummation of a Plan of Development for the San Luis Valley

The difficulties that would be encountered in providing proper reservoir capacity for the San Luis Valley, other than financial, which will not be discussed here, are both inter and intra-state in character.

Due to the past attitude of the representatives of New Mexico and Texas, it is felt that they will not accede to any plan of development in the San Luis Valley, which would have to do with the storing of additional water, unless a guarantee is made of stateline delivery. Such guarantee on a monthly basis, which has been insisted upon in the past, and even on a yearly basis, would defeat the purpose of storage development and could not be agreed to. It is conceivable that the lower states' representatives, might consider a plan whereby diversions were limited to a certain amount and a certain yearly return flow guaranteed. Such plan might not meet with favor by the water users of the San Luis Valley.

From an intra-state standpoint, even though an agreement were reached between the states either to limit diversions or guarantee a certain stateline deliverym the terms of such an agreement at present could not be enforced in Colorado, in view of the State Supreme Court decision, concerning the La Plata River Compact. To limit diversions would require the curtailment of diversions by some ditches during

TX_MSJ_005189

periods when the water would be naturally in the stream for them, unless the aggregate diversions agreed upon exceeded the capacity of all the ditches. The diversions of such an amount of water obviously would not be agreed to by the lower states. The only way, apparently, that the terms of an agreement between the states could be carried out, insofar as Colorado is concerned, would be by the mutual consent of all the interested water users in the San Luis Valley, or by the formation of a district, and the pooling of all water by the interested users to be stored and regulated by the district.

The entire problem is complicated and involved, and, due to the fact that most of the water users on the stream in all three states are entirely uninformed concerning conditions on the river, it is believed that, before an agreement can be reached that will be satisfactory to all interested parties, considerable educational work must be done in order that the water users in the San Luis Valley may be more fully advised of their requirements and limitations that they might safely impose upon themselves, together with certain guarantees that might be safely made to the lower states, and in order that the water users of the lower states and their representatives might be fully advised as to the effect the necessary and proposed development in the San Luis Valley will have upon the water supply.

TX_MSJ_005190

"SUGGESTIONS FOR THE BASIS OF A COMPACT
BETWEEN THE STATES OF COLORADO, NEW MEXICO, AND TEXAS,
COVERING THE USES OF THE WATERS OF THE RIO GRANDE
BY R. J. TIPTON, SEPTEMBER 22, 1937"

TX_MSJ_005191

CONFIDENTIAL

SUGGESTIONS FOR THE BASIS OF A COMPACT BETWEEN THE STATES OF COLORADO, NEW MEXICO, AND TEXAS

Covering the Uses of the Waters of the Rio Grande

By R. J. Tipton, Consulting Engineer
September 22, 1937

1. General - It should be recognized that the formulation of a compact between the three states of Colorado, New Mexico and Texas is impossible unless the present legitimate uses of water in the three states are protected by the provisions of the compact, and that no increased uses in either of the three states would be permitted that would encroach upon the legitimate uses of water in either of the other states.

The primary need in the San Luis Valley is the provision of storage to regulate the water that is being used at present to make the flow more nearly parallel with the demand. Studies made by the State of Colorado in the past have indicated that such storage could be provided without materially affecting adversely water uses in the lower basin. As a matter of fact, such studies indicated that some benefit would accrue to the Middle Rio Grande area by the proper regulation of water in the San Luis Valley (See "Resume of the Problem Concerning the Rio Grande above Fort Quitman, Texas, January 1935). These conclusions now have been substantiated by the study made by the National Resources Committee in connection with the Rio Grande Joint Investigation (see pages 372 - 402 inclusive of Part 1, Volume 1, of "Rio Grande Joint Investigation in the Upper Rio Grande Basin in Colorado, New Mexico, and Texas, 1936-1937"). Particular attention is called to Tables 115 and 116 which show the effect on the Middle Rio Grande and Elephant Butte-Fort Quitman

sections respectively under various assumed conditions of development in the San Luis Section.

Table 115 indicates the benefit the Middle Rio Grande Section would receive from storage development in the San Luis Section. Table 116 shows the Elephant Butte-Fort Quitman Section would not be affected very materially by storage development in the San Luis Valley. In the text of the report it is concluded that the additional shortage in the Elephant Butte-Fort Quitman Section, occurring in only three out of forty-eight years, would be due to increased use in the Middle Rio Grande Section rather than due to storage development in the San Luis Section.

However, it is probable that the water users in New Mexico and Texas will continue to feel that if required storage in the San Luis Section is provided the flow of the Rio Grande at the State Line would be depleted to the extent that severe shortages will result in New Mexico and Texas. In the past, representatives from these two states have been insistent that a State line delivery be guaranteed by Colorado to insure against such depletion.

The following is an outline of the basis of a compact providing for a State line delivery which it is believed will permit the needed development in the San Luis Valley on the one hand, and which on the other hand, will protect the present legitimate uses of water in New Mexico and Texas.

2. Proposed State Line Delivery by Colorado as a Basis for a Compact

The flow of the Rio Grande at Del Norte, plus the flow of the Conejos at Mogote, constitutes about 75% of the water production of the Live Area in the San Luis Valley. The flow of the Rio Grande

TX_MSJ_005193

at Lobatos represents the outflow from the San Luis Valley into New Mexico. It is proposed that the relation between the flow at Lobatos and the combined flow of the Rio Grande at Del Norte and the Conejos at Mogote, for the period 1928 - 1935 inclusive, shall be taken as the measure of the outflow from the San Luis Valley under present conditions and that the state line delivery shall be made in accordance with such relation. The relation between the above flows, as determined from the National Resources Committee report, is shown on the attached graph, Plate No. 1, and by the following table:

TABLE 1

Relation Between the Combined Flow of the Rio Grande at Del Norte and the Conejos at Mogote, and the Rio Grande at Lobatos. Values are in thousand acre feet.

Combined Flow	Rio Grande at Lobatos
150	0
300	50
400	100
500	140
600	180
700	240
800	300
900	360
1000	420
1100	480
1200	560
1300	630
1400	730

It is proposed that delivery at the State line, in accordance with the above table, shall not be required on a yearly basis, but that credits and debits be allowed to accumulate over a period of years subject to the following conditions.

At any time when accumulated debits exceed the unfilled capacity of Elephant Butte Reservoir that portion which is in excess of the unfilled capacity shall be written off. Accumulated credits shall be reduced by the amount of actual spill from the Rio Grande

project storage during the periods when spill occurs. "Spill" as defined herein shall not include waters lost to the project that originate below the Rio Grande project storage. The mean required release from Elephant Butte Reservoir shall be considered as 771,000 acre feet per year. This is the amount assumed in the report of the National Resources Committee.

In calculating the Colorado debits, the cumulative debits shall be reduced by an amount that the total releases of the Elephant Butte Reservoir or other project reservoirs exceed the necessary releases, as defined above. In the event that the contents of the Elephant Butte Reservoir, plus the contents of other project storage reservoirs, shall drop below 500,000 acre feet on April first of any year, and Colorado owes water to the river, the amount owed shall be released from reservoirs constructed after the signing of the compact and delivered at the State line. The area in New Mexico, including the Middle Rio Grande, shall agree not to deplete the flow of the river at San Marcial. Any accumulative shortage in the river flow at that point caused by water uses above Elephant Butte in New Mexico shall be supplied from storage in that area should the contents of Elephant Butte Reservoir drop below the amount specified above.

3. Stateline Delivery as it Affects the Necessary Development in the San Luis Valley

It is believed the above plan, if put into effect, would permit of the construction and operation of the necessary storage in the San Luis Valley. The general effect of storage in the San Luis Valley will be to deplete the flow of the river at the stateline during years of high runoff and to make for more water in the river at the stateline during years of low runoff. Debits, therefore, would accumulate in years of high runoff, when, under the above

assumed draft on the Elephant Butte Reservoir, spill from the reservoir would finally result. Credits to Colorado would accumulate during years of low runoff when the Elephant Butte Reservoir would be low. Table 109, page 387, of Part 1, Volume 1 of the Rio Grande Investigation report indicates the estimated annual runoff of the Rio Grande near Lobatos under various assumed conditions of storage and irrigation draft in the basin.

Condition No. 4 was based on the construction of the Wagon Wheel Gap Reservoir; a draft of 650,000 acre feet per annum on the river between Del Norte and Alamosa, and a return flow of 16% of the diversions. Condition No. 2 represents present conditions on the river. Therefore, the difference between the values in columns under Condition 2 and Condition 4 in Table 109 indicates the debits and credits to the San Luis Valley that would accrue by virtue of the operation of Wagon Wheel Gap Reservoir under the assumed conditions.

It will be noted that Table 109 covers two periods - 1892 to 1904 and 1911 to 1935. The former period includes the period of very low runoff on the river from 1895 to 1904 inclusive. No critical period occurred between 1904 and 1911. The period 1911 to 1935 inclusive includes the recent period of low runoff.

The following table indicates the credits and debits which would result from the operation of the Wagon Wheel Gap Reservoir, based on the assumptions under Condition 4. The first column indicates the year, the second column indicates the yearly credit or debit, and the third column indicates the accumulative credits or debits.

TX_MSJ_005196

TABLE NO. 2
Estimated Credits and Debits in Stateline Delivery
Under Condition Four
Values in 1000 Acre Feet

Year	Annual Credit or Debit	Cumulative Credit or Debit
1893	67	67
93	69	136
94	58	194
95	66	260
96	37	297
97	-116	181
98	1	182
99	29	211
1900	32	243
01	42	285
02	18	303
03	-59	244
04	-94	150
1911	-350	-350
12	95	-255
13	20	-235
14	-44	-279
15	25	-254
16	-88	-342
17	-5	-347
18	36	-311
19	-13	-324
1920	6	-318
21	113	-205
22	201	-4
23	-63	-67
24	218	151
25	-41	110
26	41	151
27	-158	-7
28	164	157
29	-93	64
1930	91	155
31	26	181
32	-32	149
33	40	189
34	41	230
35	-49	181

It will be noted that during the period of 1892-1904 there would have been no time when water would have had to be released from Wagon Wheel Gap Reservoir to take care of an accumulated debit. For the period 1911-1935 during the high years of runoff, debits accumulated to a maximum amount of 350,000 acre feet. During such a

TX_MSJ_005197

period, and under the conditions assumed above, Elephant Butte Reservoir would be spilling frequently. (See Table No. 6, page 20 of "Resume of the Problem Concerning the Rio Grande Above Fort Quitman, Texas"). There is not at hand the detailed operation of Elephant Butte Reservoir as worked out in connection with the Rio Grande Joint Investigation, but it is assumed that there would be spill during the same period as indicated in Table No. 6, probably in amounts greater than indicated in that table, since the demand on the reservoir was less than was assumed in Table No. 6. The indicated debits from 1911 - 1923, therefore, would be entirely eliminated by spill from Elephant Butte Reservoir.

At the end of the recent period of low runoff there would have been a credit to Colorado of 181,000 acre feet; so that during this period no releases would have had to have been made from storage in Colorado to satisfy the statline delivery.

It is concluded, therefore, if the return flow from diversions in the section Del Norte to Alamosa, as assumed by the National Resources Committee, is correct, the Wagon Wheel Gap Reservoir could have been operated freely from 1892 - 1935 under the plan proposed above without having to have released water to satisfy a debit at the statline.

Table 111, Part 1, Volume 1 of the Rio Grande Joint Investigation report indicates the estimated runoff of the Conejos River at its mouth under various assumed conditions. Under condition No. 6 storage in the amount of 162,000 acre feet on the Conejos and an average annual draft of 230,000 acre feet are assumed. The values in the second column of Table 111 represent the flow of the Conejos at the mouth under present conditions. Therefore, the difference between the values in this column and the values in the column labeled "Condition

TX_MSJ_005198

period, and under the conditions assumed above, Elephant Butte Reservoir would be spilling frequently. (See Table No. 6, page 20 of "Resume of the Problem Concerning the Rio Grande Above Fort Quitman, Texas"). There is not at hand the detailed operation of Elephant Butte Reservoir as worked out in connection with the Rio Grande Joint Investigation, but it is assumed that there would be spill during the same period as indicated in Table No. 6, probably in amounts greater than indicated in that table, since the demand on the reservoir was less than was assumed in Table No. 6. The indicated debits from 1911 - 1923, therefore, would be entirely eliminated by spill from Elephant Butte Reservoir.

At the end of the recent period of low runoff there would have been a credit to Colorado of 181,000 acre feet; so that during this period no releases would have had to have been made from storage in Colorado to satisfy the statline delivery.

It is concluded, therefore, if the return flow from diversions in the section Del Norte to Alamosa, as assumed by the National Resources Committee, is correct, the Wagon Wheel Gap Reservoir could have been operated freely from 1892 - 1935 under the plan proposed above without having to have released water to satisfy a debit at the statline.

Table 111, Part 1, Volume 1 of the Rio Grande Joint Investigation report indicates the estimated runoff of the Conejos River at its mouth under various assumed conditions. Under condition No. 6 storage in the amount of 162,000 acre feet on the Conejos and an average annual draft of 230,000 acre feet are assumed. The values in the second column of Table 111 represent the flow of the Conejos at the mouth under present conditions. Therefore, the difference between the values in this column and the values in the column labeled "Condition

TX_MSJ_005199

No. 6" indicates the credit or debit to the Conejos area by virtue of the operation of the assumed reservoir on the Conejos River. These credits and debits are indicated in the following table:

TABLE NO. 3
Estimated Credits and Debits to the Conejos Area in Connection with a Stateline Delivery under Condition No. 6.

Year	Annual Credit or Debit	Cumulative credit or debit
1911	-89	
12	66	-89
13	33	-23
14	-43	10
15	-6	-33
16	-14	-39
17	42	-53
18	24	-11
19	14	13
1920	-46	27
21	27	-19
22	12	8
23	-27	20
24	29	-7
25	14	22
26	9	36
27	-32	45
28	60	13
29	-20	73
1930	60	53
31	55	113
32	-102	168
33	32	66
34	51	98
35	-112	149
		37

The table indicates that storage on the Conejos in an amount of 162,000 acre feet could have been operated to provide an annual diversion of 230,000 acre feet and that no releases would have been necessary to satisfy a stateline debit under the above plan.

It may be that the National Resources Committee over-estimated the return flow which would come to the river between Alamosa and Del Norte. However, another condition was assumed involving a return of only 8% of the diversions. This condition is described on page 377 of Part 1, Volume 1 of the Joint Investigation report as follows:

Condition No. 5

"The items of this Condition are exactly the same as for Condition No. 4 except that the return flow to Rio Grande in San Luis Valley is taken as 8 per cent only of the total Rio Grande diversions in the Valley. Although, as described in the development of the diversion demand for the Rio Grande Area of San Luis Valley, the return flow has averaged better than 16 per cent in the 3 years 1934, 1935, and 1936, and this amount of return is considered to represent very conservatively that to be anticipated in the future, there are a number of years in the period previous to 1934, for which data are available when the return, as indicated by Table 36 was less than 16 per cent. The average for the period 1928 to 1936, inclusive, for the return above Alamosa is 7.6 per cent of total diversions above Alamosa. Because this return flow is such an important item in the water available to lower sections, and because the allowance for it constitutes one of the fundamental assumptions of the analyses, a return of 8 per cent, as a minimum remotely possible but not probable was used in certain of the analyses."

The estimated flow at the stateline under condition 5 with the Wagon Wheel Gap Reservoir constructed and operated to supply an annual draft of 650,000 acre feet is indicated in table 110 of the National Resources Committee report. An analysis of the credits and debits that would accrue to the San Luis Valley under this condition indicates releases from Wagon Wheel Gap reservoir would have been required in only two periods, from 1892 to 1935, to satisfy an accumulated debit at the stateline. The first period would have been in the early 1900's and the second period about 1935.

Therefore, even under the improbable condition of only 8% of the diversions returning to the river between Del Norte and Alamosa and the Wagon Wheel Gap Reservoir operating under draft of 650,000 acre feet per annum there would have been only two periods in 48 years when releases would have had to have been made from Wagon Wheel Gap Reservoir to take care of a stateline delivery, as out-

lined above
It is concluded that the San Luis Valley could enter into a stateline agreement in accordance with the above outline without affecting seriously the construction and free operation of the necessary storage in the San Luis Valley. Even under a condition of an annual draft on the Rio Grande above Alamosa of 750,000 acre feet, which is in excess of the mean annual flow of the stream, and an annual draft of 230,000 acre feet on the Conejos River, which is in excess of the mean annual flow of that river with the Vega Sylvestre Reservoir to Wagon Wheel Gap and Conejos Reservoirs constructed, all of which is represented by condition No. 10, the National Resources Committee found no serious effects on the water supply of the lower sections.

4 The Suggested Compact Plan as it Would Affect Uses of Water in the Middle Section

The necessary reservoir development in Colorado would not adversely affect the water supplies for the Middle Rio Grande Conservancy District, but probably would improve it. The major portion of the water supply of the Middle Rio Grande Conservancy District consists of direct flow water passing Buckman, New Mexico. In general, during the months of April, May, and June the amount of water in the stream at this point is considerably in excess of the requirements of the lands of the Middle Rio Grande Conservancy District, while during most years the supply during July, August, and in some cases September, is deficient to meet the requirements, as defined by the engineers for the Middle Rio Grande Conservancy District. The deficiencies occurring in these months are to be made up by releases from the El Vado Reservoir. The effect of reservoir development in the San Luis Valley will be to reduce the

flow of water in April, May and June, which at present is high and considerably in excess of the requirements of the Middle Rio Grande lands, and to increase the supply in July, August and September during which time it, at present, is deficient.

During years of low water supply, such as 1902, 1931 and 1934 under the proposed development in the San Luis Valley, the entire flow during the irrigation season at Buckman will be improved. This is true since the total flow of the Rio Grande in Colorado during low years is diverted and, due to the deficiency in the supply, the available return flow susceptible of development by drainage construction is small. Under the proposed development, the normal amount of water would be diverted during years of low water supply, by virtue of its being made available by carrying over the surplus water of years of high flow in the proposed reservoirs. Since the diversions during the years of low supply would be normal, the return flow would be normal, which would make for a greater direct flow supply during those years for the Middle Rio Grande Conservancy District.

The above conclusions were reached from studies made by the State of Colorado summarized in "Resume of the Problems Concerning the Rio Grande above Fort Quitman, Texas". These conclusions are substantiated by the National Resources Committee in Volume 1, Part 1 of the Joint Report. See Table 115. It will be noted from that table that under all assumed conditions of storage development in the San Luis Valley conditions would be improved in the Middle section and indicated shortages which would occur infrequently under present conditions would be somewhat relieved.

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5. The Suggested Compact Plan as it Would Affect Uses of Water in the Elephant Butte - Fort Quitman Section

The plan suggested above guarantees the Elephant Butte-Fort Quitman section against any shortage which might be occasioned by storage development in the San Luis Valley. The only objection that might be raised by this section is the limitation of releases from Elephant Butte Reservoir to 773,000 acre feet per year. However, there should be no objection to this since, when the All American Canal is completed near El Paso the Rio Grande project would get more water from a release of 773,000 acre feet than it has received in recent years.

Table 89, page 287 of the Joint report indicates that an average of 130,900 acre feet of water per annum was diverted by Mexico between Juarez and Tornillo Bridge from 1930-1936 inclusive. An additional 46,000 acre feet average annual amount of water was diverted by Mexico for this period between Tornillo Bridge and Fort Quitman, Texas. There was diverted by Mexico, therefore, for the period 1930-1936 inclusive 116,900 acre feet more than provided for in the Treaty.

The following table indicates the effect on the Rio Grande project of eliminating the over diversion by Mexico and limiting releases from Elephant Butte Reservoir to 773,000 acre feet, without taking into account the over diversion by Mexico between Tornillo Bridge and Fort Quitman.

Values in 1000 Acre Feet

Year	Actual release from Elephant Butte Reservoir	Diversion by Mexico	Over Diversion by Mexico	Net Amt. Orig. Supply left in River for Rio Grande Project	Add. Amt. that would have been rec. by proj. with release of 773,000 a.f and All Amer Canal in operation
1	2	3	4	5	6
1930	793.6	102.9	42.9	750.7	
31	750.6	111.9	51.9	698.7	22
32	831.8	153.5	93.5	738.3	74
33	826.8	152.1	92.1	734.7	35
34	803.9	135.6	75.6	728.3	38
35	636.6	151.3	91.3	545.3	45
Means	773.9	134.5	74.5	699.4	328
					73.6

It may be noted that from the above table under the conditions assumed the Rio Grande project would have received annually 74,000 acre feet more water than it did under actual operation from 1930-1935. Therefore, there should be no basis for objection to the 773,000 acre feet as a proper amount of annual release from project storage.

6. Administration of the Suggested Compact in Colorado

Under the above proposal only reservoirs constructed in the future in the San Luis Valley would be required to make up debits at the stateline if, and when necessary. It is believed the rights accruing to such reservoirs from the State could be made subject to theprovisions of such compact, and there would be no question involved of the invasion of vested water rights to satisfy the terms of the compact.

The Rio Grande area proper and the Conejos area should be considered separately with respect to credits and debits at the stateline. A good relation exists between the flow of the Conejos River at Mogote, the San Antone and Los Pinos at Ortiz and the flow of the Conejos River at its mouth. This relationship could be set up as a proper measure of delivery of water from the Conejos area to the stateline and credits and debits to the area could be calculated on the basis of this relationship. The relationship between the flow of the Rio Grande at Del Norte and at Alamosa could be used to determine credits and debits accruing to the Rio Grande area

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"STATEMENT OF THE VIEWS (OF COLORADO) AS TO THE ESSENTIALS FOR A PERMANENT COMPACT ON THE RIO GRANDE" SUBMITTED AT SANTA FE, SEPTEMBER 28, 1937.

TX_MSJ_005206

STATEMENT OF THE VIEWS AS TO THE ESSENTIALS FOR A PERMANENT COMPACT ON THE RIO GRANDE,

Submitted by

The Commissioner for Colorado at the Conference of the Rio Grande Compact Commission at Santa Fe, New Mexico, September 28, 1937.

Article VII of the Rio Grande Compact, among other things, provides:

"That the Governors of each of the signatory states shall appoint a Commissioner for the purpose of concluding a compact among the signatory states providing for the equitable apportionment of the use of the waters of the Rio Grande among the said states, and that the Commission so named shall equitably apportion the waters of the Rio Grande as of conditions obtaining on the river and within the Rio Grande Basin at the time of the signing of the Compact."

Colorado, therefore, assumes that this conference of necessity is called in harmony with the aforementioned provisions of the Compact.

It is the position of Colorado that an adequate supply of water exists in the Upper Rio Grande Basin above Fort Quitman which, if properly regulated and used, will meet the requirements of present irrigation development in that Basin at the date of the signing of the Compact, and under present conditions to the extent indicated by the Report of the Rio Grande Joint Investigation.

Facilities now exist in the Middle and Elephant Butte-Fort Quitman sections of the Basin to regulate the water in such manner as to provide a perfect water supply, except during very infrequent periods of severe drouth. Such periods are so infrequent that it would be uneconomical to provide additional storage, or other means, to relieve shortages due to such drouths.

Inadequate facilities exist in the San Luis section to regulate the water supplies required for the proper irrigation of lands,

TX_MSJ_005207

STATEMENT OF THE VIEWS AS TO THE ESSENTIALS
FOR A PERMANENT COMPACT ON THE RIO GRANDE,

Submitted by

The Commissioner for Colorado at the Conference of the Rio Grande Compact Commission at Santa Fe, New Mexico, September 28, 1937.

Article VII of the Rio Grande Compact, among other things, provides:

"That the Governors of each of the signatory states shall appoint a Commissioner for the purpose of concluding a compact among the signatory states providing for the equitable apportionment of the use of the waters of the Rio Grande among the said states, and that the Commission so named shall equitably apportion the waters of the Rio Grande as of conditions obtaining on the river and within the Rio Grande Basin at the time of the signing of the Compact."

Colorado, therefore, assumes that this conference of necessity is called in harmony with the aforementioned provisions of the Compact.

It is the position of Colorado that an adequate supply of water exists in the Upper Rio Grande Basin above Fort Quitman which, if properly regulated and used, will meet the requirements of present irrigation development in that Basin at the date of the signing of the Compact, and under present conditions to the extent indicated by the Report of the Rio Grande Joint Investigation.

Facilities now exist in the Middle and Elephant Butte-Fort Quitman sections of the Basin to regulate the water in such manner as to provide a perfect water supply, except during very infrequent periods of severe drouth. Such periods are so infrequent that it would be uneconomical to provide additional storage, or other means, to relieve shortages due to such drouths.

Inadequate facilities exist in the San Luis section to regulate the water supplies required for the proper irrigation of lands,

TX_MSJ_005208

the irrigation of which was initiated many years prior to the construction of all present reservoirs in the two lower sections of the river.

For more than forty (40) years Colorado has been denied the right to properly regulate the waters theretofore applied to beneficial use, which has resulted in a direct loss and injury to Colorado and its citizens, conservatively estimated at not less than $200,000,000.

Colorado asserts that equitable apportionment of the use of the waters of the Rio Grande, as provided by the Rio Grande Compact, must include the necessary regulation of these waters for the most efficient use of the same.

Sufficient storage capacity can be provided and operated to furnish a water supply for the San Luis section comparable to that which now exists in the Middle and Elephant Butte-Fort Quitman sections, without adversely affecting the water supplies for those sections. As a matter of fact, the usable water supply for the Middle section would be improved by the construction and operation of the reservoirs required in the San Luis section.

All this is shown by the attached graphs which have been prepared from certain Tables appearing in Part I, Vol. I, of the Report of the Rio Grande Joint Investigation.

The first graph hereto attached shows shortages in irrigation requirements which exist under present conditions of development in the San Luis Valley section along the main river, and in the Middle and Elephant Butte-Fort Quitman sections.

The periods covered are 1892 to 1904, inclusive, and 1911 to 1925, inclusive. The period 1905 to 1910, inclusive, is not included since there was no critical period of water supply during those years.

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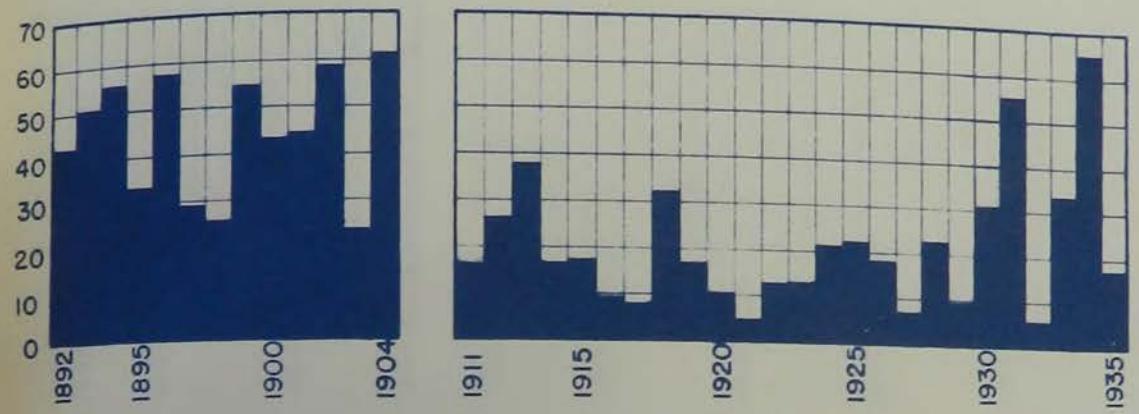
UPPER RIO GRANDE BASIN

SHORTAGES UNDER PRESENT CONDITIONS

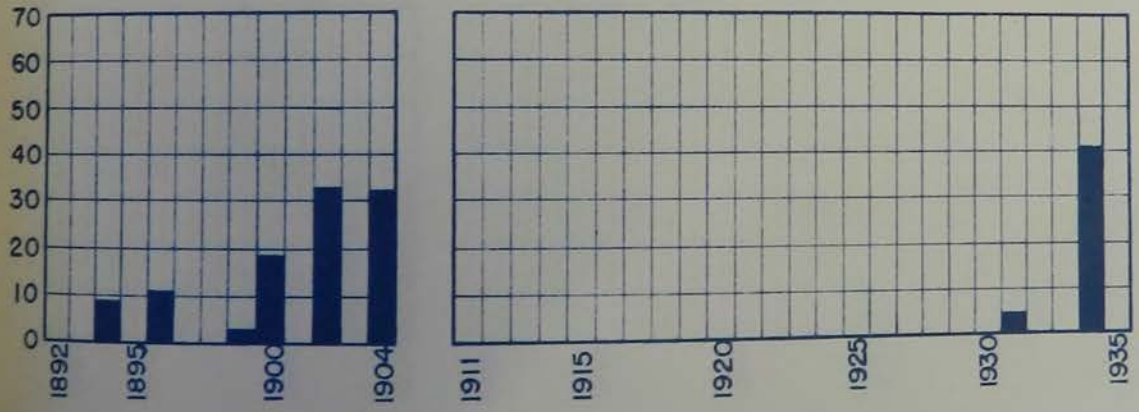
SAN LUIS SECTION — MAIN RIO GRANDE

Table 114



MIDDLE SECTION

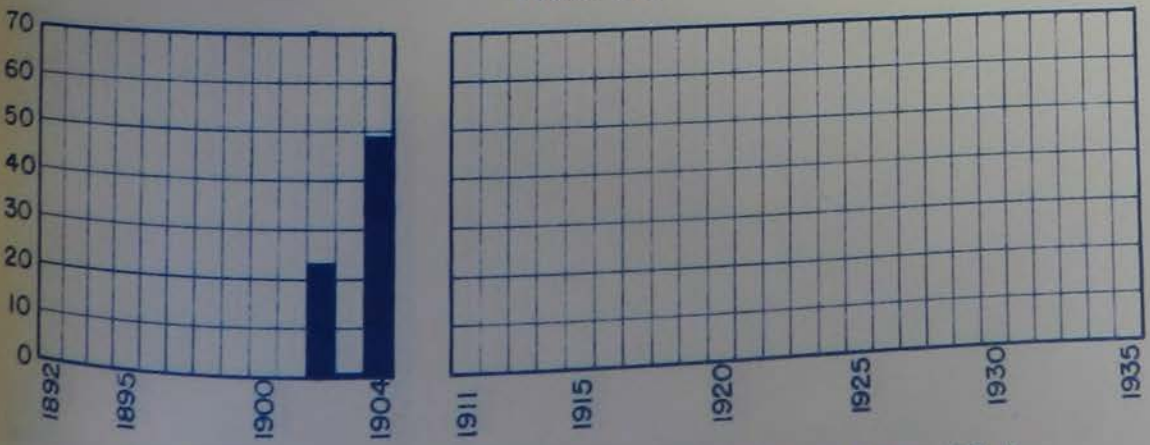
Table 115



SHORTAGE IN PER CENT OF DEMAND

ELEPHANT BUTTE — FT. QUITMAN SECTION

Table 116



DATA FROM RIO GRANDE JOINT INVESTIGATION — PART I, VOL. I

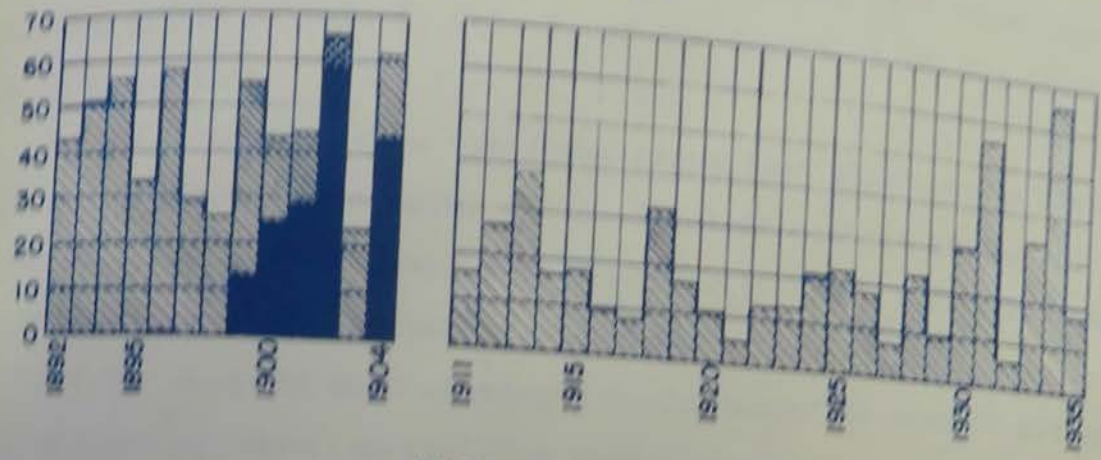
COLORADO STATE PLANNING COMMISSION — SEPT. 1937

TX_MSJ_005210

UPPER RIO GRANDE BASIN
SHORTAGES ASSUMING WAGON WHEEL GAP RESERVOIR CONSTRUCTED

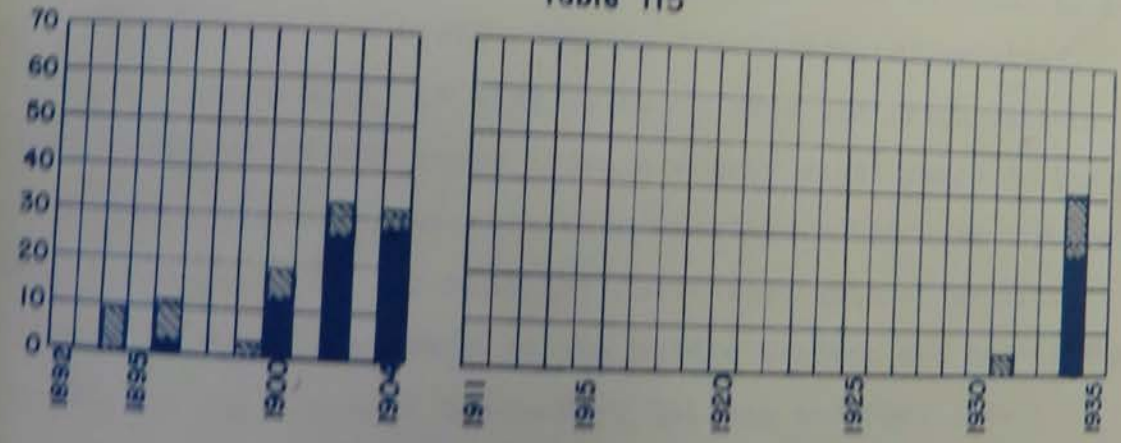
SAN LUIS SECTION — MAIN RIO GRANDE

Table 114



MIDDLE SECTION

Table 115



SHORTAGES IN PER CENT OF DEMAND

ELEPHANT BUTTE — FT. QUITMAN SECTION

Table 116



■ SHORTAGE WITH RESERVOIR ▩ SHORTAGE WITH RESERVOIR IN EXCESS OF PRESENT SHORTAGE
▨ SHORTAGE RELIEVED BY RESERVOIR

DATA FROM RIO GRANDE JOINT INVESTIGATION — PART I, VOL I
COLORADO STATE PLANNING COMMISSION — SEPT. 1937

TX_MSJ_005211

The second graph shows the shortages which would exist in the three sections of the Basin if the Wagon Wheel Gap Reservoir were constructed and operated.

The data from which the graphs were prepared were taken from Tables 114 to 116 of Part I, Vol. I, of the Report of the Rio Grande Joint Investigation.

It will be noted from the first graph that shortages in irrigation requirements would occur in the San Luis section in each of the years covered by the graph. As a matter of fact, shortages would occur during every single year of a 48-year period such as that of 1890 to 1937. Many of such shortages would amount to over 50 percent of the irrigation requirement. The shortage would average more than 30 percent of the irrigation requirement for periods as great as 13 years. Similar shortage would occur on the Conejos River also.

On the other hand, it will be noted from the graph that in the Middle section of the Basin there are only eight years during the entire period under consideration when shortage would have occurred, and only three years in the Elephant Butte-Fort Quitman section. During four of the eight years in the Middle section and one of the three years in the Elephant Butte-Fort Quitman section, the shortages would have been negligible.

Attention is now directed to the second graph which shows conditions which would obtain in the three sections if the Wagon Wheel Gap Reservoir were constructed and operated. Note that in the San Luis section the shortage would have been eliminated for all years from 1892 to 1935, except in the five years from 1899 to 1903 and 1904.

In the Middle section the shortage during the years 1894, 1899,

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and 1931 would have been entirely eliminated, and other indicated shortages would have been materially reduced.

In the Elephant Butte-Fort Quitman section the operation of the Wagon Wheel Gap Reservoir would have reduced the indicated shortage in 1902. The indicated shortage of 1904 would have been increased somewhat by increased uses of water in the Middle section. Only those two years of shortage, in addition to a negligible one in 1903, would have occurred in this section during a period such as 1893 to 1935, and such shortages would occur without the Wagon Wheel Gap Reservoir being in operation.

Part I, Vol. I, of the Report of the Rio Grande Joint Investigation under assumed condition No. 7, Page 379, and Table 115, shows that storage capacity at least equal to that of the capacity of the Wagon Wheel Gap Reservoir could be constructed and operated on the main stem of the Rio Grande in Colorado, and storage in an amount of at least 162,000 acre-feet could be constructed and operated on the Conejos river without adversely affecting the water supply of the lower sections of the Basin.

The above analysis, together with the attached exhibits, shows the lack of parity between the San Luis section and the two lower sections of the Basin.

Colorado submits that recognition be accorded its citizens to construct and operate the reservoirs required in the San Luis section of the Basin to place the water supplies of that section on a parity with the water supply of the Middle and Elephant Butte-Fort Quitman sections of the river.

M. C. Hinderlider
Rio Grande Compact Commissioner
for the State of Colorado

TX_MSJ_005213

PROPOSAL MADE BY TEXAS AT SANTA FE,

OCTOBER 1, 1937

DELIVERIES AT SAN MARCIAL
(Submitted by State of Texas)

Over each period of sixty consecutive months the total discharge of the Rio Grande as measured at San Marcial shall be not less than that set forth in the following tabulation as corresponding to certain amounts of full natural runoff of the Rio Grande at Otowi originating in New Mexico, and for other amounts of such natural runoff the corresponding total discharge at San Marcial shall be equal to that corresponding to the next lower amount of runoff plus the same proportion of the respective increments between said lower values and the next higher amounts set forth in the tabulation below:

Full Natural Runoff at Otowi, originating in New Mexico, over any period of 60 consecutive months.	Corresponding Total Discharge at San Marcial over same period of time
1,000,000 acre-feet	1,000,000 acre-feet
2,000,000	2,000,000
3,000,000	3,500,000
4,000,000	5,500,000
5,000,000	8,000,000
6,000,000	10,500,000

Said deliveries at San Marcial may be made at any time within the sixty-month period, provided that the total amount of water stored in reservoirs in the Rio Grande Basin in New Mexico above San Marcial shall at no time exceed thirty percent of the quantity then in storage in reservoirs on the Rio Grande between San Marcial and Fort Quitman.

Provided further that the amounts of water to be delivered at San Marcial as set forth above, shall be increased by five percent for each ten percent increase above 0.7 tons per acre-foot average concentration of dissolved solids in the water so delivered.

All provided that each incomplete sixty-month period shall be deemed ended whenever all reservoirs on the Rio Grande between San Marcial and Fort Quitman are filled and the next succeeding sixty-month period shall commence when water is thereafter first withdrawn from storage in any of said reservoirs.

For the purposes of this Compact, the flow as measured at Otowi minus the flow as measured at or near Lobatos, but below any dam near the state line, if such be constructed, shall be deemed to be the natural runoff at Otowi originating in New Mexico, provided that the measured flow at Otowi shall be adjusted for the effect of any works constructed after October 1, 1937, which alter the consumptive use of water in New Mexico above Otowi or which increase the quantity at Otowi by importations from without the Rio Grande Basin.

PROPOSAL MADE BY NEW MEXICO AT SANTA FE,

OCTOBER 1, 1937

TX_MSJ_005216

Schedule of Rio Grande Flow to Pass the New Mexico-Colorado State Line.

(Proposed by New Mexico)

The aggregate discharge of the Rio Grande passing the New Mexico-Colorado State Line in each period of sixty (60) consecutive months shall be not less than the quantities stated in the following table when the aggregate discharge of the Rio Grande immediately above the first point of diversion to lands in the San Luis Valley over the same period of time is as follows:

Aggregate Discharge Near Del Norte in 60 Consecutive Months	Corresponding Aggregate Discharge Passing N. Mex.-Colo. State Line
2,000,000 acre-feet	1,200,000 acre-feet
3,000,000	1,800,000
4,000,000	2,600,000
5,000,000	3,500,000
6,000,000	4,500,000

Intermediate quantities shall be in proportion to the respective values in the above table.

Provided that the total discharge passing the New Mexico-Colorado State Line in any twelve (12) consecutive months shall not be less than 25 percent of the total quantity in the Rio Grande measured immediately above said first point of diversion in the same period of time.

Provided, further, that the flow passing the New Mexico-Colorado State Line shall not be less than 100 cubic feet per second during the period of time from June 15th to September 15th of any year.

Provided, further, that quantities set forth above shall be exclusive of any amount of water which may be discharged into the Rio Grande from the Sump Drain or other drains from the San Luis Lakes.

PROPOSAL MADE BY COLORADO AT SANTA FE,

OCTOBER 1, 1937

(Proposal)
(Submitted by State of Colorado)

October 1, 1937

Deliveries of water shall be made by Colorado at Lobatos gaging station near the Colorado-New Mexico State line in accordance with the following schedule, which indicates the relation, under present conditions (1928-1937) of development, between the recorded flow of the Rio Grande at the gaging station near Del Norte, plus the recorded flow of the Conejos at the Mogote gaging station, and the recorded flow of the Rio Grande at the Lobatos gaging station:

Recorded flow of Rio Grande Near Del Norte, plus recorded flow of Conejos at Mogote	Recorded flow of Rio Grande at Lobatos
400,000 acre-feet	80,000 acre-feet
500,000	120,000
600,000	175,000
700,000	230,000
800,000	285,000
900,000	350,000
1,000,000	420,000
1,100,000	490,000
1,300,000	565,000
1,300,000	650,000
1,400,000	745,000
1,500,000	840,000

Delivery shall not be required on an annual basis in accordance with the above schedule, but credits and/or debits shall be allowed to accumulate over a period of years subject to the following conditions:

1. At any time when accumulated debits exceed the unfilled effective capacity of Rio Grande Project storage, that portion which is in excess of the unfilled capacity shall be written off.

2. Accumulated credits shall be reduced by the amount of actual spill from Rio Grande Project storage during the periods

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when spill occurs.

3. The mean required releases from Rio Grande Project storage shall be considered as 750,000 acre-feet per year.

4. In calculating Colorado debits, cumulative debits shall be reduced by an amount that the total releases from Rio Grande Project storage exceed 750,000 acre-feet per annum.

5. In the event that the contents of Rio Grande Project storage shall drop below 300,000 acre-feet on April first of any year, and Colorado owes water to the river, the amount owed shall be released from reservoirs constructed after the consummation of a permanent Compact, and delivered to the state line.

6. Future reservoir construction and operation in Colorado shall not impair the present flow at the Lobatos Gaging Station during those periods when the flow at Otowi Bridge gaging station would be insufficient under present conditions to supply the requirements of the Middle Rio Grande Conservancy District as defined by the Report of the National Resources Committee.

New Mexico, and the Middle Rio Grande Conservancy Project, shall agree not to deplete the flow of the river at San Marcial. Any cumulative shortage in the river flow at San Marcial, caused by water uses above that point in New Mexico, shall be supplied by New Mexico, should the contents of Rio Grande Project storage drop below the amount specified above.

In calculating the combined flow of the Rio Grande at Del Norte, and the Conejos at Mogote, for application to the above schedule, water imported to the area above either, or both, of these gaging stations by projects constructed after October 1, 1937, shall be subtracted from the combined recorded flow at those stations, and the resulting indicated flow shall be applied to the schedule to

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determine the amount of water that shall be delivered at the Lobatos gaging station.

When and if water is imported to the Upper Rio Grande Basin below the Colorado-New Mexico state line at no expense to either of the signatory states, the amount of water required to be delivered by Colorado at Lobatos gaging station, as defined by the above schedule, shall be reduced in an amount equal to 50 percent of the imported water as measured each year. In the event water is imported from Colorado to the area below Colorado-New Mexico state line by projects financed by New Mexico, the amount of water required to be delivered by Colorado at Lobatos, as defined by the above schedule, shall be reduced in an amount equal to 20 percent of the imported water as measured each year.

In the event that power is developed by projects constructed to import water to the Basin below the Colorado-New Mexico state line, Colorado shall not be discriminated against in the allocation of the power or the establishment of rates.

The provisions outlined above with respect to state line deliveries, in accordance with the suggested schedule, shall not become effective until the contemplated storage in the San Luis section is constructed and placed in operation.

TX_MSJ_005221

"REPORT OF COMMITTEE OF ENGINEERS
TO RIO GRANDE COMPACT COMMISSIONERS,
DECEMBER 27, 1937"

December 27, 1937

The Rio Grande Compact Commission,
Mr. S. O. Harper, Chairman,
Mr. M. C. Hinderlider, Member for Colorado,
Mr. T. H. McClure, Member for New Mexico,
Mr. F. B. Clayton, Member for Texas.

Gentlemen:

The Engineering Advisers of your Commission have held two meetings, the first in Santa Fe from November 22 to 24, and the other in Los Angeles from December 15 to 27. The first meeting was largely devoted to consideration of the general factors affecting the discharge of Rio Grande at the Colorado-New Mexico State Line and the delivery of water into Elephant Butte Reservoir. At the second meeting more detailed consideration was given to these matters, and definite schedules of deliveries were developed.

We avoided discussion of the relative rights of water users in the three states, and were guided throughout our work by the general policy - expressed at the meeting of the Compact Commission in October - that present uses of water in each of the three States must be protected in the formulation of a Compact for administration of the Rio Grande above Fort Quitman, because the usable water supply is no more than sufficient to satisfy such needs.

The Rio Grande above Fort Quitman, which constitutes the part of the drainage basin in which the Commission has primary interest, is divided naturally into three sections:

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(a) The San Luis Valley, comprising the drainage area above the Lobatos gaging station on the Rio Grande near the Colorado-NewMexico State Line;

(b) The Middle Rio Grande from Lobatos to Elephant Butte Reservoir and the drainage basins of streams tributary to the river in this section;

(c) The balance of the Rio Grande Basin between Elephant Butte and Fort Quitman, including the Juares Valley in Mexico.

It must be recognized that precise determination of past conditions and close estimates of future changes are not possible. Accordingly, in submitting the following for your favorable consideration and inclusion in a permanent Compact, we suggest that provision be made for review of these matters after five years and for adjustments within the intent of the Compact.

SCHEDULED DELIVERIES AT LOBATOS

A consistent relationship has long been noted between the combined inflow of the major streams to San Luis Valley and the outflow of the Rio Grande at Lobatos. This relationship, however, may be disturbed in the future due to construction of storage reservoirs, and we have therefore prepared separate schedules applicable to the Conejos and Rio Grande stream systems. This is a departure from previous plans but has no practical disadvantage and has certain definite advantages; variations in discharge of the contributing streams will automatically be taken into account, particularly if storage

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reservoirs are constructed; and it will also enable the San Luis Valley water users to apportion among themselves their relative responsibility for meeting the obligation of Colorado.

The flow of Conejos River at its confluence with the Rio Grande was found to bear a close relation to the combined discharge of Conejos River near Mogote and its principal tributaries below that point. The following values are from a smooth curve expressing that relationship for the past ten years, and it is recommended that these be used as a schedule of future deliveries.

SCHEDULE OF DELIVERIES FROM CONEJOS RIVER

Quantities in thousands of acre feet

Conejos Index Supply (1)	Conejos River at Mouths (2)
100	0
150	20
200	46
250	76
300	111
350	150
400	191
450	235
500	280
550	328
600	375
650	424
700	480

Intermediate quantities shall be computed by proportional parts.

(1) Conejos Index Supply is the natural flow of Conejos River at the U.S.G.S. gaging station near Mogote for the calendar year, plus the natural flow of Los Pinos River at the U.S.G.S. gaging station near Ortiz and the natural flow of

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San Antonio River at the U.S.G.S. gaging station at Ortiz, both for the months of April to October, inclusive.

(2) Conejos River at its mouth is the combined discharge of branches of this river at the U.S.G.S. gaging stations near La Sauses (Los Sauces) during the calendar year.

When from the total discharge of Rio Grande at Lobatos there is subtracted the contribution from Conejos River, a close relationship also is found to exist between that residual quantity and the discharge of Rio Grande near Del Norte. The following values are from a smooth curve expressing the relationship for the past ten years, and it is recommended that this be the schedule of deliveries for the future.

SCHEDULES OF DELIVERIES FROM RIO GRANDE ABOVE DEL NORTE

Quantities in thousands of acre feet

Rio Grande at Del Norte (3)	Rio Grande at Lobatos less Conejos at Mouths (4)
	60
200	65
250	75
300	86
350	98
400	112
450	127
500	144
550	162
600	182
650	204
700	229
750	257
800	292
850	335
900	380
950	430
1 000	540
1 100	640
1 200	740
1 300	840
1 400	

Intermediate quantities shall be computed by proportional parts.

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(3) The recorded flow of Rio Grande at the U.S.G.S. gaging station near Del Norte during the calendar year (measured above all principal points of diversion to San Luis Valley).

(4) The total flow of Rio Grande at the U.S.G.S. gaging station near Lobatos, less the discharge of Conejos River at its mouths, during the calendar year.

The obligation of Colorado to deliver water in the Rio Grande at the Colorado-New Mexico State Line would be the sum of the quantities set forth in the above tabulations, except for such departures from normal deliveries as are provided for below. In the application of either schedule, appropriate adjustments must be made for any trans-mountain diversions, for any change in location in gaging stations, and for any new or increased depletion of the natural runoff at gaging stations above Lobatos.

SCHEDULED DELIVERIES INTO ELEPHANT BUTTE RESERVOIR

The relation between the amount of water in the Rio Grande above the principal agricultural areas in New Mexico and inflow to Elephant Butte Reservoir is quite erratic, due primarily to wide variations in the discharge of tributary streams. Your Committee tried many devices to eliminate the influence of such tributary inflow. Finally, it was found that there was a reasonable relationship between the discharge of Rio Grande at Otowi Bridge and the inflow to Elephant Butte Reservoir when the discharge at Otowi Bridge and the inflow to the

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reservoir during the months of July, August, and September were excluded. Such a relationship does not reflect possible changes in consumptive use during the summer months between these points, and tributary flow in other months still results in considerable variation, but it is our opinion that no more precise relationship can be developed from present information, and that its use as a schedule of deliveries will be practicable.

In order that all available data might be used in determining the proper schedule, the flow of the Rio Grande at Otowi Bridge, exclusive of July, August, and September, was first compared to the flow of the Rio Grande at San Marcial, excluding the same months, and a curve was drawn which expressed most closely the relationship which existed in the past. However, the gaging station at San Marcial is expensive to operate, and physical conditions make it difficult to obtain accurate records, while water released from Elephant Butte reservoir can be measured with considerable precision. The second step was to determine the normal net loss from the river below San Marcial and from the reservoir. It was found that for more than ten years these losses have borne a very close and consistent relation to the discharge of the river at San Marcial. The third step was then the subtraction of the normal losses so found from the curve of relationship between the flow at Otowi Bridge and that at San Marcial. The net result was to give a curve which expressed the relation between the flow of the Rio Grande at Otowi Bridge and the usable

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supply of water at Elephant Butte, both exclusive of July, August, and September. This curve was then shifted arbitrarily to compensate for increased salinity of the Elephant Butte supply.

The final relationship which we recommend be used as the schedule of deliveries is as follows:

DELIVERIES INTO ELEPHANT BUTTE RESERVOIR
EXCLUSIVE OF JULY, AUGUST, AND SEPTEMBER

Quantities in thousands of acre feet

Otowi Index Supply (5)	Elephant Butte Index Supply (6)
100	12
200	57
300	113
400	173
500	237
600	305
700	378
800	455
900	540
1 000	630
1 100	725
1 200	825
1 300	935
1 400	1 052
1 500	1 175
1 600	1 305
1 700	1 440
1 800	1 583
1 900	1 737
2 000	1 895
2 100	2 058
2 200	2 224
2 300	2 392

Intermediate quantities shall be computed by proportional parts.

(5) The natural flow of Rio Grande at the U.S.G.S. gaging station at Otowi Bridge near San Ildefonso (formerly station near Buckman) during the calendar year, exclusive of the flow during the months of July, August, and September.

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(6) The usable supply at Elephant Butte during the calendar year, exclusive of the months of July, August, and September, such usable supply being equal to the actual release from Elephant Butte Reservoir, plus any gain in the amount of water stored in that reservoir and minus any draft on it over the same period of time.

The obligation of New Mexico to deliver water into Elephant Butte Reservoir in accordance with the foregoing schedule would be subject to the provisions set forth below, and in the application of this schedule appropriate adjustments must be made for any change in points of measurements, for any new or increased depletion in New Mexico of the natural runoff at Otowi Bridge, and for any trans-mountain diversions into the Rio Grande between Lobatos and Elephant Butte.

ALLOWABLE DEPARTURES

There will be natural variations in the relationships between the discharge at the control stations in the future, as in the past, and reasonable departures must be expected. Furthermore, departures which are caused by storage of water in reservoirs at time of flood should be permitted, subject to proper safeguards.

Definitions

The following terms will be used repeatedly and are here defined:

(a) Annual Debits - are the amounts by which deliveries in any calendar year fall below scheduled deliveries.

(b) Annual Credits - are the amounts in any calendar year

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by which actual deliveries exceed scheduled deliveries.

(c) Accrued Debits - are the amounts by which the sum of all debits exceeds the sum of all credits over any common period of time.

(d) Accrued Credits - are the amounts by which the sum of all credits exceeds the sum of all debits over any common period of time.

(e) Normal Release from Elephant Butte - is an average of 800,000 acre feet per annum drawn out of Elephant Butte Reservoir, adjusted for any gain or loss in usable water resulting from the operation of any reservoir below Elephant Butte; provided that this amount shall be reduced or increased by two-thirds of any change in aggregate diversions and loss to Mexico between Courchesne gaging station and the lowest point of diversion to lands of Rio Grande Project. In determining the amount of such change, the average annual diversion and loss to Mexico from 1928 to 1937, inclusive, shall be used as a basis.

(f) Project Storage - is the combined capacity of Elephant Butte Reservoir and all other reservoirs available for storage of usable water between Elephant Butte and Courchesne, but not more than a total of 2,638,860 acre feet.

(g) Usable Water - is all water in Project storage which is available for release in accordance with irrigation demands, including deliveries to Mexico.

(h) Unusable Spill - is the amount of water which is

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actually spilled from Elephant Butte Reservoir or released for flood control in excess of the current demand for irrigation of Rio Grande Project lands plus deliveries to Mexico and which is not stored in another reservoir for subsequent release for such uses; provided that, if the actual release from Elephant Butte Reservoir from the time of previous spill has averaged more than the normal release, the time of occurrence and amount of spill shall be adjusted by the difference between the total actual release and the accrued normal release.

Limitation on Debits

In the case of Colorado, no annual debit nor accrued debit shall exceed 100,000 acre feet, except as either or both may be caused by storage of water in reservoirs constructed above Lobatos after 1937. Accrued debits which are caused by storage of water in reservoirs not now constructed shall not be greater at any time than the amount of water then in storage in such reservoirs.

In the case of New Mexico, the accrued debit shall not exceed 200,000 acre feet at any time, except as such debit may be caused by storage of water in reservoirs in New Mexico. Accrued debits caused by storage of water in reservoirs shall not be greater at any time than the amount of water then in storage in such reservoirs. In computing the magnitude of accrued credits or debits, annual debits greater than 150,000 acre feet shall be taken as equal to that amount.

If in any year the aggregate of accrued debits of Colorado

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and the Nation exceeds the difference between the total capacity of Project storage and the amount of water then in storage, such debits shall be reduced proportionately in an aggregate amount equal to the storable natural waters in that year.

If in any year there is unusable spill from Elephant Butte Reservoir, all accrued debits of Colorado and New Mexico shall be cancelled, and no debits shall be considered in that year, excepting debits caused by storage in reservoirs prior to the time of spill.

Limitation on Credits

In the case of Colorado, accrued credits in excess of 100,000 acre feet at any time shall be not considered, provided that larger accruals may be applied to offset debits caused by storage in reservoirs. In computing the amount of accrued credits or debits, any annual credits in excess of 15,000 acre feet shall be taken as equal to that amount.

In the case of New Mexico, accrued credits in excess of 200,000 acre feet at any time shall not be considered, provided that larger accruals may be applied to offset debits caused by storage in reservoirs. In computing accrued credits or debits, annual credits in excess of 150,000 acre feet shall be taken as equal to that amount.

At the time of unusable spill from Elephant Butte Reservoir the aggregate credits of Colorado and New Mexico shall be reduced by the amount of such spill at Elephant Butte in

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proportion to their respective credits at the time of such spill, and no credits shall be considered in a year of spill.

Other Limitations

Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs constructed since 1929 whenever there is less than 400,000 acre feet of water in storage available for use in the Rio Grande Project, and if this minimum stage is reached on January first of any year Colorado and New Mexico shall each release on demand, at the greatest rate practicable, water from reservoirs in an amount equal to the total debit of each which was caused by storage of water in reservoirs.

In event any works are constructed after 1937 for the purpose of delivering water into the Rio Grande from the Closed Basin in San Luis Valley, Colorado shall be credited with the amount of such water delivered, provided the proportion of sodium ions is less than 45% of the total positive ions in that water.

In the event that the normal release from Elephant Butte Reservoir is modified by any change in the amount of diversions and loss to Mexico, Colorado and New Mexico shall share equally therein, and the accrued credits or debits of each shall be adjusted annually by an amount equal to one-third of such change in diversions and loss to Mexico.

RECOMMENDATIONS

We are satisfied that no material expansion of the irrigated area in the Rio Grande Basin above Fort Quitman will be practicable without importations from other watersheds. Good use could be made of this water in each of the States, but we deemed that the allocation of any supply so obtained constituted a matter of policy beyond our province. Accordingly, no recommendation is made.

We do recommend that the normal release from Elephant Butte Reservoir be deemed to be 800,000 acre feet per annum, adjusted for any gain or loss of usable water resulting from the operation of any reservoir below Elephant Butte. We also recommend that this normal release be reduced or increased by two-thirds of any change in aggregate diversions and loss to Mexico.

We recommend that deliveries by New Mexico into Elephant Butte Reservoir be in accordance with the schedule based on the flow at Otowi Bridge and the usable supply at Elephant Butte, subject to proper limitations on departures.

We recommend that deliveries by Colorado be the sum of the amounts set forth in the schedules for the Conejos stream system and for the Rio Grande system, exclusive of Conejos River, both subject to proper limitations on departures.

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RECOMMENDATIONS

We are satisfied that no material expansion of the irrigated area in the Rio Grande Basin above Fort Quitman will be practicable without importations from other watersheds. Good use could be made of this water in each of the States, but we deemed that the allocation of any supply so obtained constituted a matter of policy beyond our province. Accordingly, no recommendation is made.

We do recommend that the normal release from Elephant Butte Reservoir be deemed to be 800,000 acre feet per annum, adjusted for any gain or loss of usable water resulting from the operation of any reservoir below Elephant Butte. We also recommend that this normal release be reduced or increased by two-thirds of any change in aggregate diversions and loss to Mexico.

We recommend that deliveries by New Mexico into Elephant Butte Reservoir be in accordance with the schedule based on the flow at Otowi Bridge and the usable supply at Elephant Butte, subject to proper limitations on departures.

We recommend that deliveries by Colorado be the sum of the amounts set forth in the schedules for the Conejos stream system and for the Rio Grande system, exclusive of Conejos River, both subject to proper limitations on departures.

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It is our opinion that these schedules and provisions would permit the maximum practicable use of the waters of the Rio Grande, and would minimize unusable spill at Elephant Butte. Your favorable consideration and inclusion of these in a permanent Compact is recommended.

Respectfully submitted,

COMMITTEE OF ENGINEERING ADVISERS

E. B. Debler for the United States

Royce J. Tipton for Colorado

John H. Bliss for New Mexico

Raymond A. Hill for Texas

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032.1	RIO GRANDE BASIN	CORRES. RE COMPACT BETWEEN STATES OF COLORADO; NEW MEXICO & TEXAS RE RIO GRANDE BASIN WATER RIGHTS.	JAN. 1938 THRU MAY 1939	032.1

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COPY

STATE OF COLORADO
Engineering Department
DENVER

February 4, 1938

S. O. Harper, Chairman
Rio Grande Compact Commission
Customhouse
Denver, Colorado

Dear Mr. Harper:

I have reviewed Commissioner McClure's letter to you under date of January 25, 1938, from which it is noted that he takes strong exception to the report of the Committee of Engineer Advisors to the Rio Grande Compact Commission, and is of the opinion "that it would be a waste of time for the Compact commissioners to meet and accept the report as a basis for negotiations of a new Compact, without clarification of the provisions of the report".

Mr. McClure also asserts that the report in question is too vague and indefinite, and does not set up sufficient data used by the Committee to permit a check of the relationship of stream flow at various river stations, and concludes that, instead of reporting accurate basic data, the conclusions of the Committee of Engineers are based upon a compromise of basic data.

Mr. McClure reaches the conclusion that it is necessary for the Engineer Advisors to give further consideration to their studies prior to attempts at further negotiations.

It seems to the writer that Mr. McClure should not unqualifiedly accept the views of Mr. Neuffer; that the Committee of Engineers should call in consultation the engineers of the Middle Rio Grande Conservancy District, for the reason that it was agreed by the Compact Commissioners that the engineering phases of the subject matter be referred to a Committee of Engineers, on which each state had an engineering advisor. Such designation was largely for the purpose of avoiding confusion and delays which would result from a multiplicity of opinions between conflicting interests in each state.

It is our feeling that any internal or intra-state differences with the views of the Engineering Advisor of any state should be composed with such Advisor. I feel that it will be impossible to reach an interstate agreement so long as every individual group of water users is permitted to inject and insist upon individual points of view.

As has been repeatedly stated in previous conferences, Colorado has taken the position that she is entitled to parity with the two lower states, in the development of her water resources in the San Luis Valley. It is our understanding that the report of the Committee of Engineers

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attempts to suggest a basis upon which this could be accomplished without material injury to the interests of any of the states involved, and, therefore, could be accepted in principle as a basis of further discussions and negotiations by the Compact Commission, in its attempt to reach an interstate agreement.

It is felt that, prior to a further meeting of the Committee of Engineers, as suggested by Mr. McClure, he should specifically and definitely point out the items in the said report to which he takes exception, and indicate the particular points upon which he desires further information. Doubtless such information may be obtained from Mr.Bliss, his Engineering Advisor.

When such information has been submitted by Mr. McClure, the members of the Commission will be able to determine if further meetings of the Committee of Engineers would be helpful.

Very truly yours,

(Sgd.) M. C. Hinderlider

Commissioner for Colorado

CC: Mr. McClure
Mr. Clayton
Mr. Carr
Mr. Corlett
Attorney General

CC-Commissioner
-Prof. Harlan H. Barrows
Chicago, Ill.
-Prof. Frank Adams,
Berkeley, Calif.

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In re: Rio Grande Project
AG No. 011504362

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Raymond A. Hill Papers

&

The Rio Grande Compact Commission

Collection

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Letter from Raymond A. Hill to Frank B. Clayton, February 8, 1938
("... the time has come when the State of Texas should cease being the direct representative of an irrigation district situated in New Mexico.")
Rio Grande Compact Commission
Box 2F466 (2 pages)

QUINTON, CODE AND HILL-LEEDS AND BARNARD
MEMBERS AMERICAN SOCIETY OF CIVIL ENGINEERS
SUITE 905 EDISON BUILDING
LOS ANGELES, CALIFORNIA

February 8, 1938.

Mr. Frank B. Clayton,
Bassett Tower,
El Paso, Texas.

Dear Frank:

In your recent letter to Mr. Harper you alluded to the failure of McClure to consider the interest of Elephant Butte Irrigation District. I have been giving considerable thought to the implications of this situation and believe that the time has come when the State of Texas should cease being the direct representative of an irrigation district situated in New Mexico.

So long as Texas bears the burden of protecting the rights of all lands under the Rio Grande Project, the official attitude of New Mexico is going to be the same as that of Middle Rio Grande Conservancy District. This was clearly brought out in the meetings of the Committee of Engineers when Bliss not only failed to assist me in discussions with Tipton but went so far as to make demands which favored Colorado beyond those that Tipton felt justified in making. The only conclusion from Bliss' attitude and from the expressions of McClure is that the use of water below Elephant Butte Dam should be reduced even if the benefit of such reduction would be solely Colorado's. If this attitude is continued into the Compact negotiations, and I see no reason to expect anything else, it will put Texas in an untenable position.

I suggest, therefore, that you present the issue clearly to Judge Mechem and Phillips. I think that they, either directly or through political channels, should bring pressure on the State Engineer of New Mexico to protect their interests; also, that they should sit in on all conferences of New Mexico interests to the end that the Elephant Butte District may be given the same consideration by New Mexico that the Middle Rio Grande Conservancy District is given. If this is done, the Elephant Butte District can demand of McClure the schedule of deliveries into Elephant Butte Reservoir which will protect the Elephant Butte District. Texas can likewise demand the same schedule of deliveries in the Compact meetings as a protection to the lands in Texas.

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THE UNIVERSITY OF TEXAS AT AUSTIN

In order to accomplish the above and protect directly the interests of Texas land owners and indirectly the interests of all lands in the Rio Grande Project, I suggest that demand be made for the adoption of a schedule of deliveries at Courchesne. This schedule of deliveries should provide:

(a) for all water diverted or lost to Mexico;
(b) for all consumptive requirements below El Paso;
(c) for drainage outflow in sufficient amount to give a salt balance and provide equivalent service;
(d) for operating waste; and
(e) for water undivertible in the winter and in excess of irrigation demands during the irrigation season.

In round numbers these items would total 500,000 acre feet per year.

I realize that a similar suggestion was categorically rejected at a general conference just prior to the Compact Commission meeting in October. I believe, however, that the situation is sufficiently changed to warrant such a demand from Texas. In my judgment, the interests of the Elephant Butte Irrigation District will be better served thereby than will be the case if the full burden of providing for deliveries into Elephant Butte Reservoir is placed upon Texas.

Sincerely yours,

RAYMOND A. HILL

RAH/AM

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THE UNIVERSITY OF TEXAS AT AUSTIN

Letter from Raymond A. Hill to Frank B. Clayton, February 8, 1938
("... the time has come when the State of Texas should cease being the direct representative of an irrigation district situated in New Mexico.")
Rio Grande Compact Commission
Box 2F466 (2 pages)

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BUREAU OF RECLAMATION

PROJECT CORRESPONDENCE FILE

1930-1945

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1930
Item

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Wash. copy.
Sgd) Roydis
Thomas

CONTRACT

This contract made and entered into by and between the Elephant Butte Irrigation District of New Mexico and El Paso County Water Improvement District No. 1 of Texas, pursuant to resolutions of the Board of Directors of the respective Districts, authorizing the same, WITNESSETH THAT:

WHEREAS, it is expedient that the acreage within each irrigation District which is to be irrigated should be cushioned by allowing the distribution of water to a small excess of acreage over and above that allotted to the two Districts under the Rio Grande New Mexico-Texas Reclamation Project, to the end that annual variations, within narrow limits, shall be permitted, and so that, each year, there will be within the Elephant Butte Irrigation District 88,000 acres of land, and within El Paso County Water Improvement District No. 1, 67,000 acres upon which construction and operation and maintenance charges may be levied;

THEREFORE, it is mutually agreed that either District may increase the acreage to be irrigated and to be subject to construction charges, not to exceed three (3%) per cent of the present authorized acreage in each District, that is to say, Elephant Butte Irrigation District, having an authorized acreage of 88,000 acres, may increase such acreage to the extent of three (3%) per cent thereof, amounting to not to exceed 2,640 acres; that El Paso County Water Improvement District No. 1, having a present authorized acreage of 67,000 acres, may increase such acreage to three (3%) per cent thereof, that is, not to exceed 2,010 acres, said additional lands, in any case, to be within the limits of the present irrigation Districts or any future extensions thereof.

It is further agreed and understood that in the event of a shortage of water for irrigation in any year, the distribution of the available supply in such year, shall so far as practicable, be made in the proportion of 67/155 thereof to the lands within El Paso County Water Improvement District No. 1, and 88/155 to the lands within the Elephant Butte Irrigation District.

It is further agreed and understood that the operation and maintenance costs of the project works (exclusive of the storage and power development) for the calendar year 1938 and thereafter shall be distributed between the two Districts in the same manner as similar costs were distributed for the calendar year 1937, and that the same ratios for the two Districts, respectively, that were applied to said costs for that year common to both Districts shall be used in 1938 and subsequent years.

This contract to be effective only during the period when the proposed contracts under Public No. 249, Seventy-fifth Congress, 1st Session, between, (1) the United States and Elephant Butte Irrigation District and (2) the United States and El Paso County Water Improvement District No. 1 are in force, and if either or both of said contracts should terminate after both have become effective, this contract is also to terminate.

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IN TESTIMONY WHEREOF, the parties hereunto have caused the same to be signed by the Presidents of their respective Boards of Directors, and attested by the Secretary with the seal of said corporation,

this 16th day of February, A. D. 1938.

THE ELEPHANT BUTTE IRRIGATION DISTRICT
OF NEW MESICO.

By /s/ Arthur Starr
Its President

(SEAL)

Attest: /s/ Jose R. Lucero
Secretary, Elephant Butte
Irrigation District.

EL PASO COUNTY WATER IMPROVEMENT DISTRICT
DISTRICT NO. 1 OF TEXAS.

By T. D. Porcher /s/
Its President

(SEAL)

ATTEST: /s/ (Idus T. Gillett)
Secretary, El Paso County Water
Improvement District No. 1.

APPROVED THIS 11th DAY OF April, A. D. 1938.

(Sgd) Oscar L. Chapman.
Assistant SECRETARY OF THE INTERIOR

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RIO GRANDE BASIN

P R O C E E D I N G S

OF THE

MEETING OF THE

RIO GRANDE COMPACT COMMISSION

Held
at

Santa Fe, New Mexico,

March 3rd to March 18th, inc.

1938

TX_MSJ_005253

C O N T E N T S

	Page
Frontispiece - Photograph of Commissioners and Advisers	A
March 3 meeting	1
March 4 meeting	11
March 7 meeting	24
March 8 meeting	24
March 9 meeting	24
March 10 meeting	24
March 11 meeting	26
March 17 meeting	33
March 18 meeting	34

- - - -

Appendix No. 1, Report of Committee of Engineers . . .	39
Appendix No. 2, Letter from Thomas M. McClure	48
Letter to Thomas M. McClure	49
Appendix No. 3, Letter from Frank B. Clayton	50
Appendix No. 4, Letter from M. C. Hinderlider	52
Appendix No. 5, Letter from S. O. Harper	54
Appendix No. 6, Report by Engineer Advisers	56
Appendix No. 7, Letter from Committee of Engineering Advisers March 9, 1938	58
Appendix No. 8, Letter from Committee of Engineering Advisers March 11, 1938	66
Appendix No. 9, Memorandum from Committee of Engineers	68
Appendix No. 10, Letter from Committee of Engineering Advisers	71
Appendix No. 11, Rio Grande Compact	72
Appendix No. 12, Report by the Chairman to the Secretary of the Interior	83

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Rio Grande Compact Commission
with its Legal and Engineering Advisers,
La Fonda Hotel, Santa Fe, New Mexico,
March 18, 1938.

Seated, left to right:

Governor Teller Ammons of Colorado; M. C. Hinderlider, Commissioner for Colorado; Frank B. Clayton, Commissioner for Texas; S. O. Harper, Chairman and Representative of the United States; Thomas M. McClure, Commissioner for New Mexico; Governor Clyde Tingley of New Mexico.

Standing, left to right:

John H. Bliss, Engineering Adviser, New Mexico; Royce J. Tipton, Engineering Adviser, Colorado; Raymond A. Hill, Engineering Adviser, Texas; E. B. Debler, Engineering Adviser to the Chairman; Clifford H. Stone, Legal Adviser, Colorado; H. J. S. Devries, Legal Adviser to the Chairman; George M. Corlett, Legal Adviser, Colorado; A. T. Hannett, Legal Adviser, New Mexico; Fred E. Wilson, Legal Adviser, New Mexico. Absent: Ralph L. Carr, Legal Adviser, Colorado.

PROCEEDINGS

OF THE

MEETING OF THE

RIO GRANDE COMPACT COMMISSION

Held at

Santa Fe, New Mexico,

March 3rd to March 18th, inc.
1938

The Rio Grande Compact Commission was called to order at 2:30 P.M., March 3, 1938, by the Chairman, in the Council Chamber of the City Hall at Santa Fe, New Mexico, whereupon the following proceedings were had:

MR. HARPER: The meeting will please come to order. Before proceeding with our order of business I will ask each of the commissioners to state for the record the representatives of their respective states who are present at this meeting. Mr. Hinderlider, may we hear from you?

MR. HINDERLIDER: Mr. Chairman, members and advisers: For Colorado there are present M. C. Hinderlider, River Commissioner, Attorney General B. F. Rogers, legal adviser to the Commissioner; Judge Clifford Stone, attorney for the Colorado State Water Conservation Board; Royce J. Tipton, Engineering Adviser to the Compact Commissioner; Attorney George M. Corlett, representing the Rio Grande Water Users' Association; Oscar Lindstrom, Secretary of the same association; Ralph Carr, Attorney representing the Conejos River Water Users' Association; F. B. Goudy, attorney representing certain interests in the San Luis Valley. There will be other representatives of the water users in the San Luis Valley with us tommorow. Do you want to enter their names?

MR. CORLETT: J. C. Smittel, one of the board of directors; Corbin Wright, President, Rio Grande Water Users' Association; F. Higel, also member of the board of directors; James A. Reed, member of the board of directors; Omar Underwood of Del Norte and George Voss of Del Norte.

MR. HINDERLIDER: I believe those who have been named will be all who will be here representing Colorado or its interests.

MR. HARPER: Mr. McClure, may we have the names of your representatives.

MR. McCLURE: Mr. Chairman and Members of the Commission and advisers: Representing New Mexico there are Thomas M. McClure, Rio G[illegible] Compact Commissioner; Frank H. Patton, Attorney General of New Mexico; Governor A. T. Hannett, Spec. Asst. Atty. General, counsel for the Interstate Streams Commission of New Mexico;

John H. Bliss, engineer adviser; R. H. Hanna, counsel for the Middle Rio Grande Conservancy District; Fred E. Wilson, counsel for the Middle Rio Grande Conservancy District; William Brophy, counsel for Middle Rio Grande Conservancy District; Edwin Mechem, counsel for Elephant Butte Irrigation District; N. B. Phillips, Manager of Elephant Butte Irrigation District; H. C. Neuffer, engineering adviser for Middle Rio Grande Conservancy District; Stanley Phillippi, Asst. Chief Engineer Middle Rio Grande Conservancy District. There may be others who will come into the meeting at a later date and they will be named at the time they arrive.

MR. HARPER: Mr. Clayton, may we hear from you.

MR. CLAYTON: Mr. Chairman and Gentlemen: For the State of Texas there are present Frank B. Clayton, Rio Grande Compact Commissioner for Texas; C. S. Clark, Chairman Board of Water Engineers for the State from Austin; Major Richard F. Burges, attorney for El Paso County Water Improvement District No. 1, El Paso; Raymond A. Hill, Los Angeles, consulting engineer for the State of Texas; Allen Laflin, Albuquerque, engineer for the State of Texas. There will be present at a later date Asst. Attorney General H. Grady Chandler of Austin; Roland Harwell, Manager of El Paso County Water Improvement District No. 1. There are also in attendance F. S. Robertson of San Benito, Secretary of Water Conservation Association of the Lower Rio Grande Valley; and A. L. Montgomery of San Benito, attorney representing the Water Conservation Association of Lower Rio Grande Valley.

MR. HARPER: Professor Barrows, will you please state the names of the representatives of the National Resources Committee present.

DR. BARROWS: Mr. Chairman and members of the Commission: Frank Adams and H. H. Barrows, members of the consultant board for the Rio Grande Joint Investigation; Harlow M. Stafford, engineer in charge of the Joint Investigation; J. C. Stevens, consulting engineer for the Joint Investigation; N. C. Grover, Chief Hydraulic engineer of the Geological Survey and member of the Water Resources Committee; Vincent M. Miles, assistant to Attorney General Cummings, and legal consultant of the National Resources Committee.

MR. HARPER: There are also present as advisers to the Chairman, E. B. Debler, Hydraulic Engineer of Bureau of Reclamation and H. J. S. Devries, district counsel of the Bureau of Reclamation. If the name of anyone has been overlooked, I hope he will speak out.

At the last meeting of this Commission, which was held September 27th to October 1, 1937, the decision was reached to delegate to the engineering advisers of each of the Commissioners and the engineering adviser for the Chairman, the task of preparing a report setting forth certain factual data bearing on the state line flow schedules. A resolution was adopted, which I will read to refresh your memories. (reads) "In line with the conversation had by the commissioners, I move that one engineering

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consultant of each state, together with Mr. E. B. Debler, meet in Santa Fe, or such other place as they may mutually elect, on October 25th, for the purpose of discussing the engineering features, particularly of the state line deliveries and deliveries at San Marcial, in order to determine if they can arrive at a determination of general principles and if possible agree on the details of the deliveries, and the engineering factual data which should underlie the compact. Also that the meeting of the commission itself be deferred to such date as may be mutually agreed upon, pursuant to the call of the chairman."

The engineering committee held one meeting in Santa Fe and a later meeting in Los Angeles, and submitted a report under date of December 27, 1937, copies of which I believe have been furnished the commissioners and all interested parties. I trust that the representatives of each of the states that are concerned in this matter have had time to analyze this report and that the commissioners are prepared at this time to state whether this report meets with their approval, and if not, to bring out any points on which they are not in agreement with the findings of the report. If the commissioners have no other suggestion to offer, I would suggest that we proceed to discuss this report and in particular to give all of the representatives here an opportunity to state whether the report is agreeable to them.

MR. CLAYTON: May I suggest that we proceed with the states in the order they have been called on heretofore to get the views of the commissioners.

MR. HARPER: Very well. Mr. Hinderlider, what have you to say in reference to this report?

MR. HINDERLIDER: I will say that Colorado is satisfied with the general conclusions arrived at by the engineering committee. There are certain items, however, which we will want to discuss at greater length a little later on, but in view of the fact that the commissioner for New Mexico has heretofore, in writing, voiced objections to the findings of the engineering committee, I feel that the proper procedure at this time would be for Mr. McClure to present in more detail, than was done in correspondence with the chairman and the other two members, those points which he does not concur with in the findings of the engineering committee. I apprehend such a procedure will open the entire report for general discussion, at which time Colorado probably will want to present certain views as a result of the findings of the engineering committee.

MR. HARPER: Are you prepared to go ahead, Mr. McClure?

MR. McCLURE: I don't remember the date of the letter I wrote to Mr. Harper, but I believe it was about January 18th. After receiving the engineering committee report and making a preliminary analysis of it, I came to the definite conclusion that from New Mexico's standpoint that there should be one or two distinct

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basic changes in the report and some minor changes that were not quite so important. I will go through the major changes which we consider should be made in the report. First, New Mexico feels that the Otowi index supply in relationship to the Elephant Butte usable water supply is not an accurate or good basis on which to set up a schedule at San Marcial or Elephant Butte. We feel that that schedule should be based on the Otowi index supply to San Marcial in that supply and not to the Elephant Butte usable water supply. For the next change, it was stated that natural flows would be used on these control points or stations. We feel that recorded flow should be used instead of natural flow. On page 8 of the report, second paragraph, New Mexico feels that due to Indian rights there might be some new development over which New Mexico has no control; therefore that paragraph should be changed to include only development that New Mexico would have control over. In regard to the normal release from Elephant Butte, New Mexico is not satisfied, and cannot be satisfied, with the figures set up. At the same time we feel that there should be some definite consideration or basis for Mexican diversions and losses, as that paragraph refers to adjustments of saving or loss due to Mexican use. Under project storage of the Elephant Butte, there is an indefiniteness in that paragraph regarding the 2,638,860 acre-feet. As we understand it, there is flood control water included in that, and that paragraph should be made definite in regard to these flood control waters. On pages 11 and 12 of the report, which deals with the limitatiin of credits in regard to unusable spill, we feel there should be a clarifying of this paragraph in relation to what might be accomplished on debit that Texas has over normal increase in regard to theoretical spill. Before that, on pages 10 and 11, the paragraph on reduction of debits, we feel that the word "actual" should be added to the capacity of project spill. The first line after the word 'total' on page 11. The first paragraph under other limitatiins is very indefinite and a clarification of that paragraph should be made. Also, we feel that the question of power should be considered in that paragraph, and there should be included in the report a relationship between operation of El Vado in regard to the three summer months that have been eliminated from this schedule. Those are the major exceptions that New Mexico takes to the report.

MR. HARPER: May we hear from you now Mr. Clayton?

MR. CLAYTON: On the whole, we are satisfied with the report. It may be that as this discussion proceeds we may have suggestions primarily for the clarification or phraseology of the report in certain particulars. Most of them are of minor importance. I am not prepared to speak at this time with reference to the objections which the commissioner for New Mexico has just offered, but I would suggest that the commissioner from New Mexico give us, in writing, the gist of the statement he just made so we can take it under consideration. I must say, however, that Texas does not concur with the view expressed

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by Mr. McClure in his letter to you, to which he has just referred, under date of January 25th, that the engineers representing the several states and the United States exceeded their authority in this report. As I see it, they did precisely what they were instructed to do, and in general the principles that they laid down we believe to be sound. When we offered the suggestion at the last meeting that the engineering advisers meet and try to work out a basic formula, we had in mind definitely that they were to work out a schedule of state line deliveries based upon experiences in the past, and as I understand it, that's what they attempted to do in this report. Texas is willing to proceed with the negotiation for a compact based upon the report of the engineers. As I say, if there are any suggestions for modification of the report, we would like to have them in writing in order that we can digest them and prepare to answer them. In particular I should like a statement, either now or later, from the Commissioner of New Mexico as to what he considers a proper figure for a normal release from Elephant Butte or supply in the Elephant Butte.

MR. HARPER: Mr. McClure, could you arrange to furnish each of the commissioners and the chairman, later in the afternoon but before this evening, a written statement of your objections so they would have time to consider them this evening?

MR. McCLURE: I can furnish a partial statement on that, but I don't think its necessary to go into the major details of working out these various changes, or showing these changes by a written statement. My suggestion would be that the engineering committee meet again and go into these discussions from that standpoint. I would be glad to state now the major defects I think are in more or less basic principles, or the basis that they laid their report on, but as far as going into all the details of the other things, I think it would save time and accomplish much more if the committee would meet again and attempt to clarify the indefiniteness and see if they can arrive at a basis which New Mexico has suggested in regard to the two index supplies, Otowi against San Marcial instead of Elephant Butte usable, and also on a basis of relreases from the Elephant Butte Reservoir. Our main objection, of course, is on the basis of Otowi to the usable water supply. It doesn't show the past picture in any way, or even arrive at it closely, and I think it can definitely be shown by engineering data. In that case it might be that it would cast reflections on the release, and for that reason I would like to make the suggestion, and if necessary the motion, that the engineering committee do meet and arrive at a clearness of these paragraphs, as well as see if they can reach an agreement. As far as the statement I made that they exceeded their authority, I do think they did. If they had tendered actual factual data in regard to these releases and in regard to the relationship of the control points and stations, it would have been different. However, it was strictly a compromise and I don't think any compromise or any division lies in the hands of the engineering committee but should be brought before the commission. I certainly didn't understand at the time the resolution was passed that that would be the condition. I understood they would determine what had been done in the past and

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set up schedules accordingly and submit it to this commission. That was not done either in releases from Elephant Butte or in relationship between Otowi and San Marcial as the resolution requested.

MR. HARPER: Do you wish to make a formal motion?

MR. McCLURE: I will be glad to make a motion that the engineering committee meet again to clarify and reword the report that they submitted to the commission. I might add it may not be necessary to adjourn this meeting; there are other points on this compact which might be taken up while they are in session. We might take other phases besides the engineering phase, but I do think before we can arrive at any definite conclusions from an engineering standpoint, we will have to have more information from the committee.

MR. HARPER: My idea in making the suggestion that you furnish a written statement is not that you should go into very much detail, but only furnish a summary of any statement you had written when you made your presentation so the commissioners could have before them a precise statement of each of the points raised. I believe that would be helpful in guiding them in their future procedure.

MR. CLAYTON: I confess I cannot see at this time the point of having another meeting of the engineering advisers without the compact commissioners. This report was agreed to unanimously by the engineering advisers; they spent a great deal of time in its preparation and when they signed it, I can see they believed that they were recommending for adoption into the compact, or to serve as a basis for a compact, the data, facts and figures which they believed to be reasonably accurate, within the limitations which they express in the report itself. It seems to me it would reflect on these four engineering advisers to go into another conference by themselves for the purpose - as Mr. McClure says - of a clarification of their report, certainly until the matter has been further thrashed out here in meeting of the commission and the points of difference, if any, aired. My suggestion would be, if there is anything in this report that needs clarification, that the engineering advisers who prepared it be called upon by any of the commissioners, or for that matter, by the representatives of the National Resources Committee, for an explanation in order that we may all have it. If they arrived at certain conclusions in this report with which any of the commissioners take issue, those points should be made known. In other words, since the committee of engineers have met and gone over this thing thoroughly, and I might say strenuously, I can't see that anything could be accomplished by giving it back to them without specific instructions as to what they are to do, and for that reason, Mr. Chairman and gentlemen of the commission, my suggestion would be, in opposition to the motion made by Mr. McClure, that we take up the report for discussion here and now and if it needs clarification, let's get the explanation here.

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MR. HARPER: Mr. Hinderlider, have you anything to say on this subject?

MR. HINDERLIDER: Mr. Chairman, Mr. McClure has voiced the feeling that the engineering committee has exceeded its authority given under a resolution which the commission adopted at its last meeting, and has pointed out certain objectionable points or conclusions which may have considerable weight. I would not, myself, be disposed to object to an immediate meeting of the engineering advisers if such procedure would expedite the work of the commission. I do not personally think it is necessary, as Mr. Clayton has just stated. I think the commission could proceed to analyze the report and all those objectionable points mentioned by Mr. McClure could be discussed in detail at the same time. If, perchance, the business of the meeting will be expedited, I see no serious objection to adjourning this meeting until tomorrow to give the engineers an opportunity to meet this evening to see if they can reach common ground on some of these points. There are a few items to which Colorado will later direct its attention and raise questions which will need clarification and possibly some alterations, but I think probably they are not of major consequence at this time. I suggest Mr. McClure present in more specific form to the commission a statement of his objections so if the engineering committee is called together this evening to give it further consideration, they will have specific points before them for definite consideration. It may be such procedure will result in saving some time rather than try to proceed at this time before the whole commission. Either plan is agreeable to me.

MR. HARPER: In order to get this matter before the commission, Mr. McClure has made a motion and unless a second is made to that motion, the matter will have to die.

MR. HINDERLIDER: I am inclined to think that out of courtesy we should accede to his request. I doubt if we can make much progress as long as one of the commissioners is dissatisfied.

MR. CLAYTON: I don't object to the engineers furnishing the commission with any clarification needed, but I am at a loss to know what instructions we should give the advisers if they are asked to go over this report.

MR. HINDERLIDER: I would suggest they consider Mr. McClure's objections.

MR. McCLURE: The first objection I made to the report would automatically require a definite new schedule in the relationship, and it would require work by the committee to compile that new schedule. That is based on engineering data which have been checked and analyzed since the report was made and were not checked and analyzed in Los Angeles on the basis on which the report was made. On that basis alone I would think the engineers would have to meet in order to arrive at that new schedule on the new index supply.

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MR. HARPER: It seems to me before we can instruct the engineers as definitely as you imply in your statement in regard to revamping this schedule, we must in courtesy to them, give them a chance for full expression of their views as to whether they are willing to reconsider their findings and compilation of data on these various points. It would seem to me all we could reasonably ask the engineers to do at this time would be to ask them to review a summary statement which you would make setting forth your objections and ask them to report back to the commission as to whether they are willing to consider revamping their conclusions along the line you suggest. If they report back they are willing to do it, then the commission may instruct them to go ahead; and if, on the other hand, they are of the majority opinion that they could not consider revamping the data which they have already submitted, then the matter will be back to the commission as a whole to decide. Would you have any objection, Mr. Clayton, to the engineering advisers meeting this evening after Mr. McClure has presented a summary statement of his objections, asking the engineers to report back to the commission as to whether they can see their way clear to go into the questions which Mr. McClure has raised to the extent of revamping their entire report? If their conclusion is in the negative then the commission tomorrow would have to consider the objections in regular session.

MR. CLAYTON: Do I understand that you propose the engineering advisers meet again with a view to determining whether some other basis of allocation or deliveries can be arrived at?

MR. HARPER: Not precisely. It was my view they should meet again with a view to determining whether they would feel justified in reconsidering any fundamental basis of their report in the light of Mr. McClure's objections. If they are not so willing to do, then the matter would have to come back to the commission and we would have to take up Mr. McClure's objections.

MR. CLAYTON: I cannot see any objection to that. I am afraid this report was the result of a great deal of strenuous labor and I am afraid much more time will be consumed by the engineering advisers which may turn out to be profitless discussion. I have no objection to the engineering advisers meeting with the view that you just mentioned. That's entirely satisfactory.

MR. HARPER: It might expedite the progress of the deliberations of the commission if we give the engineering advisers an opportunity to get together for an informal discussion, having before them these several points which Mr. McClure has raised.

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MR. CLAYTON: I think that's entirely all right.

MR. HINDERLIDER: They have submitted a report and it may be that report should be considered upon its face rather than they meet again and revise it.

MR. HARPER: They should certainly have their chance to express their collective views as to whether the points raised had any bearing on their findings which they would care to reconsider. We would not ask them at this time to go into the matter of revision of the report in any form. But I would be glad to ask them for their individual views at this time.

MR. HINDERLIDER: May I ask first, Mr. McClure, have you available factual data, figures and analyses of such data which would be available to the engineering advisers at this time to indicate to them the effect of your objections on this schedule which they worked out?

MR. McCLURE: We have an analysis of this in the office, of the relationship of the control stations which we feel is the basis the report should be made on.

MR. HINDERLIDER: Unless you already have such figures it might be a waste of time to open up the whole thing by the engineers.

MR. McCLURE: We have the figures showing the difference it does make. The relationship of Otowi to the Elephant Butte was not accurate. We made a complete analysis of that.

MR. HARPER: The advisers should be given a chance to express their views as to whether they feel their report should be reopened. In order to determine that question they must have a statement from Mr. McClure listing these points and they must have a chance to consider these in a meeting of their own.

MR. CLAYTON: That's a much narrower scope than if they went into new figures at this time.

MR. HARPER: As to the suggestion that we ask the views of the engineers at this time, do you think we should proceed to do that?

MR. HINDERLIDER: I think that certainly should be done, as a matter of courtesy to our engineering advisers. I would ask Mr. Tipton to express an opinion as to whether or not he would be agreeable to go into the matter of the figures and the protests submitted by Mr. McClure.

MR. TIPTON: This is an advisory committee of the commission and I think should follow the wishes of the commission. If the commission thinks the report should be reviewed in view of Mr. McClure's objections, I think the committee should do that. I have no objection to meeting with other members of the committee to determine whether or not there should be changes made. I have no objection to taking Mr. McClure's objections and

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considering them with a view to changing figures if they should be changed. I think the text of the report in some places needs clarification. While basic data were thoroughly analyzed certain major premises were assumed, upon which the whole report was based and those premises I don't think should be changed. However, the method of expressing certain of the sections of the report probably need some change for clarification rather than any change in principle, but those are matters which the engineering committee should take up with the commission. I am at the disposal of the commission.

MR. HARPER: Mr. Bliss.

MR. BLISS: I have had time since the Los Angeles meeting to analyze the various data and schedules together and agree that the changes which Mr. McClure has suggested should be made. I would be willing to meet with the other members of the committee and see if such changes can be made.

MR. HARPER: Mr. Hill.

MR. HILL: I think the engineering advisers should very properly meet to discuss in committee what position they should take. So far as expressing at this time as to whether any changes are desirable, the committee is in no position to make any such statement - we don't have the data upon which to base any statement.

MR. HARPER: Mr. Debler.

MR. DEBLER: As I see it this committee was organized for the purpose of assisting the commissioners, and as such I am sure everyone of us is ready to consider anything the commissioners wish to pass to us to work on. I have no objection whatever to this meeting which has been suggested. I believe, however, we should have for consideration at this time the material on which Mr. McClure has based his objections. Only by having such material before us could we hope to arrive at any conclusion with regard to consideration as to conclusions adopted by the committee.

MR. HARPER: The engineering advisers have all expressed themselves as agreeable to meeting in this preliminary way, and I will be glad to entertain a motion to put that into effect if the commissioners see fit to do so. Mr. McClure's motion was too broad for this purpose - that the engineering committee should meet and revise the whole report. As I understand it our feeling now is that the engineering advisers should meet and report back to the commission tomorrow as to whether they feel they should undertake the revision of the report.

MR. McCLURE: I'll withdraw my former motion and make the motion that the engineering committee meet and decide whether they shall take up the revision of the present report that has been submitted.

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MR. HINDERLIDER: That's exactly what the motion was before - to revise the report. It is my understanding that was not the purpose; it was to meet and decide after receiving, in writing, Mr. McClure's objections and see if in the minds of the committee they are well founded and if so, then entertain the question of whether they would attempt a modification of the report in harmony with such suggestions, or report back to the commission.

MR. McCLURE: My motion is for them to go into the report and determine whether it is advisable to revise it.

The motion was seconded by Mr. Hinderlider and unanimously carried.

MR. HARPER: Is there anything further to come before the meeting this afternoon?

MR. DEBLER: As these engineering advisers are to meet, I would like to make the suggestion that the committee be authorized to call before it any individuals it may desire to hear with respect to the objections which Mr. McClure has made.

MR. HARPER: I don't think there will be any objection to that. I believe it should be understood that the meeting of the engineers is not to be public.

MR. DEBLER: The engineers only, but that we be authorized to call such witnesses as we may wish to hear.

MR. HARPER: You can take that for granted. If there is nothing further at this time to come before the meeting I will entertain a motion for adjournment. If there is, I will be glad to stay.

MR. CLAYTON: I move that the commission recess until 10 o'clock tomorrow morning to receive the committee of engineers report.

The motion was seconded by Mr. Hinderlider and unanimously carried. Whereupon at 4 P.M. the meeting recessed until 10 A.M. March 4, 1938.

Santa Fe, New Mexico,
March 4, 1938.
10:30 A.M.

MR. HARPER: I understand the engineers have completed a review of the objections which Mr. McClure submitted yesterday and that they are now ready to submit their report back to the commission. I will ask Mr. Debler to present that report.

MR. DEBLER: Mr. Chairman and members of the commission: The Compact Commissioners on March 3, 1938, in open session, instructed this committee of engineer advisers to review a statement to be submitted by the Compact Commissioner of New Mexico on New Mexico's objections to the December 27, 1937, committee report

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and to report back to the commission whether such objections warranted the committee in reconsidering its report. The Compact Commissioner of New Mexico thereafter submitted a statement, copy of which is hereto attached, of such objections, and the committee of engineer advisers report thereon as follows:

Opening Paragraph and Paragraphs 1 and 2:

New Mexico proposes a substitute plan for the control of operations by New Mexico interests above Elephant Butte Reservoir. The committee has heretofore considered some alternatives to the plan adopted by it but stands ready to give further consideration to the New Mexico plan upon submission by New Mexico of its alternate plan, including applicable curves, tables and other details and including a tabular comparison with the committee plan, of resulting stream flows.

Paragraph 3:

New Mexico desires to be relieved of responsibility for Indian or other operations beyond its control. The committee believes this matter is one of policy for determination by the Compact Commission.

Paragraph 4:

New Mexico claims that 800,000 acre-feet of water exceeds both past uses and requirements below Elephant Butte Reservoir. The committee is agreeable to reviewing any data in support of this claim not heretofore available to the committee.

Paragraph 5 and first sub-paragraph thereof:

New Mexico desires a figure adopted for present use by Mexico. The committee has heretofore discussed this matter but failed to reach common ground by reason of the meager data available. It is suggested that New Mexico present its conclusions, together with all supporting data for review by the committee.

Second sub-paragraph of Paragraph 5:

New Mexico insists that treaty provisions be carried out and that Texas or the United States be made responsible therefor. The responsibility for observance of the treaty with Mexico is one of policy for determination by the Commission.

Third sub-paragraph of Paragraph 5:

New Mexico objects to a judicial interpretation by the committee on Mexican Treaty obligations. Since no interpretation was made, this objection has no point.

Paragraph 6:

As explained to us by the New Mexico member, this paragraph aims to secure clarification. The committee is agreeable to such clarification.

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Paragraphs 7 and 8:

These paragraphs aim at revision of features governing operation of Elephant Butte Reservoir. A further discussion may show some changes warranted.

Paragraph 9:

New Mexico desires to compel avoidance of power waste at Elephant Butte Reservoir. The committee is agreeable to preparing such a provision.

The committee stands ready to consider written specific requests by any commissioner for clarification of the intent of any of the provisions of the committee plan.

Respectfully submitted,
Committee of Engineering Advisers
E. B. Debler, for the U. S.
R. J. Tipton for Colorado
John H. Bliss for New Mexico
R. A. Hill for Texas.

Objections of New Mexico to the Engineering Report Filed with the Rio Grande Compact Commission on December 27, 1937.

New Mexico objects to the use of the Otowi Index Supply and Elephant Butte Index usable water supply as a basis for deliveries to San Marcial. This should be changed to a delivery to San Marcial based on an Otowi Index supply to a San Marcial Index supply, excluding the months of July, August, and September.

1. The best relationship which existed in the past is expressed by a curve showing the relationship of Otowi to San Marcial. The numerous indeterminate factors that enter into the picture of usable supply in the reservoir will reflect greater inaccuracies than will the San Marcial method in using this as a basis for deliveries. These factors are bank storage, withdrawal of bank storage, the determination of silt content on an annual basis, and losses occurring from the San Marcial gaging station to the reservoir.

2. New Mexico objects to natural flow at the Otowi station and insists upon recorded flow. Natural flow debits us with El Vado storage during the spring months, with no credit when this stored water is released during the months of July, August, and September.

3. On page 8, second paragraph of the report, provision should be made so that New Mexico would not be responsible for any new diversions or use above Otowi over which she has no control, such as Indian development.

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4. New Mexico objects to a normal release from the Elephant Butte based upon 800,000 acre-feet of water annually. This is far in excess of past and present average releases and is far in excess of their project needs.

5. New Mexico insists that a definite figure be set up as the average quantity diverted to the Republic of Mexico during the period 1928 to 1937, inclusive. This to be used as a basis for determining the quantity of water which will be saved so that due credit may be given to New Mexico, Colorado, and Texas.

New Mexico likewise insists that a definite method of determining the amount of saving shall be fixed and established.

New Mexico insists that the treaty rights be carried out and the responsibility of carrying out such treaty provisions be definitely placed either with the State of Texas or with the United States.

New Mexico takes the position that it is no part of the duty of the engineering committee to place a judicial interpretation upon the treaty obligations to Old Mexico.

6. New Mexico insists upon a determination of the exact elevation of water in Elephant Butte Reservoir, which shall determine the maximum capacity of project storage.

7. New Mexico insists that, on pages 11 and 12, paragraph on reduction of credits, the following clause shall be added: "...provided that Colorado and New Mexico credits shall not be reduced by any quantity of theoretical unusable spill caused by the adjustment of actual water in storage by the quantity by which project releases exceed the normal release."

8. New Mexico suggests that the first paragraph under "Other Limitations" be changed to read: "... that only sufficient water shall be released from storage debits to bring project storage up to 400,000 acre-feet," or some other method for attaining the same result.

9. New Mexico believes that under "Other Limitations" a paragraph should be included so that any water released from Elephant Butte Reservoir for power development which is not stored in another project reservoir for subsequent release for irrigation purposes shall be considered as part of the normal release.

MR. HARPER: What is the pleasure of the commission in regard to this report? Mr. Hinderlider, have you any suggestion to offer as to procedure?

MR. HINDERLIDER: It would probably be more proper for Mr. Clayton to reply to that.

MR. HARPER: Mr. Clayton, will you come to the rescue?

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MR. CLAYTON: It seems to me the report here seeks to have the commissioner from New Mexico furnish the data and other figures on which they predicate their demands. It would seem proper to me, therefore, that the request of the committee be acceded to if the commissioner from New Mexico wishes to insist upon their demands in order that the committee of engineers can proceed further.

MR. HARPER: Do you concur in that?

MR. HINDERLIDER: I concur.

MR. HARPER: May I ask Mr. Debler and the other members how long you anticipate it would take to go into these various matters which you indicate a willingness to review?

MR. DEBLER: It is my impression it would take, on the first matter, which is probably the most important, two or possibly three days to consider the material which New Mexico might submit, for committee discussion and for the hearing of any others whom we might wish to interrogate or to ask for guidance on the alternate plan. There are no other matters for discussion by the committee which I believe would take more than probably half a day to reach a conclusion on. If I am wrong in my estimate, I hope these other gentlemen will correct me.

MR. HARPER: Mr. McClure, do you have your data in such shape it can be submitted without delay to the committee of engineers?

MR. McCLURE: It is, I think, yes sir.

MR. CLAYTON: I suggest in view of what Mr. Debler said, that each of the engineer advisers representing the states express their views as to how long they think it will take to review the data to be submitted by New Mexico in order that we may have the views of all the advisers.

MR. HARPER: That's a good suggestion. Mr. Tipton.

MR. TIPTON: I believe Mr. Bliss could answer that because he knows what shape New Mexico's material is in.

MR. BLISS: I don't believe Mr. Debler has understated the time; it will take at least 2 or 3 days to consider this proposed schedule.

MR. HARPER: Would you estimate that by Monday morning you might have the matter reviewed?

MR. BLISS: It might be possible.

MR. HARPER: Do the other engagements of the engineers make it convenient for them to stay with this over next week?

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MR. TIPTON: I have to be in Topeka on Tuesday or I might possibly not have to be there until Wednesday. I will have to talk that over with Judge Stone.

MR. HARPER: I haven't discussed this particular question with the commissioners, but I feel we should make every effort to carry on our negotiations here just as far toward a conclusion as possible at this meeting and not turn this matter over to the engineers with a view to having them report back to the commissioners at some future date. If any of the commissioners have any view contrary to that I would be glad to have them so state.

MR. HINDERLIDER: I heartily concur in your statement.

MR. CLAYTON: If we are going to compact, we ought to compact now. We have delayed this thing as long as it should be delayed. We have no way of knowing whether another report by the committee won't be objected to. We should consider these problems as they arise and reach common ground or find out we will not be able to. I can see no advantage to further delay.

MR. McCLURE: I don't feel New Mexico can consider the report as part of a compact, or a basis to compact on as it is now. If there are other things to be discussed and necessary in a compact at this time, I think they can be taken up while the engineers meet. On the basis of the engineers' report, as I stated in my letter to you, it would be a waste of time for New Mexico to even consider that report as a basis to arrive at a permanent compact on.

MR. HARPER: We understand your position clearly, but the point I wanted to bring out was whether it was your view, after we get this revised report from the engineers, to stay right here to determine whether or not we will be able to reach an agreement on the revised report, not the report as it now stands.

MR. McCLURE: Absolutely so; my time is available until the compact is reached or not reached.

MR. HARPER: I will hold everyone here until we agree on a compact.

MR. CLAYTON: Since our discussions so far have been taken up with the committee of engineers report, I think it will be proper to incorporate in the proceedings the report of the engineers and correspondence had between members of the commission with reference to it prior to this meeting in order that they may all be made a matter of record.

MR. HARPER: I will see that that's done. (The report and correspondence are included in the appendix). We have now agreed on a course of procedure and it seems to me we should let the engineers start immediately on a review of their report if that is at all possible. I would like to have the views of the commissioners as to whether the commission should go ahead and attempt to discuss some of these matters which are not to be covered by the

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engineers report, or whether we should simply wait until the engineers have completed their review. What is your pleasure?

MR. CLAYTON: It occurs to me that there are other matters which might properly be considered by the commission during the deliberations of the committee of engineer advisers. For instance, if we agree upon an allocation of the waters and program of deliveries, there will still be the question of setting up machinery for the carrying out and enforcement of the provisions of the compact, and general provisions of the compact that do not relate to engineering matters, and those I should think could be profitably considered by the commission while the engineers are meeting, and probably we can get that matter out of the way.

MR. HINDERLIDER: It has been my feeling all along that the paramount question for arriving at a decision upon this compact is the equitable division of the waters of the river, and I have felt very strongly that that matter should be disposed of, if at all possible to reach a decision, before other questions are injected into our discussions which might, as we say, have the effect of muddying the water. There may be certain points which might profitably be discussed by the commission and their advisers pending the further report of the engineering committee. Before agreeing to the suggestion made I should like to have a little time to discuss this point with my legal adviser, the attorney general, who is present, and if possible agree upon such points as might be fruitful of further discussion by the commission, possibly including some of those points referred back to the commission by the engineering advisers. Therefore, before committing myself on that, I would like to discuss the matter briefly with my advisers.

MR. HARPER: I suggest the meeting recess for 10 or 15 minutes to permit informal discussion. Meanwhile, the engineers could get together and make preparations to start their work of review. (10 minute recess.)

MR. HINDERLIDER: In view of the fact, Mr. Chairman, that the question propounded will require considerable discussion between the commissioners and their advisers, I suggest that we recess until 2 o'clock this afternoon at which time we can report back here as to the advisability of discussing further the questions presented looking to the formulation of a compact outside of the question of the equitable division of the waters of the river.

MR. CLAYTON: Do you propose the committee of engineers go ahead with their deliberations?

MR. HINDERLIDER: That, I feel, is paramount and must be settled one way or another.

MR. CLAYTON: Will you incorporate that in your motion?

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GOV. HANNETT: Before a motion is put, I have a suggestion which I think will save a lot of time. On the engineering committee Mr. Bliss represents the State of New Mexico; the engineering expert for the Middle Rio Grande Conservancy District is Mr. Neuffer. Since that district is the most vitally interested area in New Mexico as to the effect of this compact, we believe it will save time if Mr. Neuffer is included in this engineering committee. Otherwise at the end of three days Mr. Neuffer will probably have to spend three more days checking these figures, and for that reason we make the suggestion that he be included in the engineering committee.

MR. HARPER: I have no doubt the engineering committee will be glad to keep Mr. Neuffer advised as negotiations proceed, but I feel we should leave it to the committee as to what extent they wish Mr. Neuffer to participate in their deliberations since Mr. Neuffer is not a member of the committee.

GOV. HANNETT: We will withdraw that suggestion then.

MR. HARPER: I am just expressing my indivisual views. I will be glad to hear from others.

JUDGE MECHEM: I would like to inquire whether the gentlemen here represent the State of New Mexico or the Middle Rio Grande Conservancy District. We have the largest interest in the Elephant Butte Irrigation District of any of the subdivisions in the State of New Mexico and Mr. Neuffer doesn't represent us.

GOV. HANNETT: As a practical matter, we all know that any compact entered into here would be absolutely futile unless the legislatures of the various states ratify it. If the Middle Rio Grande Conservancy District goes before the legislature and objects to any compact we enter into here, its just as certain as two and two makes four that it won't be ratified. For that reason the engineering expert of that district has got at least to have the opportunity to check our figures before we bind ourselves, and that's all we ask. If the committee wants to exclude him, that will be all right with us, but it will take an additional two or three days' time.

JUDGE MECHEM: My only objection was to have him substituted for the State's expert.

MR. HARPER: This committee has been set up by formal action of the commission and consists of the engineering advisers of each of the three commissioners, in addition to the engineering adviser to the chairman, and any changes in the make-up of that committee of course would have to be accomplished through formal action of the commission. What I stated a few minutes ago was in the nature of a suggestion so as not to disrupt the committee but at the same time accomplish what Governor Hannett is trying to do. I am sure the committee will be glad to have Mr. Neuffer confer with them as they go along so there will not be any time

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lost when their report is submitted in asking him then to go over what they have done. I would like to have Mr. Debler express the views of the committee. We are instructing them to undertake a task and I think we ought to let them express their views as to how they wish to conduct their meetings.

MR. DEBLER: I might say that this matter was presented yesterday when I suggested we have authority to call in anyone we wanted at any time to consult with us on these matters. We have no idea of excluding anybody, but at the same time there are discussions coming up where it is advisable that the participants be, in the main, the official representatives of the commissioners representing the states themselves. I believe, as has heretofore been stated, that would avoid loss of time which Governor Hannett fears, and at the same time I believe it will avoid having too large a committee as that always slows up operations. Its only proper that if any one state or district has more than its official representatives present, that privilege must be accorded to all other interests and it might be an unwieldy committee.

MR. HINDERLIDER: May I suggest, without having heard from the other commissioners, a happy solution might be for Mr. Neuffer to be considered a witness before the engineering committee without any authority to advise or formulate any policy or cast any vote in the committee. I don't know whether that would be agreeable to Mr. Debler and the other members of the committee or not. Its unfortunate, of course, that we find something of a division among the water users in any one of our states, but I have felt all along that the commission and engineering advisers could not very well invite in and take the views of all the different factions of the different states, or we probably will never get anywhere. There must be someone to represent all interests, but at the same time it might be possible to alleviate this situation - or it may be the commissioner from Texas or New Mexico might have a better suggestion.

MR. CLAYTON: I don't think we would have any objection to the suggestion made by Mr. Hinderlider. We have no say as to who shall constitute New Mexico's representation on that committee. It seems to me the idea was to confine it to one representative from each state and if we are going to enlarge it the chances are we will make it unwieldy. I think its entirely up to the committee to have observers or witnesses to the extent to which they think they should take part in the deliberations - it would be up to the committee primarily. As far as Texas is concerned, the suggestion made by Mr. Hinderlider is satisfactory.

MR. HARPER: Will that meet your requirements, Mr. McClure?

MR. McCLURE: The only thing in regard to that is that what we desire is to have Mr. Neuffer with the committee, not as a member, but if a question comes up that could be clarified as to the attitude of the conservancy district, why he would be present to do so. It would be an imposition on Mr. Neuffer to wait around here for 2 or 3 days subject to call when these things

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might be ironed out in a minute if he were in the meeting. We don't intend him to be a member of the committee, but more or less available to the committee for his suggestions when they want him.

MR. DEBLER: That's what the committee had in mind. Whenever we are discussing matters where we feel he is going to be helpful, we could have him in the room with us.

MR. HARPER: What do you have to say Mr. Neuffer?

MR. NEUFFER: I haven't any objection. I want you to understand that all I want is information, to know what I've got to consider. As the report was submitted I tried to get information on it but I couldn't. I asked Mr. Bliss and I understood him to say he wrote for the information, but we couldn't analyze the proposition. An item I asked particularly about was the Elephant Butte water supply, the matter of the 800,000 acre-feet. I asked him how they arrived at that with no basis of analyzing it and he said they just set up that figure. We have no closed door on this but we do want to be able to analyze the data upon which the figures are arrived at. Otherwise, we would have to go and work out something of our own and we would like to save time. I don't want to sit around here - I have other things to do and it is quite a sacrifice to go into this matter at this time but we want to help in every way we can. I don't want to tell the committee what to do, but when they do arrive at a figure we would like something tangible to make a study of. I will be available if they want me but if they won't call me for a day or two I want to be out of town. I haven't any pre-conceived ideas on this entire matter. The report may be perfectly all right but we haven't been able to analyze it.

MR. HINDERLIDER: As I understand it, the commissioners from Colorado and Texas are in agreement on this, and I would like to inquire if the commissioner for New Mexico is in accord with the other two states with respect to Mr. Neuffer appearing before the committee.

MR. McCLURE: As I stated, I am in agreement, but if it is a case of holding Mr. Neuffer here for a day or two and maybe not calling him, I think it is an imposition. However, I do think it can be arranged by having him available only in an advisory capacity for suggestions or if he would want information on the analysis of certain factors, he would know just what steps were taken. Whether he can do that best by waiting around and then going over it, I don't know.

MR. HINDERLIDER: I move that the matter be left to the discretion of the engineering committee. (Seconded by Mr. Clayton and unanimously carried.)

MR. HARPER: The matter will be left to the discretion of the committee. I am sure the committee will give Mr. Neuffer every opportunity to learn what is going on and to get the full benefit

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of his views. Is there a motion for recess pending?

MR. FRED WILSON: As one of the attorneys for the Middle Rio Grande Conservancy District I appreciate the courtesy you have shown in permitting us to be present and listen to your deliberations. I want to say our attitude is one of helpfulness and hope. We are perhaps as anxious as anybody that a compact be arrived at, but I want to say frankly that the attitude you have taken here this morning is a matter I cannot understand and I do not think its a matter that can be explained successfully to the average ordinary person in New Mexico. Just why a committee should be appointed by this commission to hold secret meetings is more than I can understand, and it seems to me that your committee should welcome the presence of Mr. Neuffer at all times because it will save time. If you don't do that you will go through the same thing you did this morning, and frankly I don't understand, and I don't believe its fair, to have secret sessions of this character with your committee. So far as I am concerned, if Mr. Neuffer's services are not desired by the committee, I will withdraw him as well as the legal representative.

MR. HARPER: I feel that we are magnifying unimportant matters into something out of all proportion with the facts. I don't think anything like a secret meeting is intended. The only reason that the engineering committee was delegated to prepare certain factual data in conference among themselves was to permit them to do that work without interruption, as it would be impossible.for them to sit around a table and do that with unlimited access by representatives of every interest here in this room. There is nothing secret about any deliberations carried on here, and I would like to correct that impression. The engineering committee is not going to exclude anyone, I don't believe, but at the same time they want to be free to carry on their studies and complete them in two or three days' time without too much interruption. I repeat what I said a while ago - I am sure this committee, knowing them as I do, are going to be frank with Mr. Neuffer and keep him informed as they go along about every detail of their deliberations. At the same time the committee is responsible for its report and we must give them freedom to conduct the details of their meeting as they see fit in the hope that all of those present can look at the matter in that light and not with the impression that they are trying to exclude anybody or any interest. Not only Mr. Neuffer, but there are other representatives from other states who no doubt will want to be accorded the same privilege.

MR. WILSON: I think it should be.

JUDGE MECHEM: On behalf of the Elephant Butte Irrigation District, we have no objection to Mr. Neuffer or any other representative of any special interests being present. We don't object to that at all; the only thing we did object to was that Mr. Neuffer should be substituted for a representative of the state engineer's office to represent the State of New Mexico.

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MR. HARPER: If there is nothing further, I will entertain a motion for recessing as Mr. Hinderlider suggested a moment ago.

MR. HINDERLIDER: If possible before voting on that motion, I should like to state that so far as Colorado is concerned, we have a multiplicity of problems in the San Luis Valley - possibly not as serious as appear to have arisen between the Middle Rio Grande and the interests under the Elephant Butte Project. We conceived that if every interest in our state had been permitted to come in and inject questions of what they considered their rights, it would have had the effect of clogging, or bogging down, our deliberations. Personally I regret - I am not speaking for Colorado at this time, but I personally regret any difference between elements in any of our three states. We are faced with a practical problem, however, and to the end that we may ultimately reach a decision in this matter, which is devoutly hoped for by all of us, I feel the commissioners should take a stand at this time of not precluding the presence of any designated representative from any part of the basins in any of our states if they want to be heard by any of this engineering committee. I think it would be a mistake to make such representative a member of the committee, but they certainly should have the opportunity to appear before the engineering committee and submit any factual data they have, and I so move if it is not already the concensus of opinion of the commission that such opportunity be afforded to Mr. Neuffer, or anyone else who represents an interest in New Mexico as well as the other two states. The engineering committee is trying to ascertain the facts; they are a fact finding body for the enlightening and advising of the three compact commissioners in their deliberations, and we should, of course, have all the facts as nearly as we can obtain them. The door should not be closed to the ascertainment of all the facts within reasonable bounds certainly.

MR. HARPER: Mr. Hinderlider made a motion; do you all understand its import without repeating it?

MR. HINDERLIDER: I didn't intend to include all those statements in a motion, but it is my feeling it should be the sense of the commission that the commission, through the engineering advisers, was not seeking to close the door to anyone who has the opportunity and capacity to submit facts for the information of the engineering advisers. (Seconded by Mr. Clayton and unanimously carried.)

MR. HARPER: We now have up for consideration the motion which Mr. Hinderlider made previously to recess. (Seconded by Mr. Clayton and unanimously carried.)

Whereupon at 11:30 A.M. the meeting recessed until 2 P.M.

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MR. HARPER: (2:15 P.M.) Mr. Hinderlider, are you ready to report on plans for the next day or two ?

MR. HINDERLIDER: Mr. Chairman and gentlemen of the commission: The meeting this morning recessed until this afternoon for the purpose of deciding whether or not it would be helpful and advisable for the commission to take up for consideration other pertinent points or features of a proposed compact pending the further report of the engineering committee. While Colorado has no objection to a consideration at this time of other features which doubtless will have to be considered before entering into a compact, we believe that it would be in the interest of the conservation of time and energy, and probably eventually expedite the conclusions of the commission if it were to recess at this time until the engineering committee is ready to report which, I understand, may be some time Monday. In making this suggestion it is not the idea that the conference should adjourn, or any of the parties who are necessary to this conference go home, but that they remain here subject to the call of the chairman for receiving the engineering committee's report, after which time it may well be that the conference could give its time and attention to the consideration of further points which will have to be taken up eventually.

MR. HARPER: Do you concur in Mr. Hinderlider's remarks?

MR. CLAYTON: Mr. Chairman and gentlemen: We have no objection to the procedure suggested by Mr. Hinderlider so long as it is understood that this, as he expressed it, is not an adjournment but a recess only until the committee of engineers is ready with their report. It may be, as he says, that it will be in the interest of conservation of time if some of the matters that may come up before the commission are thrashed out within the state delegations and perhaps informal meetings of the commissioners with their counsel. That is something that we can take up among ourselves, but I should be very much opposed to seeing this meeting adjourned indefinitely and called back at some future time. I think while we are here, as long as there is any possibility of settlement, we should thrash it out, and with that reservation, we have no objections to Mr. Hinderlider's suggestion.

MR. HARPER: Mr. McClure, do you have any objections to this procedure?

MR. McCLURE: New Mexico has no objections to the program outlined by Mr. Hinderlider. Since all of the members, under his suggestion, are going to remain here, it might be they could keep their mind on some of these additional things and iron them out among their own constituents so they would be in a better position when these matters do come up to take action immediately. The only other suggestion I would like to make at this time would be, as Mr. Hinderlider intimated, there might be some minor changes in the report. If he could get Mr. Tipton to bring those out perhaps we could iron those out during the present

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engineers meeting and expedite those, rather than waiting to take them up at a later date after the report is finished. That's all I would suggest.

MR. HARPER: The feeling appears to be unanimous that we should recess and hold ourselves in readiness to meet at any time. At this time we will recess the meeting until not later than 10 o'clock Monday morning, and such earlier time as circumstances may justify calling the commission together, but in any event not later than 10 o'clock Monday. Meanwhile, I suggest that we follow Mr. McClure's idea in having informal conferences to crystallize the ideas of each delegation and possibly among the different commissioners on various points. If there is nothing further at this time, the meeting will be recessed until 10 o'clock Monday morning. (Recessed at 2:45 P.M.)

Santa Fe, New Mexico,
March 7, 1938.

At 10 o'clock the Committee of Engineering Advisers not being ready to report, the meeting was postponed by the Chairman to 10 o'clock Tuesday morning, March 8, 1938.

Santa Fe, New Mexico,
March 8, 1938.

The Committee of Engineering Advisers not yet being ready to report, the Chairman postponed the meeting to 10 o'clock Wednesday, March 9, 1938.

Santa Fe, New Mexico,
March 9, 1938.

At 10 o'clock the Committee of Engineering Advisers not yet being ready to report, the Chairman postponed the meeting to 10 o'clock Thursday, March 10, 1938.

Santa Fe, New Mexico,
March 10, 1938.

MR. HARPER: (10:15 A.M.) The record, I believe, shows that this meeting was recessed last Friday to meet Monday monring at 10 o'clock. As you know, we have postponed the meeting from day to day until we could receive a unanimous report signed by the Engineering Committee, and that report has now been submitted to the Chairman and copies have been distributed to each of the Commissioners. I think the expressed views of the Commissioners is that the report be read at this time for the information of those who have not yet had a chance to look it over. I will ask Mr. Debler to read the Engineering Committee report.

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MR. DEBLER: (reads) The report dated March 9, 1938 appears in the appendix.

MR. HARPER: Thank you, Mr. Debler. I think I can speak for all of the members of the Commission when I say we are very deeply appreciative of the untiring efforts which the Engineering Committee has devoted to this very difficult task. I know they have worked night and day and have been confronted with difficulties which could only be surmounted by the broadest viewpoint of the problems confronting each of their states. I also wish to express appreciation for the very fine assistance which Mr. Neuffer gave to the committee. What is the pleasure of the Commission as to disposition of this report?

MR. HINDERLIDER: Mr. Chairman, in view of the fact the Commisioner for Colorado received a copy of the report of the Engineering Advisers just before we came into this conference, I feel it highly necessary that Colorado's delegation have an opportunity to digest the results of the report. Unless the Commissioners from the other two states, with their advisers, at this time wish to have the report as presented more definitely clarified on some of the points, I suggest the Commission now recess until - let's say, in the morning possibly, or whatever time is mutually agreeable to the Commission, for a further study of the report just presented.

MR. HARPER: I will be glad to hear the views of the other commissioners.

MR. HINDERLIDER: I might ask that additional copies of the Engineering Committee report be provided, not only to the commissioners, but their respective delegations.

MR. HARPER: Yes, we will see to that.

MR. McCLURE: Mr. Chairman, New Mexico concurs in the suggestion of Mr. Hinderlider. I don't believe there are any points which are necessary to be cleared up now, at least, and I believe we should recess.

MR. CLAYTON: Mr. Chairman, we are prepared to proceed at any time. However, it is entirely satisfactory to recess until the commissioners from New Mexico and Colorado feel they are ready to proceed.

MR. HINDERLIDER: May I also state it will be necessary for my Engineering Adviser, Mr. Tipton, to be in Topeka, Kansas, Saturday morning, to attend a hearing there on the Colorado-Kansas Interstate suit. It will be very necessary for Mr. Tipton to be with us in our discussions of this report, and we hope that from the present moment to the time he has to leave, to proceed at least with partial discussions.

MR. HARPER: May I suggest to Mr. Hinderlider that you inform the Chairman at the earliest moment when you will be in a position

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to resume deliberations. I take it you are asking for perhaps more time than either of the other two delegations. I am not sure about Mr. McClure's requirements, but if it is at all possible to meet later in the day I will be glad if you will so advise me; otherwise we will count on meeting tomorrow morning at 10 o'clock.

MR. HINDERLIDER: We will so advise you at the earliest possible moment, but 10 o'clock tomorrow we think will be satisfactory.

MR. HARPER: Is there anything further to come up for discussion before we recess? If not, we will recess with the understanding that we will meet not later than 10 o'clock tomorrow morning, and earlier if circumstances permit. (11:45 A.M.)

Santa Fe, New Mexico,
March 11, 1938.
10 A.M.

MR. HARPER: We recessed yesterday to give the several state delegations an opportunity to review the Engineering Committee report, and I believe it is in order at this time to proceed with disposition of this report. Therefore, I will ask if the commissioners have any action to offer on the disposition of the committee report?

MR. HINDERLIDER: Colorado moves that the report of the Engineering Committee, under date of March 9, 1938, be received and accepted as a basis for further discussions in the negotiations looking to a permanent compact. (Seconded by Mr. McClure and unanimously carried.)

MR. HARPER: I will be glad at this time to have any suggestions from the commissioners as to procedure in considering the formulation of a compact, or any other matters that you desire to present in that connection.

MR. HINDERLIDER: Mr. Chairman, having adopted the report just offered, I presume that the next order of business will be for the various commissioners to present any points contained in that Engineering Committee report which may require further clarification or change. In that connection, may I suggest that this be informal discussion, off the record, so we can all speak frankly.

MR. HARPER: If that is agreeable to the other commissioners, this informal discussion will be off the record.

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At 12 o'clock the meeting recessed until 2 P.M.

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MR. HARPER: (2 P.M.) The meeting is now open for resumption of the discussions. I understand Mr. Hinderlider wishes to take up something further.

MR. HINDERLIDER: I stated before we recessed there may be other items Colorado would want to present, but on second thought I think there is nothing now that we care to present in connection with the Engineering Committee report.

MR. HARPER: Did the engineers go over these matters on which they were asked for additional information this noon?

MR. DEBLER: We did. I think as long as Mr. Hill did the writing, I will ask him to do the reading. --I will substitute for that,-- We have gone over these matters and have agreed on a redefinition of some of these terms that were not so clear. There was one controversial matter at issue and that was this matter of the stage of project storage when the upstream reservoirs ceased storing. It has been determined to make that 400,000 acre-feet for the entire use below Elephant Butte. In other words, for the project and Mexico, this 400,000 acre-feet in excess of the normal release of 790,000 acre-feet of usable water. The whole thing will be written up in the form of a report which will cover this matter and the matter of clarification of several of these provisions, specifying the intent of the committee with regard to one or two minor matters, one of which was this question of losses in upstream reservoirs on water belonging to the Rio Grande Project. The committee intended, and will so state, that the Rio Grande Project share in the evaporation losses in these upstream reservoirs in the proportion of storage held in these reservoirs in the same manner it was proposed to have them share in reservoir losses at Elephant Butte.

MR. HILL: That last statement you made - as I understand it, the principle adopted by the committee was that each state should share in reservoir losses in proportion to the amount of water in those reservoirs belonging to the respective states regardless of what reservoir.

MR. DEBLER: That's right. We have not arrived at any arbitrary figure for these other reservoirs and we may not be able to do so before two of us have to leave, but at any rate the committee now recommends that that be done and be provided for in the compact.

MR. CLAYTON: Does the figure at Elephant Butte remain the same?

MR. DEBLER: While that was arbitrary, my idea is it will not be changed enough to talk about.

MR. HILL: The point I want to make clear - the figure of 10 percent which was figured on one and zero percent which was figured on the other, the same principle applies to both. You don't close the door on the 10 percent and then change the zero.

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MR. DEBLER: I don't want to leave the inference that that 10 percent is very far away from what our idea is as to the actual storage. I want to avoid that impression, that the 10 percent is far off, but we didn't determine what the percent should be but we are agreeable and so recommend that it be determined for the others in the same manner.

MR. CLAYTON: That's not something you determine each year, is it?

MR. DEBLER: I am not sure about that, because the situation is a little different with regard to Elephant Butte. The change in storage is not so big in any one year and the difference in losses during the year does not vary much by reason of change in storage, but with respect to the other reservoirs it is very materially different. The El Vado Reservoir fluctuates between full and empty almost every year, and the Wagon Wheel Gap Reservoir will also, so it will be a little different, but nevertheless the intention is they shall share pro rata on the basis of the capacity used during the year in some way. Whether it will be one specific figure to be applied at the end of the year, or a specific percentage, or whether it should be something different will be a matter which we will think about a little more.

MR. HARPER: Are there any further matters for discussion in connection with the engineers report?

MR. McCLURE: In paragraph (e) on page 8, there is some confusion over that word 'average' of 790,000 acre-feet. I wonder if we can get a little explanation from the engineers on that release at Elephant Butte?

MR. DEBLER: I would say we know that their releases in some years will exceed 790,000 acre-feet and in other years will fall below that, so that's the reason the average is to be employed.

MR. McCLURE: What I am getting at, what would be the effect if it would continue, say, at 850,000 acre-feet continuously? What safeguards are there on that?

MR. DEBLER: Two things come into play on that. One is that if the reservoir is falling, then when the reservoir gets to a stage of 400,000 acre-feet at which the upper reservoirs must cease storing, that 400,000 acre-feet is adjusted for excess releases. In other words, for a period of five years the project has taken 10,000 acre-feet a year too much, then project storage would have to come down to 350,000 acre-feet before the upper reservoirs would cease storing. The other point at which that becomes important is when the adjustment of credits is brought about at a time of approaching spill, because at that time if there has been too much water drawn out, while it's a little complicated and I don't want to explain it in detail, but there is a penalty right there.

MR. McCLURE: If your reservoir approaches an actual spill point and it's short, say 100,000 acre-feet, which has in turn been

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over released, from the normal, then it becomes spill. That would remove any debits.

MR. DEBLER: Those are the two point at which it becomes effective. So long as the reservoir hits neither one, it has no effect, except, of course - I will put it this way - if the United States is still operating the reservoir, we are going to bear down awfully hard so those boys down there don't short themselves in low periods as they have in the past.

MR. HARPER: Any further questions regarding the engineers report? Apparently there is nothing further for discussion in regard to the engineers report. Are there any matters which the commissioners wish to take up now as to general policy or administrative provisions outside of the scope of the engineers report?

MR. HINDERLIDER: I suppose we will have the typewritten corrections of the engineers some time this evening?

MR. HARPER: Yes.

MR. TIPTON: I might state the suggestions we have to make are to clarify these various matters and to remove all doubts which were expressed this morning in respect to these provisions. I think they will be entirely acceptable to the Commission.

(The revisions of the engineers report are contained in the following letter.)

March 11, 1938.

The Rio Grande Compact Commission,
Mr. S. O. Harper, Chairman,
Mr. M. C. Hinderlider, Member for Colorado,
Mr. T. M. McClure, Member for New Mexico,
Mr. F. B. Clayton, Member for Texas.

Gentlemen:

At your meeting this morning you asked that we clarify certain parts of our report of March 9th. We have reviewed those features of the report and recommend the following for your favorable consideration:

1. The definition of "Normal Release from Elephant Butte" shall be disregarded and the following definition shall be substituted:

> Actual Release - is the amount of usable water released from the lowest reservoir comprising project storage.

2. The definition of "Unusable Spill" shall be modified to read as follows:

> Unusable Spill - is the amount of water which is actually spilled from Elephant Butte Reservoir or released therefrom for flood control in excess

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of the current demand on project storage, and which does not become usable water by storage in another reservoir; provided, that if the actual releases of usable water from the time of previous unusable spill have aggregated more than an average of 790,000 acre-feet per annum, the time of occurrence of spill shall be adjusted by the difference between the total actual release and releases at such average rate.

3. The recommendation on Page 13, dealing with normal release, shall be changed to read as follows:

> We recommend that the normal release of usable water from the lowest reservoir comprising project storage be deemed to be an average of 790,000 acre-feet per annum.

4. The first sentence following the caption "Other Limitations" shall be changed to read as follows:

> Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs constructed after 1929 whenever there is less than 400,000 acre-feet of usable water in project storage; provided, that if the actual releases of usable water from the time of previous unusable spill have aggregated more than an average of 790,000 acre-feet per annum, the time at which such minimum stage is reached shall be adjusted by the difference between the total actual release and releases at such average rate.

5. The intention of the second provision in the first paragraph following the caption "Other Limitations" was that debit water should be released at the greatest rate practicable under the conditions then prevailing and that the aggregate release of debit water should be limited to the amount which would enable a normal release to be made from project storage in that year.

6. The provisions for reduction of accrued credits to compensate for evaporation losses from Elephant Butte Reservoir shall be eliminated, and in lieu thereof the following general provision shall be substituted:

> To the extent that accrued credits are impounded in reservoirs between San Marcial and Courchesne, and to the extent that accured debits are impounded in reservoirs above San Marcial, such credits and debits shall be reduced annually to compensate for evaporation losses in the proportion that such credits or debits

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bore to the total amount of water in such reservoirs during the year.

Respectfully submitted,
COMMITTEE OF ENGINEERING ADVISERS
(Signed) E. B. Debler for the United States
" R. J. Tipton for Colorado
" John H. Bliss for New Mexico
" Raymond A. Hill for Texas.

MR. McCLURE: To expedite matters in drafting a compact, I move that two members from each state's attorneys be designated as a committee to draw a tentative draft of the compact, and meet as a committee to which the commissioners of the states will be available to sit in if they wish. Also, of course, the drafting committee will have use of the engineers or any other resources they want to arrive at a tentative draft of a permanent compact.

MR. HINDERLIDER: Does your motion also carry the provision that any matter which any state wants to submit to this drafting committee would, of course, be received?

MR. McCLURE: I think so, - yes.

MR. CLAYTON: As I understand it, the motion is that each commissioner appoint two legal advisers to a committee to prepare a tentative draft which will incorporate in substance the report of the engineers and provide administrative machinery, etc.; that the commissioners are free to sit in with the committee and can be called upon by the committee, and that the engineering representatives of the commissioners are likewise subject to call when engineering questions arise to a point on which members of the committee desire advice?

MR. McCLURE: I would say a tentative draft of the compact, and also, as Mr. Hinderlider suggests, any one from the states can submit whatever they desire to this committee.

MR. CLAYTON: It's understood it won't be binding until passed on by the Commission.

MR. HARPER: You stated, Mr. Clayton, that this committee might bring in a report similar to the report of the engineers. My understanding was that Mr. McClure had in mind that they submit an actual draft of a compact in rough draft form. Is that right?

MR. McCLURE: Yes sir, which they would recommend for consideration by the commissioners.

MR. HINDERLIDER: I would like to offer an amendment to that motion. I feel that the arrangement should be such as first suggested by Mr. McClure - that the drafting committee consist of two attorneys designated by each commissioner and that the

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committee would actually make a preliminary draft of the compact for final submission after it is discussed by all of the states and the respective commissioners of the states. I have no objection to the commissioner of each state being called in by this committee, but I do believe that the matter of drafting the preliminary compact should be left to this committee, with the provision that if the committee members of any state desire the Commission to come in from time to time for advice, that might be all right.

MR. CLAYTON: That's entirely all right.

MR. HARPER: I don't think it will be necessary to repeat the motion, I think you all grasp the intent. (Seconded by Mr. Clayton and unanimously carried.) Are you prepared to designate your representatives on the legal committee? If so, we will proceed to name them.

MR. HINDERLIDER: For Colorado, George Corlett and Ralph Carr.

MR. McCLURE: For New Mexico, Gov. A. T. Hannett and Fred Wilson.

MR. CLAYTON: For Texas, Major Richard F. Burges and Judge Edwin Mechem.

MR. HINDERLIDER: What is there that the commissioners can do pending submission of this tentative draft of the compact?

MR. HARPER: I don't know of any other business at this time.

MR. McCLURE: Should there be a representative of the United States on that drafting committee?

MR. HARPER: Mr. Devries is the only legal representative here and he will not be available, so I have no other representative. The committee will report back to the Chairman when they are ready to report to the Commission and I will call a meeting. One question before we recess. Is there a complete understanding in regard to administrative provisions which will go into this compact? Will the attorneys be able to proceed and draft those administrative provisions without further consultation with the Commission as a whole?

MR. HINDERLIDER: I am inclined to think that's a matter we might well leave to the committee. It will not be final, I assume.

MR. HARPER: If that's the understanding, it is satisfactory. If there is nothing further, we will be recessed subject to the further call of the Chairman. (2:40 P.M. Mar. 11)

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Note by Chairman Harper:

During the recess between March 11 and March 17 the Drafting Committee worked continuously on the drafting of a compact. Several closed and informal meetings of the Commission were held during this period at which controversial questions were discussed with the Drafting Committee and the engineering advisers, and differences resolved. No record of these meetings was kept.

Santa Fe, New Mexico,
March 17, 1938.
5:30 P.M.

MR. HARPER: The Commission is called together at this time for the purpose of receiving the draft of proposed compact from the Legal Committee. I will read a letter I have received from the committee.

March 17, 1938.

The Rio Grande Compact Commission,
Mr. S. O. Harper, Chairman,
Mr. M. C. Hinderlider, Member for Colorado,
Mr. T. M. McClure, Member for New Mexico,
Mr. F. B. Clayton, Member for Texas.

Gentlemen:

We, the undersigned Legal Committee appointed by your Commission, beg leave to submit for your favorable consideration the following proposed compact.

Respectfully submitted,

LEGAL COMMITTEE

(Sgd.) George M. Corlett

(Sgd.) Clifford H. Stone (For Ralph L. Carr)
Representatives of Colorado

(Sgd.) A. T. Hannett

(Sgd.) Fred E. Wilson
Representatives of New Mexico

(Sgd.) Richard F. Burges

(Sgd.) Edwin Mechem
Representatives of Texas.

What is your pleasure?

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MR. HINDERLIDER: I move that the draft of compact be received and taken under advisement by the Commission. (Seconded by Mr. Clayton and unanimously carried.)

MR. HARPER: We will recess until 8 o'clock tonight in order to give the commissioners time to go over the compact. (5:45 P.M.)

8:00 P.M.

The commissioners not having had sufficient time to study the compact, the Chairman postponed the meeting until 10 A.M., Friday, March 18, 1938.

Santa Fe, New Mexico,
March 18, 1938,
10:30 A.M.

The commissioners met, together with their engineering and legal advisers, and made certain changes in the draft of compact heretofore submitted. Whereupon the meeting then recessed until the final draft of compact could be prepared. (11:15 A.M.)

March 18, 1938.
5:15 P.M.

MR. HARPER: Before we proceed with our business, in view of the number of distinguished governors present, the photographer has stated he would like a picture of the Commission, together with the governors. * * * As most of you know, we have met here for what we have hoped would be the concluding meeting of the Rio Grande Compact Commission. We have had seven sessions here in Santa Fe during the last four years, and we, the members of the Commission, are glad to know that we are now approaching the end of our labors. The compact has been drafted, redrafted, checked and double checked, referred to the engineers, to the drafting committee of attorneys, back to the engineers and then to the Commission. This afternoon we read it over carefully, checked every word, and it is my understanding that each of the commissioners is now ready to approve this compact which I have before me and affix his signature thereto. I suggest that a motion is in order at this time for the approval and adoption of this compact before the signatures of the commissioners are affixed.

MR. CLAYTON: Mr. Chairman and gentlemen of the Commission: I move the adoption of the compact as it was discussed, and as it is before us now, and that the commissioners affix their signatures in quadruplicate originals to the end that the master original may be sent by the Chairman, Mr. Harper, to the Secretary of State to be kept in the archives of the United States Government, and that one of the other three originals be sent to the governors of the respective states. I further move that carbon copies of each of the originals be signed by the commissioners

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to the end that each of the commissioners may keep one in his file. (Seconded by Mr. Hinderlider and unanimously carried.)

MR. HARPER: The commissioners will now proceed to sign the compact, beginning first with Mr. Hinderlider, Commissioner for Colorado. * * * The compact has been duly signed by the three state commissioners and by the representative of the President. What is the pleasure of the Commission as to further procedure?

MR. CLAYTON: Before making a motion to adjourn, I think that each of the states should be congratulated upon this compact. I know we all feel it is fair and equitable and represents a happy solution of our common problems. I want to express my own very deep personal appreciation to the Chairman of this Commission. If it had not been for his moderating influence, it would have been practically impossible, in my judgment, to have arrived at a compact, and I think I speak for the Commission when I say that Mr. Harper is due the thanks of the Commission. It seems to me that this compact we have signed today is an historic document in that it ends the controversies and disputes which have existed between the signatory states for many years. We all know during the progress of these negotiations at times our tempers became hot and we said things perhaps we regretted later, but on the whole, the officials and advisers who participated in this, have viewed it from the constructive viewpoint of the entire Rio Grande Valley above Fort Quitman, and it is in that light, and with that attitude that we are signing this today. I should like to have the views of the other commissioners on that, following which I move we adjourn.

MR. HINDERLIDER: I should like the opportunity to read into the record a statement from the Commissioner for Colorado, if I may do so at this time. First, I desire to express to Mr. R. J. Tipton, my engineering adviser, throughout these long years of negotiatiins, and to his able associate engineers, Messrs. E. B. Debler, John H. Bliss, Raymond A. Hill, and H. C. Neuffer, my very deep appreciation for the splendid work they have accomplished under most trying conditions which has provided the formula for the accomplishment of the final objective of the three states; viz, the equitable division of the waters of the Rio Grande, the chief obstacle all these years to an interstate understanding. Without their work a compact between these states would not have been possible. To Dr. H. H. Barrows and his associates, Prof. Frank Adams, Harlow M. Stafford, N. C. Grover, and John C. Stevens, and their corps of able assistants, our appreciation and gratitude for constructive thought and effective effort in pointing the way, and providing the factual data in an unbiased manner which was so essential to a full understanding by each state of not only the physical conditions within that state, but also those in our sister states, without which factual information there would have been no common fund of information upon which the three states probably could have agreed. To the legal advisers of the water users and the States of Colorado, New Mexico, and Texas, Hon. George M. Corlett, Hon. A. T. Hannett, Attorneys Ralph Carr, Burris Goudy,

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Fred Wilson, William Brophy, Maj. Richard F. Burges, Edwin Mechem, and to Judge Clifford Stone, my personal legal adviser, I desire to express my sincere appreciation for their wise counsel, and the statesmanship shown by them in resolving the difficult and, at times, seemingly insurmountable questions of law and equity, and for their exercise of that fine spirit of tolerance, so essential in the attainment of our objective - a permanent understanding between these three states based upon equity and justice - without such wise and constructive work no such understanding was possible. To Mrs. Ethel Stevenson, our most efficient and gracious secretary who has had the responsibility of recording and typing in orderly manner, the records of the deliberations of the Commission during all these years of its labors, and now the final draft of this momentous document which we have just signed, I desire to extend my personal thanks and appreciation for a job well done.

And to Chairman Harper and my fellow commissioners I desire to extend this expression of my respect and regard for your exemplification of the principles of tolerance, fair play and patience. I can only hope that in the future when we may be called upon to administer this treaty, I may be so fortunate as to merit the same feeling of confidence and esteem that I have long had for you. However, if we do not stand together now, we will most certainly hang together later. Let us hope that in after years our epitaph will not read as follows:

Although he was guiltless of intent at wrong doing,
The signing of the Rio Grande Compact was his un-doing.

(Applause)

MR. McCLURE: Mr. Chairman and Fellow Commissioners: I don't know of any further ground to be covered that has not already been covered by Mr. Clayton and Mr. Hinderlider in regard to appreciation and thanks to all who have furnished information and participated in the drafting of this document. I do personally wish to extend my appreciation to all those mentioned by Mr. Hinderlider and Mr. Clayton and concur fully in all the remarks they have made. I have spent almost five years in work on this document at the various meetings. I have been Commissioner for New Mexico during that time and it has always been a pleasure to negotiate these meetings with my fellow commissioners.

MR. HARPER: Fellow Commissioners, you have left very little, I am afraid, for the Chairman to say. I appreciate your kind expressions, which I am sure I do not deserve. I have served here only in the capacity of a referee and onlooker, most of the time, from the sidelines, but I do want to here express my personal appreciation for the fine consideration, patience, and tolerance which has been exhibited by each of you commissioners in your deliberations here during the last four years. After all we could eliminate 99 percent of the misunderstandings in this world if we could only place ourselves in a position to see the other fellow's viewpoint, and I think that's what this Commission has accomplished. I also wish to express my sincere appreciation, and the official

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appreciation of the Commission, for the fine work which has been accomplished by the committee of engineers. I am frank to say that without the work which they did we never could have written a compact. They gave unstintingly of their time, night and day, and each one of them should be given a large portion of the credit for the results we have accomplished here: Mr. Tipton, Mr. Hill, Mr. Bliss, and Mr. Debler. I also wish to express my sincere appreciation of the fine work which was accomplished by the drafting committee of attorneys: Messrs. Corlett, Stone, and Carr for Colorado; Messrs. Hannett and Wilson for New Mexico, and Messrs. Burges and Mechem for Texas. Furthermore, I want to express a sincere word of appreciation for the fine assistance which has been given us by the National Resources Committee, particularly by Prof. Barrows, Prof. Adams, and Messrs. Stevens, Grover, and Stafford. Those of you who attended the last meeting when we were addressed by Prof. Barrows, I am sure received a lasting impression from the talk which he gave us, and I, for one, feel that, without the sincere effort he devoted to this task, and the clear understanding which he brought to us, our efforts perhaps would have failed. I feel that what we have done here today is more than simply to sign a compact between these three states for the division of this water - we have established a precedent here which will stand in all history as a fine example of meeting the test of democracy successfully. We have shown that three states can get together on a common meeting ground and work out their mutual problems in a spirit of understanding, without invoking the assistance of any super-authority or submitting to dictation from any source whatsoever. I feel after all that this will go down in history as perhaps the principal accomplishment of this Rio Grande Compact Commission.

Finally I want to say, that in spite of the fact that we have had many discouragements in facing what everyone looked upon as a hopeless task, and that we were all ready to fold up and quit at different times, by your forbearance, patience, and understanding you have turned defeat into victory. I will look back on this experience as one of the finest in my life, and the pleasant associations I have had here with each of you, I will cherish always. (Applause.)

MR. CLAYTON: I now move that we adjourn sine die. (Seconded by Mr. McClure and unanimously carried.) 5:45 P.M.

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I am including in the record a gracious farewell message from our faithful and efficient reporter and secretary, Mrs. Ethel F. Stevenson.

S. O. H.

THANKS FOR THE MEMORIES

(With apologies to the songwriter)

Thanks for the memories
Of the Rio Grande Comish
Hope it proves a merry dish
For Clayton and McClure
And Hinderlider sure
If the water just stays pure
How lovely it was!

Thanks for the memories
Of Carr's tight pants
Of Hannett's rants
Of Texas suit and salt
With not a drop of malt
How lovely it was!

Tipton, Bliss and Debler dissected
How the steno was affected
And Hill's commas neglected
We did have fun and no harm done
So thanks for the memories
Of Mr. Harper's patience
Cause he never did get sore
It sometimes was a headache
But it never was a bore,
So thank you so much.

By E.F.S.

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Appendix No. 1

REPORT OF COMMITTEE OF ENGINEERS

to

RIO GRANDE COMPACT COMMISSIONERS

December 27, 1937

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December 27, 1937.

The Rio Grande Compact Commission,
Mr. S. O. Harper, Chairman,
Mr. M. C. Hinderlider, Member for Colorado,
Mr. T. H. McClure, Member for New Mexico,
Mr. F. B. Clayton, Member for Texas.

Gentlemen:

The Engineering Advisers of your Commission have held two meetings, the first in Santa Fe from November 22 to 24, and the other in Los Angeles from December 15 to 27. The first meeting was largely devoted to consideration of the general factors affecting the discharge of Rio Grande at the Colorado-New Mexico State Line and the delivery of water into Elephant Butte Reservoir. At the second meeting more detailed consideration was given to these matters, and definite schedules of deliveries were developed.

We avoided discussion of the relative rights of water users in the three States, and were guided throughout our work by the general policy - expressed at the meeting of the Compact Commission in October - that present uses of water in each of the three States must be protected in the formulation of a Compact for administration of the Rio Grande above Fort Quitman, because the usable water supply is no more than sufficient to satisfy such needs.

The Rio Grande above Fort Quitman, which constitutes the part of the drainage basin in which the Commission has primary interest, is divided naturally into three sections:

(a) The San Luis Valley, comprising the drainage area above the Lobatos gaging station on the Rio Grande near the Colorado-New Mexico State Line;

(b) The Middle Rio Grande from Lobatos to Elephant Butte Reservoir and the drainage basins of streams tributary to the river in this section;

(c) The balance of the Rio Grande Basin between Elephant Butte and Fort Quitman, including the Juarez Valley in Mexico.

It must be recognized that precise determination of past conditions and close estimates of future changes are not possible. Accordingly, in submitting the following for your favorable consideration and inclusion in a permanent Compact, we suggest that provision be made for review of these matters after five years and for adjustments within the intent of the Compact.

SCHEDULED DELIVERIES AT LOBATOS

A consistent relationship has long been noted between the combined inflow of the major streams to San Luis Valley and outflow of the Rio Grande at Lobatos. This relationship, however, may be

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disturbed in the future due to construction of storage reservoirs, and we have therefore prepared separate schedules applicable to the Conejos and Rio Grande stream systems. This is a departure from previous plans but has no practical disadvantage and has certain definite advantages; variations in discharge of the contributing streams will automatically be taken into account, particularly if storage reservoirs are constructed; and it will also enable the San Luis Valley water users to apportion among themselves their relative responsibility for meeting the obligation of Colorado.

The flow of Conejos River at its confluence with the Rio Grande was found to bear a close relation to the combined discharge of Conejos River near Mogote and its principal tributaries below that point. The following values are from a smooth curve expressing that relationship for the past ten years, and it is recommended that these be used as a schedule of future deliveries.

SCHEDULE OF DELIVERIES FROM CONEJOS RIVER

Quantities in thousands of acre feet

Conejos Index Supply (1)	Conejos River at Mouths (2)
100	0
150	20
200	46
250	76
300	111
350	150
400	191
450	235
500	280
550	328
600	375
650	424
700	480

Intermediate quantities shall be computed by proportional parts.

(1) Conejos Index Supply is the natural flow of Conejos River at the U.S.G.S. gaging station near Mogote for the calendar year, plus the natural flow of Los Pinos River at the U.S.G.S. gaging station near Ortiz and the natural flow of San Antonio River at the U.S.G.S. gaging station at Ortiz, both for the months of April to October, inclusive.

(2) Conejos River at its mouth is the combined discharge of branches of this river at the U.S.G.S. gaging stations near La Sauses (Los Sauces) during the calendar year.

When from the total discharge of Rio Grande at Lobatos there is subtracted the contribution from Conejos River, a close relationship also is found to exist between that residual quantity and the discharge of Rio Grande near Del Norte. The following values are

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from a smooth curve expressing the relationship for the past ten years, and it is recommended that this be the schedule of deliveries for the future.

SCHEDULES OF DELIVERIES FROM RIO GRANDE ABOVE DEL NORTE

Quantities in thousands of acre feet

Rio Grande at Del Norte (3)	Rio Grande at Lobatos less Conejos at Mouths (4)
200	60
250	65
300	75
350	86
400	98
450	112
500	127
550	144
600	162
650	182
700	204
750	229
800	257
850	292
900	335
950	380
1 000	430
1 100	540
1 200	640
1 300	740
1 400	840

Intermediate quantities shall be computed by proportional parts.

(3) The recorded flow of Rio Grande at the U.S.G.S. gaging station near Del Norte during the calendar year (measured above all principal points of diversion to San Luis Valley).

(4) The total flow of Rio Grande at the U.S.G.S. gaging station near Lobatos, less the discharge of Conejos River at its mouths, during the calendar year.

The obligation of Colorado to deliver water in the Rio Grande at the Colorado-New Mexico State Line would be the sum of the quantities set forth in the above tabulations, except for such departures from normal deliveries as are provided for below. In the application of either schedule, appropriate adjustments must be made for any trans-mountain diversions, for any change in location in gaging stations, and for any new or increased depletion of the natural runoff at gaging stations above Lobatos.

SCHEDULED DELIVERIES INTO ELEPHANT BUTTE RESERVOIR

The relation between the amount of water in the Rio Grande above the principal agricultural areas in New Mexico and inflow to

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Elephant Butte Reservoir is quite erratic, due primarily to wide variations in the discharge of tributary streams. Your Committee tried many devices to eliminate the influence of such tributary inflow. Finally, it was found that there was a reasonable relationship between the discharge of Rio Grande at Otowi Bridge and the inflow to Elephant Butte Reservoir when the discharge at Otowi Bridge and the inflow to the reservoir during the months of July, August, and September were excluded. Such a relationship does not reflect possible changes in consumptive use during the summer months between these points, and tributary flow in other months still results in considerable variation, but it is our opinion that no more precise relationship can be developed from present information, and that its use as a schedule of deliveries will be practicable.

In order that all available data might be used in determining the proper schedule, the flow of the Rio Grande at Otowi Bridge, exclusive of July, August, and September, was first compared to the flow of the Rio Grande at San Marcial, excluding the same months, and a curve was drawn which expressed most closely the relationship which existed in the past. However, the gaging station at San Marcial is expensive to operate, and physical conditions make it difficult to obtain accurate records, while water released from Elephant Butte Reservoir can be measured with considerable precision. The second step was to determine the normal net loss from the river below San Marcial and from the reservoir. It was found that for more than ten years these losses have borne a very close and consistent relation to the discharge of the river at San Marcial. The third step was then the subtraction of the normal losses so found from the curve of relationship between the flow at Otowi Bridge and that at San Marcial. The net result was to give a curve which expressed the relation between the flow of the Rio Grande at Otowi Bridge and the usable supply of water at Elephant Butte, both exclusive of July, August, and September. This curve was then shifted arbitrarily to compensate for increased salinity of the Elephant Butte supply.

The final relationship which we recommend be used as the schedule of deliveries is as follows:

DELIVERIES INTO ELEPHANT BUTTE RESERVOIR
EXCLUSIVE OF JULY, AUGUST, AND SEPTEMBER

Quantities in thousands of acre-feet

Otowi Index Supply (5)	Elephant Butte Index Supply (6)
100	12
200	57
300	113
400	173
500	237
600	305
700	378
800	455

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DELIVERIES INTO ELEPHANT BUTTE RESERVOIR
EXCLUSIVE OF JULY, AUGUST, AND SEPTEMBER (continued)

Quantities in thousands of acre feet

Otowi Index Supply (5)	Elephant Butte Index Supply (6)
900	540
1 000	630
1 100	725
1 200	825
1 300	935
1 400	1 052
1 500	1 175
1 600	1 305
1 700	1 440
1 800	1 583
1 900	1 737
2 000	1 895
2 100	2 058
2 200	2 224
2 300	2 392

Intermediate quantities shall be computed by proportional parts.

(5) The natural flow of Rio Grande at the U.S.G.S. gaging station at Otowi Bridge near San Ildefonso (formerly station near Buckman) during the calendar year, exclusive of the flow during the months of July, August, and September.

(6) The usable supply at Elephant Butte during the calendar year, exclusive of the months of July, August, and September, such usable supply being equal to the actual release from Elephant Butte Reservoir, plus any gain in the amount of water stored in that reservoir and minus any draft on it over the same period of time.

The obligation of New Mexico to deliver water into Elephant Butte Reservoir in accordance with the foregoing schedule would be subject to the provisions set forth below, and in the application of this schedule appropriate adjustments must be made for any change in points of measurements, for any new or increased depletion in New Mexico of the natural runoff at Otowi Bridge, and for any trans-mountain diversions into the Rio Grande between Lobatos and Elephant Butte.

ALLOWABLE DEPARTURES

There will be natural variations in the relationships between the discharge at the control stations in the future, as in the past, and reasonable departures must be expected. Furthermore, departures which are caused by storage of water in reservoirs at time of flood should be permitted, subject to proper safeguards.

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Definitions

The following terms will be used repeatedly and are here defined:

(a) Annual Debits - are the amounts by which deliveries in any calendar year fall below scheduled deliveries.

(b) Annual Credits - are the amounts in any calendar year by which actual deliveries exceed scheduled deliveries.

(c) Accrued Debits - are the amounts by which the sum of all debits exceeds the sum of all credits over any common period of time.

(d) Accrued Credits - are the amounts by which the sum of all credits exceeds the sum of all debits over any common period of time.

(e) Normal Release from Elephant Butte - is an average of 800,000 acre-feet per annum drawn out of Elephant Butte Reservoir, adjusted for any gain or loss in usable water resulting from the operation of any reservoir below Elephant Butte; provided that this amount shall be reduced or increased by two-thirds of any change in aggregate diversions and loss to Mexico between Courchesne gaging station and the lowest point of diversion to lands of Rio Grande Project. In determining the amount of such change, the average annual diversion and loss to Mexico from 1928 to 1937, inclusive, shall be used as a basis.

(f) Project Storage - is the combined capacity of Elephant Butte Reservoir and all other reservoirs available for storage of usable water between Elephant Butte and Courchesne, but not more than a total of 2,638,860 acre-feet.

(g) Usable Water - is all water in Project storage which is available for release in accordance with irrigation demands, including deliveries to Mexico.

(h) Unusable Spill - is the amount of water which is actually spilled from Elephant Butte Reservoir or released for flood control in excess of the current demand for irrigation of Rio Grande Project lands plus deliveries to Mexico and which is not stored in another reservoir for subsequent release for such uses; provided that, if the actual release from Elephant Butte Reservoir from the time of previous spill has averaged more than the normal release, the time of occurrence and amount of spill shall be adjusted by the difference between the total actual release and the accrued normal release.

Limitation on Debits

In the case of Colorado, no annual debit nor accrued debit shall exceed 100,000 acre-feet, except as either or both may be caused by storage of water in reservoirs constructed above Lobatos

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after 1937. Accrued debits which are caused by storage of water in reservoirs not now constructed shall not be greater at any time than the amount of water then in storage in such reservoirs.

In the case of New Mexico, the accrued debit shall not exceed 200,000 acre-feet at any time, except as such debit may be caused by storage of water in reservoirs in New Mexico. Accrued debits caused by storage of water in reservoirs shall not be greater at any time than the amount of water then in storage in such reservoirs. In computing the magnitude of accrued credits or debits, annual debits greater than 150,000 acre-feet shall be taken as equal to that amount.

If in any year the aggregate of accrued debits of Colorado and New Mexico exceeds the difference between the total capacity of Project storage and the amount of usable water then in storage, such debits shall be reduced proportionally to an aggregate amount equal to the minimum unfilled capacity in that year.

If in any year there is unusable spill from Elephant Butte Reservoir, all accrued debits of Colorado and New Mexico shall be cancelled, and no debits shall be considered in that year, excepting debits caused by storage in reservoirs prior to the time of spill.

Limitation on Credits

In the case of Colorado, accrued credits in excess of 100,000 acre-feet at any time shall be not considered, provided that larger accruals may be applied to offset debits caused by storage in reservoirs. In computing the amount of accrued credits or debits, any annual credits in excess of 150,000 acre-feet shall be taken as equal to that amount.

In the case of New Mexico, accrued credits in excess of 200,000 acre-feet at any time shall not be considered, provided that larger accruals may be applied to offset debits caused by storage in reservoirs. In computing accrued credits or debits, annual credits in excess of 150,000 acre-feet shall be taken as equal to that amount.

At the time of unusable spill from Elephant Butte Reservoir, the aggregate credits of Colorado and New Mexico shall be reduced by the amount of such spill at Elephant Butte in proportion to their respective credits at the time of such spill, and no credits shall be considered in a year of spill.

Other Limitations

Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs constructed since 1929 whenever there is less than 400,000 acre-feet of water in storage available for use in the Rio Grande Project, and if this minimum stage is reached on January first of any year Colorado and New Mexico shall each release on demand, at the greatest rate practicable, water from reservoirs

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in an amount equal to the total debit of each which was caused by storage of water in reservoirs.

In event any works are constructed after 1937 for the purpose of delivering water into the Rio Grande from the Closed Basin in San Luis Valley, Colorado shall be credited with the amount of such water delivered, provided the proportion of sodium ions is less than 45% of the total positive ions in that water.

In the event that the normal release from Elephant Butte Reservoir is modified by any change in the amount of diversions and loss to Mexico, Colorado and New Mexico shall share equally therein, and the accrued credits or debits of each shall be adjusted annually by an amount equal to one-third of such change in diversions and loss to Mexico.

RECOMMENDATIONS

We are satisfied that no material expansion of the irrigated area in the Rio Grande Basin above Fort Quitman will be practicable without importations from other watersheds. Good use could be made of this water in each of the States, but we deemed that the allocation of any supply so obtained constituted a matter of policy beyond our province. Accordingly, no recommendation is made.

We do recommend that the normal release from Elephant Butte Reservoir be deemed to be 800,000 acre-feet per annum, adjusted for any gain or loss of usable water resulting from the operation of any reservoir below Elephant Butte. We also recommend that this normal release be reduced or increased by two-thirds of any change in aggregate diversions and loss to Mexico.

We recommend that deliveries by New Mexico into Elephant Butte Reservoir be in accordance with the schedule based on the flow at Otowi Bridge and the usable supply at Elephant Butte, subject to proper limitations on departures.

We recommend that deliveries by Colorado be the sum of the amounts set forth in the schedules for the Conejos stream system and for the Rio Grande system, exclusive of Conejos River, both subject to proper limitations on departures.

It is our opinion that these schedules and provisions would permit the maximum practicable use of the waters of the Rio Grande, and would minimize unusable spill at Elephant Butte. Your favorable consideration and inclusion of these in a permanent Compact is recommended.

Respectfully submitted,

COMMITTEE OF ENGINEERING ADVISERS

(Sgd) E. B. Debler
E. B. DEBLER for the United States

(Sgd) Royce J. Tipton
ROYCE J. TIPTON for Colorado

(Sgd) John H. Bliss
JOHN H. BLISS for New Mexico

(Sgd) R. A. Hill
RAYMOND A. HILL for Texas

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STATE OF NEW MEXICO
OFFICE OF
STATE ENGINEER
SANTA FE
January 25th, 1938.

Mr. S. O. Harper, Chairman,
Rio Grande Compact Commission,
Customhouse,
Denver, Colorado.

Dear Mr. Harper:

On the eighth day of January, 1938, I received a copy of the report of the committee of engineers to the Rio Grande Compact Commission under date of December 27, 1937, which you enclosed in your letter of January 4th, 1938. The report has been submitted to the engineers, attorneys and officials of the Middle Rio Grande Conservancy District, the area in New Mexico most affected, and under date of January 13, I received a letter from Mr. Neuffer, consulting engineer for the Middle Rio Grande Conservancy District, a copy of which is hereto attached.

I have given the report additional study since receiving Mr. Neuffer's letter, and I am in thorough accord with the position taken by Mr. Neuffer in his letter. I have discussed these with others in authority representing the State of New Mexico, and we have reached the conclusion that it would be a waste of time for the compact commissioners to meet and accept the report as a basis for negotiations of a new compact without clarification of the provisions of the report. It is too vague and indefinite in some respects; nor does it set up sufficient of the data used by the committee to work out the relationship of the flow at various stations; likewise, the report fixes a basis for water supply to the State of Texas, which, in my judgment and in the judgment of others in authority in New Mexico, is so far out of reason that it could not be considered as a basis for negotiations.

Furthermore, the engineers in their recommendation plainly exceeded their authority. I understand that their authority was to present basic facts upon which the commissioners themselves might arrive at a permanent compact. It appears that, instead of reporting accurate basic data, a compromise on basic data was reported.

I believe that it will save time and further the reaching of an ultimate agreement between the various states for the engineers to reassemble at the earliest possible moment and give this matter further study.

Very truly yours,

(Sgd) Thomas M. McClure
State Engineer.

TMM:m
cc: Mr. Frank B. Clayton, El Paso, Texas.
Mr. M. C. Hinderlider,
State Engineer, Denver, Colorado.
CC-Commissioner.
Prof. Harlan H. Barrows, Chicago, Ill.
Prof. Frank Adams, Berkeley, Calif.
2-12-38

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Mr. Thomas M. McClure,
State Engineer,
Santa Fe, New Mexico.

Dear Mr. McClure:

We have received a copy of the report of the Committee of Engineers to the Rio Grande Compact Commissioners, dated December 27, 1937. Careful study has been made of this report and it is our conclusion that, in view of the statements and recommendations contained therein, the State of New Mexico, in representing the various interests involved, should not accept this report as a basis for further Compact negotiations.

There are parts of the report which we have not been able to check on account of lack of the availability of the data used by the Committee in working out the relationship of the flow of the Rio Grande at various stations and we, therefore, cannot comment upon them. There are, however, certain other items which we feel, if agreed upon, would result in permanent damage to the Middle Rio Grande Conservancy District and other water users in New Mexico above the Elephant Butte Dam.

It is suggested that the Compact Commissioners request the Engineers' Committee to give this matter further consideration before it is submitted to the Commission as a basis for discussion of a new compact. The District offers the services of its engineers to assist this Committee with the hope that something more tangible and workable can be prepared.

Very truly yours,

CC-Commissioner
-Prof. Harlan H. Barrows
Chicago,Ill.
-Prof.Frank Adams,
Berkeley,Calif.
2-12-38

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Appendix No. 3

LAW OFFICES
McBROOM & CLAYTON
BASSETT TOWER
EL PASO, TEXAS

January 27, 1938

Mr. S. O. Harper,
Chairman, Rio Grande Compact Commission,
Customhouse,
Denver.

Dear Mr. Harper:

I am in receipt of a copy of the letter written to you by Mr. Thomas M. McClure, State Engineer of New Mexico, under date of January 25, with which was enclosed copy of a letter to him from Mr. H. C. Neuffer.

I can not agree with Mr. McClure that the engineers, in their recommendations to the Commission, exceeded their authority, nor that their report is too vague and indefinite to serve as a basis for negotiations towards a permanent compact.

Nor can I agree with Mr. McClure that the engineers' report "fixes a basis for water supply to the State of Texas which . . . is so far out of reason that it could not be considered as a basis for negotiation." It seems to me and to those interested with me in the protection of Texas' water supply that the report contains no recommendations for the benefit of Texas than what she is plainly entitled to. In fact, it makes concessions to the two upper States about which we are somewhat dubious. But in the interest of an amicable settlement of our common problems, we are willing to accept the report as a basis for further negotiation.

If there are points in this report that are not clear to the commissioner for New Mexico and which the engineering representative for New Mexico can not make plain to him, we have no objection to our engineer-representative's meeting with the other engineering representatives for the purpose of clarifying these points.

In our judgment, the report presents a fairly workable basis for the equitable apportionment of the waters of the Rio Grande, without permitting further encroachments upon Texas' already inadequate supply. It was our understanding that both Colorado and New Mexico professed to have neither the intention nor the desire to further deplete the waters of the Rio Grande system, and the engineering representatives of all three States and of the United States, as well, apparently reached the conclusion, after considerable research and negotiation, that the basis suggested in the report will do no more than preserve the status quo

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as far as the water supply is concerned, while, at the same time, permitting New Mexico and Colorado to proceed with certain desired developments.

It might be noted in passing that the commissioner for New Mexico seems to lose sight of the fact that there is a very extensive section of his own State lying below the Elephant Butte dam, and that its large vested interests are likewise entitled to representation and protection, along with the Middle Rio Grande Conservancy District.

We tender our readiness to proceed with negotiations towards a permanent compact, based upon the report of the committee of engineers, and if there is any point needing clarification, we believe this can be accomplished in connection with the negotiations. We are unwilling to recede from what we conceive to be the minimum requirements for the protection of Texas' water supply as embodied in the report.

Yours very truly,

(Sgd) Frank B. Clayton

Frank B. Clayton
Rio Grande Compact Commissioner for Texas

FBC:ESC
cc Mr. McClure
cc Mr. Hinderlider

CC-Commissioner
-Prof. Harlan H. Barrows
Chicago, Ill.
-Prof. Frank Adams
Berkeley, Calif.
2-12-38

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STATE OF COLORADO
ENGINEERING DEPARTMENT
DENVER

February 4, 1938

S. O. Harper, Chairman
Rio Grande Compact Commission
Customhouse
Denver, Colorado

Dear Mr. Harper:

I have reviewed Commissioner McClure's letter to you under date of January 25, 1938, from which it is noted that he takes strong exception to the report of the Committee of Engineer Advisors to the Rio Grande Compact Commission, and is of the opinion "that it would be a waste of time for the Compact commissioners to meet and accept the report as a basis for negotiations of a new Compact, without clarification of the provisions of the report".

Mr. McClure also asserts that the report in question is too vague and indefinite, and does not set up sufficient data used by the Committee to permit a check of the relationship of stream flow at various river stations, and concludes that, instead of reporting accurate basic data, the conclusions of the Committee of Engineers are based upon a compromise of basic data.

Mr. McClure reaches the conclusion that it is necessary for the Engineer Advisors to give further consideration to their studies prior to attempts at further negotiations.

It seems to the writer that Mr. McClure should not unqualifiedly accept the views of Mr. Neuffer; that the Committee of Engineers should call in consultation the engineers of the Middle Rio Grande Conservancy District, for the reason that it was agreed by the Compact Commissioners that the engineering phases of the subject matter be referred to a Committee of Engineers, on which each state had an engineering advisor. Such designation was largely for the purpose of avoiding confusion and delays which would result from a multiplicity of opinions between conflicting interests in each state.

It is our feeling that any internal or intra-state differences with the views of the Engineering Advisor of any state should be composed with such Advisor, I feel that it will be impossible to reach an interstate agreement so long as every individual group of water users is permitted to inject and insist upon individual points of view.

As has been repeatedly stated in previous conferences, Colorado has taken the position that she is entitled to parity with

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the two lower states, in the development of her water resources in the San Luis Valley. It is our understanding that the report of the Committee of Engineers attempts to suggest a basis upon which this could be accomplished without material injury to the interests of any of the states involved, and, therefore, could be accepted in principle as a basis of further discussions and negotiations by the Compact Commission, in its attempt to reach an interstate agreement.

It is felt that, prior to a further meeting of the Committee of Engineers, as suggested by Mr. McClure, he should specifically and definitely point out the items in the said report to which he takes exception, and indicate the particular points upon which he desires further information. Doubtless such information may be obtained from Mr. Bliss, his Engineering Advisor.

When such information has been submitted by Mr. McClure, the members of the Commission will be able to determine if further meetings of the Committee of Engineers would be helpful.

Very truly yours,

(Sgd) M. C. Hinderlider
Commissioner for Colorado

CC: Mr. McClure
Mr. Clayton
Mr. Carr
Mr. Corlett
Attorney General

CC-Commissioner
-Prof. Harlan H. Barrows,
Chicago, Ill.
-Prof. Frank Adams,
Berkeley, Calif.
2-12-38

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Appendix No. 5

February 12, 1938

Mr. M. C. Hinderlider,
Rio Grande Compact Commissioner for Colorado,
Denver, Colorado.

Mr. Thomas M. McClure,
Rio Grande Compact Commissioner for New Mexico,
Santa Fe, New Mexico.

Mr. Frank B. Clayton,
Rio Grande Compact Commissioner for Texas,
El Paso, Texas.

Gentlemen:

I have received Mr. McClure's letter of January 25, Mr. Clayton's letter of January 27, and Mr. Hinderlider's letter of February 4, all commenting on the report of the Committee of Engineers dated December 27, 1937.

Mr. McClure expresses the view that the engineers exceeded their authority in not confining their report to a presentation of basic facts, and suggests that they reassemble at an early date and give the matter further study. Mr. Clayton expresses disagreement with Mr. McClure's views and states that he is willing to proceed with negotiations for a permanent compact based on the report of the Committee of Engineers, leaving any disputed points to be clarified in connection with the negotiations. Mr. Hinderlider also expresses disagreement with Mr. McClure's views, and suggests that prior to any further meeting of the Committee of Engineers, he point out specifically the items in the report to which he takes exception, and indicate the particular points upon which he desires further information.

The resolution adopted at the meeting of the Compact Commission on October 1, 1937, which authorized the report by the Committee of Engineers, reads as follows:

> "In line with the conversation had by the commissioners, I move that one engineering consultant of each state, together with Mr. E. B. Debler, meet in Santa Fe, or such other place as they may mutually elect, on October 25th, for the purpose of discussing the engineering features, particularly of the state line deliveries and deliveries at San Marcial, in order to determine if they can arrive at a determination of general principles and if possible agree on the details of the deliveries, and the engineering factual data which should underlie the compact. Also that the meeting of the Commission itself be deferred to such date as may be mutually agreed upon, pursuant to the call of the chairman."

After carefully considering the report of the Committee of Engineers, the resolution authorizing such report, and the comments of the Commissioners thereon, and after also discussing this

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matter with two of the engineers, it is my view that little would be accomplished by another meeting of the Committee. The engineers proceeded with the preparation and submission of their report in accordance with their understanding of their instructions. The question of whether they have exceeded their authority in not confining their report to factual matters, is one which can, in my judgment, be best decided by the whole Compact Commission, which can accept or reject any part or all of the report, as may, after due deliberation, be considered advisable. The report of the Committee of Engineers is, of course, in no way binding upon the members of the Commission, either individually or collectively, but it was hoped that such a report would be of material assistance to the Commissioners in reaching an understanding and agreement on the basic factual data, and the application of such data to a permanent compact.

Another reason why it appears inadvisable for the engineers to attempt to hold another meeting is the difficulty of fixing a date which will conform to all of their other engagements. This might entail a delay of several weeks, and it is also probable that considerable additional time would thereafter be required to get the Commission together for its next meeting.

I therefore suggest that consideration be given to holding a meeting of the Compact Commission in the first week of March, which previous correspondence has indicated is the earliest date which will be convenient for all of the members. If advisable, a preliminary meeting of the engineers might be arranged just prior to the deliberations of the Commission. I will appreciate your early reaction to this suggestion, and if it is favorable, I will issue a formal call for a meeting of the Commission at Santa Fe, on February 28, or March 1.

Very truly yours,

S. O. Harper,
Chairman, Rio Grande
Compact Commission.

CC-Prof. Harlan H. Barrows,
Univ. of Chicago,
Chicago, Ill.
Prof. Frank Adams,
Univ. of California,
Berkeley, Calif.
Commissioner
(With copies of three letters
to each.)

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Appendix No. 6

Santa Fe, New Mexico,
March 4, 1938.

REPORT TO RIO GRANDE COMPACT COMMISSION BY THE ENGINEER ADVISERS ON NEW MEXICO OBJECTIONS TO THEIR REPORT OF DEC. 27, 1937

The Compact Commissioners on March 3, 1938, in open session, instructed this committee of engineer advisers to review a statement to be submitted by the Compact Commissioner of New Mexico on New Mexico's objections to the December 27, 1937, committee report and to report back to the Commission whether such objections warranted the committee in reconsidering its report. The Compact Commissioner of New Mexico thereafter submitted a statement, with a copy hereto attached, of such objections, and the committee of engineer advisers report thereon as follows:

Opening Paragraph and Paragraphs 1 and 2:

New Mexico proposes a substitute plan for the control of operations by New Mexico interests above Elephant Butte Reservoir. The committee has heretofore considered some alternatives to the plan adopted by it but stands ready to give further consideration to the New Mexico plan upon submission by New Mexico of its alternate plan, including applicable curves, tables and other details and including a tabular comparison with the committee plan, of resulting stream flows.

Paragraph 3:

New Mexico desires to be relieved of responsibility for Indian or other operations beyond its control. The committee believes this matter is one of policy for determination by the Compact Commission.

Paragraph 4:

New Mexico claims that 800,000 acre-feet of water exceeds both past uses and requirements below Elephant Butte Reservoir. The committee is agreeable to reviewing any data in support of this claim not heretofore available to the committee.

Paragraph 5 and first sub-paragraph thereof:

New Mexico desires a figure adopted for present use by Mexico. The committee has heretofore discussed this matter but failed to reach common ground by reason of the meager data available. It is suggested that New Mexico present its conclusions, together with all supporting data for review by the committee.

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Second sub-paragraph of Paragraph 5:

New Mexico insists that treaty provisions be carried out and that Texas or the United States be made responsible therefor. The responsibility for observance of the treaty with Mexico is one of policy for determination by the Commission.

Third sub-paragraph of Paragraph 5:

New Mexico objects to a judicial interpretation by the committee on Mexican Treaty obligations. Since no interpretation was made, this objection has no point.

Paragraph 6:

As explained to us by the New Mexico member, this paragraph aims to secure clarification. The committee is agreeable to such clarification.

Paragraphs 7 and 8:

These paragraphs aim at revision of features governing operation of Elephant Butte Reservoir. A further discussion may show some change warranted.

Paragraph 9:

New Mexico desires to compel avoidance of power waste at Elephant Butte Reservoir. The committee is agreeable to preparing such a provision.

The committee stands ready to consider written specific requests by any Commissioner for clarification of the intent of any of the provisions of the committee plan.

Respectfully submitted,

COMMITTEE OF ENGINEERING ADVISERS

(Sgd) E. B. Debler
E. B. Debler for the United States

(Sgd) R. J. Tipton
R. J. Tipton for Colorado

(Sgd) John H. Bliss
John H. Bliss for New Mexico

(Sgd) R. A. Hill
R. A. Hill for Texas.

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March 9, 1938.

The Rio Grande Compact Commission,
Mr. S. O. Harper, Chairman,
Mr. M. C. Hinderlider, Member for Colorado,
Mr. T. H. McClure, Member for New Mexico,
Mr. F. B. Clayton, Member for Texas.

Gentlemen:

The Engineering Advisers of your Commission have held three meetings, the first in Santa Fe from November 22 to 24, 1937, the second in Los Angeles from December 15 to 27, 1937, and the third at Santa Fe from March 3 to 9, 1938. The first meeting was largely devoted to consideration of the general factors affecting the discharge of Rio Grande at the Colorado-New Mexico State Line and the delivery of water into Elephant Butte Reservoir. At the second meeting more detailed consideration was given to these matters, and certain schedules of deliveries were developed. Additional schedules were developed and other features discussed at the last meeting to consider matters referred to the committee by the Compact Commission at its meeting of March 3, 1938.

We avoided discussion of the relative rights of water users in the three States, and were guided throughout our work by the general policy - expressed at the meeting of the Compact Commission in October - that present uses of water in each of the three States must be protected in the formulation of a Compact for administration of the Rio Grande above Fort Quitman, because the usable water supply is no more than sufficient to satisfy such needs.

The Rio Grande above Fort Quitman, which constitutes the part of the drainage basin in which the Commission has primary interest, is divided naturally into three sections:

(a) The San Luis Valley, comprising the drainage area above the Lobatos gaging station on the Rio Grande near the Colorado-New Mexico State Line;

(b) The Middle Rio Grande from Lobatos to Elephant Butte Reservoir and the drainage basins of streams tributary to the river in this section;

(c) The balance of the Rio Grande Basin between Elephant Butte and Fort Quitman, including the Juarez Valley in Mexico.

SCHEDULED DELIVERIES AT LOBATOS

A consistent relationship has long been noted between the combined inflow of the major streams to San Luis Valley and the outflow of the Rio Grande at Lobatos. This relationship, however, may be disturbed in the future due to construction of storage reservoirs, and we have therefore prepared separate schedules applicable

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to the Conejos and Rio Grande stream systems. This is a departure from previous plans but has no practical disadvantage and has certain definite advantages; variations in discharge of the contributing streams will automatically be taken into account, particularly if storage reservoirs are constructed; and it will also enable the San Luis Valley water users to apportion among themselves their relative responsibility for meeting the obligation of Colorado.

The flow of Conejos River at its confluence with the Rio Grande was found to bear a close relation to the combined discharge of Conejos River near Mogote and its principal tributaries below that point. The following values express that relationship for the past ten years.

DISCHARGE OF CONEJOS RIVER

Quantities in thousands of acre-feet

Conejos Index Supply (1)	Conejos River at Mouths (2)
100	0
150	20
200	46
250	76
300	111
350	150
400	191
450	235
500	280
550	328
600	375
650	424
700	480

Intermediate quantities shall be computed by proportional parts.

(1) Conejos Index Supply is the natural flow of Conejos River at the U.S.G.S. gaging station near Mogote for the calendar year, plus the natural flow of Los Pinos River at the U.S.G.S. gaging station near Ortiz and the natural flow of San Antonio River at the U.S.G.S. gaging station at Ortiz, both for the months of April to October, inclusive.

(2) Conejos River at Mouths is the combined discharge of branches of this river at the U.S.G.S. gaging stations near La Sauses (Los Sauces) during the calendar year.

When from the total discharge of Rio Grande at Lobatos there is subtracted the contribution from Conejos River, a close relationship also is found to exist between that residual quantity and the discharge of Rio Grande near Del Norte. The following values express the relationship for the past ten years.

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DISCHARGE OF RIO GRANDE EXCLUSIVE OF CONEJOS RIVER

Quantities in thousands of acre-feet

Rio Grande at Del Norte (3)	Rio Grande at Lobatos less Conejos at Mouths (4)
200	60
250	65
300	75
350	86
400	98
450	112
500	127
550	144
600	162
650	182
700	204
750	229
800	257
850	292
900	335
950	380
1 000	430
1 100	540
1 200	640
1 300	740
1 400	840

Intermediate quantities shall be computed by proportional parts.

(3) Rio Grande at Del Norte is the recorded flow of the Rio Grande at the U.S.G.S. gaging station near Del Norte during the calendar year (measured above all principal points of diversion to San Luis Valley) corrected for the operation of reservoirs constructed after 1937.

(4) Rio Grande at Lobatos less Conejos at Mouths is the total flow of the Rio Grande at the U.S.G.S. gaging station near Lobatos, less the discharge of Conejos River at its mouths, during the calendar year.

The obligation of Colorado to deliver water in the Rio Grande at the Colorado-New Mexico State Line in each calendar year shall be 10,000 acre-feet less than the sum of the quantities set forth in the above tabulations, except for such departures from normal deliveries as are provided for below. The application of either schedule shall be subject to the provisions hereafter set forth and appropriate adjustments shall be made for: (a) any change in location in gaging stations; (b) any new or increased depletion of the natural runoff above inflow index gaging stations, and (c) any trans-mountain diversions.

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SCHEDULED DELIVERIES INTO ELEPHANT BUTTE RESERVOIR

The relation between the amount of water in the Rio Grande above the principal agricultural areas in New Mexico and inflow to Elephant Butte Reservoir is quite erratic, due primarily to wide variations in the discharge of tributary streams. Your Committee tried many devices to minimize the influence of such tributary inflow and found that there was a reasonable relationship between the discharges of Rio Grande at the Otowi Bridge and San Marcial gaging stations when the months of July, August, and September were excluded.

The following values express that relationship for the period prior to 1930.

DISCHARGE OF RIO GRANDE EXCLUSIVE OF JULY, AUGUST, AND SEPTEMBER AT OTOWI BRIDGE AND SAN MARCIAL

Quantities in thousands of acre-feet

Otowi Index Supply (5)	San Marcial Index Supply (6)
100	0
200	65
300	141
400	219
500	300
600	383
700	469
800	557
900	648
1 000	742
1 100	839
1 200	939
1 300	1 042
1 400	1 148
1 500	1 257
1 600	1 370
1 700	1 489
1 800	1 608
1 900	1 730
2 000	1 856
2 100	1 985
2 200	2 117
2 300	2 253

Intermediate quantities shall be computed by proportional parts.

(5) The Otowi Index Supply is the recorded flow of the Rio Grande at the U.S.G.S. gaging station at Otowi Bridge near San Ildefonso (formerly station near Buckman) during the calendar year, exclusive of the flow during the months of July, August, and

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September, corrected for the operation of reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and Otowi Bridge.

(6) San Marcial Index Supply is the recorded flow of the Rio Grande at the gaging station at San Marcial during the calendar year exclusive of the flow during the months of July, August, and September.

Although the foregoing relationship does not reflect possible changes in consumptive use during the summer months between Otowi and San Marcial, and tributary flow in other months still results in considerable variation, we recommend its use as a schedule of deliveries. The obligation of New Mexico to deliver water at San Marcial in each calendar year exclusive of the months of July, August, and September, shall thus be the quantity determined from the relationship set forth in the above tabulation. The application of this schedule shall be subject to the provisions hereafter set forth and appropriate adjustments shall be made for: (a) any change in location of gaging stations; (b) depletion after 1929 in New Mexico at any time of the year of the natural runoff at Otowi Bridge; (c) depletion of the runoff during July, August, and September of tributaries between Otowi Bridge and San Marcial, by works constructed after 1937; and (d) any trans-mountain diversions into the Rio Grande between Lobatos and San Marcial.

ALLOWABLE DEPARTURES

There will be natural variations in the relationships between the discharge at the control stations in the future, as in the past, and reasonable departures must be expected. Furthermore, departures which are caused by storage of water in reservoirs at time of flood should be permitted, subject to proper safeguards.

Definitions

The following terms will be used repeatedly and are here defined:

(a) Annual Debits - are the amounts by which deliveries in any calendar year fall below scheduled deliveries.

(b) Annual Credits - are the amounts in any calendar year by which actual deliveries exceed scheduled deliveries.

(c) Accrued Debits - are the amounts by which the sum of all debits exceeds the sum of all credits over any common period of time.

(d) Accrued Credits - are the amounts by which the sum of all credits exceeds the sum of all debits over any common period of time.

(e) Normal Release from Elephant Butte - is equal to an average of 790,000 acre-feet per annum; provided that this amount shall be adjusted for any gain or loss in usable water resulting from the

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operation of any reservoir below Elephant Butte; provided, further, that water released from Elephant Butte reservoir for the generation of power which encroaches on flood control capacity of and which is not subsequently released from another reservoir for irrigation of Rio Grande project lands plus deliveries to Mexico, shall be deemed to have been released for such purposes, excepting only when such release for power is made by an agency beyond the control of any of the States contrary to the formal protest of New Mexico or Texas or any irrigation district thereof.

(f) Project Storage - is the combined capacity of Elephant Butte Reservoir and all other reservoirs actually available for storage of usable water between Elephant Butte and Courchesne, but not more than a total of 2,638,860 acre-feet.

(g) Usable Water - is all water in Project storage which is available for release in accordance with irrigation demands, including deliveries to Mexico.

(h) Unusable Spill - is the amount of water which is actually spilled from Elephant Butte Reservoir or released for flood control in excess of the current demand for irrigation of Rio Grande Project lands plus deliveries to Mexico and which is not stored in another reservoir for subsequent release for such uses; provided that, if the actual releases from Elephant Butte Reservoir from the time of previous unusable spill have aggregated more than the sum of the normal releases, the time of occurrence of spill shall be adjusted by the difference between the total actual release and the accrued normal release.

Limitation on Debits

In the case of Colorado, no annual debit nor accrued debit shall exceed 100,000 acre-feet, except as either or both may be caused by storage of water in reservoirs constructed after 1937 in the drainage basin in the Rio Grande above Lobatos. Within the physical limitations of storage capacity in such reservoirs, Colorado shall retain water in storage at all times to the extent of its accrued debit.

In the case of New Mexico, the accrued debit shall not exceed 200,000 acre-feet at any time, except as such debit may be caused by storage of water in reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and San Marcial. Within the physical limitations of the storage capacity in such reservoirs, New Mexico shall retain water in storage at all times to the extent of its accrued debit. In computing the magnitude of accrued credits or debits, any annual debit greater than 150,000 acre-feet shall be taken as equal to that amount, plus all gains in the quantity of water in storage in such year.

If in any year the aggregate of accrued debits of Colorado and New Mexico exceeds the difference between the total capacity of Project storage and the amount of usable water then in storage, such debits shall be reduced proportionally to an aggregate amount equal to the minimum unfilled capacity in that year.

If in any year there is unusable spill from Elephant Butte Reservoir, all accrued debits of Colorado and New Mexico shall be cancelled, and no debits shall be considered in that year other than gains in the amount of water in storage in reservoirs prior to the time of spill.

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Limitation on Credits

In the case of Colorado, accrued credits in excess of 100,000 acre-feet at any time shall be not considered, provided that accruals in any amount may be applied to offset debits caused by storage in reservoirs, and provided further that accrued credits at the end of each year shall be reduced by ten percent to compensate for evaporation losses therefrom in Elephant Butte Reservoir. In computing the amount of accrued credits or debits, any annual credits in excess of 150,000 acre-feet shall be taken as equal to that amount.

In the case of New Mexico, accrued credits in excess of 200,000 acre-feet at any time shall not be considered, provided that accruals in any amount may be applied to offset debits caused by storage in reservoirs, and provided further that accrued credits at the end of each year shall be reduced by ten percent to compensate for evaporation losses therefrom in Elephant Butte Reservoir. In computing accrued credits or debits, annual credits in excess of 150,000 acre-feet shall be taken as equal to that amount.

At the time of unusable spill from Elephant Butte Reservoir, the aggregate credits of Colorado and New Mexico shall be reduced by the actual amount of such spill at Elephant Butte in proportion to their respective credits at the time of such spill, and no credits shall be considered in a year of spill.

Other Limitations

Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs constructed after 1929 whenever there is less than 400,000 acre-feet of water in storage available for use in the Rio Grande Project. On or about January first of any year any authorized representative of the water users in the Rio Grande Project may demand of Colorado and New Mexico the release from storage reservoirs of accrued debits, and such releases shall be made by each in proportion to the total debit of each and in amounts sufficient to bring the quantity of usable water in project storage to 600,000 acre-feet by March first and to maintain this quantity in storage until April thirtieth.

In event any works are constructed after 1937 for the purpose of delivering water into the Rio Grande from the Closed Basin in San Luis Valley, Colorado shall be credited with the amount of such water delivered, provided the proportion of sodium ions shall be less than 45% of the total positive ions in that water when total concentration of salts in such water exceeds 350 parts per million.

Gaging Stations

The difficulties and cost of securing reliable records of stream flow at San Marcial are increasing and may become insurmountable. In order to be prepared for such an emergency, immediate

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steps should be taken to insure that reliable records of discharge will be secured at or near San Acacia, San Marcial and below Elephant Butte reservoir to permit substitute schedules to be adopted, if necessary.

The above gaging stations, together with other gaging stations referred to in connection with the schedules set forth herein, should be operated by the Commission, directly or in cooperation with an appropriate Federal agency. At each gaging station the equipment, methods and frequency of measurements should be such as to produce reliable records. Additional gaging stations should be installed and operated where necessary to carry out the intent of any Compact.

RECOMMENDATIONS

In submitting this analysis of conditions and our recommendations for your favorable consideration in the formulation of a permanent Compact, we ask that you recognize that many of the factors influencing our conclusions were not possible of close determination and that the effect of changes of salinity of the Elephant Butte supply since 1930 was left for future adjustment. Accordingly, we recommend that all of the provisions hereof be reviewed five years hence.

We are satisfied that no material expansion of the irrigated area in the Rio Grande Basin above Fort Quitman will be practicable without importations from other watersheds. Good use could be made of this water in each of the States, but we deemed that the allocation of any supply so obtained constituted a matter of policy beyond our province. Accordingly, no recommendation is made.

We recommend that the normal release from Elephant Butte Reservoir be deemed to be an average of 790,000 acre-feet per annum, adjusted for any gain or loss of usable water resulting from the operation of any reservoir below Elephant Butte.

We recommend that deliveries by Colorado and New Mexico shall be in accordance with the schedules and applicable provisions hereinbefore set forth.

It is our opinion that the application of all of the recommendations and provisions set forth herein will be equitable to each State and will permit the maximum practicable use of the waters of the Rio Grande.

Respectfully submitted,

COMMITTEE OF ENGINEERING ADVISERS

(Sgd) E. B. Debler
E. B. Debler for the United States

(Sgd) Royce J. Tipton
Royce J. Tipton for Colorado

(Sgd) John H. Bliss
John H. Bliss for New Mexico

(Sgd) R. A. Hill
Raymond A. Hill for Texas.

I CONCUR:

(Sgd) H. C. Neuffer
H. C. Neuffer

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Appendix No. 8

March 11, 1938.

The Rio Grande Compact Commission,
Mr. S. O. Harper, Chairman,
Mr. M. C. Hinderlider, Member for Colorado,
Mr. T. M. McClure, Member for New Mexico,
Mr. F. B. Clayton, Member for Texas.

Gentlemen:

At your meeting this morning you asked that we clarify certain parts of our report of March 9th. We have reviewed those features of the report and recommend the following for your favorable consideration:

1. The definition of "Normal Release from Elephant Butte" shall be disregarded and the following definition shall be substituted:

Actual Release - is the amount of usable water released from the lowest reservoir comprising project storage.

2. The definition of "Unusable Spill" shall be modified to read as follows:

Unusable Spill - is the amount of water which is actually spilled from Elephant Butte reservoir or released therefrom for flood control in excess of the current demand on project storage, and which does not become usable water by storage in another reservoir; provided, that if the actual releases of usable water from the time of previous unusable spill have aggregated more than an average of 790,000 acre-feet per annum, the date spill would have occurred shall be determined by taking into consideration the difference between the total actual release and releases at such average rate, and the date so determined shall be adopted as the date of spill, and of the same effect as though the spill had actually occurred on said date.

3. The recommendation on Page 13, dealing with normal release, shall be changed to read as follows:

We recommend that the normal release of usable water from the lowest reservoir comprising project storage be deemed to be an average of 790,000 acre-feet per annum.

4. The first sentence following the caption "Other Limitations" shall be changed to read as follows:

Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs constructed after 1929 whenever there is less than 400,000 acre-feet of usable water in project storage; provided, that if the actual releases of usable water from the time of previous unusable spill have aggregated more than an

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average of 790,000 acre-feet per annum, the time at which such minimum stage is reached shall be adjusted by the difference between the total actual release and releases at such average rate.

5. The intention of the second provision in the first paragraph following the caption "Other Limitations" was that debit water should be released at the greatest rate practicable under the conditions then prevailing and that the aggregate release of debit water should be limited to the amount which would enable a normal release to be made from project storage in that year.

6. The provisions for reduction of accrued credits to compensate for evaporation losses from Elephant Butte Reservoir shall be eliminated, and in lieu thereof the following general provision shall be substituted:

To the extent that accrued credits are impounded in reservoirs between San Marcial and Courchesne, and to the extent that accrued debits are impounded in reservoirs above San Marcial, such credits and debits shall be reduced annually to compensate for evaporation losses in the proportion that such credits or debits bore to the total amount of water in such reservoirs during the year.

Respectfully submitted,

COMMITTEE OF ENGINEERING ADVISERS

(Sgd) E. B. Debler
E. B. Debler for the United States

(Sgd) R. J. Tipton
Royce J. Tipton for Colorado

(Sgd) John H. Bliss
John H. Bliss for New Mexico

(Sgd) R. A. Hill
Raymond A. Hill for Texas.

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Appendix No. 9.

MEMORANDUM FROM COMMITTEE OF ENGINEERS
IN RE MARCH 16th DRAFT OF RIO GRANDE
COMPACT

March 16, 1938.

Page 1. No comment.

Page 2. Suggest that phrase "in any calendar year" be placed in item (h) in the same position as in item (g); also that words "actual deliveries" be used in both.

In items (i) and (j) insert word "annual" before the words "credits" and "debits."

Page 3. Strike word "only" in last line of item (n).

Modify item (o) to read: "Actual Release" is the amount of usable water released in any calendar year from the lowest reservoir comprising project storage.

Correct typographical error in last line, changing word "such" to "each."

Page 4. No comment.

Page 5. In our reports of December 27, 1937, and March 9, 1938, we stated that the values in the Conejos River schedule expressed the relationship which had prevailed for the past ten years. Upon further analysis we find that this curve was slightly in error, and now recommend that the following values be used:

DISCHARGE OF CONEJOS RIVER
Quantities in thousands of acre-feet

Conejos Index Supply (1)	Conejos River at Mouths (2)
100	0
150	20
200	45
250	75
300	109
350	147
400	188
450	232
500	278
550	326
600	376
650	426
700	476

Intermediate quantities shall be computed by proportional parts.

Page 6. No comment.

Page 7. To avoid confusion between natural and recorded runoff, we suggest elimination of word "natural" in line 4.

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To be more accurate technically, the last two lines should read:

"....the total dissolved solids in such water exceeds three hundred fifty parts per million."

Page 8. No comment.

Page 9. The wrong paragraph was apparently copied and the following from our report of March 9 should be substituted:

"The application of this schedule shall be subject to the provisions hereinafter set forth and appropriate adjustments shall be made for (a) any change in location of gaging stations; (b) depletion after 1929 in New Mexico at any time of the year of the natural runoff at Otowi Bridge; (c) depletion of the runoff during July, August, and September of tributaries between Otowi Bridge and San Marcial, by works constructed after 1937; and (d) any trans-mountain diversions into the Rio Grande between Lobatos and San Marcial."

We suggest that the last paragraph be eliminated.

Page 10. To cover the specific intent of the last paragraph on page 9, we suggest the addition of the following:

"The Commission shall cause special studies to be initiated and continued to determine the relationship between the flow of the Rio Grande at San Acacia, at San Marcial, and below Elephant Butte reservoir, to the end that an equivalent schedule may be substituted without delay should the necessity arise. Similar studies shall be made elsewhere when advisable."

Page 11. For clarification, in the third lines of the second and third paragraphs, insert the word "holdover" ahead of the word "storage."

Change last paragraph to read as follows:

"In computing the amount of accrued credits and accrued debits of Colorado and New Mexico, any annual credit in excess of 150,000 acre-feet shall be taken as equal to that amount."

Insert paragraph ahead of the above to read as follows:

"The Commission by unanimous action may authorize the release from storage of any amount of water which is then being held in storage by reason of accrued debits of Colorado or New Mexico; provided, that such water shall be replaced at the first opportunity thereafter."

Page 12. Eliminate the first paragraph.

Change order of remaining paragraphs, as follows:

"In any year in which actual spill occurs..."
"In any year in which there is actual spill of usable water..."
"In any year in which the aggregate of accrued debits..."

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Page 13. Eliminate first paragraph as this is covered by definition of "hypothetical spill."

Page 14. Modify the first proviso to read in part as follows:

"...provided, that if the actual releases of usable water from the beginning of the calendar year following the effective date of this Compact, or from the beginning of the calendar year following actual spill, have aggregated more..."

Add the following proviso:

"Provided further, that Colorado or New Mexico, or both, may relinquish accrued credits at any time, and Texas may accept such relinquished water, and in such event the State, or States, so relinquishing shall be entitled to store water in the amount of the water so relinquished."

Page 15. Amplify this paragraph as follows:

"During the month of January of any year the Commissioner for Texas may demand of Colorado and New Mexico, and the Commissioner for New Mexico may demand of Colorado, the release of water from storage reservoirs constructed after 1929 to the amount of the accrued debits of Colorado and New Mexico, respectively, and such release..."

In the next to the last line insert after the word "release" the expression:

"...of 790,000 acre-feet."

Page 16. No comment.

Page 17. The intent of this provision is not clear to us.

Page 18, et seq. No comment.

The foregoing recommended changes are within the intent of our reports.

Respectfully submitted,

COMMITTEE OF ENGINEERING ADVISERS

(Sgd) E. B. Debler
E. B. Debler for the United States

(Sgd) R. J. Tipton
Royce J. Tipton for Colorado

(Sgd) John H. Bliss
John H. Bliss for New Mexico

(Sgd) R. A. Hill
Raymond A. Hill for Texas.

I CONCUR:

(Sgd) H. C. Neuffer
H. C. Neuffer

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Appendix No. 10

Santa Fe, N. M., March 17, 1938.

The Rio Grande Compact Commission,
Mr. S. O. Harper,
Mr. M. C. Hinderlider,
Mr. Thomas M. McClure,
Mr. Frank B. Clayton.

Gentlemen:

The Engineering Advisers of your Commission have reviewed the draft of the Rio Grande Compact submitted to you by your Legal Advisers on March 17, 1938. It is our opinion that this is in accordance with the intent of our report of March 9, 1938, and we recommend it for your favorable consideration and approval.

Respectfully submitted,

COMMITTEE OF ENGINEERING ADVISERS

(Sgd) E. B. Debler
E. B. Debler for the United States

(Sgd) R. J. Tipton
Royce J. Tipton for Colorado

(Sgd) John H. Bliss
John H. Bliss for New Mexico

(Sgd) R. A. Hill
Raymond A. Hill for Texas.

I CONCUR:

(Sgd) H. C. Neuffer
H. C. Neuffer

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RIO GRANDE COMPACT

The State of Colorado, the State of New Mexico, and the State of Texas, desiring to remove all causes of present and future controversy among these States and between citizens of one of these States and citizens of another State with respect to the use of the waters of the Rio Grande above Fort Quitman, Texas, and being moved by considerations of interstate comity, and for the purpose of effecting an equitable apportionment of such waters, have resolved to conclude a Compact for the attainment of these purposes, and to that end, through their respective Governors, have named as their respective Commissioners:

For the State of Colorado - M. C. Hinderlider

For the State of New Mexico - Thomas M. McClure

For the State of Texas - Frank B. Clayton

who, after negotiations participated in by S. O. Harper, appointed by the President as the representative of the United States of America, have agreed upon the following articles, to-wit:

ARTICLE I.

(a) The State of Colorado, the State of New Mexico, the State of Texas, and the United States of America, are hereinafter designated "Colorado," "New Mexico," "Texas," and the "United States," respectively.

(b) "The Commission" means the agency created by this Compact for the administration thereof.

(c) The term "Rio Grande Basin" means all of the territory drained by the Rio Grande and its tributaries in Colorado, in New Mexico, and in Texas above Fort Quitman, including the Closed Basin in Colorado.

(d) The "Closed Basin" means that part of the Rio Grande Basin in Colorado where the streams drain into the San Luis Lakes and adjacent territory, and do not normally contribute to the flow of the Rio Grande.

(e) The term "tributary" means any stream which naturally contributes to the flow of the Rio Grande.

(f) "Transmountain Diversion" is water imported into the drainage basin of the Rio Grande from any stream system outside of the Rio Grande Basin, exclusive of the Closed Basin.

(g) "Annual Debits" are the amounts by which actual deliveries in any calendar year fall below scheduled deliveries.

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(h) "Annual Credits" are the amounts by which actual deliveries in any calendar year exceed scheduled deliveries.

(i) "Accrued Debits" are the amounts by which the sum of all annual debits exceeds the sum of all annual credits over any common period of time.

(j) "Accrued Credits" are the amounts by which the sum of all annual credits exceeds the sum of all annual debits over any common period of time.

(k) "Project Storage" is the combined capacity of Elephant Butte Reservoir and all other reservoirs actually available for the storage of usable water below Elephant Butte and above the first diversion to lands of the Rio Grande Project, but not more than a total of 2,638,860 acre-feet.

(l) "Usable Water" is all water, exclusive of credit water, which is in project storage and which is available for release in accordance with irrigation demands, including deliveries to Mexico.

(m) "Credit Water" is that amount of water in project storage which is equal to the accrued credit of Colorado, or New Mexico, or both.

(n) "Unfilled Capacity" is the difference between the total physical capacity of project storage and the amount of usable water then in storage.

(o) "Actual Release" is the amount of usable water released in any calendar year from the lowest reservoir comprising project storage.

(p) "Actual Spill" is all water which is actually spilled from Elephant Butte Reservoir, or is released therefrom for flood control, in excess of the current demand on project storage and which does not become usable water by storage in another reservoir; provided, that actual spill of usable water cannot occur until all credit water shall have been spilled.

(q) "Hypothetical Spill" is the time in any year at which usable water would have spilled from project storage if 790,000 acre-feet had been released therefrom at rates proportional to the actual release in every year from the starting date to the end of the year in which hypothetical spill occurs; in computing hypothetical spill the initial condition shall be the amount of usable water in project storage at the beginning of the calendar year following the effective date of this Compact, and thereafter the initial condition shall be the amount of usable water in project storage at the beginning of the calendar year following each actual spill.

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ARTICLE II.

The Commission shall cause to be maintained and operated a stream gaging station equipped with an automatic water stage recorder at each of the following points, to-wit:

(a) On the Rio Grande near Del Norte above the principal points of diversion to the San Luis Valley;

(b) On the Conejos River near Mogote;

(c) On the Los Pinos River near Ortiz;

(d) On the San Antonio River at Ortiz;

(e) On the Conejos River at its mouths near Los Sauces;

(f) On the Rio Grande near Lobatos;

(g) On the Rio Chama below El Vado Reservoir;

(h) On the Rio Grande at Otowi Bridge near San Ildefonso;

(i) On the Rio Grande near San Acacia;

(j) On the Rio Grande at San Marcial;

(k) On the Rio Grande below Elephant Butte Reservoir;

(l) On the Rio Grande below Caballo Reservoir.

Similar gaging stations shall be maintained and operated below any other reservoir constructed after 1929, and at such other points as may be necessary for the securing of records required for the carrying out of the Compact; and automatic water stage recorders shall be maintained and operated on each of the reservoirs mentioned, and on all others constructed after 1929.

Such gaging stations shall be equipped, maintained and operated by the Commission directly or in cooperation with an appropriate Federal or State Agency, and the equipment, method and frequency of measurement at such stations shall be such as to produce reliable records at all times.

ARTICLE III.

The obligation of Colorado to deliver water in the Rio Grande at the Colorado-New Mexico State Line, measured at or near Lobatos, in each calendar year, shall be ten thousand acre-feet less than the sum of those quantities set forth in the two following tabulations of relationship, which correspond to the quantities at the upper index stations:

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DISCHARGE OF CONEJOS RIVER

Quantities in thousands of acre-feet

Conejos Index Supply (1)	Conejos River at Mouths (2)
100	0
150	20
200	45
250	75
300	109
350	147
400	188
450	232
500	278
550	326
600	376
650	426
700	476

Intermediate quantities shall be computed by proportional parts.

(1) Conejos Index Supply is the natural flow of Conejos River at the U.S.G.S. gaging station near Mogote during the calendar year, plus the natural flow of Los Pinos River at the U.S.G.S. gaging station near Ortiz and the natural flow of San Antonio River at the U.S.G.S. gaging station at Ortiz, both during the months of April to October, inclusive.

(2) Conejos River at Mouths is the combined discharge of branches of this river at the U.S.G.S. gaging stations near Los Sauces during the calendar year.

DISCHARGE OF RIO GRANDE EXCLUSIVE OF CONEJOS RIVER

Quantities in thousands of acre-feet

Rio Grande at Del Norte (3)	Rio Grande at Lobatos less Conejos at Mouths (4)
200	
250	60
300	65
350	75
400	86
450	98
500	112
550	127
600	144
650	162
700	182
750	204
800	229
	257

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DISCHARGE OF RIO GRANDE EXCLUSIVE OF CONEJOS RIVER

Quantities in thousands of acre-feet (continued)

Rio Grande at Del Norte (3)	Rio Grande at Lobatos less Conejos at Mouths (4)
850	292
900	335
950	380
1,000	430
1,100	540
1,200	640
1,300	740
1,400	840

Intermediate quantities shall be computed by proportional parts.

(3) Rio Grande at Del Norte is the recorded flow of the Rio Grande at the U.S.G.S. gaging station near Del Norte during the calendar year (measured above all principal points of diversion to San Luis Valley) corrected for the operation of reservoirs constructed after 1937.

(4) Rio Grande at Lobatos less Conejos at Mouths is the total flow of the Rio Grande at the U.S.G.S. gaging station near Lobatos, less the discharge of Conejos River at its Mouths, during the calendar year.

The application of these schedules shall be subject to the provisions hereinafter set forth and appropriate adjustments shall be made for (a) any change in location of gaging stations; (b) any new or increased depletion of the runoff above inflow index gaging stations; and (c) any transmountain diversions into the drainage basin of the Rio Grande above Lobatos.

In event any works are constructed after 1937 for the purpose of delivering water into the Rio Grande from the Closed Basin, Colorado shall not be credited with the amount of such water delivered, unless the proportion of sodium ions shall be less than forty-five percent of the total positive ions in that water when the total dissolved solids in such water exceeds three hundred fifty parts per million.

ARTICLE IV.

The obligation of New Mexico to deliver water in the Rio Grande at San Marcial, during each calendar year, exclusive of the months of July, August and September, shall be that quantity set forth in the following tabulation of relationship, which corresponds to the quantity at the upper index station:

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DISCHARGE OF RIO GRANDE AT OTOWI BRIDGE AND AT SAN MARCIAL EXCLUSIVE OF JULY, AUGUST AND SEPTEMBER

Quantities in thousands of acre-feet

Otowi Index Supply (5)	San Marcial Index Supply (6)
100	0
200	65
300	141
400	219
500	300
600	383
700	469
800	557
900	648
1000	742
1100	839
1200	939
1300	1042
1400	1148
1500	1257
1600	1370
1700	1489
1800	1608
1900	1730
2000	1856
2100	1985
2200	2117
2300	2253

Intermediate quantities shall be computed by proportional parts.

(5) The Otowi Index Supply is the recorded flow of the Rio Grande at the U.S.G.S. gaging station at Otowi Bridge near San Ildefonso (formerly station near Buckman) during the calendar year, exclusive of the flow during the months of July, August and September, corrected for the operation of reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and Otowi Bridge.

(6) San Marcial Index Supply is the recorded flow of the Rio Grande at the gaging station at San Marcial during the calendar year exclusive of the flow during the months of July, August and September.

The application of this schedule shall be subject to the provisions hereinafter set forth and appropriate adjustments shall be made for (a) any change in location of gaging stations; (b) depletion after 1929 in New Mexico at any time of the year of the natural runoff at Otowi Bridge; (c) depletion of the runoff during July, August and September of tributaries between Otowi Bridge and

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San Marcial, by works constructed after 1937; and (d) any trans-mountain diversions into the Rio Grande between Lobatos and San Marcial.

Concurrent records shall be kept of the flow of the Rio Grande at San Marcial, near San Acacia, and of the release from Elephant Butte Reservoir, to the end that the records at these three stations may be correlated.

ARTICLE V.

If at any time it should be the unanimous finding and determination of the Commission that because of changed physical conditions, or for any other reason, reliable records are not obtainable, or cannot be obtained, at any of the stream gaging stations herein referred to, such stations may, with the unanimous approval of the Commission, be abandoned, and with such approval another station, or other stations, shall be established and new measurements shall be substituted which, in the unanimous opinion of the Commission, will result in substantially the same results, so far as the rights and obligations to deliver water are concerned, as would have existed if such substitution of stations and measurements had not been so made.

ARTICLE VI.

Commencing with the year following the effective date of this Compact, all credits and debits of Colorado and New Mexico shall be computed for each calendar year; provided, that in a year of actual spill no annual credits nor annual debits shall be computed for that year.

In the case of Colorado, no annual debit nor accrued debit shall exceed 100,000 acre-feet, except as either or both may be caused by holdover storage of water in reservoirs constructed after 1937 in the drainage basin of the Rio Grande above Lobatos. Within the physical limitations of storage capacity in such reservoirs, Colorado shall retain water in storage at all times to the extent of its accrued debit.

In the case of New Mexico, the accrued debit shall not exceed 200,000 acre-feet at any time, except as such debit may be caused by holdover storage of water in reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and San Marcial. Within the physical limitations of storage capacity in such reservoirs, New Mexico shall retain water in storage at all times to the extent of its accrued debit. In computing the magnitude of accrued credits or debits, New Mexico shall not be charged with any greater debit in any one year than the sum of 150,000 acre-feet and all gains in the quantity of water in storage in such year.

The Commission by unanimous action may authorize the release from storage of any amount of water which is then being held in storage by reason of accrued debits of Colorado or New

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Mexico; provided, that such water shall be replaced at the first opportunity thereafter.

In computing the amount of accrued credits and accrued debits of Colorado or New Mexico, any annual credits in excess of 150,000 acre-feet shall be taken as equal to that amount.

In any year in which actual spill occurs, the accrued credits of Colorado, or New Mexico, or both, at the beginning of the year shall be reduced in proportion to their respective credits by the amount of such actual spill; provided, that the amount of actual spill shall be deemed to be increased by the aggregate gain in the amount of water in storage, prior to the time of spill, in reservoirs above San Marcial constructed after 1929; provided, further, that if the Commissioners for the States having accrued credits authorize the release of part, or all, of such credits in advance of spill, the amount so released shall be deemed to constitute actual spill.

In any year in which there is actual spill of usable water, or at the time of hypothetical spill thereof, all accrued debits of Colorado, or New Mexico, or both, at the beginning of the year shall be cancelled.

In any year in which the aggregate of accrued debits of Colorado and New Mexico exceeds the minimum unfilled capacity of project storage, such debits shall be reduced proportionally to an aggregate amount equal to such minimum unfilled capacity.

To the extent that accrued credits are impounded in reservoirs between San Marcial and Courchesne, and to the extent that accrued debits are impounded in reservoirs above San Marcial, such credits and debits shall be reduced annually to compensate for evaporation losses in the proportion that such credits or debits bore to the total amount of water in such reservoirs during the year.

ARTICLE VII.

Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs constructed after 1929 whenever there is less than 400,000 acre-feet of usable water in project storage; provided, that if the actual releases of usable water from the beginning of the calendar year following the effective date of this Compact, or from the beginning of the calendar year following actual spill, have aggregated more than an average of 790,000 acre-feet per annum, the time at which such minimum stage is reached shall be adjusted to compensate for the difference between the total actual release and releases at such average rate; provided, further, that Colorado or New Mexico, or both, may relinquish accrued credits at any time, and Texas may accept such relinquished water, and in such event the state, or states, so relinquishing shall be entitled to store water in the amount of the water so relinquished.

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ARTICLE VIII.

During the month of January of any year the Commissioner for Texas may demand of Colorado and New Mexico, and the Commissioner for New Mexico may demand of Colorado, the release of water from storage reservoirs constructed after 1929 to the amount of the accrued debits of Colorado and New Mexico, respectively, and such releases shall be made by each at the greatest rate practicable under the conditions then prevailing, and in proportion to the total debit of each, and in amounts, limited by their accrued debits, sufficient to bring the quantity of usable water in project storage to 600,000 acre-feet by March first and to maintain this quantity in storage until April thirtieth, to the end that a normal release of 790,000 acre-feet may be made from project storage in that year.

ARTICLE IX.

Colorado agrees with New Mexico that in event the United States or the State of New Mexico decides to construct the necessary works for diverting the waters of the San Juan River, or any of its tributaries, into the Rio Grande, Colorado hereby consents to the construction of said works and the diversion of waters from the San Juan River, or the tributaries thereof, into the Rio Grande in New Mexico, provided the present and prospective uses of water in Colorado by other diversions from the San Juan River, or its tributaries, are protected.

ARTICLE X.

In the event water from another drainage basin shall be imported into the Rio Grande Basin by the United States or Colorado or New Mexico, or any of them jointly, the State having the right to the use of such water shall be given proper credit therefor in the application of the schedules.

ARTICLE XI.

New Mexico and Texas agree that upon the effective date of this Compact all controversies between said States relative to the quantity or quality of the water of the Rio Grande are composed and settled; however, nothing herein shall be interpreted to prevent recourse by a signatory state to the Supreme Court of the United States for redress should the character or quality of the water, at the point of delivery be changed hereafter by one signatory State to the injury of another. Nothing herein shall be construed as an admission by any signatory state that the use of water for irrigation causes increase of salinity for which the user is responsible in law.

ARTICLE XII.

To administer the provisions of this Compact there shall be constituted a Commission composed of one representative from each State, to be known as the Rio Grande Compact Commission. The

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State Engineer of Colorado shall be ex-officio the Rio Grande Compact Commissioner for Colorado. The State Engineer of New Mexico shall be ex-officio the Rio Grande Compact Commissioner for New Mexico. The Rio Grande Compact Commissioner for Texas shall be appointed by the Governor of Texas. The President of the United States shall be requested to designate a representative of the United States to sit with such Commission, and such representative of the United States, if so designated by the President, shall act as Chairman of the Commission without vote.

The salaries and personal expenses of the Rio Grande Compact Commissioners for the three States shall be paid by their respective States, and all other expenses incident to the administration of this Compact, not borne by the United States, shall be borne equally by the three States.

In addition to the powers and duties hereinbefore specifically conferred upon such Commission, and the members thereof, the jurisdiction of such Commission shall extend only to the collection, correlation and presentation of factual data and the maintenance of records having a bearing upon the administration of this Compact, and, by unanimous action, to the making of recommendations to the respective States upon matters connected with the administration of this Compact. In connection therewith, the Commission may employ such engineering and clerical aid as may be reasonably necessary within the limit of funds provided for that purpose by the respective States. Annual reports compiled for each calendar year shall be made by the Commission and transmitted to the Governors of the signatory States on or before March first following the year covered by the report. The Commission may, by unanimous action, adopt rules and regulations consistent with the provisions of this Compact to govern their proceedings.

The findings of the Commission shall not be conclusive in any court or tribunal which may be called upon to interpret or enforce this Compact.

ARTICLE XIII.

At the expiration of every five year period after the effective date of this Compact, the Commission may, by unanimous consent, review any provisions hereof which are not substantive in character and which do not affect the basic principles upon which the Compact is founded, and shall meet for the consideration of such questions on the request of any member of the Commission; provided, however, that the provisions hereof shall remain in full force and effect until changed and amended within the intent of the Compact by unanimous action of the Commissioners, and until any changes in this Compact are ratified by the legislatures of the respective states and consented to by the Congress, in the same manner as this Compact is required to be ratified to become effective.

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ARTICLE XIV.

The schedules herein contained and the quantities of water herein allocated shall never be increased nor diminished by reason of any increase or diminution in the delivery or loss of water to Mexico.

ARTICLE XV.

The physical and other conditions characteristic of the Rio Grande and peculiar to the territory drained and served thereby, and to the development thereof, have actuated this Compact and none of the signatory states admits that any provisions herein contained establishes any general principle or precedent applicable to other interstate streams.

ARTICLE XVI.

Nothing in this Compact shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties, or to the Indian Tribes, or as impairing the rights of the Indian Tribes.

ARTICLE XVII.

This Compact shall become effective when ratified by the legislatures of each of the signatory states and consented to by the Congress of the United States. Notice of ratification shall be given by the Governor of each state to the Governors of the other states and to the President of the United States, and the President of the United States is requested to give notice to the Governors of each of the signatory states of the consent of the Congress of the United States.

IN WITNESS WHEREOF, the Commissioners have signed this Compact in quadruplicate original, one of which shall be deposited in the archives of the Department of State of the United States of America and shall be deemed the authoritative original, and of which a duly certified copy shall be forwarded to the Governor of each of the signatory States.

Done at the City of Santa Fe, in the State of New Mexico, on the 18th day of March, in the year of our Lord, One Thousand Nine Hundred and Thirty-eight.

(Sgd.) M. C. Hinderlider.

(Sgd.) Thomas M. McClure.

(Sgd.) Frank B. Clayton.

APPROVED:

(Sgd.) S. O. Harper.

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Appendix No. 12

March 26, 1938.

The Honorable,
The Secretary of the Interior,
Washington, D. C.

Re: Rio Grande Compact.

My dear Mr. Secretary:

I have the honor to submit my final report on the deliberations of the Rio Grande Compact Commission.

On December 8, 1934, I received the following telegram:

"S. O. HARPER, BUREAU OF RECLAMATION, DENVER.

"BY DIRECTION OF PRESIDENT YOU ARE DIRECTED TO ATTEND MEETING SANTA FE DECEMBER TEN AS HIS REPRESENTATIVE TO PRESIDE AT MEETING OF COMMISSIONERS REPRESENTING COLORADO NEW MEXICO AND TEXAS TO CONFER FOR PURPOSE OF NEGOTIATING A NEW INTERSTATE COMPACT REGARDING WATERS OF THE RIO GRANDE TO REPLACE TEMPORARY COMPACT TO WHICH THE UNITED STATES IS A PARTY STOP PLEASE CONFIRM.

ICKES, SECRETARY."

Pursuant to your instructions, I have served as the representative of the United States and chairman of the Commission authorized by appropriate action of the legislatures of the States of Colorado, New Mexico, and Texas, to negotiate an interstate compact for an equitable division of the waters of the Rio Grande. The other members of the Commission were M. C. Hinderlider, Thomas M. McClure, and Frank B. Clayton, Commissioners for Colorado, New Mexico, and Texas, respectively.

Six meetings have been held, all at Santa Fe, New Mexico, since the Commission was organized on December 10, 1934, the final meeting lasting from March 3 to 18, 1938. The progress made in the earlier meetings has been heretofore reported to you, but may be briefly summarized as follows: The temporary compact between the three states, dated February 12, 1929, which expired on June 1, 1935, was renewed for a period of two years, ending June 1, 1937, and was thereafter renewed for a further period of four months, ending October 1, 1937.

In December 1935, the National Resources Committee, through its Water Resources Committee, represented by Consultants Harlan H. Barrows and Frank Adams, met with the Commission and suggested a plan of cooperation between the Committee and the several States and Federal agencies concerned, under which there might be undertaken a comprehensive investigation of the water resources of the Rio Grande Basin above Fort Quitman, including studies of the past, present, and prospective uses of water in

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such basin, and the opportunities for conserving the water and land resources, to assist the Commission in reaching a satisfactory basis for the equitable apportionment of the waters of the Rio Grande between the three States. The Commission gladly accepted the offer of the National Resources Committee and the results of its work, extending over a period of 18 months, were made available as the report of the Rio Grande Joint Investigation in June 1937. The last extension of the temporary compact from June 1, 1937, to October 1, 1937, was agreed to for the purpose of enabling the Commission to make full use of the results of the Rio Grande Joint Investigation in the formulation of a permanent Compact.

It is now my pleasure to report that at the meeting held in Santa Fe from March 3 to 18, 1938, a final and complete agreement was reached by the Commission on an equitable division of the waters of the Rio Grande, and a permanent Compact was signed on March 18, by the Commissioners representing the three states, and by the representative of the United States. It will become effective when ratified by the legislatures of each of the signatory States and consented to by the Congress of the United States.

The Compact, if ratified, will end over forty years of controversy and dispute among the States, and it is the unanimous opinion of the Commissioners and their advisers that it provides an eminently fair and equitable solution of this troublesome problem. It is my belief that the interests of the United States are fully safeguarded by (a) inclusion, in the State allocations, of all water to which Federal irrigation projects are entitled, (b) provision in Article XII for a representative of the United States to serve on the permanent commission set up to administer the Compact, and (c) by the provisions of Article XVI that "Nothing in this Compact shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties, or to the Indian Tribes, or as impairing the rights of the Indian Tribes."

The successful outcome of these negotiations may be ascribed in a large degree to the cooperative spirit which actuated the Commissioners and their advisers throughout the four-year period of negotiations and the patience, tolerance, and earnest effort in evidence at all times. Special credit is due to the engineering committee, consisting of E. B. Debler, representing the United States, R. J. Tipton, representing Colorado, John H. Bliss, representing New Mexico, and Raymond A. Hill, representing Texas, who set up the factual data on which the Compact is based; to the committee of attorneys to which the duty was assigned of drafting the Compact in appropriate legal form, consisting of George M. Corlett, Ralph Carr, and Clifford Stone, representing Colorado, A. T. Hannett and Fred E. Wilson, representing New Mexico, and Richard F. Burges and Edwin Mechem, representing Texas and the lands in New Mexico below Elephant Butte Reservoir; to all of the representatives of the National Resources Committee, and in particular to Consultants Harlan H. Barrows and Frank Adams, who rendered most valuable assistance not only through the Rio Grande Joint Investigation, but also in helpful advice and counsel during the progress of the negotiations.

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There is herewith transmitted the authoritative original Compact which, in accordance with the provisions in the concluding article, is to be deposited in the archives of the Department of State, and a duly certified copy thereof is to be forwarded to the Governor of each of the signatory States. For the latter purpose three additional copies are enclosed, which, it is respectfully requested, be certified by the State Department and one copy forwarded to the Governor of each signatory State. Two copies are also enclosed for the files of the Interior Department.

Respectfully,

S. O. Harper

S. O. Harper,
Chairman, Rio Grande
Compact Commission.

Encls.

In dupl.

CC-Mr. M. C. Hinderlider
Mr. Thomas M. McClure
Mr. Frank B. Clayton
Commissioner of Reclamation

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032.1	RIO GRANDE BASIN	CORRES. RE COMPACT BETWEEN STATES OF COLORADO; NEW MEXICO & TEXAS RE RIO GRANDE BASIN WATER RIGHTS.	JAN. 1938 THRU MAY 1939	032.1

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RETURN TO FILES OF
BUREAU OF RECLAMATION

ADDRESS ALL COMMUNICATIONS TO
THE CHIEF ENGINEER

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CUSTOMHOUSE
DENVER, COLORADO

Asst. Coxwain

...FFICE OF THE CHIEF ENGINEER

March 26, 1938.

The Honorable,
The Secretary of the Interior,
Washington, D. C.

Re: Rio Grande Compact.

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Six meetings have been held, all at Santa Fe, New Mexico, since the Commission was organized on December 10, 1934, the final meeting lasting from March 3 to 18, 1938. The progress made in the earlier meetings has been heretofore reported to you, but may be briefly summarized as follows: The temporary compact between the three states, dated February 12, 1929, which expired on June 1, 1935,

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In December 1935, the National Resources Committee, through its Water Resources Committee, represented by Consultants Harlan H. Barrows and Frank Adams, met with the Commission and suggested a plan of cooperation between the Committee and the several States and Federal agencies concerned, under which there might be undertaken a comprehensive investigation of the water resources of the Rio Grande Basin above Fort Quitman, including studies of the past, present, and prospective uses of water in such basin, and the opportunities for conserving the water and land resources, to assist the Commission in reaching a satisfactory basis for the equitable apportionment of the waters of the Rio Grande between the three States. The Commission gladly accepted the offer of the National Resources Committee and the results of its work, extending over a period of 18 months, were made available as the report of the Rio Grande Joint Investigation in June 1937. The last extension of the temporary compact from June 1, 1937, to October 1, 1937, was agreed to for the purpose of enabling the Commission to make full use of the results of the Rio Grande Joint Investigation in the formulation of a permanent Compact.

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The Compact, if ratified, will end over forty years of controversy and dispute among the States, and it is the unanimous opinion of the Commissioners and their advisers that it provides an eminently fair and equitable solution of this troublesome problem. It is my belief that the interests of the United States are fully safeguarded by (a) inclusion, in the State allocations, of all water to which Federal irrigation projects are entitled, (b) provision in Article XII for a representative of the United States to serve on the permanent commission set up to administer the Compact, and (c) by the provisions of Article XVI that "Nothing in this Compact shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties, or to the Indian Tribes, or as impairing the rights of the Indian Tribes."

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ational Archives at Denver

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Respectfully,

Encls.

S. O. Harper,
Chairman, Rio Grande
Compact Commission.

In dupl.

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The John H. Bliss Collection

BOX #27

ACC #7978

SEE DETAILED RECEIPT

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RIO GRANDE COMPACT
Engineer-Adviser Data 1937-1938

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PROVISIONS OF THE RIO GRANDE COMPACT

The Rio Grande Compact, entered into and signed by the Compact Commissioners March 18, 1938, represents a complete agreement by the Commission on the division of the waters of the Rio Grande stream system above Fort Quitman, Texas. It is the unanimous opinion of the Commissioners and their advisers that the Compact provides an eminently fair and equitable solution of a very troublesome problem and will end over forty years of controversy and dispute among the three States. It will become effective when ratified by the legislatures of the signatory States and consented to by the Congress of the United States.

Schedules

The division of the waters of the Rio Grande between the three States is based upon two schedules: (1) at the Colorado-New Mexico State Line, and (2) at San Marcial at the head of Elephant Butte Reservoir. The measurement of the water at San Marcial rather than at the New Mexico-Texas line is necessary because the Elephant Butte Project must be operated as a unit.

The Colorado obligation is based upon two schedules of discharge, the sum of which equals the condition of flow of the Rio Grande at the State Line during the past 10 years. One schedule is based upon the index inflow, above all major points of diversion, of three main streams comprising the Conejos River system and the resulting index outflow at the mouth of the Conejos near Los Sauces; the other is based upon the index inflow

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of the main stem of the Rio Grande above all major points of diversion and the resulting index outflow at the State Line minus the contribution of the Conejos River. In the application of these schedules appropriate adjustments are to be made for (a) any change in location of gaging stations, (b) any new or increased depletion above the inflow index stations, and (c) any transmountain diversion into the drainage basin. Any water from the Closed Basin in Colorado made available to the river by works constructed after 1937 shall be considered as imported water and Colorado shall receive full credit for the same, provided the quantity and quality of dissolved salts therein do not exceed certain minimums.

The obligation of New Mexico to deliver water at San Marcial is based upon the index inflow of the Rio Grande at Otowi at the head of the Middle Valley and the index outflow at San Marcial at the lower end thereof, the relationship between the two representing conditions prior to 1930 when reclamation and drainage in the Middle Rio Grande Conservancy District was started. The index flows in each case represent annual discharges reduced by the discharges during the months of July, August and September. The inclusion of these three months seemed to be impracticable because of the extremely variable tributary inflows between the two stations during these periods and the difficulty of arriving at the amounts thereof. Although the schedule takes no account of possible changes in consumption during the three months period (except for certain provisions elsewhere in the Compact), it was the feeling of the Commissioners that such changes if any would be small in amount. Should appreciable deviation in either

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direction become evident in the future, it is probable that a supplementary schedule will be drawn to compensate for such change. In the application of the New Mexico schedule appropriate adjustments are to be made for (a) any change in location of gaging stations, (b) additional depletions after 1929 of the runoff between the State Line and Otowi gaging stations, (c) depletion of tributary runoff during July, August and September between Otowi and San Marcial by works constructed after 1937, and (d) transmountain diversions into the drainage basin.

Although there is no schedule of releases from Elephant Butte Project storage, the normal release therefrom is considered to be an average of 790,000 acre feet per annum, when and if available. Should the stage of Elephant Butte reservoir become low enough to involve storage in upstream reservoirs, or high enough to involve the reduction of debits of the upper States - both as provided for in the Compact, and as discussed hereinafter - proper adjustments are provided for correcting the stage thereof by the amount by which actual releases have exceeded the average normal release of 790,000 acre feet.

Debits or credits may be accumulated by Colorado or New Mexico by deliveries at their respective outflow index stations below or in excess of schedule requirements. No restrictions have been placed upon the amount of credit water which may be accrued by either State, excepting certain natural restrictions mentioned hereinafter. The total debit, however, which may be accrued by

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either State has been limited, excepting as such debit may be caused by storage in reservoirs constructed after 1929. A limit on debits is of course necessary to prevent additional depletions in one State to the detriment of downstream users.

Storage

The Compact recognizes by implication, in several of its provisions, that storage in Elephant Butte reservoir is prior in right to storage in reservoirs constructed in the Rio Grande basin after 1929. The effect of storage in small reservoirs constructed prior to 1929 are already reflected in the schedules and therefore no restrictions are placed upon their operations. The Compact provides for the unlimited storage in post-1929 reservoirs excepting at such times as the Elephant Butte supply may become deficient by reason of such storage. Credit water of Colorado and New Mexico may be stored in Elephant Butte whenever there is available capacity. The effect of this arrangement is to allow for the storage of Elephant Butte reservoir water in upstream reservoirs and for the storage of upstream water in Elephant Butte reservoir to the mutual benefit of all three States.

To protect each of the three States, the exchange of reservoir water is circumscribed by several restrictions. The credit water belonging to any State and stored in another State's reservoir must not crowd out the second State's own, or what may be called "usable", storage. For this reason

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credit storage is considered as riding on top of the "usable" supply and is of course the first to spill as a reservoir near capacity. Again, each State should share the losses of water from another's reservoir in which she may be storing water; each is therefore charged with evaporation losses from another's reservoir in which she may have storage in the proportion her water bears to the total amount in storage.

Whenever spill from Elephant Butte reservoirs is imminent and water may be lost to the entire basin, any debits of Colorado and New Mexico shall be reduced by the amount by which their debits exceed the unfilled capacity. Should spill actually occur, all debits of the two upper States are wiped out. In determining the occurrence of those periods when the debits of the upper States are reduced or cancelled, adjustment shall be made for any amount by which actual project releases have exceeded the "normal" release. At any time when spill from Elephant Butte seems imminent, the Commissioners of the two upper States may authorize the release of any credit water they may have in Elephant Butte in order that the actual duration of such spill may be lengthened in time and the best possible use of it made on lands below the reservoir.

A restriction to unlimited storage in reservoirs above Elephant Butte constructed after 1929 occurs at those times when Elephant Butte storage (corrected for releases in excess of normal) becomes deficient due to such upstream storage. Whenever the usable project supply drops below 600,000 acre feet and it seems unlikely that natural flows will make up the deficiency, the Commissioner from Texas or from New Mexico may, on or near

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the first of January, call for the release of Elephant Butte water in storage in upstream reservoirs in amounts sufficient to bring project storage up to 600,000 acre feet by the first of March and to maintain it there until April 30th. To assure that such Elephant Butte water is available to the project when needed the Compact provides that within the physical limitations of their reservoirs, Colorado and New Mexico shall each retain water in storage at all times to the extent of their respective accrued debits. However, the Commission by unanimous action may authorize the release of any or all of the Elephant Butte water so held provided that it shall be replaced at the first opportunity thereafter. This general provision allows for the fullest use of the available storage supply and provides that only the minimum release of debit water need be made from upstream reservoirs to assure the project supply.

The only other restriction upon storage above Elephant Butte occurs at the time when the usable project supply (again corrected for over-releases) drops below 400,000 acre feet. During such periods neither Colorado or New Mexico is allowed to increase the amount of water in storage in reservoirs constructed after 1929 until that minimum stage is again reached; provided, however, that if either Colorado or New Mexico has credit water in Elephant Butte she may relinquish her claim thereto and store water in her own reservoirs in the amount of the water so relinquished.

It has been mentioned above that credits, or credit water in Elephant Butte, may be accrued by Colorado or New Mexico by deliveries in excess of schedule requirements. One of the chief sources of credit water,

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particularly in the Middle Valley, is the saving effected by the reclamation and drainage of seeped and swampy lands which formerly consumed large quantities of water. In the amount by which any deliveries exceed the scheduled deliveries at her outflow index station, either Colorado or New Mexico may remove restrictions from water stored in her reservoirs; i. e., that amount becomes her storage and is no longer Elephant Butte water. Another condition which permits upper reservoirs to own their water restriction-free occurs whenever spill is imminent or actually occurs from Project storage. If spill actually occurs, all water in storage in upstream reservoirs is freed of any restrictions; if spill is imminent but does not actually occur, the debit, or, practically, the amount of Elephant Butte water in upstream reservoirs, is reduced in amount to a quantity equal to the minimum unfilled capacity. If either Colorado or New Mexico produces credits sufficient at all times to wipe out any debits caused by storage in reservoirs constructed after 1929, the operation of her reservoirs will, of course, never be restricted -- she will never have any Elephant Butte water in storage.

The engineering basis upon which the works of the Conservancy District were predicated was that flood control and drainage thereof would conserve large quantities of water formerly lost by useless seepage and evaporation and would permit of complete agricultural development of the entire area in the District. Analyses of the records of the past eight years show that substantial savings have been made annually and indicate that even under complete development of the District the deliveries at San Marcial should be substantially in excess of those required by the schedule. Because of these savings it is probable that the operation of

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El Vado Reservoir, based upon a series of years such as 1890 to 1938, will be obligated by the above restrictions on storage no more than once or twice in a fifty-year period, and in these years which necessarily must be unusually dry ones, it is probable that the available supply will be so limited that little water could be stored. At all other times the Conservancy District should be able to develop and operate her system in accordance with her Official Plan with no restriction or hinderance whatsoever.

General Provisions

Besides the engineering features, there are several general provisions of the Compact, including the administration thereof, present controversies, and rights of the Federal Government.

The rights of both Colorado and New Mexico to transmountain diversion of San Juan River waters to the Rio Grande basin are recognized, subject only to the safeguarding of all water uses in the San Juan basin itself. All present controversies between New Mexico and Texas regarding quantity and quality of water are deemed settled. A further article states that no rights or obligations of the Federal Government shall be construed as being affected by the provisions of the Compact.

The administrative agency of the Compact shall be a Compact Commission consisting of one Commissioner from each State, namely, the State Engineers of Colorado and New Mexico and a Commissioner from Texas to be appointed by the Governor. The chairman of the Commission shall be a representative of the United States appointed by the President and shall have no vote.

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The salaries and expenses of the Compact Commissioners shall be borne by their respective States; all other expense incident to the administration of the Compact, not borne by the United States, shall be borne equally by the three States. The Commissioners' general duties are (1) to collect, correlate and present factual data; (2) to maintain stream gaging records at stations required by the Compact; (3) by unanimous action, to make recommendations to their respective States upon matters connected with the administration of the Compact; (4) to employ engineering and clerical aid reasonably necessary; (5) to compile annual reports to be transmitted to the Governors of the three States on or before March 1st of the year following; and (6) to adopt rules and regulations to govern the details of administration. At the end of each five-year period the Commission may review any provision not substantive in character and which does not affect the basic principles upon which the Compact is founded. All previous provisions of the Compact shall remain in full force and effect until any such changes or amendments are ratified by the lagislatures of the respective States and consented to by Congress.

Summary

The schedules of delivery, the provisions for storage, and the system of interchange of waters in the various reservoirs provide not only an equitable division of the waters of the Rio Grande but provide for the reduction of spills from Project storage at which times water is lost to the entire basin. Colorado will be enabled to improve the regimen of flow of her streams by storing spring runoff and releasing it in the late summer months when it is

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The salaries and expenses of the Compact Commissioners shall be borne by their respective States; all other expense incident to the administration of the Compact, not borne by the United States, shall be borne equally by the three States. The Commissioners' general duties are (1) to collect, correlate and present factual data; (2) to maintain stream gaging records at stations required by the Compact; (3) by unanimous action, to make recommendations to their respective States upon matters connected with the administration of the Compact; (4) to employ engineering and clerical aid reasonably necessary; (5) to compile annual reports to be transmitted to the Governors of the three States on or before March 1st of the year following; and (6) to adopt rules and regulations to govern the details of administration. At the end of each five-year period the Commission may review any provision not substantive in character and which does not affect the basic principles upon which the Compact is founded. All previous provisions of the Compact shall remain in full force and effect until any such changes or amendments are ratified by the lagislatures of the respective States and consented to by Congress.

Summary

The schedules of delivery, the provisions for storage, and the system of interchange of waters in the various reservoirs provide not only an equitable division of the waters of the Rio Grande but provide for the reduction of spills from Project storage at which times water is lost to the entire basin. Colorado will be enabled to improve the regimen of flow of her streams by storing spring runoff and releasing it in the late summer months when it is

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badly needed; by storing water which would otherwise have spilled from Elephant Butte, she may improve her available supply from time to time without adversely affecting the lower States' supplies. New Mexico will receive all the water she has been accustomed to receive in the past whenever it is required for her uses and will receive credit for any savings which she may make due to reclamation and drainage of the Middle Valley. Because of these credits her El Vado reservoir will probably not be restricted in operation more than once or twice in a fifty-year period. Reservoir operation in Colorado should improve the Middle Valley supply by providing additional return water during the late summer months. The Rio Grande Project, involving lands in both Texas and New Mexico, will receive all the water she has received in the past prior to 1930 whenever it is required for her normal releases; she may make annual releases averaging 790,000 acre feet whenever her available supply is sufficient to do so; finally, if any upstream reservoir is storing Elephant Butte water at the time the project becomes short of water, she may require the release of such water to supply her needs.

The Compact settles and composes all present controversies between New Mexico and Texas, thereby relieving both states of an expensive, burdensome suit. It allows for transmountain diversion of San Juan River water to either Colorado or New Mexico without hinderance from the other. Should any present provision of the Compact prove unfair to any State, the article providing for review and adjustment thereof allows an orderly way for righting the wrong.

It is believed that the present Rio Grande Compact is not only fair and equitable to all three States but provides the machinery by means of which

TX_MSJ_005358

the best and fullest use may be made of the available water supply. The provisions are simple and direct and little difficulty should be experienced in their administration. In fact, with a future water supply comparable to that of the past 48 years, there should be very few occasions when the Commissioners need do more than keep routine records and make annual reports to their respective States.

The ratification of the present Compact by the several State Legislatures and its acceptance by Congress is earnestly recommended.

Respectfully submitted,

J. H. Bliss

Engineer.

JHB:mm
Santa Fe, N. M.,
April 2, 1938.

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Congress is earnestly recommended.

Respectfully submitted,

D. T. Bliss

Engineer.

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PROCEEDINGS OF MEETING

held on Friday, May 27, 1938

at El Paso, Texas

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between

Representatives of Lower Rio Grande Water Users

and

Representatives of Irrigation Districts Under the Rio Grande Project

of the Bureau of Reclamation

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PROCEEDINGS OF MEETING

held on Friday, May 27, 1938

at El Paso, Texas

between

Representatives of Lower Rio Grande Water Users

and

Representatives of Irrigation Districts Under the Rio Grande Project

of the Bureau of Reclamation

In attendance were:

Mr. C. S. Clark,
Chairman, Board of Water Engineers,
Austin.

Mr. F. S. Robertson,
Secretary, Water Conservation Association of the Lower Rio Grande Valley,
San Benito.

Mr. Robt. E. Kirkpatrick,
Attorney representing the Water Conservation Ass'n, Lower Rio Grande Valley,
Mercedes.

From Laredo:
Messrs. A. F. Muller, Hal Ellsworth, and L. A. Pierce.

From Eagle Pass:
Judge Ben V. King.

From Presidio:
Judge C. E. Mead, attorney of Marfa, representing Presidio Water Control Association, and Messrs. P. F. Wagner, of Presidio, D. D. Kilpatrick, of Candelaria; and Wm. Burson, of Presidio.

Representing the Elephant Butte Irrigation District were the manager, Mr. N. B. Phillips, the Board of Directors, Messrs. Arthur Starr, president, W. T. Scoggins, Jose R. Lucero, and Jos. W. Wright, and the attorney, Judge Edwin Mechem.

Representing the El Paso County Water Improvement District No. 1 were the manager, Mr. Roland Harwell, and the Board of Directors, Messrs. T. D. Porcher, Idus Gillett, C. A. Mebus, and K. B. Ivey.

Representing the Bureau of Reclamation, Rio Grande Project, was Mr. L. R. Fiock, Project Superintendent.

By special request, Dr. Harlan H. Barrows, of the Department of Geography, University of Chicago, who is a member of the Water Resources Committee, of the National Resources Committee, was present and addressed the meeting.

Also present was Frank B. Clayton, of El Paso, Rio Grande Compact Commissioner for Texas, who, by request, acted as chairman.

The meeting was called to order at 9:30 a. m., in Room 540, Hotel Cortez.

Frank B. Clayton, Rio Grande Compact Commissioner for Texas, presiding.

Introductory remarks by the Chairman:

We all know in a general way the business we have before us today.

During the progress of the negotiations looking towards the signing of a compact among the States of Colorado, New Mexico and Texas, the meeting towards the latter end of those conferences were attended by representatives of the lower Rio Grande valley, specifically of the two lower counties—Cameron and Hidalgo. Their interest in the negotiations was from the standpoint of their own interests in down-stream conditions, and they were represented at various times by some of their attorneys and engineers.

At the request of Mr. Clark, Chairman of the Board of Water Engineers, and of Mr. F. S. Robertson, Secretary of the Water Conservation Association of the Lower Rio Grande Valley, I undertook to arrange this meeting, in order that the problems of the lower Rio Grande water users might be presented here, and that specific proposals might be made. They suggested it might be proper to invite Mr. S. O. Harper, Assistant Engineer of the Bureau of Reclamation, at Denver, to attend as representing the Bureau. For a considerable period of time Mr. Harper acted as chairman of the Rio Grande Compact Commission, of which I happen to be the commissioner for Texas. I wrote Mr. Harper, conveying the invitation, but he replied that his connection with the Rio Grande Compact Commission had terminated with the signing of the compact (which of course is yet to be ratified) and that his only connection now with problems of the Rio Grande watershed is by virtue of his position as assistant chief engineer of the Bureau of Reclamation, stating that he had discussed the matter with Mr. Walters, the chief engineer, and that Mr. Walters suggested that Mr. L. R. Fiock and Mr. H. J. S. Devries, representing the Bureau here, be invited in his stead. Unfortunately, Mr. Devries, who is counsel in El Paso for the Bureau of Reclamation, is in Washington, as is also Major Richard F. Burges, council for the El Paso County Water Improvement District No. 1.

The views of the different districts and water associations below Fort Quitman will be stated by spokesmen for those districts

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Briefly, as you all know, these gentlemen are here seeking an understanding with reference to the amount of water to be permitted to flow past Fort Quitman; and in order that we may have a better understanding of the situation, I will now ask Mr. Robertson to state his views.

Mr. F. S. Robertson:

Mr. Chairman and Gentlemen: As Secretary of the Water Conservation Association of the Lower Rio Grande it was my privilege to attend the last two meetings of the Rio Grande Compact Commission, as Mr. Clayton has just told you, the first one last September or October and the last one in the early part of March, of this year. This compact commission, as you probably know, was authorized by act of the respective state legislatures, limiting the scope of their jurisdiction to Fort Quitman, leaving out of the picture altogether anything doing with the waters of the Rio Grande below that point.

We discussed the matter with Mr. Clayton, Mr. Fiock, Mr. Phillips and Mr. Harwell, and it was the consensus of opinion that if the Rio Grande below Fort Quitman, that is the spokesmen representing the interests of the lower Rio Grande, had much to say in these meetings, it would tend to hurt, rather than help, the situation. It was suggested by the representatives of the upper sections, and we concurred in their idea, that if we insisted on pressing our views, the net result would be: no compact. But if we let the compact be consummated up to the point of ratification, then they would undertake to reach an agreement between the lower sections and the upper sections whereby enough water could come down the creek for our use below.

In the writing of the compact between the three States they used the last ten-year period as a basis for fixing the allocation or use of the waters—using that period as an average, and it was the view of our committee that the same basis, that is the ten-year average, should be used in arriving at any agreement here.

In our discussions of what we wanted down below, we were not thinking so much of the lower Rio Grande at any one particular point but considered the stream as a whole. However, the lower sections have a large population, and the river below Fort Quitman covers a large territory—affects a large territory, so I feel that we are more vitally interested—rather, interested to a greater extent, if not more vitally, than the upper sections which have more limited areas.

What we are here for now is to try and reach some agreement with these two districts—Elephant Butte, of New Mexico, and El Paso County, in Texas, and, we understand, with the Bureau of Reclamation, which is operating the system under this project, any such agreement to be with the Bureau and concurred in by the districts. That is my understanding. So, we have come together here to try to get some agreement by which the flow, comparable with the last ten years on an average, will be assured.

What we in the lower section—in Hidalgo, Cameron, and Willacy Counties—what we have been getting down there since about 1880, when irrigation began to take on a more definite form, when a great number of private companies were organized, the land subdivided into areas, first taking out water filings according to statute and subdividing the land by canals and systems, and the lands sold out with the obligation to irrigate, well, there seemed to be plenty of water. Then about 1917, maybe '16, we began to check the flow on privately owned land, and besides the private corporations, municipal irrigation districts were organized, until now the entire valley is covered by irrigation districts, and only one private corporation is still operating in the valley, 'though there are some hundred twenty privately owned corporations, owning a majority of the land, belonging to the association I represent, in the districts in those three counties. We have some 550,000 or 600,000 acres of land included in those drainage projects depending altogether on water from the Rio Grande for existence, both for domestic use and irrigation purposes, and we are all vitally interested in the quality, as well as the quantity, of the water that we get from the stream. We have no storage facilities as yet, but we must depend on the unregulated flow of the river for our supply. We have been for at least thirty years considering storage on down stream, but that requires a treaty with Mexico, and so far this has not been obtained. We hope some day to have such a treaty by which we can build storage dams on the main stream and thus get a more dependable supply. But now we are faced with a shortage quite frequently. We have had two periods of short flow this year. About the 10th of April the river was very low. It ceased to flow below the San Benito intake. I happen to be the manager of a 70,000-acre district, and below our intake there was no flow for a period of ten days. About five days of that time the water was pumped when there was a little flow, intermittently, but the last three days of that ten-day period, we got no water, at all. We had no material damage because of the shortness of the period. Then, the 1st of this month, we had three or four days when there was no flow past our intake. Two good-sized districts below us and several small ones were affected, and what water they got was from underground. The river continually keeps diminishing in quantity. Back in the period prior to the building of Elephant Butte reservoir, during 1901 to 1913, of which we have stream gaging records, we got (I don't think any record was kept at Fort Quitman but there was at Presidio) from around 650,000 acre-feet a year at Presidio. The last few years we have been getting only a very small fraction of that. The last three years we got 26½% of the former flow at Fort Quitman, calculated for the 1901 to 1913 period. So, the lower Rio Grande is gradually drying up. While we have no expectation whatever of going back to the 1901 to 1913 big flow, yet we do feel that we have a perfect right to expect the continuation of the average flow of the last ten years. And we should like, as far as the lower valley is concerned, to have an agreement from these two irrigation districts and the Bureau of Reclamation, not for any particular year but for the average of the ten-year period, a recognition, that is to say an agreement recognizing the rights of the lower river water users to a continuation of that flow, of the average of that flow.

The salt content naturally enters into a discussion of these problems. These districts here complain bitterly of the salt content and have difficulty in getting a proper balance. Well, we have the same thing to contend with down below, only more so. My opinion is that whether we get 100,000 acre-feet, we will need about the same quantity to dilute the salt at the lower end of the district.

The Chairman then called on Mr. Kirkpatrick.

Mr. Kirkpatrick:

I don't believe I can add anything to what Mr. Robertson has said, except this: We have in our country—what we call the lower Rio Grande valley, a population of 150- to 175,000. And the irrigation projects down there represent perhaps an investment of $100,000,000.00. Down there, in the lower Rio Grande valley, we have an absolutely inadequate allocation of the waters of the river—of the upper river. This is of the gravest concern to us. As I understand the terms of the compact, all the water released from Elephant Butte can be used here, except the certain quota to be delivered to Mexico. About that we are vitally concerned to have an equitable quantity released in the main stream below Fort Quitman, and we are also concerned with the quality of the water to be released. As to the amount and the kind, I believe we can leave

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that to our engineers. We first should have, and need, some agreement whereby we can be assured, both of the quantity and the quality to be released to Fort Quitman.

The Chairman:
It may be of interest at this time if you are prepared to state, generally and briefly, the legal basis or theory on which this proceeding is had, in order that we may know just how we stand in that respect.

Mr. Kirkpatrick:
I can say very briefly that I have discussed this with Mr. Robertson, and we maintain that we are entitled, as a matter of law, to have a certain equitable flow of the waters of the Rio Grande pass to us in the lower valley, by virtue of old Spanish grants made back in the 17th century to various grantees along that particular section of the river, coupled with riparian rights. That, briefly is one of our contentions.

Next, our people in the Water Control District No. 9, in Willacy, Hidalgo and Cameron Counties, are the oldest appropriators on the river. Our diversion and appropriation rights were acquired prior to the enactment of the present statute creating the board of water engineers. We filed under the then existing law, have been actually using that water for more than thirty years. Therefore, we also claim the right by reason of usage to have an equitable amount of water.

It might be said that our main source of supply comes from the Mexican tributaries. But as has been stated we have no treaty with Mexico that would safeguard any supply from those tributaries.

We feel that under our rights as riparian owners and as users and appropriators and diverters, over a long period of time, we are entitled to have a sufficient supply of water pass down the main stream.

The Chairman:
What is the extent of cultivation in the three counties embraced within your district?

Mr. Kirkpatrick:
I don't represent the three counties. I will have to ask some one else. I can give you the figures for my particular district only.

Mr. Robertson:
We have around 400,000 acres in cultivation. At one time we had as much as 440,000 acres.

The Chairman:
And you irrigate by gravity canals or by means of pumps?

Mr. Robertson:
Yes, except two or three systems have a small amount of gravity diversion when the river is up to some given stage. The bulk of our irrigation is done by pumping.

Mr. Clark:
What acreage would be in cultivation this year, or could be next year, if you had water, plenty of water?

Mr. Robertson:
Right around 500,000 acres.

The Chairman:
Before we proceed to the next district upstream, are there any questions?

We should treat this meeting as one of open discussion and clarify everything as we go along.

Mr. Harwell:
As a matter of information, I should like to ask how much water annually, on the average, now passes through the lower channel into the Gulf.

Mr. Robertson:
Around 4½ million acre-feet annually pass Rio Grande City, which is below the last tributary to the main stream.

Mr. Harwell:
4½ million acre-feet of water going into the Gulf, unused, at the present time?

Mr. Robertson:
That is about the annual contribution less what is being used—about 700,000 acre-feet being used, 70% of this comes from the Mexico side, 28½% from United States side.

The Chairman:
Mr. Muller, will you now state your views?

Mr. Muller:
Our district is so small compared to the lower valley generally, it wouldn't appear that we have much interest in this discussion. We have only about 29,000 acres covered by water permits, and are not using the whole amount. But we feel that it is just as important for us proportionately as it is to the greater areas, and it is just as necessary for us that we have water as it is for them, at the particular times when it is needed. For instance, onions, which is one of our main crops, has only a six-months' growing period, but if you don't happen to get water on the crop every week or so, you lose your crop. And it is of vital concern to us that we have water at certain times to irrigate with.

We haven't any irrigation systems such as you gentlemen have up here. We depend entirely on individually owned pumping plants, piping the water where it is needed, and each unit is privately owned. There is not an irrigation district in our county.

The Chairman:
Have you any gravity diversions, at all?

Mr. Muller:
No, sir. We use pumps entirely. We have to pump on an average of 70 to 150 feet high, mostly from flumes. It is a very expensive system but efficient. Every bit of the water goes on the land. It is, as I say, very expensive. From the point of view of domestic consumption—we have pretty close to 70,000 people who are domestic users—we have had serious complaints during the past several years as to the quality of the water. It is very high in salt. We notice that the salt content is increasing. We have not been out of water like Mr. Robertson's end of the river, but our intake is decreasing all the time and the salt increasing. Up to the present time we have not suffered for want of water but we don't have the kind of water we ought to have.

The Chairman:
That was one of the principal points of the controversy giving rise to the lawsuit between Texas and New Mexico.

What, briefly, is the history of development in your county, Mr. Muller?

Mr. Muller:
We have been pumping since 1890. We have one of the oldest pumping plants in any district along the border.

The Chairman:
Do you have any figures on the flow of the Rio Grande, the average flow past your point?

Mr. Muller:
No.

The Chairman:
You have no gaging stations?

Mr. Muller:
No, sir.

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Mr. Ellsworth:
May I correct that. At least, I'd like to say that we are installing one now, and should soon have it in operation. We haven't had one till now.

The Chairman:
Can you estimate the flow?

Mr. Muller:
We can estimate it only from actual experience. Our intake has continuously been dropping.

Mr. Harwell:
Contrasting your situation with the amount passing beyond the lower limits of the gentlemen below you—they spoke about the amount emptying into the Gulf—how much passes your pumping station unused?

Mr. Muller:
During flood times, although the average flow has materially decreased, and we have no government gage there, a lot passes on below.

Mr. Harwell:
Several millions of feet—acre-feet, of course, annually, would you say?

Mr. Muller:
I wouldn't be able to say just how much.

Mr. Clark:
There is a gaging station in the vicinity of Laredo, maintained by . . .

Mr. Harwell:
Would you venture a guess within fifty per cent, of accuracy?

Mr. Clark:
No, I couldn't.

The Chairman:
Looking forward to negotiations with Mexico for a treaty with respect to the use of the waters of the Rio Grande, has there been any recent survey made delineating the areas under ditch, the acreage in cultivation in the past, the amount in cultivation now, when the filings originated, and the like?

Mr. Muller:
The filings are a matter of record at Austin, with the exact dates, etc. Also, the applications set out the number of acres intended to be irrigated, and the number of acre-feet of water are shown by the permits. That is all a matter of record at Austin.

The Chairman:
About the history of irrigation in that area: you don't have any reports of investigations developing those facts in detail, do you?

Mr. Muller:
No. I don't think so. I don't think there has ever been any survey by anybody, at all. We have no general irrigation systems or districts. The pumping plants are all privately owned. There are not over two farms, probably, that use the same pumping plant. Each man has his own.

Judge Mechem:
What development of irrigation has been made in Mexico?

Mr. Muller:
There has been considerable development in recent years in Mexico. The Don Martini development, for one. But if they didn't use all the water, it ran on down below us through the Salado and the other tributaries in Zapata County.

The Chairman:
What tributaries enter the Rio Grande below Fort Quitman and above you?

Mr. Muller:
The Pecos and Devil's River on this side. The Conchas on the other side between Fort Quitman and Laredo, and then below Laredo, the very small Salado, and below that, the San Juan.

The Chairman:
As I recall, the salt content of the Pecos is very high. Has that improved or grown worse?

Mr. Ellsworth:
It is getting worse in the last year or so.

The Chairman:
Is that because of development in New Mexico and the upper sections in Texas?

Mr. Ellsworth:
I don't know why but the fact is, it is getting worse. We have chemical statistics on that point, and have to treat the water for domestic use. There are eight plants in the valley taking this water out of the river and treating it before it can be used. We filter it before using it.

Mr. Muller:
As a delegate from the Chamber of Commerce at Laredo, I am representing the districts around Laredo. We have no association of any kind, and the Chamber of Commerce has taken it up in behalf of the landowners and farmers. My occupation is county tax collector for my county. I am also a director of the Chamber of Commerce, and was sent up here to represent the farmers of our community. In fact, I am a farmer myself in a small way. We are all farmers.

The Chairman:
Mr. Ellsworth, do you have anything more to add?

Mr. Ellsworth:
The only thing more I can say is: we'd like to have more water in that river.

The Chairman:
Mr. Pierce, have you anything you would like to add?

Mr. Pierce:
I might add for Laredo that when we started to get together, we had a meeting with the agricultural committee of the Chamber of Commerce. That committee is made up of men from a cross-section of the area around Laredo, and all negotiations we have had have been through the Chamber of Commerce, acting through that committee.

The Chairman:
This is all one county?

Mr. Pierce:
No, two—Webb and Zapata.
Our connection with the lower valley has been through the Chamber of Commerce at Laredo.

Mr. Muller:
Zapata County, itself, has few farmers who irrigate their lands—mostly around Laredo. So, Webb and Zapata Counties may be considered as a unit.

The Chairman:
Judge King, may we hear from you?

Judge King:
I am the attorney and representative of the Maverick County Water Control and Improvement District No. 1, which is the only public corporation in the way of improvement districts in Maverick County. It was organized in 1926 for the purpose of irrigating 60,000 acres of land in that county. Our irrigation permit, granted in 1927, I believe—maybe in 1928, I am not sure, gives us the right to irrigate 60,000 acres and for beneficial use of not to exceed 2½ acre-feet, limited to

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600 second-feet of water. In connection with the irrigation of the district, a permit was secured for the diversion of water for power—electric power; and in a supplemental permit granted in 1928 or 1929 an additional 900 second-feet was authorized for that purpose.

In this connection, I might state that water for our use is diverted about thirty-five miles above where our plant is located and goes back into the river. The water is diverted by gravity; and the first diversion for irrigation was in 1932. Shortly after that a flood destroyed the canal, and it was out of operation for quite a while. We now irrigate somewhere around 15,000 acres. The District expects to have about 20,000 acres to come under irrigation during the next year.

I am not an engineer, and regret that I do not have the statistical information this meeting will probably require. If I had known more about it, I would have endeavored to secure information with reference to the amount of water being diverted at the present time, as well as other statistical information. Mr. Robertson and Mr. Clark came by only a short time ago and invited us to the meeting, and I have never understood, really, until today just exactly what we are interested in.

Of course I know this: I know that we are interested in getting our proportionate share of the water, the share to which we are entitled. Under the compact between the States of Texas, Colorado and New Mexico, none of the diversions below Fort Quitman have been taken into consideration. I don't know how that could be handled, but I imagine it would be the request of the lower property owners that some amendment be made, if possible, to this compact that users below Fort Quitman may be taken into consideration. I understand that under the ruling of the Supreme Court laid down in the la Plata case, each State is entitled to its proportionate part of the water, that is to an equitable apportionment. Now, what that is, I don't know. I imagine that to arrive at it, the number of users would have to be taken into consideration—the number using water, probably, at the time the compact was made. In view of the fact that the users below Fort Quitman haven't been taken into consideration, we rather feel that in justice to them some provision should be made for a certain diversion for the lower users of this Rio Grande water.

The Chairman:
Now, as I understand it, your first gravity diversion was taken out in 1932?

Mr. King:
Yes, the first gravity. Before that time a number of users—private companies and individuals, who had appropriations from the State, were using water, and, in addition, some of the riparian owners had been using it previous to the enactment of the law for appropriations by permit.

The Chairman:
Do they pump their water from the river?

Mr. King:
Until now. After this month probably I would say that only one user will be pumping. Others will be taking from the canal system.

The Chairman:
How does your 15,000 acres compare with what has been in cultivation in the past?

Mr. King:
Prior to 1932 I would say somewhere around 5- or 6,000 acres.

Mr. Robertson:
Mr. King, a moment ago you said the first appropriation there was in 1928 to 1929. Isn't it true that in your irrigation district or water improvement district appropriation of 60,000 acres there was included some 7,000 acres statutory filings?

Mr. King:
Yes, that's true.

Mr. Robertson:
About 7,000 acres in the present Maverick County district, under three, four, five old appropriations were under statutory filings, included in the present district. I don't know how well they are recognized.

The Chairman:
How far back do they go, do you know?

Mr. Robertson:
No, I don't, Mr. Clayton. They came under the old statutes prior to 1913. They were old declarations prior to 1913.

The Chairman:
Were these riparian owners?

Mr. Robertson:
First, under the old Texas statute, by simply filing declarations with the county clerk, you were permitted to divert a certain amount, at a certain point. The declaration had to be put into effect by actual use.

Mr. Harwell:
What is your theory relative to encroachments? For example, does Mr. King's organization encroach to the extent of water used on some 8,000 acres of land? Does not this recent development operate to encroach on the development below?

Mr. Robertson:
Our theory is: first in time, first in right. When the present law was put into effect . . .

Mr. Harwell:
What are you doing about that?

Mr. Robertson:
Nothing, so far.

The Chairman:
Judge King, what is your supply now? Adequate or inadequate?

Judge King:
Adequate right now. The source of supply, the Rio Grande, is not failing just at this time.

The Chairman:
How about the tributaries above you?

Judge King:
There is the Devil's river on our side; I believe two on the Mexican side above our intake.

The Chairman:
Do those tributaries make your principal source of supply?

Judge King:
No, not the principal source. Of course they contribute.

The Chairman:
Do you know in about what proportion they contribute, compared to the Rio Grande above Fort Quitman?

Judge King:
I couldn't say about that. Anything I might say would only be a guess.

Mr. Muller:
Mr. Chairman, if it is not improper, I should like to make a statement.

Mr. Kirkpatrick explained why we think we have rights, legal rights to water from the river. I don't know if you are familiar with the way our counties are

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laid out or not. Webb and those other counties down there, some of them, are divided into sections and porciones. These porciones are strips fronting on the river a certain distance and going back, some as much as sixteen to eighteen miles, three-quarters of a mile to a mile wide. Well, Webb and Zapata Counties have those long strips going back from the river, divisions or subdivisions made by the Spanish, and called porciones. There you have your riparian rights.

I just wanted to inject this fact in the discussions at this point. I don't know whether Judge King has this down in his county or not.

Judge King:
No, we do not have subdivisions such as that, but we do have our riparian rights.

Mr. Harwell:
I suppose you gentlemen know that so far as the greater part of the land in El Paso valley is concerned, and certainly much of the land in the Mesilla valley, above El Paso, the same situation exists with respect to the old Spanish grants. For instance, immediately below the town of Ysleta and southeast to Socorro, encompassing the entire valley from the river to the foothills, is one of these old grants. Above, all the way up through the project, are others.

Mr. Muller:
Are they large grants or just narrow strips?

Mr. Harwell:
Large grants originally. Later they were, most of them, if not all, subdivided and apportioned among the inhabitants, each being given a fractional part.

Mr. Muller:
I just wanted to make clear how our river below is divided.

Mr. Harwell:
And I thought it might be of interest to you to know that your situation is not unique. This system no doubt was followed by the Spaniards, all along the river, up and down.

Judge King:
Our county has two Spanish grants: one containing about a third of the irrigable land that is contained within all of Maverick county.

The Chairman:
Any other questions?

Judge Mechem:
I should like to know how these so-called riparian rights work out, how do they work out in actual use?

Judge King:
We don't have any of those in our county, that is, these porciones. We have one large grant, as I said, containing 156,000 acres of land.

Judge Mechem:
You have riparian rights, don't you? I believe you said so a while ago.

Judge King:
Yes. Not only do they attach to the old Spanish grants, but any other lands patented before the law authorizing permits, allowing appropriations, carried riparian rights.

The Chairman:
I will now call on Judge C. E. Mead, of Marfa, who is here as representative of the Presidio County Water Control Association. Judge Mead.

Judge Mead:
I am speaking as an attorney of Marfa. I am also interested, directly and indirectly, in some of the lands adjacent to the Rio Grande. I am speaking principally, however, for the farmers along the Rio Grande in Presidio County.

As respects the association of these landowners and other interested parties, known as the Presidio Water Control Association, this organization has no charter, but is simply a voluntary association.

The picture with us is this: Presidio County and Brewster County constitute what is known as the Big Bend of Texas. Some of you already know the Big Bend, and I hope you will all know it when we get the million-acre park down there. The river makes a big bend there, dropping down into Mexico and bending sharply up into Texas. That's how it gets its name —Big Bend. I think our county there has between 125 and 150 miles of river front on the American side. And all along the American side the river there, with few exceptions, forms the boundary. Our valley is a strip, not very wide in parts—not wide anywhere, and most of it is rather rough country, except close to the river where the land levels out into the valley proper. Some places there are bluffs right down to the river, and there is not much of that land that can be cultivated. Other parts spread out for quite a distance, then we strike a bluff again where the water can't be raised from the river onto the land.

The land under irrigation—cultivation, rather, has to depend entirely on the little rainfall we get. The principal irrigation is around the town of Presidio. Just above the town the Conchas river enters the Rio Grande from the Mexico side. The Conchas is a pretty long river. It runs back probably a thousand miles into Mexico. It is a nice stream. It has given very little trouble from a salt standpoint. Above there, we depend entirely on the flow of the Rio Grande.

I haven't any accurate figures, in fact I have no figures, at all, except some estimated figures on how much land is under irrigation, that or in cultivation. There has been no actual survey of these lands. Different people have estimated that we have about 25,000 acres in cultivation. As I said, we have a long river front—some 125 to 150 miles. And similar conditions exist in Brewster County. They have no representative here. Our farms along the river range from an acre to 8- or 900 acres, but most are small farms. Up until, well, until after Elephant Butte dam was built, we had all the water we needed. And the water was good water. They didn't make much fuss down there when Elephant Butte dam was built. They rather assumed that Elephant Butte would take care of them. They didn't know that it would make any difference. But in late years there has been a big change. Since 1931, from then on, for seven or eight years, conditions have been getting worse and worse. There are two reasons for this: one is, when we needed water it was cut off. The farmers below you lost their crops, planting was uncertain—the whole situation was changed. In addition to that, the water has become more salty year by year. Now it is so bad many crops will not grow, at all. The water, the salt, simply kills 'em. It is getting to be a desperate situation. And it isn't any theory; it is a fact. These people down there have no way to live except by farming. Probably 4500 to 5000 people have no other way of living; if they can't get water to irrigate with, they are sunk. There are no streams running into the main stream down there, at all, except the Conchas, and it runs in at the town of Presidio. It of course is helpful to the people below, and to those it is very helpful except in times of flood. Unfortunately for them, during the last few years the Mexicans have learned about their Conchas and are using it more and more every year. They have some method over there by which they can take the water legally, and that is gradually cutting off the supply to the users on the American side, so unless the people below get relief, pretty soon they won't have any water and then there'll be trouble. Now, these people are way down there, not too well informed about

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these matters like farmers are, and they wait until trouble comes before they try to do anything. They have no incorporated irrigation districts. They get their water either simply as riparian owners, right off the river, or through permits from the State. That's the way they all get their water.

Mr. Harwell:
Of these 25,000 acres, how many acres are below the inflow of the Conchas and how many above?

Mr. Mead:
I don't have any figures. I'd say approximately one-fourth below; the rest above.

Mr. Harwell:
Any other tributaries to the Rio Grande between your location and Fort Quitman?

Mr. Mead:
No, none. None at all, from either Texas or Mexico. We do have a lot of pretty large creeks and arroyos that bring down a lot of water in the rainy season. It doesn't amount to much, really, because in those times the water isn't needed and it soon runs off anyhow.

Mr. Harwell:
What is the total quantity of water annually passing below your lower diversion?

Mr. Mead:
I haven't any figures, as I have said.

Mr. Harwell:
Is any storage work, of any nature, in contemplation for that area at the present time?

Mr. Mead:
Yes, some are under consideration but none developed very far. Our people have had this question of storage-diversion dams up many times, especially along the big creeks. Mr. Lawson knows about it and is much interested. It has been taken up with the State Department, and I have a letter here from Secretary Hull. He is very sympathetic with the idea. Any such plan of course is involved with Mexico.

Mr. Harwell:
Have you any information tending to show that if storage works were constructed, the total run-off would supply your requirements?

Mr. Mead:
No, I can't quote any definite information on it. But it is the concensus of opinion that storage dams can be built along some of these big creeks but they would be of very little help. I attended a meeting not long ago at Fort Stockton, presided over by Mr. Merrill, of the Water Conservation-Soil Conservation Department. That question was discussed at length with those people then. They seemed to have the idea that at small expense dams could be built along these tributaries, probably across the river, itself, and would help materially. But there is the flood menace. Whenever those big arroyos get up, there are overflows—principally along the Conchas. These overflows do much damage. The matter, though, is under consideration. They hope to work out something. Our people were uneasy about this Caballo dam, above El Paso. The got in trouble over Elephant Butte. They are getting "dam shy." The Reclamation authorities have been looking into the location of another dam, similar to the Caballo, over there in the north edge of Presidio County, way down below Fort Quitman. I had some correspondence with Mr. Lawson on that. They have a lot of data gathered up; have been doing some gaging down there. Lawson says something like that might be done. He seems very sympathetic, that is he seemed very sympathetic until all at once he got cold feet. Somebody suggested that evaporation would amount to about as much as the excess water that was stored. Of course we would get a lot of water out of the arroyos and creeks on the American side. But as I said, that is being considered.

Now, a word about the legal phase and historic features from our point of view: From Presidio on up are some of the oldest settled parts of Texas. When the Spaniards who went to Santa Fe and settled up that far, and here, at Ysleta, they came right up that river to El Paso, and followed that river right on up to Santa Fe, and dropped settlers all along. We have some of the oldest settled parts of Texas, and I have reliable information that those people there at Presidio and at Ruidoso and some other points along the river have been taking water out of the Rio Grande for seventy-five years. Talk about established right by usage: they have been taking water for seventy-five years—more than that. Some twenty years ago I had a suit between a company that had a permit from the State and some riparian owners, growing out of some controversy between them. They didn't want to be regulated. They proved at that trial that they had been getting water out of the river for seventy-five years.

The Chairman:
In your association, do you have any community organization, do you have community ditches?

Mr. Mead:
No, they get water through permits, taking it out here and there where it is required.

The Chairman:
But you take it into ditches, do you not? And the ditches serve several users?

Mr. Mead:
Yes, sir. Well, I had that lawsuit between those people. We went to trial, but before we were through those fellows came at me with a proposition that they had the usage right for seventy-five years. We, both sides, were afraid to go on, so we compromised, and my people agreed to give those fellows water.

Well, they take it both ways: by pumps and gravity.

Do you know, if you look at a map of Presidio County, you will find all along that river that the land is in strips. All that land down there was patented by the State. I don't think there are any Spanish grants. Most of the land was classed as public lands—it came into Texas when Texas won her independence, and belonged to the people. The county is laid off in sections—640 acres each, 1900 varas square. When you get down on the river these are not square but in long strips, each with a little frontage on the river running a mile or two back. The purpose of course was to give every man a little water. That has been in existence for fifty years—those patents are fifty years old or more.

Of course our people contend that under the constitution of this State they have those riparian rights, and they don't feel they should let them be taken away from them.

You ask how they get the water. Originally it was by gravity. They would run a little dam across there, just a brush dam or something like it, and run the water out in a ditch. That is the way it was until recent years, when they began pumping right out of the river and run the water back through ditches over the lands. Mr. Kilpatrick has been down there over thirty-five years. He knows about it—that the folks have been using gravity ditches and pumps, taking the water for fifty years or more. That's the situation that we have there.

Mr. Harwell:
What proportion of your lands under cultivation has been put in cultivation in the last ten years?

Mr. Mead:
I couldn't say. They have been farming all these years. The country has settled up more as time went on, of course, and more land put in cultivation. But

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the situation has got so bad in late years that no more is being cultivated.

Mr. Harwell:
Would it be as much as one-half, would you say?

Mr. Kilpatrick:
About as much now as thirty-five years ago.

Mr. Harwell:
You mean to say you had 25,000 acres in cultivation thirty-five years ago?

Mr. Kilpatrick:
I can't speak for Presidio County but up above the Conchas about one-half the cultivated area has been put in in the last thirty-five years.

Mr. Harwell:
One more question: From the description of your situation, it occurs to me that if this agreement that has been mentioned were put in effect your situation wouldn't be much changed.

Mr. Kilpatrick:
I don't see why it wouldn't. These troubles have arisen in the last few years. There has been no material increase in cultivation.

Mr. Harwell:
I understood your proposal is that you want the same amount of water passing Fort Quitman as has been passing during the last ten years. How long have you been having this trouble?

Mr. Kilpatrick:
More and more for ten years and every year less and less water comes down the river.

Mr. Harwell:
But your real solution is in storage.

Mr. Kilpatrick:
Of course if we could get more water down the river it wouldn't be as salty as it is. So much is taken up above that what reaches us can't be put to proper use.

Mr. Mead:
And by the time it reaches Presidio County, you can hardly see the river. And besides it is growing up in brush and reeds and is becoming just a kind of morass.

Mr. Harwell:
Taking into consideration the effect of the drouths over the whole country, there wasn't any more water above Elephant Butte than down in your district.

Mr. Mead:
Of course I understand that. And then some times we have had too much water. That is, we have had floods from the runoff through the creeks and arroyos.

The Chairman:
Are there any Mexican diversions above the Conchas inlet?

Mr. Mead:
Yes, about the same number as on this side.

The Chairman:
Has there been any increase in that number in recent years?

Mr. Mead:
Yes, and more every year.

The Chairman:
Have they increased the number of diversions or simply put more land in cultivation?

Mr. Mead:
No, it has decreased. They can't increase it much because their valley is practically all cultivated. But there isn't much water and they make more and more diversions to get what there is.

Mr. Muller:
What is the average rainfall in that area?

Mr. Mead:
About eight or nine inches. It all comes, nearly all, in July, August and September.

Mr. Muller:
Then you wouldn't have much luck damming up water in those dry creeks.

Mr. Mead:
No, maybe not, but it would help.

Mr. Scoggins:
When did you first file a protest against these unlawful diversions?

Mr. Mead:
We haven't filed any protest with anybody. We have been complaining about the situation, and that's about all.

Mr. Harwell:
Wasn't your trouble worse in 1934 than any other year?

Mr. Mead:
You understand, I am not blaming anybody.
We had a bad flood in 1932.
In 1934 the river was dry all summer, I believe.

Mr. Harwell:
Mr. Fiock, do you recall the total annual inflow into Elephant Butte dam that year?

Mr. Fiock:
Around 250,000 acre-feet. But that wouldn't be the years they were short down there. We carried over enough to give them all they had been getting.

Mr. Harwell:
The point I am trying to make, Mr. Fiock, is that during 1934 over 200,000 acre-feet reached Elephant Butte dam, was impounded in the lake. The normal flow into the lake is 1,000,000 acre-feet.

Mr. Fiock:
1,100,000.

Mr. Harwell:
Assuming that at least part of this total could be distributed, aside from our operation of the works here, the general drought over the country at that time must have affected the entire Southwest.

Mr. Mead:
I should like to make this concluding statement: I think the law has been correctly stated about the division of water between States, which is nothing but the common-sense view, of course. Then the waters are prorated among all riparian owners: first, deal with the States; then take the States as units; then when it gets to the various sections of the State, each riparian owner has a right that ought to be protected. I think the law doesn't amount to anything unless it gives him his proportionate part of the water, and the water itself must be the kind of water he can use.

Our folks didn't build this dam up here and start these irrigation works; and we think it is up to you to work out some way by which our folks can get water they can use, in the amounts they need and are entitled to out of this river here. We are a part of Texas, and we are entitled to our share, and when the rule is broken, then we can't do anything but go to the proper authorities. We aren't big enough to make much of a fuss; we don't control many votes; but we have certain rights and we believe they should be considered. We got this meeting here to consider this question, and I think in simple fairness something should be worked out. We are in trouble. We didn't make that trouble.

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Mr. Robertson:
Two or three localities along the river are not represented at this meeting. The county above the one I represent has an irrigation district, that is they irrigate several thousand acres. The county above that and on up to Kinney or Val Verde—lots of people along there, lots or irrigation being done. All those counties are not represented here today. There is no one here from Del Rio. Some areas are not represented, at all.

Mr. Kilpatrick:
One year, I believe it was last year, the river went dry in July and stayed dry over a month. The crops were all ruined. The farmers lost their entire crops. 1937 was about our dryest year.

Mr. Wagner:
I am a farmer, farming on a small scale. All I can do to make a living. I am on the board of directors of the association in Presidio County.

The Chairman:
Do you have an engineer supervising the distribution of water to the farmers?

Mr. Wagner:
No, sir.
I was working at the mine at Shafter and got to looking 'round for something where I could make a little money. I saw the river and the valley there, and got me a farm, looking towards the future. When I first went there the people were using the river water for drinking but the water has got so salty, it is no longer fit for that.

The Chairman:
What is the source of your domestic supply now?

Mr. Wagner:
Well, we tried digging wells but the water we got was just as salty. All the people have to haul water all the way from one to seven, eight, ten miles, from springs up in the hills above the town of Presidio.
It looks from the way things are now that all the money we have invested in lands around there is gone. We used to grow cotton, and vegetables—tomatoes, pepper—can't grow anything there now. Cotton will grow in spots when we can get water—we get a little water in the river from the hills, once in a while.

The Chairman:
I should like to hear from Mr. Burson.

Mr. Mead:
I want to add something here.
None of our people can get anything for their lands —lands that only a few years ago were worth $200.00 an acre—plenty of them sold at that, some even as high as $300.00—well,you can't get $50.00 an acre for them now. I am interested in a farm of about 4- or 500 acres at Ruidoso, and I have been trying to sell for a long time, but can't get anybody to take it, can't find anybody who wants to buy at any price—there is simply no market, due entirely to this salty water and lack of water.

The Chairman:
I might say that you strike a responsive chord in my breast, because in Hudspeth County (I represent the district down there as attorney), lands that sold for as much as $200.00 an acre in the rough won't bring a quarter of that in their cleared and cultivated state, and the decline in values has been attributed partly to the salinity of the water. In the last few years, due to the depression, the low price of cotton, etc., values there have so declined that they are about on a par with those farther down. Hudspeth County, as you know, is the next county below the Rio Grande project. As a matter of fact, during the period of the extreme drouth, the farmers in the lower part of the project, in El Paso County, and Mr. Harwell will confirm this, experienced about the same thing as to the quantity and character of water. In short, most of the water they got was drain water. The situation up and down the Rio Grande is one, of course, that we all have to face in varying degrees.

Mr. Wagner:
Do you all take your water out of the Franklin canal?

The Chairman:
Below Tornillo there are other outlets. And the water they get is of increasing salinity. That is true from the headwaters on down because of the drainage.

Mr. Harwell:
This group here apparently represents the interests between Fort Quitman and the mouth of the Rio Grande, composed in part of irrigation districts authorized by the laws of Texas and in part of voluntary associations without any formal organization, their representation being through chambers of commerce or individuals, and other individuals, themselves. I think that's correct.
Now, you propose that we enter into an agreement concerning the amount of water that is to pass Fort Quitman annually. Now who are we supposed to enter into such an agreement with? and in what manner? To go a step further, to make clear exactly the question I am asking, what assurance would we have under the present circumstances that any agreement entered into with anybody would be binding on the people below us, all of them, so that subsequently they wouldn't be demanding some other agreement?
Is anybody here prepared to give us his views on this question, so we can think it over?

Mr. Kirkpatrick:
We have discussed very briefly among ourselves down there the possible legal vehicle, as it might be termed, in which this agreement might ride, if I understand your question. The association which Mr. Robertson and I represent is not a legal entity, such as to enter into a binding contract with others. Practically all the irrigation districts in the lower Rio Grande valley, however, are legal entities, political subdivisions of the State, and are capable of contracting and being contracted with.
I feel certain that whatever the executive board of the Lower Rio Grande Water Conservation Association recommends would be adopted by the respective boards of directors of the districts, and that as legal entities they would be willing to enter into a contract binding on them.
Now, of course, I can't speak for the appropriators upon the river.

Mr. Harwell:
What assurance would anybody have that we would be free from subsequent claims or complaints by entering into any agreement?

Mr. Mead:
Right now I don't know how we could make a contract that would bind everybody. But that is a matter that can be worked out. We are here today with our troubles, here to talk them over and get started on something that will solve them. We don't want to be in the attitude of threatening to go to the Legislature to try to get them to buck this compact. We just want to talk things over. A gentlemen's agreement might not do any good, but then it might. For our part, I don't believe our people will make any trouble at all, down at Austin.

Mr. Clark:
I have been wondering if we couldn't reach an agreement whereby the Texas Compact Commissioner could bind these appropriators below Fort Quitman.

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Mr. Clayton (chairman):

I have always felt that my authority was limited to the making of the compact and seeing that it was enforced as between the States. Mr. Robertson stated, and I think fairly, that at the conferences we had at Santa Fe with reference to the Compact we mutually agreed that whatever differences of opinion might lie between us in this State were not proper and legitimate subjects of inquiry there. That, it seemed to me, was both legal and practical. From the legal standpoint, at least, as you all know, our negotiations related to the division of the waters above Fort Quitman. That was the authority conferred on the commissioners from each of the States. From a practical standpoint, it goes without saying that the two upper States would hardly be in a position, assuming their willingness, to enter into any compact which would provide for the division of the waters within the State of Texas, itself, or to have anything to say concerning any differences among the various sections of Texas. Even if our authority was not limited to the supply of water passing the State line, whatever controversies might arise among us as to the division of the waters in Texas would be a subject that could not legitimately be decided by any state but Texas. Our authority was to negotiate for an equitable division of the waters above Fort Quitman. That is the status of the matter as far as the Rio Grande Compact Commission is concerned.

Now, I arranged this meeting at the request of Mr. Robertson, Mr. Clark, and these gentlemen here this morning, not because the Legislature has conferred on me the authority to enter into any agreement such as you seek, nor even any authority to call you together for the purpose of discussing such an agreement, but because it was your desire to meet with the upper districts and confer together, and I felt that such a conference might be helpful in reaching a solution of our difficulties.

Deliberations have proceeded for years between New Mexico, Colorado and Texas, seeking to determine an equitable basis for a compact, the equitable share each State was entitled to have of the waters of this river and its tributaries, from its headwaters in Colorado down to Fort Quitman.

The controversy over the waters of the Rio Grande originated, as most of you know, in the last century. It began with a protest on the part of Mexico to our government, arising out of the fact that after development in the Juarez valley had reached considerable proportions their water supply began to fail, Mexico claiming that encroachments principally by Colorado were a serious menace and threatened to eliminate agriculture in the Juarez and El Paso valleys. Thus the stream was practically dry, almost throughout its length in New Mexico, and down to below Fort Quitman, for months during the summer. That is how the controversy originated, and that is why the treaty was entered into in 1906, and in pursuance of that treaty the Bureau of Reclamation made filings in 1906 and 1908 upon all the unappropriated waters of the Rio Grande in the State of New Mexico for the purpose of impounding them in a storage dam in the vicinity of Engle, New Mexico, for the benefit of lands between that point and Fort Quitman.

Under the treaty of 1906 the United States guaranteed to Mexico, at the Acequia Madre, the principal heading opposite El Paso, 60,000 acre-feet of water a year. In consideration of that guaranty, Mexico relinquished all claims to waters of the Rio Grande from that point down to Fort Quitman.

After the treaty had been made, and after the filings had been made by the Bureau of Reclamation, for the benefit of the lands above Fort Quitman, of all the unappropriated waters in New Mexico, Elephant Butte dam was constructed, and is being paid for by farmers within the Rio Grande Project.

Now, as a practical matter, when we talk about deliveries of water to Texas, we are speaking of deliveries into the reservoir at Elephant Butte, because below Elephant Butte there are no tributaries to speak of, and, except in times of flood, the flow is not augmented in any considerable measure until after the water passes Fort Quitman.

When the temporary compact was entered into between the three Rio Grande Basin States, in 1929, it was designed as a temporary expedient only. It provided that neither Colorado nor New Mexico would impair the supply to the reservoir at Elephant Butte. It was temporary merely, intended to provide a stopgap, a make-shift, until we could agree on the respective rights of the three States and embody those rights in a permanent compact.

So I conceived it my duty, as commissioner for Texas, to see that Texas got every drop of water originating in Colorado and New Mexico that she was entitled to and to see that that water was delivered into the Elephant Butte Reservoir. That was my duty as I conceived it under the statute.

Now, I have told you of the situation confronting us, there in our negotiations for a compact. Having entered into the negotiations on the basis that I was to try and get every drop of water Texas had a right to claim, irrespective of how or where it was to be used in Texas, I could not but feel that whatever differences there might be within the State over the supply to be furnished the users in Texas below the Texas line and all the way down to Brownsville, were matters for internal negotiation.

I am not in a position to speak for the districts within the Rio Grande project, nor for the users below the project. I think as to them I am without jurisdiction. I think you gentlemen will agree with me that if we are satisfied, as I think those of you who attended the compact meetings are satisfied, that in the compact we got everything we were entitled to or could physically secure, then from that point on there should be, can be, no question of ratification on the part of Texas. I feel that any questions as to the relative rights of users below the New Mexico-Texas state line are in their very nature foreign and apart from any consideration as to the value of this compact or any question as to whether it should or should not be ratified. The ratification of the compact should be considered independently. By that compact Texas got all she is entitled to, all she can get, and these questions of relative rights of the lower users have nothing to do with the two upper States.

I am here with you merely as chairman, and I do not wish to be thought of as taking part in any way, except to clarify or help to clarify the situation for you as far as I can as we go along. I think it is for you gentlemen to thrash this thing out, and any assistance I can give you, without taking sides, I stand ready to give.

Mr. Kirkpatrick:

Our position in this meeting is—and if I am not correct, gentlemen, I hope you will correct me, not to recommend who should make such a contract as we might like to have. We are here to find out whether these gentlemen up here are willing to make a contract to allow a certain quantity of water to pass Fort Quitman, of a certain quality, and if they are so willing, then the terms and details can be worked out and the legal vehicle in which the agreement can ride will be provided. Am I correct? Our object is simply to find out whether these men up here are willing to enter into such a contract.

Mr. Harwell:

I should like to ask Mr. Clayton one question: Do you feel that you are competent, that is that you have the authority, as Compact Commissioner for Texas, to enter into any agreement or take part in any agreement that might be made? Could you join in such an agreement from any legal aspect, whatever?

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Mr. Clayton:
No, sir. My duty, and my sole duty as Texas commissioner, was to negotiate with the upper States, through their duly qualified commissioners, for a compact, to enter into such a compact if reached, and to work out the necessary means for the enforcement of its terms as far as Texas' rights under it were concerned, and during my tenure of office to see that it is enforced—to see that, as concerning Texas, the provisions of the compact are obeyed by the two upper States and to take whatever action is necessary to that end. What to do with the waters after we get them under the compact is something outside the province of the commissioner. That is my interpretation.

Mr. Mead:
I understand that the amount of water given Texas by the terms of the compact is fixed but nothing is said about the quality of tht water.

The Chairman:
That question was a very sore spot, and almost prevented the consummation of the compact. One of the principal issues in the suit with New Mexico was the inpairment on her part of the quality of the water by development of the Middle Rio Grande Conservancy District and for that reason we were not getting the equivalent of what we were entitled to in undiluted, unimpaired water. That point was discussed at great length in the negotiations for the compact. We tried to get a definite agreement from Colorado and New Mexico that if the quality of the water was impaired beyond a certain grade or point, defining it in terms of total dissolved salts, instead of in terms of general quality, then the amount would be increased according to the proportions worked out by the engineers. We could not agree on that point. There has never been any determination by the courts of the legal effects of changing the quality of water by irrigation, as far as the rights of users below are concerned. We did insert in the compact a provision substantially to the effect that the compact was without prejudice to the rights of Texas, or of any of the signatory States, to invoke the jurisdiction of a court of competent jurisdiction in the event the quality of the water is impaired. That provision is Article XI of the Compact. It reads:

ARTICLE XI.

> New Mexico and Texas agree that upon the effective date of this Compact all controversies between said States relative to the quantity or quality of the water of the Rio Grande are composed and settled; however, nothing herein shall be interpreted to prevent recourse by a signatory state to the Supreme Court of the United States for redress should the character or quality of the water, at the point of delivery, be changed hereafter by one signatory state to the injury of another. Nothing herein shall be construed as an admission by any signatory state that the use of water for irrigation causes increase of salinity for which the user is responsible in law.

That, gentlemen, was a compromise between opposing views. They took the position that they were not in law responsible. We took the contrary position, not only in the negotiations for the compact but in the lawsuit. But we could not reach any definite agreement as to the legal effect nor as to the relation between salinity and amount. Consequently, we left that point open, to be determined by litigation in the event the quality should be impaired in the future to our detriment.

With reference to the discussions here, if, in those negotiations, we had permitted the conflicting interests in each State to attempt to insert in the compact provisions protecting their own particular requirements, no compact could ever have been arrived at. There is as much controversy in Colorado as in Texas, maybe more, and fully as much in New Mexico as here. You gentlemen know that as far as the Rio Grande project is concerned, the interests of the Elephant Butte District, in New Mexico, and the districts in Texas above Fort Quitman are common interests. We have with us the manager and attorney of the Elephant Butte district, in New Mexico, and because our interests are common we determined long ago that no satisfactory, practical, legal or engineering way could be devised by which the waters could be allocated between these districts at the Texas line. As far as they and we are concerned, our source is the same. If the supply is impaired above Elephant Butte, we all suffer alike. Consequently, from both the legal and practical standpoint there is an identity of interests.

To do justice by all, it is up to us to work out our own internal problems.

Mr. Muller:
The amount of water that comes down to Texas, where is that controlled, at Elephant Butte?

The Chairman:
Yes. After completion of Caballo, it will be controlled at Caballo.

Mr. Harwell:
Not the return water.

Mr. Muller:
How will that be controlled? Whose jurisdiction will that come under? What is the complaint? Who uses too much? El Paso?

Mr. Mead:
We don't complain, but we haven't heard that the El Paso Valley doesn't get water.

Mr. Muller:
Well, how can it be corrected? Can Elephant Butte let out more water?

Mr. Mead:
Probably under the compact they can't let out more water. That's fixed. But when it gets down here, it is a question of distribution.

What we are here for, what we would like to know, is what is the attitude of these people here at El Paso, these people under the Rio Grande project towards the people below. Are the people here entitled to all the water in the river? All that comes out of Elephant Butte reservoir?

The Chairman:
I should like to call on Mr. Phillips for a statement at this time, although it is nearly 12:30.

Mr. Phillips:
I don't think a statement from my district at this time would be appropriate. I have listened with a great deal of interest to the remarks of the gentlemen representing the districts below Fort Quitman, and would like to ask a question or two. If I understand Mr. Robertson, speaking for the districts he represents, he requests from us—the two districts of the Rio Grande project, an agreement which will insure the delivery of 200,000 acre-feet annually at Fort Quitman. I would like to know whether or not the other gentlemen here, representing the other lower valley areas, concur in th amount which Mr Robertson has requested that we agree to. I would like to know whether that is the amount of water that all the districts below Fort Quitman desire to have delivered.

Mr. Muller:
Speaking for Laredo, if that figure—200,000 acre-feet, is adequate, then we agree that that is the amount we want.

Mr. Phillips:
In other words, 200,000 acre-feet of water annually at Fort Quitman would cure your ills?

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Mr. Muller:
I assume that that takes into consideration the needs of all the people below, and that when that water arrives at that particular point . . . . .

Mr. Phillips:
But you agree, do you not, that . . . .

Mr. Robertson (interrupting):
My assumption is that 200,000 acre-feet of water delivered annually at Fort Quitman would be about right was based on the fact that the Compact Commission took into consideration the average flow passing there during the past ten years. Following the same reasoning, I calculated that we were entitled to the same amount that has passed there during the last ten-year period—a little in excess of 200,000 acre-feet.

Mr. Phillips:
I know how you made your calculations, and I know, too, that you probably have advised with these other gentlemen.

Mr. Robertson:
To a very brief extent, we have.

Mr. Phillips:
I also suppose that when you did advise with these other gentlemen, you took the opportunity to explain that by the provisions of this compact there is nothing that would alter the method of distribution— the practice of distributing the water followed by these districts in the past?

Mr. Robertson:
We didn't go that far.

Mr. Phillips:
Do you think it is an opportune time or a fair time for the two districts on the project to be asked to consider what you have requested without first receiving an expression from all the rest of the districts that the arrangement suggested by you will meet their approval? We are talking about a long-time proposition, something to be in perpetuity, aren't we? and will that be agreeable and acceptable to them?
I reiterate my question: Are all you gentlemen here agreed, and will the others not here represented agree, that the demands made by Mr. Robertson will take care of you, will cure your troubles, and are you willing, will the others be willing, to accept a delivery of 200,000 acre-feet of water annually at Fort Quitman?

Mr Mead:
I will speak for our county—Presidio: If that gives them enough, there is no reason why we shouldn't agree.

Mr. Phillips:
Are you going on the theory that you will get yours first?

Mr. Mead:
If we cheat them, they will have cause of action against us.

Mr. Phillips:
Would you come back on us then?

Mr. Mead:
No, not if you furnished the water at Fort Quitman. That would be between them and us.
I believe everybody would be willing, assuming that what he says is enough, and for us it will be, to make the agreement.

Mr. Muller:
Your question, Mr. Phillips, is stated very clearly and seems to me to be a fair question.
We came up here without any advance information, to try and find out more about it. If you ask me the direct question, whether I would be satisfied with 200,000 acre-feet at Fort Quitman, I would say no, I wouldn't be, until I could go into it and find out for sure if Mr. Robertson is correct. After that, if he is correct, if he has taken into consideration . . .

Mr. Phillips (interrupting):
How could you expect us up here to arrive at any definite agreement, any definite basis for an agreement, when you don't know yourselves whether Mr. Robertson's demands are proper demands?

Mr. Muller:
We came up here to get your point of view. We don't know a damn thing about it. We can sit down and talk it over, get some engineers together, and find out just how much we will need. Whether you can give us what we need, I don't know.

Mr. Phillips:
That puts me right back in the same position, so we can't say whether we would be agreeable to releasing 200,000 acre-feet until we know what you gentlemen have to have to fix you up.

Mr. Mead:
I imagine these gentlemen here have a pretty good idea.

Mr. Clark:
I think what they would like to know is this: are you people willing, do you look with favor on releasing a reasonable quantity of water to pass Fort Quitman, something based on the past ten-year record?

Mr. Phillips:
Well, I would still want to know whether that water was going to cure all your evils down there.

The Chairman:
You could probably get from them an expression . . .

Mr. Phillips:
We've had a good deal of different expressions, varying expressions as to the amount of water these people would like to have pass Fort Quitman, water, you must remember, that we have no control over but are asked to guarantee as to the amount delivered, which in my opinion can never be realized.

The Chairman:
I don't believe their idea is to make demand for any certain amounts each year but for an average over a period of years.

Mr. Harwell:
It is getting rather late, but I should like to ask Mr. Mead one question, and after his answer to that question, as far as we are concerned, we should like to have an opportunity to talk matters over among ourselves.
I might say first that about 99% of what has been said this morning is new to us. I mean, no one has discussed these matters at any length or has been specific about them but they have been mentioned rather as vague generalities. Mr. Mead, you made a statement a while ago in connection with your general remarks which sounded curious. I believe you said, if I recall, that what you want, what you are interested in, is a general agreement such as would satisfy you down there without causing you to attempt to defeat the compact before the State legislature. Are we to understand what that statement would seem to imply?

Mr. Mead:
I probably didn't mean anything when I said that. There is no disposition as far as our folks are concerned to do that, at all. I just merely mentioned the fact a good many of our people feel they have been mistreated. Some say, "Well, if they are going to take it all, they won't take any."

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The Chairman:
In the light of the statute enacted at the beginning of the negotiations among Colorado, New Mexico, and Texas, and from the standpoint of Texas as a whole—not taking any particular section alone, do you think that the commissioner representing the State of Texas should satisfy himself and negotiate with the object in view of securing to the State, as a State, as much water as she could get and as much as she was entitled to, without reference to any particular district within the State?

Mr. Mead:
I think you are right, Mr. Clayton. You couldn't settle all the questions among the various sections about the distribution of that water. But Colorado and New Mexico agree to deliver it: now what are we going to do with it? Are these districts up here to get it all. We below also have rights in this water.

The Chairman:
And if you were satisfied that the compact did secure for Texas whatever she was entitled to, what point is there in defeating the compact?

Mr Mead:
No point at all. But if you feel like you haven't been fair in the distribution of this water, then what we are here for is to settle our differences. We didn't come here to pick a fight. Nobody has any money for things like that. But it seems that we could get a gentlemen's agreement out of you fellows . . .

Mr. Harwell:
I move we adjourn until two o'clock.
Adjourn for lunch

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2 p. m.

The Chairman:
Are there any other representatives from the districts below Fort Quitman who would like to express their views?

Mr. Mead:
There is one thing I should like to ask about: Is there any attempt to build another dam on the Rio Grande that might divert more water? That is, is there in contemplation along the watershed up above the construction of another dam that would materially affect the flow of the river?
The Chairman:

Not that I know of. Mr. Robertson may be in a better position to speak of that than I. I didn't understand that there is any such construction in contemplation or that there was any fear on the part of the users in the lower valley in regard to it.

Mr. Robertson:
I have no information other than the Caballo up above here. It is under construction, I believe, and everything in regard to it was taken into consideration in this compact.

The Chairman:
Generally speaking, Mr. Mead, I believe all the lands under the Elephant Butte project or below Elephant Butte dam have been fully developed. I don't mean to say that all the land is in cultivation. But substantially all that can be brought under irrigation are under ditch.

Mr. Mead:
I may not be as well informed as some. We are pretty far distant from El Paso and all the New Mexico watershed. But this morning we started down there at the mouth of the Rio Grande and got up here to Fort Quitman. Now, when did the El Paso district start using this water? According to the testimony, we have had our irrigation since before 1930.

The Chairman:
The El Paso district itself was formed—I will let Mr. Harwell, Mr. Phillips and Mr. Fiock answer specifically, as the talk has been about the history of the valley.

Mr. Mead:
May I ask when this district was started, in 1930?

Mr. Harwell:
If you are speaking strictly from the point of view of organization, formal organization . . .

Mr. Mead:
No, what I am trying to get at is this: when you were questioning us as to when we started using water —that is what I want to know about. When did you start using water up here and how much increase has there been?

Mr. Harwell:
The irrigation district I represent was formed in 1917. It replaced the El Paso Valley Water Users Association, a different form of organization, organized, as I recall it, in 1908 or '09. As far as organization is concerned, the El Paso County Water Improvement District, as I have said, was an outgrowth of the El Paso Valley Water Users Association. They just changed the name.
There are areas in this project, in the vicinity of Ysleta and elsewhere, that have been in cultivation and under irrigation since following the retreat of the Spaniards from Santa Fe in 1670. As I recall the history of the El Paso valley, this area was first settled then and the use of water to irrigate the farms commenced by the settlers. There was considerable development, growth of development from then on. Then, in 1890 much complaint was heard about encroachments on the part of Colorado. The old river channel dried up at El Paso throughout the summer, from April of each year. A great deal of land was in cultivation, and when the river dried up, the farmers took to pumping. Along in 1905 the government sent engineers down and negotiations were begun for a treaty with Mexico. Thereafter followed the treaty and the building of Elephant Butte, and the rehabilitation of the valley lands. Does that answer your question?

Mr. Mead:
How many acres were in cultivation before the dam was built and how many now?

Mr. Fiock:
About 60,000.

Mr. Harwell:
And now between the two districts, 155,000.

Mr. Mead:
The point to me is that the waters should be allocated all down the line, that all should have an equitable amount of this water, from here down to Presidio. The condition down in our country is growing worse and worse. If the river dries up above Laredo, something is wrong, and we should try to find the answer and work it out.
Our people have had up the matter of another dam below Candelaria.

Mr. Muller:
I was talking with one of the Boundary Commission men from Mexico about a year ago. I want to make it plain that I am not representing any association. The committee sent up here was delegated by the Chamber of Commerce. Well, this man and I were talking about the contemplated dams along the Rio Grande . . .

The Chairman:
Below Fort Quitman?

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Mr. Muller:
I think so. I asked him when are we going to get together so we can get a portion of the water from the Colorado. He said they wanted to settle the whole thing at once. Since then I talked with Mr. West. And it doesn't look like there's any chance of our getting those dams. Of course they would help. If we can get the dams, there ought to be enough water for everybody. I don't believe there is any chance of an immediate solution, though, with Mexico.

The Chairman:
This morning, in asking for statements from the users along the Rio Grande, from the individuals and districts here, we proceed upstream from Brownsville. We will reverse the order of procedure this afternoon, and go downstream, beginning with Mr. Phillips' district. Mr. Phillips, may we hear from you at this point?

Mr. Phillips:
I hardly know this early in the discussion what would be of real benefit to this meeting. The proposition of a diversion of waters, aside from the diversions provided for by the compact, are greatly complicated. For instance, I advised with counsel and they pointed out—the only time I had left to talk with counsel was a few minutes at noon—and was advised that before and agreement such as has been proposed here could be entered into, as far as we in New Mexico are concerned, would require an act of the New Mexico state legislature. Now, you fellows think you have got troubles down in Texas: you ought to come up to my part of the country and try to divide with my people. I feel very sympathetic to the occasion of this meeting. I know that you gentlemen all have your problems. But at this particular time, I can't make any definite statement that would add a great deal to the discussion. For instance, this morning I asked a couple of questions, and without appearing to be mean in the least and without trying to embarrass anybody, I just wasn't satisfied with the answers I got. I don't know whether we are going along the right road or not when we talk about entering into agreements, even if we could, for a guaranteed delivery at Fort Quitman. And I am not so sure that that is what your trouble really it—too little water at Fort Quitman. I think that the compact which has been signed and agreed to represents an equitable division among the three States in the drainage area above Fort Quitman. I think it represents an equitable division of the waters of the Rio Grande, and with ratification of the compact there will naturally be an increase in the flow at Fort Quitman.

I think we will all agree that during the last three-four-five years the runoff of the watersheds in the upper reaches of the Rio Grande has been below normal, and naturally when the water deliveries on the upper reaches of the river are below normal, they must of necessity be below normual on the lower end.

I feel that this question must be considered very carefully by all concerned, and a considerable amount of study will have to be given to the problem. I doubt seriously if a lot of this talk about water rights and dams are pertinent. If they are, I certainly want to inject into the record that we can show, in my section of the country, that we were irrigating in 1539. But don't take me too seriously on that question. I don't think it has any place in the picture. But until we can hear more and have more facts bearing on your general conditions down there, of which I personally know very little, I feel that out of justice to the people I represent that I should reserve any official statements. Maybe I will be in better position at a later time in this conference.

And I don't want to appear to be pessimistic but I don't think it would do any good for me to go to the state legislature of New Mexico and try to get any guaranty for you, if I was so inclined which I assure you I can not agree to, and I should like to reserve any further expression from myself on the part of our district until some later hour in the conference.

The Chairman:
Is there any member of your delegation you would like to call on?

Mr. Phillips:
We have here the president of our district and two or three members of our board. Also, our local counsel. They are all free to take the flfloor, and some of them will. I should be very glad if you would call on them, Mr. Chairman.

The Chairman:
Mr. Starr.

Mr. Starr:
I think Mr. Phillips has expressed the sentiments of all of us here from New Mexico. I don't believe I could add anything to what he has said.

The Chairman:
Mr. Scoggins.

Mr Scoggins:
Mr. Chairman and Gentlemen, I don't think I can add anything that would help in any way. I think our ground has been pretty well covered by Mr. Phillips.

The Chairman:
Mr. Wright.

Mr. Wright:
I feel very much as do the other directors, that Mr. Phillips has said about all there is to say. He has been our spokesman for a long time and we have always found his ideas concurring exactly with ours, with few exceptions.

The Chairman:
Judge Mechem.

Judge Mechem:
I don't have anything to say, I believe, except to state what most of you already know: the Elephant Butte Irrigation District doesn't own any water or control any water except to take what is delivered to it and collect from the water users within its boundaries the charges assessed against them and pay it over to the United States Government The water in New Mexico belongs to the landowners. Elephant Butte Irrigation District as such has no rights in the water, and it of course could not agree to anything that would tend to impair the rights of the landowners in the district.

The Chairman:
Mr. Lucero.

Mr. Lucero:
I don't believe I can add anything to what Phillips and the others have said.

The Chairman:
We are proceeding downstream, you know. We now come to the district in El Paso County. Mr. Harwell.

Mr. Harwell:
While I . . .

Mr. Muller (interrupting):
May I ask Mr. Phillips a question. I don't want to interrupt but it seems this is the place to ask it.

Mr. Phillips made a statement a while ago which I think was in line with the questions and answers. You don't know exactly what our conditions are down there; I don't know your conditions up here. When you ask us would 200,000 acre-feet of water at Fort Quitman satisfy us, I have been wondering if you are

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in a position to give us that amount of water. Have you got it there?

Mr. Phillips:
I wouldn't for a minute say that we would.

Mr. Muller:
I don't mean that. I mean, is it there, is it available?

Mr. Phillips:
I don't know. That is what I was trying to say all the time. Certainly we ought to know what you need, to know what your problems are and what it will take to solve them before we try to make an agreement about this water at Fort Quitman.

Mr. Muller:
It might be that our interests are one. The only way we can arrive at things is by asking these questions.

Mr. Phillips:
Yes, indeed. And my question wasn't asked with any intention to embarrass you in the least. I am here to try to help solve this problem, and am only trying to pick up the facts.

Mr. Muller:
Well, I couldn't commit our country, either, that 200,000 acre-feet would be enough water.

Mr. Scoggins:
You say, Mr. Chairman, that the respective rights of Colorado, New Mexico, and Texas entered into this compact. Now the question is, was there a fair division of the waters of the Rio Grande as between them? Did Texas get a fair division?

The Chairman:
I feel, all of those with me in the negotiations feel, that she did, Mr. Scoggins. If I hadn't, I wouldn't have signed the compact.

Mr. Scoggins:
And any further division of Texas' share would be between the water users in Texas?

The Chairman:
Yes, sir.

Mr. Mead:
Didn't they talk about the river below Fort Quitman?

The Chairman:
No, sir. I just handed Judge King the statute that controls here in Texas. It is Article 7466a. If I may, I will read it (reading):

> "The Governor of this State shall, with the advice and consent of the Senate appoint some qualified person a commissioner to represent the State of Texas in conference with the commissioners duly appointed to represent the states of New Mexico and Colorado, and a representative of the Government of the United States, to negotiate an agreement respecting the use, control and disposition of the waters of the Rio Grande and its tributaries above Fort Quitman, Texas."

In the temporary compact adopted about ten years ago, there was the same limitation. This compact was ratified by the Texas Legislature, the Congress, and the other state legislatures, and has been on our statutes for about ten years.

I might add this: It seemed for some time that our negotiations had broken down, and they had broken down to such an extent that we felt constrained to institute a lawsuit against New Mexico, partly based on water rights independent of the compact and partly on provisions of the compact, itself. Shortly after that lawsuit was instituted, Prof. Barrows, who, as I have said, is a member of the Water Resources Committee of the National Resources Committee, and Prof. Adams, consultant for the Water Resources Committee, attended a meeting of the Rio Grande Compact Commission and offered their services in making a survey of the entire watershed above Fort Quitman, in order that accurate data might be assembled for our use in reaching an intelligent opinion, and thus perhaps arrive at a fair and equitable compact. Something over $400,000 was spent on that survey, some $350,000 by the federal government. It was a very exhaustive undertaking. They went into the past, present and prospective uses of the waters of the entire watershed above Fort Quitman, determining the economic use of water, how it could be conserved, how put to best use, how augmented by transmountain diversions and otherwise. Their report was over a year in preparation. We had that information available to us when we went into the later negotiations. In keeping with this statute, which is substantially the same as in Colorado and New Mexico, and in keeping with the provisions of the temporary compact, we confined ourselves to the consideration of the uses of water above Fort Quitman.

Mr. Mead:
New Mexico and Colorado have no interest below Fort Quitman, at all?

The Chairman:
No. As a practical matter, we could not allocate it at the state line. The control is at Elephant Butte reservoir.

Mr. Mead:
Why couldn't you regulate . . .

Mr. Harwell:
Part of Texas diversions are made in New Mexico.

The Chairman:
In the negotiations and in the compact no attempt was made to fix the amount of water to pass Fort Quitman. As we viewed it, that was quite beyond the control and jurisdiction of the commission.

Mr. Mead:
I can't see, though, with a river five thousand miles long, why pick Fort Quitman and tie up all the rest of the river?. I am just trying to understand this business.

The Chairman:
The selection of Fort Quitman as a dividing point dates back a good many years before my time. Developments in Colorado in the latter part of the nineteenth century dried up the river for months at a time in New Mexico and in Texas above Fort Quitman. That brought about a protest from Mexico, and as a result, the treaty of 1906 was entered into designating Fort Quitman as the dividing point. The appropriations filed by the Bureau of Reclamation of the unappropriated flood waters in New Mexico, in 1906 and 1908, were stated to be for the benefit of lands between Engle, New Mexico and Fort Quitman, Texas, as well as I remember.

Aside from the historical feature of the matter, the lands above Fort Quitman receive their entire water supply from the Rio Grande and its tributaries in Colorado and New Mexico. The lands below Fort Quitman, except those immediately below, receive by far the greater part of their supply from tributaries flowing in below that point in Texas and Mexico. For instance, we are discussing now an average annual flow of approximately 200,000 acre-feet of water, and very poor water at that, whereas some three and a half to four million acre-feet flow into the Gulf at Brownsville, annually.

The Texas statute authorizing the appointment of a Rio Grande compact commissioner and, through him, negotiations with Colorado and New Mexico

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for a compact, recognized Fort Quitman as the dividing point and provided for an agreement with respect to the use of the waters of the Rio Grande above that point. That statute has been on the books for about thirteen years and under it we had a temporary compact for almost ten years, and this is the first time I have ever heard this particular question raised.

Mr. Muller:

Looks to me like what you diverted, what you allocated was just enough to supply El Paso, because what goes beyond El Paso is just drainwater, you say, and you just figured that the district here was all there was and just forgot about the rest of Texas.

The Chairman:

I suggest that the question in your mind now will be answered in the discussion to follow. Mr. Harwell.

Mr. Harwell:

I am going to try to answer Mr. Mead and Mr. Muller in just a word or two. I have no intention of speaking long.

I think the reason why the river has been divided into sections, one above, the other below, Fort Quitman follows a very logical development. The crisis created here prior to 1905 and which brought about the treaty of 1906 was very acute above Fort Quitman. The situation below was not acute, as I remember the history of those times, then nor for many years afterwards. Then when the United States and Mexico got off together to settle their differences, they settled on that portion of the river along which there were difficulties and didn't include any other part, because there were no difficulties. Those of you living down there, if you had just had the foresight of what the future had in store for you in the way of encroachments on the part of Mexico, you might have been interested. But the facts are, you weren't interested, the crisis did not affect you, and that's why the river generally was divided between Fort Quitman and the source and Fort Quitman and the mouth.

In those days the river petered out at Fort Quitman or above completely, and nobody could feel certain that there would be any water in the stream down there during the summer, unless water flowed in from other sources prior to 1906. So, I think the river just naturally got divided into two sections; they tried to solve the problem up above; there was no problem to solve down below. Not then.

Mr. Barrows:

The National Resources Committee first became interested in the problems of the upper Rio Grande because of representations made by Dr. Elwood Mead, the late Dr. Elwood Mead. He pointed out that a situation had developed above Fort Quitman which in his opinion was becoming dangerous both to public and private interests and with respect to which the Bureau of Reclamation was unable to cope. He begged us to help out, and when the Committee first took notice, I chanced to be one of the two men sent to Santa Fe, in December, 1935, as Mr. Clayton stated. I went to see Dr. Mead in his office to ask various questions about the river which related to the situation, and I asked him the very question, precisely the very question you now ask: why is it proposed that we shall concern ourselves with the river above Fort Quitman and not with its entire length? Mr. Harwell, to whom I never reported that conversation, almost paraphrased what Dr. Mead said to me: that the problem facing us had grown out of difficulties which led to the treaty of 1906, of our dealings with Old Mexico, and various things subsidiary, some of them independent problems, but mainly dependent, secondary problems growing out of those difficulties. As has been said here, there were no problems then of a serious nature in the 1300 miles of river from Fort Quitman to the Gulf—perhaps a few in the more or less restricted area at the mouth or delta, and that those local problems and more extended problems which later might develop would have to be solved in other ways than those concerned with the river above Fort Quitman; that in his opinion that was the natural, physical, historical dividing line. The problems of the two upper sections are separate problems. Just at this moment what Dr. Mead said to me in that conversation struck me here with much interest.

Mr. Mead:

I can see what would happen as far as Mexico and the United States are concerned. What I don't see that as between Colorado, New Mexico and Texas, there should have been such an arbitrary dividing of the river, at all.

Mr. Barrows:

You must remember we were concerned with an investigation that would help to provide a satisfactory basis for an interstate agreement. We were not concerned with intrastate problems, whether in Texas, New Mexico, or Colorado.

Mr. Muller:

Our representatives apparently weren't concerned or they would have made some investigation at that particular time. Now there is none, and I believe our cause is a just cause. Because our rights were ignored then, that isn't going to be any bar from now on, is it?

Mr. Harwell :

We can never get anywhere as long as we consider this from a purely hypothetical point of view, and if you or any one else have any rights anterior to ours, that you claim either legally or otherwise, you have the door open to you. I think if you will let me get through with what I started to say, I may have thrown some light on the situation. If I may proceed, maybe I can clear up two or three matters that you have come a long way to find out about.

One of the things I want to tell you, and this you must have clear in your minds; you have undertaken a difficult proposition—although I am not a lawyer, I associate with lawyers, and I have learned that once in a while a lawyer finds himself in the situation you are in today —you haven't the proper people in court. You propose to enter into an agreement with the Elephant Butte Irrigation District, of New Mexico, and with the El Paso County Water Improvement District, and with the United States Bureau of Reclamation, for some definite passage of water below Fort Quitman. None of the organizations which I have mentioned could guarantee to you, under any reasonable proposition of their own, any such delivery at Fort Quitman, or anywhere, for one or two very simple reasons, and I am hoping that during your visit out here you will take occasion to investigate for yourselves. If you do, we will all understand each other a lot better.

Now, then, as far as the Rio Grande project is concerned, and those here today are representing the Rio Grande project, our project ends at the end of the Tornillo district, a point down below Fabens a relatively short distance. The last diversion which we contemplate making here will be at Ysleta, twelve miles below El Paso. Our control over the water still will end at Fabens, in part, and at the head of the Tornillo main canal, at the end of the Tornillo district. I am sorry we haven't a map, because I want you to get this situation clearly in mind. What happens beyond that point, and Fort Quitman is well beyond that point, is something wholly without our control, as it is without your control. We have no more control over the operations below those points than you have.

Now I think that as far as the supply of water at the end of this project is concerned, the supply will be substantially as it has been in the past. I think that will be true, because a certain amount of operating water and a certain amount of summer runoff, entirely beyond our control, will run in the river. But once

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that water reaches Fabens and the end of the Tornillo district, it passes completely out of our control. And you are going to be surprised to hear, in part, at least, I am sure, what happens to it then:

This new rectified channel of the Rio Grande, of course you know about. On down to Fort Quitman the water now goes into the new channel, and the drain waters and irrigation waste waters at Fabens and at the lower end of the Tornillo district, all empty into the new rectified channel. And this water is now being diverted by Mexico, notwithstanding the treaty, which provides that 60,000 acre-feet shall be delivered to Mexico at El Paso. Notwithstanding that fact, those agragrians down there are constantly putting in new diversions, and taking the water when and where they please, and that water will probably be subjected to more and more such diversion in the future. I, myself, was given a little shock just during the noon hour, in talking over this matter with one of our directors, when I learned that certain activities have been going on recently which we had not observed. My earlier impression was that there were four diversions on the Mexican side below the point where we release control. But this director tells me he was down along the rectified channel yesterday with some of the farmers, and one counted fourteen diversions. Another counted sixteen. So, it is obvious that as far as the Mexicans are concerned, they are intent on taking whatever water they please below our point of control of it, at least as much of it as they can use and get on the land—substantially everything but the flood runoff is being put on their land. They are developing, under their agrarian program, the fullest use of their land on that side the stream.

Then, below our district here is the Hudspeth County District. The Hudspeth County Conservation & Reclamation District No. 1 is not a party in this transaction, they are not represented here. They have some 16,000 acres of land that is being irrigated, in part by surplus waters which we deliver into their canal for a consideration, and in part by diversion from the river. This, again, is beyond our control.

We are just getting at this roughly, so don't take the figures I have mentioned as exact. They are merely estimated.

But below us and before you get to Fort Quitman, there are some 40,000 acres of land that is being put to use, and all that water put on it—who controls it? we don't. So, you see, even if we were willing to guarantee to deliver at Fort Quitman 200,000 acre-feet of water, how could we get it there? We would find that we had undertaken, with these facts staring us in the face, to supply all these unauthorized uses in Mexico, and all these uses below us, and we would find we had undertaken to deliver to you so much water only after providing sufficient water to take care of all those people. This would be a distinct loss to us, not only by reason of the unathorized and unlawful diversions into Mexico, but there is the Hudspeth County district that we don't control. Any such proposition would be absurd from a business point of view, and simply could not be undertaken by any man in his right mind.

Somebody is going to ask me presently why we don't stop those Mexicans. And the answer might be, why don't you stop them? When we get through with that water, we are through with it. We have had years and years of battling, and while our own attitude would be that we would certainly wish the people of Texas, the people of the United States could profit by that water, on the other hand it is not our business to undertake to do any further fighting on that score, and those of you who are interested in that water will have to undertake the fight.

I believe that is fairly clear, fairly specific, and I will stand on these statements. Any questions anybody wants to ask me? If you have any apprehension that I am giving more importance to the Mexican diversions than they warrant, and other unauthorized diversions, you remain over and investigate for yourselves, and if then you feel I am wrong, I will gladly stand corrected.

Now, we have been in this water business for a long time. I have been personally connected with the organization here for eighteen years. The most important thing that ever happened to us here was the building of Elephant Butte dam. I have known the agony we have gone through to secure results. I have known the necessity of overcoming prejudices, the necessity of staring facts, hard facts, in the face, whether on our side or the other fellows' side, and the necessity of working long and against heavy odds for what seemed wise and then having to suffer disappointment. But we have made material progress, what we have done is constructive, and out of our hard won experience, if you will pardon me, I want to offer a suggestion or two: We live to learn, and we pay plenty while we are learning. What you are asking us to do, even if we could do it, is a mere drop in the bucket. When you got it down and went home, you would find that really the edges have not been more than touched. We hear of your troubles in general terms. We know nothing about them in specific terms. But you need storage; and you need a treaty; and you need to go back and employ other means, exactly as we did back in 1906. And that will bring up again the answer to the gentlemen's question, and I am just about through: when we lost a normal flow of water through diversions in Colorado, and we did lose it, we went about to restore our supply by negotiating a treaty that would enable us to capture new water and substitute flood waters for the regular supply. We had floods all those years but flood water meant little or nothing to us, certainly not in the way it could be put to use. Now, it looks to me as if you are having the same experience. You have lost your normal flow to Mexico. That is what creates your problem. And to solve it, you will find the vehicle is not a contract with us; it is a treaty with Mexico—almost a duplication of our circumstances back in 1906. Next, you can develop storage. Then your problems are solved.

Now, all those undertakings are big things. I am not trying to tell you how to run your business. But any of you can see that at least I have given you an outline. To make real progress, in my opinion, you would want to initiate a program under an agency capable, not only of handling the lower Rio Grande, but handling, as well, the Colorado situation, because the two go hand in hand. There is such an agency, in my opinion, which would successfully lead you on to your goal, and that agency you are already aware of.

Now, I think we had just as well put our cards on the table and say what's what. Part of the reason why my district and the Elephant Butte Irrigation District invited Dr. Barrows to come down here—rather, the reason why was two-fold: one, because the National Resources Committee had a great interest in the consummation of this compact, on which it spent its money, and its work affected, directly or indirectly, the consummation of the compact. Another reason was that we thought if you men had an opportunity to get in contact with, and learn some of the possibilities of the real solution of your problems from Dr. Barrows, you would escape a great deal of worry. It is a rather harrowing experience to go through, what we went through some years ago, trying to deal with all those attorneys over in Juarez. And after all these years we know what it means. We had far rather offer you sound, constructive advice and help you in a way really worth while than simply sit here and dicker and fuss about your rights and our rights.

I gather from the remarks this morning that you really haven't enough information to do much of anything as yet. Water is a very precious commodity in this western country, and nobody is going to give you, just give you, or give us, or anybody else, much of that precious element until it is demonstrated that it

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will not be wasted, that you are entitled to it by right, by legal right or some other right, and that giving it would settle all controversies, once and for all. As I said awhile ago, I think you have the wrong party in court. As far as the future is concerned, we believe that substantially the same quantity of water will be delivered at Fort Quitman as has been in the past. But we have no control over the water when it leaves the lower end of our district, and we could not guarantee that delivery without absolutely wrecking our district and ruining our farms and our farmers, and this we could not, under any circumstances, consider doing.

Mr. Robertson:
You say there are 14 or 16 diversions below you here? Do you have any information as to just where they are, are they between the acequia Madre and Tornillo or below that? Are they gravity diversions or by pump?

Mr. Harwell:
I understand they have built brush wiers and in two places have built permanent structures.

Mr. Mead:
This compact, has it been approved by Mexico?

The Chairman:
Mexico is not a party to the compact. It is an interstate compact, among the States of Colorado, New Mexico and Texas.

Mr. Scoggins :
How long did it take to work out this compact?

The Chairman:
We have been negotiating towards this permanent compact since the temporary compact was ratified in 1929.

Mr. Wagner:
Would Mexico require a permit from the United States?

The Chairman:
No, sir.

Mr. Wagner:
How about the United States?

The Chairman:
As a matter of treaty, the United States is obligated to deliver 60,000 acre-feet a year at the Acequia Madre. When they take out below the Acequia Madre they are violating the treaty, but they don't ask permission.

Mr. Scoggins:
Who has jurisdiction over those unlawful diversions?

The Chairman:
The State Department and the International Boundary Commission.

Mr. Harwell:
I understand the Mexican people are cutting through the levee on the Mexican side, due to scarcity of water originating above. As I said, it is absolutely news to me, and starting at this stage of development, as their requirements become more acute, it will present a menace no doubt, to users downstream.

Mr. Kirkpatrick:
If I understood you, you said you proposed to lay your cards on the table. Do I understand you to mean that even though you and your directors feel you could legally enter into an agreement, you would not be constrained to do so for business reasons?

Mr. Harwell:
I approached the matter more broadly. I said if we were disposed to enter into an agreement, we could do so only by practically wrecking our district, by carrying these unauthorized diversions in order to get the quantity desired at Fort Quitman.

Mr. Kirkpatrick:
I understood you to say it would completely wreck your district from a business standpoint and you didn't propose to do it.

Mr. Harwell:
I meant to say that it would wreck our water supply. That would of course mean the wrecking of the district.

Mr. Kirkpatrick:
I should like to ask Mr. Phillips if that is his sentiment.

Mr. Phillips:
Yes.

Mr. Porcher:
This carries me back to about 40 years ago, hearing you gentlemen from Presidio state your troubles. We came here in 1893. The following summer we had no water until September. That was the situation for over ten years, until there was a little more flood water in the river and we got by with pumping in between times from wells dug along the river, some of them right in the riverbed. I can certainly sympathize with you gentlemen. I have been through all this fight with Mexico and New Mexico until now we have an agreement with New Mexico, and we got the treaty back in 1906. I remember one meeting like this, where we talked and talked, and directly one of the younger men got up and said, "Gentlemen, we are getting nowhere. In my opinion you are just going 'round in circles. Why can't we do something constructive?" Well, I am not a young man, but it looks to me like what you need, you men from New Mexico, and you men from down in Texas, is to see that you aren't getting anywhere. With us, that time, it was like this. Then the reclamation people said, you've got to have a dam. But how could we get a dam? Well, we got it. The job was done.

Mr. Mebus:
I don't believe I care to say anything.

Mr. Ivey:
I will say very little. I will speak of one incident that may be of interest in this case. Sometimes we speak of prior water rights. About 1934, under the Bankhead Law, a farm census was taken throughout the State of Texas, getting crop averages, time of cultivation, etc. That census revealed that down at Ysleta, twelve miles below El Paso, is the oldest farm in the State, and if I am not mistaken the record is that that farm was irrigated from the beginning. That is just merely a little thought thrown in for what interest it may have.

Mr. Harwell spoke awhile ago of the diversions below the Elephant Butte project, on the Mexican side. On Wednesday, of this week, I made it a point to go down the levee and look for those diversions. As you probably know, the new rectified river channel has a high levee and it is graded, making a very good road all the way down, so it is easily accessible. Two others were with me. I asked them to count the various places where water is being taken out on the Mexican side. Some are small—probably one man just irrigating direct out of the river his own little farm. Other places are larger. Two or three are of pretty good size, with canals where the water lets out. There were two permanent structures in or across the river in that area—

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a distance, probably, of forty-five miles. These are across the new rectified channel. There were two structures across the river of a more or less temporary nature, one of sandbags and the other a brush wier. We also saw one fellow down at the lower end out in the channel putting in a brush wier. It looked as if he was going to get it built, all right—he was just driving stakes into the sand. We supposed he had a small farm.

Now, those diversions—about fourteen in number, don't necessarily mean a large area is being irrigated. But it shows a tendency on the part of the Mexicans to take water whenever and wherever they like. It is, perhaps, naturally to be expected, although under our treaty with Mexico they haven't that right. And, while the district up here would much rather they wouldn't take the water that way, yet, as far as I can see, there's very little we can do about it, if anything.

Mr. Mead:
Just how much space do these diversions cover?

Mr. Ivey:
This project ends about 38 or 40 miles below the City of El Paso. The last place where we take out water for this project is at Fabens, thirty miles below here. For a few miles the river is not the international boundary but it soon will be. From the lower end of San Elizario Island the Mexicans find it easy to divert the water. The first diversion is about a mile below that point. There they have cut through the levee on their side but very little water was going through. They have started brush wiers immediately below but they are not finished. Some 100 feet above that temporary cut they have a concrete structure, with three screw gates about completed. It is about 40 miles from there to Fort Quitman.

The Chairman:
I should like now to hear from Mr. Clark, chairman of State Board of Water Engineers.

Mr. Clark:
I don't see that there is much for me to say after the statements made by Mr. Harwell and Mr. Phillips.

As I understood it, the purpose of this meeting was to talk matters over together. We know from our records that there is something like 2,000,000 acres of land under appropriation below Fort Quitman, representing an expenditure of several millions of dollars. We know further those people, in order to satisfy their land and those appropriations, require all the water in the river below Fort Quitman and more. We know that they need every drop of that water. Of course it is admitted that they are going to have to make some provision for storage.

I appreciate Mr. Harwell's suggestion that it is probably best to have some national organization take hold of this matter. I agree that that would be the best solution. But no national organization can make any water. There is just so much in the river, and those people down there need every bit of it.

I believe this is what those people in the lower valley have in mind: This river has been gradually reducing in flow since 1910. The flow at Fort Quitman or around Presidio used to be some 7- to 800,000 acre-feet. It is now down to somewhere around 200,000. Probably at that time the people weren't in position to use it, and they are not now in a position to use what passes there without storage, without regulation. What they have in mind is that they want to safeguard, protect their rights in the event they can or in the event a treaty with Mexico is consummated and provision made for storage. They came up here, as I understand it, to try to work out a friendly understanding or agreement between you people, with the idea of getting something they can depend on. They want to know that the average flow past Fort Quitman for the past ten or twelve years will not be diminished.

Mr. Phillips:
Mr. Clark, you were up at Santa Fe when they were negotiating for this compact. Do you or do you not believe the terms of the compact, as you know them, will or will not affect the flow of water at Fort Quitman, in an average way? In other words, do you think the terms of this compact, if it is approved, will decrease the average flow at Fort Quitman over what or under what it has been in the last ten years?

Mr. Clark:
The flow at Fort Quitman has been decreasing for the past five years. The presumption is that you people have been using as much as you could let out at Elephant Butte dam, probably in the neighborhood of the amount specified.

Mr. Phillips:
I didn't ask you that question.

But you will admit, won't you, from the records, that for the past five years the supply on the headwaters of the Rio Grande has been below normal?

Mr. Clark:
That is probably so.

Mr. Phillips:
And you will admit that that must be of necessity have affected the flow at Fort Quitman?

What I would like to know is your opinion—let us be honest—do you think that the terms of this compast is going to reduce the flow at Fort Quitman?

Mr. Clark:
The only way I can answer is just what I have answered: if you have been letting 700,000 acre-feet out of Elephant Butte dam for the past five years, the flow at Fort Quitman has decreased. I don't see how it is going to increase.

Mr. Phillips:
But I don't say it is going to increase.

Mr. Clark:
The gage at Fort Quitman shows a gradual decrease for the past five years, down to 100,000 acre-feet.

Mr. Phillips:
I understand that. But do you not understand that under the terms of the compact, these compacting agencies are going to more or less continue the regular practice of water distribution?

Mr. Clark:
Yes.

Mr. Phillips:
I assume you will take my word for it that the project limits here are about net. In other words, we are irrigating practically all we ever will.

Mr. Clark :
Yes, I can see that that is probably so.

Mr. Phillips:
Let me ask you, now: will the terms of the compact serve to diminish the flow at Fort Quitman?

Mr. Clark:
The only water the people below can have is what passes there, and I have already stated what the gage shows.

Mr. Phillips:
Still, you do not answer my question.

The Chairman:
It is frequently of value in a conference of this kind to have the views of a man who, while he is thoroughly conversant with the problem, is not interested personally or financially in any particular element, and who has the perspective of distance—the long-range viewpoint. I think it will be of great

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value to us all in our discussions here to have the reaction of a man in that position. We have such a man here. I took the liberty of asking Dr. Barrows to attend this conference. My association with him during the past few years has been such that I attach a great deal of weight and importance to his views. They are always well considered and well thought-out. He is thoroughly conversant with the problems of this river from its source to its mouth. I now call on Dr. Barrows for any statement he may wish to make.

Mr. Barrows:

Mr. Chairman and Gentlemen:

I was pleased when Mr. Clayton asked me to join you today, for two reasons: In the first place, I have been making occasional trips to Santa Fe since December, 1935, and in so doing I have made many good friends in New Mexico, Colorado and Texas, including, from the lower Rio Grande valley, Mr. Clark and Mr. Robertson, and I knew that I would meet some of them here today.

I was glad to come, too, because I am tremendously interested in the critical and complex problems of this interstate and international river. I began to study it in connection with the problems above Fort Quitman. Those problems led me over to the Colorado River. That step led me in turn to a consideration of various international questions. And they led me to the lower Rio Grande. There, I gained a general idea of current and prospective problems. I have been thinking of them, I confess, chiefly in terms of the so-called delta, in the lowermost section; I haven't known so much about the districts farther up, to which the questions presented by the river are proportionately just as important.

As two or three of you said this morning, you have in the lowermost section something like 400,000 acres now irrigated, and the possiblity of irrigating, say, roughly, as much again. You have an enormous investment there, which has been growing through the years and which is of far more than local importance. You have experienced several shortages of water in recent years. At the same time, from 3,500,000 to 4,000,000 acre-feet of water flow unused into the Gulf in normal years. The present situation, therefore, is unsatisfactory. But the outlook is even more unsatisfactory.

Much already has been said about the large developments that Mexico has under way on various tributaries of the river (the Conchos, the San Juan, and others), developments which, when carried through, may mean for you more frequent and more serious shortages of water. I think you have got along pretty well thus far. Most of the shortages haven't been long-continued nor critical to a large area or to a large number of people. Future shortages may be of longer duration and greater magnitude.

It seems to me the only solution for your problem involves the construction, at appropriate places on the lower river, of dams, very probably including the three dams that have been planned by the International Boundary Commission, which would have a combined storage capacity of 2,650,000 acre-feet. By the construction of such regulatory works, it would be physically possible to utilize most of the water which now, in normal years, flows unused into the Gulf.

But those dams can not be constructed, obviously, without a treaty with Mexico.

You need not only storage dams but also a definite allocation of an equitable part of the flow of the lower Rio Grande. Patently, you cannot have that without a treaty.

Repeatedly, as every one in the room knows, Mexico has indicated that she will not negotiate with the United States with respect to the lower Rio Grande alone. She will deal only with respect to the Colorado of the West and the Rio Grande — the lower Rio Grande—considered jointly. Now, that fact means that you cannot have a treaty, as one or two already have indicated, in the immediate future, if, by the immediate future, you mean the next few months. It is, however, I believe, entirely possible within a reasonable number of years.

The situation on the Colorado alone is complicated. The States, or most of the States, of the Colorado basin have taken the position that after the completion of the All-American Canal we will not be under obligation to furnish Mexico any water. They have indicated, however, that as a neighborly and friendly act they would be willing to give Mexico seven hundred fifty thousand acre-feet annually. At various times, however, Mexico has claimed 3,600,000 acre-feet or more as her proper share of the water of the river. It has been rumored recently that she proposes to claim some five million acre-feet. There are other problems. As you doubtless know, the four upper States of the basin of the Colorado, under the Colorado River Compact, must deliver to the lower States seven million five hundred thousand acre-feet annually. The upper States still have to agree among themselves on their individual responsibility in permitting the required volume of water to flow to the Lower Basin and on the allocation among themselves of their joint apportionment.

I think there is, fortunately, a rapidly growing appreciation of the fact that unnecessary delay in settling the interstate and international aspects of the Colorado River problem would be unfortunate. The construction and operation of Boulder dam will mean an increased reliable supply of Colorado water for the Mexicans, which they can divert and utilize for further extensive development. Appreciating this fact, and similar and allied facts, the people of the American part of the basin appear to have a new or strengthened feeling that these unsolved water problems should be settled as soon as practicable. To that end, interstate conferences have been held in the recent past and others are planned for the near future. The outlook for an early, proper solution of the problems of the Colorado is distinctly better than it has been at any time in the past.

When the time comes for negotiations dealing with the two rivers, you obviously should be ready with all relevant data concerning the American side of the lower Rio Grande. Are you now ready? Have you all the facts of all kinds with respect to the supplies of water and the uses of water, past, present, and prospective, in the Texas part of the valley, that will be needed by the negotiators? I have heard it stated in various quarters that you have them, but I venture to doubt it.

When the time comes, we will want—and by "we" I mean the United States—we will want Mexico to present reliable facts concerning the irrigated lands on her side of the river, the past and present consumptive use of water on those lands, the irrigable acreage, the future water requirements of the irrigated and irrigable areas, and the like, with a view to judging of the amount of surplus water which she could make available to you. I am not implying that your needs or your rights could be determined in such ways alone. But clearly the United States would want Mexico to present such evidence. Have we, on our side, corresponding evidence ready to present in detail? Can any one say at all closely, for example, to what extent the flow of the Rio Grande will be depleted by developments on the Pecos in New Mexico and in Texas? By developments along Devil's river? By developments elsewhere? I don't think any one has these facts and many other facts that will be needed. In reaching this opinion I am guided somewhat by the findings of the eminent Colorado engineer, R. J. Tipton, who served the National Resources Committee as consultant on the Lower Rio Grande and neighboring rivers in connection with our drainage basin reports to the President. It was his belief that a thor-

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oughgoing review of existing data and supplementary fact-finding surveys and investigations along various lines are needed, and that they should be initiated at once as a preliminary step to treaty negotiations. Apparently his opinion is also the opinion of some leaders in the lowermost valley itself, for a year ago last winter Senator Neal introduced a bill in the state legislature authorizing an expenditure of $35,000 by the State Board of Water Engineers in connection with such surveys and investigations.

Now, if you agree that you do need more facts—and bear in mind that successful negotiations with Mexico can rest only on our possession of exact and adequate data—then we come to the next question:

Do you desire the services of the National Resources Committee in reviewing and interpreting the internal or domestic data now available and in gathering new data, in anticipation of such negotiations? It is, of course, for you to decide. The Committee would not wish, not for the briefest moment, to appear to be seeking to inject itself into your problems. If, however, you men of the lower river want the help of the Committee, I think the requisite arrangements probably can be brought about.

If you wish the National Resources Committee to act as an over-all planning, guiding, and co-ordinating agency in the surveys and investigations that may be jointly agreed upon as needed, much as it did in the case of the Rio Grande above Fort Quitman, then I suggest the following procedure: (1) That you appoint a regional committee, made up of representatives of the several irrigated sections of the lower valley. (2) That this Committee, with the assistance of one or more representatives of the El Paso district if you so wish (I am sure such aid would be available), solicit the Governor of Texas to present an official request to the Department of State that it, in turn, ask the services of the National Resources Committee. The approval and participation of both the State and the Federal Department of State will be essential to success in launching and carrying out the studies that appear to be needed. The time was never so opportune as now for cooperative efforts by Federal, State, and local agencies looking to solution of the problems of the lower river.

I remember hearing of an appeal that Mr. Robertson, now with us, made on behalf of the American water users in the valley below Fort Quitman at a meeting of the Texas Planning Board in June, 1936. He asked the Board to think of the problems of the lower river not as local problems but as problems affecting the entire State. I repeat his request here, but I go even farther. I ask you to think of them not as local problems merely, not as either regional or State problems exclusively, but as phases of urgent national and international problems. They cannot be solved in isolation.

Our relationships with Mexico, and indeed with all Latin America, are of paramount importance to the peace and welfare of the Western Hemisphere. Anglo-American civilization to the north of the Rio Grande and Latin American civilization to the south of it owe much to each other. Problems of mutual concern to them will multiply rather than diminish in number. The Rio Grande binds its tributaries together; it does not separate them. It should also help to bind together in friendly relations the people who inhabit its opposite banks. We cannot afford to have Mexico point in the future to our failure—it might be, I grant you, her failure as well as ours—but we can not afford to have her point to any dereliction on our part in coming to some friendly and fair understanding with her over the questions of these boundary rivers. I confidently predict, in view of such considerations, however intangible some of them may seem to you at the moment, that the International Boundary Commission, the Department of State, and the National Resources Committee would welcome prompt action by you in preparation for treaty negotiations. That, gentlemen, is the only way in which your problems on the lower river can be solved; you will agree if you look at the matter realistically.

The small amount of water that could be passed at Fort Quitman and the low quality of that water make it only "a drop in the bucket" with respect to your requirements. You need regulation of the lower river. That means storage dams. You cannot get dams without a treaty. You need a definite allocation of water from the lower river, seventy per cent of the flow of which comes from tributaries on the Mexico side. You cannot get that without a treaty. An equitable treaty is the big thing, the all-important thing, for which you should strive, with or without the aid of the National Resources Committee.

I was surprised — I confess I was shocked — this morning when remarks were made that seemed to imply that some groups or some individuals might feel it to be in their interest to oppose and, if possible, to defeat ratification of the Rio Grande Compact in the state legislature if it be found impossible by the people of the Elephant Butte project to meet your wishes or suggestions. I was surprised because, as one or two earlier speakers have indicated, that compact, in the judgment of lawyers who have studied it carefully, in the opinion of a relatively large group of competent engineers, in the opinion, I think, of most of the citizens of the areas immediately concerned in all three States who have had it explained to them, and, as far as I know, in the mind of everyone conversant with it, represents a fair allocation of the waters of the upper river to the three States. I have yet to hear any one suggest any dissatisfaction with it. Colorado got what she was entitled to; New Mexico got what she was entitled to; and Texas got what she was entitled to. That compact, you should remember, ended a serious controversy of more than forty years duration. It was welcome to the national administration. It was welcome to the state administrations. It was welcome, I am sure, to Mr. Charles Warren, the eminent special master for the Supreme Court in the suit now in abeyance between Texas and New Mexico. I think I cannot be mistaken when I say that the Supreme Court would regret non-ratification, for it repeatedly has taken a friendly attitude toward the compact mode of action in dealing with controversies over water. Failure of the compact would necessitate resumption of the litigation between Texas and New Mexico. Such litigation always is a slow and costly method of settlement, and its results are likely to be inconclusive and unsatisfactory to the public. Already, the beneficial influence of expected ratification may be seen in accelerated movements looking to the solution by compact of various other interstate water problems in the west.

There is a great conflict under way in the United States between centralized federal authority and state authority. Democracy in America is slipping. The Administration is not responsible. All sorts of factors enter into the situation. I, for one, deplore, as I could scarcely deplore anything else, any unnecessary or avoidable encroachment of federal authority upon the rights of the states. The only way in which that tendency can be stopped, so far as water resources are concerned, is by friendly adjustment of interstate problems by the states themselves, by such adjustment as was accomplished in the signing of the Rio Grande compact. It would be tragic if that compact were not ratified by each of the States. It would be calamitous to the lower basin as well as to the upper basin.

Further, I venture frankly and in the most friendly spirit to say this to you, and you may write it down almost as a formula: No compact, no treaty; no treaty, no storage dams; no dams, no regulation of the waters of the lower river. Unless a program leading to an equitable treaty is followed, nine-tenths or more of your problem can not be solved.

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Whether or not you agree with all of my statements, you will believe me when I say they have been offered in the friendliest spirit. I have come to have a real love for the Rio Grande, perhaps because its problems are so baffling, perhaps because if we can solve them, step by step, it will mean so much to so many.

Mr. Robertson:
In getting the National Resources Committee to make the investigation, just how do we proceed?

Dr. Barrows:
In the first place, what the Committee could do would depend upon whether the requisite co-operation could be obtained. The Committee certainly would not go into this matter unless all interested parties cordially wanted it to do so: the people of Texas, the people of the lower valley especially. Many agencies are involved; The International Boundary Commission, the State Department, and others.

Then there would be the question of funds. I don't know how much such an investigation would cost. Frankly, I think Texas should make an equitable contribution, just as it did to the investigation of the upper basin. But I think the bulk of the cost, which let me say, roughly, might be some $200,000.00, should be contributed by the federal government. The problems are not only interstate; they are international. The river is already the subject of a treaty. The federal government is directly interested in many intimate ways. This river is an international boundary from here to the Gulf, and the problem it presents to the United States can not drift indefinitely. These problems tie in with those of the Colorado. It is natural and reasonable to expect the federal government to carry most of the load.

I repeat, the Committee's willingness and ability to help you would depend fundamentally on your desire to obtain its help. If such a desire exists, I believe that action could well be requested by your governor, as I have suggested; and if he requests Secretary Hull to ask the National Resources Committee to act in this matter, in principle as it did in the case of the upper Rio Grande, I believe it could be arranged.

Mr. Harwell:
Wouldn't it be possible, under any such investigation, to utilize the data already existing?

Dr. Barrows:
Certainly those data would have to be obtained and utilized. New data also are needed.

Mr. Harwell:
These sections would have available, by this investigation, for the first time a thorough and comprehensive picture of their situation, so that their requirements and needs would be definitely set forth, and the solution of their problems would get under headway and proceed on a definite and scientific basis. But would these data stand up before the Congress?

Dr. Barrows:
As far as I am able to judge, yes.

Whatever any one may think, theoretically, as to the division of the Rio Grande into sections, certainly now the area below Fort Quitman should be planned for and dealt with as a unit—not one part of it by itself, in disregard of some other section. What we have got to have in some way is an integrated, comprehensive, clear and logical setting forth of the problems on the American side, both with respect to the Rio Grande and the Colorado, before we can negotiate successfully with Mexico.

Mr. Robertson:
Just how long, in your opinion, would it take to get a report of such an investigation?

Dr. Barrows:
I am frank to say I don't know. We underestimated the time in the case of the upper Rio Grande joint investigation. We began that in December, 1935—that is, it was agreed upon at that time, and we had it under way, everything planned, the various phases of the investigation assigned to the several investigating agencies by the middle of February, 1936, and we hoped to submit the report, as I remember it, very early in 1937. As a matter of fact, however, it was July or August, of that year, before we were able to put the report in mimeographed form in the hands of the Compact Commission, and the Commission had to get along with that. The report, printed in two volumes, has been released at the White House within the last ten days, I believe.

I should think the work on the lower Rio Grande, after the money is made available and the machinery set up, could be completed in a year. That's just a guess; it may be too low.

Mr. Robertson:
Is anything like this being done on the Colorado? Could we correlate the two?

Dr. Barrows:
Oh, yes. Various studies have been made and various helpful things are now being done, much more will be done. I am very optimistic that the problems of the two rivers, on the American side, can be worked out in reasonable time in preparation for treaty negotiations.

As Mr .Clayton well knows, and Mr. Harwell, there were times when all of us were almost in despair of the compact concerning the upper river. But as we went along, the hurdles were successfully surmounted, one by one. Everybody worked toward that one great aim: not the Compact Commission, alone, but also the engineers and the lawyers, just as patiently, just as arduously. And so did the representatives of the National Resources Committee. All contributed to the happy outcome. The same thing should be done in this case: all should work and strive together for a treaty with Mexico and the equitable solution of the problems we are here considering.

Mr. Mead:
In order to get anywhere we must have some plan. We can't just go ahead each in his own way. I would make a motion that each one of the counties or the districts represented select a member of a committee and that that committee be vested with authority to act for these people in the various suggestions Dr. Barrows has made. And I think the other counties or districts ought to be invited, so we can have all the people represented. I have in mind Mr. Robertson to act as chairman and have each place name a member to report to him and take part in the organization necessary. We have learned enough here today to make that start. I think Mr. Clark can get a report of everything done here and get that report before all these people. That will give them something to read and study while the committee is getting together. Then we can request the Governor to take up with the State Department the suggestion that the National Resources Committee make the investigation. I don't think we ought to wait two or three years before we begin this business. Some of us may starve to death before that time. This committee might do something temporary to save the situation down there, give us some temporary relief. I just drop that out as a suggestion. Each member of the committee can get definite, detailed information of his district or section, and before we know it we will have something tangible to go on.

Mr. Muller:
I know more about this problem now than when I started up here, a lot more, and I think Dr. Barrows' suggestion is the only solution.

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It seems that the International Boundary Commission has already suggested three dams. Now, where did they get their information to base that on? I do know that they suggest one dam in the northerly part of Webb County, another down by Roma, and a third in the Big Bend. Where did they get their information? How did they arrive at those locations?

The Chairman:
I suggest the answers to your questions can be got from Mr. Lawson.

Mr. Muller:
It seems as if a lot of ground-work has already been done. This organization Dr. Barrows represents, if they can get in and further the work along, it looks to me like we can get somewhere.

Mr. Barrows:
We have available all data compiled by the International Boundary Commission.

Mr. Muller:
They are bound to have something pretty important, to be able to figure out three dams and three locations.
Those dams, if ever they are built, will help us down below. Whether they will help Presidio, I don't know. All that of course can be worked out. They would take care of Maverick County, all right.
I can't speak for everybody, but I can almost assure you that we are willing to go down the line with you.

The Chairman:
I agree the first point of approach is to get the very information you have just referred to. I don't purport to speak for the International Boundary Commission but I believe they have in mind certain projects which would serve as a starting point, to say the least, for a solution of your problem.

Mr. Muller:
I believe the State appropriated $35,000 for an investigation of the areas below Fort Quitman.

Mr. Robertson:
The didn't appropriate anything. We asked ther for $35,000 but we didn't get it.

Mr. Muller:
It's going to take a good many years to get any treaty with Mexico, so we had better get started.

Mr. Ivey:
Mr. Chairman, I wish to express the opinion that the Boundary Commission at the present time has one of the best qualified engineers in the whole country. He knows the problems of the whole Mexican boundary line, from the Pacific to the Gulf. I personally believe he is the best engineer in our country. We have watched his work for many years, and we know that he is eminently qualified. He is vitally interested in the solution of the Rio Grande problems, and the data he has worked up will be of great assistance in the solution of this particular problem. All of us who know him are thoroughly convinced that you gentlemen will have his whole-hearted co-operation. You would get wonderful ability in Engineer Lawson.
I just rose to point that out to those of you who may not be acquainted with Mr. Lawson and his ability.

Mr. Barrows:
In order to get the maximum efficiency of effort, you should, in my judgment, first have your Governor request the State Department to ask the National Resources Committee to take on this necessary investigation.

Mr. Muller:
It seems like our representative up in Washington, Mr. West, is very familiar with our problems. He has been working with us for a long time, has been fighting for us up there. Wouldn't his experience and familiarity with our problem be of advantage in taking this to the State Department?

Mr. Robertson:
Answering that question, Mr. West has been and is, and so have both our senators, working on this thing. But I think Prof. Barrows' suggestion that it should come from the Governor, who is the head of the State, is the best plan. Governor Allred knows a good deal more about this than some of you might think. We have been digging into him for the last year or so. We could ask Mr. West and Senator Connally to supplement the Governor in this matter.

Mr. Muller:
Mr. Clayton, I don't think there are enough delegates here to represent all the water users. Don't you think, though, that we should delegate somebody to ask the Governor?

The Chairman:
I don't know the extent of your authority. It seems to me that the lower Rio Grande is well represented. Certainly your people intended to confide in you a certain measure of discretion, and whatever action you take here, whatever action you feel should be taken, it seems to me would have their fullest co-operation and approval.
I feel deeply grateful to Dr. Barrows for the aid and suggestions given here. It seems to me, if I may speak personally, that enough has been said to give you the right approach, the common-sense approach, to the solution of your problem, and you can do a lot more if you will pull together than if you expend your efforts separately, whether as individuals or as districts or associations. In my individual or personal capacity, I stand ready to do all that is in my power to expedite matters.

Mr. Kirkpatrick:
We came up here to reach an agreement with these upper districts with reference to releasing a certain amount of water to Fort Quitman. We have completely got away from that purpose. This general matter of course concerns us all, but our chief concern just now is to get an agreement that the supply of water below Fort Quitman wil not be further impaired.

Mr. Harwell:
As I said awhile ago, we have no way of making a guaranteed delivery.

Mr. Kirkpatrick:
Of course the question of delegating or appointing a committee to take these matters up further through the Governor and the State Department is perhaps a matter of greater concern to the lower valley than to these people here. The suggestion that you appoint a committee, I think perhaps that is something we should decide on among ourselves.

The Chairman:
As I said, I don't know what your authority is. As you say, your authority may be confined to this particular purpose, that of getting an agreement from the upper districts. The point that appeals to me, however, is the suggestion of Dr. Barrows. That appeals to me as being the best, the most logical approach to your problem.

Mr. Kirkpatrick:
As Dr. Barrows suggested, we should perhaps arrange for finance before going to the State Department. I don't know if I can speak for Mr. Robertson and the others. They will probably have to go home and take it up with their people.

Mr. Muller:
Yes, it looks like the expense will have to be looked after first.

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Mr. Kirkpatrick:
We might get together in reference to the appointing of a committee to confer with the Governor.

Mr. Muller:
You might make the request of the Governor through Mr. Clark or through Mr. Anderson.
We are losing our chance to talk these fellows out of that water.

Mr. Kirkpatrick:
No, my point was . . .

The Chairman:
Permit me to make a suggestion: while it is entirely out of my jurisdiction, from a practical standpoint, if you intend to pursue this line and have in mind the question of finances, the first thing to do is get an organization; then, ask the Governor to make the request of the State Department; next, after your organization is set up, get an estimate of the costs of the entire investigation, with the amounts to be allocated to the various interests. You will then be in a position to go to the Legislature and the Governor and ask for an appropriation. You can say, Here is the proposition from the National Resources Committee: our share is so much; they will stand so much; and now we ask you to appropriate so much. Until that time comes, until you have some definite understanding, an estimate of the costs, an estimate of the time it will take and the extent to which it will go, you have nothing tangible.

Mr. Barrows:
What Mr. Clayton has suggested is in principle just what we did with the upper Rio Grande.

Mr. Scoggins:
When we were in our fight against Colorado we had to have a large amount of engineering data. The State of New Mexico wouldn't pay for it. We had to go up and down the river collecting our data, and as far as this discussion here today goes, I haven't heard anybody say anything about the engineering data that will be needed. For instance, who knows what has been passing Fort Quitman for the past several years? Who knows whether the stream has been increasing or decreasing? What hydrographic data do you have up and down the river, from Fort Quitman to the end?

The Chairman:
As far as data at Fort Quitman is concerned, there is a gaging station there. What may be needed is engineering information down below.

Mr. Scoggins:
Isn't there about a thousand miles of that river? It would take a whole lot of time to go over all that.

Mr. Robertson:
I presume, gentlemen, I am more responsible for this meeting than any other man here. I was at two meetings of the Compast Committee, at Santa Fe. I was up here at a meeting with the Texas section of the Commission just after the first engineers' report was submitted. I came up here with the view, not of making a fight on anybody, but to agree, to get what we want by co-operation. I went to Eagle Pass with Charlie Clark, chairman of the State Board of Water Engineers, to get them down there to get together. We drove nearly 4- or 500 miles telling them what we had to tell them about this meeting up here today. We told them the compact had been signed by the three commissioners and the representative of the United States Government, that it was up for ratification or would be at the next session of the legislature, and was required to be approved by the Congress, and that we thought somebody ought to come up here and enter some discussions about it. I am very happy at the conclusion and outcome of this meeting. Laredo, Eagle Pass, Presidio — some of those places — haven't taken a lot of interest in this compact. Now we are certainly getting a lot of first-hand information from the discussions, pro and con.

When we left Eagle Pass we drove down to Laredo. We asked the secretary of the Chamber of Commerce to get a representative bunch of the Laredo people together. There is no organized irrigation district there. We asked him to call them together at ten o'clock on a certain morning. He had there some ten or twelve men, members of the agricultural committee of the Chamber of Commerce. We didn't have much time at Laredo. We didn't talk with the people at Presidio, at all, but we did tell them we were trying to get some such meeting as this and wanted some representative from every section of the river, where we could wash out our differences. We didn't some up here to unload our pack of troubles or to pick a fight with anybody, but to try to learn something, to work out the problems that confront us. We are pleased with the reception we have met with from Mr. Clayton, from the Elephant Butte Irrigation District of New Mexico, from the El Paso Water District, and from Mr. Fiock, over there, of the Reclamation District. We came up here in a co-operative spirit and not in any antagonistic spirit.

Mr. Muller asked about prospective dams up the river. I said I didn't know of any, but I think he had confused in his mind the dams you spoke of in the lower river. Those three dams that you mentioned, that the Boundary Commission were working on, are the outgrowth of some ten or twelve years' work, first by the International Water Commission created in 1924, but the Mexicans declined to appoint a commissioner until 1927. Beginning with that year, the International Water Commission gathered quite a considerable volume of data, published a report, with all manner of maps and charts outlining the cultivated areas, the areas under some manner of irrigation or water appropriations, the prospective area that might be irrigated, the number of acres under any manner of development. And I think the same things were done in Mexico. About 1932 Congress saw fit to consolidate the International Water Commission with the International Boundary Commission. Dr. Elwood Mead was a director. Mr. Lawson, Lansing H. Beach, and W. E. Anderson were the three commissioners. About 1932, after making this report, the three commissioners resigned, and President Harding appointed L. M. Lawson as Water Commissioner and as Boundar Commissioner, so he did double duty. So, over a period of ten or eleven years somebody has been gathering data on the uses of water along the Rio Grande, and most of them are available in Mr. Lawson's office. Excerpts from the compilation of those data I have seen, and from it you can find that they determined the proper regulation of this stream was to dam the river about midway between Eagle Pass and Laredo for the main storage reservoir, again at Salineno, down in Starr County, more of a regulatory dam, then to put one somewhere in the Big Bend. Besides the selection of those dam sites, the Commission had certain surveys made as to the storage capacity of the reservoirs to result. They also investigated the possibility of putting a dam across the stream at Candelaria.

This whole thing I think hinges on a treaty with Mexico. Our people of the lower Rio Grande valley are in the attitude that what we want is water. We don't care how we get it, so we get it. If it is necessary to jump through a hoop, all right. We will do it. We are willing to co-operate with anything and anybody that will do anything we believe will further our interests. The Rio Grande flows around 4,000,000 acre-feet annually that pours into the Gulf of Mexico that nobody gets any benefit from. Of course a lot of that comes when we don't want it down there and you don't want it up here. In certain years there are floods

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that are a menace, and, as has been pointed out, there are quite numerous violations of our treaty with Mexico, and it is absolutely essential that we have storage. Without storage, we are sunk. We are ready to do anything to advance treaty negotiations with Mexico. I have been working on this thing personally for twenty-one or twenty-two years. I haven't got discouraged yet. A few weeks ago somebody said to the Vice-President: "How is the situation on the Rio Grande?" Mr. Garner said, "Just like it was ten years ago, six months ago."

Mr. Scoggons:
I don't believe you want our water.

Mr. Robertson:
If you would keep your salt along with your water, you would be welcome to it.

Mr. Harwell:
There is one thing I should like to make absolutely clear: I have been back to Washington frequently, and I know the attitude of the people on the Colorado. As Mr. Kirkpatrick said a few moments ago, if you had dams you wouldn't be up here about water. Now here is the situation: it isn't Mexico that is standing in your way. It is the basin States on the Colorado. You can leave Mexico out. Mexico wants water from the Colorado just as bad as you want water from the Rio Grande. What agency is capable of taking the action necessary to work this out? In times past, in all our experience, there never has been an opportunity such as you are presented with today. I am saying this from my heart, without any effort to get you to do something against your real interest. Fortunately, the National Resources Committee is represented here, and that committe can do something with those fellows there. Not you nor anybody else, not even the Boundary Commission can hope to accomplish, in my opinion, what that Committee can easily do, and I think that you should feel that you are fortunate in having available a federal agency able to control such a wide influence, not only on those people in the departments and bureaus at Washington, those able to do something about your problem, but also on the people there in the seven basin States. I really believe that in a reasonable length of time the National Resources Committee could effect a treaty between Mexico and the United States that would compose all the differences among those people on the Colorado and all these problems would be solved. I mean that sincerely.

Mr. Kirkpatrick remarked that you certainly want to avail yourselves of the services of the National Resources Committee, so why not get together, name a steering committee, follow the advice of some of the speakers here about how to proceed, and then if you want to talk matters over with us any further, we shall be glad to get together again tomorrow.

Mr. Robertson:
I want to go down the river and see both sides at first-hand.

We came up here to ask you gentlemen for an agreement. I take it for granted that your explanation why you con't enter into such an agreement is perfectly reasonable. I don't believe you could if you would.

But I would like to ask Mr. Fiock about the quantity of water he has been releasing for the last three years. I understand you have been using very considerably less than you actually needed. If you are to use more, there will naturally be more to flow back into the stream.

Mr. Fiock:
Yes, the more water used, the more the return flow.

Mr. Robertson:
And the more you use the less salt there will be in it. If you apply more water to your own land, that naturally increases the flow at the lower end. Is that right? I got that idea from Raymond Hill. You had in 1936 only 102,000 acre-feet at Fort Quitman.

Mr. Phillips:
That was in 1935. We started the year with one-half year's water supply.

Mr. Robertson:
What I had in mind was, if you have the water and apply more to your district, would you come somewhere near utilizing all that you are entitled to regularly?

Mr. Fiock:
If we required the use of more water, the prospects are we would use the full allotment, that is we would automatically release the full amount.

Mr. Robertson:
That is what I was getting at. If we can't get a verbal or written agreement, would you, to the best of your ability, co-operate so as to release as much as possible and let it go on down the stream?

Mr. Fiock:
We will use all we are permitted to use out of Elephant Butte, that could safely be let out of the reservoir. The drainage water resulting from that use and augmented from the runoff during rainy season would be what would go past our project.

Mr. Robertson:
What I am trying to get at is the question of co-operation—not to pin you down to any definite quantity but to . . .

Mr. Fiock:
Anthing that is done that would affect this project must of course be concurred in by the two irrigation districts and other interested parties. It would take the concurrence of the three agencies—the two districts and the Bureau of Reclamation.

Mr. Phillips:
We will co-operate to the full extent of our ability.

Mr. Harwell:
From a purely selfish interest, as far as the district at El Paso is concerned, it is necesary to pass excess amounts of water in order to maintain the salt balance. We are concerned about the salt balance, so it naturally follows that our interests are not adverse to yours when it comes to a matter of passing water down to the lower areas. We need to pass plenty, unless we are circumscribed by the balance in the reservoir.

Why wouldn't it be desirable for you gentlemen to get together and talk with two or three of us some time before you leave, and see whether or not there is anything else we could contribute to this situation, and if any of you want to go down or up the river to see those diversions or the new works upstream, or anywhere else, we will make transportation available to you.

The meeting was then adjourned.

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J. H. McBROOM FRANK B. CLAYTON

LAW OFFICES
McBROOM & CLAYTON
BASSETT TOWER
EL PASO, TEXAS

August 3, 1938

Hon. Homer L. Leonard,
McAllen, Texas

Dear Homer:

On May 27 last a meeting between representatives of water users on the Rio Grande below Fort Quitman, on the one hand, and representatives of the irrigation districts under the Rio Grande Project and of the Bureau of Reclamation, on the other, was held at El Paso. I arranged this meeting at the request of Mr. W. S. Robertson, of San Benito, who is secretary of the Water Conservation Association of the Lower Rio Grande Valley, and, likewise at Mr. Robertson's request, presided over the meeting as chairman. The purpose of this meeting was to discuss a possible arrangement or understanding with reference to the amount of water in the Rio Grande to be permitted by the upper districts to flow past Fort Quitman. Mr. Robert H. Kirkpatrick, an attorney, of Mercedes, attended the meeting as representing the water districts in your county.

I am enclosing a copy of the printed transcript of the proceedings of this meeting, with the hope, for reasons which I shall presently explain, that you will take an opportunity to read it.

I know that you are interested in the Rio Grande Compact and in the conflict among the States of Colorado, New Mexico, and Texas over the waters of the Rio Grande. This conflict, as you know, has existed over a long period of time, and to resolve it the Compact, after months of negotiation, was entered into. Your interest in these matters has been manifested in the past by the very generous aid you have given me as Rio Grande Compact Commissioner, not only in connection with the compact negotiations, but also in connection with the lawsuit against New Mexico. This litigation so far has cost the State and the irrigation districts most vitally concerned more than $100,000.00. It is now stayed, pending the action of the Congress and the three state legislatures with reference to the approval and ratification of the Compact.

I also know that you are interested in these questions from the standpoint of your own district. We all understand that the lower Rio Grande valley is in a very precarious

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condition with respect to its water supply and that in the very near future steps are going to have to be taken to rectify this situation.

It is for all these reasons that I am writing you.

Your attitude towards ratification of the Rio Grande Compact will be influenced, I know, solely by the consideration of what you believe is for the best interest of your constituents. And regardless of what that attitude is or may be, I very much desire that you shall be in possession of all the facts; and I know that when you do have all the facts before you the conclusion you reach will be a fair one.

Towards the latter part of the negotiations among the commissioners for the three States, the meetings were attended by representatives of the lower Rio Grande valley interests. The final meeting was attended by Mr. Clark, Chairman of the Board of Water Engineers, Mr. Robertson, and Mr. A. L. Montgomery, of San Benito. It was the opinion of every one of the Texas representatives attending the meeting that by the Compact Texas secured all that she was entitled to, and, indeed, all that could physically be delivered to her. And I knew then of course, as I do now, that a difference of opinion existed between the upper and lower water users in Texas as to whether the districts under the Rio Grande Project were obligated to deliver any water past Fort Quitman and if so, the amount. But we felt that this controversy (if the difference had then reached the stage where it could be so termed) was a matter for internal negotiation, and that its injection into the negotiations for a permanent compact would gravely prejudice our case and perhaps result in the collapse of the negotiations. Obviously, Colorado and New Mexico could not be asked to guarantee that any certain quantity of water would be delivered to any particular locality in Texas. Their only responsibility was to see that Texas' equitable share was delivered at the state line, or, rather, delivered into Elephant Butte reservoir, which is the point of control.

It seemed to me then that there was some attitude on the part of certain individuals in the lower Rio Grande valley to predicate their support of the ratification of the Compact by the Legislature upon a successful termination of their differences with the two upper districts. Or, to put it in another way, there seemed to me to be an indication that if their claims were not conceded by the upper districts, the lower water users would oppose ratification. This attitude, if it in fact exists, seems to me unwise from every viewpoint:

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THE UNIVERSITY OF TEXAS AT AUSTIN

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Concededly, Texas received in the Compact everything she was entitled to receive, and perhaps more than she could get as a result of litigation, which would inevitably follow the defeat of ratification. Obviously, the lower districts could not profit by this.

If a solution of their mutual difficulties could not be arrived at by negotiation and the representatives of the lower districts feel that their rights were being invaded by the upper districts, there are forums in which these matters can be settled authoritatively. Most assuredly, however, these issues are quite foreign to any question of ratification of the Compact. Ratification or non-ratification should be based solely upon a consideration of whether Texas, as a State, was getting, by virtue of the Compact, all she was entitled to or even more than she could get as a result of litigation, taking into consideration the time, effort, expense and hazards involved in the latter very unsatisfactory way of settling these interstate difficulties. If the Legislature is satisfied that Texas has made a good bargain, then I can not see how any intrastate disagreements should be allowed to influence its action.

I hope and firmly believe that the meeting here on May 27 clarified this situation and that whatever hostility may have existed prior to the meeting now no longer exists. It seemed to me that when the gentlemen representing the interests below Fort Quitman left El Paso their attitude was one of friendship and coöperation, and that many things had been made plain to them that were not understood before. My impressions seemed to be confirmed yesterday, when Judge Oscar Dancy, of Cameron County, called at my office to discuss the very serious water problems of the lower Rio Grande valley.

You may be sure that I thoroughly appreciate how very serious these problems are. I also want to assure you that if I can be of any service in helping to solve them, I am yours to command.

Judge Dancy assured me that it is not his attitude, and he does not believe it is the attitude of others in the lower valley, to seek to defeat ratification of the Compact simply because a difference of opinion exists as to the relative rights of the upper and lower valley water users. This is the same as the feeling expressed by many of the gentlemen attending the meeting on May 27, and I hope it is the universal feeling among your constituents.

I am frank to say that I do not believe that even a partial solution of your difficulties lies in an agreement

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as to any guaranteed delivery past Fort Quitman with the upper districts. In the first place, because of the small quantity that can actually, physically be passed and the very poor quality of the water, the amount which you could beneficially use twelve hundred miles below us would be infintesimal, some 200,000 acre-feet passing Fort Quitman annually (the past ten-year record) as against some 3,500,000 to 4,000,000 discharging annually into the Gulf, unused, in normal years. And, irrespective of any agreement, the consensus of engineering authority is that at least this amount (200,000 acre-feet) will necessarily continue to flow past Fort Quitman, and very probably will be increased, rather than diminished, if the supply to the reservoir is made more certain by the ratification of the Compact. Some discussion of this point was heard at the meeting (see p. 25 of the transcript).

The insuperable obstacles that lie in the way of any such guaranteed delivery were fully explained at the conference of May 27, and it is for this reason, as well as for the many others, that I should very much like for you to read this transcript or, at any rate, the particular portions I have marked and to which I shall refer below.

Mr. Robertson, the man primarily responsible for the meeting, who represented the districts in Cameron County, said: "We came up here to ask you gentlemen for an agreement. I take it for granted that your explanation why you can't enter into such an agreement is perfectly reasonable. I don't believe you could if you would."

The history of the matter is pretty well set out on pp. 10 and 11, and 15 to 19 of the transcript. On pp. 18 and 19 you will find some statements bearing upon the question of whether ratification of the Compact should not be considered quite independently of the situation in the lower valley. On pp. 19 to 22 you will find a discussion by Dr. Harlan H. Barrows, of Chicago, a member of the Water Resources Committee of the National Resources Committee, who was responsible, more than any one else, for the Rio Grande Joint Investigation, which cost the United States and the three compacting States (but especially the United States government) the sum of $400,000.00, and upon the basis of which we were finally able to negotiate the Compact. Pp. 24 and 25 will show you pretty well the spirit of the gentlemen attending this meeting at the time it adjourned. These excerpts in particular I wish you would read. They summarize the situation, and I feel that when you have read them and discussed

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them with the men down there who were present at this meeting, you will agree that the question of ratification should be decided on the merits of the Compact alone, and not upon any possible conflict of interests within the State. In truth and in fact, I believe you will satisfy yourself that there are not in fact any conflicting interests. In any event, as I think you know, I hold your views in very high esteem, and I am grateful to you for the unfailing assistance you have given me in the past.

It seems to me that Dr. Berrows pointed out the real solution of the difficulties of the lower valley. Primarily, you need storage on the Rio Grande. But to get it, we must have a treaty with Mexico. To get the treaty will probably require that the Colorado and Rio Grande water problems be treated together, and this will demand a very extensive investigation on both rivers. I know of no other federal agency than the National Resources Committee which commands both the prestige and the funds to undertake the huge task this would be. And, since the National Resources Committee spent a large sum of money in connection with the Rio Grande Joint Investigation in an effort to facilitate a mutual understanding among the three States, its attitude will hardly be friendly now to any State defeating the Compact by non-ratification.

I should be very glad indeed to go to Cameron County, to go into these matters with you thoroughly if you think it desirable. In any event, I should appreciate having an expression from you, without intending in any way to embarrass you or commit you to any particular course of action when the Compact is up for ratification. I understand of course that the interests of your constituents come first, and I am hopeful that when you have thoroughly reviewed the matter, you will reach the conclusion their interests will be best subserved by the ratification of the Compact.

With kindest personal regard and best wishes, I am ever

Sincerely yours,

Frank B. Clayton
Rio Grande Compact Commissioner for Texas

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Entire box

October 4, 1938

Mr. Sawnie B. Smith,
Edinburg, Texas

Dear Mr. Smith:

This will acknowledge receipt of your letter of September 29.

The question of where the point of division of the waters of the Rio Grande as between Texas and New Mexico should be fixed has been the subject of a great deal of study ever since the original Rio Grande Compact Act was passed, in 1928. It was decided prior to the signing of the temporary compact that New Mexico's obligations as expressed in the compact must be with reference to deliveries at Elephant Butte reservoir, and this provision was inserted in the temporary compact. The reasons for it are numerous. In fact, the obstacles in the way of providing for any fixed flow at the Texas line were considered insuperable.

The Rio Grande Project, as you know, is operated as an administrative unit by the Bureau of Reclamation, and the dam and releases from the reservoir are controlled by the Bureau and will continue to be at least until the federal government is repaid its investment, and very probably even beyond that time. Obviously, neither Colorado nor New Mexico could be expected to guarantee any fixed deliveries at the Texas line when the operation of the dam is not within their control but is in the control of an independent government agency.

Moreover, measurements of the waters passing the Texas state line would be very difficult and expensive, if not impossible. This, for the reason that irrigation canals, ditches and laterals cross the line, which is of a very irregular contour, at many different points, carrying water in addition to what is carried in the river, itself, and it would require continual measurements in these various channels to make any reasonably accurate computations of the total flow.

However, the question of the division of the water released from Elephant Butte reservoir is taken care of by

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contracts between the districts under the Rio Grande Project and the Bureau of Reclamation. These contracts provide that the lands within the Project have equal water rights, and the water is allocated according to the areas involved in the two States. By virtue of the contract recently executed, the total area is "frozen" at the figure representing the acreage now actually in cultivation: approximately 88,000 acres for the Elephant Butte Irrigation District, and 67,000 for the El Paso County Water Improvement District No. 1, with a "cushion" of three per cent. for each figure.

I apprehend that there will never be any difficulty about the allocation of this water.

The arrangement just mentioned is of course a private one between the districts involved, and for that reason it was felt neither necessary nor desirable that it be incorporated in the terms of the Compact.

The lands above Fort Quitman and below the Rio Grande Project eastern boundary receive only "tail-end" or waste water, the lands in the Hudspeth County district taking its water by virtue of a contract and the lands privately owned below the district lower boundary only by taking by gravity or pumps what happens to be in the river channel.

The deliveries to Mexico are of course governed by treaty.

I trust this is the information you desire but if there is any other which I can supply, please feel free to call upon me.

With best regards personally, I am

Yours sincerely,

Frank B. Clayton
Rio Grande Compact Commissioner for Texas

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RG 115 FY 13

Bureau of Reclamation
Project Correspondence File
1930 - 1945

Rio Grande Pro.

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Box 927 Entry 7

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301. Rio Grande Project - JAN 1, 1937
BOARD + ENGINEERING REPORTS ON CONSTRUCTION FEATURES

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RG No. 115

301.

RIO GRANDE

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Page	
Williams	
Cheadle	X
Sanford	
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Schnurr	
Colze	
McCulloch	

Airmail — El Paso, Texas — May 22, 1939

From Superintendent

To The Commissioner, Washington, D. C.

Subject: Protest of Hudspeth County Conservation and Reclamation District No. 1 - Rio Grande Project.

1. Reference is made to letter of March 7 to the Commissioner from Mr. Frank B. Clayton, Attorney for the Hudspeth County Conservation and Reclamation District No. 1, and to resolution of the Board of Directors of the District passed at a meeting held on February 10, 1939, certified copy of which was attached to the above referred to letter.

2. The settlement and the development of land in the area now comprising the Hudspeth County Conservation and Reclamation District No. 1 was begun by individual land holders about 1918. By 1923 the point had been reached where it was necessary to obtain improved irrigation and drainage facilities, which the individual land owners were unable to provide, and the area was organized into the Hudspeth County Conservation and Reclamation District No. 1 for the purpose of accomplishing the construction of irrigation and drainage systems. The District is stated to have a total irrigable area of 16,000 acres, but crop report data has shown an area of from 11,000 to 12,000 acres in cultivation.

3. The first endeavor of the District was to be included within the Rio Grande Reclamation Project by petitioning for consolidation with the El Paso County Water Improvement District No. 1. We are unable at the moment to ascertain what action was taken on the District's petition or application for inclusion in the project, but it is our impression that the conclusion was reached after due consideration that the project's primary water supply was not adequate enough to take in the additional acreage, but it was anticipated that there would be delivered to the District under the Warren Act such waste, return flow and developed water as might be available for delivery to the District at the lower end of the project, which was ultimately provided for by a contract dated December 1, 1924. To finance the construction of its irrigation and drainage systems, the District voted a bond issue of $750,000. With this the District constructed a main canal with distribution laterals and a deep well pump drainage system, which proved to be impracticable and has been entirely replaced by an open drain system as land owners could put up funds therefor or as it could be financed from District operation and maintenance funds.

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Copy 223.02 - Hudspeth Co. Consv. & Recl. Dist. No. 1

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Archival Operations
RG No. 115

4. Prior to the organization of the District, an endeavor was made to sign up individual land owners on annual applications and contracts for water, which they diverted from the river under the theory that it was project developed water, and collection of the charges from individuals was more or less successful, but not entirely so. A temporary contract dated August 6, 1924 was executed with the Hudspeth District, providing for payment of water charges for the season of 1924, but the Tornillo Canal not yet having been completed and in operation, it was necessary for the District to take its water from the river below the Rio Grande Project, which it did through several private or community ditch headings which existed before the organization and development as a District.

5. Since the sale of bonds were predicated upon a showing of a water supply for the District, and it being otherwise advantageous to the District to have a more permanent arrangement for its water supply, a contract under the Warren Act was negotiated with the approval of the project irrigation districts. A copy of the contract, which bears the date of December 1, 1924, is attached hereto for ready reference. The basic purpose and intent of the contract is set forth in Article 4 in the premises of the contract which reads as follows:

> "4. WHEREAS, the United States will have available for disposal at the terminus of said Tornillo Main Canal, certain water developed from the Rio Grande project, which water may be used for the irrigation of lands within the district;"

and in Article 6 thereof which reads as follows:

> "Rentals of Water to District.
>
> "6. The United States will deliver to the District at the terminus of the Tornillo Main canal, during the irrigation season of 1925 and thereafter during each irrigation season as established on the Rio Grande project, such water from the project as may be available at said terminus without the use of storage from Elephant Butte reservoir. The Secretary of the Interior shall be at all times the sole judge of the availability of such water. The rental of water hereunder is secondary and inferior to the right to use water for any purpose on the lands of the Rio Grande Federal Irrigation Project. In consideration of such rental the District hereby relinquishes all right, title, interest, and claim to any and all waters of the Rio Grande, except as herein provided."

6. The Tornillo Canal, which was built during 1923 and 1924, was constructed with a sufficient capacity to deliver to the Hudspeth District such waste, return flow and developed water as was considered might be available at the lower end of the project. Construction of the larger canal and the additional cost involved therein was approved and authorized by the irrigation districts of the project in order that beneficial use of such water that was available at the lower

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Archival Operations
RG No. 115

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end of the project might be made and a revenue derived therefrom to the account of the project districts. The entire cost of the Tornillo Canal was and is charged to the construction account of the project districts.

7. Beginning with the season of 1925, water has been delivered to, and the District charged therefor, in accordance with the contract dated December 1, 1924 except for the season of 1931, and each year since then the charges to the District have been fixed and collected under annual contracts supplemental and amendatory to the basic contract of December 1, 1924, the basic contract being impractical of application and not reflecting cost adjustments granted in the project proper.

8. The water delivered to the District at the terminus of the Tornillo Main Canal has not been sufficient to meet the total requirements of the Hudspeth District, and the amount so delivered has been supplemented through direct diversions made by the District from the river at a distance approximately one-third the length of the District below the terminus of the Tornillo Canal, which is the beginning of the District's main canal. Water so diverted has been available in the river from the discharge of the project drains entering the river below the Tornillo Canal Heading, and from such surplus of water as has been in the river at the Tornillo Canal Heading and not diverted into the canal, principally at times when the amount of water in the river at the canal heading was in excess of the capacity of the canal.

9. The Tornillo Canal does not, nor has it ever, supplied the entire needs of the Hudspeth District, the reason for this being the limitations of the capacity of the Tornillo Canal and of the upper portion of the District's main canal, and also the limitations of the amount of water available for diversion through the Tornillo Canal, therefore the necessity for the District supplementing its water supply by diversion from the river of the water made available by the discharge of the drains below the Tornillo Canal Heading.

10. The Tornillo area, extending from Fabens, a distance of twelve miles, to the lower end of the project, and containing an irrigable area of 8,600 acres, comprises the lower unit of the Rio Grande Project, and until the routing of the rectified river channel and international boundary line on the south side of the San Elizario Island, which was completed in July, 1938, the irrigation supply for the Tornillo area was diverted from the river through the Tornillo Canal Heading at Fabens. The Tornillo Canal, extending the full length of the area, a distance of twelve miles, terminates in a waste return to the river, or delivery into the heading of the Hudspeth District's main canal in accordance with operating requirements.

11. Being the last diversion on the project and located below the major project drain outlets into the river, the water available at the Tornillo diversion has contained a high percentage of

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RG No. 115

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drain water and a corresponding low percentage of project stored water. The water users in the Tornillo area have been very reluctant to use the water for irrigation when it is dominately drain water, and they have at times emphatically registered complaints of the water being injurious to crops, particularly to young plants. This phase of the situation has been considerably more persistent due to the emphasis given to the quality of irrigation water in the hearings before the Special Master appointed by the United States Supreme Court in the case of Texas vs. New Mexico. Just to what extent injury may be or has been done by the use of drain water is not definitely known, but the land owners in the Tornillo District are inclined to attribute all of their troubles in connection with soil and crop conditions to the use of drain water. In some instances the difficulty may be inherent in the soil itself. Some of the water users have been emphatically asserting their right to the same quality of water for irrigation as other portions of the Rio Grande Project, or at least the same quality of water as the upper divisions of the El Paso Valley has.

12. It has been the project operating practice to carry enough of the reservoir released water on through to Fabens so that when mixed with the drain water discharging immediately above Fabens, the concentration of dissolved salts will be held to what is considered a tolerance limitation, this being set at not to exceed 150 parts per 100,000, but usually maintained at around 130 parts per 100,000, or ranging between 130 to 150 parts. To obtain this dilution has required approximately a 50-50 mixture of upper valley irrigation water and the drain water discharging immediately above Fabens. To maintain this mixture has produced a total discharge at Fabens about equal to the capacity of the Tornillo Canal, or more than twice the amount necessary for the irrigation requirements of the Tornillo area alone, thus making available water for delivery to the heading of the Hudspeth District Canal at the terminus of the Tornillo Canal.

13. When there has been more water at Fabens than the capacity or requirements of the Tornillo Canal, the surplus or excess which has been allowed to go on down the river under the above operating arrangement, being a mixture of drain and upper valley irrigation water, contains partly reservoir stored water going to waste. Also in the fall, winter and early spring irrigations the above operating arrangement requires as much of the upper valley irrigation water supply reaching Fabens in order to accomplish the dilution of drain water to meet the very limited irrigation requirements with a large part of the mixed water going to waste as is required to meet the requirements during the regular irrigation season. It will be seen that for the conservation of the project's water supply and the improvement of the quality of water delivered to the Tornillo District, there should be some means for the separation or keeping segregated the irrigation and drain water, or mixing it in desired proportions so that when water is wasted, it would be straight drain water, except as a portion of the drain water may be needed to make up the irrigation requirements, unless, of course, the upper valley irrigation water supply available at Fabens is in excess of the requirements.

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RG No. 115

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14. Such separation or segregation of the irrigation and drain water at Fabens could have been accomplished before the change in the course of the river, but at a considerably greater cost than it can be accomplished now. The changing of the river course from the north side of the San Elizario Island to the international boundary line on the south side through the River Rectification Project of the International Boundary Commission has greatly facilitated the practicability of accomplishing the separation of the irrigation and drain water. The construction necessary to accomplish it is one of the objects or items of new work proposed or considered under the contract recently executed between the United States and the El Paso County Water Improvement District dated February 2, 1939, providing for the crediting of certain water rental revenues and the building of additional works, and would consist of the construction of separate channels for the irrigation and drain water from the river drain outlet located approximately one mile above Fabens to the Tornillo Canal Heading at Fabens with necessary crossing structures. There are other features proposed for construction pursuant to the above mentioned contract which have no direct connection with or any way affect the separation of the irrigation and drainage water at Fabens. You are referred to a report prepared by this office as transmitted with letter of April 2, 1938, subject "Additional Construction Work - El Paso County Water Improvement District No. 1."

15. After the works to accomplish the separation of the irrigation and drainage water have been built, there are three possibilities of their operation in supplying the Tornillo area irrigation requirements. For requirements during the normal irrigation season with operations continuing as at present sufficient upper project irrigation supply water (about the same amount as would be required by the Tornillo area if not mixed with any drain water) could be carried to Fabens to dilute the drain water to a tolerance limit of dissolved salts, and there be delivered to the Hudspeth District the excess over the Tornillo requirements. But it might be said that if the Tornillo area is to use mixed water why sho uld any more upper project water be used than just enough that when mixed with the allowable amount of drain water to produce a tolerant mixture would meet the Tornillo area requirements without regard to any of the Hudspeth District requirements. Or, the Tornillo requirements could be supplied from upper project water without any mixture of drain water except during times of acute shortage of the project water supply.

16. Without any basis in agreement or otherwise concerning service to the Hudspeth District, the project management would be constrained to operate the project, and to control and regulate the project water supply to best meet the requirements of the project lands, including the Tornillo area, with the least amount of waste

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RG No. 115
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and without any regard to the requirements of the Hudspeth District. Under such circumstances there would be at the terminus of the Tornillo Canal, and so available to the Hudspeth District, only the unavoidable and uncontrollable waste at the end of the project. That would be wholly inadequate in quantity and too uncertain in time and regularity of availability to be relied upon for irrigation, even of the upper section of the Tornillo District. This the District realizes, and therefore their protest.

17. The total discharge of the drains would probably be adequate in quantity, though it may be questionable in quality, if diversion of it to Mexico can be avoided to meet the Hudspeth District requirements, but none of it can be delivered to the lands in the upper section of the Hudspeth District except by pumping, or by incurring the expense of the extension of their canal heading up into the Tornillo area to divert the drain water originating above Fabens before it reaches the rectified channel of the river at the lower end of the San Elizario Island. It is feasible to carry all of it by gravity to the lower two-thirds or more of the District, but that too would require additional construction to keep it out of the river where it would be available to intervening Mexican diversions.

18. Specifically, the Hudspeth District's protest is against the construction of that portion of the improvements contemplated in the vicinity of the San Elizario Island that have been made possible and desirable as a result of the removal of the river by the Rectification Project, which are for the purpose of effecting a separation of irrigation and drain water, or of their mixture under control as desired, until they have assurances regarding their own water supply. What the District has a right to, or is entitled to expect in its present status are matters involving legal phases. What there is for them and how they can get it are engineering and financial matters to be carefully studied out. The quality of water which may be available and the tolerance limitations in dissolved salts for its practical irrigation use are matters for study and advice of experts along that line. It would appear that considerable study and investigation will be necessary and conferences and negotiations held between the interested parties, including the project districts and their technical and legal advisers before arriving at conclusions.

19. The basic contract now in effect, in addition to having been complicated and difficult of application, is now also inadequate and not applicable to present or future conditions, and a new or revised one seems eventually inevitable. It does not seem, however, that the District has any right or justification to stand in the way of improvements designed for the conservation or improvement of the project water supply, or any portion thereof. If they do have any rights as to the manner of operation or the results thereof, they undoubtedly could have their due and proper recourse in connection therewith.

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RG No. 115

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WASHINGTON, D.C.

20. Some of the matters referred to in the District's protest seem to be extraneous. The amounts paid by the District have, of course, been annual rental or service charges largely representing operation and maintenance items. To be sure, the collections for items representing rental charges for use of project works have been credited to the project districts' installments of construction charges, but that does not necessarily give the Hudspeth District an interest in the works. It is doubtful if the District could possibly gain any prescriptive rights under the contracts, but that is a matter for legal determination. The illegal diversions of water from the rectified channel of the Rio Grande Project, if they are illegal, and the prevention of such diversions are, of course, matters of international concern.

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Enc. Copy of contract
of 12-1-24
Copy of letters from
Irrigation Districts.
In duplicate.
✓Original by regular mail
Copy by airmail

cc-Chief Engineer with copy of encls.
cc-District Counsel with copy of encls.

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RG 267 RECORDS OF THE SUPREME COURT OF THE UNITED STATES

ORIGINAL JURISDICTION CASE FILES, 1792-2005

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Office - Supreme Court, U. S.
FILED
SEP 25 1939
CHARLES ELMORE CROPLEY
CLERK

SUPREME COURT OF THE UNITED STATES

October Term 1939

No. 10, Original

STATE OF TEXAS,

Complainant,

v.

STATE OF NEW MEXICO, ETAL.

FINAL REPORT OF THE SPECIAL MASTER. ff Caps

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SUPREME COURT OF THE UNITED STATES

October Term 1939

No. 10 Original

STATE OF TEXAS

v. Complainant

STATE OF NEW MEXICO, ETAL.

FINAL REPORT OF THE SPECIAL MASTER.

On May 25, 1936, this Honorable Court appointed me as Special Master in the above entitled case, by an Order entered as follows (298 U. S. 644):

> "The motion for the appointment of a Special Master is granted, and it is ordered that Charles Warren, Esquire, of Washington, D. C., be, and he is hereby, appointed Special Master in this cause, with authority to summon witnesses, issue subpoenas, and to take such evidence as may be introduced and such as he may deem it necessary to call for. The Master is directed to make findings of fact and conclusions of law, and to submit the same to this Court with all convenient speed, together with his recommendations for a decree. The findings, conclusions, and recommendations of the Master shall be subject to consideration, revision, or approval by the Court. The Master shall be allowed his actual expenses and a reasonable compensation for his services, to be fixed hereafter by the Court. The allowances to him, the compensation paid to his stenographic and clerical assistants, and the cost of printing his report shall be charged against and be borne by the parties in such proportion as the Court hereafter may direct. If the appointment herein made of a Master is not accepted, or if the place becomes vacant during the recess of the Court, the Chief Justice shall have authority to make a new designation which shall have the same effect as if originally made by the Court herein."

The proceedings and pleadings in the cause have been as follows.

On October 28, 1935, the State of Texas filed a motion for leave to file an original bill of complaint against the State of New Mexico and the Middle Rio Grande Conservancy District (a quasi-municipal corporation

TX_MSJ_005409

organized under the laws of New Mexico). Leave to file was granted by the Court and the bill was filed on November 11, 1935 (296 U. S. 547).

Owing to circumstances hereinafter set forth, it is unnecessary to state in detail the contents of the bill. In general, the State of Texas based its suit on two grounds. First, it contended that the State of New Mexico had violated a certain temporary Compact entered into by the States of Colorado, New Mexico, and Texas on February 12, 1929, regulating the use of the waters of the Rio Grande River — the violations consisting of impairment of the water supply in the Elephant Butte Reservoir built by the United States Government in New Mexico, by excessive diversions and by injurious increase of the salt contents of the water. Second, it contended that such excessive diversions and increase of salt contents were in violation of the irrigation rights of Texas water users under the general doctrines of law laid down by this Honorable Court and by Courts in the States of the Southwest.

On January 13, 1936, the defendants filed a motion to dismiss the bill on the ground (a) that the United States of America and the State of Colorado were indispensable parties; (b) that the Compact of February 12, 1929, relied on by the State of Texas was to expire on June 1, 1937 before the suit could be determined; (c) that specific performance could not be required of any party to the suit not being a party to the Compact. This Court denied the motion to dismiss, on March 9, 1936 (297 U. S. 698).

Thereafter, answers were filed by the defendants on March 26, 1936, which in general denied the facts set forth in the bill, and further alleged that the decrease of water, if any, was due to diversion by the Republic of Mexico in violation of a treaty with the United States, and to wasteful methods of operation of the Elephant Butte Dam system

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and to unlawful diversion of the water, by the United States Government or by corporations under contract with it.

On March 26, 1936, the defendants filed a motion to have the State of Colorado and the United States of America made additional parties to the suit, which motion was denied by this Court on April 6, 1936.

In pursuance of my appointment by this Court on May 25, 1936 as Special Master, I proceeded to hold a conference in Washington, D. C., with counsel for the parties, on August 4, 1936. Thereafter, at their request, I held hearings, between November 6, 1936 and March 20, 1937, in Albuquerque, New Mexico and in El Paso, Texas. I also personally visited the locus involved and inspected conditions on the Rio Grande River, and most of the dams and the drainage systems and irrigation works, for a distance of about 500 miles on the river. At the hearings, testimony of twenty-four witnesses (chiefly engineers, chemists, and scientific experts) was heard by me; and other evidence was introduced by the parties — comprised in sixteen volumes of 3266 typewritten pages, together with 267 documentary exhibits consisting of historical and scientific publications, Government reports, graphs, calculations, statistical tables, maps and charts.

On March 20, 1937, at a hearing in El Paso, Texas, when the complainant and the defendants had completed the introduction of evidence (except rebuttal testimony for the complainant), I notified counsel that conditions had arisen during the progress of the case which I felt should be called to the attention of this Honorable Court before the introduction of evidence in the case should be closed and before I should hear arguments of counsel.

Accordingly, I filed with this Court, on April 1, 1937, an Ad Interim Report, setting forth a general statement as to the circumstances

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out of which the suit arose (to which printed Ad Interim Report, I hereby make reference and make a part of this Final Report), and also setting forth a statement of conditions developed during the progress of the hearings, which I felt should be called to the attention of the Court before any further action in the case should be taken by me. I also called the attention of the Court to the fact that, on the initiative of the Governor of the State of New Mexico, the Legislature of that State had conditionally (subject to similar action by Colorado and Texas) extended the time for the Rio Grande Compact of February 12, 1929 to October 1, 1937, for the purpose of affording to the three States a further opportunity to conclude a permanent Compact prior to the extended date.

In my Ad Interim Report, I recommended that this Court authorize me as Special Master to postpone hearings in the case, at my discretion, until such date after October 1, 1937 and prior to January 15, 1938 as I should determine.

I was impelled to make this recommendation by my belief: (a) that the problems arising out of the conditions set forth in the bill of complaint and in the answers thereto and which had been the subject of evidence by the parties could be more satisfactorily settled by Compact between the parties than by further litigation; (b) that the general problem involved was a broad one, in which three States (rather than the two States parties litigant) were in fact interested, and that the State of Colorado ought to be a party to any such Compact; (c) that satisfactory terms of such a Compact could probably be agreed upon by the engineers of the respective States, provided sufficient time be allowed for arriving at such an agreement.

On April 6, 1937, this Court entered an order authorizing me to postpone further hearings, as recommended by me. On December 30, 1937,

at my suggestion and agreement of counsel for the parties, this Court authorized me again to postpone date for hearings, in my discretion.

During a period of a year after the date of my Ad Interim Report of April 1, 1937, meetings were held by Commissioners and engineers of the States of Texas and New Mexico and also of the State of Colorado, together with a representative of the United States of America. On March 18, 1938, the Commissioners from each of said States signed a Compact, which was approved by the United States representative (copy of which Compact, I annex hereto as Exhibit A).

In my opinion, this Compact reasonably and fairly deals with most of the conditions referred to in my Ad Interim Report and represents a fair and reasonable settlement of the issues and problems presented by the State of Texas in its bill of complaint and by the State of New Mexico and by the Middle Rio Grande Conservancy District in their answers in the present case, and also represents a fair and reasonable settlement of the larger problem of the respective rights of the three States — Texas, New Mexico and Colorado — and of the United States of America, in the waters of the Rio Grande River and (to a certain extent) of its tributaries.

The Compact so signed on March 18, 1938 has been ratified by the Legislature of the State of Colorado, by the Legislature of the State of New Mexico, and by the Legislature of the State of Texas. Subsequently the Congress of the United States of America gave its consent to the Compact by Act of May 31, 1939 (Chapter 155 of the 76th Congress, First Session) entitled "An Act giving the consent and approval of Congress to the Rio Grande Compact signed at Santa Fe, New Mexico, on March 18, 1938."

The case presented by the bill and answers in the pending suit has

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therefore become moot; and the issues involved are, so long as the Compact remains in force and complied with, settled. There appears to be no necessity for further action on my part as Special Master.

Accordingly, I respectfully recommend:

(1) That the bill of the State of Texas be dismissed.

(2) That the costs be divided, one half to be paid by the complainant State of Texas and one half by the defendant State of New Mexico and the Middle Rio Grande Conservancy District.

Since there have been introduced before me in the hearings, much testimony and many technical exhibits of great value, which ought to be preserved in connection with the problems involved in the suit and also in the Compact, I further recommend that the Court direct the Special Master to return to the parties respectively the original copies of record of testimony and the exhibits introduced in evidence before him.

Respectfully submitted,

Charles Warren

Special Master.

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OFFICE OF THE SECRETARY
CENTRAL CLASSIFIED FILES
1937-1953

8-3 Rio Grande--Contracts-Nelson, J.P.
8-3 Rio Grande Flood Control

Box No. 3623

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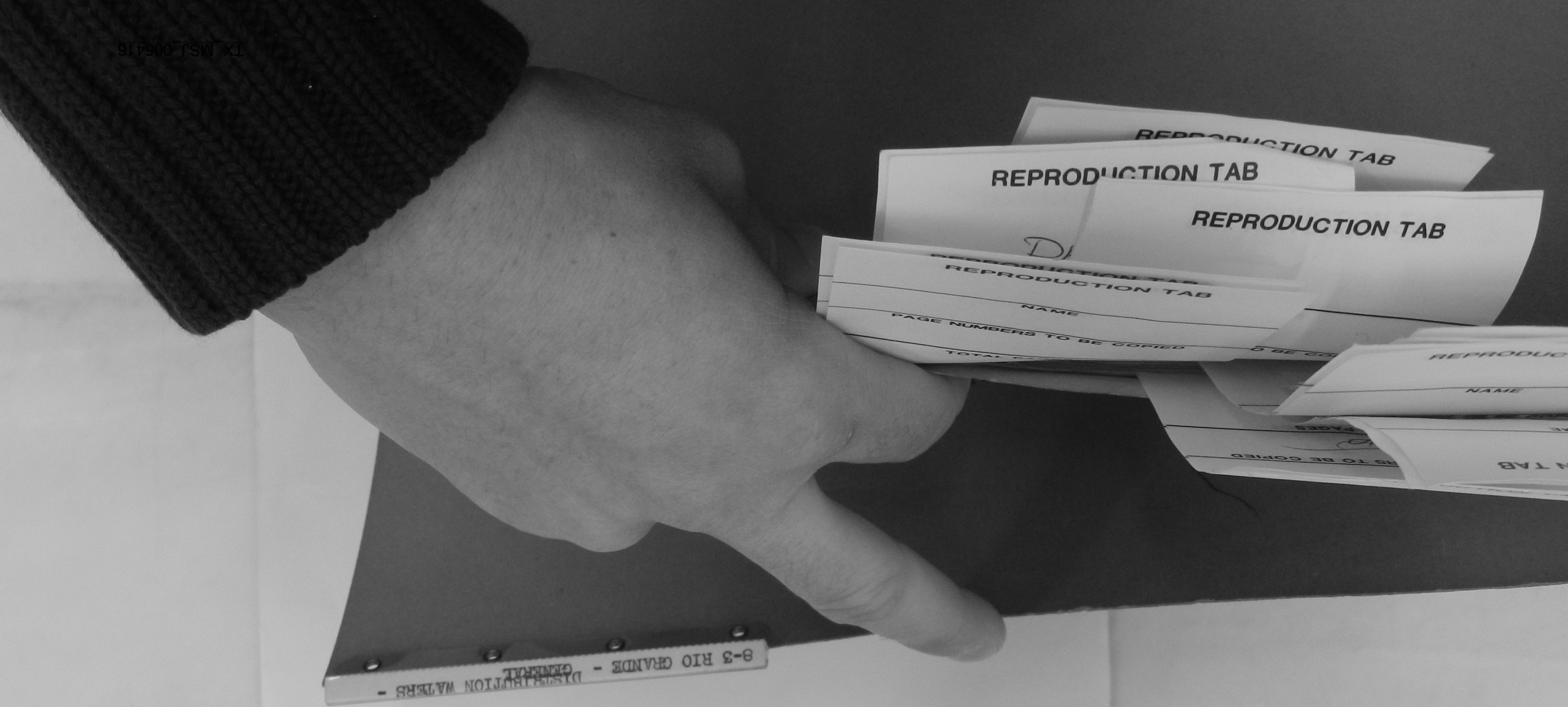

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UNITED STATES

DEPARTMENT OF THE INTERIOR

OFFICE OF THE SECRETARY

File No. 8 3
(Part 8)

RECLAMATION BUREAU

-0-

RIO GRANDE PROJECT

-0-

DISTRIBUTION OF WATERS

GENERAL

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Harold L. Ickes

Secretary.

(Part 8)

January 27, 1937

thru

February 10, 1950

U. S. GOVERNMENT PRINTING OFFICE 6—7385

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Stinson
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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WASHINGTON

OFFICE OF THE COMMISSIONER

FEB 17 1941

The Secretary

of the Interior.

INTERIOR DEPT.
RECEIVED
FEB 18 1941
SECRETARY'S
MAIL CENTER

FEB 18 1941
Office of the
Under Secretary

Sir:

There is enclosed for your approval as to form a proposed contract (El Paso draft 11/18/40, Revised W. O. 1/6/41) among the United States, the City of El Paso and the El Paso County Water Improvement District No. 1 in connection with the Rio Grande Project, New Mexico-Texas.

This proposed contract under the authority of the Act of February 25, 1920 (41 Stat. 451) will provide the City of El Paso with a supplemental water supply for municipal purposes from the Rio Grande Project. The urgency of the City's need for a supplemental water supply is set out in the attached letter from the Chief Engineer of the Bureau to you dated February 12. The Chief Engineer also states that the only other practicable source of water for the City is from the project water supply.

Under the proposed contract the City will acquire not to exceed 2,000 acres of land within the El Paso County Water Improvement District No. 1, and will receive each year subject to certain limitations provided in the contract the same amount of water from the project water supply as would have been received by the lands acquired by the City if those lands were held by private owners qualified to receive water. The City each year will pay to the United States a total sum equal to the aggregate of all the charges and assessments which would have been payable to the District if the lands acquired by the City had been held by individual land owners and received the amount of water in such year as received by the City pursuant to the contract. These annual payments will be credited upon the District's obligations to the United States, as provided in the contract.

The contract is in form satisfactory to the Bureau and the City of El Paso. It is also in form satisfactory to the El Paso County Water Improvement District No. 1 and to the Elephant Butte

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Irrigation District, the two water users' organizations within the project. I, therefore, recommend that the enclosed contract be approved as to form, and that the Bureau's Superintendent at El Paso, Texas, be authorized to execute it on behalf of the United States.

Respectfully,

John C. Page

Commissioner.

Enclosure 2555942.

Approved: FEB 18 1941

(Sgd.) A. J. WIRTZ

Under Secretary.

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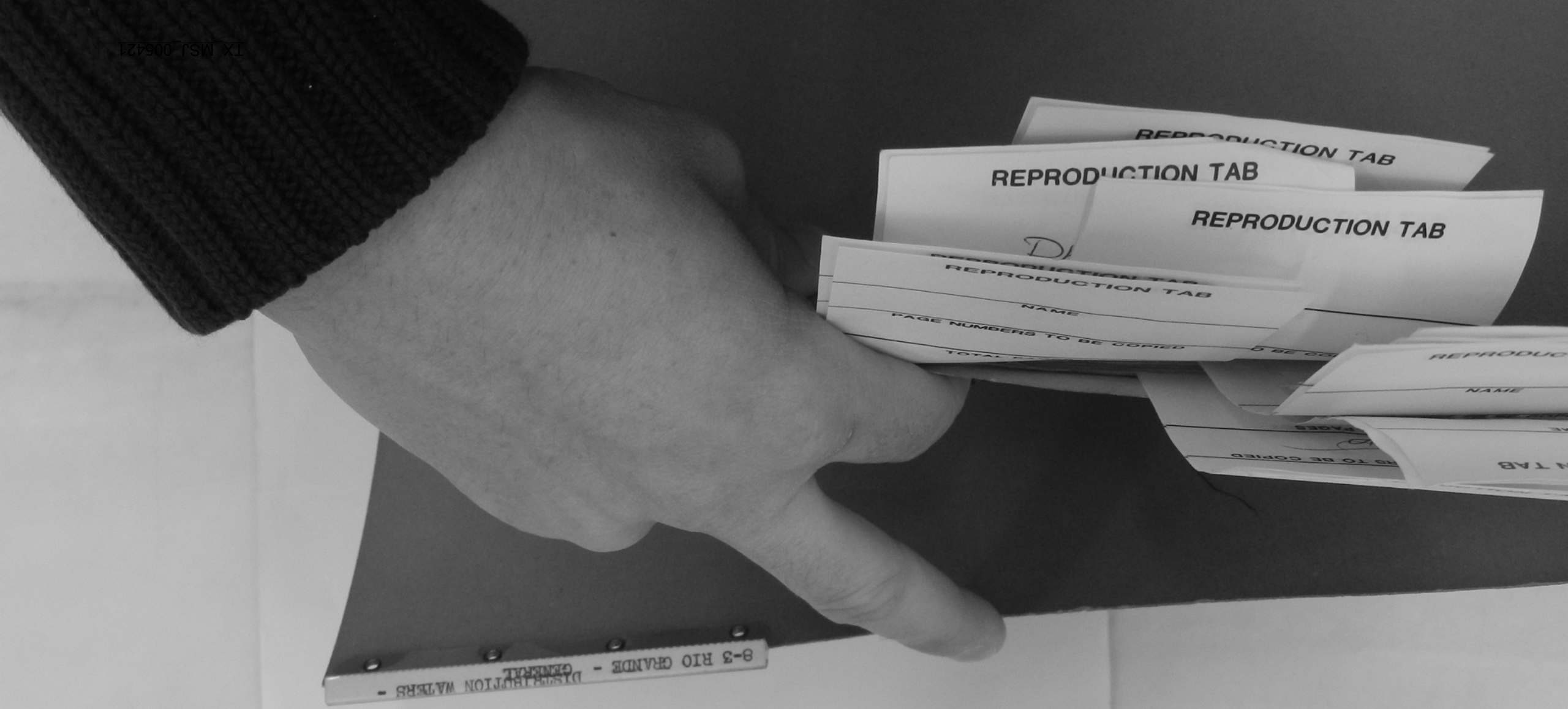

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UNITED STATES

DEPARTMENT OF THE INTERIOR

OFFICE OF THE SECRETARY

File No. 8 3
(Part 8)

RECLAMATION BUREAU

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RIO GRANDE PROJECT

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Harold L. Ickes

Secretary.

(Part 8)

January 27, 1937

thru

February 10, 1950

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Surname:

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Fite
Kelleher
Wakelin

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WASHINGTON

8-3
Rio Grande-
Dist of
water
gen

NOV 22 1944

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NOV 23 1944
SECRETARY'S
MAIL CENTER

OFFICE OF THE COMMISSIONER

INTERIOR DEPT.
NOV 23 1944
SEC'Y.

The Secretary

of the Interior.

Sir:

There is enclosed a proposed contract (D. C. Draft 8-28-44, amended 9-14-44 and 11-4-44) among the United States, the City of El Paso, the El Paso County Water Improvement District No. 1, and the Elephant Butte Irrigation District, to furnish the City of El Paso, Texas, a water supply from the Rio Grande project in order to relieve the City in its present emergency resulting from overdrafts on the ground water municipal water supply.

This proposed contract is in pursuance of the provisions of the Act of February 25, 1920 (41 Stat. 451), permitting the sale of project water for miscellaneous purposes. The increasing need for a supplemental municipal water supply has been recognized for some time, and by a similar contract dated February 18, 1941 and approved as to form by the Department on that date, the City was permitted to acquire up to 2,000 acres of land in the El Paso County Water Improvement District No. 1, and transfer the water rights appurtenant thereto to municipal and domestic use. The attached draft would grant permission to the City to acquire up to 2,000 acres of land in the Elephant Butte Irrigation District also, and would amend the February 18, 1941 contract with the El Paso County Water Improvement District No. 1 to provide for payments thereunder direct to the Districts, rather than to the United States. Payments are to be on the same basis as assessments made against district lands assessed for construction charges payable to the United States, and receipts will be available for payment of contract obligations to the United States.

The Manager of the El Paso County Water Improvement District No. 1 has orally suggested (1) that the definition of Water Right Lands on the second page of the contract form be amended so as to read as follows: "Lands within the boundaries of the El Paso District and the Elephant Butte District, which are subject to the payment of district assessments or charges, to meet the district's obligations to the United States under existing contracts for the repayment of construction costs," and (2) that in the third line of Article 4, "among other things," be inserted after the comma, following "law." These changes are believed to be immaterial.

The draft of contract is in form satisfactory to the Bureau, the City of El Paso, and the two Districts comprised in the Rio Grande project, and it is recommended that it be approved as to form and that the Bureau's Superintendent at El Paso, Texas, be authorized to execute it on behalf of the United States. It is also recommended that the changes listed above, as requested by the Manager of the El Paso District, be authorized, if satisfactory to the districts.



Mailed by
Gould

Respectfully,

J Kennard Chadle

Enclosure 947.

Approved: NOV 24 1944

(Sgd.) MICHAEL W. STRAUS

Assistant Secretary.

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Commissioner.

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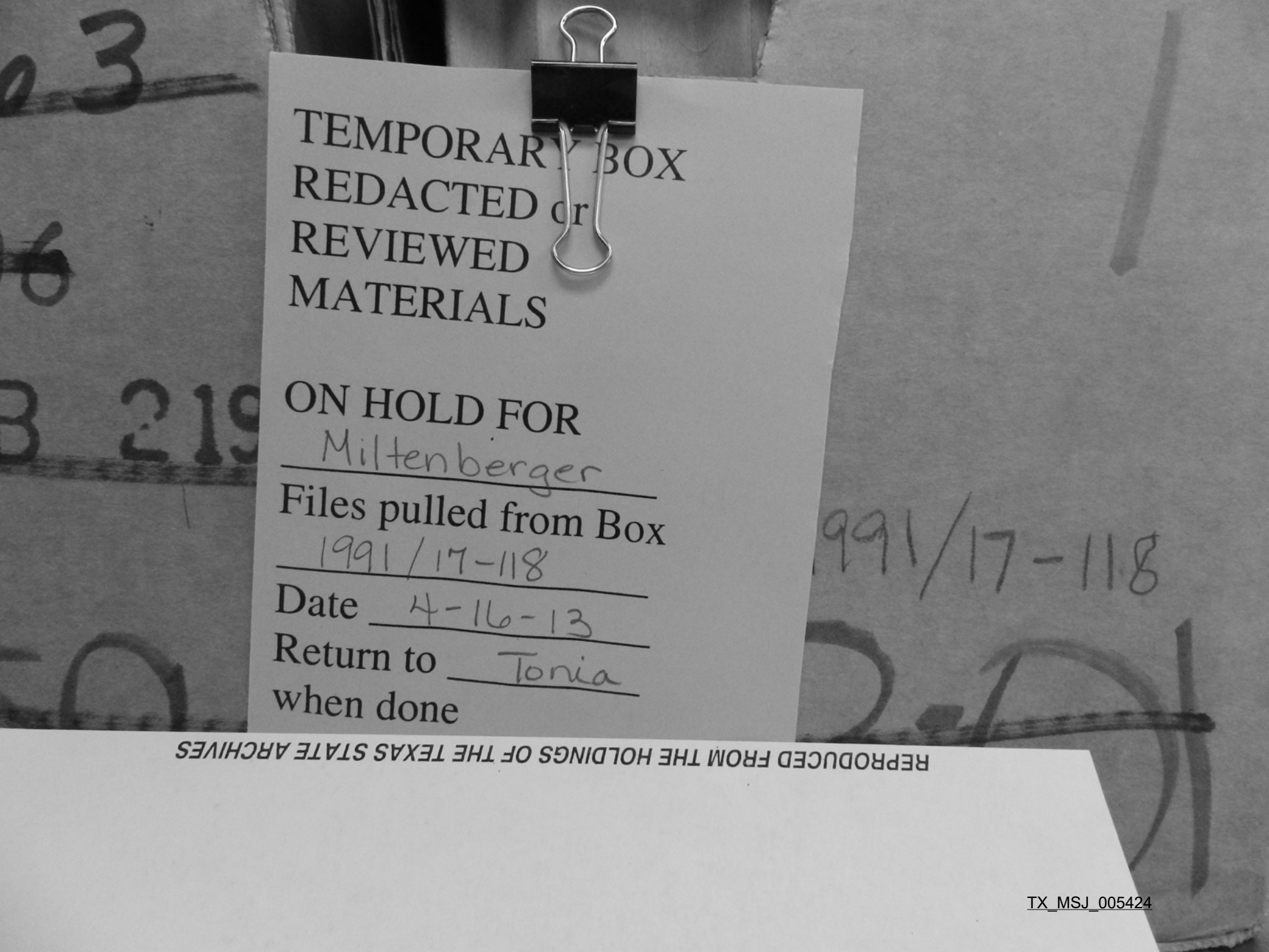

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FACTUAL RESEARCH

AG NO. 51-238

STATE OF TEXAS VS.
STATE OF NEW MEXICO, ET AL
U. S. SUPREME COURT

III

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REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

Research

opinions of Attorney Generals
concerning switch of Gaging
Stations

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COLORADO
M. C. HINDERLIDER
STATE ENGINEER
DENVER, COLORADO

TEXAS
J. E. QUAID
316 CAPLES BLDG.
EL PASO, TEXAS

Rio Grande Compact Commission

NEW MEXICO
JOHN H. BLISS
STATE ENGINEER
SANTA FE, NEW MEXICO

UNITED STATES
BERKELEY JOHNSON, CHAIRMAN
POST OFFICE BOX 277
SANTA FE, NEW MEXICO

SECRETARY
RIO GRANDE COMPACT COMMISSION
POST OFFICE BOX 277
SANTA FE, NEW MEXICO

MINUTES OF NINTH ANNUAL (NINETEENTH) MEETING OF THE
RIO GRANDE COMMISSION HELD IN EL PASO, TEXAS.
FEBRUARY 22, 23, 24, 1948.

The meeting of the commission convened at the Paso del Norte Hotel at 2 P. M. Feb. 22nd.

Present were Berkeley Johnson, Chairman
M. C. Hinderlider, Commissioner for Colorado
R. J. Tipton, Engineer Adviser for Colorado
J. H. Bliss, Commissioner for New Mexico
J. R. Erickson, Engineer Adviser for New Mexico
M. A. Threet, Legal Adviser for New Mexico
I. S. Moise, Legal Adviser for New Mexico
J. E. Quaid, Commissioner for Texas
R. A. Hill, Engineer Adviser for Texas
E. L. Barrows, Acting Secretary.

The first order of business was the presentation of the 1948 schedules covering deliveries of water and releases from Project storage together with computed debits and credits as compiled by the Acting Secretary, which after certain corrections had been made by the three Engineer Advisers, and upon motion having been duly made and seconded, were adopted by the Commission and are attached hereto.

Mr. Hinderlider then brought to the attention of the Commission the matter of repairs to certain compact gaging stations in Colorado, which had been suggested by the Chairman in his letter of March 3, 1947. Mr. Hinderlider announced that a new steel cable and equipment had been purchased for the station at Lobatos on the Rio Grande and that certain minor repairs had been made at other stations, but that due to scarcity of labor and materials, repairs at other stations which had been suggested, had not as yet been made, but that it is now anticipated the remaining work will be completed this summer.

The question was then raised as to the desirability of establishing additional gaging stations on the Rio Grande and tributaries thereof above the high water line of a proposed reservoir on the Rio Grande astride the Colorado-New Mexico state line, for the purpose of correlating records of stream flow at such points with records at the Lobatos gaging station. Following a full discussion of the matter, it was decided that the station on the Rio Grande above Trinchera Creek should be improved, and if necessary, that additional stations be installed near the mouths of Trinchera and Culebra Creeks above the high water line of the proposed reservoir.

A letter was then presented from the Forest Service relative to stock water tanks in which it was suggested that reports on such tanks by the Forestry Service should be discontinued.

In this connection it was suggested that Mr. Bliss interview the various interested Federal agencies and request that a check be made by such agencies of the stock tanks now constructed and that a report be pre-

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pared and submitted, which would disclose the total present effective capacity of such tanks, all for the information and records of the Commission.

The Chairman then presented the question as to whether or not the last enlargement of the Rio Grande Reservoir in the amount of 5,280 acre-feet was subject to the Rio Grande Compact.

Mr. Hinderlider described the spillway of this reservoir and the collapsible flashboards in the spillway by means of which the said enlargement had been accomplished. He stated that he had interviewed the representatives of the owners of the reservoir and had reviewed correspondence between those representatives and his office, as a result of which he was of the opinion that the enlargement in question had been completed prior to Jan. 1, 1930. Accordingly Mr. Hinderlider moved that the said enlargement of the reservoir be recognized by the Commission as not being subject to the provisions of the Compact. This motion was lost for lack of a second. Mr. Hinderlider then advised the Commission that he would later furnish the Commission a statement of the evidence available to him in support of his views, which statement was agreeable to the Commission.

The following amendment to the Rules and Regulations whereby the duties of the former Secretary to the Commission would be performed by the office of the District Engineer of the U. S. Geological Survey at Santa Fe, New Mexico, was presented for consideration.

The section of the Rules and Regulations captioned "Secretary" shall be amended to read as follows:

"The Commission, subject to the approval of the Director, U. S. Geological Survey, to a cooperative agreement for such purposes, shall employ the U. S. Geological Survey on a yearly basis, to render such engineering and clerical aid as may reasonably be necessary for administration of the Compact.

"Said agreement shall provide that the Geological Survey shall:

(1) Collect and correlate all factual data and other records having a material bearing on the administration of the Compact and keep each Commissioner advised thereof.

(2) Inspect all gaging stations required for administration of the Compact and make recommendations to the Commission as to any changes or improvements in methods of measurement or facilities for measurement which may be needed to insure that reliable records be obtained.

(3) Report to each Commissioner by letter on or before the fifteenth day of each month, except January, a summary of all hydrographic data then available for the current year - on forms prescribed by the Commission - pertaining to:

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(a) Deliveries by Colorado
(b) Deliveries by New Mexico
(c) Operation of Project Storage

(4) Make such investigations as may be requested by the Commission in aid of its administration of the Compact.

(5) Act as Secretary to the Commission and submit to the Commission at its regular meeting in February a report on its activities and a summary of all data needed for determination of debits and credits and other matters pertaining to administration of the Compact.

Mr. Bliss moved adoption of the amendment which was seconded by Mr. Quaid and unanimously adopted.

Chairman Johnson then presented for consideration the following proposed Amendment recommended by the three engineer advisers:

Add three paragraphs to the section of the Rules and Regulations captioned "Evaporation Losses" to read as follows:

"Net losses by evaporation, as defined above, shall be used in correcting Index Supplies for the operation of reservoirs upstream from Index Gaging Stations as required by the provisions of Article III and Article IV of the Compact".

"In the application of the provisions of the last unnumbered paragraph of Article VI of the Compact:

(a) Evaporation losses for which accrued credits shall be reduced shall be taken as the difference between the gross evaporation from the water surface of Elephant Butte Reservoir and rainfall on the same surface.

(b) Evaporation losses for which accrued debits shall be reduced shall be taken as the net loss by evaporation as defined above".

"In determination of Hypothetical Spill and in the application of the provisions of Article VII of the Compact, the correction for change in evaporation losses shall be taken as the difference between the gross loss by evaporation from Elephant Butte Reservoir, which would have occurred if 790,000 acre-feet of usable water had been released from Project Storage each year and the corresponding losses which actually did take place".

Recommended for Adoption

Signed R. J. Tipton
Signed John R. Erickson
Signed Raymond A. Hill

February 20, 1948.

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Mr. Bliss requested that consideration of this amendment be postponed until tomorrow morning.

There was some discussion relative to the establishment of a gaging station on Costilla Creek near the mouth thereof, and it was agreed that such station will be established and operated.

Mr. Threet asked the members of the Commission to take action on the proposed diversion out of the Red River (Rio Colorado) into the water shed of the Cimarron River. Following a full discussion of the matter, it was the unanimous opinion of the members of the Commission, that the Commission as such, had no authority to take any action in the matter, and so advised Mr. Threet.

The Commission recessed at 4:30 P.M., February 22.

Meeting reconvened at 10 A.M. February 23.

In addition to all those present on the preceding day was S. P. Davalos, engineer in the office of the State Engineer of New Mexico.

It was brought to the attention of the Commission by Mr. Hinderlider that the Minutes of the last Annual Meeting of the Commission state that the Annual Reports of the Commission for 1939, 1940, 1945 and 1946 were to be published in one booklet. Mr. Hinderlider moved the action taken by the Commission at that time be amended to authorize, subject to availability of funds, publication of the Annual Reports for 1939 and 1940 in one booklet and that the Annual Reports for 1945 and 1946 be published in separate booklets, which motion having been duly seconded was unanimously carried.

Mr. Hinderlider moved that the Commissioner for Colorado be authorized as State Engineer for Colorado to release for use in Colorado any water which may be impounded in 1948 in the Fuchs, Troutdale No. 2 and Squaw Lake Reservoirs, which motion seconded by Mr. Quaid was unanimously carried.

Mr. Bliss Moved that the suggested amendment to the Rules and Regulations for computation of evaporation losses from reservoirs be referred to the Engineer Advisers for further consideration, which was duly seconded by Mr. Hinderlider and unanimously carried.

Consideration was then given to the Report of the Engineer Advisers dated February 24, 1947, relative to placing New Mexico's obligations to make deliveries of water on a twelve months schedule. Mr. Hinderlider moved and Mr. Bliss seconded the motion that the legal advisers present prepare a suitable resolution in conformity with the provisions of Article V of the Compact for the consideration of the Commission, following which the meeting was recessed at 11:40 A.M. until 2 P.M.

The Commission reconvened at 2:00 P.M.

In connection with the adequacy of the San Marcial gaging station for Compact purposes, Mr. Quaid propounded the following questions to Chairman Johnson:

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Question. Mr. Johnson, are you District Engineer for the U. S. Geological Survey, and as such, responsible for measurements of the flow of the Rio Grande at the Gaging Station at San Marcial?

Answer. Yes.

Question. In your capacity as District Engineer, as distinguished from your duties as the representative of the United States on this Commission, do you believe that reliable records can be obtained of the total flow of the Rio Grande passing San Marcial under existing physical conditions?

Answer. No, in my opinion reliable records cannot be obtained at times because of the seepage and other unmeasured flow into the sloughs or lake which by-pass the gaging station.

Question. Would it be practicable to obtain accurate measurements of said seepage and unmeasured flow?

Answer. No.

Question. Could accurate measurements be made and reliable records be obtained of the flow of the Rio Grande below Elephant Butte Dam near Hot Springs, New Mexico?

Answer. Yes.

The financial report of the Commission for the fiscal year ending June 30, 1947, was then presented and after full consideration upon motion duly made by Mr. Hinderlider, seconded by Mr. Bliss, was adopted, which report is incorporated herein.

A budget for the fiscal year ending June 30, 1949 was then presented for consideration and action, and upon motion made by Mr. Quaid and seconded by Mr. Hinderlider, was unanimously adopted and is incorporated herein.

The Commission recessed at 4:30 P. M. until 10 A.M. February 24.

The Commission reconvened at 10 A. M. February 24.

The following resolution was submitted to the Commission for consideration.

R E S O L U T I O N

Whereas, at the Annual Meeting of the Rio Grande Compact Commission in the year 1945, the question was raised as to whether or not a schedule for delivery of water by New Mexico during the entire year could be worked out, and

Whereas, at said meeting the question was referred to the Engineering Advisors for their study, recommendations and report, and

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

Whereas, said Engineering Advisors have met, studied the problems and under date of February 24, 1947, did submit their Report, which said Report contains the findings of said Engineering Adviros and their recommendations, and

Whereas, The Compact Commission has examined said Report and finds that the matters and things therein found and recommended are proper and within the terms of the Rio Grande Compact, and

Whereas, the Commission has considered said Engineering Advisors' Report and all available evidence information and material and is fully advised:

Now, Therefore, Be it Resolved:

The Commission finds as follows:

(a) That because of change of physical conditions, reliable records of the amount of water passing San Marcial are no longer obtainable at the stream gaging station at San Marcial and that the same should be abandoned for Compact purposes.

(b) That the need for concurrent records at San Marcial and San Acacia no longer exists and that the gaging station at San Acacia should be abandoned for Compact purposes.

(c) That it is desirable and necessary that the obligations of New Mexico under the Compact to delivery water in the months of July, August, September should be scheduled.

(d) That the change in gaging stations and substitution of the new measurements as hereinafter set forth will result in substantially the same results so far as the rights and obligations to deliver water are concerned, and would have existed if such substitution of stations and measurements had not been so made.

Be It Further Resolved:

That the following measurements and schedule thereof shall be substituted for the measurements and schedule thereof as now set forth in Article IV of the Compact:

"The obligation of New Mexico to deliver water in the Rio Grande into Elephant Butte Reservoir during each calendar year shall be measured by that quantity set forth in the following tabulation of relationship which corresponds to the quantity at the upper index station:

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DISCHARGE OF RIO GRANDE AT OTOWI BRIDGE AND ELEPHANT BUTTE EFFECTIVE SUPPLY

Quantities in thousands of acre feet

Otowi Index Supply (5)	Elephant Butte Effective Indiex Supply (6)
100	57
200	114
300	171
400	228
500	286
600	345
700	406
800	471
900	542
1000	621
1100	707
1200	800
1300	897
1400	996
1500	1095
1600	1195
1700	1295
1800	1395
1900	1495
2000	1595
2100	1695
2200	1795
2300	1895
2400	1995
2500	2095
2600	2195
2700	2295
2800	2395
2900	2495
3060	2595

Intermediate quantities shall be computed by proportional parts.

(5) The Otowi Index Supply is the recorded flow of the Rio Grande at the U.S.G.S. gaging station at Otowi Bridge near San Ildefonso (formerly station near Buckman) during the calendar year, corrected for the operation of reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and Otowi Bridge.

TX_MSJ_005433

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

(6) Elephant Butte Effective Index Supply is the recorded flow of the Rio Grande at the gaging station below Elephant Butte Dam during the calendar year plus the net gain in storage in Elephant Butte Reservoir during the same year or minus the net loss in storage in said reservoir, as the case may be.

The application of this schedule shall be subject to the provisions hereinafter set forth and appropriate adjustments shall be made for

(a) any change in location of gaging stations;

(b) Depletion after 1929 in New Mexico of the natural runoff at Otowi bridge; and (c) any trans-mountain diversions into the Rio Grande Between Lobatos and Elephant Butte Reservoir."

BE It Further Resolved:

That the gaging stations at San Acacia and San Marcial be and the same are hereby abandoned for Compact purposes.

Be It Further Resolved:

That this Resolution has been passed unanimously and shall be effective January 1, 1949, if within 120 days from this date the Commissioner for each State shall have received from the Attorney General of the State represented by him, an opinion approving this Resolution, and shall have so advised the Chairman of the Commission, otherwise, to be of no force and effect.

After complete discussion, it was moved by Mr. Bliss, seconded by Mr. Hinderlider that the Resolution be adopted. Passed unanimously.

It was moved by Mr. Bliss, seconded by Mr. Quaid, as follows:

"That if the approval of the Attorneys General of the three states is not obtained so as to make the Resolution just passed effective under its terms, then and in that event a special meeting of the Commission shall be held in Santa Fe on July 20, 1948".

Duly passed.

Commission recessed at 12:30 P. M. to reconvene at 4:00 P.M.

The Commission reconvened at 4:00 P.M. The Minutes of this Meeting were presented, read and unanimously approved.

The Commission adjourned at 5:00 P. M.

/s/ J. E. QUAID
Commissioner for Texas

/s/ M. C. HINDERLIDER
Commissioner for Colorado

/s/ BERKELEY JOHNSON
Chairman

/s/ JOHN H. BLISS
Commissioner for New Mexico

COST OF OPERATION
FOR THE FISCAL YEAR ENDING JUNE 30, 1947.

ITEM	TOTAL COST	Borne by United States	Borne by Compacting States Colorado	New Mexico	Texas
Gaging Stations					
In Colorado	$ 3500	$1700	$1800		
In New Mexico					
Above Elephant Butte	11300	7700		$3600	
Below San Marcial	3500				$2500
Sub Total	$17300	$9400	$1800	$3600	$2500
Administration	1100		100	950	50
TOTAL	$18400	$9400	$1900	$4550	$2550
Borne by U. S.	9400	9400			
Net By States	9000		1900	4550	2550
Share of each State	--		3000	3000	3000
Cash Adjustment			Dr.$1100	Cr.$1550	Dr.$450

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

BUDGET

FOR FISCAL YEAR ENDING JUNE 30, 1949

ITEM	TOTAL	U. S.	COMPACTING STATES		
			COLORADO	NEW MEXICO	TEXAS
Gaging Stations					
In Colorado	$3500	$1700	$1800		
In New Mexico					
Above Elephant Butte	10400	6800		$3600	
Below San Marcial	3500	500			$3000
Sub Total	$17400	$9000	$1800	$3600	$3000
Administration					
U.S.G.S.Corporation	$4000	$ 400	$1200	$1200	$1200
Publishing Reports	2100		700	700	700
Misc. Expense	300		100	100	100
Sub. Total	$23800	$9400	$3800	$5600	$5000
Share of Each State					
Total by States	$14400		$3800	$5600	$5000
Equal Share			$4800	$4800	4800
Estimated Cash Adjustment	--		Dr. $1000	Cr. $ 800.00	Cr. $ 200

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

Ground-Water Conditions in the Rincon and Mesilla Valleys and Adjacent Areas in New Mexico

By C. S. CONOVER

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1230

Prepared in cooperation with the Elephant Butte Irrigation District



UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1954

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UNITED STATES DEPARTMENT OF THE INTERIOR

Douglas McKay, *Secretary*

GEOLOGICAL SURVEY

W. E. Wrather, *Director*

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TX_MSJ_005438

CONTENTS

	Page
Abstract	1
Introduction	4
Purpose and scope of investigation	4
Previous investigations	5
Acknowledgments	7
Well-numbering system	8
Features of the area	10
Location and general features	10
Climate	12
Topographic features	15
Rio Grande project	17
Geology	21
Character of sediments	22
Thickness of sediments	24
Occurrence of ground water in upland areas	27
Depth to water	27
Movement and flow of ground water	31
Recharge of ground water	37
Water conditions in the Rincon and Mesilla Valleys	38
Surface water	38
Available surface flow	38
Diversions to canals of Rio Grande project	40
Distribution of diversions	40
Unit diversions	41
Canal waste	41
Canal-seepage losses	42
Water delivered to farms	43
Flow of drains in Rincon and Mesilla Valleys	43
Relations of drain flow and diversions	45
Required water supply	50
Ground water in valley fill	52
Depth to water	52
Fluctuations of the water table	58
Effect of irrigation	58
Effect of precipitation	64
Effect of transpiration	65
Source and movement of ground water	65
Direction of movement	65
Source of ground water	66
Seepage from the Rio Grande	66
Seepage from canals	73
Recharge from irrigation water	76
Recharge from precipitation	77
Discharge of ground water	77
Chemical quality of water	79
General features	79
Variation of quality with depth	82
Variation of quality areally	84
Quality of Las Cruces water supply	88
Summary of quality of water	89
Hydrologic characteristics of water-bearing formation	90
General conditions	90
Coefficient of transmissibility	90
Methods of determining	90
Pumping tests	92
Water-table gradients and flow of drains	96
Specific yield	102

TX_MSJ_005439

Page

Ground-water development 103
Previous development 103
Present development 105
Domestic supplies 105
Irrigation supplies 107
Performance of existing wells 107
Future development 110
Pumping of ground water 114
General conditions 114
Effect of pumping upon flow of drains 116
Supplemental pumping of ground water in a drought period 121
Pumping of ground water with a normal supply of surface water 128
Cost of pumping supplemental ground water 129
Recommended location of wells 130
Recommendations for future studies 132
Summary 133
Literature cited 135
Records 136
Index 197

ILLUSTRATIONS

[All plates are in pocket]

Page

Plate 1. Map of Dona Ana County, N. Mex., showing contours on the water table, depth to water, and wells for which information was obtained, 1947.
2. Map of Rincon Valley, N. Mex., showing canals, drains, and wells for which information is given in well tables.
3. Map of Mesilla Valley, N. Mex., showing canals, drains, Bureau of Reclamation auger holes, and wells for which information is given in well tables.
4. Profiles of water table in vicinity of Mesilla Park, N. Mex.
5. Map of Mesilla Valley, N. Mex., showing water-table contours and depth to water in June 1917 prior to construction of drainage system.
6. Map of Mesilla Valley, N. Mex., showing water-table contours and depth to water in summer of 1919 after construction of a part of the drainage system.
7. Map of Rincon Valley, N. Mex., showing water-table contours and depth to water in summer of 1919 and in 1926.
8. Water levels as measured monthly by the U. S. Bureau of Reclamation in 11 auger holes in Mesilla Valley, N. Mex., showing seasonal and long-term changes.
9. Water-table contours showing seepage from Three Saints Lateral to Anthony Drain.

Figure 1. Map of southwestern part of New Mexico showing area covered by report 11
2. Relation of reported net diversions to return drain flow in Rincon Valley, N. Mex 46
3. Relation of reported net diversions to return drain flow in Mesilla Valley, N. Mex. and Tex 47
4. Seasonal relations of gross headgate diversions and drain flow for selected years, Rincon and Mesilla Valleys 48
5. Departures from average drain flow and diversions, Mesilla and Rincon Valleys, 1930-46 49
6. Fluctuations of water level in three auger holes in Mesilla Valley, and precipitation at State College 59
7. Fluctuations of water level in seven wells located in arroyo beds or in sediments above the valley floor of Rio Grande in Sierra and Dona Ana Counties, N. Mex 62
8. Flow of Rio Grande from Elephant Butte Dam to International Dam, 1917, 1918, and 1936 70
9. Water-table contours for July 1921 in the Hill area, New Mexico, showing seepage from Leasburg Canal and high water table prior to construction of Dona Ana Drain 74

TX_MSJ_005440

Page

Figure 10. Water-table contours for January and July 1922 in the Hill area, New Mexico, showing seepage from Leasburg Canal and lowering of water table during winter and by Dona Ana Drain 75
11. Diagram for use in interpreting analyses of irrigation water 80
12. Curves of recovery of water levels obtained from pumping tests on five wells in Rincon and Mesilla Valleys 93
13. Curves of recovery of water levels obtained from pumping tests on two wells in Rincon and Mesilla Valleys 94
14. Profiles of water table across Park Drain for selected times in 1947, as measured in auger holes in two lines about 3 miles south of Mesilla Park 98
15. Percentage of pumped water diverted from a drain or the river by a pumped well in the Rincon or Mesilla Valleys 118

TABLES

Page

Table 1. Annual flow and depletion of the Rio Grande, 1930–46 136
2. Releases from Caballo Reservoir, 1938–46 137
3. Gross diversions from the Rio Grande, 1930–46 138
4. Acreage irrigated and distribution of diversions, 1930–46 138
5. Flow of the drains to the Rio Grande, 1930–46 141
6. Drillers' logs of wells 143
7. Analyses of ground waters 152
8. Auger holes in Mesilla Valley 154
9. Water levels in auger holes, 1947–48 155
10. Water levels in auger hole 23.2E.29.214, 1947–48 157
11. Water levels in wells in Rincon and Mesilla Valleys, 1946–48 159
12. Records of large-diameter wells near or on the valley floor of the Rio Grande 163
13. Records of wells located principally above the valley floor of the Rio Grande 180

TX_MSJ_005441

GROUND-WATER CONDITIONS IN THE RINCON AND MESILLA VALLEYS AND ADJACENT AREAS IN NEW MEXICO

By C. S. CONOVER

ABSTRACT

The Rio Grande in New Mexico winds through a succession of basins lying between isolated northward-trending mountain ranges constituting part of the Basin and Range physiographic province. The flood plain of the Rio Grande, in general, consists of wide and narrow sections corresponding to alternately soft and hard rocks traversed by the river. The Rincon and Mesilla Valleys are the two southernmost expanded flood plains of the Rio Grande in New Mexico and are parts of the Rio Grande project of the U. S. Bureau of Reclamation. Water for the project is stored at Elephant Butte Reservoir, which was constructed to equalize the flow of the river to the Rio Grande project because large variations occur in the natural flow. Caballo Dam, about 20 miles south of Elephant Butte Dam, permits control of irrigation water to the project after its use for generating electric power at Elephant Butte Dam.

After the heavy precipitation of 1941, Elephant Butte Reservoir filled to capacity, 2,197,600 acre-feet, but drought conditions followed, and by early 1946 the reservoir contained less than a year's normal supply of water for the project. The Elephant Butte Irrigation District, the administrative control agency for the New Mexico part of the project desired to know whether it would be advisable to try to develop a supplemental ground-water supply for the district. The District and the U. S. Geological Survey signed a cooperative agreement whereby the Ground Water Branch of the Survey would make a ground-water study of the area to determine the feasibility of using ground water to supplement the present supply of surface water for irrigation in the district.

Below Elephant Butte Dam the Rio Grande flows westward for about 6 miles across the northern end of the Caballo Mountains, a fault-block mountain of pre-Cambrian, Paleozoic, and Cretaceous rocks dipping to the east. The river then turns south, following the western base of the mountains. The land rises gently west of the river in a series of pediment slopes toward the Black Range, which forms the Continental Divide. At the south end of the Caballo Mountains the river swings southeastward and crosses the northward-trending Jornada del Muerto, an intermountain basin, and its southern extension, La Mesa, the river being bounded on the east by the Dona Ana, Organ, and Franklin Mountains. These mountains consist largely of tilted Paleozoic sedimentary rocks on a basement of pre-Cambrian rocks, but they also contain Tertiary volcanic rocks. The bolsonlike troughs between the mountains east and west of the river are filled with Tertiary and Quaternary sands, silts, clays, and gravels, constituting a valley fill that belongs largely to the Santa Fe formation of Miocene and Pliocene age. Overlying this material and terrace gravels, basalt lava flows, and the flood-plain deposits of the Rio Grande, the latter forming the smooth valley floor, generally bordered by steep bluffs, which may exceed 100 feet in height

Ground water occurs beneath the plains of La Mesa and Jornada del Muerto. Generally the water is unconfined--that is, water-table conditions exist. The map showing contours of the water table indicates that the ground water flows from La Mesa toward the valley rather than following a possible former course of the Rio Grande toward Mexico. The hydraulic gradient of the water table ranges from as little as 1.2 feet to the mile in the central part of La Mesa, where the aquifer is thick, to more than 100 feet to the mile on the steep slopes along the mountains, where the aquifer is relatively thin and the water is apparently upheld by the buried impermeable rocks of the mountains. The depth to water is generally greatest (more than 400 feet) in the central parts of the

TX_MSJ_005443

plains, and least (less than 100 feet) toward the edges of the plains, near the mountains, and along the valleys. The ground water beneath the plains is recharged from precipitation upon the upland and mountainous areas. In the La Mesa area, the recharge is estimated to be about 0.02 inch of water per year. The average annual precipitation is a little less than 10 inches. The ground water from beneath the plains is discharged to the Rio Grande at a rate estimated to be less than 1 cubic foot a second per mile of valley, with that part in the Mesilla Valley approximating 40,000 acre-feet a year.

Water of the Rio Grande which generates hydroelectric power at Elephant Butte Dam is stored in Caballo Reservoir for irrigation use. Diversions from the Rio Grande to the irrigated lands of the district are made at Percha Dam in the Rincon Valley and at Leasburg and Mesilla Dams in the Mesilla Valley. A drainage system, consisting of 42 miles of open drains in the Rincon Valley and 226 miles in the Mesilla Valley, discharges return irrigation seepage to the Rio Grande.

The depth to the water table in the valley fill along the flood plain in the Rincon and Mesilla Valleys is generally less than 10 feet. The ground-water level rises during the irrigation season to a high level in late August and declines during the nonirrigation season to its lowest level in February or March. The water table, in general, slopes down the valley at a rate of about 4.5 feet to the mile, which is essentially the same as that of the valley floor. The ground water in the valley fill of the flood plain is recharged by infiltration of water applied to the land for irrigation, seepage from canals, seepage from certain stretches of the river, precipitation upon the flood plain, and ground-water flow from the mesas and other elevated areas. Recharge by direct infiltration of precipitation is, on the average, small.

Discharge of ground water in the valleys is essentially by seepage to the drains and parts of the river and by transpiration by plants in areas of high water table. Discharge of ground water in the project, as represented by the water returned to the river by the drains, is 249,400 acre-feet a year when a normal supply of surface water is available for irrigation. A quantity of ground water, which has not been exactly determined, is discharged directly to the river in certain stretches.

The coefficient of transmissibility of the alluvial deposits in the Rincon and Mesilla Valleys averages 75,000 gallons a day per foot, as determined from pumping tests on 7 wells and from the relation between the accretion to 7 drains and the slope of the water table perpendicular to them.

Ground water obtained by pumping in the Rincon and Mesilla Valleys does not represent an additional supply or new source of water to the project, but rather a change in method, time, and place of diversion of the supplies already available.

Sufficient water for irrigation can be obtained from wells throughout the major part of the Rincon and Mesilla Valleys. Wells will "sand up" and special well construction may be necessary to control it. Water for irrigation, generally in small amounts, can be obtained by drilling wells on the low bench lands that border the valley floor and in the arroyos cut in them. Some wells in these areas will have only small yields.

In 1946 the anticipated shortage of surface water gave impetus to the drilling of wells for irrigation water in the Mesilla and Rincon Valleys. The number of irrigation wells increased from 11 at the end of 1946 to about 56 at the end of 1947. By February 1948, 14 additional wells had been constructed or were under construction.

Some of the lands now irrigated from wells do not have water rights under the Rio Grande project. There are about 15,000 acres of such lands on the flood plain and bordering higher land which could be irrigated by ground water. These lands, if developed, would ultimately utilize about 38,000 acre-feet of water annually on a basis of 2.5 acre-feet per acre.

TX_MSJ_005444

The writer concludes that in a hypothetical year having only 50 percent of a normal supply of surface water available for diversions, the project lands would require an additional acre-foot per acre of water from wells to assure successful irrigation of the crops. However, because of the reduction in flow of the drains caused by pumping and because of losses in distribution, the use of water from wells to supply this deficit would require pumping 2.42 acre-feet per acre, or 213,000 acre-feet a year for the 88,000 acres of water-right land in New Mexico. Of the amount pumped, it is calculated that all but 63,000 acre-feet would be diverted from surface-water flow. If supplemental pumping were resorted to for 5 successive dry years, continued pumping would be necessary for 3 to 4 years after a return to normal surface supply so as to permit bypassing of the required share of water to the El Paso district, awaiting the restoration of ground-water storage by recharge from surface water.

The total cost of pumping equipment and pumping of this supplemental water for a period of 5 years with about 50 percent of normal surface supply, such as has been recorded in the past at San Marcial gage above Elephant Butte Reservoir, would be approximately one-fifth of the resulting additional gross crop returns, on the basis of the average gross return per acre from 1937 to 1946.

Substitution of pumping of ground water for the usual winter releases of surface water for irrigation of a small percentage of the lands would result in a saving to the project of possibly 34,000 acre-feet of water annually if no water were allowed to bypass the project in the winter.

The chemical quality of the shallow ground water in the alluvium of the Rincon and Mesilla Valleys is slightly poorer than that of drain water but is satisfactory for most irrigation requirements. Comparatively good water is obtained on the surrounding high lands and in the arroyo beds.

As water pumped from wells in the Rincon and Mesilla Valleys is not an additional or new supply but rather water that is normally intercepted by the project, continuing records should be kept of the amount of water pumped, of water-level measurements, and of the location and performance of the irrigation wells. Measurements of the flow of the drains should be made periodically and at enough points to determine the magnitude of the effect of pumping upon the flow of the drains.

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INTRODUCTION

PURPOSE AND SCOPE OF INVESTIGATION

Prolonged drought conditions on the Rio Grande watershed during the preceding 5 years reduced surface-water storage so greatly that a serious water shortage seemed to impend in 1947, and became more serious in 1948, for the Rio Grande project of the Bureau of Reclamation. The annual supply of water allowable to the project under the terms of the Rio Grande Compact is 790,000 acre-feet, including 60,000 acre-feet required for delivery to Mexico. The total amount of water available to the project, including about 105,000 acre-feet of water stored in El Vado Reservoir and owed to the project, had dropped to about 465,000 acre-feet by the second week of August 1947. The amount of stored water in Elephant Butte Reservoir August 12, 1947, was 317,000 acre-feet, the lowest on record since operation of the reservoir began in 1916, and 29 percent of the average from 1915 to 1947 for the last day in August. On the same date, the available 43,000 acre-feet of stored water in Caballo Reservoir was about average. With another month of irrigation due in 1947, the carry-over water storage would be very small and unless very substantial replenishment occurred there would be insufficient water for irrigation in 1948. Rationing of water for the 1948 year was announced in August 1947. The initial allotment of water was set at 1 acre-foot per acre, subject to change if more water became available. In addition, no winter releases of water were to be made, and no water was to be delivered to lands lacking a full water right.

In 1946 the Elephant Butte Irrigation District, which comprises the valley lands of the Rincon and Mesilla Valleys of the Rio Grande in the New Mexico part of the Rio Grande project, anticipated a shortage of surface water because of the low stage of Elephant Butte Reservoir. One of the measures considered to relieve the impending shortage was the use of ground water for irrigation. Intelligent planning of the use of ground water required a knowledge of the ground-water conditions of the area. Accordingly, the district requested the U. S. Geological Survey to make a study of the possibilities of pumping ground water for irrigation, mainly from the standpoint of productiveness of wells and of the effect that the pumping of wells would have upon the surface-water supply in the river and drains.

Field work, begun in 1946 by the author, consisted of obtaining available information concerning the wells in the valley, primarily wells that would produce sufficient water for irrigation and

TX_MSJ_005446

municipal supply. Pumping tests were made on a few wells to determine the hydrologic constants of the aquifer and the specific capacities of the wells. Considerable data on file at the U. S. Bureau of Reclamation, relative to the ground-water conditions in the valleys in the early years, were studied. These data consisted of measurements of depth to water in a number of auger holes over a period of years; depth-to-water maps of the Mesilla Valley prior to, and subsequent to, installation of the drains; profiles of the water table across various drains and across the entire valley; land classifications; records of surface-water diversions and applications and return flow of the drains in past years; annual project histories; and other related information.

In 1947, G. R. Chenot of the Geological Survey gathered data concerning wells on the upland mesa lands bordering the Mesilla Valley. He attempted to visit all known wells to determine their altitudes, measure the depth to water in them, and obtain other available data. Information concerning newly developed irrigation wells in the valleys was obtained at intervals, and periodic measurements of water levels were made in a few observation wells in the valleys. Water samples for chemical analysis were collected from a number of wells in the valley and on the mesa lands.

In February 1947, 2 lines of auger holes were placed across the Park Drain on the Seale and Holt roads south of Mesilla Park in order to determine the relation between the slope of the water table and the accretion of ground water to the drain. Water levels were measured in these wells every 2 weeks by the Geological Survey, and the drain flow was measured every month by the Bureau of Reclamation. In the same month, an auger hole was installed at the shelter for weather instruments at the New Mexico College of Agriculture and Mechanic Arts to obtain a daily record of the water level. Observations on this well have been made by those employed to record the weather observations.

The studies in Rincon and Mesilla Valleys were made under the direction of A. N. Sayre, geologist in charge, Ground Water Branch, Water Resources Division of the U. S. Geological Survey, and under the immediate supervision of C. V. Theis, district geologist in charge of ground-water investigations in New Mexico.

PREVIOUS INVESTIGATIONS

The earliest published report available on the ground-water conditions in the Mesilla Valley is that by Slichter (1905). At the time of his investigation considerable interest was exhibited in the pump-

TX_MSJ_005447

ing of ground water from the valley fill as a means of supplementing the erratic flows of the Rio Grande. Slichter (1905, p. 13) investigated the underflow of the Rio Grande at the narrows above El Paso and determined that the underflow did not exceed 50 gallons a minute. A number of auger test holes were bored in a line across the valley on the east side of the river in the vicinity of Mesilla Park to determine the gradient of the water table and the changes caused by flows in the Rio Grande. Slichter (1905, p. 27-29) determined that the greater part of the underflow was evidently derived from the river and that only a small amount—possibly about 0.5 cubic foot a second per mile along the valley—was derived from the adjoining mesas. Data are given for pumping tests made upon 12 irrigation wells near Las Cruces and Berino. Specific capacities of the wells ranged from a minimum of 5.8 to a maximum of 88.0 gallons a minute per foot of drawdown (Slichter, 1905, p. 34).

Lee (1907) in his report on the water resources of the Rio Grande valley gave data on a number of wells in the Mesilla Valley, including 6 that had not been previously reported by Slichter. He discussed the quantity, source, and probable disposal of the ground water in the Mesilla Valley and concluded that the ground water was probably discharged by evaporation in the valley (Lee, 1907, p. 50). Although a few data indicated the possibility of ground-water flow into Mexico, Lee believed, because of the downcutting of the Rio Grande in the Mesilla Valley and the accumulation of surface water in the gravels of La Mesa, that the flow from La Mesa, should be toward the Rio Grande rather than away from it (Lee, 1907, p. 40, 50).

The rising water table in the Mesilla Valley caused by the increased dependable water supply after the beginning of operation of Elephant Butte Dam in 1916 made installation of drains necessary. Preparatory to the installation of drains, auger holes were installed throughout the valley by the Bureau of Reclamation and water-table maps were prepared from the measurements of the water level. The results of the ground-water observations were incorporated in the annual project histories of the Rio Grande project and in a drainage report by L. R. Fiock of the Bureau of Reclamation in February 1917.

Dunham (1935) discussed the geology of the Organ Mountains and noted briefly the water conditions in a few of the mines.

The report of the Rio Grande joint investigation, 1936 to 1937, contains only casual mention of the ground-water conditions in the Mesilla Valley, except with respect to the quality of the drain and subsoil waters (National Resources Committee, 1938, p. 451). In

TX_MSJ_005448

the report Kirk Bryan states that, because the lands west of the Rincon Valley are higher than the valley, the Rincon Valley must receive water from, rather than lose water to, the west. He also states that because the ground-water levels in La Mesa appear to be higher than the floor of the Mesilla Valley, the Mesilla Valley must receive ground water from La Mesa, and inasmuch as the enclosed basins south of La Mesa appear to have altitudes higher than the valley floor above El Paso, flow of ground water south to Mexico from La Mesa appears unlikely (National Resources Committee, 1938, p. 225).

Chemical analyses of the surface, drain, and subsoil waters of the Rincon and Mesilla Valleys, sampled during the Rio Grande joint investigation, are contained in a report by Scofield (1938).

A reconnaissance investigation of the water supply for Las Cruces was made in September 1936 by C. V. Theis[1] of the Geological Survey. He concurred with the city officials of Las Cruces in locating the wells of the city on the mesa land to the east and believed it possible to obtain water of a better quality than that found in the valley.

A reconnaissance report was prepared by the Bureau of Agricultural Economics[2] on the possibility of obtaining water supplies for a settlement in the southern part of the Jornada del Muerto, east of the Dona Ana Mountains. The report included data on a few stock wells and stated that the depth to water was in excess of an economic pumping lift for irrigation.[3]

ACKNOWLEDGMENTS

The writer acknowledges the cordial assistance of members of the Bureau of Reclamation who made available data concerning all aspects of the Rio Grande project, frequently spending a considerable amount of their time, especially L. R. Fiock, project manager, and W. F. Resch, acting superintendent of the Rio Grande project in El Paso. Mr. Resch also made many helpful comments. The writer's thanks are also due E. S. Mayfield, division engineer, Las Cruces division; Joe Carbine and Mr. Williams, watermasters for the Mesilla Valley, for general information, for monthly meas-

[1]Theis, C. V., 1936, Memorandum on water supplies at Las Cruces: U. S. Geol. Survey unpublished report, Albuquerque, N. Mex., 9 p.
[2]Bureau of Agriculture Economics, 1939, Reconnaissance report on possibilities for water facilities for the southern Jornada del Muerto, Dona Ana County, N. Mex., U. S. Dept. Agr., (unpublished), 14 p.
[3]Idem, p. 11, 12.

TX_MSJ_005449

urements of the flow of the Del Rio Drain, and aid in finding irrigation wells; to M. B. Bonor, watermaster for the Rincon Valley, who helped in finding irrigation wells; and Mr. Sadler of the Las Cruces office for his help in obtaining data on file. Nearly all the data in this report concerning irrigated acreages, diversions, drain flow, and water levels in past years were obtained from the Bureau of Reclamation.

Albert Curry, assistant director of the Agricultural Experiment Station at State College, gave permission and made arrangements for the pumping test on the college well and furnished valuable data pertinent to the irrigation wells of the college. Professor Overpeck also assisted in the pumping test and arranged for the daily observations in the auger hole at the weather-instruments shelter.

Grateful acknowledgment is especially due John L. Gregg, treasurer-manager of the Elephant Butte Irrigation District, who, from his detailed knowledge of the area, made many very helpful comments and suggestions throughout the study.

The well drillers were invariably helpful in supplying what information they had concerning wells, and the well owners and residents of the area were courteous and helpful; their assistance is appreciated.

WELL-NUMBERING SYSTEM

The system of numbering wells shown in this report is the same as that used in other parts of New Mexico. The system is based on the common designations of public land divisions, and by means of it the well number, in addition to designating the well, locates its position to the nearest 10-acre tract. The number is divided into four segments by periods. The first segment denotes the township north or south of the New Mexico base line, the second denotes the range east or west of the New Mexico principal meridian, and the third denotes the section. In a county such as Dona Ana County, where wells are situated both east and west of the principal meridian, and E is added to the second segment of the well number if the well is east of the principal meridian, but no letter is added if the well is west of the principal meridian. In counties in which no confusion can arise, the direction east or west of the meridian is not given.

The fourth segment of the number, which consists of 3 digits, denotes the particular 10-acre tract in which the well is situated. For this purpose, the section is divided into four quarters, numbered 1, 2, 3, and 4, in the normal reading order, for the north-

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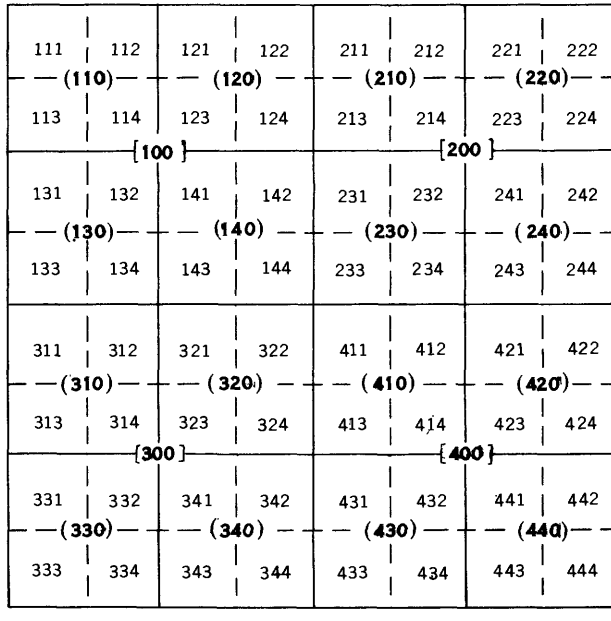
west, northeast, southwest, and southeast quarters, respectively. The first digit of the fourth segment gives the quarter section, which is a tract of 160 acres. Similarly, the quarter section is divided into four 40-acre tracts numbered in the same manner, and the second digit denotes the 40-acre tract. Finally, the 40-acre tract is divided into four 10-acre tracts, and the third digit denotes the 10-acre tract. Thus, well 23.2E.29.342 in Dona Ana County is in the NE1/4SE1/4SW1/4 sec. 29, T. 23 S., R. 2 E. If a well cannot be located accurately to a 10-acre tract, a zero is used as the third digit, and if it cannot be located accurately within a 40-acre tract, zeros are used for both the second and third digits. If the well cannot be located more closely than the section, the fourth segment of the well number is omitted. When it becomes possible to locate more accurately a well in whose number zeros have been used, the proper digit or digits are substituted for the zeros. Letters a, b, c, and d are added to the last segment to designate the second, third, fourth and suceeding wells listed in the same 10-acre tract.

The following diagram shows the method of numbering the tracts within a section:



In the well tables, pages 163 to 195 of this report, the wells are arranged in numerical sequence of the well location number, wells east of the principal meridian in a township preceding those west of the meridian.

TX_MSJ_005451

FEATURES OF THE AREA

LOCATION AND GENERAL FEATURES

The area covered by this report includes the valley lands of the Rincon and Mesilla Valleys in New Mexico and the adjacent mesa lands bordering, primarily, the Mesilla Valley.

The Rincon and Mesilla Valleys, in the south-central part of New Mexico, are two of the many widened parts of the Rio Grande valley that are separated by narrows and canyons in the eroded channel. The Rincon Valley lies north of the Mesilla Valley, in Sierra and Dona Ana Counties, N. Mex.; the Mesilla Valley is in Dona Ana County, N. Mex. and El Paso County, Tex. (See fig. 1 and pls. 1-3.)

The largest community in the Rincon and Mesilla Valleys is Las Cruces, N. Mex., 45 miles north of El Paso, Tex. It had an estimated population of 12,000 in 1946, an increase of 43 percent from 8,385 in 1940. The only other town of appreciable size is Hatch, about 36 miles north of Las Cruces, in the Rincon Valley. It had an estimated population of 1,400 in 1946, an increase of 70 percent from 822 in 1940. El Paso, in the El Paso Valley of the Rio Grande, is a nearby trade territory and tourist center with a population of about 109,000. Across the Rio Grande from El Paso is Ciudad Juarez, Mexico. Hot Springs (named Truth or Consequences in 1950), about 40 miles north of Hatch, had an estimated population of about 5,000 in 1946. It is a trade territory and health and recreation resort. Various small settlements are distributed along the Rincon and Mesilla Valleys, a few of which are Arrey, Derry, Garfield, Salem, and Rincon in the Rincon Valley, and Dona Ana, Mesilla, Mesilla Park, State College, San Miguel, La Mesa, Berino, La Union, Anthony, and Canutillo in the Mesilla Valley.

The New Mexico College of Agriculture and Mechanic Arts is at State College, about 2 miles southeast of Las Cruces. White Sands Military Proving Ground is on the east side of the Organ Mountains, about 20 miles east of Las Cruces.

The area is served by the Atchison, Topeka, and Santa Fe Railway which runs along the Jornada del Muerto, east of the Caballo Mountains that flank the Rincon Valley on the east, and enters the Rincon Valley at Rincon about 5 miles east of Hatch. From Rincon the main line extends southward in the Rincon and Mesilla Valleys through Las Cruces to El Paso, and a branch line goes westward through Hatch to Deming. U. S. Highway 85 traverses the Rincon and Mesilla Valleys from the north through Hatch to Las Cruces

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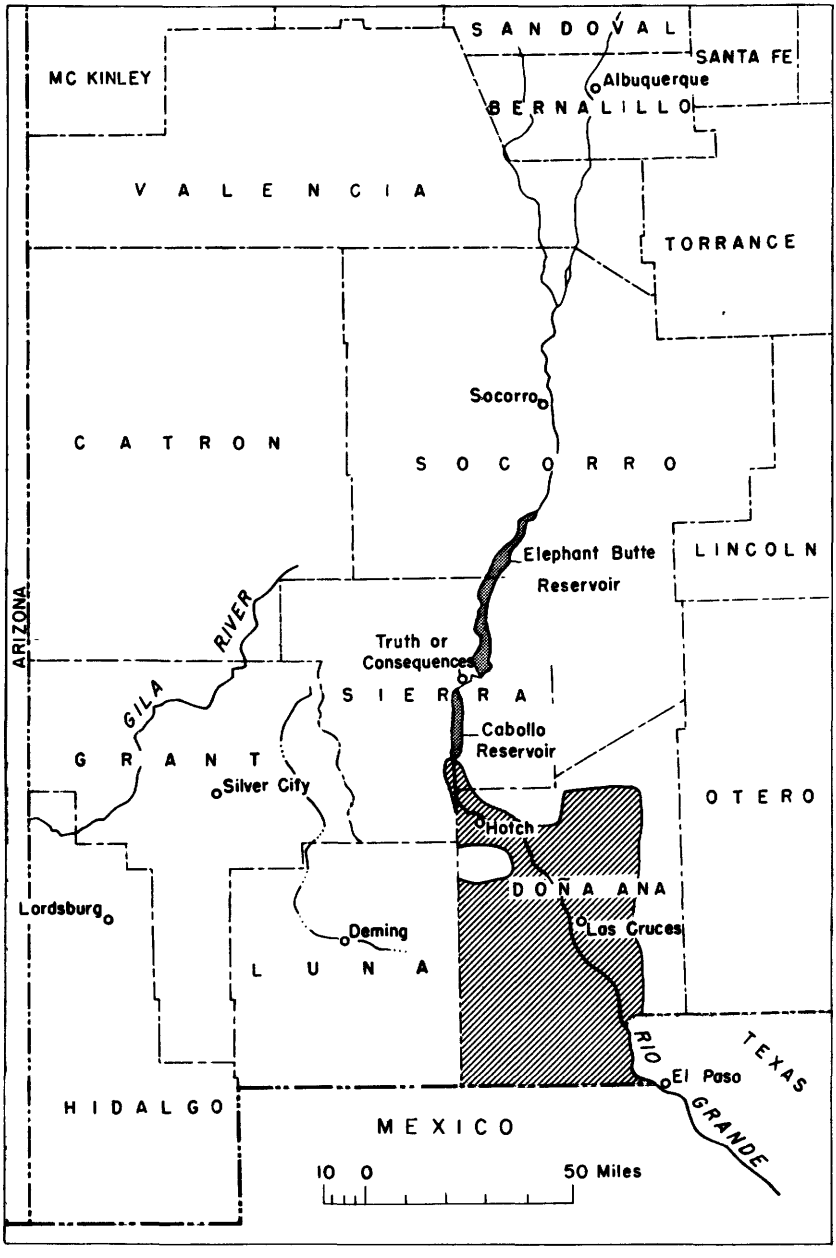

Figure 1. —Map of southwestern part of New Mexico showing the area covered by the report.

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and El Paso, and U. S. Highway 70 crosses the Mesilla Valley at Las Cruces. State Route 26 from Deming enters the Rincon Valley at Hatch.

The main industry of the valleys is farming, with 68 percent of the crop acreage in 1946 in cotton, 19 percent in alfalfa, and 4 percent in pecans. The pecan acreage is increasing. Some truck crops are grown quite successfully. Cantaloupes, chili, and onions each made up about 1 percent of the crop acreage in 1946. The total value of crop production for the Rio Grande project in 1946, in New Mexico and Texas, was $39,463,471 or $251.90 per acre, and in the New Mexico section alone was $20,912,574. Many cotton gins, 2 cottonseed-oil mills, and 2 canneries are located in the area, and plans for erection of an alfalfa mill are under way.

CLIMATE

The climate of Dona Ana County, N. Mex., typical of the climate of the arid to semiarid parts of southwestern United States, is characterized by clear and sunny days, large diurnal temperature ranges, low humidity, and scant rainfall.

Weather records maintained by the U. S. Weather Bureau at State College, south of Las Cruces, show a mean annual temperature of nearly 60 F. for the 89 years of record. The average maximum temperature for July is about 93 F. and the average minimum, about 65 F. In January the average maximum temperature is 58 F. and the average minimum is 26 F. Large diurnal temperature changes are common, summer temperatures sometimes exceeding 100 F. during the day and falling below 60 F. at night. There is a long frost-free growing season of about 200 days a year.

The low average relative humidity of less than 50 percent is a factor in the high diurnal temperature changes and is also partly responsible for the high annual evaporation of nearly 100 inches.

The rainfall in the valleys is scant, greater amounts falling on the surrounding high lands that intercept the storms. The average annual rainfall at State College is 8.68 inches and that at the Jornada Experimental Range on the mesa, northeast of Las Cruces, is 9.60 inches. The higher peaks of the Organ and Franklin Mountains probably receive in excess of 15 inches a year. The distribution of precipitation during the year is such that more than half the yearly total normally falls in July, August, and September.

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This distribution of rainfall is advantageous for growing crops, but it is totally inadequate in amount and must be supplemented by irrigation.

Variation in the time and amount of precipitation causes a variation in the time and amount of irrigation water applied to crops and also a variation in the ground-water levels. Relation of the precipitation in 1947 and part of 1948 to the water level, measured daily in three auger test holes, is shown in figure 6.

The following tables taken from reports of the U. S. Weather Bureau show data on precipitation at the Agricultural College, Hatch, and Caballo Dam from 1930 to 1948. The precipitation in 1941 of 19.60 inches at the Agricultural College was the greatest for the 89 years of record, exceeding the previous record in 1881 by 4.55 inches. The least annual rainfall was 3.61 inches, in 1860.

Annual precipitation at stations in Rincon and Mesilla Valleys, N. Mex., 1930–47

Year	Agricultural College (Altitude, 3,863 feet)		Hatch (Altitude, 4,042 feet)	Caballo Dam
	Precipitation (inches)	Departure from average	Precipitation (inches)	Precipitation (inches)
1930	6.88	-1.80	.....	.....
1931	13.26	+4.58	16.13	.....
1932	8.83	+.15	7.43	.....
1933	4.71	-3.97	8.57	.....
1934	4.62	-4.06	4.03	.....
1935	12.67	+3.99	8.20	.....
1936	9.50	+.82	7.65	.....
1937	7.01	-1.67	7.09	.....
1938	9.27	+.59	13.56	.....
1939	5.77	-2.91	10.15	8.41
1940	9.22	+.54	6.47	6.97
1941	19.60	+10.92	18.22	18.82
1942	9.80	+1.12	8.46	8.30
1943	7.55	-1.13	7.63	8.12
1944	9.77	+1.09	8.78	9.92
1945	5.77	-2.91	4.58	6.19
1946	7.14	-1.54	8.56	5.57
1947	6.08	-2.60	.....	4.88

TX_MSJ_005455

Average monthly precipitation at Agricultural College, N. Mex.

	Inches
January	0.32
February	.43
March	.32
April	.22
May	.30
June	.55
July	1.73
August	1.73
September	1.35
October	.70
November	.54
December	.49
Annual	8.68

Daily precipitation, in inches, at Agricultural College, N. Mex., 1947–48

[No precipitation on days not shown]

Date	Amount	Date	Amount	Date	Amount
1947		*1947*—Con.		*1947*—Con.	
Jan. 2	0.09	June 19	0.03	Nov. 17	0.07
7	.07	July 13	.25	18	.06
8	.47	16	.03	Dec. 3	.18
9	.02	Aug. 3	.14	31	.32
17	.46	13	.10		
Feb. 27	.05	15	.07	*1948*	
Mar. 6	.36	16	.42	Jan. 28	.18
18	.12	18	1.06	Feb. 4	.06
Apr.	Trace	20	.06	5	.28
May 8	.08	21	.18	6	.01
9	.01	23	.88	12	.03
10	.04	30	.07	25	.31
22	.01	Sept.	Trace	26	.74
23	.04	Oct.	Trace	27	Trace
26	.01	Nov. 13	.06	Mar. 18	.02
June 17	.08	14	.26	30	.03
18	.38	16	.15	31	.11

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TOPOGRAPHIC FEATURES

Dona Ana County is traversed diagonally by the Rio Grande (see pl. 1), which flows in the Rincon and Mesilla Valleys, two of the many widened lowlands along the river. The valleys have relatively smooth alluvial floors ranging in width from a few hundred feet to a maximum of about 5 miles in the vicinity of Las Cruces. The altitude of the Rincon Valley ranges from about 4,140 feet above sea level at Caballo Dam to 3,974 feet at Leasburg Dam, a slope of about 4.5 feet to the mile. Hatch, near the center of the valley, has an altitude of 4,054 feet. The altitude of the Mesilla Valley ranges from 3,974 feet above sea level at Leasburg Dam to 3,720 feet at the El Paso station 4 miles northwest of El Paso, a slope also of about 4.5 feet to the mile. Las Cruces, near the upper part of the valley, has an altitude of 3,897 feet.

The valleys are bordered by steep bluffs, about 50 to 100 feet high, of loosely cemented sand, silt, clay, and gravel. From the bluffs, gently inclined plains extend back to the mountain. The plain or mesa on the east side of Mesilla Valley that extends north from Las Cruces to San Marcial, a distance of about 100 miles, is called the Jornada del Muerto. It is nearly flat detrital plain, 10 to 20 miles in width, between the San Andres Mountains on the east and the Caballo and Fra Cristobal Mountains on the west. It has no drainage lines except at the southern end, near the river, but numerous shallow depressions throughout its length catch storm waters and form temporary lakes. The Jornada del Muerto slopes southward about 4.5 feet to the mile (Lee, 1907, p.10) The altitude of the center of the plain, at the lowest point east of the Dona Ana Mountains, about 9 miles northeast of Las Cruces, is about 4,290 feet, or 360 feet above the level of the Rio Grande to the west.

The plain west of the Mesilla Valley that extends southward from near Las Cruces into Mexico is known as La Mesa. It is similar to Jornada del Muerto in many respects. Its altitude at the northern end is approximately the same as that of the southern end of Jornada del Muerto, and the two formed a single plain previous to the excavation of the Mesilla Valley. La Mesa has a width of 20 miles or more and is undissected by erosion and devoid of surface drainage. It contains several broad, shallow depressions (Lee, 1907, p. 10). The slope of La Mesa is southward about 70 feet in 30 miles, slightly more than 2 feet to the mile, or about half that of Jornada del Muerto. The altitude of La Mesa west of Black Mountain is about 4,200 feet, or 375 feet above the level of the river to the east.

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The Caballo Mountains parallel the Rincon Valley a few miles to the east and separate it from the Jornada del Muerto. West of the Rincon Valley the plains extend nearly to the Mimbres Mountains, about 20 miles distant. At the southern end of the Rincon Valley is Selden Canyon, which has been eroded into the igneous rocks that form the Sierra de las Uvas.

The northward-trending Organ Mountains, are about 15 miles east of Las Cruces. The highest peak is Organ Needle, 9,012 feet above sea level. The Franklin Mountains extend south from the Organ Mountains to the Rio Grande at El Paso. The San Andres Mountains extend northward from the Organ Mountains about 70 miles and flank the Jornada del Muerto on the east. (See pl. 1.)

The West Potrillo and East Potrillo Mountains, which reach an altitude of 5,957 feet at Mount Riley, lie west of La Mesa and extend about 25 miles northward from the international boundary.

Other minor mountains are: the Picacho Mountain and Robledo Mountain, maximum altitude 5,876 feet, on the west side of the Rio Grande and extending northward from the vicinity of Las Cruces to Leasburg Dam; Dona Ana Mountains, maximum altitude 5,829 feet, on the east side of Mesilla Valley north of Las Cruces; Tortugas Mountain, elevation 4,912 feet, about 3 miles east of State College; and Black Mountain, about 6 miles west of Mesilla Valley in the vicinity of Chamberino. (See pl. 1.)

The Rio Grande flows southward from Truth or Consequences in Sierra County to the vicinity of the Sierra-Dona Ana County line, thence southeastward across Dona Ana County to El Paso, Tex. The flow of the Rio Grande in this area in summer is maintained principally by releases from Elephant Butte and Caballo Reservoirs and in the winter by return drainage flow. Prior to construction of Elephant Butte Dam the river was often dry for months at a time. Slichter (1905, p. 21) states that there was no water in the Rio Grande below El Paso for 9 months prior to August 25, 1904.

Many tributaries enter the Rincon and Mesilla Valleys. Most are short arroyos that have been formed by storm runoff and carry water only for short periods after sudden, heavy showers, which occur principally during the summer. A few of the tributaries, particularly those that rise in the mountains west of the Rincon Valley, have large drainage areas, and have small perennial flows in their upper reaches. The small perennial flows do not reach the Rio Grande, either being diverted for irrigation or sinking underground shortly after leaving the mountains. Only a few large arroyos enter the Mesilla Valley, the principal ones entering from the east in the vicinity of Las Cruces. (See pls. 1-3.)

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There are a few springs in the area, particularly in the Organ Mountains. The best known is Radium Springs, a mineral hot spring at the head of the Mesilla Valley. A small spring, Derry warm springs, issues from the limestone bluff on the east side of the Rincon Valley about a mile north of the Sierra-Dona Ana County line. (See analyses, p.152, 153.)

RIO GRANDE PROJECT

The Rio Grande project of the Bureau of Reclamation includes most of the valley lands of the Rio Grande in New Mexico and Texas from Caballo Dam southward to a point about 40 miles below El Paso, a distance of about 130 miles. From Caballo Dam to Selden Canyon, a distance of about 30 miles, the Rio Grande flows in the Rincon Valley, which has a maximum width of about 2 miles. (See pl. 2.) Below Selden Canyon the valley floor widens into the Mesilla Valley, which extends about 55 miles southeastward to "The Pass," 4 miles above El Paso. The Mesilla Valley is one of the larger widened areas along Rio Grande and has a width of about 5 miles near Las Cruces. (See pl. 3.) The El Paso Valley extends about 90 miles southward from El Paso and ranges in width from 4 to 6 miles, but only the upper 40 miles is included in the Rio Grande project.

The water for the Rio Grande project is stored in Elephant Butte Reservoir, which has a capacity of 2,197,600 acre-feet, and in Caballo Reservoir, which has a capacity of 345,870 acre-feet, about 28 miles below Elephant Butte Dam. Water released from Caballo Reservoir is diverted from the Rio Grande to the canals in the Rincon Valley by the Percha Dam, about 2 miles below Caballo Dam; in the Mesilla Valley by the Leasburg Dam at the head of the valley and by the Mesilla Dam, about $5\frac{1}{2}$ miles southwest of Las Cruces; and in the El Paso Valley by the American Dam, about 3 miles northwest of El Paso. Water for the Mexican side of the El Paso Valley, generally referred to as the Valle de Juarez, is diverted at the International Dam, about 2 miles below the American Dam.

Gaging stations, equipped with automatic water-stage recorders, are maintained at various points on the Rio Grande by the U. S. Bureau of Reclamation and by the International Boundary and Water Commission. The stations on the Rio Grande pertinent to this report are as follows: "Below Caballo Dam," 0.8 mile below Caballo Dam and 1.5 miles above Percha Dam; "Leasburg Dam;" "El Paso station," above American Dam; and "below American Dam," 0.6 mile below American Dam and 1.5 miles above International Dam. The flow at the El Paso station since the beginning of operation of the American Dam, in June 1938, has been generally computed as

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the sum of the flow at "below American Dam" and the diversions from the American Dam to the American canal. Prior to installation of the gage "below Caballo Dam," in February 1938, records of flow were kept at Percha Dam. Small accretions to the river take place between the Caballo Dam gage and Percha Dam. Diversions into the Bonita Lateral from Caballo Dam, about 1,000 to 2,000 acre-feet per year, are not included in records at "below Caballo Dam" station.

An extensive system of open drains has been constructed, covering practically the whole area of the project. Water from 42 miles of drains in the Rincon Valley is discharged into the river above Leasburg Dam, and water from 226 miles of drains in the Mesilla Valley, except from two drains totaling 12 miles, is discharged into the river below Mesilla Dam to be diverted for reuse in the El Paso Valley portion of the project and in Mexico. (See pls. 2 and 3.)

The total area of land irrigated in the Rio Grande project in 1946 was 156,899 acres, of which 17,000 acres was in the Rincon Valley, 83,911 acres in the Mesilla Valley, and 55,988 acres in the El Paso Valley. Of the irrigated land in the Rincon Valley, 3,087 acres was in Sierra County, and of that in the Mesilla Valley, 10,812 acres was in Texas. The division of irrigated lands in the project amounted to 90,099 acres in New Mexico and 66,800 acres in Texas.

Land that is "subject to construction charges" of the project is referred to as "SCC" land and carries a full water right. The remainder of the area of land within the limits of irrigation from the canals is classified as suspended lands, rights-of-way, or excluded class 6 (permanently nonarable). The suspended lands are classified into nine categories dependent upon the conditions of the individual tracts. Prior to 1939 the SCC land in New Mexico was 88,000 acres. In 1939, by agreement between the irrigation districts and the U. S. Government, the area of SCC land in the project was increased by 3 percent in order that the collection of assessments, allowing for delinquencies, would equal that needed for payment of construction charges. The total SCC classified land in New Mexico in 1946 was 90,623 acres, the total suspended land, 10,985 acres, and the total excluded class-6 land, 547 acres.

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The classifications of the valley lands in 1947, as obtained from the Bureau of Reclamation, are given in the following table:

Classification of lands in the Rincon and Mesilla Valleys in 1947

Classification	New Mexico (acres)	Texas (acres)	Total (acres)
Land subject to construction charges	90,616	10,782	101,398
Riverbed (between levees)	10,304	857	11,161
Rights-of-way	7,120	1,175	8,295
Suspended lands	11,526	1,017	12,543
Total	119,566	13,831	133,397
Irrigated:[1]			
SCC land			96,089
Suspended lands			5,635
Total			101,724

[1]Irrigated land included in the total 133,397 acres above.

The classification is given for 1947 in preference to 1946 as the Bureau of Reclamation included in its compilation for 1947 some riverbed areas and additional right-of-way areas not previously reported. The total area of irrigated lands, suspended lands, and class-6 lands was essentially the same in 1947 as in 1946. Because of the inclusion of additional right-of-way and riverbed areas, the total area shown for New Mexico in 1947 (about 120,000 acres), more nearly represents the total area of the New Mexico part of the flood plain of the Rincon and Mesilla Valleys than that given in 1946 (about 112,000 acres). However, the figures for 1947 do not include some water-consuming valley lands that lie outside the boundaries of the irrigation district, such as the Selden Canyon area; areas outside the limits of the canal system; and other areas of rights-of-way and riverbeds not at present determined.

For comparative purposes and in order to get a more detailed picture of the areas of land having various classifications, the following table has been taken from table C of the report of the Rio Grande joint investigation (National Resources Committee, 1938, p. 420-421).

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Irrigated lands and other water-consuming areas in the Rincon and Mesilla Valleys, in 1936, in acres

	Total area mapped (acres)	Lands given water artificially				Other water-using areas				Native vegetation			Water areas	
		Irrigated in 1936	Temporarily in need	Cities, towns, and villages	Total area irrigated	Native vegetation	Water and river bed	Total non-irrigated	Bare lands, roads, rights-of-way, and others	Grass	Brush	Trees, bosque	Pooled water	River and canal surfaces
Elephant Butte Irrigation District	124,494	87,464	7,362	1,404	96,230	18,604	6,251	24,855	3,409	3,269	8,343	6,992	47	6,204
Rincon Valley	27,914	15,206	2,129	110	17,445	7,310	2,665	9,975	494	1,010	2,672	3,628	47	2,618
Mesilla Valley (N. Mex.)	96,580	72,258	5,233	1,294	78,785	11,294	3,586	14,880	2,915	2,259	5,671	3,364	.....	3,586
Mesilla Valley (Tex.)	13,838	10,665	336	229	11,230	1,904	495	2,399	209	474	1,262	168	4	491
Mesilla Valley (N. Mex. and Tex.)	110,418	82,923	5,569	1,523	90,015	13,198	4,081	17,279	3,124	2,733	6,933	3,532	4	4,077
Rincon and Mesilla Valleys (N. Mex., and Tex.)	138,332	98,129	7,698	1,633	107,460	20,508	6,746	27,254	3,618	3,743	9,605	7,160	51	6,695

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The areas included in the two foregoing tables are not strictly analogous because of the omission of various areas in the 1947 tabulation as given above. A difference of about 5,000 acres for the total valley acreage in New Mexico is evident. The total of 138,000 acres probably is nearly equal to the area of the valley floor of the Rincon and Mesilla Valleys in New Mexico and Texas and is the maximum area from which water in the valleys can be transpired or evaporated to the atmosphere.

For the purpose of collection of charges, the lands in New Mexico are under the Elephant Butte Irrigation District and those in Texas under the El Paso County Water Improvement District. These districts are under contract with the United States to repay construction costs of the project and to advance funds for operation and maintenance of the irrigation system.

GEOLOGY

A detailed study of the geology of Dona Ana County was not made during the course of this investigation. The reader is referred to published reports on this area, the most complete and comprehensive of which is that by Dunham (1935). Included in the report by Dunham is a geologic map of Dona Ana County based on that by N. H. Darton as revised by Dunham. An account of the geology of the county by Dunham is also included. A general discussion on the geology of the Rio Grande depression is given by Bryan (1938, p. 197-225). The geology of La Mesa is discussed briefly by Sayre (Sayre and Livingston, 1945).

The most important deposits of the area, with respect to the occurrence of ground water, are the unconsolidated and partly consolidated sediments of Tertiary and younger age that cover the major part of the county. The deposits consist of varying proportions of clay, silt, sand, and gravel that partly fill the deep rock troughs between the mountains. These deposits can be separated into the older, slightly consolidated sediments that make up the greater part of the fill underlying La Mesa and the Jornada del Muerto and the younger unconsolidated deposits locally mantling the underlying older deposits.

The older sediments are generally referred to as the Santa Fe formation and were probably deposited during late Tertiary(Miocene and Pliocene) time(Sayre, and Livingston, 1945 p. 37, 39; Dunham, 1935 p. 175, 176; Bryan, Kirk, 1938, p. 205). The younger sediments were deposited in the Quaternary period during the Pleistocene and Recent epochs (Sayre and Livingston, 1945, p. 37), and they overlie the Santa Fe formation as outwash fan deposits, mainly on the surface of La Mesa and the Jornada del Muerto, and as alluvium deposited by the river in the valleys during successive periods of scour and fill.

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As the Santa Fe formation and the younger sediments were deposited and eroded from the same general rock formations by meandering streams and arroyos, they, as a consequence, have the same general character, and as they are nonfossiliferous it is not always possible to differentiate between them.

CHARACTER OF SEDIMENTS

The older, slightly consolidated deposits of the Rio Grande consist of alternate layers and lenses of variable thickness of clay, silt, sand, and gravel. The lateral extent of the layers is likewise quite variable, and these thicken or pinch out in short distances. In the Mesa well field in El Paso, individual beds of the bolson sediments found in 45 wells drilled at intervals of 300 feet in two lines 300 feet apart could not be correlated between more than 2 or 3 adjacent wells (Sayre and Livingston, 1945, p. 28).

In wells 1, 3, and 5, of the city of Las Cruces, which are within a radius of about 150 feet, the available logs (see table 6, p.143) show very little correlation of individual beds. The lack of similarity in these wells is due, in part, to the fact that different drillers do not identify like formations alike. However, city wells 3 and 5 were put down by the same driller, though an interval of about 9 years occurred between the drilling of the wells.

The available logs of three Agricultural College wells, 23.2E.29.243, 243b, and 243c (see table 6, p.143), which are within a radius of about 30 feet, show very little correlation, except possibly for the layer of fine sand at a depth of about 80 to 150 feet. The hard dark formation penetrated in well 23.2E.29.243c from 182 feet to 282 feet does not seem related to the sand, gravel, and clay at a corresponding depth in well 23.2E.29.243.

The sediments that underlie the pediments west of the Rincon Valley, particularly those from near Arrey northward to Truth or Consequences, apparently contain clay layers that in places extend westward for several miles. Direct correlation of beds is lacking, but the artesian wells drilled in the floors of 3 tributaries to the Rio Grande from the west, Mud Springs Draw, Animas Creek, and Percha Creek[4], give indirect evidence of continuous clay layers. In the well of O. B. Dawson, 16.5.23.300 (see table 12, p. 164), which is drilled in the floor of Percha Creek about 1.5 miles west of Caballo Reservoir, flowing water is obtained at a depth of 160

[4]Murray, C. R., (in preparation) Ground-water conditions in the nonthermal artesian water basin south of Hot Springs, Sierra County, N. Mex.: (New Mexico State Engineer bienn. rept.)

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feet, the flow increasing with depth to the bottom of the well at 226 feet. The clay layers may be more extensive in the tributaries than in the pediments because of deposition of sediments by flood flows in the arroyos. However, evidence of some continuity of clay beds in the Santa Fe formation west of Arrey is given by the water level in well 17.5.10.442. This well was drilled on the pediment, about 100 feet from its edge, at an elevation of approximately 40 feet above the floor of the adjacent Montoya Arroyo. The water level in the well, which is uncased and 207 feet deep. is about 16 feet below the surface of the pediment and about 25 feet above the floor of the adjacent arroyo.

The character of the Santa Fe formation is given by the drillers' logs in table 6 (p.143 to 161) and by the following section (Sayre, and Livingston, 1945, pp. 32, 33).

Section of La Mesa in railroad cut half a mile west of Anapra, Dona Ana County, N. Mex.

	Feet
Sandy soil, reddish-buff, partly removed.	
Caliche hard, dense, white, grading downward into very fine gray sand	7
Sand, light-gray, moderately fine, uncemented and containing some layers of gravel with igneous rock pebbles derived mostly from lava flows	5
Clay, brown, sandy	1
Quartz sand, medium-grained, mixed with white pellets of calcium carbonate	.5
Sand, medium- to coarse-grained, salt-and-pepper colored	6
Clay, brown to gray, sandy	2
Sand, crossbedded, light-gray, medium- to coarse-grained, contains some coarse gravel	45
Sand, light-buff, fine-grained, massive, clayey, containing irregular lenses of clean sand. Near the base are numerous tubes of sand cemented with calcium carbonate	9
Sand, extremely fine-grained, gray, with layer of coarse sand near middle	14
Clay, gray, much disturbed and broken	1.3
Sand, medium-grained, gray, containing near the base laminated layers of alternating black and white sand	30
Sand, light-buff, clayey, crossbedded	1.5
Sand, medium-grained, loose, gray	6
Sand, buff to gray, fine-grained, crossbedded; contains pellets of clay and caliche on the bedding planes	2.5
Sand, mostly covered	25
Clay, light-buff, and sandy clay	6
Sand, fine-grained, light-gray, crossbedded	5
Clay, laminated, light-buff, and sandy clay	2.5

TX_MSJ_005465

Sand, fine-grained, gray, crossbedded	3
Clay light-buff, massive	2.5
Sand, massive, fine-grained, cemented, yellowish-buff, grading into less-cemented gray sand near base and partly covered	30
Clay, chocolate-brown, and light-buff massive sandstone interbedded	11
Sand, brown, crossbedded, partly covered	10
Clay, buff to chocolate-brown, silty	9
	234.8

The Pleistocene and Recent unconsolidated sediments in the valley are predominantly sand and gravel with some thin beds of sandy clay. They are generally very loose and cause trouble in wells by running into them.

THICKNESS OF SEDIMENTS

The maximum thickness of the sediments of the Santa Fe formation in Dona Ana County is not known, but unconsolidated sediments are reported in wells of depths as low as 1,330 feet. A few comparatively deep wells have been drilled. The deepest well reported is the oil test of the Picacho Oil and Gas Syndicate, 23.1.15.211, an abbreviated log of which is given in table 6 (p. 143). This well was drilled on La Mesa, west of Las Cruces, about 1 mile from an outcrop of rock that forms part of Picacho Mountain. The log apparently shows about 550(?) feet of Tertiary or younger sediments at this location.

Near the southern part of La Mesa the Southern Pacific Co. drilled a well (28.2E.24.110), at Strauss to 1,330 feet, entirely through unconsolidated sediments. The Lippincott well, 28.3E. 25., in the lower part of Mesilla Valley is reported to have been drilled in limestone at 822 feet (Sayre and Livingston, 1945, p. 35).

The well of Edwin Parker, 21.2E.12.222, on the Jornada del Muerto about midway between the San Andres and the Dona Ana Mountains was drilled to 631 feet. Limestones and sandstones predominate below 474 feet and the well ends in 80 feet of limestone. The limestone may be similar to the limestone that dips westward beneath the sediments from the west side of the San Andres Mountains.

Valley-fill deposits west of the Rio Grande, north of the Rincon Valley, are believed by Murray[5] to extend to depths in excess of

[5]Murray, C. R., op. cit., p. 25.

TX_MSJ_005466

2,100 feet, as shown by a well drilled to that depth in the Palomas River, about 10 miles north of Caballo Dam.

The well on the Stahman Farms, 24.1E.1.111, in the Mesilla Valley near Mesilla, apparently was still in the Santa Fe formation at 331 feet.

The thickness of the flood-plain deposits of the Rio Grande constitutes an unsolved problem, according to Bryan. He states that in periods of high water the river is capable of transporting gravel that at ordinary times is unknown in the riverbed; thus the depth to gravel in the riverbed may be taken as a rough measure of the depth of scour in great floods. He states, "It seems probable that there is in the larger valleys [of the Rio Grande] from 100 to 250 feet of relatively recent deposits of flood-plain type above the Santa Fe formation." (Bryan, 1938, p. 218.)

As the Mesilla Valley is constricted at both the upper and lower ends by consolidated rocks that are exposed, it seems logical that rock lies at comparatively shallow depths in those areas. The well of Isaac Rhodes, 21.1.13.323, at the upper end of the Mesilla Valley and at the edge of an arroyo on the east side of the valley, was drilled in "rock" from 93 feet to the bottom of the well at about 215 feet. This rock may be similar to the igneous rocks of the Dona Ana Mountains on the east and to those that crop out in the valley at Leasburg Dam about $1\frac{1}{2}$ miles north of the well. "Rock" was reportedly struck at about 125 feet in the well of C. C. Rice, 21.1.11.431, which is located on the pediment at Fort Selden about 50 feet above the valley and about three-quarters of a mile south of the rock outcrop at Leasburg Dam. In the lower end of the Mesilla Valley, the maximum depth of the fill in the gorge of the Rio Grande at the narrows above El Paso has been shown by Slichter (1905, p. 1, fig. 2) to be not more than 86 feet.

The thickness of Quaternary fill near the central part of the Mesilla Valley, on the basis of the reported log of well 24.1E.1.111, appears to be about 104 feet, as most of the gravel was encountered above this level. However, on the basis of gravel reported in the log of the railroad well at Las Cruces, 23.1E.13.244, the thickness of the Quaternary fill there appears to be about 220 feet.

In the Rincon Valley, available well logs show that clay is present at comparatively shallow depths below the Quaternary alluvium. This clay, which is usually called "heavy red gumbo" or "joint clay" by the drillers, is reportedly dry and is thought by the drillers to have considerable thickness. According to Jeff Chandler, well driller at Mesilla Park, a well was drilled at Hatch in the

early years to a depth of 1,100 feet, and nothing but clay was found below about 80 feet. Water was obtained only in the sand and gravel above 80 feet. No substantiating data were obtained on this well. No other wells were reported drilled to this depth in the Rincon Valley. The drillers consider it useless to try to drill through this clay. As water is available in the shallow alluvium in sufficient quantities for all needs, the only incentive for drilling wells through the clay is the hope of obtaining water of better quality for domestic use. In the following table the wells for which data were obtained are listed in order downstream in the Rincon Valley showing the depth at which clay was found.

Reported depth to clay in wells for which data were obtained in Rincon Valley

Name	Well location no.	Total depth of well (feet)	Depth to clay (feet)	Reported description of clay
Osborn	16.5.25.343	152	128	Soft red rock.
Powers	17.5.24.333	101	73	Red gumbo clay.
Plemmons	17.5.26.212	68	68	Clay.
Welch	17.5.26.242	88	84	Clay.
Black	17.5.25.123	59	59	Joint clay.
Black	17.5.25.134	64	64	Clay.
Luchini	17.4.31.111	71	66	Red and white clay with gray sand.
Cantrell	17.4.30.133a	97	70	Red and white clay.
Hedgecock	18.4.9.130	100	50	Blue clay.
Engler	18.4.17.312	70	65	Clay.
Simms	18.4.34.211	245	70	Clay.
Franzoy	18.4.35.231	68	56	Clay.
Franzoy	18.4.35.310	230	60	Clay.
Boggs	18.4.35.221	214	114	Red-brown clay.
Oliver	19.4.3.234	68	68	Clay.
Cowan	19.4.11.221	74	70	Heavy red clay.
Village of Hatch	19.3.9.121a	70	68	Clay.
Cocks	19.3.10.333	69	69	Clay.
Smallwood	19.3.15.443	53	46	Heavy red clay.
Gary	19.2.26.300	150	55	Red clay.

Drilling of most of the wells was stopped as soon as the drillers definitely recognized clay. A few wells were drilled deeper with the hope of going through the clay. The deepest well reported was that of Mr. Simms, which was drilled in clay from 70 to 245 feet, except for a rock about 2 feet thick at about 110 feet. Of the 20 wells listed in the table, 18 reported clay at depths from 46 to 84 feet. The Osborn well, with clay at 128 feet, is located in the floor of Percha Creek about 40 feet above river level. With the exception of the Osborn, Powers, Plemmons, and Welch wells, all are located on the valley floor. The average depth to clay in the 16 wells on the valley floor is less than 70 feet. The thickness of the Quaternary alluvium in the Rincon Valley thus appears to be fairly uniform and somewhat thinner than in the Mesilla Valley.

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OCCURRENCE OF GROUND WATER IN UPLAND AREAS

In order to establish the depth to water and the direction of flow of the ground water under the upland area in Dona Ana County adjacent to the Mesilla Valley, as much information as possible on the existing wells was obtained by G. R. Chenot in 1947. The depth to water was measured in many wells and the altitude of each well was determined by use of the aneroid barometer and the U. S. Geological Survey topographic quadrangle maps. Other available information such as the depth of the well, productiveness, materials penetrated, and quality of the water, was obtained generally from the owners. Water samples for chemical analysis were obtained from various wells. Measured depths to water were checked against reported depths in order to judge the reliability of reported depths in wells where measurements were not possible.

Topographic quadrangle maps of the U. S. Geological Survey covering 15 minutes of latitude are available for all the area of Dona Ana County from the Mexican border northward to latitude 32° 30' N. They have a contour interval of 25 feet, with the exception of the quadrangle maps between the Mexican border and latitude 32°00' N. and between longitude 106° 30' and 107°15' W., which have a contour interval of 10 feet. Vertical and horizontal control in the area covered by the quadrangle maps was excellent. The elevations of the wells north of the Dona Ana Mountains, on the Jornada del Muerto, were obtained by using an aneroid barometer and are subject to some error as the distance between bench marks and check points was great and resulted in a comparatively long time interval between readings. However, the elevations of sufficient check points were read on different days to eliminate any large errors.

The resulting ground-water contours are shown on the accompanying map, plate 1. In drawing the contours greatest reliance was naturally placed upon the wells in which the depth to water was measured. With these measured depths to water as controls, the contours were drawn for the other areas, the elevations of the water table being calculated from reported depths to water as guides, more reliance being placed upon some than others. The areas showing various depths to water were defined by subtraction of the ground-water contours from the ground-surface contours and are therefore as accurate as the water-table contours.

DEPTH TO WATER

The depth to water in the upland areas in Dona Ana County ranges from less than 25 feet to more than 400 feet. Generally the areas

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of greatest depth to water, more than 300 feet, are in the relatively flat plains away from the mountain fronts, such as the La Mesa surface in T. 26 S., R. 1 W. The depth to water generally decreases toward the east side of the Jornada del Muerto and the west side of La Mesa, where the aquifer is relatively thin and the buried rocks of the mountains that form the floor of the aquifer rise, thus holding the water at a higher level than in areas farther from the mountains. The depth to water may therefore be very shallow in the arroyos along the mountain fronts where the deposit of alluvium is thin.

In the Jornada del Muerto, north of the Dona Ana Mountains, the depth to water ranges from 200 to 300 feet below the surface in the western half of the Jornada Experimental Range. A little farther east the depth to water apparently increases to between 300 and 400 feet in a narrow north-south strip and then gradually decreases eastward toward the San Andres Mountains. Northwest of the Dona Ana Mountains the depth to water is about 200 feet and it decreases westward to less than 25 feet near the Rio Grande.

In the Jornada del Muerto, south of the Dona Ana Mountains and east of Las Cruces, the depth to water gradually increases from less than 25 feet at the eastern edge of the Mesilla Valley to more than 400 feet in a narrow north-south strip about 8 miles east of the valley. Farther eastward toward the Organ Mountains the depth to water decreases and is generally from 100 to 200 feet in the vicinity of Organ.

At the southeastern edge of the Sierra de las Uvas, west of the Mesilla Valley, the depth to water is less than 25 feet. Southeastward the depth to water gradually increases to more than 400 feet in a strip about 4 miles wide roughly paralleling the eastern side of the Aden and the Sleeping Lady Hills, and in an area of La Mesa west of Black Mountain near Afton. Farther east the depth to water decreases to about 300 feet along the top of the bluff that parallels the western side of the Mesilla Valley. From the top of the bluff eastward to the valley, a distance of about 2 miles, the depth to water decreases rather abruptly from about 300 to less than 25 feet.

The depth to water, as projected in some areas on the map (pl. 1), is probably greater than the thickness of the sedimentary deposits where masses of igneous rock occur at or near the surface. In such areas water will not be obtained if the rock is impermeable. Some wells on the Bissell ranch have been drilled to a depth greater than the indicated depth to water but have failed to obtain sufficient water for stock purposes. Some of the lavas near Afton occur at the surface above the sediments (Sayre and Livingston, 1945, p. 24). In this area water may be found below the lava at

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the indicated depth to water. If intrusive sills or other impermeable igneous rocks occur at the indicated depth to water, drilling below the impermeable beds will probably reach confined water, which will rise in the well to the indicated water level.

The well on the Corralitos ranch, 23. 1. 32. 330, which was drilled to 501 feet, reportedly penetrated an igneous flow or sill from 165 to 320 feet, a sandstone from 320 to 430 feet, and a rust-colored sand from 430 to 501 feet. The estimated depth to water as reported was 350 feet but, as indicated on the map, is probably a little less than 400 feet. The Malpais well, 26. 1. 16. 330, on the Braidfoot ranch was drilled in a sink in the lava to a depth of 445 feet and reportedly reached water in sand and clay below the lava at 406 feet. The Aden station well of H. S. Bissell, 25. 3. 2. 220, on a small rise, reportedly was drilled through about 440 feet of red igneous rock to seeps of water yielding about 15 gallons a minute at 440 feet. The reported depth to water is 444 feet.

Other wells also have probably obtained water below lava, but data on many of the wells are scant.

Data on the depth to water obtained during this investigation differ from those reported by Lee (1907, p. 38-40). The following table gives the depths to water in various wells as reported by Lee and as collected from various sources during this investigation.

The difference in depth and water level as shown for well 29. 1E. 6. 110 for early and present dates may possibly be due to comparing different wells in the same locality, or may be due to inaccurate reporting. Actual changes in water level may have occurred. The water levels show a rise from the time reported by Lee to later dates. The Lanark well 1 shows a fall in water level from 1899 to the time reported by Lee. On the data for this well one could postulate that water levels declined from early years to a low level in the year reported by Lee and then rose again. However, as all depths to water reported by Lee are lower than those obtained for the same wells from other sources, there may be a consistent error. It is not known how many, if any, of the depths to water reported by Lee were measured by him or were values reported to him. The apparent rise in water levels is greater than one would expect to find in static levels under an area such as La Mesa where the annual rainfall is small. It therefore appears that the reported values are somewhat unreliable.

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Comparison of water levels in Dona Ana County, N. Mex., at different times and as reported from different sources

Well location no.	Field name	Owner or name	Source of information	Date of reported water level	Depth of well (feet)	Depth to water (feet)	Apparent difference in water level, earliest to latest report (feet)
21.2E.25.430a	.....	J. D. Isaacs.	Lee, W. T. (1907, p. 38)	1905 (?)	330	292	
..... Do.....	.....	W. F. Isaacs.	Owner and measurement.	1947	325	290.5	+1.5
22.1.19.330	.....	Mr. Hawkins.	Lee, W. T. (1907, p. 40)	1905 (?)	218	170	
.....Do.....	Hawkins	H. S. Bissell.	Owner and measurement.	1947	180	151.0	+19
27.1E.11.330	Lanark well 1	Southern Pacific Co.	Railroad log 3049.....	1899	950	365	
.....Do.....	do.....	.....do.....	Lee, W. T. (1907, p. 40)	1905 (?)	945	380	-15
27.1.26.430	.....	J. B. Stahling.	.....do.....	1905 (?)	350	311	
.....Do.....	Phillips Hole	Mrs. Annie Braidfoot.	Owner and measurement.	1947	314	286.9	+24
28.2E.24.110	Strauss well 1	Southern Pacific Co.	Railroad log 3084.....	1917	950	342	
..... Do.....	do.....	.....do.....	El Paso office file.....	1941	950	340	+2
28.2E.24.110a	Strauss well 2	.....do.....	Railroad log 3085.....	1918	705	342	
..... Do.....	do.....	.....do.....	El Paso office file.....	1941	705	330	+12
28.2E.24.110b	Strauss well 3	.....do.....	.....do.....	1945	550	328	+14
28.2E.31.340	.....	R. A. Gardner.	Owner.....	1910-20(?)	400	325	
..... Do.....	.....	.....do.....	Measurement.....	1947		392.5	+32.5
29.1E.6.110	.....	Robert Herrington.	Lee, W. T. (1907, p. 40)	1905 (?)	435	350	
..... Do.....	.....	Herrington ranch.	R. A. Gardner.....	1947 (?)	400	265	+85 (?)
29.1E.8.210	Noria well 1	Southern Pacific Co.	Lee, W. T. (1907, p. 40)	1905 (?)	438	358	
29.1E.8.210a	Noria well 2	.....do.....	Railroad log.....	1914	565	321	+37 (?)
29.1E.8.210b	Noria well 3	.....do.....	.....do.....	1916	560		

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MOVEMENT AND FLOW OF GROUND WATER

The contours of the water table on the accompanying map (pl. 1) connect points of the water table having equal altitude. The direction of flow of the ground water is perpendicular to the contours, from higher to lower elevations. The flow of ground water in a homogeneous aquifer of constant width and thickness is proportional to the gradient or slope of the water table—that is, to the spacing of the contours.

The general direction of flow of the ground water in the upland areas of Dona Ana County is from the higher elevations toward the lower along the Rio Grande. The movement of some of the ground water, however, is quite circuitous.

North of the Dona Ana Mountains, in the Jornada Experimental Range, ground water flows westward from the San Andres Mountains and is joined by ground water from the Jornada del Muerto to the north and from the eastern slope of the hills on the east side of the Rio Grande. This water is indicated as flowing through a gap north of the Dona Ana Mountains into the Rio Grande in the vicinity of Leasburg Dam, near Fort Selden.

A ground-water divide evidently occurs in the broad saddle formed between the Dona Ana Mountains and the San Andres Mountains, so that the ground water on the northern slope flows toward the Jornada Experimental Range and that on the southern slope flows to the river in the vicinity of Las Cruces. Ground water originating west of the Organ Mountains flows westward to the Mesilla Valley.

Ground water originating from runoff on the east side of the Sierra de las Uvas flows to La Mesa through the gap between Sleeping Lady Hills and Rough and Ready Hills, T. 22 S., R. 2 W., and through the gap between Sleeping Lady Hills and the Aden Hills, Tps. 23 and 24 S., R. 2 W. The ground-water contours suggest that a ground-water divide occurs in T. 21 S., R. 2 W., and a small part of the ground water on the east side of the Sierra de las Uvas may flow northeastward to the Rio Grande through alluvial fill in canyons and arroyos.

Ground water that originates to the west and south of Robledo Mountain in part finds its way to the Rio Grande in the vicinity of Las Cruces. A ground-water divide probably occurs between Robledo Mountain and the Rough and Ready Hills, about 4 miles to the west, and thus a small part of the ground water probably reaches the Rio Grande northward by way of Faulkner Canyon.

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Most of the ground water that originates from precipitation on La Mesa south of T. 23 S. and that which flows through the gap between the Sleeping Lady Hills and the Aden Hills flows southward on the west side of Black Mountain, where it is joined by ground water from the east slope of the Potrillo Mountains, and then moves eastward to enter the Rio Grande near Strauss.

Lee (1907, p. 39-40), on the basis of reported water levels in the wells owned by the railroad at Lanark and Noria on the La Mesa surface north of the Mexican boundary, stated that the water table sloped southward 20 feet in 12 miles or 1.7 feet to the mile and presumably, therefore, ground water flowed southward from the Rio Grande and La Mesa to Mexico. Lee (p. 40-50) recognized that his meager data indicated a flow southward but, because of the downcutting of the river that formed the Mesilla Valley and the accumulation of water in the gravels of La Mesa, he believed that the underflow down the probable old channel of the river on La Mesa had been reversed and that the ground water flowed into the valley. As Slichter (1905, p. 9-13) had demonstrated that very little ground water escaped from the Mesilla Valley through the narrows at El Paso, Lee showed that the more probable escape of both the water moving from La Mesa to the valley and the water lost from the river in the valley was by evaporation in the valley.

Information gathered during this investigation confirms Lee's belief that ground water does not flow southward under La Mesa to Mexico but rather, from the Mexican boundary, between the East Potrillo Mountains and the Rio Grande, northward and eastward to the Rio Grande. Conflicting data gathered on various wells in this area do not indicate that there is an appreciable change in the configuration of the water table, shown on plate 1.

The depths to water in the Lanark and Noria wells, as recorded in well logs obtained from the railroad, are 365 and 321 feet, respectively, and the altitudes of the wells, as reported by Lee, are 4,156 and 4,114 feet, respectively. Thus the water table is shown as being 2 feet higher at Noria than at Lanark. If altitudes of 4,170 and 4,124 feet at Lanark and Noria, as determined from the topographic quadrangles, are used with the depths to water as recorded in well logs obtained from the railroad, then the water table at Noria is 2 feet lower than at Lanark. Even if the data as reported by Lee, which show the water table 20 feet higher at Lanark than at Noria, are assumed to be correct, it does not necessarily follow that the ground water flows southward, as a ground-water trough lies between Lanark and Noria. (See pl. 1.)

If the depth to water in the Herrington ranch well, 29.1E.6.110, reported by Lee to be 350 feet, and that in the well at Noria, 29.1E.8.210, 358 feet, are considered correct, then a low spot is

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indicated in the contours of the water table that would shift the 3,800-foot contour to the west of Noria. However, the water level measured in 1947 in well 28.2E.31.340 does not allow an appreciable change in the shape of the contours. It is probable that a ground-water divide occurs just south of the international boundary, in the area between the East Potrillo Mountains and the Cerro de Muleros, similar to that indicated in the vicinity of Mount Riley and Malpais sidings.

A ground-water divide occurs between the Sierra de las Uvas and the West Potrillo Mountains. West of R. 3 W. the ground water apparently flows westward into the topographic basin east of the Florida Mountains in Luna County, and thence southward east of Columbus, N. Mex., into Mexico.

The ground water west of the Rincon Valley in the area traversed by Placita Arroyo is shown as flowing toward the Rio Grande in the vicinity of Hatch. Wells in this upland surface are too widely scattered to indicate the exact slope of the water table or the exact direction of flow.

The water-table contours on the water-level map of Dona Ana County (pl. 1) show that the Rio Grande gains water in the Mesilla Valley from the upper part of the valley almost to Mesilla, loses water from Mesilla to Vado, and again gains water south of Vado. The contours were generally drawn through the corresponding riverbed elevations shown on the topographic maps, which may not be the altitude of the water table under the river. If the river water is not in direct contact with the water table, then the river must be perched and must lose water to the water table. In such a case, contours drawn to the river level would show a mound, and therefore indicate correctly that the river is losing water. In the section where the river is shown to be losing water the loss is probably to the paralleling drains, the true contours being inflected somewhat more sharply than can be shown on the scale of the map. The loss or gain in the river is discussed more fully in the section on sources of ground water in the valley fill.

The gradient of the water table under the upland surfaces ranges from about 1.2 feet per mile in the trough of the water table under La Mesa to the west and south of Black Mountain to more than 100 feet per mile on steep slopes along the mountains, such as on the east side of the Aden Hills and West Potrillo Mountains. The average slope of the water table in the Mesilla Valley, as shown by the water-table map of Dona Ana County from the 3,900-foot contour north of Las Cruces to the 3,750-foot contour near the southern end of the valley, is about 4 feet to the mile, essentially the same as that of the river.

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The range of gradients is due to various factors, which include width, thickness, and permeability of the formations, and the quantity of ground-water flow. The steep gradients along the slopes of the mountains are due primarily to the thinness of the water-bearing formation that lies upon the steep slopes of the relatively impermeable rocks that compose the mountains. The gradients in themselves do not indicate the volume of flow of the ground water.

The relatively steep gradient of the water table, about 30 feet to the mile, shown by the contours that extend from the southern end of Robledo Mountain southwest to the West Potrillo Mountains, may be caused by a connection underground of igneous or other relatively impermeable rock between the hills in this area, acting as a "ground-water dam," water on the west thus being held at a higher level than that east of the hills. Southeastward the gradient flattens to about 13 feet to the mile between the 3,800- and 3,900-foot contours in T. 25 S., R. 1 W., and to about 1.2 feet to the mile in the water-table trough west of Black Mountain.

The progressive flattening of the gradient of the water-table in the direction of flow from the gap between the Aden and Sleeping Lady Hills to the Rio Grande east of Strauss is caused by an increase in the width, thickness, or permeability of the saturated aquifer, by a decrease in amount of ground-water flow, or by a combination of these factors. Undoubtedly, the thickness of saturated sediments increases in the direction of flow. The saturated aquifer along the east side of the Aden and Sleeping Lady Hills is presumably thin, as the hills protrude through the sediments. The thickness of the sedimentary deposits of La Mesa is not known. Apparently the deepest well, the 1,330-foot well at Strauss, penetrated only unconsolidated deposits (Sayre and Livingston, 1945, p. 35). The bolson deposits in the Hueco Bolson east of the Franklin Mountains seems to be at least 4,000 feet thick (Sayre and Livingston, p. 33).

The width of the saturated aquifer, however, does not increase but, instead, decreases from a width of about 12 miles east of the Aden Hills to about 3 miles in the ground-water trough west of Black Mountain. The sediments underlying the central portion of La Mesa may be more permeable than those along the slopes of the hills. This is probable if the central part of La Mesa is composed of sediments deposited by the Rio Grande, which flowed at one time through the Jornada del Muerto and La Mesa, as postulated by Lee (1907, p. 22). Undoubtedly, the amount of ground-water flow does not decrease in the direction of flow as there is no area of surface discharge of the ground water. Instead, the amount of ground-water flow probably increases eastward because the ground-water trough also carries water from the east slope of the Potrillo Mountains.

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Therefore, the decrease in gradient of the water table from northwest to southeast across La Mesa is due to the increased thickness, and possibly to the increased permeability, of the saturated sediments, which more than offset the increase in amount and the decrease in width of flow of the ground water.

The amount of water flowing eastward from R. 1 E. to R. 2 E. toward the Rio Grande, between the two 3,800-foot contours south of Lanark, can be roughly calculated. The average coefficient of transmissibility of the aquifer may be taken as 70,000 gallons a day per mile of width of the aquifer for each foot per mile of slope of the water table, approximately equal to that of 73,000 determined by the pumping test of Las Cruces city well 5 (p. 96). With a gradient of 1.2 feet per mile and a width of about 9 miles, the ground-water flow to the Rio Grande in the vicinity of Strauss is of the order of 750,000 gallons a day or 840 acre-feet a year, a small quantity.

The selected gradient of the water table, 1.2 feet a mile, is an average from the 3,800-foot to the 3,775-foot contour and may be significantly smaller than the actual gradient at the section. The gradient of the water table in the Hueco Bolson, between the 3,700-foot and 3,675-foot contours, east of the Franklin Mountains and northeast of El Paso, is 2.4 feet per mile (Sayre, and Livingston, 1945, pl. 2). The amount of precipitation on the Hueco Bolson is similar to that on La Mesa, and therefore approximately the same average unit amount of recharge probably reaches the water table in both areas. As the deposits are thick in both areas, the steeper gradient in the Hueco Bolson may be due to a lower average permeability of the formation than in La Mesa. However, the gradient of 2.4 feet a mile is small and is given for comparison with that determined in La Mesa. The coefficient of transmissibility used, 70,000, is believed to be rather high as an average for the Santa Fe formation and would tend to offset the probable higher gradient, so that the amount of computed ground-water flow to the Rio Grande in the vicinity of Strauss would not be changed materially.

The annual flow of roughly 800 acre-feet of ground water to the Rio Grande in the vicinity of Strauss, if distributed equally across the 9-mile width of the section, would amount to an accretion to the river from the west of about 0.13 cubic foot a second per mile along the river.

The average gradient of the water table, along the trough in the water table under the central part of the plain northeast of Las Cruces, is about 20 feet to the mile. If the transmissibility of the sediments here is about the same as that determined for city well 5, or about 70,000 gallons a day per mile of width of the formation

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with a gradient of 1 foot per mile, the flow toward the valley from northeast of Las Cruces would be about 1,400,000 gallons a day per mile of width of the aquifer, or about 2 cfs (cubic feet a second) per mile along the valley. However, the average transmissibility in this area is probably less than 70,000, possibly not more than 30,000, and the ground-water flow to the river from northeast of Las Cruces may be as little as 1 cfs per lineal mile. Slichter (1905, p. 27-29) in his study of the ground waters of the Rio Grande valley, determined in the vicinity of Mesilla Park that about 0.5 cfs was being contributed to the valley from the northeast for each lineal mile.

Flow to each mile of the Mesilla Valley from the remainder of the area east of the valley is expected to be less than that from northeast of Las Cruces because the aquifer is thinner. The amount of water entering each mile of valley from the east may be somewhat greater than that from the west as a result of the greater precipitation on the higher mountains. Arroyos from the highlands to the river are more definitely developed east of the valley than west. The gradient of the water table under most of the area east of the river and south of Las Cruces is not known but may be slightly greater than that northeast of Las Cruces, because of the steepness of the surface from the Organ and Franklin Mountains. The overall average accretion to the valley from the highlands on the east is believed to be less than that northeast of Las Cruces and more than that west of the valley; it is estimated as about 0.7 cfs per mile along the valley.

The flow of the drainage ditches in the Mesilla Valley is composed of varying percentages of return irrigation water, canal seepage losses, and seepage from the river, in addition to some ground-water flow from the side mesas. Presumably, if diversions to the irrigated lands were stopped and there were no flow in the river, the resultant drain flow, if any, would be that contributed by ground water from the side mesas. Figure 3, which shows the relation of reported net diversions in the Mesilla Valley to water being returned to the river by the drains, indicates that with no diversions there would be approximately 5,500 acre-feet a year of drain flow, equivalent to about 0.1 cfs per mile for 55 miles along the valley. This figure necessarily is very rough as it was assumed that a linear relation existed between the diversions and drain flow, which may not be true. Also, the line in the figure is not determined exactly by the points plotted. This small quantity does not necessarily represent the total flow from the side mesas but probably only that part of the side flow that contributes to the drainage ditches, the balance being consumed by vegetation.

The total accretion of ground water to the valley from the highlands on both sides of the Mesilla Valley may therefore amount to

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less than 1 cfs per lineal mile, less than 40,000 acre-feet a year for the 55 miles of valley. The accretion to the Rio Grande in the 150 miles from Pena Blanca to San Marcial previously has been estimated as nearly 1 cfs per lineal mile (National Resources Committee, 1938, p. 291). The exactness of the value for accretion of ground water from the highlands to the Mesilla Valley is open to question, but the order of magnitude is believed to be right, and it shows the small amount of ground water reaching the valley from the side mesas.

RECHARGE OF GROUND WATER

The ground water in the upland areas of Dona Ana County is derived from precipitation upon the upland and mountainous areas. It seems probable that by far the larger part of the precipitation upon La Mesa evaporates and is transpired by plants and that very little reaches the water table. As most of the rainfall occurs in the form of showers during the summer when the ground surface is very hot and dry, the amount of evaporation is large, and whatever precipitation does get below the ground surface replenishes the soil moisture for use by plants. Only in wet years or periods of protracted wet spells can an appreciable quantity of water be expected to reach the water table from the surface of the plain. H. S. Bissell, of the Corralitos ranch, states that flood water has collected, at times, in the depression southwest of Robledo Mountain, east of Sleeping Lady Hills, forming a shallow lake from 4 to 6 miles in length which lasts from about 1 month to as much as 6 months before disappearing. This long time suggests that most of the water is lost by evaporation and little by downward percolation because of the clay bottom of the depression. The greater part of the recharge in the La Mesa area is probably from precipitation upon the various areas of lava exposed at the surface. A small part of the recharge also probably occurs along the mountain fronts where freshets discharge upon and sink into the plain. It is believed that in the Hueco Bolson, east of the Franklin Mountains, very little recharge to the ground-water body occurs from precipitation upon the floor of the basin, which may collect in sinks, but rather that the major part of the recharge comes from precipitation in the area of gravels along the western edge of the bolson, along the east slope of the Franklin Mountains (Sayre and Livingston, 1945, p. 70-72).

The ground-water flow through an area is in approximate equilibrium with the average amount of recharge that contributes to the flow. The surface area contributing to the flow of about 800 acre-feet a year in the section south of Lanark comprises roughly 26 townships or 600,000 acres. On this basis the average ground-

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water accretion from precipitation on the area is less than 0.02 inch annually. This small quantity is what might be expected in this area where the annual rainfall is less than 10 inches.

The small amount of precipitation annually recharging the ground water in the La Mesa area, computed above, may be compared with an amount of 0.05 to 0.06 inch contributing annually to the ground-water supply of the High Plains in Texas where the average annual precipitation is about 17 inches. The recharge to the High Plains has been computed on the basis of an estimated natural ground-water discharge of 25,000 to 30,000 acre-feet a year from 9,000 square miles of the High Plains (White, Broadhurst, and Lang, 1946, p. 391).

WATER CONDITIONS IN THE RINCON AND MESILLA VALLEYS

In the Rincon and Mesilla Valleys surface and ground water are closely related. A change in the condition of one is reflected by a change in the other. The surface water and ground water are in approximate equilibrium, the level of the water table and the flow of the drainage ditches being controlled by the losses occurring from the surface supply. Normally the surface water is diverted to irrigate the land, and the seepage that occurs from the irrigated lands, canals, and the river reappears as return flow in the drains and is reused in the lower divisions of the project. Because of the physical connection between the surface and ground waters and because the water in the drains is part of the project water supply, it is not possible logically to discuss the ground-water conditions without also discussing those of the surface water.

SURFACE WATER

AVAILABLE SURFACE FLOW

To evaluate properly the effects upon the supply of surface water caused by pumping ground water in the Rincon and Mesilla Valleys and to arrive at the quantity of water that would have to be pumped for irrigation in case of a shortage of surface water, it is necessary to consider the quantity and the seasonal distribution as involved in the present exclusive use of surface water for irrigation.

The quantity of surface water released to the project has varied widely from year to year, dependent upon the amount of water in

storage in Elephant Butte Reservoir. Prior to the completion, in 1938, of Caballo Dam, about 28 miles below Elephant Butte Dam, water released to the project was gaged at the station below Elephant Butte Dam. Since 1938, the water released to the project has been gaged at the station 0.8 mile below Caballo Dam and about 1.5 miles above Percha Dam, the first diversion dam of the project. According to records obtained from the Bureau of Reclamation, there was an average annual accretion of about 27,000 acre-feet from 1925 to 1937, in the section of the river from Elephant Butte Dam to Percha Dam. A seepage run (simultaneous or nearly simultaneous stream gagings made at many places to determine the extent of gains or losses and where they occur) made on the Rio Grande in November 1928 (New Mexico State Engineer, 1928, p. 24) indicates an annual gain in flow by the river in this section of 35,000 acre-feet, and a seepage run made by the State Engineer's office in February 1936[6] indicates an annual gain in flow of 32,000 acre-feet. In order to include this gain in flow in the water supply of the project and to have records comparable to records of water released from Caballo, the data for flow of the Rio Grande at Percha Dam for years prior to 1938 has been used in this report. The table on page 136 gives the annual flow from 1930 to 1946 at Percha and Caballo Dams, at Leasburg Dam, and at the El Paso station along with the streamflow depletion between Percha and Leasburg Dams, corresponding to the Rincon Valley, and between Leasburg Dam and the El Paso station, corresponding to the Mesilla Valley.

The large flow in 1942 was caused by water discharging over the spillway of Elephant Butte Dam, the only time there has been such a discharge. The average annual flow below Caballo Dam from 1930 to 1946, with the exception of the abnormal year of 1942, was 794,200 acre-feet. Of the water released, 60,000 acre-feet per year is required by international treaty for delivery to Mexico; this leaves 734,200 acre-feet minus losses plus return waste, drain flow, and arroyo accretions to be diverted for use in the project. The diversions from the Rio Grande into the Acequia Madre near Ciudad Juarez, for use in Mexico, have averaged 62,500 acre-feet during the period of record, 1938 to 1946 (International Boundary and Water Comm., 1946, p. 51) approximately equal to the required amount.

The monthly distribution of water released from Caballo Reservoir from 1938 to 1946 is given in the table on p. 137. The water releases for the 6 months from April through September account

[6]Bliss, J. H., 1936, Report on investigation of invisible gains and losses in the channel of the Rio Grande from Elephant Butte to El Paso, Tex. (unpublished), table 2, p. 8, February 1936.

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for about 84 percent of the demand on the reservoir, not taking into account the abnormal year of 1942. In each year except 1942 the releases for May were smaller than those for April. This decrease in demand in May is characteristic of the project.

DIVERSIONS TO CANALS OF RIO GRANDE PROJECT

The gross annual diversion of water to the canals of the project varies annually, depending upon the release of water from storage. Table 3 on page 138 gives the annual diversions at Percha Dam, Leasburg Dam, Mesilla Dam, to the El Paso Valley of the project, and to the Acequia Madre which serves the Valle de Juarez of Mexico. The water diverted at the Percha Dam to the Arrey Canal serves the Rincon Valley. The water diverted at the Leasburg Dam to the Leasburg Canal and at the Mesilla Dam to the East and West Side Canals serves the Mesilla Valley, the lower part of which is in Texas. Included as diversion at the Mesilla Dam is water wasted from the Leasburg Canal to the East Side Canal. Diversions to the Acequia Madre for the Valle de Juarez are made at the International Dam, and figures for these diversions are available only for the period since the beginning of operation of the American Dam in 1938.

A portion of the gross diversion in each valley is wasted back to the river or to the drainage ditches and is again diverted, along with the return drain water, by the next lower unit. This wastage in a normal year, as discussed in the following pages, is estimated for the period 1930 to 1946 as averaging about 24 percent of the gross annual diversion of 589,300 acre-feet to the Rincon and Mesilla Valleys. The net annual diversion to the Rincon and Mesilla Valleys is therefore estimated as averaging 447,900 acre-feet or 61 percent of the 734,200 acre-feet released from storage from Caballo Dam and available to the project, and the gross annual diversion of 589,300 acre-feet averages 74 percent of the release from reservoir storage.

DISTRIBUTION OF DIVERSIONS

The distribution of diversions, which include canal wastes and seepage losses, is important not only because the losses contribute to the ground-water body and eventually the flow of the drains but also because the losses must be known in order to determine the quantity of ground water that must be pumped for irrigation in a dry year.

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Table 5 (p. 141 to 142) obtained from the U. S. Bureau of Reclamation gives the compilation of irrigated acreage and water distribution by years, 1930 to 1946, for each division of the Rio Grande project and for the project as a whole.

Figures for the irrigated acreage are compiled every year by the U. S. Bureau of Reclamation information furnished by the watermasters of each division and are believed to be reasonably accurate. The headgate diversions are the quantities measured at the heads of the main canals and are also reasonably accurate. Canal waste or return is unused diverted water that is returned to the river or wasted to the drains from the canals. This quantity is estimated daily by the ditch riders and is probably reported low. Water delivered to the farms is, in general, estimated by the ditch riders, a few deliveries during a year being measured with a current meter. It is believed that the reported deliveries are less than actual, as they are conservatively estimated quantities on which payment for water is based.

The acreage irrigated, as shown in the tables, has increased nearly every year for all divisions of the project, with the exception of the early 1930's, when economic conditions were poor, and in 1935, when there was an impending shortage of water. The total acreage irrigated in the project increased from 141,197 acres in 1930 to 159,899 acres in 1946. This increase was brought about mainly by gradual leveling of land formerly too rough to irrigate. The area supporting native vegetation probably has been reduced by this process.

UNIT DIVERSIONS

The average annual diversion of water from the river to the canals in the Mesilla and Rincon Valleys from 1930 to 1946 was about 6.5 acre-feet per irrigated acre. The minimum annual diversion reported for the Rincon and Mesilla Valleys occurred in 1941 with 4.7 acre-feet per acre for the Rincon Valley, 4.8 feet for the Leasburg division, and 5.4 feet for the Mesilla division.

CANAL WASTE

Canal waste or return is of an operational nature and can be reduced by careful attention to water schedules. It is reported that much of the wastage is due to cancellation of water orders by the farmers after the water has already been released from the dam and diverted to the canals. The minimum figure reported for annual canal waste in the Rincon and Mesilla Valleys from 1930

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to 1946 was 8 percent of the diversion, occurring in 1946 in the Leasburg division, and the maximum was 35 percent, occurring in 1930 and 1931 in the Rincon Valley and Leasburg division. In general, lower percentages for canal waste have been reported in the later years. The weighted average of the reported wastage for the Rincon and Mesilla Valleys is about 19 percent. As the reported canal wastage is probably low, the actual average canal wastage is estimated as about 24 percent of the gross headgate diversions of 6.5 acre-feet per acre, or 1.6 acre-feet per acre.

CANAL-SEEPAGE LOSSES

The canal and unaccounted-for losses, given in the tables (p. 71 to 72), include seepage losses from the canals, evaporation from the water surface in the canals, transpiration by plants along the banks of the canals, and any other losses. The reported seepage losses are derived by subtracting from the diversions the estimates of the water wasted from the canals to the river or drains and the water delivered to the farms. As both the wastage and the deliveries are believed to be greater than reported, it is probable, therefore, that the actual seepage losses are lower than reported. The lowest figure reported for annual canal losses in the Rincon and Mesilla Valleys from 1930 to 1946 was 26 percent, which occurred in 1937 and 1940 in the Leasburg division.

A seepage run was made in November 1923 by the Bureau of Reclamation upon the Leasburg Canal from Wasteway No. 1, about a mile below the Leasburg Dam station, to Elwood, a distance of 11.59 miles. The stretch of canal was divided into 5 sections in lengths ranging from 0.7 mile to 4.3 miles. The loss of water in the sections ranged from 0.7 cfs per mile to 2.2 cfs per mile, with an average loss for the whole distance of 1.2 cfs per mile. The total length of canals and laterals in the Leasburg system is 115.3 miles. The total indicated loss of water, therefore, is about 138 cfs, about 22 percent of the reported capacity (635 cfs) of the Leasburg Canal near its head.

The percentage of seepage loss from the canals is not constant, either for the whole of the canals or any part of them or for various quantities of flow. The actual quantity of water lost by seepage is more nearly constant. Small quantities of flow will show, in general, a larger percentage of loss than large quantities of flow in the same canal. However, in a normal year the estimated canal seepage and unaccounted-for losses in the Rincon and Mesilla Valleys average about 20 percent of the gross headgate diversions of 6.5 acre-feet per acre, or 1.3 acre-feet per acre.

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WATER DELIVERED TO FARMS

The water delivered to the lands in the Rincon and Mesilla Valleys is the remainder of headgate diversions after accounting for canal wastage and seepage losses. Using the figures of 24 percent for canal wastage and 20 percent for seepage loss to be deducted from headgate diversions in an average year, the water delivered to the lands in the past is 56 percent, which in an average year with headgate diversions of 6.5 acre-feet per acre amounted to 3.6 acre-feet per acre of irrigated lands. In contrast, the reported average delivery of water to the land in the period from 1930 to 1946 was only 2.8 acre-feet per acre or about 43 percent of the water diverted from the river. The maximum reported percentage of the diversions delivered to the farms in any one year was 58 percent, in 1937 and 1940 in the Leasburg division. In general, larger percentages have been reported as delivered to the farms in later years.

A rough comparison of the estimated percentages of diversions delivered to the lands in the past, averaging about 56 percent, with what possibly could have been delivered under past conditions can be made by combining the minimum quantities reported in any year for canal wastes and for canal losses in each division and assuming the remainder of the diversion to have been available for delivery to the farms. In the Rincon Valley, the minimum reported percentage for canal waste is 14, in 1946, and for canal losses 29, in 1939 and 1940, making a possible delivery to the lands of 57 percent. In the Leasburg division, the minimum reported percentage for canal waste is 8, in 1946, and for canal losses 26, in 1937 and 1940, making a possible delivery to the lands of 66 percent. In the Mesilla division, the minimum reported percentage for canal waste is 10, in 1946, and for canal losses 30, in 1943, making a possible delivery to the farms of 60 percent. The average for the three divisions is 61 percent, compared with the estimated actual delivery of 56 percent.

FLOW OF DRAINS IN RINCON AND MESILLA VALLEYS

The flow of the drains is directly related to the ground-water levels, which, in turn, are related to the amount and seasonal distribution of the surface-water supply. To show this relationship the seasonal variation of the drain flow must be known, as well as the total annual flow. Also, in order to determine the effect of pumping upon the drains it is necessary to determine the average gain in flow of the drains.

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Drains have been constructed in the Rincon, Mesilla, and El Paso Valleys to maintain the water table at a low level. In 1946 there were about 42 miles of drains in the Rincon Valley and about 226 miles of drains in the Mesilla Valley. The rate of flow in the drains is measured about three times a month with a current meter at the outlet of each drain, except the two short intercepting drains in the Mesilla Valley, the Santo Tomas and Montoya, totaling about $8\frac{1}{2}$ miles, which are not measured. The monthly and annual drain flow for the Rincon Valley and the Mesilla Valley, from 1930 to 1946, are given in table 5 on pages 141, 142. On the average, about 64 percent of the drain flow occurs in the 6 months from April through September, as contrasted with 84 percent of the release from storage in the same period. The average annual drain flow for the Rincon and Mesilla Valleys from 1930 to 1946 is 249,400 acre-feet, or about 42 percent of the gross diversions and 52 percent of the gross diversions and 52 percent of the reported net diversions—that is, gross diversions minus wastage—to the Rincon and Mesilla Valleys in the same period.

The average return flow of the drains for the Rincon Valley is 50 percent of the reported net diversion to that valley, and the return flow of the drains for the Mesilla Valley is 52 percent of the reported net diversions to that valley. The close agreement between the percentages of return flow of the drains for the 2 valleys indicates a similarity of conditions.

With a normal supply of surface water the average monthly gain in flow of the drains in cubic feet per second per mile of drain, in the Rincon Valley ranges from a minimum of about 0.6 in January to a maximum of about 1.7 in August, with an average of 1.2 for the year; in the Mesilla Valley it ranges from a minimum of 0.8 in February to a maximum of 1.9 in August, with an average of 1.3 for the year.

Average river depletions by Rincon and Mesilla Valleys

[Based upon diversions less drain return flow, 1930–46, in thousands of acre-feet]

Average diversions to Rincon and Mesilla Valleys (p. 72)	589.3 (gross)	447.9 (net)
Average drain flow returned to river (p. 72)	249.4	249.4
Average river depletions	339.9	198.5
Depletions, percent of average reservoir releases to project of 734,200 acre-feet, (omitting abnormal release for 1942), p. 39.	46	27

The water in the drains is composed of varying percentages of waste from the canals, seepage from canals, return seepage from irrigated lands, seepage from the Rio Grande, and flow of ground-water from the mesa lands to the valley.

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Wastage from the canals to the drains supposedly is not included in the measured flow of the drains, the practice being not to measure the flow when it contains waste water, as indicated by a change in color of the drainage water. However, as this is not always practicable, it is probable that the measured flow of the drains contains some waste water.

RELATIONS OF DRAIN FLOW AND DIVERSIONS

A relation is to be expected between the ground-water recharge, represented mainly by return of irrigation water, and the ground-water discharge, represented mainly by drain flow. Knowledge of the relation is necessary in order to show the direct connection existing between the available surface supply and the return drain flow and to ascertain the amount of drain flow to be expected in a year of decreased surface supply.

As all components of the ground-water recharge to the valley fill, except that from the mesa lands and from precipitation, vary seasonally and annually with the amount of surface water available, it is logical to expect a seasonal and annual variation of the drain flow.

The relation of drain flow to reported net diversions has been plotted for the Rincon and the Mesilla Valleys in figures 2 and 3. On this type of graph the points should fall along a line if a relation exists between the variables, the line being straight if a linear relation exists. The points show some scattering but in general fall along the straight lines given, which indicate a drain flow of about 50 percent of the net diversions in the Rincon Valley and the Mesilla Valley, essentially the same as computed previously (p. 44).

The scattering of the points is probably mainly due to inaccurate estimates of canal wastes and therefore inaccurate figures for net diversions. Varying amounts of waste water inadvertently included with measured drain flow and varying amounts of seepage directly from the river to the drains also may be responsible in part for the scattering.

Also plotted on figures 2 and 3 are graphs of the drain flow and net diversions, by years, for the Rincon and the Mesilla Valleys. These graphs show, in different form, the same relations as those shown in the scatter diagrams, increases and decreases in net annual diversions generally being accompanied by increases and decreases in the drain flow.

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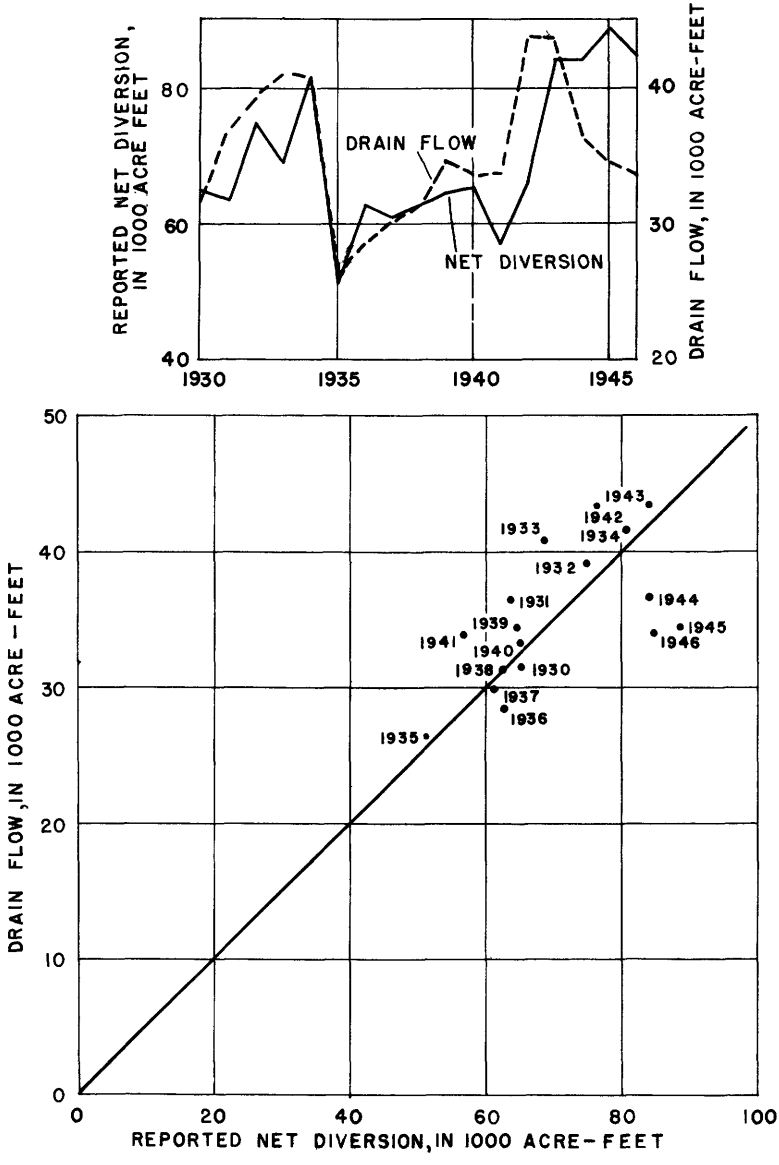

Figure 2. — Relation of reported net diversions to return drain flow in Rincon Valley, N. Mex.

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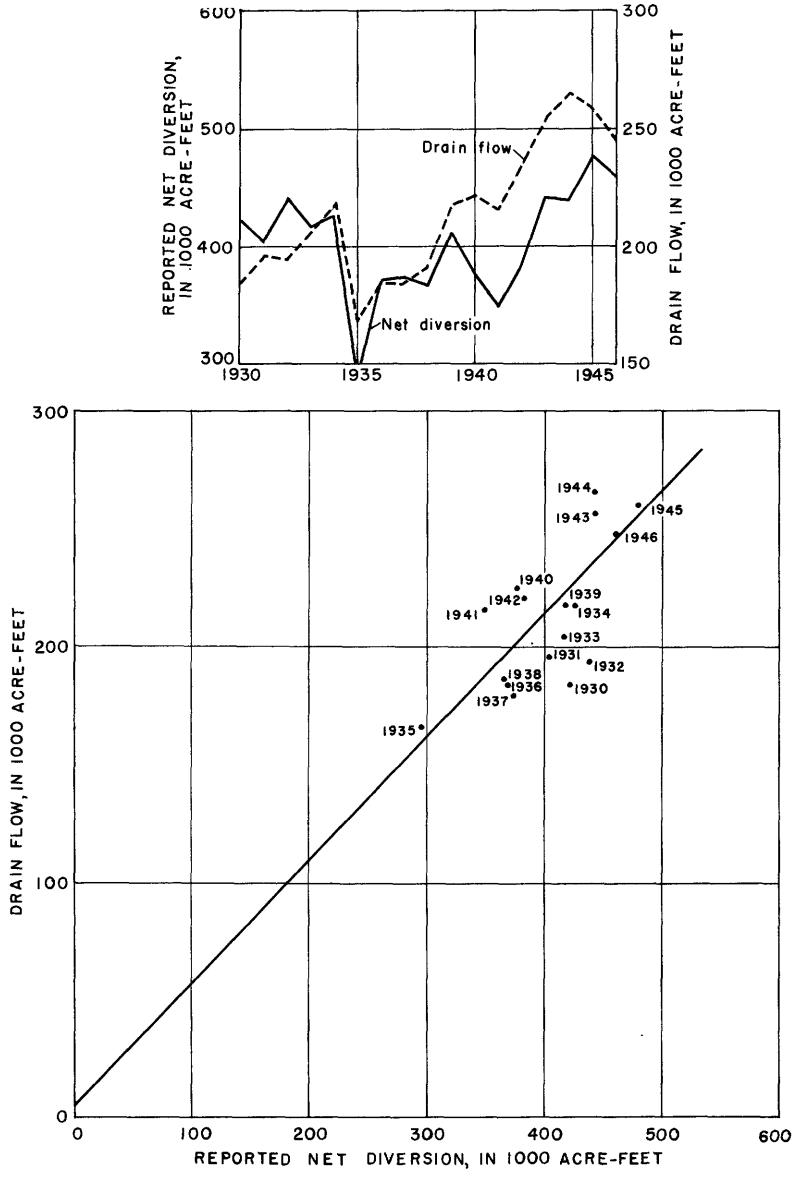

Figure 3. — Relation of reported net diversions to return drain flow in Mesilla Valley, N. Mex. and Tex.

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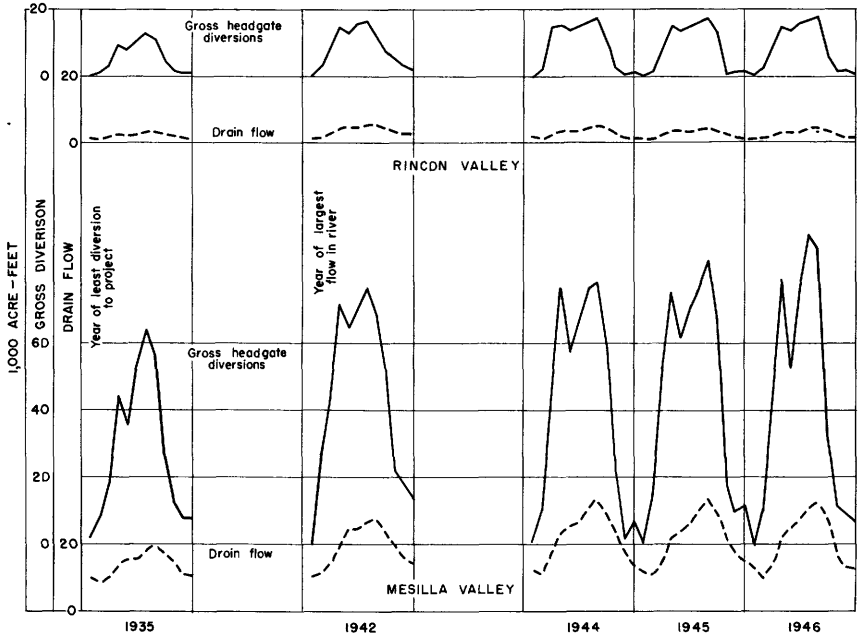

Figure 4. — Seasonal relations of gross headgate diversions and drain flow for selected years, Rincon and Mesilla Valleys.

In order to show the seasonal relations between diversions and drain flow, the gross diversions and the drain flow have been plotted by months on figure 4 for the Rincon and the Mesilla Valleys for the years 1935, 1942, and 1944-46. The smallest diversion to the project occurred in 1935; the largest flow in the river occurred in 1942.

The close relations between the diversions and the flow in the drainage ditches is readily apparent. The characteristic decrease in diversions each May is reflected in the drain flow, generally a month later, as either a slight reduction or a slackening in the rate of increase of drain flow. The maximum diversions occur in either July or August as, generally, does the maximum drain flow. As this flow would continue to decline as long as there were no diversions or water in the river, the time of minimum drain flow would not necessarily be related only to the time of minimum diversions. The minimum drain flow occurs in February just before the effects of the February diversions are apparent. Diversions in February are followed by increases in the drain flow by March. Evidently there is a very little lag in seasonal effects between the diversions and the return drain flow.

In order to determine whether a long-term lag effect exists, of the order of a year or more, between diversions and drain flow, figure 5 was prepared by plotting the cumulative annual departures

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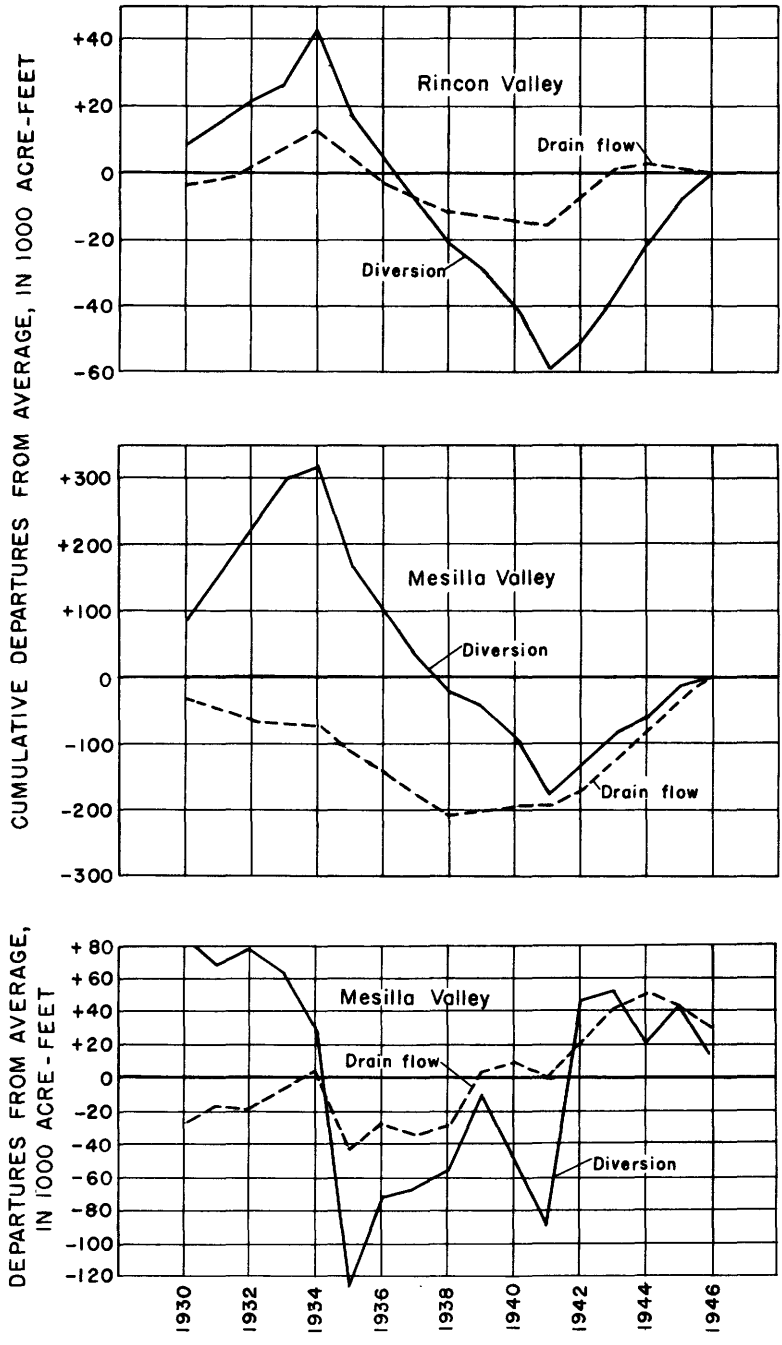

Figure 5. —Departures from average drain flow and diversions, Mesilla and Rincon Valleys, 1930-46.

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from the average during the period 1930 to 1946 for both the return flow in the drains and the gross diversion in the Rincon and the Mesilla Valleys. Upward-trending lines indicate above-average conditions; horizontal lines, normal conditions; and downward-trending lines, below-average conditions. The graphs of drain flow and diversions for the Rincon Valley conform very closely except for 1945 and 1946, when an opposite trend between the two is indicated. No lag of the order of a year or more for the Rincon Valley is apparent.

The relation in the graphs for the Mesilla Valley is not so apparent. Below-average conditions of drain flow through 1938 are followed by above-average conditions. Diversions, on the other hand, show above-average conditions through 1934, followed by below-average conditions through 1941, after which above-average conditions again prevailed. It is possible that the above-average drain flow beginning in 1939 is related to the above-average diversions for a number of years preceding 1935, for which the beginning year is not known. If that is true, then the below-average diversions beginning in 1935 have not yet been reflected in the drain flow through 1946, a lag of at least 12 years. However, as the flow of the drains in the Mesilla Valley has shown a general increase from 1930 to 1944, the plot of cumulative departures does not show the relation that exists. Selection of a different figure for a base from which to compute departures from normal would result in a different graph.

The other graph, in figure 5, which shows only departures from average for the drain flow and the diversions for the Mesilla Valley, better portrays the relation and indicates little or no lag in the drain flow with an increase in the diversions, but possibly a lag of 1 or 2 years with a decrease in diversions.

REQUIRED WATER SUPPLY

In order to determine the amount of ground water that would be required for irrigation in a year with a shortage of surface water it is necessary to consider the quantity involved under the present conditions of irrigation with surface water exclusively.

During years of plentiful water supply the estimated average amount of water delivered to the lands of the project in the Rincon and Mesilla Valleys was 3.6 acre-feet per acre, 56 percent of that diverted. The minimum amount of water reported as delivered to the land from 1930 to 1946 was 1.74 acre-feet per acre for the Rincon Valley and 2.12 acre-feet per acre for the Mesilla Valley, amounts which are assumed to have been conservatively estimated as they represent only 23 and 29 percent, respectively, of the

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water available for delivery. The maximum percentage of diverted water that was delivered to the lands from 1930 to 1946 occurred in 1940 and amounted to 51 percent, or 2.78 acre-feet per acre, for the Rincon Valley and 58 percent, or 3.12 acre-feet per acre, for the Mesilla Valley.

The unit consumptive use for crops is subject to a large variation in both actual and computed use. The unit consumptive use of cotton in the Rincon and Mesilla Valleys for the 17-year period from 1919 to 1935 was estimated 2.5 acre-feet per acre in the report of the Rio Grande joint investigation, with minimum of about 2.0 feet and a maximum of about 3.0 feet. The unit consumptive use of alfalfa for the same period was estimated 4.5 acre-feet per acre, with range from 4 feet to 5 feet. The estimated consumptive use of other crops ranged from a minimum of 1.5 feet for grains to a maximum of 3.0 feet for forage, with an average of about 2.0 feet (National Resources Committee, 1938, v. 1, p. 382, 383). The acreage of cotton in the Rincon and Mesilla Valleys in 1945 was 66,624, of alfalfa 21,864, and of other crops 11,060 acres. The corresponding acreages in 1946 were 68,921 acres, 19,362 acres, and 12,628 acres. Using the unit figures given above, the total consumptive use of crops in 1945 was about 288,000 acre-feet and in 1946 about 285,000 acre-feet. The average unit consumptive use for the total irrigated acreage in the Rincon and Mesilla Valleys in 1945 was therefore about 2.9 acre-feet per acre and in 1946 about 2.8 acre-feet per acre. Precipitation probably furnished about 0.4 acre-foot per acre, leaving about 2.4 to 2.5 acre-feet per acre supplied by irrigation.

Assuming that in the period 1930 to 1946 the average consumptive use of water for the irrigated lands was the same as in 1945, 2.5 acre-feet per acre in addition to the amount furnished directly by precipitation, the excess water delivered to the lands was 1.1 feet, about 30 percent of that delivered to the farms of 17 percent of the gross annual diversions of 6.5 acre-feet per acre and 22 percent of the estimated net annual diversion of 4.9 acre-feet per acre. This return seepage of 1.1 acre-feet per acre from the irrigated lands plus that of 1.3 acre-feet per acre from the canals is about 37 percent of the gross or 49 percent of the estimated net diversion and is to be compared with the measured drain flow of 42 percent of the gross diversion.

The difference of 5 percent between the computed and measured percentages of the gross diversion represented by the drain flow probably is made up in part of waste water that has been included in the measured drain flow, seepage directly from the river, and ground-water flow from the side mesas to the drains.

TX_MSJ_005493

The amount of water applied to the lands in past years doubtless was more than actually necessary, even though irrigation of crops requires that an excess of water be applied. It is therefore assumed that an excess of about 30 percent of the consumptive use of 2.5 feet, giving a total of 3.3 feet of irrigation water, would be sufficient to grow a normal crop in the Rincon and Mesilla Valleys.

In a dry year with a shortage of surface water, canal waste could be reduced by careful attention to water schedules. The minimum reported percentage of canal wastage occurred in 1946 for each division and ranged from 8 percent in the Leasburg division to 14 percent in the Rincon Valley. It seems reasonable, therefore, to assume that wastage could be reduced to 5 percent. This would be likely if a project pumping system were operated, in which case cancellation of water orders by the farmers could be handled quickly by stopping the necessary pumps. Of course, the canal waste water is not actually wasted, except that lost by evaporation, if used for irrigation of lands in a lower part of the valley. However, excessive wastage makes it necessary for the lower operating units to change their diversion schedule or in turn to waste the water.

Also, in a dry year the canal-seepage losses probably would be relatively higher than the 20 percent in an average year, probably about 25 percent of the gross diversion. The delivery of water to the lands would therefore be about 70 percent of the surface-water diversion.

In a hypothetical year having 3.25 acre-feet per acre or 50 percent of an average supply of surface water available for diversion, 70 percent or 2.28 feet of water could be delivered to the farms, or about 70 percent of the 3.3 feet believed necessary to raise a normal crop. Thus, in a year when the available surface supply was only 50 percent of the average, about 70 percent of the land probably could be irrigated with judicious use of water without pumping; or, as about two-thirds of the total acreage is planted to cotton, the main staple crop of the district, sufficient water would be available to water the entire cotton crop. This would be possible if every care in the distribution of the water were exerted by the farmers and ditch riders.

GROUND WATER IN VALLEY FILL

DEPTH TO WATER

The depth to water in the Rincon and Mesilla Valleys in the early years prior to construction of Elephant Butte Dam was considerably greater than at present. The flow of the Rio Grande at that time

TX_MSJ_005494

was unregulated and there were periods when there was no flow of water. The amount of water applied to the lands was quite variable, large amounts being applied when available and none during periods when the river was dry. The amount of land irrigated in early years was relatively small, about 26,229 acres in the Mesilla Valley and 4,370 acres in the Rincon Valley in 1907 (National Resources Committee, 1938, p. 75).

By 1914 the irrigated acreage had increased to about 45,356 acres in the Mesilla Valley and 6,961 acres in the Rincon Valley (National Resources Committee, 1938, p. 75). The increase resulted partly from construction of the Leasburg diversion dam in 1908 by the Bureau of Reclamation and partly from improvements in the distribution system. As a result of the increase in irrigated acreage, the water table rose.

The first water from the Elephant Butte Reservoir was made available to the project in 1915. The reservoir not only assured a more plentiful supply of water but also resulted in clear water being available, whereas formerly silt-laden water had been used. The clear water seeped more rapidly from the canals, and, as the clear water also drained faster from the irrigated lands, more water was applied to the lands. These conditions, described in the project histories of the Bureau of Reclamation, resulted in a rise of water level to alarming heights and caused abandonment of productive farmlands.

The change in water level is shown by the profiles of the water table in the vicinity of the State Agricultural College and westward to the river on plate 4, which has been taken from a similar diagram prepared by the Bureau of Reclamation in 1927. The low water table shown in 1904 was taken from Slichter (1905, p. 26-27). The water level given for June 1917 ranged from nearly 6 feet to as much as 12 feet above the level of 1904 and in some low spots was at the surface. Four years after construction of the drains the water table had been lowered 1 to 4 feet in the areas between the drains in the vicinity of the cross section, to the level given for June 1927.

The rise of the water table from 1904 to 1916 in the vicinity of Mesilla Park, in the locality of the cross section, is given in the following table obtained from the Bureau of Reclamation[7].

[7]Fiock, L. R., 1917, Drainage report, Rio Grande project, U. S. Bur. Reclamation unpublished report. El Paso, Tex., February 1917.

TX_MSJ_005495

Rise of water table in vicinity of Mesilla Park, N. Mex., 1904–16

Year	Average depth to water (feet)	Rise of water table	
		Period (feet)	Per year (feet)
1904	11.5		
1915	7.0	4.5	0.4
1916	5.7	1.3	1.3

The rise of the water table to within 4 feet of the ground surface in 33,000 acres, representing 40 percent of the irrigable area south of T. 23 S., resulted in a reduction of irrigated land to 47,000 acres by November 1916[8].

As a result of the high water table in the Mesilla Valley, plans were made for the installation of open drains. In order to determine the depth to water and the configuration of the water table, preparatory to construction of the drains, the Bureau of Reclamation in the period 1913 to 1917 bored about 800 holes with hand augers in the Mesilla Valley. These holes were located on the east-west section lines across the valley at intervals of about a quarter of a mile, except on the east side of the river from a mile north of Berino to 2 miles south of Fort Fillmore, where additional holes were put in at quarter-mile intervals on east-west lines midway between the section lines. Plate 5 is a water-table map prepared by the Bureau of Reclamation in 1917 from measurements made in these holes in June 1917. The areas having various depths to water are indicated by shading. About 4 percent of the reported area had water standing on the surface, and more than 66 percent of the area had water within 4 feet of the surface. The sloughs and meanders of the old river beds are clearly shown by the pattern of the depth to water, particularly that of the water on the surface and ground water within 2 feet of the surface. At that time (1917) about 6 miles of the east drainage ditch had been completed. The effect of the lowering of the water table in the vicinity of the east drain is clearly shown.

The depth to water in the auger holes in the summer of 1919 is shown on the map prepared in September 1919 by the U. S. Bureau of Reclamation. (See pl. 6.) The drains that had been constructed by that time are indicated on the map. The lowering of water level that occurred in the vicinity of the completed drains is apparent. The following table from the Bureau of Reclamation report[9] shows the change in water levels that occurred in two districts from June

[8] Fiock, L. R., op. cit.
[9] Fiock, L. R., 1920, Rio Grande project history, 1919: Ch. 9, U. S. Bur. Reclamation, El Paso, Tex., January 1920.

TX_MSJ_005496

Comparison of depth to water in Mesilla Valley in drained part of the west side unit in September 1919 with corresponding conditions in June 1917 before draining

[Note: Drainage construction was progressing through the above districts in September 1919]

Depth to water (feet below land surface)	La Union district				Upper west side district			
	1917, before construction of drains		1919, area affected by drains		1917, before construction of drains		1919, area affected by drains	
	(acres)	(percent)	(acres)	(percent)	(acres)	(percent)	(acres)	(percent)
On surface	175	1.0	6	0.04	1,748	8.5	63	0.67
0 to 2	3,118	17.1	278	1.95	5,224	25.6	229	2.44
2 to 4	11,027	61.4	628	4.4	8,171	39.8	867	9.23
4 to 6	[1]3,665	20.5	4,230	29.6	[1]5,376	26.2	2,149	22.85
6 to 8	.....	.....	5,799	40.6	.....	.....	3,570	38.0
Over 8	.....	.....	3,339	23.4	.....	.....	2,521	26.81
Total gross area	17,985	100	14,280	100	20,519	100	9,399	100
Area affected by drains	0	0	14,280	79.4	0	0	9,399	45.7
Total area in which water is less than 4 feet	14,320	79.5	912	6.39	15,143	73.9	[2]1,159	12.34
Total area in which water is 6+ feet	([3])	([3])	9,138	64.01	([3])	([3])	6,091	64.81

[1]Includes everything over 4 feet, practically all between 4 and 6 feet.
[2]Practically all in old riverbeds.
[3]Practically none.

TX_MSJ_005497

1917 to September 1919. In the La Union district, where 79 percent of the area had water at less than 4 feet in June 1917, only 6 percent of the drained area had water at less than 4 feet in September 1919. Similar conditions are shown for the upper west side district.

Additional overall lowering of the water level has occurred since September 1919. At that time only a part of the drainage system had been completed, and sufficient time had not elapsed for the water level to become stabilized. On the profile in plate 4 has been plotted the water level in September 1919 as scaled from the water-table contours on the map, plate 6. At that time the Mesilla drainage ditch had been completed to a point a little less than a mile north of the line of the profile. As shown, the water level in the Mesilla Drain in September 1919 was practically the same as in June 1927, whereas water levels at some distance from the drain were higher in September 1919 than in June 1927. With two additional drains across the line of the profile and the 8 years of additional drainage, the water levels were lowered about 3 feet in areas between the drains.

A comparison of depths to water in a few of the auger holes, as measured in late August 1946 by the Bureau of Reclamation, with the depths to water as taken from the map for September 1919 are given in the following table. The designations of the wells are as shown on plate 3.

Changes in depth to water in Mesilla Valley, N. Mex., as measured in auger holes in late August 1946 and as determined from depth-to-water map of September 1919

Hole designation	Depth to water (feet)		Change (feet)	Hole designation	Depth to water (feet)		Change (feet)
	September 1919	August 1946			September 1919	August 1946	
5	1.8	4.4	-2.6	32	6.0	6.2	-0.2
6	2.0	3.4	-1.4	33	5.7	5.0	+.7
9	2.5	5.6	-3.1	Dunn	8.2	6.5	+1.7
15	4.2	8.3	-4.1	Bartlett	8.5	7.9	+.6
16	6.0	8.0	-2.0	Liberty	7.8	5.4	+2.4
17	6.0	4.6	+1.4	Thalman	8.0	6.7	+1.3
23	4.0	9.8	-5.8	Bloomberg	5.8	5.8	0
27	2.5	6.6	-4.1	Berino	5.0	4.4	+.6
37	4.2	3.5	+.7	Rice road	6.5	5.1	+1.4
40	3.8	5.9	-2.1	Opitz	3.3	2.4	+.9
46	4.1	7.6	-3.5	Pool	7.0	5.4	+1.6
Stahman	2.0	7.6	-5.6	Campbell	4.0	2.8	+1.2
Duran	4.5	9.3	-4.8	McKamey	3.9	3.3	+.6
Mesquite	4.5	4.7	-.2	Dairy farm	7.0	7.8	-.8
Sweet	3.8	4.0	-.2	HighSchool	8.0	4.6	+3.4
Find	3.7	2.6	+1.1	Anthony West	5.3	4.1	+1.2
Vado	3.9	4.2	-.3	Longwell	6.0	2.0	+4.0
Anthony head	5.0	4.4	+.6	Borderland	5.3	4.9	+.4
Three Saints	3.8	4.7	-.9	Wade	7.8	4.0	+3.8
La Union	3.0	6.2	-3.2				
Average			-2.0	Average			+1.2

[1]Affected significantly by drainage by 1919.

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Only parts of the Mesilla Valley, particularly the lower half, had been affected by drainage by September 1919. Wells located in such areas are indicated in the table. The depth-to-water measurements given in the table are not as accurate as desired. The land surface near a well tends to change position, especially as there has been considerable leveling of the land since 1919. The depths to water taken from the map are subject to errors of as much as 2 feet; an error in location of a well, for instance, such as occurs in an area of rolling topography, may affect the determined depth to water by that amount. The map itself is subject to error at any particular spot. The time of observation for the 2 years differs possibly by a month, which in itself may account for a difference of water level. With these factors in mind, it seems that tne water table in areas not yet affected by drainage in September 1919 had declined by late August 1946 from 2 to 6 feet, with a probable average of more than 2 feet, whereas the water table in areas affected by drainage in September 1919 was higher in late August 1946 possibly by as much as a foot. This rise may be partly due to a clogging of the drains or a decrease in the depth of the drains by filling with debris and, also, partly to the increase of irrigated land since 1919.

About 220 holes were bored with hand augers in 1917 and 1918 in the Rincon Valley. Maps of the water table from a mile north of the Sierra County line to R. 2 W. were prepared by the U. S. Bureau of Reclamation from the measurements made in these wells, probably in 1919 prior to construction of the Garfield and Hatch Drains. The accompanying map, plate 7, was taken from the original maps which were drawn to a scale of 500 feet to an inch. The water table at that time ranged from land surface to more than 4 feet below land surface and was from 2 to 4 feet below land surface in a large part of the area. The lowering of water level that has taken place since construction of the drainage system is not known, although it is probably similar to that which occurred in the Mesilla Valley.

The changes in water level in the Rincon Valley are given in the following table. The measurements for 6 of the wells are for August when the water table normally is near or at its seasonal high, and those for the other 3 wells are winter readings when the water table is near its seasonal low level. As the time of the water levels shown on the maps prepared in 1919 is not known, and as the seasonal range of water levels is about 4 feet, the changes shown in the table are not conclusive as to amount but indicate a probable drop of more than 2 feet from 1919 to 1947.

The water level in the Rincon Valley, in the area near the lower end of the Rincon Drain in 1926 after completion of the drain, is also shown on plate 7. In about half the area the depth to water was in excess of 4 feet.

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Changes in water level in Rincon Valley, N. Mex., as measured in wells in August 1947 and as determined from depth-to-water map of 1919

Well location number	Occupant of property	Depth to water (feet)		Change (feet)
		1919	August 1947	
17.4.32.112	Painter	2	6.6	-4.6
17.4.31.111	Luchini	4	5.5	-1.5
18.4.5.214	Prater	6	[1]13.4	-7.4
18.4.17.312	Engler	4	5.3	-1.3
18.4.17.411	Riggs	3	[2]8.3	-5.3
19.3.10.333	Cocks	5	5.0	0
19.3.10.432	Stotts	6	9.1	-3.1
19.3.9.121	Hatch	2	3.4	-1.4
19.3.15.443	Smallwood	1	[3]5.6	-4.6
Average				-3.2

[1]February 1948.
[2]December 1947.
[3]February 1947.

FLUCTUATIONS OF THE WATER TABLE

Changes in water level in the Mesilla and Rincon Valleys are brought about by return of irrigation water, canal and river seepage losses, precipitation, transpiration and evaporation, and, in part, by changes in the level of the drains and the river. Daily, weekly, seasonal, and yearly changes in the water level are the net effect of all these factors.

EFFECT OF IRRIGATION

The lands are irrigated during the summer months, with about 83 percent of the diversions from the Rio Grande occurring from April through September. Return seepage from irrigation and seepage from canals and the river all occur about the same time; the result is that water levels in the valleys and along the edges of the adjoining mesas are higher in late summer than in late winter. Figure 6 shows the fluctuations of water level as measured daily at 5 p. m. in an auger hole, 23.2E.29.214, on the east edge of the valley in the northeast corner of a field at the weather-instruments shelter of the Agricultural College. The field is a grass-covered athletic practice field that is irrigated about once a month. The times of irrigation, as noted by the local observer, are plotted at appropriate points on the graph. A major "peak" in the water level occurred about 1 day after each irrigation of the surrounding field. Weekly fluctuations are roughly indicated, and

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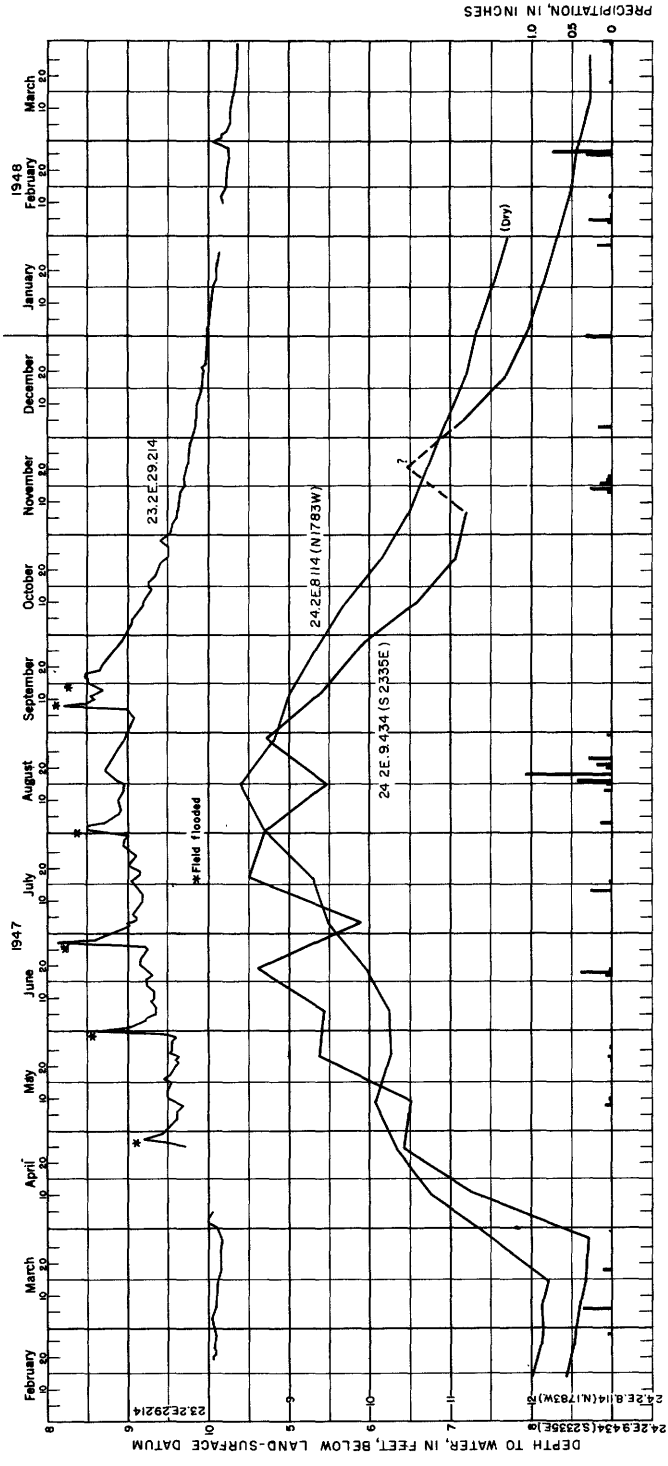

Figure 6.—Fluctuations of water level in three auger holes in Mesilla Valley, and precipitation at State College, N. Mex.

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probably correspond to the times of irrigation of nearby lands. The low level was reached in late March and the high level—except for a short-lived peak in June—in early September. A nearly continuous rise occurred from March to September while water was being diverted to the canals.

Also plotted on figure 6 are graphs of water levels from measurements made every 2 weeks in 2 other auger holes. Well 24.2E. 9.434 is 2,335 feet east of the Park Drain along the Seale road. Well 24.2E.8.114 is 1,783 feet west of the Park Drain along the Holt road, which is about a mile north of the Seale road. Irrigated fields are on both sides of the 2 roads.

The graphs for these two auger holes show marked summer highs like the preceding auger hole but differ from each other in their minor fluctuations. The smaller rises in water level in May than in April reflect the characteristic decrease in diversions to the valleys in May, which is also reflected in a decrease in drain flow, as indicated previously. The magnitude of the seasonal change in water level is dependent upon the location with respect to nearby drains, canals, and irrigated lands.

The Bureau of Reclamation has measured water levels at monthly intervals for a number of years in about 50 auger holes distributed over the Mesilla Valley, from about 7 miles south of Leasburg Dam to the southern edge of the valley. About 15 of these wells are so-called sample wells that were bored in 1936 for the purpose of obtaining samples of ground water for chemical analysis during the time of the Rio Grande joint investigation. The remaining holes were bored in 1924. The water levels have been measured roughly to the tenth of a foot by a "sounder" attached to the end of a metallic tape. The available records of water level in 11 of the auger holes are plotted in plate 8. In addition to the well location number, the number or name of the hole as designated by the Bureau of Reclamation is given; the holes are located on plate 3. Sample wells on plate 8 are designated by a number, enclosed in parentheses following the hole number or name, which corresponds to the number assigned during the Rio Grande joint investigation.

The water level in each auger hole indicates the yearly cycle, the high level occurring in late summer in response to return of water diverted from the canals, and the low level occurring in the late winter. The reduction in diversions that usually occurs in May of each year is generally reflected by a lowering of the water levels in the auger holes. However, as the time of measurement of the water levels has varied each month, this lowering of water

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level is not always apparent. The detailed and long-term trend in water levels shown in each well is a net result of factors surrounding each well, such as a change in the amount of water applied to nearby lands, which in turn can be caused either by a change in type of crops grown or by a change of irrigation practices. As the valley is traversed by drains, the minimum level of the ground-water table at any point is controlled largely by the elevation of the bottom of nearby drains. As a drain gradually fills with debris over a period of years, the nearby water levels will rise until such time as the drain is cleaned. In the early years of the project a smaller proportion of the land was irrigated than in late years. Irrigation of new land near an auger hole causes a gradual rise in water level in that hole over a period of time until approximate equilibrium is again reached. None of the above factors is known concerning the area around a particular well.

The auger holes for which records through 1946 are available are shown on plate 3. Wells 32, 33, and 37 are on an east-west line east of Mesilla Dam, and their water levels are plotted on plate 8 to show that water levels in the same general area are affected differently. The graphs show a general agreement but differ in detail. Well 37 shows a greater seasonal change than wells 32 or 33, which may be partly due to seepage from the east side canal in the vicinity of well 37. There was a lowering of the water level in 1935 in all the wells coincident with reduced diversion in that year, and a rise of water level in 1942 coincident with the increased diversion and river flow in that year. Minor fluctuations shown on the graph may be in part due to inaccuracies in measurement of the water levels.

If a true average water level could be obtained over the Mesilla Valley, it is probable that the average yearly levels would fluctuate with the annual diversion and the long-term trend in levels might show a slight rise because of increased irrigated acreage; this might be offset in some areas by a lowering of water levels resulting from the lowering of the riverbed by scouring.

Water levels were measured at about monthly intervals during 1947 in approximately 18 wells, mostly irrigation wells, in the Rincon and Mesilla Valleys in order to observe the change in level throughout the year. A few of the observation wells are located in sedimentary deposits above the level of the alluvium in the valleys. Fluctuations of water level in 7 such wells are shown in figure 7.

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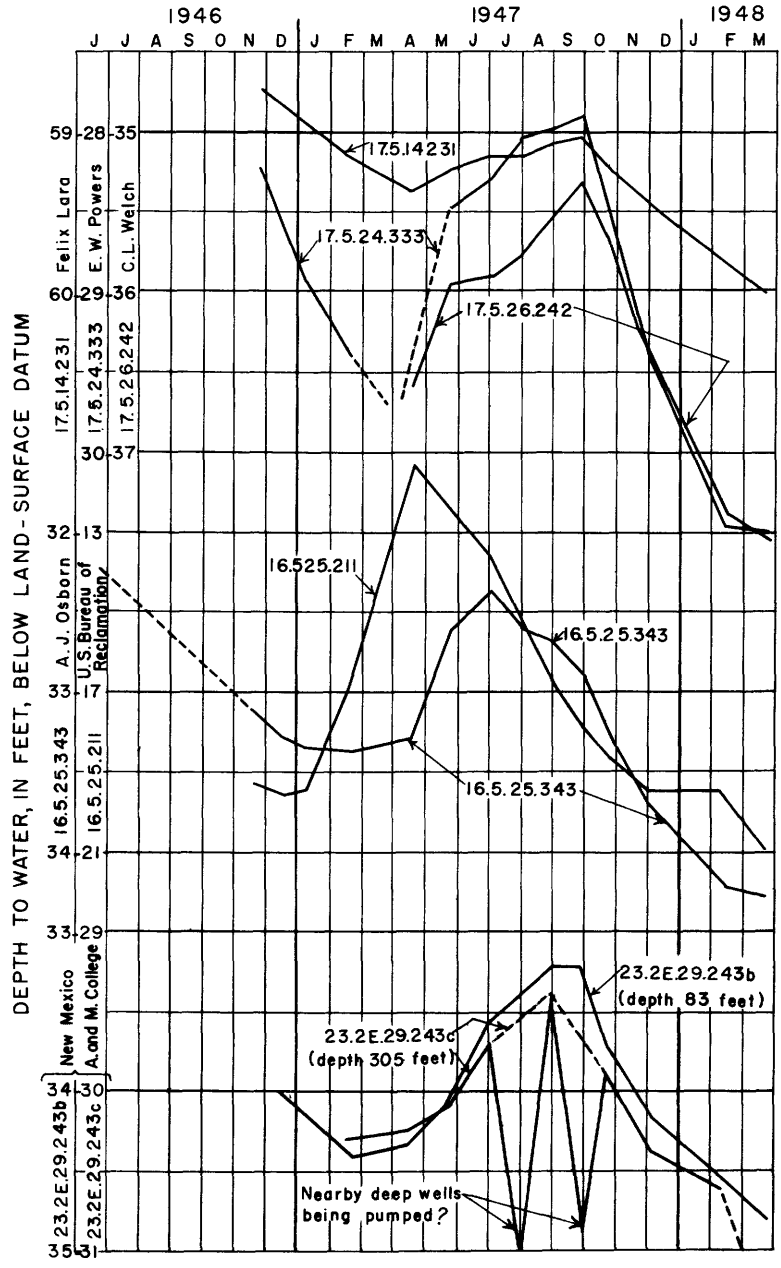

Figure 7. —Fluctuations of water level in seven wells located in arroyo beds or in sediments above the valley floor of the Rio Grande.

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Well 17. 5. 14. 231 belonging to Felix Lara, is an unused well near the northern end of the Rincon Valley on the south side of Montoya Arroyo, about 0. 8 mile west of the Arrey Canal which at this point follows the western edge of the valley floor. The water level in this well is about 10 feet above the water level in the river which is about 1 1/4 miles to the east. Wells 17. 5. 24. 233 and 17. 5. 26. 242, belonging to E. W. Powers and C. L. Welch, are wells used for irrigation near the northern end of the Rincon Valley in Tierra Blanca Creek, above the valley floor and about 1, 500 feet west of an irrigation lateral. The water level in these three wells reached the low level for the year in April and the high level near the end of September. A slight reduction in the rate of rise of the water level in June or July seems related to the decrease in diversions in the valley in May. The trend of the water levels in these wells during the year is the same as that in the auger holes on the floor of the Mesilla Valley and shows the relation of the ground water under the adjoining mesas to that in the valleys.

The fluctuations of the water level in 2 unused wells at the State Agricultural College in Mesilla Valley are also given in figure 7. The ground surface at these wells, 23. 2E. 29. 243b and 23. 2E. 29. 243b (83 and 305 feet deep, respectively), is from 15 to 20 feet above the level of the valley. The times of the seasonal high and low water levels in these wells correspond to those in wells in the valley, and again indicate a close relation between the water in the valley and that under the adjoining higher lands. The altitude of the static water level in February 1947 was nearly the same in these 2 unused wells, from 0. 5 to 1. 0 foot below the water level in the valley. Two domestic wells, 228 and 428 feet deep, are about 100 feet from the 2 unused wells. The water level in the 305-foot unused well seems to be influenced by pumping in the deep domestic wells. The upper water in the 305 foot unused well is cased off, only water near the bottom entering the well.

Wells 16. 5. 25. 211 owned by the U. S. Government (Bureau of Reclamation) and 16. 5. 25. 343 belonging to A. J. Osborn, are south of Caballo Dam and on ground above the level of the valley floor. Well 16. 5. 25. 211 is on the north side of the former channel of Percha Creek, about 1, 000 feet south of the dam, and well 16. 5 25. 343 is on the south side of the former channel of Percha Creek on a line perpendicular to the dam through well 16. 5. 25. 211 and about 5, 800 feet south of the dam. Fluctuations in the water level in these two wells, shown in figure 7, seem related to the seepage from Caballo Reservoir, which varies with the reservoir level. The high level in the reservoir occurs each year in mid-March and the low level in mid-September.

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EFFECT OF PRECIPITATION

Precipitation in the Rincon and Mesilla Valleys causes changes in the water levels. The water table rises as the ground water is recharged from precipitation percolating downward and as a result of reduced transpiration by plants that normally get their water from the ground-water body. However, at times of precipitation, application of irrigation water to the lands is usually reduced or stopped. The effect of the reduced recharge from irrigation water probably more than offsets the effect of the slight recharge from light precipitation, and thus a lowering of the water level results. Precipitation in the Rincon and Mesilla Valleys is small, amounting to only 6.08 inches in 1947 at State College (2.60 inches below normal) and 4.88 inches at Caballo Dam. The effect of precipitation on the water level is expected to be small except during moderate to heavy showers, when the precipitation that reaches the water table may offset the decrease in recharge from irrigation water. The moisture content of the soil at the time of precipitation influences the amount of precipitation that reaches the water table, showers on wet soil having a greater effect than those on dry soil. As the soil generally contains more moisture in the summer than in the winter because of irrigation and as more than half of the total annual precipitation occurs in July, August, and September, probably most of the recharge to the ground water from precipitation in the valley comes from showers in the summer.

The daily precipitation at State College in 1947 and part of 1948 has been plotted on figure 6 along with the water levels measured daily, about 5 p. m. in the auger hole, 23.2E.29.214, located beside the rain gage. Some showers during the summer caused rises in the water level, whereas others apparently had little effect or were accompanied by slightly lower levels resulting from reduced irrigation. Precipitation from August 20 to 23 totaled 0.52 inch and apparently did not affect the water table, whereas that from June 17 to 19, of 0.49 inch, caused a rise of 0.16 foot in the water level in the auger hole. The heavy rains from August 13 to 18 totaled 1.65 inches, of which 1.06 inches fell on the 18th, and apparently caused a rise in the water level of 0.23 foot. Comparatively heavy rains in the winter seemingly had little or no effect on the water level. Precipitation from November 13 to 18 of 0.60 inch caused only a slight temporary decrease in the rate of lowering of the water table. Heavy rains February 27 and 28, 1948, amounting to 1.05 inches, caused an apparent rise of water level of 0.21 foot.

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EFFECT OF TRANSPIRATION

In areas of native vegetation where the water table is shallow, the water level shows a typical diurnal fluctuation, falling during the day and rising during the night. The fluctuation is small, generally less than two-tenths of a foot in most areas where such fluctuations have been investigated. The fall of the water level in the daytime is caused by the use of water by plants, producing an effect similar to a small pump. After sundown the transpiration from the plants becomes small or ceases and the water levels recover.

Fluctuations of water level in nine wells in the middle Rio Grande valley near Socorro, N. Mex., in groves of cottonwood, tornillo, and willow, and in saltgrass meadows, are given in the report of the Rio Grande joint investigation (Theis, 1938, p. 275-276). Records of fluctuations of water level due to transpiration in the Rincon and Mesilla Valleys were not obtained but are believed to be similar to those in the middle Rio Grande valley.

SOURCE AND MOVEMENT OF GROUND WATER

Ground water is seldom stationary but nearly always moving from an area of recharge to an area of discharge. The direction of flow of the ground water gives an indication of the sources of recharge and areas of discharge. Because ground water flows down gradient, just as surface water does, altitudes of the water table determined at many places will show the direction of flow of the ground water, which is at right angles to the contours of the water table. A change of gradient of the water table is shown by a change in spacing of the contours, and under natural conditions it indicates a change in velocity of the ground water brought about by a change in the amount of water flowing through the sediments under consideration, a change in the thickness or width of the formation, a change in the permeability of the aquifer, or a combination of changes in any of them.

DIRECTION OF MOVEMENT

The direction of movement of the ground water under the valley floor of the Rincon and Mesilla Valleys is indicated by the contours of the water table shown in plates 5-7. The general direction of flow is down the valleys. Superimposed on this general circulation of ground water are circulations of smaller scale such as, lateral flow into the drains—in places, more or less directly from adjacent canals or the river—flow from the bordering uplands, and, in

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places, flow from or to the river. Plate 9, taken from a map prepared by the Bureau of Reclamation, shows a direct flow from the Three Saints lateral eastward to the Anthony Drain. Figures 9 and 10 show direct flow in the vicinity of Hill from the Leasburg Canal to the Leasburg Drain.

In the Mesilla Valley in June 1917, the average gradient of the water table along the axis of the valley from the 3,900-foot contour near the north end of the valley to the 3,710-foot contour near Montoya, a distance of about 42 miles, was about 4.5 feet to the mile, the same as that of the ground surface. The gradient at any particular spot as determined from the spacing between 10-foot contours on the map of the water table for June 1917 ranged from as little as 3 feet to the mile, just north of Chamberino, to as much as 10 feet to the mile, just north of Las Cruces. The gradient of the water table as determined in September 1904 from a line of wells from Las Cruces to a point south of Mesilla, a distance of nearly 5 miles, was 4.64 feet to the mile (Slichter, 1905, p. 24, 25).

It is believed that the average gradient of the water table down the valley at the present time is essentially the same as in 1917, the effect of the drains having been an overall lowering of the water table.

The gradient of the water table in 1919 in the Rincon Valley from the 4,070-foot contour 1 mile north of the Dona Ana County line to the 3,994-foot contour, a distance of about 16 miles, was about 4.8 feet to the mile, essentially the same as that of the ground surface. (See pl. 7.)

SOURCE OF GROUND WATER

The ground water in the valley fill is derived from a number of sources, the quantity from each being generally indistinguishable. Water is derived from seepage from the river in various sections, seepage from the canals and laterals, seepage from irrigation water applied to the lands, ground-water flow from the bordering mesa lands, precipitation upon the valley floor and adjacent mesas, and a small amount from flash floods in the arroyos that discharge from the mesas to the valley.

SEEPAGE FROM THE RIO GRANDE

In several stretches the river loses water to the ground-water body, as indicated by the contours on the water table in the accompanying maps. Seepage from the river in the Mesilla Valley in

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June 1917 is indicated at the Mesilla diversion dam between the 3,830- and 3,820-foot contours. (See pl. 5.) The seepage from this stretch may be due partly to raising of the river level by the diversion dam. A pronounced seepage loss from both sides of the river is indicated from Fort Fillmore to Mesquite between the 3,810- and the 3,790-foot contours. Seepage from the river is also indicated in the vicinity of Montoya from the 3,712-foot contour to below the 3,704-foot contour. Other isolated contours show seepage loss from the river. In some stretches, such as from opposite Chamberino to opposite Anthony between the 3,758-foot contour and the 3,740-foot contour, the river is shown to be gaining water. It is shown to be gaining water on the north side of the bend opposite Dona Ana and probably losing water from the south side. In June 1917, before construction of the drains, the river apparently was losing more water than it was gaining. This condition probably was responsible in part for the high water table.

In September 1919, after construction of a number of the drains, the seepage loss from the river apparently increased, as evidenced by the steep water-table gradients from the river to the drains. (See pl. 6.) Increased seepage losses are especially apparent in areas where the drains, such as the Chamberino Drain, were constructed near the river. This seepage loss from the river induced by the drains does not mean an actual loss of water from the valley, as the drain water is discharged into the river farther down the valley.

The seepage loss from the river has been changed somewhat by the storage of water in Elephant Butte Reservoir. Previous to this storage, the river water that was used in the Rincon and Mesilla Valleys contained the usual load of silt, which during normal flows sealed the riverbed and canals to some extent. After release of clear reservoir water began in 1915, a greater amount of seepage occurred from the river and canals. This increased seepage loss was in part responsible for the rapid rise in ground-water levels that necessitated construction of the drains.

The clear water also has had a tendency to scour the riverbed. The scouring has been helped by the program of river rectification of the International Boundary and Water Commission, which has consisted of confining the river in a narrow channel and straightening or cutting off large bends of the riverbed. From 1917 to 1932 the river from Percha Dam to Leasburg Dam was shortened about 2.93 miles and from Leasburg Dam to International Dam was shortened about 2.81 miles.[10]

[10]U. S. Army Corps of Engineers, Albuquerque district, 1947, Survey for flood control, Rio Grande and tributaries: v. 8, appendix F, Sedimentation, chart 87, Sept. 1, 1947.

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The average annual degradation of the riverbed from 1917 to 1932, from 1932 to 1941, and from 1941 to 1942 is given in the following table. The values were obtained by the U. S. Army Corps of Engineers by taking the average of the lowering at 1-mile intervals from profiles of the riverbed as prepared by the International Boundary and Water Commission. The profile in 1917 was of the water surface while, 2,000 cfs was being released from Elephant Butte Reservoir. The riverbed was assumed to be 1.5 feet below the water surface. The profiles of the riverbed for both 1941 and 1942 were taken in December of each year, before and after the large spill (maximum of 8,000 cfs) from Elephant Butte Reservoir in early 1942. This large spill caused considerable scouring, as shown in the table. Complete data for the Rincon Valley for years succeeding 1932 are not available. Six cross sections of the river in the Rincon Valley, obtained from the International Boundary and Water Commission, indicate a lowering of the riverbed from 1932 to 1943 from near Hatch southward. However, the cross sections are too few to show the conditions for all the valley. Reports of a few farmers indicate scouring in sections of the Rincon Valley comparable to that in the Mesilla Valley. Some lands bordering the river in the upper portion of the valley that formerly could be farmed without irrigation, because the water table was accessible to plant roots (the practice being called subirrigation), have not been suitable for farming in that way in the last few years because of the lowered water table.

Degradation of the bed of the Rio Grande, Percha Dam to Courchesne bridge, 1917–42

[U. S. Army, Corps of Engineers, Albuquerque district, N. Mex., Sept. 1, 1947, Survey for flood control, Rio Grande and tributaries: v. 8, appendix F, Sedimentation, chart 87]

Section	Average annual degradation in feet			Total 1917-1942
	1917-1932	1932-1941	1941-1942	
Percha Dam to Leasburg Dam	0.14	.....	.....	[1]2.08
Leasburg Dam to Mesilla Dam	.11	0.07	0.95	3.28
Mesilla Dam to Courchesne bridge	.07	.10	.40	2.36

[1]1917-1932.

The table shows an average degradation of the river bed of more than 2 feet in the Rincon and Mesilla Valleys from 1917 to 1942. However, greater scouring has taken place in the upper part of each valley. In the Rincon Valley practically all scouring from 1917 to 1932 was north of the Haynor bridge, about 10 miles south of Hatch, where a maximum scouring of 7 feet was measured in 2 sections. In the section from Leasburg Dam to Mesilla Dam all

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the scouring took place above a point about 5 miles north of the Mesilla Dam, a maximum of 8.0 feet from 1917 to 1942 occurring in the section 3 miles below Leasburg Dam. In the section from Mesilla Dam to Courchesne bridge, all the scouring from 1917 to 1942 took place above Montoya, about 8 miles north of Courchesne bridge, a maximum of about 5 feet occurring about 9 miles below Mesilla Dam.

The probable effect of this degradation of the riverbed has been to reduce the seepage loss from the river. However, the installation of drains in the valleys has tended to increase the seepage loss from the river, which may have offset the decrease due to the degradation of the river bed.

Very few seepage runs have been made on the Rio Grande below Elephant Butte. A seepage run in October 1913 (Follansbee, Follett, and Gray, 1915, p.687) showed a gain in 12 cfs from Elephant Butte to Las Palomas, below Hot Springs (Truth or Consequences), a loss from there to Leasburg Dam, a slight gain from that locality to the present location of the Picacho flume, a loss to Mesquite, a slight gain to Berino, and no loss or gain from Berino to near El Paso. The total loss from Elephant Butte to near El Paso was 59 cfs. This seepage run was considered not accurate (Follansbee, Follett, and Gray, p. 689). It was made before construction of any drains.

Seepage runs were made by the U. S. Bureau of Reclamation in November 1917, January 1918, and February 1918. Figure 8, which has been taken from "Report on drainage results" by Fiock, U. S. Bureau of Reclamation, October 1919, shows the results of the three runs. The progressively smaller flow shown from November 1917 to February 1918 is due to decreasing bank storage and return of water released for irrigation during the previous irrigation season. The seepage run in February was made after the gates at Elephant Butte Dam had been closed for 2 months and thus should be more indicative of natural losses and gains. The only drains constructed at that time were portions of the East and West Drains. The graph shows a general gain as far as Salem bridge, due south of Salem, a loss from there to Leasburg Dam, a small gain from Leasburg Dam to Picacho flume, a loss from Picacho flume to Anthony bridge, and a gain from there to Courchesne bridge. For the Mesilla Valley this is about the same as is indicated by the ground-water contours on the map of June 1917 (pl. 5). In February 1918, an overall gain of about 14 cfs is indicated from south of Hot Springs (Truth or Consequences) to Courchesne bridge, consisting of a gain of 54 cfs to Salem bridge then a loss of about 40 cfs.

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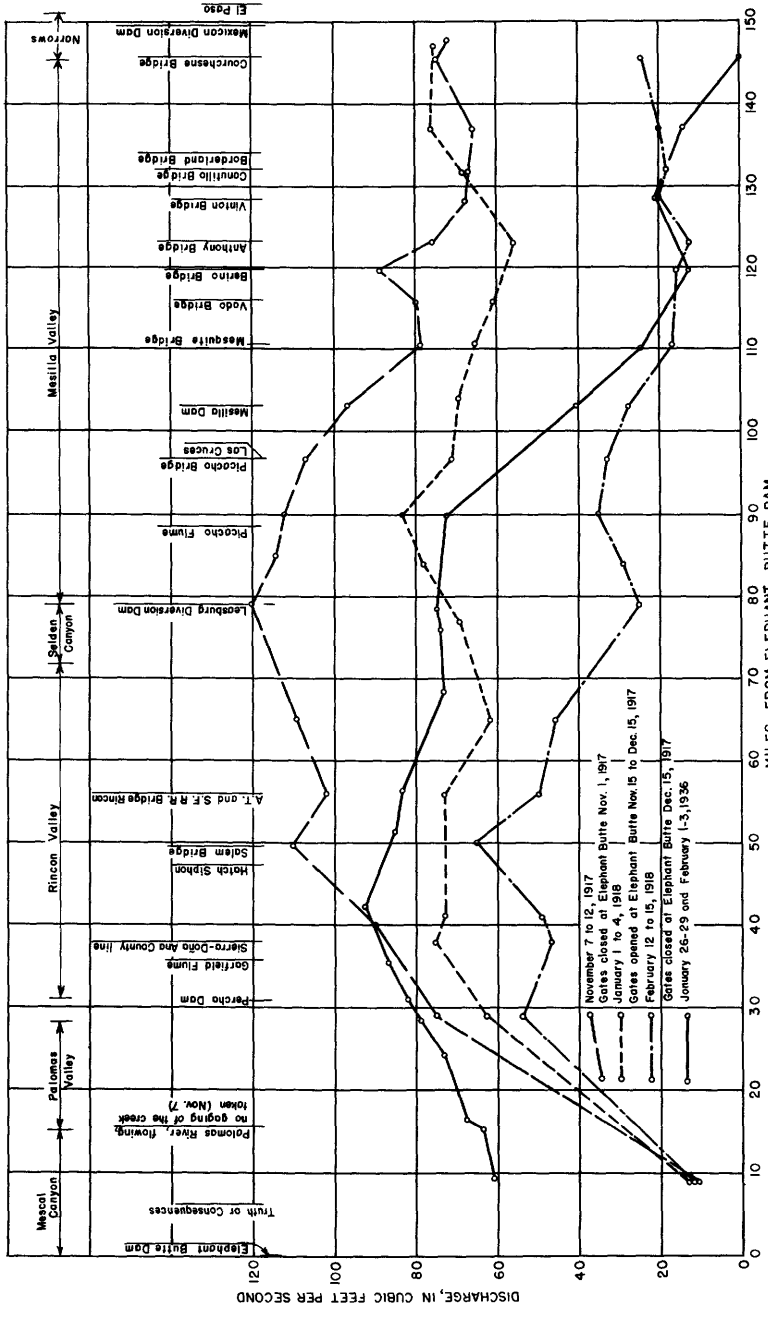

Figure 8.—Flow of Rio Grande from Elephant Butte Dam to International Dam, 1917, 1918, and 1936.

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Seepage runs from Elephant Butte Dam to Courchesne bridge were made in January and February 1936 by the State Engineer's office[11]. The average results of this run, as taken from table 2, (p. 8), of the report, are given in the following table and are also shown on figure 8.

Average invisible gains and losses in the channel of the Rio Grande from Elephant Butte to El Paso, Tex., Jan. 26–29, Feb. 1–3, 1936

River section	Distance (miles)	Corrected gains and losses (cfs)				
		Section	Per mile	Stretches		
Elephant Butte Dam	0					
Mescal Canyon	2.0	-0.2	-0.10			
Above Hot Springs	5.7	+7.9	+2.14			
Below Hot Springs	9.9	+3.4	+.81			
Above Palomas Creek	15.3	+2.0	+.37			
Below Palomas Creek	16.4	+4.6	+4.18	+32.0	+32.0	
Caballo P. O.	24.4	+6.0	+.75			
Caballo Dam site	29.0	+5.0	+1.09			
Percha Dam	31.3	+3.3	+1.43			
Garfield flume	36.5	+4.6	+.88			
Below County line	42.4	+5.6	+.95	+10.2		
Highway bridge, Hatch	51.1	-7.3	-.84		-8.2	Rincon Valley
Above Hatch drain	56.9	-1.2	-.21			
Selden Canyon	69.0	-10.5	-.87	-18.4		
Leasburg Dam	75.9	+.6	+.09			
Leasburg spillway	78.4	+.7	+.28			
Picacho flume	87.4	-2.4	-.27	-1.7		
Mesilla Dam	99.7	-31.6	-2.57	-31.6		
Mesquite bridge	106.5	-16.1	-2.37	-16.1	-74.3	Mesilla Valley
Berino bridge	115.9	-11.8	-1.26	-11.8		
Vinton bridge	124.9	+8.3	+.92			
Country Club bridge	132.7	-6.7	-.86	-13.1		
Courchesne bridge	140.0	-14.7	-2.01			
Total	140.0	-50.5	.....		-50.5	

A gain of about 42 cfs is shown from Elephant Butte Dam to below the Sierra-Dona Ana County line and a loss of about 93 cfs from there to Courchesne bridge, giving a net loss of about 51 cfs from Elephant Butte Dam to Courchesne bridge. The seepage loss in the Rincon Valley was about 8 cfs, and in the Mesilla Valley about 74 cfs.

The seepage loss from the river is especially large from Picacho flume to Berino bridge. In this section the Del Rio Drain parallels the river on the east, emptying into the river about 2 miles above Berino bridge opposite Berino. Also in this section the upper half of the La Mesa Drain and the upper third of the Chamberino Drain parellel the river on the west. The average flow of the Del Rio Drain for February 1936 plus half that of the La Mesa Drain and one-third that of the Chamberino Drain is about 71 cfs, as compared with the measured seepage loss of the river in this section of about 60 cfs.

[11] Bliss, J. H., 1936, Report on investigation of invisible gains and losses in the channel of the Rio Grande from Elephant Butte to El Paso, Tex., (unpublished), 15 pp., February 1936.

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The gain in flow of the river caused by seepage to the river in the stretch from Berino bridge to Vinton bridge is in the section where four drains empty into the river. This gain may be due to seepage from the drains near their river outlets, where the water table is probably high with respect to the water level in the river. The seepage gains and losses are not constant throughout the year but rather change seasonally and yearly in response to irrigation returns and other factors.

The long-term seepage loss or gain of water from or to the river in the Rincon and Mesilla Valleys is determined by subtracting the sum of the diversions from the river plus the outflow at the lower end of the valley from the sum of the inflow at the head of the valley plus the return wastage and drain flow of the river. The resultant computed loss includes evaporation and transpiration, water that was picked up by the drains and returned to the river, and any changes in ground-water storage and net ground-water inflow or outflow from the valley. These factors, with the exception of the change in ground-water storage, also are factors in results obtained from a seepage run. As even a substantial change in ground-water storage—such as the gain resulting from irrigation in the early years and the loss resulting from installation of drains—is small when averaged over a period of years, the two methods of computation are comparable. The following table shows the net loss in the Rincon and Mesilla Valleys as determined from mean annual flows, diversions, and wastage in the two valleys from 1930 to 1946. The wastage was taken as 24 percent of the diversions, determined previously in the section on operational aspects. The seepage loss for the Rincon Valley is indicated to be about 6 cfs and for the Mesilla Valley about 76 cfs, as compared with the losses of about 8 and 74 cfs, respectively, obtained in the seepage run of February 1936—a total of 82 cfs for both methods.

Average annual seepage loss from the Rio Grande in the Rincon and Mesilla Valleys, 1930–46

	Acre-feet (in thousands)
Rincon Valley:	
Flow at Percha and Caballo Dams	(+) 835.1
Diversions at Percha Dam	(-) 91.8
Wastage (24 percent of diversions)	(+) 22.0
Return drain flow	(+) 35.4
Flow at Leasburg Dam	(-) 814.2
Seepage loss	4.5
	or 6.2 cubic feet a second
Mesilla Valley:	
Flow at Leasburg Dam	(+) 814.2
Diversions at Leasburg Dam	(-) 186.9
Diversions at Mesilla Dam	(-) 310.6
Wastage (24 percent of diversions)	(+) 119.4
Return drain flow	(+) 214.0
Flow at El Paso Station	(-) 594.5
Seepage loss	55.6
	or 76.2 cubic feet a second

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This seepage (invisible) loss does not mean that the valleys consume or lose 60,000 acre-feet per year, but only that the river itself loses this amount, a part of which may be picked up by the drains discharged back into the river as visible flow. It indicates that on the whole the river replenishes the ground-water body rather than that the ground water replenishes the river. This invisible seepage loss is the excess of losses over gains in the river and may be termed a net loss.

The gross loss of water from the river in the Rincon and Mesilla Valleys may be estimated as the total of losses shown for various stretches of the river in the seepage run of 1936, equal to 102.3 cfs or about 74,000 acre-feet a year.

The relation between the flow of the river and the position of the water table is shown by Slichter (1905; p. 26). The water level in an auger hole 0.4 mile east of the river, west of Mesilla Park, rose 1.6 feet from the 1st to the 9th of October when the greatest flood recorded over a period of 10 years occurred in the river on October 5, 1904. The total rise in water level in this well was nearly 5 feet from September 19, 1904, when the river was dry, to March 26, 1905, when observations ceased. The Rio Grande had a continuous flow from the time of the flood to the end of observations. In that period of time the rise in the water table was apparent for more than 2 miles from the river.

It is probable that in certain stretches the river is perched above the water table, in which case a variation in the flow of the river will not cause an apparent change in water levels in adjacent areas.

SEEPAGE FROM CANALS

The amount of seepage from the canals varies from section to section. In some stretches of the canals where the soil is tight only small amounts of water are lost; in others where the canal traverses sandy soil the losses are quite large. No data are available as to the relative losses in various sections of the canals. Along sections where the losses are especially large, the water table rose to such high levels in 1916 and 1917 that drains were necessary. The large amount of seepage from the canals can be inferred from the large number of drains that have been constructed parallel to the canals, as shown on the accompanying maps. (See pls. 2 and 3.) This condition is particularly apparent along the upper parts of the East Side and West Side Canals.

The construction of numerous spur drains to intercept the seepage from the canals has resulted in the presence of drains along both sides of some stretches of the canals.

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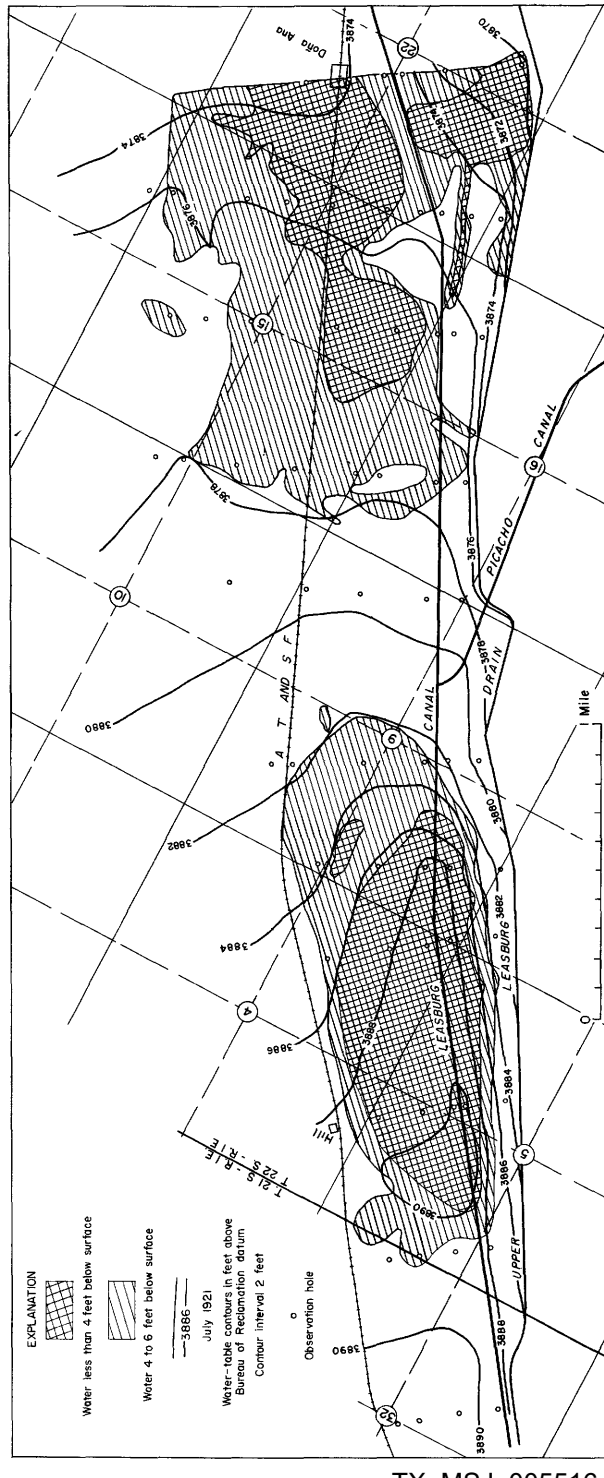

Figure 9. — Water-table contours for July 1921 in the Hill area, New Mexico, showing seepage from Leasburg Canal and high water table prior to construction of Dona Ana Drain.

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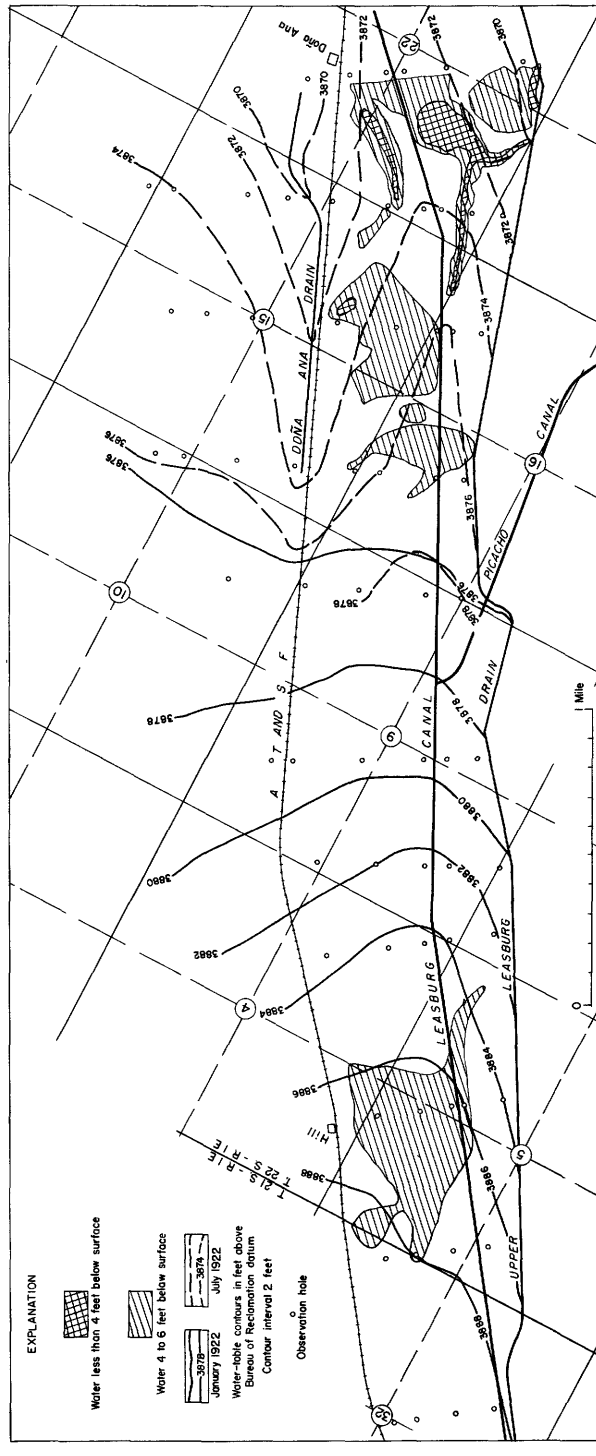

Figure 10. — Water-table contours for January and July 1922 in the Hill area, New Mexico, showing seepage from Leasburg Canal and lowering of water table during winter and by the Dona Ana Drain.

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Figures 9 and 10 show the seepage from the Leasburg Canal in the vicinity of Hill. These maps, obtained from the Bureau of Reclamation, resulted from an investigation of seepage made to determine means of relieving the seeped (waterlogged) land east of the canal. Three sets of water-table contours are shown. Those for July 1921 cover the whole area and show the conditions that existed before construction of the Dona Ana Drain; those for January 1922 and July 1922 are based on data obtained after construction of this drain. The water-table contours show seepage of water from the Leasburg Canal, a greater gradient being indicated in the summer than in the winter.

Plate 9 shows the seepage from the Three Saints Lateral to the Anthony Drain in the vicinity of Berino. The map was prepared by the Bureau of Reclamation in 1924 during an investigation of the seeped land along the river. The steep gradient of the water table from the canal to the drain and the slight gradient on the west side of the canal show that most of the drain water from the west in this area is derived from the canal.

Water levels in auger hole 16, located in the west toe of the Las Cruces Lateral on the north line of sec. 2, T. 23 S., R. 1 E., have been measured monthly since 1924 by the Bureau of Reclamation. The seasonal fluctuation of the water level, plotted on plate 8, is similar in time and magnitude to that in the other auger holes located in the valley away from laterals. On the basis of a comparable range of seasonal fluctuations in well 16 and in other auger holes some distance from canals, it seems that at this spot the seepage from the canal is about equal to that which would occur from irrigated land.

It has been estimated, in a previous section of the report, that the seepage and unaccounted-for losses from the canals and laterals average about 20 percent of the gross headgate diversions in a normal year, which is equivalent to about 118,000 acre-feet a year.

RECHARGE FROM IRRIGATION WATER

A portion of the ground water in the Rincon and Mesilla Valleys is derived from irrigation waters applied to the lands in excess of the consumptive use of the crops. The amount of this excess varies with the practices of the individual farmer, the type of land, and the type of crops grown.

The interrelation of the ground water and irrigation waters has been discussed previously under "Fluctuations of the water table" and "Depth to water." The seasonal high ground-water level

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occurs at the end of the irrigation season and the seasonal low water level occurs just before the initial diversions for the irrigation season.

The excess of irrigation water applied to the lands in an average year has been estimated (see p.) to be about 17 percent of the gross annual diversions, or about 100,000 acre-feet a year.

RECHARGE FROM PRECIPITATION

The amount of ground water in the Rincon and Mesilla Valleys derived from rainfall upon the valley floor is probably small on the average. The normal annual precipitation at the Agricultural College is less than 9 inches, most of which occurs in the form of showers during the summer months when the evaporation and transpiration rates are high. Thus probably the greatest part is returned to the atmosphere. Some recharge to the ground water occurs from showers upon land that has been previously irrigated or from pools of rainwater that collect in shallow depressions. Also, some recharge occurs directly from precipitation in years of above-normal precipitation, such as in 1941 when the rainfall exceeded the average by more than 100 percent.

Precipitation results in cancellation of orders for irrigation water, which in turn results in a lowering of the water table. Thus, as stated previously, the net effect of a light precipitation upon the ground-water supply in the valleys is probably negative.

Figure 6 shows the water level for 1947 and part of 1948 in well 23.2E.29.214 as measured daily at 5:00 p. m. and the daily precipitation as recorded at the Agricultural College at the same location. Heavy rains in mid-August 1947 and in late February 1948 apparently caused rises of more than 0.2 foot in the water table. Precipitation in the winter months generally had little effect upon the water table because of the dryness of the soil.

DISCHARGE OF GROUND WATER

Ground water is discharged from the Rincon and Mesilla Valleys by return drain flow to the river, by direct seepage to sections of the river, by evaporation from water surfaces of the drains and ground-water ponds, by transpiration by plants in areas of shallow water, and by ground-water flow leaving the lower end of the valleys.

The amount of ground water discharged by the drains is by far the largest, about 249,400 acre-feet a year in the Rincon and Mesilla Valleys. (See table 5, p. 141.)

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The direct seepage to the river occurs in a few stretches where the water table is higher than the level of the water in the river. The seepage run made in February 1936, which was discussed on pages 71-73, shows that the river gained 10.2 cfs from Percha Dam to below the Sierra-Dona Ana County line, 1.3 cfs from Selden Canyon to Leasburg spillway, and 8.3 cfs from Berino bridge to Vinton bridge, a total invisible seepage gain of 19.8 cfs or about 14,000 acre-feet a year. The present amount gained by the river is probably greater, as the level of the riverbed has lowered somewhat since the seepage run was made. (See page 68.)

The discharge of ground water by underflow at the lower ends of the Rincon and Mesilla Valleys is small. Slichter (1905, p. 9, 13) in 1904 showed that the thickness of the alluvium in the narrows of the Rio Grande a few miles above El Paso probably does not exceed 86 feet and that the ground-water flow probably does not exceed 11,200 cubic feet a day, or 94 acre-feet a year. The ground-water flow from the Selden Canyon, at the end of Rincon Valley, to the head of the Mesilla Valley is not known, but, because of the narrowness between the rock walls of the canyon and the apparent thinness of the alluvium, the flow is probably small and may be about the same as that leaving the Mesilla Valley.

Water evaporates from the drains and the small area of ground-water pools at the surface. The evaporation of ground water that is discharged to the drains is not definitely known but, on the basis of about 270 miles of drains having a width of flow of about 5 feet and an estimated annual evaporation of 4.5 feet, (National Resources Committee, 1938, p. 91, table 80) it probably amounts to about 700 acre-feet a year in the Rincon and Mesilla Valleys. The total area of ground-water pools at the surface in 1936 was determined as 51 acres in the Rincon and Mesilla Valleys. (See table, p. 20.) The ground-water discharge by evaporation from this area is therefore only about 230 acre-feet a year.

Transpiration of ground water by plants in areas of shallow depth to water may be roughly estimated from the area of native vegetation. The area of native vegetation is not definitely known but may be estimated as about 8,400 acres, on the basis of the total acreage of the valleys less the area of irrigated lands, river and canal surfaces, riverbed rights-of-way, and towns. (See p. 115.) Some of the area of 8,300 acres constituting the rights-of-way may be covered with native vegetation. If half the area of rights-of-way is assumed to be covered with native vegetation, the total area of native vegetation in the Rincon and Mesilla Valleys is about 13,000 acres. The total annual discharge of ground water by native vegetation in these valleys is, thus, about 40,000 acre-

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feet a year, on the basis of an average consumptive use of 3.5 feet minus an estimated 0.4 foot supplied by precipitation (National Resources Committee, 1938, p. 92, table 81).

CHEMICAL QUALITY OF WATER

GENERAL FEATURES

The chemical quality of ground water—that is, the character and amount of dissolved mineral matter in the water—is dependent upon its source, temperature, the chemical character of the water-bearing formation, and the length of time spent in flowing from the source to the point of sampling. Rainwater, which has only minor amounts of dissolved mineral matter, begins to dissolve mineral matter from the time it falls upon the ground. The part that remains on the ground as surface water generally dissolves less mineral matter than that which sinks underground to be in constant contact for long periods with the material composing the aquifer. Therefore, ground water generally contains a greater amount of dissolved mineral matter than natural surface water.

Use of water for irrigation results in loss of a part of the applied water to the atmosphere by transpiration and evaporation. This process increases the concentration of salts in the soil and in that part of the irrigation water that percolates to the ground-water body and then feeds the drains. As a result, the drain water has a higher concentration of dissolved salts than the surface water initially applied to the lands. Reuse of drain water again increases the concentration of dissolved salts in the remaining water. Therefore, an increase in dissolved salts in the irrigation waters is to be expected from the upper to the lower end of the project.

No definite limits can be set on the amount of various dissolved salts in water that will make water unsuitable for irrigation. The more dissolved solids a water contains, the less suitable it becomes for use as irrigation water. In general, the higher the concentration of salts in irrigation waters, the greater the excess of water that must be applied to the crops in order to keep the concentration of dissolved salts in the soil moisture within satisfactory limits. Certain crops are more tolerant of a high concentration of dissolved salts than others. Figure 11, from Wilcox (May 1948, p. 6), gives a classification of waters for use in irrigation. The electrical conductivity is the specific conductance of the water in micromhos at 25 C. The conductance is a relative measure of the concentration of dissolved solids, or, more specifically, of the total number of ions in the solution. A rough measure of the dissolved solids in a water can be obtained by multiplying the specific conductance in micromhos by 0.7, an average figure for waters of the Rio Grande.

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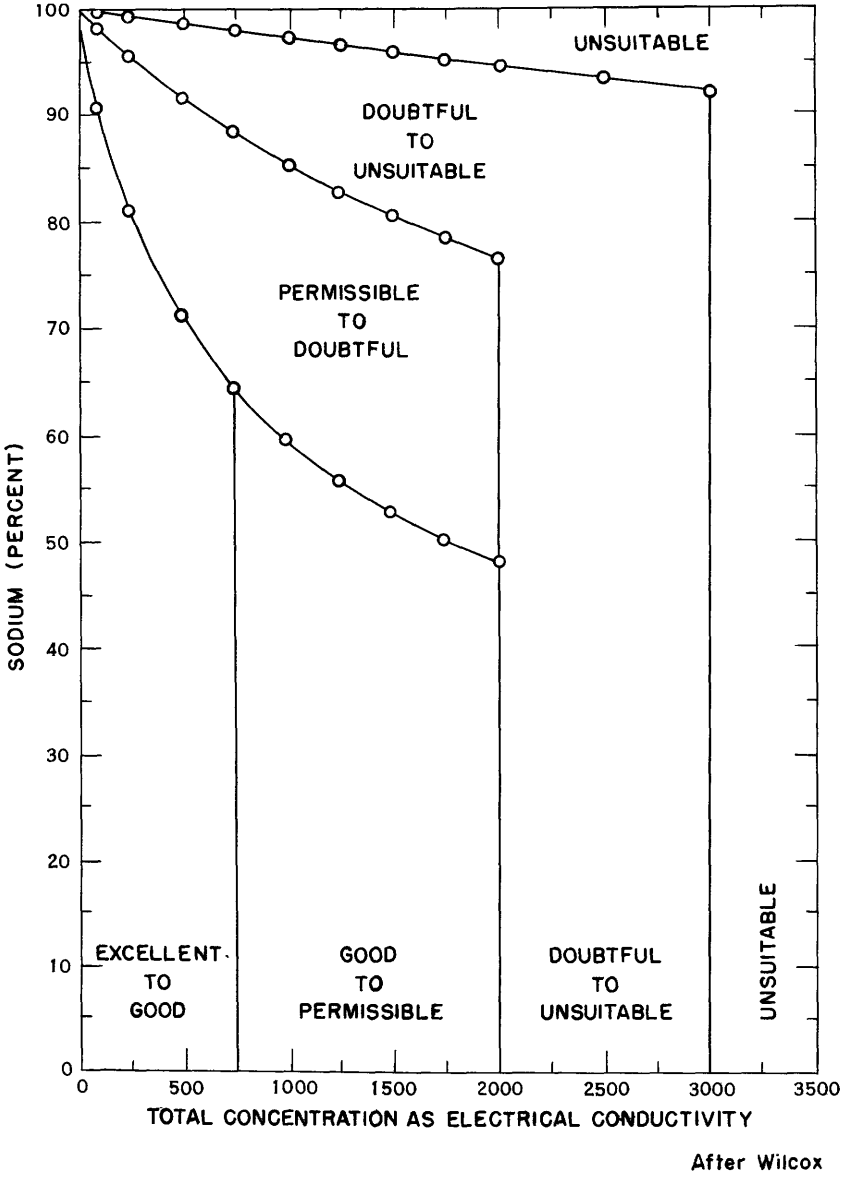

Figure 11. —Diagram for use in interpreting analyses of irrigation water.

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The significance of the sodium percentage is due to the role of the basic or cation constituents in the exchange reactions that occur when water containing dissolved salts comes in contact with the soil. The use of irrigation water containing a high percentage of sodium tends to impair the physical condition of the soil whereas the use of water having a low percentage of sodium tends to maintain a good physical condition or to improve a poor physical condition that has been caused by the deflocculation of the clay fraction (Scofield, 1938, p. 5).

Thirty-four analyses of ground waters from 30 wells and 2 springs in the Rincon and Mesilla Valleys and adjacent high lands were made by the Quality of Water Branch of the U. S. Geological Survey during the present investigation. These and a few other analyses of water are reported in the table on pages 83, 86. Radium Springs is at Leasburg Dam and Derry warm springs is about a mile northeast of Derry. The wells have been separated in the table into those in the flood plain of the Rio Grande and those above the flood plain. This classification, adopted mainly to show the difference in the quality of water from the two sources, is not definite for a few wells, such as (22. 1E. 33. 321), that are along the edges of the valley floor; they are on ground that is somewhat higher than that of the valley but they actually derive water from underflow of the valley.

According to the available analyses, the water obtained from wells above the flood plain of the valley generally has less dissolved solids but a higher percentage of sodium than water obtained from shallow wells in the valley floor. However, there are numerous exceptions to this.

The ground water above the valley floor may be subdivided generally by type into: that occurring under the mesa or high land surfaces; that under the arroyo beds; and that under land adjacent to the arroyos, which may be a mixture of the other two. The type of water obtained from beneath an arroyo bed is illustrated by the water obtained from Tierra Blanca Creek near Arrey (in the wells of E. W. Powers and Mickey Plemmons), which is characterized by a small amount of fluoride and dissolved solids and a low percentage of sodium. Water from the mesas of the Santa Fe formation, as shown by the wells of A. J. Osborn (near Arrey), the Southern Pacific wells at Afton and Strauss, and those of Mrs. Annie Braidfoot in the southern part of La Mesa area, is somewhat higher in fluoride, dissolved solids, and percent sodium than the water beneath the arroyo beds. The well of J. W. Daugherty, located

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on the Jornada del Muerto east of Las Cruces in the Santa Fe formation, obtained particularly good water, similar to arroyo-bed water, with only 205 ppm of dissolved solids and a sodium percentage of 36.

The analyses of samples of water from the irrigation wells of Clyde Cowan and K. H. Walker indicate that the water is essentially the same as that found in the valley floor, as shown by the small amount of fluoride and the large amounts of calcium, magnesium, sulfate, chloride, and dissolved solids. These wells are close to the edge of the area of irrigated lands in the valley, on higher ground, and they probably derive a large part of their water from the underflow of the valley. Water obtained from the valley fill along the Rio Grande is generally low in fluoride and rather high in calcium, sulfate, chloride, and dissolved solids, has a moderate percentage of sodium, and is hard.

The well of C. C. Rice is on the mesa beside the railroad at Fort Selden, about a mile south of Radium Springs and above the valley floor. It reportedly hit rock at about 125 feet. The water in this well contains 3,280 ppm of dissolved solids and 74 percent sodium and is similar to the water of Radium Springs. Analysis of the water of Selden Drain (p. 86) indicates that water with a high concentration of dissolved solids and a high percentage of sodium is entering the valley in this area.

VARIATION OF QUALITY WITH DEPTH

The quality of the water in any area varies considerably both laterally and vertically. Variation in the quality of water with depth is shown in the following table. The 3 wells of different depth owned by T. L. Simpson show very poor water at the shallow depth of 42 feet, containing 1,950 ppm of dissolved solids and having a hardness of 934 ppm, and comparatively good water at the depth of 242 feet, with 297 ppm of dissolved solids and a hardness of 170 ppm. The analyses of the water in the wells of Fay Sperry and the Las Cruces Country Club, which are about a quarter of a mile apart and above the valley floor of the Rio Grande, north of Las Cruces, indicate water of better quality at lower depths. The analyses of water as reported at different depths in the domestic well 3 of the State Agricultural College indicate progressively better water with depth to 401 feet. Analyses of water from wells in the vicinity of Mesilla Park also indicate better water at depth, particularly with respect to hardness. Analyses of water from wells in the vicinity of Berino indicate very little decrease in the dissolved solids but a slight decrease in hardness at depth.

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Change in quality of water with depth in localities in Mesilla Valley, N. Mex.

[Analyses by C. W. Botkin, Chemist, State Agricultural College, N. Mex., unless otherwise indicated]

Location and name	Date of collection	Depth (ft)	Dissolved solids (ppm)	Hardness (ppm)
Northwest of Las Cruces, on valley floor				
T. L. Simpson	Aug. 13, 1947[1]	42	1,950	934
Do	do	162	481	314
Do	do	242	297	170
North of Las Cruces, above valley floor				
Fay Sperry	Prior to Sept. 1936 (upper water)	78±	2,130	565
Do	do (lower water)	130	720	240
Las Cruces Country Club	February 1929	200	473	145
Do	Aug. 13, 1947[1]	200	411	214
State College, above valley floor				
Domestic well 3 (Total depth 428 feet)	1938	64	2,500	350
		73	1,070	300
		185	732	240
		230	1,054	350
		230	810	280
		300	440	145
		401	[2]510	[2]200
		401	[2]698	[2]260
		401	370	150
Mesilla Park, on valley floor				
Albert Archer	August 1925	100	450	
H. B. Elmendorf	July 1929	108	824	305
Barker well	October 1930	117	430	220
H. B. Elmendorf	July 1929	140	528	210
Albert Archer	Oct. 1, 1925	150	670	
Las Cruces Ice Co.	Aug. 13, 1947[1]	224	[3]285±	
Ray Langford	June 25, 1946	268	300	150
Berino				
Tom Locke	February 1928	40-	1,700	240
Frank Bowman	April 1927	31	707	200
Do	do	205	1,660	200
Do	May 1927	246	1,530	120

[1]Analysis by U. S. Geological Survey.
[2]Before clearing well of drilling water.
[3]Estimated from conductance.

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The quality of the ground water in the area does not everywhere improve with depth. The present well of the Santa Fe Railway at Las Cruces was originally drilled to 251 feet in 1925 in search of water of a better quality than that obtained at a shallow depth. However, water of poorer quality was reportedly obtained and the well was filled back to 83 feet.

J. M. Taylor of White, Tex., reports that a well at his place in sec. 25, T. 28 S., R. 3 E., drilled to 300 feet in the valley floor near the lower end of the Mesilla Valley, obtained very poor water. He helped drill a number of wells in the same general area a number of years ago in search of water suitable for the town supply. All had poor water at lower depths, especially below 100 feet.

Mr. Paul Harvey, owner of the waterworks of White, reports that he drilled 10 or 12 wells a few years ago and 11 wells in 1946, in search of water suitable for the town supply. The wells were drilled at various localities near the town, on and above the valley floor in the Texas portion of the Mesilla Valley. The only satisfactory water was found at the location of the present supply wells in sec. 35, T. 28 S., R. 3 E. The 8 present town wells are 130 feet deep and are located between the bank of the Rio Grande, about 200 to 800 feet to the west, and the Montoya Lateral to the east, an area not more than 1,500 feet wide. Mr. Harvey reports that the wells end in a clay stratum and that poor water is found below the clay. It is probable that these wells obtain water from the river and from seepage from the lateral.

Sayre and Livingston (1945, p. 7) report that 2 test wells drilled in the Mesilla Valley, in search of a water supply for El Paso, yielded salty water. The Lippincott well, drilled to 1,074 feet in the Mesilla Valley by the city of El Paso, encountered water too highly mineralized for most purposes (Sayre and Livingston, 1945, p. 47, 106).

Slichter (1905, p. 11, 12) in his study of the underflow of the Rio Grande at the narrows at the lower end of the Mesilla Valley, found a definite increase in chloride and dissolved solids in the ground water to the observed depth of 60 feet. The dissolved solids increased from 1,690 ppm at a depth of 10 feet to 46,000 ppm at 60 feet.

VARIATION OF QUALITY AREALLY

The quality of both surface and ground waters of the area included in the Rio Grande project varies areally, being generally best at the head of the project and becoming progressively poorer toward

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the lower end. In the following table are given analyses of the surface water below Elephant Butte Dam, Leasburg Dam, and the El Paso gaging station, along with analyses of drain waters and individual samples from auger holes in the Mesilla and Rincon Valleys. These were taken from the detailed analyses reported in the Rio Grande joint investigation. The analyses given for the surface water at the three points on the Rio Grande are the average of the monthly averages reported for 1936 and represent closely the average quality of the surface water in that year. The analyses reported for the drain water are an average of 10 samples taken in the period 1929 to 1936 and may represent the average quality of water of the drains better than the individual sample taken in 1936. Except for the East Drain, however, the analyses show no large variation in quality with respect to time. Variation of the quality of water in the East Drain appears to be related to the change in amount of waste water present. The analyses given for the subsoil waters in the auger holes established for the Rio Grande joint investigation include only the one detailed analysis available for each hole, made in 1936. The one analysis for each hole probably does not represent the average quality of the subsoil waters at the hole but probably does give an indication of the relative quality areally in 1936 and gives some basis for comparison of the drain waters and the surface waters with the subsoil waters.

The water of the Rio Grande shows an increase in concentration of dissolved salts downstream from Elephant Butte to El Paso station. There is little change in the relative concentrations of the dissolved mineral constituents through the percent sodium shows a very slight increase.

The drain waters of the Rincon Valley seem to be nearly uniform in quality, all having, in 1936, higher concentrations of salts than the river above the Rincon Valley at Elephant Butte and below the valley at Leasburg Dam.

The waters of the various drains in the Mesilla Valley differ considerably in quality. The differences probably reflect to some extent the sources of waters in the various drains. In general the drain waters become more highly mineralized from the upper end of the valley to the lower end. However, the Selden Drain, at the upper end of the valley, has a higher concentration of dissolved solids and percent sodium than the water of the Rio Grande and of the Leasburg Drain to the south. Radium Springs (Selden Springs), in the valley just above Leasburg Dam, bring some highly mineralized ground water into the upper end of the Mesilla Valley and may form part of the accretion of the Selden Drain. The irrigation well of C. C. Rice at Fort Selden at the upper end of the valley, referred to previously, also has water of poor quality.

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Analyses of water in Rincon and Mesilla Valleys, N. Mex.

[Schofield, Carl S., 1938, Quality of water of the Rio Grande Basin above Fort Quitman, Tex.: U. S. Geol. Survey Water-Supply Paper 839, p. 23, 28, 34, 264, 284-88]

Source of water	Dissolved solids		Percent sodium	Remarks
	Tons per acre-foot	ppm		
Rio Grande:				
Below Elephant Butte Dam	0.79	581	43	Average for 1936.
Leasburg Dam	.95	699	44	Do.
El Paso station	1.41	1,040	53	Do.
Drains:				
Rincon Valley:				
Garfield Drain, near outlet to river	1.33	978	44	Average of 10 analyses, 1929-1936.
Hatch Drain, near outlet to river	1.33	978	38	
Angostura Drain, near outlet to river	1.05	773	39	
Rincon Drain, near outlet to river	1.35	993	46	Do.
Mesilla Valley:				
Selden Drain, near outlet to river	1.43	1,050	51	Do.
Leasburg Drain, above inlet to Del Rio Drain	1.01	743	42	Do.
Picacho Drain, above outlet to river	1.15	846	41	Do.
Mesilla Drain, above inlet to Del Rio Drain	1.30	956	46	Do.
Del Rio Drain, above outlet to river (includes flow of Leasburg and Mesilla Drains)	1.26	927	45	Do.
Chamberino Drain, above confluence with La Mesa Drain	2.13	1,570	55	Do.
La Mesa Drain, above confluence with Chamberino Drain	1.13	832	47	Do.
East Drain, above confluence with Anthony Drain	4.06	2,980	71	Do.
Anthony Drain, above confluence with East Drain	2.34	1,720	61	Do.
Nemexas Drain, above confluence with West Drain	2.50	1,840	64	Do.
West Drain, above confluence with Nemexas Drain	1.61	1,180	58	Do.
Montoya Drain, above outlet to river	2.33	1,710	64	Do.
Auger holes:				
Rincon Valley:				
Garfield well (206) 18.4.8.244	2.70	1,980	46	Aug. 12, 1936.
Salem well (207) 18.4.35.111	2.10	1,540	30	Do.
Hatch well (208) 19.3.10.334	1.70	1,250	77	Do.
Tonuco well (209) 19.2.35.422	2.13	1,570	33	Do.
Mesilla Valley:				
Dona Ana well (223) 22.1E.16.433	1.50	1,100	49	Aug. 12, 1936.
Picacho well (224) 23.1E.16.444	2.11	1,550	87	Do.
Mesilla well (225) 23.1E.35.211	2.06	1,520	43	Do.
Santo Tomas well (226) 24.2E.33.124	1.47	1,080	39	Do.
Chamberino well (227) 26.3E.19.113	1.28	941	38	Do.
Anthony well (228) 26.3E.34.444	3.24	2,380	65	Do.
La Union well (229) 27.3E.16.343	5.07	3,730	47	Do.
Montoya well (230) 28.3E.26.142	3.02	2,220	77	Do.

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On the basis of quality, the waters of the remaining drains in the Mesilla Valley, except possibly the East Drain, which apparently has water of higher concentrations than found in the irrigation water, seem to be composed mainly of return irrigation water with some river seepage and canal wastes. There seems to be no definite relation between quality of the water and distance of the drains from the river. The drains that parallel the river and intercept the seepage from it may be called riverside drains, whereas those away from the river may be called interior drains. The water of the Del Rio Drain, which parallels the river and includes the flow of the interior drains, the Leasburg, Mesilla, and Park Drains, is comparatively good, having 927 ppm of dissolved solids and 45 percent sodium. The water of the Chamberino Drain, which is predominantly a riverside drain, has a high concentration of dissolved salts, 1,570 ppm, and 55 percent sodium, as compared to 832 ppm dissolved solids and 47 percent sodium for water of the La Mesa Drain, which is partly a riverside and partly an interior drain, in the same general area. The West Drain, which parallels the western edge of the valley, has water of poorer quality, 1,180 ppm of dissolved solids and 58 percent sodium, than that of the La Mesa Drain.

The drain in the Mesilla Valley that has water of the poorest quality appears to be the East Drain, which includes the flow of the Mesquite Drain. These drains parallel the east side of the valley from Anthony to a point north of Mesquite. The average concentration of dissolved salts in this water is 2,980 ppm with about 71 percent sodium. Waters of high sodium percentage are found in some of the wells on the side mesas, and it may be that water east of the valley toward the Franklin Mountains also has a high concentration of dissolved solids and enters the drain, or that similar water occurs in the valley in this area and has not been completely flushed by excess irrigation water applied to the lands.

The individual water analyses for the shallow auger holes in the Mesilla Valley in 1936 show a higher concentration of dissolved solids than the water of the adjacent drains. The percentage of sodium in the water is variable, being less than 40 in 4 of the holes more than 60 in 4 of the holes, and between 40 and 60 for the remaining 4 holes. If these analyses are representative, the subsoil waters have a higher concentration of dissolved solids than the drain waters. This may be true, as the drain waters are a mixture of canal waste and river seepage along with the ground-water accretion of excess irrigation water applied to the lands. As none of these holes are located between a drain and the river, their water may represent more nearly the quality of the excess irrigation water applied to the land than do the waters of the drains.

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The Anthony auger hole is located at the lower end of the East Drain, which has water of poor quality. Water from the Anthony hole also is of poor quality but apparently not as poor as that in the drain. As the hole is west of the drain it is not evident whether poorer water is entering the drain from the east or from other areas along the drain above the hole.

QUALITY OF LAS CRUCES WATER SUPPLY

The water supply of Las Cruces prior to 1937 was obtained from 2 wells, 75 and 100 feet deep, drilled in the valley floor. As water from these wells was very hard (hardness about 500 ppm) a new supply was developed east of the town, from wells drilled between 2 arroyos on the pediment overlooking the valley. Water obtained from this source originally had less than half the hardness of the former supply. Additional wells have gradually been added at this new location to a total of 5 in 1947, all within a radius of about 150 feet. Pumping of these wells has resulted in a lowering of the water level below that in the valley. The original water level is not definitely known but was probably slightly above that in the valley. The trough in the contours of the water table in the vicinity of the city wells, as shown on the water-table map of Dona Ana County (pl. 1), indicates that a lowering of at least 10 feet has probably occurred. This lowering will cause a greater proportion of the pumped water to be drawn from the valley and will eventually cause an increase in the hardness and dissolved solids of the city supply. The following tabulation of the quality of water of the city supply indicates that a slight increase in dissolved solids may have taken place at the present location, as shown by the analysis of the hydrant water in 1939 and that from well 2 in 1948. Analyses in May 1947 and in March 1948 of the water from the new city well 5 also show an increase in dissolved solids and hardness. These increases may indicate that a progressively greater part of the water in the wells is being drawn from the valley.

Change in chemical quality of city water supply of Las Cruces, N. Mex., 1918–48

[Note: Water supply prior to 1937 obtained from two wells, 75 and 100 feet deep, drilled on valley floor. Beginning in 1937, water obtained from wells located on high ground east of city]

Source	Date	Hardness (ppm)	Total dissolved solids (ppm)	Sodium (percent)
Hydrant	Aug. 15, 1918[1]	.....	913	.....
Do.	1930[1]	501	943	36
Do.	1934 (?)[1]	485	970	35
Do.	November 1935[1]	527	1,012	34
Hydrant[2]	May 11, 1939[3]	210	403	.....
City water	May 6, 1942[1]	160	490	.....
City well 2	Mar. 25, 1948[3]	248	442	36
City well 5	May 6, 1947[3]	441	747	32
Do.	Mar. 25, 1948[3]	482	770	27

[1]Analyzed by C. W. Botkin, chemist, State College, N. Mex.
[2]Hydrant water at Pueblo Courts.
[3]Analyzed by U. S. Geological Survey.

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The concentration of dissolved solids in the new city well 5, more than 750 ppm, and hardness of more than 440 ppm approach the concentration of the waters in the valley in this area. Well 5 when originally completed was screened from 262 to 285 feet but because of the small discharge, about 50 gallons a minute, the casing was later perforated from 210 to 250 feet. The poorer water is evidently entering the well at the higher level. The casing record for well 2 is not known but is presumedly about the same as for wells 1, 3, and 4, which have 20-foot screens set near the bottom of the wells, at about 300 feet.

SUMMARY OF QUALITY OF WATER

In conclusion, the quality of water obtained by wells of moderate depth in the valley floor is similar to that in the drains and somewhat poorer than river water. The dissolved solids in the ground water at moderate depths in the Rincon and Mesilla Valleys may average about 1,000 ppm, with 35 to 50 percent sodium. This water is suitable for irrigation, although not as good as river water, being classed as good to permissible. (See fig. 11.) In general, deeper wells in the Mesilla Valley supply better water. One notable exception is in the lower end of the Mesilla Valley where the quality apparently becomes worse with depth. Some shallow waters in various areas are particularly poor. The quality of the water is evidently poorer at the lower ends of the Rincon and Mesilla Valleys than at the upper ends, except in the vicinity of Radium Springs.

The quality of water obtained by wells drilled in the Santa Fe formation flanking the valleys is generally potable, with dissolved solids of about 500 to 700 ppm and a hardness of generally less than 200 ppm. The sodium content is generally high, about 70 percent, and the fluoride in some localities is quite high, more than the 1.5 ppm generally considered the safe limit for growing children to escape mottled teeth (Public Health Service, 1946, p. 371-384).

The best water in the area, with respect to dissolved mineral matter, apparently occurs under the arroyo beds where the comparatively fresh flood waters from the hills and the mesas sink into the ground. This water probably contains, on the average, less than 300 ppm of dissolved solids, less than 200 ppm hardness, and only minor amounts of fluoride.

The source of the comparatively good water at depth in many localities of the Mesilla Valley is probably the side inflow from

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the bordering mesas. This may be particularly true at the outlets to the arroyos, which at various times have flooded and built alluvial fans extending into the valley. These fans may have thin clay lenses extending from the arroyo mouth into the valley under which fresher water may have been stored.

HYDROLOGIC CHARACTERISTICS OF WATER-BEARING FORMATION

GENERAL CONDITIONS

In order to properly evaluate the amount of flow of underground water and the long-term effects of pumping, two important hydrologic characteristics of an aquifer, the coefficients of transmissibility and storage, must be known. The storage coefficient under water-table conditions is approximately equal to the specific yield.

The ease with which water moves through an aquifer depends upon the interconnection and size of the pore spaces and to some extent upon the temperature of the water. The coefficient of transmissibility, which expresses the rate of flow, is defined as the quantity of water in gallons a day that will percolate under the prevailing temperature through a vertical strip of the aquifer 1 foot wide, oriented perpendicular to the direction of flow of the water, under a unit hydraulic gradient.

Not all the water stored in an aquifer is available to wells. Only a portion of the water filling the pore spaces will drain out under the action of gravity. The specific yield of an aquifer is a measure of the ability of the aquifer to release water to wells under the action of gravity. It is defined as the ratio, expressed as a percentage, between the volume of water that a saturated aquifer would yield by gravity and its own volume. As not all the water drains from the aquifer, the specific yield is somewhat less than the porosity of an aquifer. The larger the size of the pore spaces the larger the specific yield. Clay has a large porosity but a very small specific yield as a result of the minute size of the pore spaces. If the specific yield of an aquifer were 25 percent, then a decline of water level of 1 foot would represent a quantity of water of a depth of 0.25 foot distributed over the area of the aquifer.

COEFFICIENT OF TRANSMISSIBILITY

METHODS OF DETERMINING

The coefficient of transmissibility can be determined either in the laboratory or in the field by computations based on the rate of discharge of the water in relation of the gradients. Exact determination of the coefficient is difficult; of the several known methods, the two used in this investigation as described below.

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One of the field methods of determining the coefficient of transmissibility is that developed by Theis (1935, p. 522), which consists of pumping a well at a constant rate for a period of time and noting the rate of recovery of the water level in the well after pumping has ceased. The coefficient of transmissibility is then computed by means of the following formula:

$$T = (264\ Q/s')\log_{10}(t/t')$$

in which

T=coefficient of transmissibility, defined above.
Q=discharge rate of well, gallons per minute.
s'=residual drawdown in well at time t', in feet.
t -time since pumping started.
t' =time since pumping stopped.

If the pump has been operated for periods previous to the period of pumping immediately preceding the measurement of recovery of water level, then these previous periods of pumping can be taken into account by modifying the formula as follows:

$$T = 264\ (Q/s')\log_{10}\frac{t_1 \cdot t_2 \cdot t_3 \cdots t_n}{t_1' \cdot t_2' \cdot t_3' \cdots t_n'}$$

in which t_1, t_2, t_3, t_n = time since the beginning of previous periods of pumping
and t_1', t_2', t_3', t_n' =time since the end of previous periods of pumping

Theoretically, the equation applies only to an aquifer of infinite areal extent that is composed entirely of homogeneous sediments, in which a well penetrates the entire thickness of the aquifer, and in which the coefficient of transmissibility is constant at all times and places.

In practice almost none of these conditions is completely fulfilled. However, in most aquifers the departures from the theoretical conditions are small enough to allow use of the formula to obtain workable results.

As the aquifer in the Rincon and Mesilla Valleys is composed of sediment deposited by a meandering stream, the deposit is not homogeneous in either vertical or horizontal extent and therefore the coefficient of transmissibility will vary from locality to locality, even within a short distance. This necessitates the determination of the coefficient of transmissibility at as many points as feasible. No aquifer is of infinite areal extent; however, the horizontal extent of an aquifer can usually be considered as infinite for short periods of pumping. Failure of wells to penetrate the full thickness of the aquifer causes some error but this error is considered to be small so long as the drawdown is not too large a percentage of the saturated formation penetrated by the well and the well casing is perforated at all water-bearing formations.

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The rate of accretion of ground water to a drain is dependent upon the coefficient of transmissibility of the aquifer and the slope of the water table to or from the drain. Given the rate of gain in flow of a drain in cubic feet per second per mile and the sum of the average gradients of the water table to each side of the drain, expressed as a decimal, the transmissibility of the aquifer can be determined from the following formula:

$$T = \frac{\text{Gain in flow} \times 122}{\Sigma \text{ Gradient}}$$

Gradients of the water table to the drain are considered positive; those away from the drain are negative. Gradients must be selected where the water table has a nearly constant slope, far enough from the drain to be uninfluenced by the sharp change in slope of the water table that occurs near the drain. (See fig. 14.) Also, water must not be added to the water table between the drain and the points of measurement of the slopes.

In practice, determination of the coefficient of transmissibility from any individual set of measurements is subject to error because of addition to the ground water by return irrigation water at points between the drain and the wells used for measurement. An average of the values determined at monthly intervals for a period of a year would probably approach the correct value for the coefficient of transmissibility.

PUMPING TESTS

The coefficient of transmissibility was determined by the Theis method (p. 91) by noting the recovery of water levels in 4 wells on the floors of the Rincon and Mesilla Valleys, and in 3 wells on the higher lands bordering the valleys. The curves of the recovery of the water level obtained from the 7 wells are given in figures 12 and 13.

The irrigation well of B. S. Thurman, in the Rincon Valley, sec. 4, T. 19 S., R. 3 W., located in the valley bottom about 1,500 feet north of the river and about 300 feet south of the bluff of the mesa, was pumped at the rate of about 660 gpm for 4 days, after which the rate of recovery of the water level was measured. This well is only 52 feet deep and reportedly ends in a gravel bed. The maximum drawdown was 8.9 feet, 13.5 feet below the land surface at the end of the 4 days' pumping. The coefficient of transmissibility as determined from the recovery rate of the water level was 136,000 gpd per foot. It is probable that if the well had been deeper a slightly larger value for the coefficient of transmissibility might have been determined. However, the value determined is high and is probably representative of the unconsolidated riverbed deposits.

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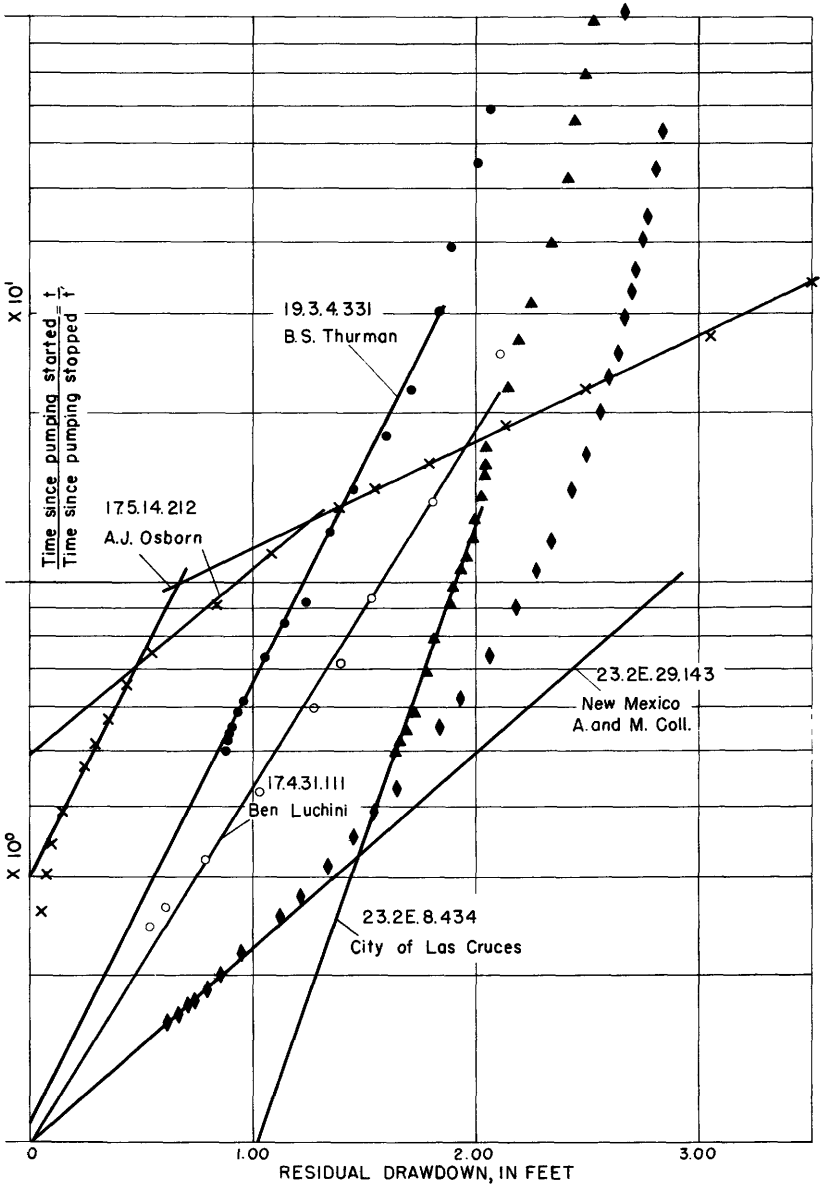

Figure 12. — Curves of recovery of water levels obtained by pumping tests on five wells in Rincon and Mesilla Valleys.

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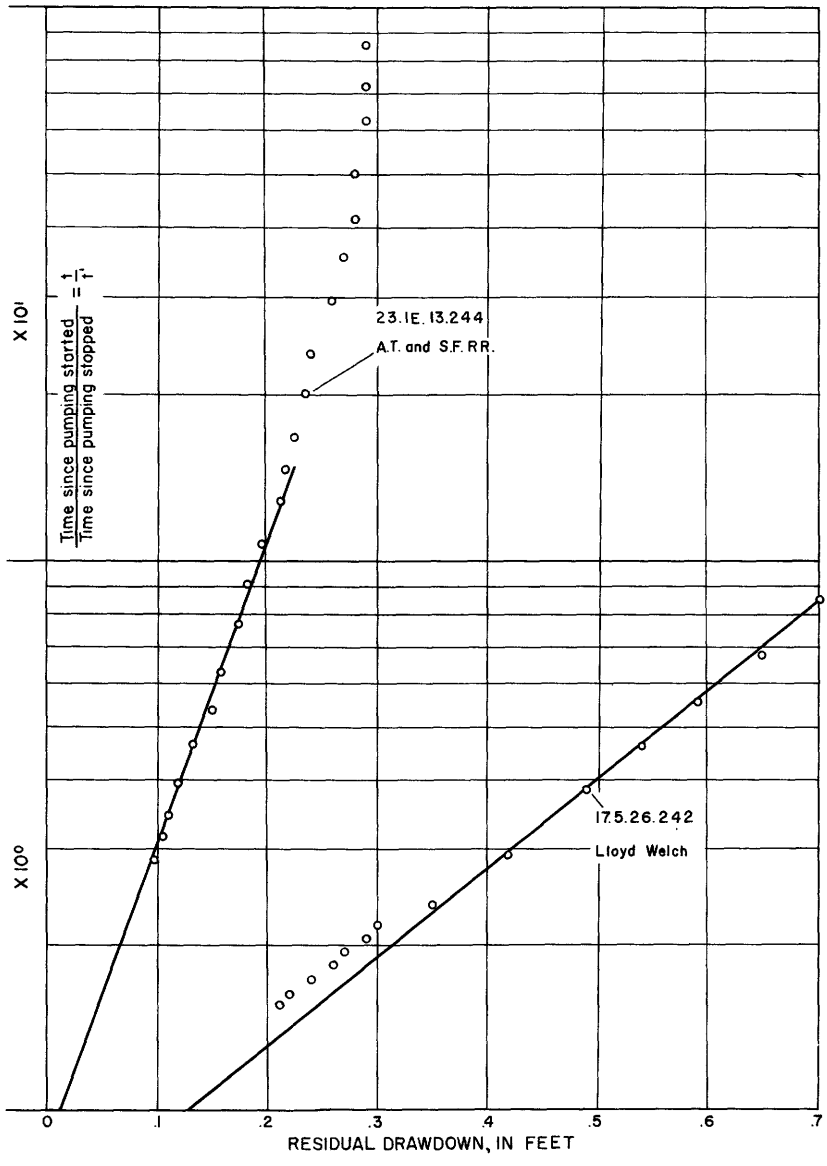

Figure 13. — Curves of recovery of water levels obtained from pumping tests on two wells in Rincon and Mesilla Valleys.

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The irrigation well of Ben Luchini, also in the valley bottom of the Rincon Valley, sec. 31, T. 17 S., R. 4 W., about 1,000 feet east of the river, was pumped for about 9 hours with a discharge of about 1,000 gpm and a drawdown of about 14 feet. The well had been pumped on previous days also. The coefficient of transmissibility determined from the recovery of the water level was 167,000 gpd per foot, which is quite high.

The water supply well of the Atchison Topeka & Santa Fe Railroad at Las Cruces was pumped for 15 hours at an average rate of about 64 gpm with a drawdown of 3.9 feet. This well at present is reported to be 83 feet deep but originally it was drilled to 251 feet. The coefficient of transmissibility was determined as 91,000 gpd per foot. This value may be slightly lower than actual, as it is probable that the sediments were not completely drained because of the small drawdown. However, the value determined is probably of the right order of magnitude for the sediments. The low specific capacity of this well compared with the high coefficient of transmissibility suggests that the perforations in the well casing are encrusted, causing a large entrance loss of head of the water.

The irrigation well of the State College, 23.2E.29.143, located on the valley floor, was pumped for 24 hours at an average rate of 1,270 gpm with a drawdown of 13 feet, to 26 feet below the land surface. The well was reportedly drilled to 50 feet. The value of the coefficient of transmissibility determined from the recovery of the water level was 116,000 gpd per foot. As the drawdown in this well was a large percentage of the depth of the well, it may be that the actual value of the coefficient of transmissibility is slightly higher. However, as stated for the other wells, the value obtained is high and is what might be expected for the sediments.

The irrigation well of A. J. Osborn in sec. 14, T. 17 S., R. 5 W., was pumped at 250 gpm for about 7 hours with a drawdown of about 23 feet from the static level of 60 feet. This well is near the northern end of the Rincon Valley, on the north side of Montoya Arroyo above the valley floor. The value obtained for the coefficient of transmissibility was about 13,000 gpd per foot. However, this figure may not be correct because recovery of the water level did not conform to theory, the curve obtained being composed of essentially 3 straight segments. (See fig. 10.) Other portions of the recovery curve yielded values of 22,000 and 51,000 for the coefficient of transmissibility. It is evident, though, that the formation is less permeable than that of the valley floor.

Another irrigation well above the valley floor, belonging to Lloyd Welch, was pumped at 700 gpm for 10 hours with a drawdown of

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9 feet. This well is on the south side of Tierra Blanca Creek in sec. 26, T. 17 S., R. 5 W., about 2 miles south of the Osborn well. The coefficient of transmissibility obtained from the recovery of the water level was 298,000 gpd per foot, which is very high. This well reportedly penetrated 43 feet of good gravel below the water level in a total depth of 88 feet, which may account for the high value obtained on this short test. It is probable, had the pump been operated for a longer time, the effect of the pumping would have reached beyond the extent of the gravel stringer and a smaller value of the coefficient of transmissibility would have been obtained.

The new city well 5 of Las Cruces, drilled to 300 feet, was pumped for $3\frac{1}{2}$ days at 250 gpm. The maximum drawdown of water level was about 12 feet below the static level of about 186 feet below land surface. The value of the coefficient of transmissibility as determined from the recovery of the water level was 73,000 gpd per foot. This well is located on the bluff east of Las Cruces, out of the valley, in sediments of the Santa Fe formation. The value of the coefficient of transmissibility determined from this well is possibly higher than the average for the bordering mesas.

The following table summarizes the figures of the coefficient of transmissibility determined from pumping tests on the wells.

Coefficients of transmissibility determined from pumping tests on wells in the Rincon and Mesilla Valleys

Well location number	Name of owner	Discharge (gpm)	Drawdown (ft)	Specific capacity (gpm per ft)	Coefficient of transmissibility (gpd per ft)
	On valley floor				
17.4.31.111	Ben Luchini	1,000	14	71	167,000
19.3.4.331	B. S. Thurman	660	9	73	136,000
23.1E.13.244	A. T. & S. F. Ry.	64	4	16	91,000
23.2E.29.143	New Mexico College of A. & M. A.	1,270	13	98	116,000
	Above valley floor				
17.5.14.212	A. J. Osborn	250	23	11	13,000
17.5.26.242	Lloyd Welch	700	9	78	298,000
23.2E.8.434	City of Las Cruces	250	12	21	73,000

WATER-TABLE GRADIENTS AND FLOW OF DRAINS

The coefficient of transmissibility was determined also by correlation of the slopes of the water table to a few drains and the flow of the drains, in order to have an independent check upon the

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coefficients of transmissibility determined from the pumping tests on wells.

Two lines of auger holes were installed in February 1947 across the Park Drain, along Holt and Seale roads about 5 miles south of Las Cruces, extending about 1,800 feet to 2,900 feet from both sides of the drain. Water-level measurements were made at intervals of 2 weeks in the auger holes and the gain in flow of the drain between the 2 hole lines was measured every month by Mr. Williams or Mr. Carbine of the U. S. Bureau of Reclamation. Values of the coefficient of transmissibility were determined every month by using the gradient of the water table determined from the measurements made on the auger holes within a few days of the measurement of the gain in flow of the drain in that section. If conditions were ideal, that is, if equilibrium of the water table and the drain were established and all measurements were accurate, it would be expected that the coefficient of transmissibility determined every month would be the same. However, application of irrigation water to the lands during the growing season results in an unstable condition not only between the water table and the drain but of the water table at the points of observation. The result is a range of figures for the coefficient of transmissibility determined every month. An average of the figures for 12 months, a full cycle, is expected to approach the true magnitude of the coefficient of transmissibility. The figures are given in the following table along with the water-table gradients on each side of the drain and the gain in flow of the drain between the 2 hole lines, which has been converted to accretion per mile as the 2 hole lines are 6,800 feet apart. Also, as the southern auger hole line is not perpendicular to the drain, the gradients on this line have been multiplied by 1.765 to convert the figures to a gradient perpendicular to the drain. The elevations of the water level are in feet above the 3,800-foot level of the U. S. Bureau of Reclamation datum. The hole numbers indicate the distances of the auger holes from the drain, in feet. The slope of the water table to the drain for several months is given in figure 14. The magnitudes of the coefficient of transmissibility obtained for each month ranged from 52,500 to 116,000 with an average of 76,000 gpd per foot.

The U. S. Bureau of Reclamation at various times has made studies of the drainage conditions in local areas. The studies included establishment of lines of auger holes across certain stretches of the drains. These studies were made a number of years ago, and not all the data are available. Measurements of water-table elevations in holes as shown on water-table profiles across 6 drains were complete enough to be of some use in determining the coefficient of transmissibilities. The location of some of the auger-

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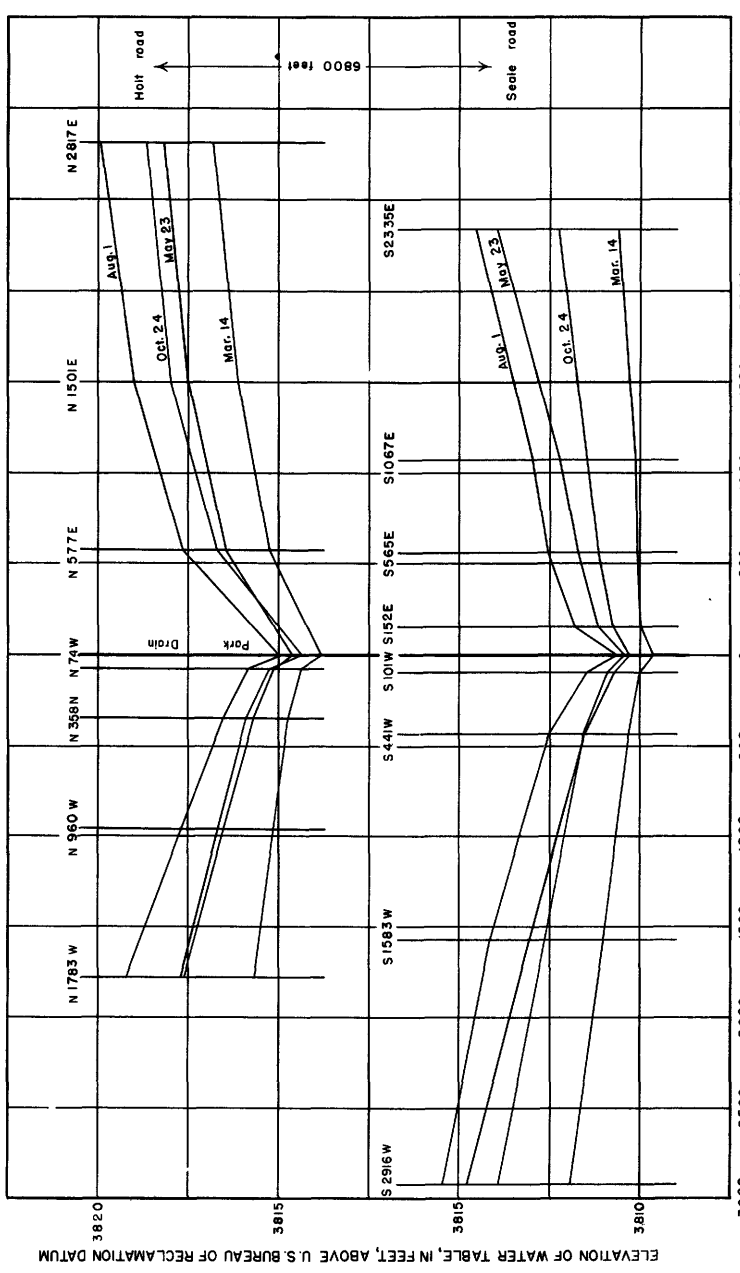

Figure 14. — Profiles of water table across the Park Drain for selected times in 1947, as measured in auger holes in two lines about 3 miles south of Mesilla Park.

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Computation of coefficients of transmissibility determined from gain in flow of Park Drain and water-table gradients on 2 auger hole lines along Holt and Seale roads across Park Drain, about 3 miles south of Mesilla Park

[Gradients on south line have been corrected by multiplying by 1.765 to correct gradient perpendicular to drain]

No. of computation	Date	Water-table gradient to drain and date of measurements						Double average gradient	Accretion to drain (cfs per mile) and date	Computed transverse coefficient of transmissibility (gpd per ft)
		Holes west of the drain			Holes east of the drain					
		Holes N1783W and S2916W	Holes N358W and S441W	Gradient to drain	Holes N2817E and S2335E	Holes N557E and S565E	Gradient to drain			
		Elevation of water table (feet above datum)			Elevation of water table (feet above datum)					
	1947								1947	
1	Feb. 14	15.86	14.83	0.00072	17.07	15.39	0.00075		Feb. 18	
		12.27	10.47	.00128	10.89	10.20	.00069	0.00172	0.74	52,500
2	Mar. 14	15.68	14.75	.00065	16.82	15.28	.00069		.....	
		11.95	10.35	.00114	10.61	10.10	.00051	.00149	[1] 1.65	53,000
3	Apr. 11	17.11	15.36	.00123	17.69	16.18	.00067		Apr. 15	
		12.77	11.19	.00112	12.08	10.81	.00126	.00214	2.04	116,000
4	May 23	17.63	15.73	.00133	18.16	16.46	.00076		May 20	
		13.93	11.57	.00168	13.95	11.74	.00220	.00299	1.96	80,000
5	June 19	17.92	15.84	.00146	18.34	16.69	.00074		June 23	
		14.30	11.86	.00174	14.71	12.07	.00263	.00328	1.66	61,800
6	Aug. 1	19.20	16.55	.00186	19.90	17.66	.00100		July 28	
		15.48	12.50	.00212	14.60	12.53	.00206	.00372	2.66	87,200
7	Sept. 12	18.86	16.43	.00171	19.47	16.39	.00138		Sept. 9	
		16.40	12.61	.00270	13.92	12.19	.00173	.00376	2.71	87,900
8	Oct. 24	17.72	15.89	.00128	18.67	16.73	.00087		Oct. 23	
		[1] 14.80	11.58	.00230	12.25	11.18	.00107	.00276	1.89	83,600
9	Nov. 21	17.17	15.71	.00116	18.17	16.28	.00084		Nov. 24	
		14.06	11.30	.00197	12.85(?)	10.96	.00188	.00292	2.09	87,100
	1948								Dec. 26	
10	Jan. 2	16.57	15.28	.00091	17.53	15.85	.00075		1.10	
		13.07	10.89	.00155	11.38	10.64	.00074	.00198		67,500
11	Feb. 13	16.13(?)	15.03	.00077	17.09	15.58	.00067		Feb. 16	
		12.28	10.54	.00124	10.85	10.28	.00057	.00162	0.77	58,000
Average										75,900

[1] Estimated.

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hole lines along the drains was not given. Some profiles had only a few holes, whereas others had as many as 18 across the drain in question. The gain in flow of the drain was not given in any case. To determine the water-table gradients the change in water level in a distance on each side of a drain on each auger-hole line was noted. All the gradients for the cross sections of a particular drain were then averaged and doubled. The average gain in flow of the drain through the section of the auger-hole lines was assumed to be equal to the average accretion of the drain as a whole for the particular month. The coefficients of transmissibility so obtained are of course subject to many errors but should show the magnitudes to be expected.

By using water-table gradients obtained from 4 auger-hole lines across the Rincon Drain, covering a distance of 4,430 feet along the drain, for an unknown month in 1926 and the mean accretion per mile for the total length of the drain for 1926, a mean coefficient of transmissibility of 96,000 gpd per foot was obtained. The coefficient of transmissibility determined from using the month having the minimum accretion to the drain was 64,000 and that for the month having the maximum accretion was 134,000.

Water-table gradients were available for 18 auger-hole lines, established in July 1930, that extended eastward from the drain to the river along nearly the entire length of the Picacho Drain. Gradients to the west of the drain were not given but as the drain is mainly a riverside drain and probably receives most of its seepage from the river to the east, the gradients on the west side were assumed as being 0.4 of those on the east side. By using the average accretion per mile of the drain for its total length for July 1930, a coefficient of transmissibility of 77,000 gpd per foot was obtained.

The average of water-table gradients for May and August 1927 was obtained on nine auger-hole lines extending on both sides of the West Drain. By using the average accretion of the West Drain for its total length, for the months May through August 1927, a coefficient of transmissibility of 135,000 gpd per foot was obtained.

Water-table gradients for July 1930 were obtained for 9 auger-hole lines across the lower portion of the Del Rio Drain near Mesquite, 6 lines of which extended on both sides of the drain. By using the average gain in flow of the Del Rio Drain for its full length for July 1930, 2.8 cfs per mile, a coefficient of transmissibility of 60,000 gpd per foot was obtained.

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The total length of the Del Rio Drain includes about 11 miles of the Park Drain, an interior drain. The average gain in flow of the Park Drain is undoubtedly less than that of the Del Rio Drain, which parallels the river. If it is assumed that the accretion of the Park Drain is about the same as that of the Mesilla Drain, also an interior drain, which for July 1930 was 0.8 cfs per mile, then a correction of 9 cfs is to be subtracted from the flow of the Del Rio Drain. The flow of the Del Rio Drain is then about 81 cfs for 27 miles or a gain in flow of about 3.0 cfs per mile. The coefficient of transmissibility, using this value of the accretion, is 64,000 gpd per foot, not essentially different from the 60,000 obtained above.

Water-table gradients were obtained for July 1930 for 7 auger-hole lines along the Mesquite Drain extending west from the drain, north of the town of Mesquite. Gradients east of the drain were estimated and the average gain in flow per mile of the East Drain, into which the Mesquite Drain empties, for the month of July 1930 was used. The coefficient of transmissibility so obtained was 47,000 gpd per foot, which is not reliable because of the large number of assumptions used.

Water-table gradients were obtained for July 1930 for 11 auger-hole lines that extended west toward the river along the lower $2\frac{1}{2}$ miles of the Anthony Drain. Gradients east of the drain were estimated and the average gain in flow of the drain for its full length for the month of July 1930 was used. The value of the coefficient of transmissibility obtained was about 54,000 gpd per foot.

The coefficients of transmissibility obtained from the profiles are given in the following table. Part of the variance in the coefficients is due to assuming that the water-table gradients obtained were representative of the drain as a whole or that the average accretion for the drain as a whole was equal to that through the stretch covered by the auger-hole lines; in a few cases it is due to estimation of the gradients on one side of the drain. As these drains are in widely separated parts of the valleys, a range in values of the coefficient of transmissibility is to be expected from the nature of the sediments.

The coefficients of transmissibility obtained by correlation of water-table gradients to several drains with accretion to the drains are somewhat less than those obtained from the pumping tests. This may be caused by the stratification of the sediments, which would reduce the depth of the effect of the drains. Because the coefficient of transmissibility is the product of the thickness of the aquifer and

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Coefficients of transmissibility determined from auger-hole profiles across various drains in the Rincon and Mesilla Valleys

Drain	Length of drain (miles)[1]	Length of section (miles)	Double average gradient	Accretion to drain (cfs per mile)	Coefficient of transmissibility (gpd per ft)
Rincon	6.5	0.8	0.0022	1.75	96,000
Picacho	7.3	5.3	.0030	1.90	77,000
West	28.3	2	.0019	2.1	135,000
Del Rio	[2]37.7	3	.0057	2.8	60,000
Mesquite	[3]22.8	2.5	.0031	[3]1.2	47,000
Anthony	7.9	2.5	.0025	1.1	54,000
Average					78,000

[1]Length at time of measurement of water-table profile.
[2]Includes Park Drain, an interior drain.
[3]East and Mesquite Drains.

the permeability of the aquifer, the resulting value obtained from the drains might be expected to be lower than that obtained from wells. Also, the coefficient of transmissibility obtained from the drains is a transverse transmissibility, across the valley, which perhaps is less than the transmissibility along the valley.

It seems probable that the average coefficient of transmissibility for the alluvial valley fill as a whole can be taken as 75,000 gpd per foot. On the basis of the poor performance of wells on the higher lands bordering the valley as compared with those in the valley and pumping tests on wells in the Santa Fe formation in this and other areas, it appears that the coefficient of transmissibility of the higher lands bordering the valley is less than half that of the alluvium in the valley and probably does not exceed 30,000.

SPECIFIC YIELD

The specific yield of an aquifer, defined on page 90, is a measure of the ability of the aquifer to release water to wells under the action of gravity and is difficult to determine either in the field or in the laboratory. Determination depends upon many factors that cannot be readily evaluated. The percentage of water in an aquifer that can be drained by gravity depends not upon the amount of pore space but upon the size of the connecting pore spaces. Also, the amount of water drained is dependent upon the length of time drainage takes place. In well-sorted sands the porosity is fairly large, possibly approaching 50 percent, and a large percentage of the available water would drain out, under the force of gravity, in a

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short time. However, it is problematical when complete drainage would take place—probably a matter of years. The longer drainage takes place, the greater the volume of water recovered from a given volume of an aquifer. Owing to the effect of capillarity, a lowering of the water table by a short period of pumping represents less extraction of water from the sediments than would occur from an equal lowering of water level by a long period of pumping.

In well-sorted gravels, which have a porosity about equal to that of sand, the percentage of water draining out in a short time would be larger than for sand. Clays in general have a high porosity but because of the small size of the grains and pores the capillary forces are large and the amount of water that will drain by gravity may be negligible.

The alluvial fill of the Mesilla and Rincon Valleys is variable and consists of mixtures of sand, gravel, silt, and sandy clay, as well as some lenses of well-sorted gravel or sand. The specific yield of such sediments also would be variable.

The specific yield of eight various sands tested by Hazen (Meinzer, 1923, p. 54) ranged from 23 to 37 percent. The specific yield for 36 samples from the fill of major stream valleys of San Diego County, Calif., was estimated by Lee (Meinzer, 1923, p. 60) as between 33 to 37 percent by volume, with a practical value of between 20 and 25 percent.

Probably a specific yield of about 25 percent would be an average for the valley fill as a whole in the Rincon and Mesilla Valleys.

GROUND-WATER DEVELOPMENT

PREVIOUS DEVELOPMENT

Pumping of ground water from wells for irrigation in the Mesilla Valley is not new but, as indicated by Follett, was practiced as long ago as about 1896 by a man named Schiller, who irrigated about 800 acres that had been formerly served by the Dona Ana ditch (National Resources Committee, 1938, v. 1, p. 312).

The variable nature of the flow of the Rio Grande in the years prior to construction of Elephant Butte Dam caused much crop loss and induced a number of farmers to install irrigation wells in order to have a dependable water supply. Slichter (1905, p. 51-73) gave data on 10 irrigation wells in 1904 in the vicinity of Las

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Cruces and Mesilla Park and 3 near Berino. The construction of the wells and the pumping equipment ranged from poor to good. All pumps but 1 were of the horizontal centrifugal type, set in open pits about at the water level. The diameters of the wells ranged from 5 5/8 inches to 12 inches, only 2 being more than 10 inches. The wells ranged from 48 to 75 feet in depth and had from 8 to 18 feet of strainer in the bottoms. The measured discharge of the wells ranged from 131 to 1,000 gpm with specific capacities of about 6 to 88 gpm per foot of drawdown. The first irrigation wells were the 2 of the Agricultural College at Mesilla Park (Slichter, 1905, p. 22). These 2 wells were each 48 feet in depth, of good construction, and equipped with good motors and pumps. The 6-inch well produced 800 gpm and the 12-inch well 1,000 gpm, the latter with a specific capacity of 88 gpm per foot of drawdown.

Lee (1907, p. 41-47) gave data on additional wells in the Mesilla Valley. Nine of these wells, ranging in depth from 51 to 197 feet, were of moderate to large capacity and discharged from 130 to 1,500 gpm.

A 12-inch well of the Agricultural College located on the Horticultural farm near Mesilla Park was drilled in 1905 to 62 feet and an 18 foot strainer was placed in the bottom. The pump discharged 1,000 gallons a minute. This well eventually filled with sand and was replaced by a new well, Horticulture well 2, about 75 feet to the southwest. This newer well was not successful as the maximum discharge was only about 250 gpm. In 1935 another well, Horticulture well 3, was drilled about 2 feet from the original location of Horticulture well 1. Well 3 was successful and discharged about 1,100 gpm (New Mexico Agr. Exper. Sta. 1934-35, p. 53-38). However, this well also gradually filled with sand until by November 1946 the sustained discharge was only about 250 gpm.

The 6-inch well of the Agricultural College, described above, known as Irrigation Department Well 1, was replaced about 1915 by a new well, Irrigation Department Well 2, about 40 feet west of well 1. Well 2, 12 inches in diameter below the pit and only 43 feet deep, discharged 1,400 gpm. Well 2 also filled with sand and was in turn replaced in 1935 by Irrigation Department Well 3, about 35 feet north of well 1. Well 3 initially was a poor well but after about 2 weeks of development of the well its discharge increased to a maximum of 1,625 gpm. This well is still in use at the present time, and a pumping test of it is described in another section of this report.

An irrigation well of the old Shalam Colony is described by Lee (1907, p. 45). This well consisted of a circular pit 18 feet in

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diameter to a depth of 30 feet, with the sides and bottom cemented. Five wells were drilled in the bottom of the pit, of which 3 were 6 inches in diameter and drilled to a depth of 90 feet, 1 was 12 inches in diameter, drilled to 90 feet, and the other was 6 inches in diameter, drilled to 197 feet. The pump discharged 1,500 gpm with a drawdown in the pit of 18 feet. This well, now owned by Rudolf Garcia, is still in existence. In November 1947 a turbine pump was installed and reportedly pumped 1,000 gpm with a drawdown of 16 feet. The well is in the northwest corner of the NE1/4 sec. 21, T. 22 S., R. 1 E., about 400 feet west of U. S. Highway 85.

A well, known as the Mesa Pumping Plant, was drilled about 1908 at the Agricultural College, on the low bench on the east side of the river. A concrete-lined circular pit was dug to water at 70 feet and a 12-inch hole sunk an additional 31 feet, which penetrated fine gravel for 12 feet and below this very fine sand. A 20-foot strainer was inserted into the bottom of the well. The discharge of the well was 354 gpm with an estimated specific capacity of about 16 gpm per foot of drawdown, as computed from the water horsepower reported (Fleming and Stoneking, 1909, p. 31. 32). This well is still in existence and because of its relatively poor water, as compared to that from the newer college wells, is used primarily for filling the swimming pool at the college.

Many of these older wells were of small capacity. However, the type of pumps and motors, the comparatively shallow depths, and the small length of strainer in many of the wells suggest that the small discharges were due principally to the well construction and equipment rather than to formations with low permeability. Many of the wells when pumped tended to fill with running sand.

PRESENT DEVELOPMENT

DOMESTIC SUPPLIES

The principal use of ground water in the Rincon and Mesilla Valleys at the present is for domestic purposes. The entire population of the area depends upon ground water for domestic supply, nearly all of which is obtained from wells drilled in the valley fill.

The city of Las Cruces obtains water for the municipal supply from 6 wells drilled upon the edge of the mesa east of the city. The production of these wells, when pumped individually, ranges from about 200 to about 300 gpm per well. All 6 wells are located close to a 2,885,000-gallon reservoir. Because of the close spacing of

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the wells, which results in mutual interference of the pumping effects, the total output with all 6 pumps operating is estimated to be not more than 1,200 gpm or 1,728,000 gpd. Before the addition of the last 2 wells in 1947, the consumption of water during the summer was such that the 4 wells were operated continuously during the day and 3 during the night. The maximum daily consumption in 1946 and 1947 is therefore estimated to have been about 1,000,000 gallons, and the annual pumpage about 300,000,000 gallons.

The village of Hatch obtains its water supply from a group of springs about 8 miles southwest of the town, in Spring Canyon Arroyo. The town has a well, for emergency use, drilled near the river levee. The maximum water consumption of the town is reported to be about 45,000 gallons a day, with an average of about 500,000 gallons a month.

Mesilla Park is furnished water by a privately-owned system consisting of 4 wells. The daily consumption is estimated by Mr. Archer, the owner, as about 10,000 gallons.

The New Mexico College of Agriculture and Mechanic Arts at State College, east of Mesilla Park, obtains its water supply from two wells drilled at the college above the level of the valley floor. Another well is used for emergencies and for filling the swimming pool. A new well for domestic use, drilled in 1947, is not at present equipped with a pump.

Residents of Rincon are furnished water by the Santa Fe Railway, obtained from a well drilled on the south side of Rincon Arroyo, about 3 miles northeast of Rincon. The discharge of the well is estimated as 170 gpm on the basis of the rate of filling of the water tank at Rincon. The daily use of water is about 67,000 gallons by the railroad and about 5,000 gallons by the town.

Residents of the valleys not served by one of the above domestic-supply systems generally obtain their domestic water from individual wells at their homes. These private wells range from shallow dug or driven wells equipped with buckets or pitcher pumps to jetted wells more than 300 feet in depth. Most of the jetted wells have casing 3 inches in diameter, with no perforations and draw their water from the lower end of the casing, which usually is set at the top of a gravel or coarse sand deposit immediately below a clay lens. The deeper wells generally have been drilled to seek water of a better quality than that near the surface. Some wells that were intended to be drilled to only shallow depths for good water were reportedly drilled deeper before a coarse sand or gravel deposit was encountered below a suitable clay lens. If wells of this type end in fine sand, the sand may partly fill the

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casing when the well is pumped, resulting in reduced yield. Many of the domestic wells are equipped with small automatic pressure pumps.

IRRIGATION SUPPLIES

Development of irrigation wells was quite rapid in 1947 and 1948 as a result of the anticipated shortage of surface water. At the end of 1946 about 11 irrigation wells were in operation in the Rincon and Mesilla Valleys, 5 of which had been in operation for a number of years. By the end of 1947 about 45 additional wells has been drilled for irrigation and other wells were in the process of being drilled. However, not all the new wells were equipped with pumps and a few, undoubtedly, will prove unsuccessful. About 70 wells drilled in the Mesilla and Rincon Valleys by February 1948 apparently had or would have sufficient water for irrigation.

Twelve of the irrigation wells drilled and equipped with pumps by the end of 1947 are on the side slopes of the valleys, above the level of the valley floor and present canal system. Eleven of these wells of which 9 were drilled in 1946 and 1947, are in the Rincon Valley, and the other 2 are in Mesilla Valley.

Owing to the anticipated shortage of surface water in 1948, normal winter releases of surface water were suspended from the end of the growing season in 1947 to the beginning of the growing season in 1948. No surface water was to be delivered in 1948 to lands classified as suspended, and only 2 acre-feet per acre was to be allowed initially on the classified lands. Because of these water-conservation measures, many irrigation wells were drilled to serve tracts of land devoted to truck crops that require winter irrigation and to tracts classified as suspended. However, irrigation wells have been drilled also on SCC classified lands (p. 18) as a crop-insurance measure in the event of a shortage of surface water.

PERFORMANCE OF EXISTING WELLS

The discharge of a well, other things being equal, is dependent upon the size and condition of the pump and its speed, which in turn is dependent upon the amount of power available. A pump discharging only a few gallons a minute does not in itself indicate whether the well is a poor well or a good well. In order to make a comparison between wells the specific capacities are usually given, expressed in gallons a minute per foot of drawdown. For a particular well this value is generally regarded as nearly constant for reasonable values of drawdown. For cased wells the specific

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capacity depends to some extent upon the perforations in the casing. If they become plugged or are insufficient in total area a low specific capacity may be indicated even though the aquifer is highly permeable.

The ultimate yield of and drawdown of water level in most of the wells can be inferred from the hydrologic characteristics of the aquifer, the coefficient of transmissibility, and the specific yield. Based on results of pumping tests and correlation of drain flow with ground-water gradients, the average coefficient of transmissibility for the Rincon and Mesilla Valleys is estimated to be 75,000 gpd per foot. In other areas of New Mexico where irrigation from wells is done successfully the average coefficient of transmissibility ranges from about 50,000 to about 100,000. In addition to the favorable coefficient of transmissibility, the water is quite shallow under the valley floor of the Rincon and Mesilla Valleys as compared with depths to water of 30 to more than 100 feet in other areas in New Mexico where ground water is pumped.

Reliable information on some of the present irrigation wells in the Rincon and Mesilla Valleys is lacking, particularly of those that had not been equipped with pumps by the time field work on this investigation had ended. Of 9 wells in the Rincon Valley floor equipped with pumps, the discharges, either measured or reported, range from 250 to 1,000 gpm. The specific capacities of 5 of the wells range from 57 to 96 and average about 70 gpm per foot of drawdown, values which indicate good irrigation wells.

In addition to the irrigation wells in the valley floor in the Rincon Valley, about 15 wells have been drilled on the alluvial fans of the arroyos west of the valley, 12 of which are equipped with pumps. The discharges of 11 of these wells, either measured or reported, range from 250 to 850 gpm and the specific capacities of 10 of them range from 11 to 100 and average about 50 gpm per foot of drawdown.

Two wells above the valley floor in the Rincon Valley, drilled by Mr. Osborn for irrigation, were unsuccessful. Well 16.5.25.341, in the alluvial fan of Percha Creek, produced only about 125 gpm with a drawdown almost to the bottom of the well. Well 17.5.10.442, on top of the bluff of the Santa Fe formation overlooking Montoya Arroyo, obtained only a small quantity of water, which was under sufficient pressure to rise to about 30 feet above the adjacent arroyo bed.

In the Mesilla Valley, by the end of 1947, there were about 24 irrigation wells on the valley floor and 2 on the alluvial slopes above the valley floor that were equipped with pumps. Also completed were 4 wells on the valley floor and 3 above the valley

floor that were drilled for irrigation but not equipped with pumps. In addition, there were other wells in the process of being drilled. Only 4 of these 33 wells were in existence prior to 1947, and 1 of the new wells, on the horticultural farm of the State College, is a replacement of a previous irrigation well.

As most of the irrigation wells in the Mesilla Valley are quite recent, their performance characteristics are not generally known. This is especially true of the drawdown of the water level when the wells are being pumped. The reported discharge from 16 of the wells on the valley floor range from about 600 to more than 2,000 gpm, with reported specific capacities for 8 of the wells ranging from less than 20 to about 60 gpm per foot of drawdown. The discharge measured for 2 wells were 1,100 and 1,270 gpm, with specific capacities of about 25 and 97.

As tractors furnish power for many of the wells at the present time, it is probable that the pumps are not being operated at capacity. Continued use of the wells generally results in an increased capacity as the fine sand from the formation around the well is removed. Running sand tends to fill the wells and causes the ground surface to cave. In order to keep the sand from filling the wells, constant pumping of the wells during development should be continued as long as the water contains sand. In addition to this trouble with sand, the inadequate perforations in some wells become plugged with fine gravel and sand.

The T. L. Simpson irrigation well furnishes an example of the effect of sand running into a well and of inadequate or clogged perforations. The well was drilled to a depth of 80 feet and the lower 20 feet of the casing was perforated with a Mill's knife. Large gravel was penetrated from 55 to 80 feet. Initially the pump discharged a maximum of about 800 gpm when the water level was drawn to the bottom of the pump suction pipe at about 60 feet. After cleaning out 10 feet of sand and gravel that had come into the well and reperforating the casing, the discharge of the pump was increased to 1,200 gpm with a smaller drawdown.

In order to reduce caving of the ground surface around the well, many wells are not drilled larger in diameter than the casing. The annular space between the hole and the casing is then filled with gravel, which fills the cavity that is formed by removal of the sand when the well is pumped. So far as the long-term yield of the well is concerned, gravel packing does not increase the discharge of the well. The ultimate production of a well is dependent upon the permeability of the formation surrounding the well at a distance and cannot be changed by the addition of the gravel.

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Packing together of the gravel and sand and filling of the perforations by the mixed gravel and sand may cause the permeability around the well to be lower than that of the sand alone and may actually decrease the discharge of the well at a given drawdown. Wells that can be developed by removal of the sand without caving of the ground surface and without the gravel will be as productive, if not more so, than if gravel is used. If a large amount of gravel is used, if the perforations of the casing remain open, and if the porosity of the gravel is not reduced by the sand, the gravel serves to enlarge the effective diameter of the well, decreasing friction and consequently increasing its specific capacity. Gravel of a single size has a high porosity and is to be preferred to gravel of mixed sizes, which packs tighter and results in a lower porosity.

Performances of the present irrigation wells indicate that successful wells can be obtained nearly everywhere on the valley floor of the Rincon and Mesilla Valleys, provided that proper drilling and development methods are used to care for the large amounts of fine running sand. Reports of drillers suggest that more fine sand may be found in the lower part of the Mesilla Valley than in the remainder of the valley. Wells in the Selden Canyon area of the Rincon Valley and in the extreme upper part of the Mesilla Valley will be near mountain masses which delimit the sediments supplying water to the wells and result in comparatively large drawdowns after a period of time.

Irrigation wells on the alluvial slopes above the valley floor generally will be successful, although the capacity of most such wells will be smaller than that of wells in the Quaternary alluvial fill of the valley. Some attempts to obtain wells on the alluvial slopes will fail because of the local predominance of clay and fine sand mixed. Some difference is to be expected in the permeability of the undisturbed Santa Fe formation that forms the bluff along the valley and of the alluvial fans, slopes, and arroyo deposits formed from the erosion of the Santa Fe formation. However, no definite difference in the yield of wells drilled in these deposits has been noticed, good and poor wells having been completed in both the undisturbed and the reworked deposits.

FUTURE DEVELOPMENT

The extent to which irrigation from wells will be practiced in the future is dependent in large measure on whether surface-water supplies for the project lands continue to be insufficient. It is also dependent on whether farm prices conductive to development of new lands continue in effect. The present average farm cash return is at an all-time high, with indications that favorable conditions will continue for some time.

TX_MSJ_005552

Even if sufficient surface water becomes available for the project lands, including those classified as suspended, the incentive for development of irrigation wells on high lands bordering the valley will remain. The initial cost of such land is comparatively small and its economic development probably can compete favorably with that of the project lands.

The acreage of land that can be irrigated by surface water in the Rincon and Mesilla Valleys has reached the maximum possible, being limited primarily by the amount of water available. In general less than one-third of the suspended land has been given water each year. It is supposed that in a dry year this part of the suspended land, about 4,600 acres in 1946, would not be allowed to have water. Therefore in such a dry year, when even land having a full water right might not have a full supply of water, there would be a tendency for farmers who have large tracts of suspended land to install pumps. This might also occur where an acreage of suspended land is being farmed in conjunction with land having a water right. A small tract of suspended land probably would not be irrigated in a dry year as in general it would not be economically feasible to install an irrigation well and pump on a tract of less than 20 acres. If there happened to be a few such small tracts adjoining each other it is possible that the owners might put down a cooperative well.

In 1946 there were 135 tracts of 20 acres or more of suspended land of all classifications in the Rincon and Mesilla Valleys, including the Texas portion of Mesilla Valley, with a total area of 5,822 acres, as given in the following table. This might be an indication of the maximum area of suspended land upon which wells would be drilled for irrigation. This area of 5,822 acres is slightly more than the 4,606 acres of suspended land reportedly irrigated with surface water in 1946, although not necessarily comprising the same tracts of land. The suspended land irrigated in 1946 was mainly land classified as seeped (waterlogged).

In addition to suspended land in the valleys that might be irrigated with ground water, a large part of which is now irrigated by surface water, new land susceptible to ground-water irrigation is available that is not now being farmed. This additional land is not now being farmed. This additional land is not within the area served by canals and some of it is located outside the boundaries of the Elephant Butte Irrigation District. The results of a reconnaissance survey by G. R. Chenot include the estimated maximum acreages of land that might be susceptible to irrigation by water from wells.

Tracts (20 acres or more) of land classified as suspended and irrigated suspended land in Rincon and Mesilla Valleys (including Texas portion), 1946

[From records of U. S. Bureau of Reclamation]

	Classification																Suspended land, irrigated (acres)
	High		Sandy		Overflow		Seeped		Poor soil		Rough		Isolated		Total		
	No. of tracts	Acres	No. of tracts	Acres	No. of tracts	Acres	No. of tracts	Acres	No. of tracts	Acres	No. of tracts	Acres	No. of tracts	Acres	No. of tracts	Acres	
Rincon Valley....	1	91	2	61	13	743	14	925	1	24	3	77	14	620	48	2,541	1,834
Mesilla Valley...	2	83	6	214	12	379	48	1,914	13	436	3	92	3	163	87	3,281	2,772
Total.....	3	174	8	275	25	1,122	62	2,839	14	460	6	169	17	783	135	5,822	4,606

TX_MSJ_005554

The acreages, given in the following table, have been divided into areas inside and outside the boundary of the Elephant Butte Irrigation District.

Estimated acreage of new land inside and outside the boundaries of the Elephant Butte Irrigation District that might be susceptible to irrigation by ground water

	Inside (acres)	Outside (acres)	Total (acres)
Rincon Valley	900	4,700	5,600
Mesilla Valley (N. Mex.)	2,000	4,700	6,700
Mesilla Valley (Tex.)	.....	900	900
Total	2,900	10,300	13,200

The area in the Rincon Valley susceptible to ground-water irrigation was determined by sketching, in the field, the lands that were fairly smooth, not cut by large arroyos, not too rocky, and with gentle slopes. The valley sheets of the Bureau of Reclamation, to the scale of 1 inch to 2,000 feet, were used as a base for sketching. None of these lands were on the higher mesa land; practically all were in arroyo deposits.

The area of land in the Mesilla Valley susceptible to ground-water irrigation was sketched upon the standard U. S. Geological Survey topographic maps, which had a scale of 1:62,500, about 1 inch to the mile, with a contour interval of 25 feet. The lands were limited to those having an altitude of not more than 100 feet above the river. Lands included were those with gentle slopes that were fairly smooth, not too rocky, and not cut by large arroyos. Most of the favorable land was located on the east side of the river on the low benches and below the upper mesa surface.

These acreages of land suitable for ground-water irrigation are gross or maximum figures and would be reduced by the areas needed for roads and other improvements, areas having land not suitable for farming, and areas in which successful wells could not be obtained. Some areas of rough lands or lands having a large slope probably could be leveled and terraced with the large earth-moving machinery now available.

It seems probable that about 15,000 acres of suspended and new land might eventually be irrigated with ground water, provided that conditions remain favorable for such development. If such development occurred, the minimum amount of water consumed annually on these lands would be about 38,000 acre-feet, on the basis of 2.5 acre-feet per acre. As a large part of these lands is on the higher ground along the edges of the valley, only a part of this water at the outset would be diverted from the drains or the

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river. However, as all the ground water in the valleys and mesas is connected with and contributes to the flow of the drains, any pumping must eventually mean a decrease in drain flow, in the long run equal to the amount that had been pumped, less any return of irrigation water and any small amount saved by reduction of evapotranspiration losses.

PUMPING OF GROUND WATER

GENERAL CONDITIONS

Pumping a well results at first in lowering the water level in the well and in the aquifer immediately surrounding the well, forming the so-called cone of depression in the water table. The rate of lowering of the water level is initially rapid but gradually slackens as time goes on. The drawdown at any particular time is dependent upon the rate and length of pumping and the hydrologic characteristics of the aquifer. In time, lowering of the water level occurs at greater and greater distances from the pumped well, the area affected continually expanding but at a diminishing rate. Stability of the cone of depression is not attained, until an area of rejected recharge or an area of ground-water discharge is reached.

In many localities, areas of rejected recharge and ground-water discharge either do not exist or are at such great distances that water pumped must be taken from storage for years, with a consequent continual lowering of the water table. All water pumped from wells is balanced by a loss of water somewhere in the ground-water system, commonly from the amount stored underground or from the amount seeping out of the aquifer; often in humid regions, but less commonly in arid regions, the ground-water pumpage is compensated for by a reduction in the discharge to streams in recharge areas (rejected recharge) that occurs because the aquifer is full.

Areas of ground-water discharge in the Rincon and Mesilla Valleys are the drainage ditches, where lowering of the water table would result in a decrease in the accretion of the drains, and the relatively small areas of waterlogged (seeped) land where a lowering of the water table would decrease the evaporation and transpiration of the ground water. Also, in sections of the river where the river level is below the level of the ground water, a lowering of the water table would result in a decrease of the accretion to the river, such as would occur with a drain.

Areas of rejected recharge are sections of the river where the water level in the river is above and in direct contact with the ground water. A lowering of the water table in such areas would induce a larger amount of water to seep from the river.

TX_MSJ_005556

The increased seepage from the river to the aquifer and the decreased drain flow and return seepage to the river that would result from the pumping would not make more water available to the project as a whole but, instead, would divert to the pumps water that would otherwise be available as surface supply lower down the valley. However, any water saved by pumping that is now lost by evapotranspiration in the waterlogged areas would result in an actual increase in water supply for beneficial use in the project. Unfortunately, the amount of water saved from transpiration would be small, as only 5,135 acres within the boundaries of the Elephant Butte Irrigation District in the Rincon and Mesilla Valleys in 1946 was classified as seeped. Part of this seeped land is already farmed, and part of it is in areas distant from likely sites for wells, or near the river or outlets of the drains, where a substantial lowering of the water table would be unlikely. Transpiration by plants in rights-of-way along the banks of canals, laterals, drains, or the river could not be reduced significantly by a lowering of the water table.

Additional suspended land classified as rough, sandhill, alkali, poor-soil, isolated, and overflow—totaling 5,483 acres—may have sufficient native vegetation transpiring water, so that a lowering of the water table would save water. However, of the 10,985 acres of land classified as suspended, 4,606 acres (mainly that classified as seeped), was farmed in 1946.

An indication as to the area of land from which water is transpired to such an extent that some might be saved by a lowering of the water table can be gained from the tables on pages 19 and 20. Areas in which a lowering of the water table would not result in a reduction of transpiration, such as rights-of-way, cities, and irrigated land, or areas in which a lowering of the water table is not possible, such as the river bed between levees and river and canal surfaces, are listed in the following classification. The area for cities had been increased from 1,633 acres, shown for 1936, to an estimated 2,000 acres to take into account the growth of the residential areas.

Classification of type of area

	Acres	Acres
Cities (1947 estimate)	2,000	
Irrigated (1947)	101,700	
Rights-of-way (1947)	8,300	
River and canal surfaces (1936)	6,700	
River bed, between levees (1947)	11,200	
Total classified area		129,900
Other lands (water consuming?)		8,400
Total valley area		138,300

TX_MSJ_005557

The difference between the total valley area and the areas named, that is, 8,400 acres, is presumably the maximum area under which a lowering of the water table might effect a reduction in transpiration losses, provided that this area had native vegetation dependent upon shallow ground water. There may be some duplication in the areas of "river and canal surfaces" and "river bed between levees," but as some additional right-of-way areas have not been determined the inconsistencies may be balanced. As not all the area of 8,400 acres would be located where the effects of pumping would be appreciable and as not all the transpiration from favorably located areas could be stopped, probably a few thousand acre-feet of ground water in the areas of transpiration could be salvaged by lowering the water table.

The effect of continuous pumping upon the water table is shown in the vicinity of Las Cruces by the displacement of the water-table contours around the city wells, the college wells, and to some extent around the Country Club well. (See pl. 1.) These wells are located on the higher lands east of the valley, in T. 23 S., R. 2 E. The Country Club well is the southeasternmost well shown in sec. 6, the 6 city wells are in a small group in secs. 8 and 17, and the 2 used college wells plus 2 unused new wells are in a small cluster in sec. 29. The cone of depression shown by the contours of the water table around the city wells is quite apparent and indicates a lowering of the water table of at least 10 feet and possibly as much as 15 feet from the probable original level given by projected contours of the water table over the area affected. Small cones of depression are indicated around the Country Club and college wells, with a lowering of the water table of possibly 5 feet.

EFFECT OF PUMPING UPON FLOW OF DRAINS

The effect of pumping a well upon the flow of a drain or a river that is in direct connection with the water table can be evaluated theoretically with the aid of the following formula developed by Theis (1941, p. 736).

$$P = (2/\pi) \int_0^{\pi/2} e^{-K \sec^2 u} du$$

in which

P = percentage of the pumped water taken from a river or a drain.

$K = 1.87a^2 S/Tt$.

a = distance from well to river or drain, in feet.

S = specific yield.

T = coefficient of transmissibility.

t = time since well began pumping, in days.

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In the development of this equation a number of simplifying assumptions were made. The aquifer is considered to be homogeneous and isotropic. The coefficient of transmissibility of the aquifer is considered constant, which for thick alluvial aquifers may be approximately true. The course of the river or drain is idealized as a straight line. The ground water is assumed to be in free communication with the stream or drain; that is, the stream bed is not so heavily silted as to offer appreciably more resistance to the movement of ground water than would normally occur in the aquifer. This assumption may not be true for certain sections of a river but would be true in the case of open drains. It is also assumed that the stream or drain maintains a flow past the pumped area and that the level of the water in the stream or drain is not changed significantly because of the pumping.

It can be shown from the equation (Theis, 1941, p. 736) that more than half the effect upon the stream or drain resulting from the pumping of a well occurs between a point upstream from the well at a distance equal to that of the well from the stream and a point downstream the same distance. At greater distances up or down the stream or drain the effects of the pump rapidly diminish. Therefore, if the stream or drain retains an approximately straight line past the pump for distances of more than twice that of the pump from the stream or drain, the equation will give usable results.

The results will be affected significantly if the lowering of the water level from pumping reduces the amount of transpiration from the aquifer or if the effects of the pumping reach the limits of the aquifer. This last condition will occur in the Rincon Valley from Hatch northward, where the valley is flanked on the east by the Caballo Mountains, and in the Selden Canyon area where the aquifer is shallow and is flanked on the east and west by mountain masses of the Sierra de las Uvas. The Mesilla Valley is flanked, in general, by sediments having a lower coefficient of transmissibility than that of the valley deposits. When the effect of the pumping reaches the limits of an aquifer or reaches an aquifer where the coefficient of transmissibility is less than in the aquifer being pumped, the rate of decline of the water level caused by the pumping will increase.

The theoretical effect of a pumping well upon the flow of the river or a drain in the Rincon and Mesilla Valleys is shown on figure 15, which has been computed from the formula by using the average coefficient of transmissibility of 75,000 and a specific yield of 25 percent for the Rincon and Mesilla Valleys. The percentage of the pumped water diverted by a single well from the flow of a stream or drain is obtained from the graph by the value of the

TX_MSJ_005559

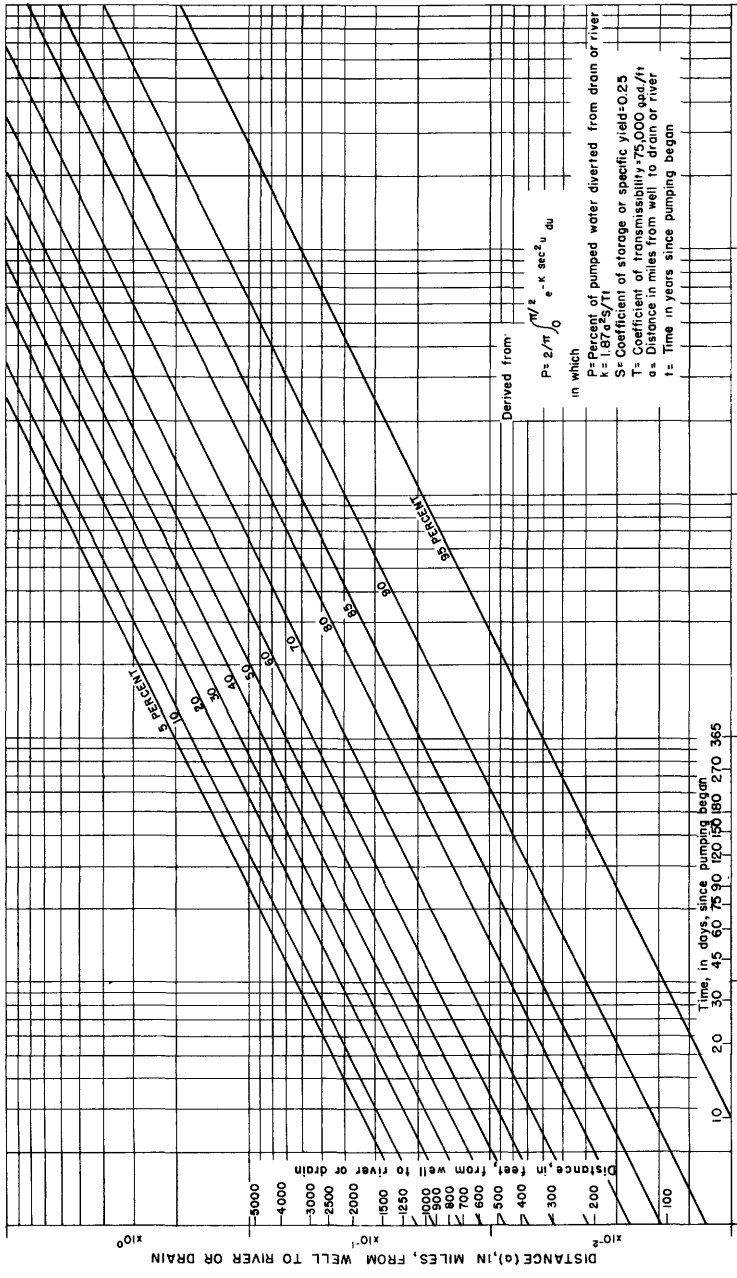

Figure 15. — Percentage of pumped water diverted from a drain or the river by a pumped well in Rincon or Mesilla Valleys.

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sloping line determined by the intersection of a horizontal line at the distance of the well from the stream or a drain and a vertical line at the time since pumping started. The residual effect of a pumped well after pumping stops can be determined by the difference in effect caused by a well pumping continuously from the time of start to the time in question and a recharge well pumping from the time of actual stop to the time in question.

This diagram shows that if a well in the Rincon or Mesilla Valleys were located a quarter of a mile from a drain the flow of the drain would be reduced after 3 months of continuous pumping by 63 percent of the pumping rate, after 6 months by 73 percent of the pumping rate, and after 1 year by 81 percent of the pumping rate. After 6 months of continuous pumping the flow of a drain would be reduced by 88 percent of the pumping rate for a well located an eighth of a mile from the drain, 73 percent for a well located a quarter of a mile from the drain, 50 percent by a well located half a mile from a drain, and 18 percent by a well located 1 mile from a drain. Within 12 days 50 percent of the water pumped by a well located an eighth of a mile from a drain would be diverted from the drain, but it would take about 2 years for a well located 1 mile from a drain to have the same effect. If a well located a quarter of a mile from a drain were pumped for 6 months and then stopped, the drain would still be losing water 1 year after the start of pumping, or its accretion would be reduced, at 8 percent of the pumping rate.

As evident from the formula and the graph, if the distance from the well to a drain is doubled the time necessary for the same effect upon the drain is four times as long; that is, for the same effect, the time varies as the square of the distance.

The effect of pumping upon the flow of a stream or a drain, in which the water is in free communication with the ground water, will be evidenced initially either by a decrease in the accretion of ground water by a gaining stream or drain, or by an increase in the rate of loss of water from a losing stream or drain. With continued pumping, in the case of a gaining drain or stream, the gradient of the water table would be reversed and the drain or stream would lose water in the section affected and finally in either case, if the pumping rate were great enough, the stream or drain would be dried in that section.

In order to dry the drains, the pumping effect per mile of drain must be at least equal to the accretion of the drain per mile. The average drainflow accretion under the present conditions of an average surface supply of water is about 0.8 cfs per mile in the late winter months, increasing to almost 2 cfs per mile in the late summer, with a maximum range from about 0.5 to 2.5 cfs per

TX_MSJ_005561

mile based upon the total lengths of the drains. Certain stretches will probably show greater or less accretion than this. Wells placed a quarter of a mile from a drain at 1-mile intervals, each pumping continuously at the rate of 3 cfs, theoretically would dry a drain in the summer under the present conditions of drain flow after about 4 months of pumping. In a year with less than the average supply of surface water, the flow of the drains would be less than normal and the amount of pumping required to dry the drains would be less.

The theoretical effect of the pumping of a well upon the flow of a drain is possibly somewhat greater than would actually occur at any particular time because of clay layers that extend under the drains, which might introduce a lag in the effects of pumping from wells that extend below the clay layers.

If a well were located between drains or between a drain and the river, the total depletion of their flow after any given period of pumping from the well would be greater than if only one drain were involved. As the ultimate effect is the same, locating a well between drains only speeds up the effect of the pumping. This accelerated effect of the pumping probably would offset the possible lag caused by the stratification of the aquifer.

The maximum practical distance that a well can be located from a drain or the river in the Rincon and Mesilla Valleys is about a mile because of the narrowness of the valleys and the numerous drains. At the northern end of the Rincon Valley in the vicinity of Arrey, where there are no drains, a well on the valley floor could be as far as a mile from the river. Also, near Salem the maximum distance from a drain that a well on the valley floor could be located is about a mile. In the remainder of the Rincon Valley the maximum distance from either the river or a drain is less than a mile, in general being closer to half a mile, and for a large number of wells the average distance probably would be between a quarter and half a mile. In some areas it would be necessary to locate a well near a canal in order to be at a maximum distance from the river or a drain.

In the Mesilla Valley, where drains are more numerous than in the Rincon Valley, practically the only area where wells on the valley floor could be more than a mile from the river or a drain is in Las Cruces. The maze of drains in the rest of the valley precludes locating a well much more than half a mile from the river or a drain and then the well might be near a canal. Also, in most of the valley a well would be situated between two drains or a drain and the river, which would increase the total effect of pumping at

TX_MSJ_005562

any particular time over that upon one drain. For a number of wells the average distance to the river or a drain probably would be between a quarter and half a mile, and many of the wells would be between two drains or between a drain and the river.

As the flow of the drains is derived principally from return seepage from irrigated lands and from canals and as interception of this seepage by a well results in a decrease in flow of the drains such interception does not reduce the ultimate effect of the pumping upon the flow of the drain.

SUPPLEMENTAL PUMPING OF GROUND WATER IN A DROUGHT PERIOD

Under the present conditions in the Rincon and Mesilla Valleys the surface and ground waters are in approximate equilibrium. The surface water is diverted throughout the year to the canals and irrigated land and a certain percentage that is not lost by evaporation and transpiration seeps underground and returns to the river directly or by drain flow for reuse in the next lower irrigation division. The drain flow, as stated before, is composed almost entirely of return diversions and seepage of river water but it contains a small amount of ground-water flow from the side mesas. The drain flow is not waste water insofar as the next lower irrigation unit is concerned but instead is counted upon as a part of the water supply of the project. Thus, no water is wasted in the project except by transpiration and evaporation—the total amount of which is increased if water is used carelessly—and for the small quantity that bypasses the lower unit, especially during the winter.

Pumping of ground water for supplemental use does not represent an additional supply or new source of water but rather a change in in method, time and place of diversion of available supplies.

The pumping effect of one well upon a drain has been discussed in another paragraph. The remaining water pumped that is not diverted from the drains or the river or saved from evapotranspiration at any particular time is taken from storage. As seen from the graph, figure 15, the percentage of water taken from storage in the case of a single well pumping for 6 months at a distance of a quarter of a mile from a drain is only about 27 percent. Thus on a short-term basis of 1 year, only about a quarter of the water pumped is taken from storage and represents water not otherwise available during that year.

Thus, on a year-to-year basis, the net gain of water to the district is that quantity of water pumped in excess of the decrease in normal drain flow caused by the pumping. This net gain of water

TX_MSJ_005563

is water taken mainly from storage, that is, borrowed from the ground-water supply. This borrowed water must be replaced in future years if the flow of the drains is to return to normal.

If in future years no excess surface water is available to the project to raise the ground-water level to the nonpumping stage, then pumping must be continued, even in a year of normal water supply, unless the pumped water is used more efficiently than surface water, in which case the total amount needed would be less and the debt to ground-water storage could gradually be reduced.

The economy of a supplemental pumping project in the Elephant Butte Irrigation District depends upon the quantity of water that must be pumped. This in turn depends upon how the gravity water in the Rio Grande project is distributed to the various valleys, what economies could be effected in its distribution, and what salvage of water would occur by reason of the lowered water table in a dry year. The distribution of surface water might be in proportion to the average diversions, or to the average river depletions. It might be assumed that pumping would be done in the El Paso district also, which would save some water that would otherwise drain from the land, and thus provide more water for the project; or it might be assumed that the El Paso district would not install pumps also, in which case the Elephant Butte district might be regarded as having an obligation not to interfere with the deliveries of water to the lower district. Some water would be saved from evaporation by drying of the drains and by lowering of the water table in waterlogged areas.

For the purpose of this study it is assumed that direct canal waste would be largely eliminated throughout the project and that the Elephant Butte district has no obligation to the lower district to continue this direct loss. It is assumed also that an obligation does exist to continue to deliver the average proportionate drain flow, which is taken to be 40 percent of the gross diversions.

As stated on page 52, in a hypothetical year in which the surface supply of water available for diversions is only half the average, it is believed that 2.28 feet of water could be delivered to the farms, or about 1 foot less than that needed for successful irrigation of the crops. If the additional foot of water were supplied by pumping ground water into the canals, some loss of the pumped water would occur, owing to waste and to seepage from the canals. Owing to closer control of the pumps and to the shorter distance that the pumped water would travel in the canals as compared with surface water, a wastage of 3 percent and a seepage loss of 17 percent of the pumped water may be assumed. This combined

TX_MSJ_005564

loss of about 20 percent is compared with a probable minimum of 30 percent for gravity water. Every additional acre-foot of pumped water delivered to the farms, therefore, would necessitate pumping about 1.25 acre-feet.

However, pumping of wells would diminish the drain flow. This decrease in drain flow presumably would necessitate a corresponding decrease in the allowable diversions for the Elephant Butte Irrigation District.

The narrowness of the valleys and the large number of drains preclude locating pumps very far from either the drains or the river. If a large number of pumps were installed, as would be necessary for a district pumping system, the average distance from a drain would be about a quarter of a mile, and it is expected that the drains would be dried during the first summer of pumping if only a small gravity water supply were available. The amount of the drain flow in an average year is about 42 percent of the gross diversions. In a dry year, with less excess water applied to the lands, the drain flow is expected to be less, probably about 40 percent of the diversions. In an assumed dry year when only 50 percent of a normal gravity-water supply were available, 3.25 acre-feet per acre would be diverted in the Rincon and Mesilla Valleys, of which 40 percent would be returned to the system as drain flow, leaving a total diversion used within these valleys of 1.95 feet. If a pumping system were installed and the drains were dried, presumably 1.95 feet would be the justifiable diversion to these valleys. It has been assumed that, in a dry year, 3.3 acre-feet of water per acre is needed for a full crop, that 30 percent of the surface water diverted would be lost, largely by seepage from the canals, and that about 20 percent of the pumped water would be lost by seepage and waste from the canals. Therefore,

$$3.3 = 1.95 \times 0.7 + \text{pumped water} \times 0.8;$$

therefore,

pumped water = 2.42 acre-feet per acre.

Thus, in order to make up the deficiency of 1 acre-foot per acre that would result from gravity irrigation alone in the assumed dry year, it would be necessary to pump about 2.42 acre-feet per acre. This is the minimum amount with judicious use of water. If canal wastage were higher and the water were inefficiently used on the land this amount would not be sufficient.

As there are water rights for about 88,000 acres of land in the New Mexico part of the project, the total pumpage of water would be about 213,000 acre-feet and the total surface water diverted about 172,000 acre-feet.

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The amount of water pumped from storage in the ground would be the difference between the amount actually used by the crops, assumed to be 2.5 acre-feet per acre, and the amount diverted from the river, 1.95 acre-feet per acre, plus evaporation and waste from the canal. The latter has been estimated as 3 percent of the pumped water or 0.07 acre-foot per acre and 5 percent of the gravity water or 0.10 acre-foot per acre, making the water pumped from storage 0.72 acre-foot per acre per year.

Viewed in another way, the amount of water pumped from storage would equal the difference between the total water pumped and that part of the pumped and surface water that would return to the water table. This amount from storage, all quantities being given in acre-feet per acre, would be: the total amount pumped, 2.42, less the pumped water lost by seepage from the canals, 17 percent (see p. 122) or 0.41, less the gravity water lost by seepage from the canals, 25 percent (see p. 52) of that diverted, 0.49, less the difference between the water applied to the land, 3.3, and the consumptive use 2.5, or 0.8. The amount of water pumped from storage in 1 year would therefore be 0.72 acre-foot per acre irrigated, or 63,360 acre-feet for the 88,000 acres in the Elephant Butte Irrigation District. The amount of water returned underground by seepage from the canals and from the irrigated lands would be 1.70 acre-feet per acre or 39 percent of the total diversions and pumpage of about 4.4 acre-feet per acre.

The period of drought during which supplemental pumped water might be needed is, of course, a matter of conjecture. A short period of pumping would be relatively costly. The flow of the Rio Grande at San Marcial above Elephant Butte Dam, at the head of the Rio Grande project, averaged only 697 cfs in the 5-year period 1898 to 1902, inclusive, 46 percent of the 52-year average of 1,530 cfs (International Boundary and Water Commission, 1946, p. 4). During a period of drought the lake level at Elephant Butte and Caballo Dams would be low and there would be less evaporation loss than under average conditions. This reduced evaporation loss, plus what water there was in storage at the beginning of the drought, would temper the actual decrease in flow of the Rio Grande. Without extensive study it appears, therefore, that a 5-year drought period in which only half the normal supply of water would be available for diversions is about the longest that could reasonably be expected.

If pumping were done for 5 such dry years the total pumpage from storage would be about 316,800 acre-feet, neglecting water saved from evaporation or transpiration, in waterlogged areas. This amount of ground water would have to be replaced before the flow of the drains would return to normal.

TX_MSJ_005566

As the drains would have been dried by the pumping, the diversions to the district in a year of average surface-water supply following a period of 5 years of pumping possibly would be reduced by the amount that the drains would normally flow, or 42 percent of the diversions. The actual diversion would then be 6.5 - (0.42 x 6.5) = 3.77 feet. This amount would make 2.64 feet available for delivery to the farms, thus requiring additional pumping of ground water to make up the difference to the 3.3 feet believed necessary for delivery to the farms. The amount of ground water that would have to be pumped would be

$$3.30 = 3.77 \times 0.7 + \text{pumped water} \times 0.8;$$

therefore,

pumped water = 0.83 acre-feet per acre.

The amount of water that would seep to the water table in this year would equal the seepage losses of pumped and surface water from the canals plus the seepage return of excess water above the consumptive use delivered to the farms, and would be

$(0.83 \times 0.17) + (3.77 \times 0.25) + (3.30 - 2.50) = 1.88$ acre-feet per acre.

The payment or reduction of the ground-water debt would be the return seepage in excess of the pumpage, or 1.05 feet. The number of years required, while pumping 0.83 acre-foot per acre, to pay off the debt would be $5 \times 0.72/1.05 = 3.4$ years.

The available surface-water diversions without pumping in the fourth year of average surface supply, following the assumed 5 years of pumping, would be less than the average by the amount of water that would have to be bypassed to the lower district to make up for the reduction in average drain flow resulting from the remaining effects of the pumping. The amount of bypassed water, x, plus the actual drain flow, y, must be equal to the average drain return flow of 2.73 feet (0.42 x 6.5) in a year of average diversions. The actual drain return flow would be equal to 42 percent of the actual diversions reduced by the remaining ground-water debt. The remaining debt would be (5 x 0.72) - (3 x 1.05) = 0.45 foot. Therefore:

$$x + y = 2.73$$

$$\text{and } y = (6.50 - x)\,0.42 - 0.45;$$

therefore:

$$x = 0.78$$

and the actual diversion would be:

$$6.50 - 0.78 = 5.72 \text{ feet.}$$

The water schedule for the 5 years of about 50-percent average surface supply followed by 5 years of average surface-water supply is given in the following table:

TX_MSJ_005567

Comparison of irrigation water available as diversions to the canals of the Elephant Butte Irrigation District, for 5 years of 50-percent average surface supply followed by a period of average surface supply

[Acre-feet per acre]

Year of irrigation	With supplemental pumping		Without supplemental pumping
	Pumped water	Surface water	Surface water
1	2.42	1.95	3.25
2	2.42	1.95	3.25
3	2.42	1.95	3.25
4	2.42	1.95	3.25
5	2.42	1.95	3.25
6	.83	3.77	6.50
7	.83	3.77	6.50
8	.83	3.77	6.50
9	.00	5.72	6.50
10	.00	6.50	6.50
Total	14.59	33.28	48.75

Little net water can be gained to the Rio Grande project as a whole by pumping ground water in the Elephant Butte district, and the total amount of water received by the Elephant Butte district under a pumping system is practically no more than would be obtained from surface supplies, if the customary interest of the El Paso district is preserved. The reason for this is, of course, that the drain water is used again in the project and the district has been assumed to be responsible for any decrease of the flow of the drains resulting from pumping.

The ground-water debt could be repaid by efficient use of water in 4 years of average water supply. If water were wasted, it would not be possible to repay the ground-water debt and pumping probably would have to be continued for years.

As indicated previously (p. 44), Rincon and Mesilla Valleys customarily use about 46 percent of the total reservoir releases in a year of average surface supply. In the assumed drought period of 5 years the surface water available for diversions was considered as 50 percent of the average. The average diversion to the El Paso division has been 395,400 acre-feet, and therefore in such a dry year presumably 197,700 acre-feet should be available for diversion to the El Paso Valley. The reservoir releases in a year should be equal to the sum of all diversions minus the return drain flow, disregarding any nonbeneficial evaporation and transpiration losses and any undiverted water that might bypass the El Paso Valley. As the return drain flow from the Rincon and Mesilla Valleys would be zero if extensive pumping were done, the reservoir releases would be 88,000 x 1.95 + 197,700 = 369,000 acre-feet. The depletion of reservoir releases by the Elephant Butte Irrigation District

TX_MSJ_005568

for any of the first 5 years of pumping is then 46 percent, which, disregarding canal wastes, is the same reservoir depletion as in an average year. In the sixth, seventh, and eighth years, the drains still being dry, the depletion of reservoir releases would be about 45 percent. This shows that the Rincon and Mesilla Valleys would be getting their usual share of the reservoir releases.

In the analysis it was assumed that the drains would be dry during all the first year, whereas actually they would not be dry until near the end of the first pumping season and a small amount of water might flow during the first winter. Therefore, during the first summer it is probable that a smaller amount of water would need to be pumped. Also, it has been assumed that all the ground water taken from storage would be derived from the lowering of the water table under only the irrigated area of the valley. Actually, the effects of pumping would be somewhat smaller in the valley area, as the cone of depression would extend away from the valley, under the mesas. As the irrigation water is applied to lands near the drains, it is possible that water in the drains would begin to flow in the eighth year, or earlier, even though all the ground-water debt had not been repaid. The district would benefit by this lag, which would spread the repayment of the ground-water debt over a longer period of time than was assumed. A small amount of the pumped water probably would not be taken from storage but would be salvaged from areas of transpiration by the lowering of the water level. This salvaged water would be a net gain of usable water and would reduce the calculated pumpage from storage.

Pumping of ground water in the valley by individual farmers would, of course, have the same effect upon the flow of the drains as would pumping by the Elephant Butte Irrigation District. And water pumped onto the land from ground-water storage that does not return to the ground-water body would be water lost to the project, even though a gain of water might accrue to an individual farm. It is probable that in a dry year enough farmers would install wells and pumps so that the flow of the drains would be reduced markedly or, in some sections, even be stopped entirely. If in a dry year such a reduction of normal drain flow occurred through installation of individual pumps, and if the El Paso division received its accustomed share of the reservoir water, diversions to the Elephant Butte Irrigation District would have to be reduced by a like amount. Any such reduction in diversions would work a hardship on the farmers who had not installed pumps, provided that the available surface water was distributed equally. If it were desired to maintain the delivery of the same amount of water to the farms not having pumps as they would have received had there been no pumping, then it would be necessary to reduce the delivery of water to the farms having pumps. This would be the condition during years of a shortage of surface water. Pumping by individuals during years of a normal supply is discussed in the following pages.

TX_MSJ_005569

PUMPING OF GROUND WATER WITH A NORMAL SUPPLY OF SURFACE WATER

Pumping of ground water in a year of normal supply of surface water might be practiced by individuals upon project lands for various reasons. A farmer who has a pump would have water available at times convenient to himself. And, in years when water was rationed, even though an adequate amount would be available, he would be able to pump additional water to satisfy his requirements. However, as pumped water would be an additional cost for water, it is not expected that pumping would be prevalent on project lands in years of normal supply of gravity water.

As the production of crops requires a certain amount of water and as there would be adequate surface water available for all crops in a normal year, the use of ground water for supplemental purposes on project lands in such a year would not deplete the project water supply any more than the use of gravity water, unless excessive irrigation by ground water caused an excessive consumptive use by the crops and excessive transpiration and evaporation losses.

Pumping of ground water in a year of normal surface supply could result in some saving of water to the project if pumps were located in areas of native vegetation where a lowering of water level would reduce nonbeneficial transpiration losses.

Also, use of ground water instead of surface water for winter irrigation would result in some water savings to the project, especially if drain water were pumped. Approximately 50,000 acre-feet of water is released from storage annually from October through February for winter irrigation of a widely distributed acreage planted principally to truck crops. This acreage constitutes a small percentage of the total irrigated acreage. An unusually large part of this winter release is lost through waste, seepage, and unnecessary evaporation and transpiration, the losses per acre served being proportionately much higher than those involved in irrigation in the summer.

The pumping of drain water during the winter would utilize some water that is now allowed to bypass the project. W. F. Resch, project manager of the Bureau of Reclamation, El Paso, Tex., estimates roughly that, of the drain flow passing the end of Mesilla Valley, 40 percent of that in October, 50 percent of that in November and December, 100 percent of that in January, and 40 percent of that in February is not used in the lower El Paso Valley. These percentage estimates, combined with the drain flow given in table 5, pages 141, 142, show that possibly 34,000 acre-feet of the winter drain flow is allowed to bypass the project. However, as part of the winter drain flow is a result of the large losses from the winter releases, it is not expected that this quantity would be available

TX_MSJ_005570

for pumping from the drains. Some pumping from ground-water storage would be necessary. The quantity of water saved in winter irrigation by substituting pumping, especially from drains, for reservoir releases therefore presumably would be about 34,000 acre-feet anually, if all water bypassing the project in the winter could be stopped, plus some small saving in losses from evaporation and transpiration. As drain flow removes undesirable salts from the lands and is as necessary as removal of sewage from a city, it is presumed that not all drain flow bypassing the project throughout the year should be stopped in order to save water, but that the drain flow seemingly could be profitably stopped in the winter.

COST OF PUMPING SUPPLEMENTAL GROUND WATER

The minimum number of pumps required to deliver the 213,000 acre-feet of pumped water believed necessary for the Elephant Butte Irrigation District in a dry year is estimated to be about 148, on the assumption that each pump would discharge 1,800 gpm continuously for 6 months. Allowance should be made for periods of high demand; otherwise, with the pumps running continuously at full capacity, the farmers would have to take water on a strict rotating schedule and any breakdown in pumping equipment would result in a shortage of water. Also, it is unlikely that every well drilled would be capable of discharging 1,800 gpm. Therefore, allowing a 15-percent operational variance and 10 percent for breakdowns, and assuming a lower average discharge per well of perhaps 1,500 gpm, the number of pumps necessary is estimated to be about 220.

Rough estimates made in 1948 of the costs of installation of a well, pump, and motor; fuel and lubrication; labor and transportation; total depreciation in 5 years; interest on investment; and taxes indicate a total charge of $2,900 per pump per year during the first 5 years of operation. The charge for 220 pumps would be $638,000 a year, or $3,190,000 for the 5-year period. This is equivalent to $7.25 per acre per year for 88,000 acres or $3.00 per acre-foot of water on the basis of 2.42 acre-feet per acre per year.

Under the assumptions given previously, only 73,000 acre-feet of water per year would need to be pumped in the sixth, seventh, and eighth years. This would require 75 pumps, on the basis that 220 pumps would be needed for pumping 213,000 acre-feet per year. Assuming the pumps to be fully depreciated at the end of the first 5 years, the unit cost per pump in the sixth, seventh, and eighth years is estimated at about $1,540 per year or $346,860 for 75 pumps for 3 years. The total cost for 8 years thus would be $3,536,900.

TX_MSJ_005571

As stated previously, a 50-percent gravity supply would suffice, with extremely careful use, to irrigate about 70 percent of the acreage. The pumping of irrigation water would result in saving all the crops on the remaining 30 percent; thus the pumping costs should be justified by that acreage. The average gross return per acre for the Rio Grande project was about $140 in 1945 and about $252 in 1946, the record year up to that time. However, the average crop return on the project from 1914 to 1946 was about $84 per acre and from 1937 to 1946 was about $120 per acre[12]. The additional gross return through ground-water irrigation in 5 dry years, on the basis of 1937-46 average crop returns, would be $15,800,000. The total cost of pumping and pumping equipment is thus approximately one-fifth of the increase in average gross crop returns and probably less than the normal net profit. The average cost per acre for 88,000 acres during the initial 5 years would be about $7.25 a year.

Intermittent operation and the probable smaller capacity of a pump on an individual farm would result in a somewhat higher unit cost of pumping than would continuous operation of large-capacity pumps by a district pumping system.

The favorable factor of cost of pumping is offset somewhat by the unfavorable factor of little net gain of water and the problem of installation and operation. Installation of 220 wells, pumps, and motors would consume some time, but possibly less than the period of shortage of surface water supply. Among the operational problems would be the distribution of the pumped water to the New Mexico lands only. About 11,000 acres of irrigated land in the Mesilla Valley is in Texas and is served by the same canal system. Also, very strict operating and irrigating schedules would have to be maintained, as only a 3-percent wastage was assumed in the estimates.

RECOMMENDED LOCATION OF WELLS

Wells producing sufficient water for irrigation can be located nearly everywhere on the floor of the Rincon and Mesilla Valleys. As a result of the variable nature of the alluvial sediments that have been deposited by the meandering Rio Grande, there will be a variation in the performance of the wells. Many wells will be filled with running sand and the perforations of some well casings will be clogged by gravel and sand. It does not appear possible to predict the location of gravel stringers in which presumably better wells would be obtained than in sand alone. The meager information available indicates that sand predominates in the lower end of the Mesilla Valley.

[12]U. S. Bureau of Reclamation, 1946, Project history: unpublished report, El Paso, Tex.

TX_MSJ_005572

With respect to the chemical quality of the water, generally better water is obtained with depth; an exception is the lower end of the Mesilla Valley, where apparently very poor water is obtained at depth. Some shallow wells in the Selden Canyon area obtain so-called salt water, which may occur also at greater depths. As the shallow water is generally satisfactory for irrigation, however, the drilling of irrigation wells deeper than 100 feet for the better water is not justified. Many domestic wells in the Mesilla Valley obtain their comparatively good water from depths in excess of 100 feet. Deep irrigation wells would possibly disturb this availability of better water with depth by drawing in poorer water from the upper strata to the lower.

As water of comparatively good chemical quality enters the valleys as underflow from adjacent arroyos, wells located on the valley floor in line with or a short distance downstream from these arroyos may obtain better-than-average water from the valley fill.

The alluvial fill in the Selden Canyon area and in the northern end of the Mesilla Valley, near Leasburg Dam, is thin and narrow. If a large number of irrigation wells were drilled in these areas and used continuously, comparatively large drawdowns of water level would result and wells drilled near the impermeable rocks at the edges of the valleys would be relatively unproductive.

In order to draw a greater percentage of the pumped water from storage, the wells should be located as far as possible from the drains and the river. Canals that leak excessively are paralleled with drains, and the water level in the canals is without doubt above the water table. The water level in sections of canals that have only a small leakage is also above the water table. Wells drilled near canals whose water is not in direct contact with the ground water will not appreciably increase the leakage from the canals, but will divert to the pumps water that would normally be picked up by drains.

Locating irrigation wells in areas of native vegetation will lower the water table in these areas and will reduce transpiration losses and save some water for the project.

Therefore, for least effect upon the project supply and for maximum well production, it is recommended that irrigation wells on the valley floors should be located as far as possible from the drains and the river; be drilled as far as practicable from the mountain masses in Selden Canyon and the northern end of Mesilla Valley; be drilled near arroyo mouths where possible; be drilled no deeper than necessary to secure an adequate supply of water; and not be drilled in the lower end of Mesilla Valley.

TX_MSJ_005573

RECOMMENDATIONS FOR FUTURE STUDIES

As brought out previously, water pumped by wells in the Rincon and Mesilla Valleys is not an additional or new supply but, instead, is water that would normally flow to the drains and be diverted for use in a lower part of the project. Pumping of ground water, therefore, is essentially a change in point of diversion of an existing supply. In times of normal or adequate supply of surface water to the project, pumping obtains water that would otherwise be available by gravity. In a year of surface-water shortage, pumping results in an adequate supply of water to those farmers having pumps but may reduce the amount of surface water available for diversion in the lower part of the district or project. Pumping water from wells upon new lands, either in or bordering the valleys, will result in reducing to some extent the supply of water to the project.

Because of these effects of pumping upon the water supply of the project, continuing records should be kept of the amount pumped and the location of the irrigation wells.

The initial effect of the pumping, especially in a year of inadequate surface supply, will be a decrease in the drain flow. This decrease may not be readily apparent for a small number of pumps unless accurate and frequent measurements of the drain flow are made. If 75 pumps are in operation, the decrease in drain flow may amount to approximately 10,000 acre-feet a year. If measurements of the drain flow approach an accuracy of 5 percent, the error in measurements in a year of average drain flow may amount to about 12,500 acre-feet. Thus, unless accurate and frequent measurements of drain flow are made, any decreases noted could not be definitely attributed to the effects of pumping. At present, the drainage return flow is measured only at the outlets to the river. Measurements should be made at additional points along the drains in order that any decrease in flow caused by pumping can be localized within sections of the drains.

The ground-water levels will decline as a result of pumping. However, the decline will be small so long as water continues to flow in the drains, the drains acting as sources of recharge to the cones of depression caused by the pumps. An effort should be made to continue measurements in the fifty-odd auger holes in the Mesilla Valley that have been measured for a number of years by the Bureau of Reclamation. Auger holes should be installed in the Rincon Valley at pertinent locations in order to permit observation of any effects of pumping upon the water level there. Also, measurements of water level should be made in the irrigation wells at least once a year, preferably in January or early February when the effects from the previous irrigation season are at a minimum.

TX_MSJ_005574

Records as to the performance of each well and logs of formations penetrated would aid in interpretation of the effects of pumping.

In summary, in order to have reliable data for a future re-evaluation of the effects of pumping, if such becomes desirable, the following records should be kept: information on the irrigation wells such as, location, performance, and pumpage; measurements of water level in the irrigation wells annually and in the auger wells seasonally; and additional measurements of drain flow.

SUMMARY

1. The ground water in the valley fill originates mainly from surface water, that is, from seepage of the canals and the river, and from excess water applied to irrigated lands, but partly from ground water from the adjoining high lands, and, occasionally, from precipitation upon the valley floor.

2. The quality of the shallow ground water in the alluvium of the Rincon and Mesilla Valleys is slightly poorer than drain water but satisfactory for most irrigation requirements. The dissolved solids generally decrease with increased depth of wells except in a few areas, especially in the lower end of the Mesilla Valley and in the Selden Canyon. Comparatively good water is obtained in surrounding high lands and in arroyo beds.

3. Wells yielding sufficient water for irrigation can be developed over the major part of the valley floors of the Rincon and Mesilla Valleys, with the probable exceptions of the Selden Canyon area and the southern end of the Mesilla Valley. Sanding of wells has occurred and may occur in wells that may be drilled, and special well construction may be necessary to prevent it.

4. Irrigation wells, generally of small capacity, can be developed on the arroyos and on the low benchlands. However, many wells in these areas may not obtain sufficient quantities for irrigation.

5. Pumping of ground water will divert water from the drains and the river. The drains may practically stop flowing by the end of the first summer in a dry year if enough pumps are installed to furnish an adequate water supply for all lands.

6. If an increased portion of releases from the reservoir were made up to the lower district as compensation for the reduction in flow of the drains, caused by pumping in the Rincon and Mesilla Valleys, a corresponding reduction in the diversions to the Elephant Butte Irrigation District would be necessary.

TX_MSJ_005575

7. As no unused ground-water recharge escapes from the project, and there is very little unused ground-water discharge, only a small amount of water can be salvaged to the Rio Grande project as a whole over a period of years by pumping in the Elephant Butte district.

8. Assuming that the El Paso division continues to get diversions in the same proportion of reservoir releases as in the past, pumping of ground water will not result in any additional water for the Elephant Butte Irrigation District on a year-to-year basis unless the amount of pumping exceeds the amount of the diverted drain flow, when this excess will come from storage.

9. On a long-term basis nearly all water removed from storage must be replaced before the flow of the drains returns to normal.

10. With a gravity water supply available for diversions of 50 percent of average, about 70 percent of the land in the Elephant Butte Irrigation District probably could be irrigated by careful use and control of gravity water alone.

11. During a year in which the normal supply of surface water is deficient by 50 percent, an additional acre-foot per acre would be needed to successfully irrigate the water-right land in New Mexico. To supply this deficit for 88,000 acres by pumping from wells would, because of distribution losses and reduction in flow of the drains caused by pumping, require pumping 213,000 acre-feet per year, assuming that the El Paso division receives its accustomed share of the reservoir water.

12. As supplemental pumpage would in effect save the crops on 30 percent of the land that could not be irrigated by surface water in a year of 50-percent gravity supply, the additional gross crop return resulting from pumping would be $15,800,000 for a 5-year period on the basis of the average annual gross crop return from 1937-46 of $120 an acre.

13. The total number of wells and pumps required in a year of 50-percent gravity supply is estimated to be about 220 and the total cost about $3,190,000 on the basis of a 5-year period and $3,536,900 for 8 years, including all charges, or approximately one-fifth of the average gross dollar benefits from crops grown.

14. Total cost per acre-foot of water pumped would be about $3.00, equal to about $7.25 per irrigated acre per year for the district.

15. Pumping of ground water on individual farms in years of deficient gravity water supply would ultimately reduce the water

supply of the Rio Grande project. If such a reduction were borne by the Elephant Butte Irrigation District, it would be necessary to reduce deliveries of surface water to farms with pumps in order to maintain the expected deliveries to farms without pumps.

16. Pumping of ground water for winter irrigation in the project could effect savings in water, as losses of winter releases are disproportionately large for the acreage irrigated.

17. About 15,000 acres of now undeveloped land and suspended land could be irrigated by ground water. Water pumped on these lands will, in a few years, reduce the water available to the existing irrigated lands by an amount equal to the consumptive use by the lands and crops irrigated.

18. As the water pumped will affect the water supply of the project, especially in years of deficient surface supply, continuing records should be kept of the amount of water pumped, of water-level measurements, and of the location and performance of irrigation wells.

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RECORDS

Table 1.— *Annual flow and depletion of the Rio Grande, 1930–46, in thousands of acre-feet*

[Water Bulletins 13-16, International Boundary and Water Commission, United States and Mexico and U. S. Bureau of Reclamation, El Paso, Tex.]

Year	Flow passing			Depletion		
	Caballo Dam	Leasburg Dam	El Paso station	Rincon Valley	Mesilla Valley	Rincon and Mesilla Valleys
1930	[1]799.9	790.5	532.7	9.4	257.8	267.2
1931	[1]776.0	740.7	517.8	35.3	222.9	258.2
1932	[1]854.0	816.0	567.2	38.0	248.8	286.8
1933	[1]829.0	824.0	609.2	5.0	214.8	219.8
1934	[1]813.9	768.2	508.5	45.7	259.7	305.4
1935	[1]649.1	633.0	459.9	16.1	173.1	189.2
1936	[1]757.9	693.3	473.8	64.6	219.5	284.1
1937	[1]798.3	740.8	536.2	57.5	204.6	262.1
1938	780.4	746.8	554.9	33.6	191.9	225.5
1939	789.1	737.5	511.6	51.6	225.9	277.5
1940	731.9	689.8	435.9	42.1	235.9	278.0
1941	703.5	685.9	511.4	17.6	174.5	192.1
1942	1,795.6	1,764.1	1,559.2	31.5	204.9	236.4
1943	911.8	861.0	631.8	50.8	229.2	280.0
1944	866.5	801.0	611.9	65.5	189.1	254.6
1945	882.8	814.2	568.9	68.6	245.3	313.9
1946	763.9	734.8	497.9	29.1	236.9	266.0
Average	853.1	814.2	594.5	38.9	219.7	258.6
Average (except 1942)	794.2	754.8	534.2	39.4	220.6	260.0

[1]Percha Dam.

TX_MSJ_005578

Table 2.—*Releases from Caballo Reservoir as represented by monthly flow of the Rio Grande at "Below Caballo Dam" gage, 1938-46, in thousands of acre-feet*

[Water Bulletins 13 to 16, International Boundary and Water Commission, United States and Mexico]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1938	3.1	22.2	73.8	116.0	113.0	121.0	109.0	131.0	43.8	26.1	12.1	9.3	780.4
1939	.2	20.0	76.0	106.0	105.0	121.0	128.0	118.0	76.8	19.3	10.1	8.7	789.1
1940	.1	12.7	84.3	110.4	91.5	114.3	129.1	114.3	68.8	2.8	3.4	.1	731.9
1941	.1	7.3	49.3	115.0	93.0	117.0	129.0	110.0	62.4	4.2	5.7	10.6	703.5
1942	4.8	64.3	88.7	212.0	412.0	354.0	234.0	179.0	181.0	35.4	14.4	16.0	1,795.6
1943	4.9	32.2	95.1	138.7	123.5	131.3	125.3	153.5	70.4	19.1	12.0	5.8	911.8
1944	.3	20.4	89.2	136.0	115.0	124.0	134.0	137.0	86.1	16.1	.3	8.1	866.5
1945	.7	22.9	85.2	129.0	112.0	122.0	141.0	132.0	98.3	11.1	9.5	19.1	882.8
1946	.3	18.2	82.3	119.0	97.2	120.0	138.0	130.0	34.5	10.9	7.5	6.0	763.9
Average	1.6	24.5	80.4	131.3	140.2	147.2	140.8	133.9	80.2	16.1	8.3	9.3	913.9
Average minus 1942	1.2	19.5	78.2	121.2	106.3	121.3	129.2	128.2	67.6	13.7	7.6	8.5	802.5
Percent	.1	2.4	10.1	15.1	13.2	15.1	16.0	15.9	8.4	1.7	.9	1.0	99.9

TX_MSJ_005579

Table 3.—*Gross diversions from the Rio Grande to the divisions of the Rio Grande project and to Mexico, 1930–46, in thousands of acre-feet*

[From U. S. Bureau of Reclamation, El Paso, Tex., except Acequia Madre from Water Bulletins 13 to 16, International Boundary and Water Commission, United States and Mexico]

Year	Percha Dam (Rincon Valley)	Leasburg Dam	Mesilla Dam	Mesilla Valley	El Paso Valley[1]	Acequia Madre (Valle de Juarez)
1930	100.0	231.1	351.2	582.3	385.7	.....
1931	98.6	211.0	353.8	564.8	353.2	.....
1932	98.0	220.0	353.5	573.5	347.6	.....
1933	97.3	224.0	336.7	560.7	349.0	.....
1934	108.9	210.5	315.4	525.9	372.1	.....
1935	66.7	123.1	222.8	345.9	308.6	.....
1936	78.4	155.2	269.0	424.2	393.6	.....
1937	77.9	151.9	277.0	428.9	423.5	.....
1938	79.2	151.0	289.8	440.8	427.4	60.4
1939	84.2	164.8	321.8	486.6	387.0	60.6
1940	80.9	154.8	292.4	447.2	386.3	58.2
1941	72.8	139.1	270.5	409.6	418.9	55.3
1942	101.0	192.4	349.6	542.0	435.4	83.9
1943	105.2	219.9	330.6	550.5	500.8	61.3
1944	108.2	204.4	314.9	519.3	448.9	61.8
1945	103.8	218.1	328.2	546.3	408.7	60.7
1946	99.6	205.7	303.3	509.0	375.1	60.5
Average	91.8	186.9	310.6	497.5	392.5	62.5

[1]Computed from reported acreages and headgate diversions in acre-feet per acre.

Table 4.—*Acreage irrigated and distribution of diversions for Rio Grande project, New Mexico and Texas, as reported, 1930–46*

Year	Acres irrigated	Headgate diversion (acre-feet per acre)	Canal waste or return (percent)	Canal and unaccounted-for losses (percent)	Delivered to farms	
					percent	acre-feet per acre
			Rincon division			
1930	12,702	7.9	35	37	28	2.22
1931	13,069	7.5	35	42	23	1.74
1932	12,463	7.9	24	49	27	2.07
1933	12,283	7.9	29	47	24	1.89
1934	12,776	8.5	25	46	29	2.51
1935	11,834	5.6	23	42	35	1.98
1936	13,528	5.8	20	34	46	2.64
1937	14,462	5.4	22	33	45	2.45
1938	14,152	5.6	21	36	43	2.38
1939	14,336	5.9	24	29	47	2.78
1940	14,813	5.5	20	29	51	2.78
1941	15,280	4.7	21	30	49	2.30
1942	15,916	6.4	25	34	41	2.61
1943	16,265	6.4	19	34	47	3.03
1944	16,049	6.7	22	34	44	2.98
1945	16,272	6.4	15	36	49	3.12
1946	17,000	5.9	14	38	48	2.79
Average	14,306	6.47	23.2	37.0	39.8	2.49

TX_MSJ_005580

Table 4.—*Acreage irrigated and distribution of diversions for Rio Grande project, New Mexico and Texas, as reported, 1930–46*—Continued

Year	Acres irrigated	Headgate diversion (acre-feet per acre)	Canal waste or return (percent)	Canal and unaccounted-for losses (percent)	Delivered to farms	
					percent	acre-feet per acre
Leasburg division						
1930	28,061	8.2	35	33	32	2.62
1931	28,289	7.5	35	32	33	2.51
1932	28,569	7.7	30	36	34	2.63
1933	29,713	7.5	32	37	31	2.30
1934	25,531	8.2	23	37	40	3.28
1935	22,706	5.4	19	33	48	2.59
1936	27,670	5.6	14	32	54	3.00
1937	28,387	5.4	16	26	58	3.09
1938	25,907	5.8	16	31	53	3.08
1939	27,075	6.1	15	28	57	3.48
1940	28,811	5.4	16	26	58	3.12
1941	28,811	4.8	14	33	53	2.58
1942	28,942	6.6	24	34	42	2.74
1943	30,060	7.3	19	34	47	3.36
1944	32,081	6.4	17	35	48	3.06
1945	31,734	6.9	12	36	52	3.57
1946	31,765	6.5	8	44	48	3.14
Average	28,477	6.55	20.3	33.4	46.4	2.95
Mesilla division						
1930	48,312	7.3	23	44	33	2.37
1931	48,433	7.3	25	46	29	2.12
1932	48,140	7.3	19	49	32	2.35
1933	47,348	7.1	21	45	34	2.37
1934	43,074	7.3	16	44	40	2.90
1935	39,469	5.6	11	44	45	2.52
1936	47,143	5.7	12	40	48	2.73
1937	49,223	5.6	12	34	54	3.01
1938	47,592	6.1	16	38	46	2.80
1939	46,959	6.7	12	40	48	3.28
1940	46,566	6.0	12	36	52	3.24
1941	50,050	5.4	15	37	48	2.58
1942	52,275	6.4	24	37	39	2.61
1943	52,585	6.3	21	30	49	3.10
1944	50,768	6.2	14	34	52	3.21
1945	51,537	6.4	13	31	56	3.57
1946	52,146	5.7	10	34	56	3.28
Average	48,331	6.38	16.2	39.0	44.8	2.83

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Table 4.—*Acreage irrigated and distribution of diversions for Rio Grande project, New Mexico and Texas, as reported, 1930–46*—Continued

Year	Acres irrigated	Headgate diversion (acre-feet per acre)	Canal waste or return (percent)	Canal and unaccounted-for losses (percent)	Delivered to farms	
					percent	acre-feet per acre
El Paso Valley						
1930	52,122	7.4	33	28	38	2.86
1931	50,455	7.0	30	34	36	2.53
1932	48,277	7.2	28	36	36	2.63
1933	49,862	7.0	30	28	42	2.93
1934	47,711	7.8	27	33	40	3.15
1935	46,066	6.7	30	34	36	2.41
1936	50,460	7.8	43	23	34	2.67
1937	52,939	8.0	42	23	35	2.78
1938	49,703	8.6	48	23	29	2.47
1939	51,597	7.5	25	36	39	2.90
1940	52,921	7.3	21	39	40	2.91
1941	53,709	7.8	42	30	28	2.18
1942	54,425	8.0	38	33	29	2.32
1943	55,032	9.1	31	35	34	3.09
1944	55,424	8.1	37	27	36	2.93
1945	55,232	7.4	27	27	46	3.38
1946	55,988	6.7	30	21	49	3.23
Average	51,876	7.61	33.0	30.0	36.9	2.79
Rio Grande project						
1930	141,197	7.6	30	36	34	2.58
1931	140,246	7.2	29	39	32	2.31
1932	137,449	7.4	24	42	34	2.48
1933	139,206	7.2	25	40	35	2.51
1934	129,092	7.8	22	40	38	3.03
1935	120,075	6.0	20	39	41	2.44
1936	138,801	6.4	26	31	43	2.75
1937	145,011	6.4	28	27	45	2.89
1938	137,354	6.9	30	31	39	2.69
1939	139,967	6.8	19	35	46	3.13
1940	143,111	6.3	17	35	48	3.05
1941	147,860	6.1	28	33	39	2.40
1942	151,558	7.0	28	36	36	2.53
1943	153,942	7.4	24	36	42	3.14
1944	154,322	6.9	24	32	44	3.06
1945	154,775	6.8	18	31	51	3.46
1946	156,899	6.2	17	32	51	3.18
Average	142,992	6.85	24.1	35.0	41.1	2.80

TX_MSJ_005582

Table 5.—*Flow of drains to the Rio Grande in Rincon and Mesilla Valleys, N. Mex. and Tex.*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
							Rincon Valley						
1930	1,543	1,666	2,601	3,153	3,228	3,296	3,800	3,627	3,101	2,263	1,904	1,752	31,934
1931	1,463	1,722	2,540	3,439	3,504	3,927	4,463	4,095	3,885	2,921	2,553	2,207	36,719
1932	1,917	2,014	2,835	3,951	4,360	4,409	4,021	4,532	4,082	3,117	1,952	2,104	39,294
1933	1,605	1,692	2,638	4,006	3,831	3,963	4,426	5,386	4,772	3,382	2,642	2,681	41,024
1934	2,035	2,421	3,419	4,653	4,513	4,653	4,802	4,236	3,701	2,472	1,987	1,980	40,872
1935	1,599	1,428	1,820	2,565	2,397	2,586	3,321	3,228	2,832	2,011	1,696	1,439	26,922
1936	1,408	1,387	1,919	2,838	2,859	2,898	3,615	3,929	3,034	1,906	1,416	1,421	28,630
1937	1,235	1,289	1,882	3,004	3,474	3,213	3,419	4,021	3,189	2,214	1,696	1,612	30,248
1938	1,457	1,422	2,188	2,951	3,118	3,349	3,149	3,610	3,588	2,656	1,945	1,925	31,358
1939	1,641	1,643	2,564	3,659	3,634	3,784	3,776	3,682	3,618	2,729	2,035	1,881	34,646
1940	1,667	1,426	2,527	3,547	3,579	3,713	3,885	4,169	3,623	2,299	1,750	1,396	33,581
1941	1,322	1,188	1,630	3,434	3,720	2,903	4,218	4,372	3,511	2,933	1,922	1,813	33,966
1942	1,556	1,727	2,700	4,315	4,790	4,546	5,319	5,669	4,564	3,468	2,678	2,515	43,847
1943	2,201	2,150	3,308	4,421	4,650	4,665	4,939	5,196	4,350	3,302	2,361	2,053	43,596
1944	1,660	1,466	2,490	3,475	3,818	3,791	4,526	5,084	4,189	2,736	1,738	1,704	36,677
1945	1,420	1,370	2,080	3,540	3,940	3,780	4,060	4,400	3,890	2,670	1,930	1,740	34,820
1946	1,560	1,310	2,130	3,650	3,480	3,680	4,530	4,790	3,450	2,150	1,770	1,450	33,950
Average	1,605	1,607	2,428	3,565	3,700	3,774	4,133	4,354	3,728	2,660	1,998	1,863	35,416
Percent	4.5	4.5	6.9	10.1	10.4	10.7	11.7	12.3	10.5	7.5	5.6	5.2	99.9
							Mesilla Valley						
1930	8,602	8,624	12,857	17,548	18,483	18,762	21,416	20,020	19,643	15,408	11,526	10,884	183,773
1931	9,230	8,664	13,723	18,903	19,824	20,838	22,910	22,363	20,851	15,163	12,788	11,289	196,546
1932	9,254	9,066	12,857	17,071	18,606	19,683	21,104	23,210	23,834	16,178	12,150	11,345	194,358
1933	9,807	8,826	14,382	18,936	19,990	19,761	22,128	23,888	22,064	19,485	13,549	12,549	205,365
1934	9,880	9,670	18,840	20,791	23,101	24,291	25,378	25,857	21,607	15,876	12,281	10,213	217,785
1935	9,709	8,181	10,004	14,174	15,556	15,661	18,446	19,978	17,857	15,003	11,596	10,915	167,080
1936	9,623	8,727	11,283	15,524	18,088	18,442	21,797	23,027	19,816	15,594	12,370	10,913	185,204
1937	9,512	8,375	11,485	16,019	18,033	18,149	19,880	22,247	19,029	14,567	11,811	11,313	180,420
1938	10,378	9,141	12,426	15,155	17,623	18,430	19,911	21,416	19,376	16,565	13,364	12,094	185,879
1939	10,422	9,374	14,025	19,441	20,972	21,892	25,345	25,185	23,354	19,435	14,768	13,177	217,390
1940	10,858	9,772	14,634	19,797	22,443	24,278	27,257	27,239	25,575	18,809	13,227	11,589	225,478
1941	10,169	8,342	11,337	18,387	21,060	22,589	26,298	25,873	25,062	19,313	14,060	13,065	215,555
1942	10,840	11,273	14,227	20,917	24,859	24,534	26,913	27,934	24,349	20,014	15,798	14,265	235,923

TX_MSJ_005583

Table 5.—*Flow of drains to the Rio Grande in Rincon and Mesilla Valleys, N. Mex. and Tex.*—Continued

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
						Mesilla Valley—Continued							
1943	11,991	11,219	16,085	22,850	26,447	26,699	29,976	31,949	28,794	20,765	15,990	14,149	256,914
1944	12,285	11,170	17,192	23,968	25,771	26,716	31,494	34,040	29,599	23,671	16,762	13,310	265,978
1945	11,840	11,230	15,110	22,000	23,980	26,560	30,440	33,400	29,610	22,850	17,650	14,830	259,500
1946	13,060	9,760	13,770	22,060	25,070	26,990	30,990	32,700	26,520	17,520	13,620	12,800	244,860
Average	10,439	9,495	13,778	19,032	21,171	22,016	24,805	25,902	23,349	18,013	13,724	12,276	214,000
Percent	4.9	4.4	6.4	8.9	9.9	10.3	11.6	12.1	10.9	8.4	6.4	5.7	99.9

TX_MSJ_005584

Table 6.—*Drillers logs of wells in parts of Sierra and Dona Ana Counties, N. Mex.*

16.5.23.300. O. B. Dawson

[Casing perforated from 105 ft to 215 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay and gravel	37	37	Clay	11	171
Sand and gravel (water)	2	39	Gravel (water)	5	176
Clay and caliche	33	72	Clay with sand	3	179
Sand (water)	1	73	Water (increased flow)	3	182
Clay and sandstone (?) stringers	42	115	Pure clay	4	186
Sand (water)	2	117	Gravel (water—greatest portion of flow)	12	198
Clay and sand stringers	23	140	Hard sandstone (?)	7	205
Sand (water)	1	141	Clay	8	213
Clay and sand	11	152	Sand and gravel (water)	1	214
Gravel (water flow started)	8	160	Hard sandstone (?)	11	225
			Dry clay	1	226

16.5.25.120. U. S. Department of the Interior, Bureau of Reclamation (Caballo Dam)

[Casing perforated from 38 ft to 105 ft]

Topsoil, gravel, clay, and boulders	35	35	Soft fine sand (water at 45 ft, additional water at 97 ft, rose to 35 ft)	33	105
Fine sand	30	65			
Clay-bound conglomerate	7	72	Sandy conglomerate with hard streaks	31	136

16.5.25.343. A. J. Osborn

Hard dirt	38	38	Soft red rock	24	152
Fine sand and small gravel	90	128			

17.4.30.133a. W. B. Cantrell

Gravel and clay	4	4	Sand	4	55
Clay	8	12	White clay	4	59
Gravel and clay	6	18	Sand and gravel	2	61
Gravel (water)	2	20	Conglomerate rock	2	63
Sand and gravel	3	23	Gravel	7	70
Gravel	15	38	Red clay	1	71
Sand	2	40	White clay conglomerate	11	82
Gravel	2	42	Red clay	1	83
Sand	3	45	White clay conglomerate	13	96
Sand and gravel	6	51	White clay	1	97

17.4.31.111. Ben Luchini

Sugar sand	10	10	Gravel with some sand (water)	5	60
Sand (water)	10	20	Red clay	3	63
Sand and gravel (water)	15	35	Rock and gravel	3	66
Sand and coarse gravel (water)	18	53	Red and white clay, gray sand	5	71
Red clay	2	55			

17.5.24.333. E. W. Powers

Sand and boulders (arroyo deposits)	35	35	Dirt	10	55
Sand (water)	10	45	Sand and gravel (water)	18	73
			Red gumbo clay	28	101

17.5.26.242. Lloyd Welch

Gravel (water)	52	52	Gravel (water)	27	84
Clay	5	57	Clay	4	88

18.4.35 221. Boggs

Sand and gravel with clay stringers	111	111	Water between hard formation, limestone above and clay below	2(?)	114
Hard rock formation resembling limestone	1	112	Red-brown clay	100	214

TX_MSJ_005585

Table 6.—*Drillers logs of wells in parts of Sierra and Dona Ana Counties, N. Mex.*—Continued

19.2E.33.140b. U. S. Department of the Interior, Bureau of Reclamation (Jornada Experimental Range)

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	7	7	Pack sand	85	175
White sugar sand	13	20	Red shale	135	310
Light-gray shale	10	30	Quicksand	35	345
Sand and caliche	30	60	Soft red sandstone	15	360
Reddish-brown shale	30	90			

19.2.3.122. Atchison Topeka & Santa Fe Railway Co.

[Casing perforated from 170 ft to 259 ft]

Sand	27	27	Sand with gravel and clay balls	22	230
Gravel	8	35	Sand and clay	4	234
Sand and gravel	99	134	Sand	6	240
Fine sand	21	155	Clay and sand	8	248
Soupy coarse sand	25	180	Sand	9	257
Sand and gravel	4	184	Blue clay	3	260
Soupy coarse sand	16	200			
Clay and sand	8	208			

19.3.15.443. I. W. Smallwood

Clay and sandy loam	10	10	Red clay	3	43
Sand	12	22	Gravel	3	46
Sand and gravel	18	40	Red clay	6	52

19.4.11.221. Clyde Cowan

Soil	16	16	Coarse grayish sand, some small gravel	15	70
Quicksand (came up in casing)	39	55	Tough red clay	4	74

20.1E.14.140. U. S. Department of the Interior, Bureau of Reclamation (Jornada Experimental Range)

Topsoil	5	5	Sand	33	280
Limerock and caliche	40	45	Light-blue sandy shale	8	288
Conglomerate rock and sand	70	115	Alternate layers of clay and sand	35	323
Yellow clay	10	125	Quicksand (very little water)	7	330
Sand	60	185	Layers of clay and sand	18	348
Red bird's eye clay	15	200	Sandstone (water)	8	356
Pack sand	35	235			
Blue clay	12	247			

20.1.10. New Mexico College of Agriculture and Mechanic Arts

Caliche	20	20	Yellow clay	7	197
Dry falling sand	20	40	Sand	27	224
Conglomerate rock	7	47	Sandstone	6	230
Yellow clay, gravel	13	60	Sand	70	300
Coarse sand	12	72	Sandstone	12	312
Pack sand	8	80	Quicksand (water)	8	320
Dry falling sand	110	190			

21.1.13.323. Isaac Rhodes

Soil and sand	29	29	Gravel	10	58
Gravel	7	36	Blue gumbo or clay	35	93
Clay	12	48	Rock	122	215

TX_MSJ_005586

Table 6.—*Drillers logs of wells in parts of Sierra and Dona Ana Counties, N. Mex.*—Continued

22.1E.10.413. E. A. Knight

[Casing perforated from 50 ft to 60 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Gravel and silt	5	5	Wet clay with gravel	17	79
Sandy soil	15	20	Dry clay and gravel	43	122
Sand (water at 25 ft)	20	40	Fine sand (water level rose)	3	125
Fine gravel and sand	5	45	Dry clay and gravel	5	130
Coarse gravel	17	62			

22.1E.26.214. J. K. Nakayama

[Casing perforated from 30 ft to 52 ft]

Topsoil	6	6	Clay	3	67
Sand	24	30	Fine sand	25	92
Coarse gravel	15	45	Sticky clay	5	97
Fine gravel and sand	5	50	Sandstone	3	100
Sand	14	64			

21.2E.12.222. Edwin Parker

Topsoil	2	2	Sandstone (water)	11	381
Sand, clay, and caliche	3	5	Clay and sand	5	386
Sandstone (?)	4½	9½	Sandstone (water)	9	395
Clay	1½	11	Clay and sandstone	4	399
Sandstone	9	20	Sandstone	4	403
Lime	23	43	Clay	1	404
Conglomerate rock, gravel	6	49	Sandstone (water)	9	413
Conglomerate	27	76	Limerock	17½	430½
Conglomerate and hard sand	4	80	Sandrock	2½	433
Caliche, clay, and sand	3	83	Sandstone	12	445
Sandrock	2	85	Sand	3	448
Clay and caliche	25	110	Conglomerate sand and sandstone	26	474
Adobe and sand	11	121	Sandstone and lime	4	478
Clay	26	147	Sand	3	481
Limestone	2	149	Sandstone and lime	4	485
Clay	28	177	Sand	1	486
Clay and sand	2	179	Limerock	1	487
Clay	19	198	Sandstone	4	491
Clay and sand	10½	208½	Lime	10	501
Sandstone	10½	219	Clay	3	504
Clay and sandstone	68	287	Limestone	38	542
Sandstone	2	289	Shale	4	546
Clay	2	291	Lime and quartz	3	549
Clay and sand	37	328	Shale	2	551
Clay	4	332	Limestone	80	631
Sandstone	3	335			
Clay and sand (small amount of water)	35	370			

23.1.15.211. Picacho Oil and Gas Syndicate

[Old oil test, abbreviated log]

Sand and caliche	30	30	Brown gummy shale	25	865
Coarse sand and pink shale	130	160	Red rock	13	878
Red rock	15	175	Soft brown sandy lime	7	885
Very sticky, light-blue, gummy mud	5	180	Hard gray lime	5	890
Brown sand	5	185	Soft sandy lime	10	900
Sandy blue mud	20	205	Sandy red shale and lime	45	945
Blue marl	345	550	Gray, brown, and blue shale	30	975
Shale and lime	14	564	Third water (large amount of water rose in hole to 200 ft from top)	10	985
Blue gumbo, streaks of lime	34	598	Brown lime and shale	50	1,035
Sandy lime (first water)	22	620	Hard sand (best water)	10	1,045
Bedded blue marl	25	645	Brown lime and shale	69	1,114
Blue marl and gumbo	5	650	Blue and gray lime and shale	84	1,198
Sandy shale (second water)	4	654	Red limerock	32	1,230
Blue and gray sandy lime and shale	186	840	Hard gray lime	5	1,235

TX_MSJ_005587

Table 6.—*Drillers logs of wells in parts of Sierra and Dona Ana Counties, N. Mex.*—Continued

23.1.15.211. Picacho Oil and Gas Syndicate— Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Brown sandy lime and shale (salt water at 1,335 ft)	280	1,515	Sandy lime	12	2,852
Blue and red lime and shale	95	1,610	Rotten black shale	10	2,862
Brown shale	205	1,815	Sandy lime streaks of shale	22	2,884
Gray-blue lime and shale	805	2,620	Blue sandy shale	6	2,890
Sand (hot water)	20	2,640	Hard black lime and sandy shale	53	2,943
Dark shale	70	2,710	Red sand	3	2,946
Hard lime and black shale	90	2,800	Hard gray, brown, white, and black lime	124	3,070
Black slatey crystallized shale	40	2,840	Pink sandy shale	3	3,073
			White chalky lime	123	3,196

23.1.32.330. H. S. Bissell

Sand and gravel	165	165	Sandstone	110	430
Malpais	155	320	Rusty-colored sand	71	501

23.3.4.140. H. S. Bissell

Sand, shale, and clay	200	200	Hard blue rock (malpais) (water 600 to 900 ft)	510	1,005
Hard rock and gray and blue shale (malpais)	295	495			

23.1E.13.144. City of Las Cruces (Hadley Street well)

Soil	10	10	Sandy clay	20	110
Sand and coarse gravel	15	25	Sand and small gravel	55	165
Coarse sand	65	90	Sticky clay	10	175

23.1E.13.244. Atchison Topeka & Santa Fe Railway Co.

[Backfilled to 82 ft]

Fine sand and boulders (water)	62	62	Sand and boulders (water)	18	220
Clay parting	0	62	Soft white clay	3	223
Fine sand and boulders (water)	58	120	Light-blue clay	3	226
Clay parting	0	120	White sandy clay	8	234
Fine sand and boulders (water)	45	165	Fine sand (water)	7	241
Sticky blue clay	4	169	White sandy clay	2	243
Sand and boulders (water)	31	200	Fine sand (water)	8	251
Soft sandrock	2	202			

23.2E.6.332. Fay Sperry

Sand and gravel	101	101	Sand (water)	23	126
Sticky clay	2	103	Hard clay	7	133

23.2E.6.332a. Fay Sperry

Sand	3	3	Sand	10	110
Sand and gravel	52	55	Clay	15	125
Sand (water)	23	78	Medium to coarse sand (water)	5	130
Sand and gravel	17	95			
Boulders	5	100			

23.2E.8.434. City of Las Cruces (well 5)

[Casing perforated from 210 ft to 250 ft; screen 262 ft to 285 ft]

Sand and large gravel	60	60	Clay	15	270
Sand and small gravel	35	95	Coarse gravel and sand (water)	20	290
Packed sand with thin strips of gravel	105	200	Pure clay	10	300
Sand, gravel, and clay mixture (water at 200 ft.)	55	255			

TX_MSJ_005588

Table 6.—*Drillers logs of wells in parts of Sierra and Dona Ana Counties, N. Mex.*—Continued

23.2E.17.210. City of Las Cruces (well 1)

[Screen from 275 ft to 294 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand and gravel	45	45	Quicksand interbedded with shale layers 2 to 4 ft thick (water)	65	245
Conglomerate rock	30	75	Red shale rock and gravel	5	250
Packed sand	5	80	Red shale	28	278
Conglomerate rock	38	118	Gravel (water)	16	294
Quicksand (very little water)	4	122			
Packed sand	58	180			

23.2E.17.210b. City of Las Cruces (well 3)

[Screen from 272 ft to 291 (?) ft]

Sand and gravel	42	42	Packed sand	70	245
Conglomerate rock	28	70	Gray shale interbedded with gravel	27	272
Packed sand with conglomerate rock	26	96	Coarse gravel (water)	2	274
Gray-brown sandstone	9	105	Gray shale with some gravel and sandstone (water)	12	286
Packed sand with conglomerate rock	70	175			

23.2E.29.243 New Mexico College of Agriculture & Mechanic Arts (well 2, domestic)

Red clay and some fine sand	32	32	Yellow clay	4	151
Gravel and white sand	10	42	Sand and gravel	20	171
Fine sand, 80 percent dark, 20 percent white	40	82	Fine sand, 90 percent dark	35	206
Sand, some gravel	5	87	Sand and gravel	5	211
Fine sand, 80 percent dark, 20 percent light	60	147	Red clay	9	220
			Very large gravel and boulders	8	228

23.2E.29.243b. New Mexico College of Agriculture & Mechanic Arts

[Plugged at 81 ft with concrete; casing perforated from 52 ft to 72 ft]

Clay and sand (water)	50	50	Clay and sand	8	83
Large loose rock and gravel with coarse sand	25	75	Fine dark quicksand (ran into well)	0	83

23.2E.29.243c. New Mexico College of Agriculture & Mechanic Arts (well 4, domestic)

Soil	5	5	Coarse sand	2	182
Gravel and soil	5	10	Dark-colored material	23	205
Gravel, soil, and clay	25	35	Dark-colored sand	4	209
Sand and large gravel (water at 35 ft, rose to 31 ft)	25	60	Very hard dark-colored material	46	255
Clay, gravel, and sand (no water)	20	80	Softer dark-colored material	5	260
Fine sand	41	121	Hardest dark-colored material	15	275
Sand with trace of gravel	4	125	Hard material	7	282
Fine sand	30	155	Red clay, quartz crystals	3	285
Conglomerate gravel and rock	5	160	Dark clay	7	292
Very hard dark-colored material	20	180	Sand, gravel, and clay	13	305

23.2E.30.412c. New Mexico College of Agriculture & Mechanic Arts

[Screen from 22 ft to 92 ft]

Soil	4	4	Clay	2	88
Clay	22	26	Sand, clay	7	95
Sand and gravel	60	86			

TX_MSJ_005589

Table 6.—*Drillers logs of wells in parts of Sierra and Dona Ana Counties, N. Mex.*—Continued

24.1E.1.111. Stahman Farms, Inc. (well 1)

[Test hole from 306 ft to 331 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soft reddish-brown topsoil and sand	10	10	Soft sand	1	224
Soft reddish-brown quicksand	34	44	Hard yellow clay and gravel	4	228
Medium-hard gravel	42½	86½	Medium-hard yellow sand	7	235
Soft reddish-brown sand	7½	94	Medium-hard gravel	2	237
Medium-hard gravel	4	98	Medium-hard blue clay	8	245
Soft brown sand	1	99	Soft sand	1	246
Hard gravel	5	104	Medium-hard yellow clay	1	247
Hard red shale	14	118	Soft sand	5	252
Soft brown sand	7	125	Soft yellow clay	2	254
Medium-hard reddish-brown sandy clay	6	131	Hard sandrock	1	255
Soft brown sand	7	138	Soft sand	13	268
Hard clay and gravel	½	138½	Hard sandrock	1	269
Soft brown sand	6	144½	Soft sand	2	271
Medium-hard red clay	½	145	Medium-hard gravel (small)	2	273
Soft sand	3	148	Soft black sand	2	275
Medium-hard yellow clay	1	149	Medium-hard gravel and clay	5	280
Soft sand	18	167	Soft black sand	5	285
Medium-hard yellow clay	8	175	Medium-hard yellow clay and gravel	2	287
Hard red sandstone	1	176	Soft black sand	6	293
Soft reddish-brown sand	10	186	Medium-hard yellow clay and gravel	1	294
Medium-hard yellow clay and gravel	1	187	Soft sand	1	295
Soft sand	12	199	Medium-hard brown clay	2	297
Soft gravel	2	201	Soft sand	2	299
Soft yellow clay	1	202	Medium-hard brown clay	1	300
Medium-hard yellow clay and gravel	1	203	Soft sand	3	303
Soft sand	4	207	Medium-hard yellow clay	2	305
Soft yellow clay and gravel	2½	209½	Soft sand	1	306
Soft sand	8	217½	Medium-hard sandrock, sand, and gray conglomerate	9	315
Medium-hard yellow clay	½	218	Medium-hard yellow clay	4	319
Soft sand	2	220	Soft black quicksand	12	331
Soft yellow clay	3	223			

24.3W.8.310. H. S. Bissell

Sand and gravel	72	72	Gravel, clay (water)	5	245
Sandy shale	28	100	Sandy shale	15	260
Soapstone	140	240	Soapstone	2	262

24.3W.25.230. H. S. Bissell

Red, blue, and gray shale	200	200	Hard red shale (water)	7	212
Red clay	5	205			

24.4.12.230. Biggs ranch

Surface formation	100	100	Sand and gravel	60	200
Hard blue formation	40	140			

26.3E.9.221 Berino Cotton Gin

Sand and gravel	80	80	Clay	36	148
Sand and clay	1	81	Sand	(?)	148+
Sand and gravel	31	112			

26.3E.19.432. Judo Yabumoto

[Test hole 90 ft to 131 ft]

Sand	33	33	Small and large gravel	27	86
Gray shale (?)	2	35	Hard gray clay, shale (?)	4	90
Sand and a little gravel	24	59	Sand	41	131

TX_MSJ_005590

Table 6.—*Drillers logs of wells in parts of Sierra and Dona Ana Counties, N. Mex.*—Continued

26.3E.30.114. O. E. Egbert

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand	15	15	Coarse sand	7	75
Gravel	30	45	Sand and gravel	10	85
Clay	8	53	Gravel	22	107
Gravel, rock at 60 ft	12	65	Rock	....	107
Clay and sand	3	68			

26.1.4.410. Southern Pacific Co. (Afton)

Caliche	25	25	Fine sand (water)	188	515
Sand and gravel	75	100	Red clay	25	540
Fine sand	150	250	Yellow clay	45	585
Sand and caliche	20	270	Fine sand	43	628
Fine sand	26	296	Coarse sand and clay	27	655
Red clay with fine sand	31	327	Red clay	47	702

27.1E.11.330. Southern Pacific Co. (Lanark, well 1, center well)

Clay	229	229	Sandstone	10	849
Red and yellow clay	525	754	Red clay	53	902
Sand (water)	31	785	Sand	30	932
Clay	16	801	Clay	5	937
Sand	4	805	Sand	13	950
Clay and sand	34	839			

27.1E.11.330a. Southern Pacific Co. (Lanark, well 2, west well)

Sand	5	5	Sand	27	274
White sand	15	20	Red clay	4	278
Clay	10	30	Sand	62	340
Sand	50	80	Clay	18	358
Red clay	5	85	Sand	25	383
Sand	55	140	Clay	11	394
Red clay	10	150	Sand	9	403
Sand	20	170	Sandrock	12	415
Red clay	12	182	Sand (water 415 ft, rose to 365 ft)	100	515
Sand	30	212	Clay	15	530
Sandy clay	15	227	Sand	85	615
Clay	20	247			

27.1E.11.330b. Southern Pacific Co. (Lanark, well 3, east well)

Clay and soil	10	10	Sand	50	373
White shale	20	30	Clay	35	408
Clay	50	80	Sandstone	7	415
Sand and boulders	20	100	Sand	10	425
Clay	40	140	Sand (water at 425 ft, rose to 365 ft)	10	435
Cemented sand	12	152	Clay	30	465
Clay	30	182	Blue quicksand	55	520
Sand and gravel	20	202	Clay	30	550
Clay	50	252	Blue quicksand	30	580
Hardpan	32	284	Tough blue clay	20	600
Sand	9	293	Sandy blue clay	46	646
Clay	30	323			

27.3E.6.213. Chester Little

[Casing perforated from 60 ft to 80 ft]

Sand and soil	55	55	Clay	20	105
Large rounded boulders and gravel	30	85	Sandrock	10	115
			Quicksand	11	126

27.3E.15.143. Paul Price

[Screen from 50 ft to 90 ft]

Topsoil	5	5	Small gravel	48	90
Sand, some clay	37	42	Clay	1	91

TX_MSJ_005591

Table 6.—*Drillers logs of wells in parts of Sierra and Dona Ana Counties, N. Mex.*—Continued

28.2E.24.110. Southern Pacific Co. (Strauss, well 1)

[Well later plugged back to 975 ft]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand	3	3	Sand	5	523
Sandy soil	3	6	Yellow clay	4	527
Caliche	6	12	Sand	3	530
Sand	8	20	Yellow and blue clay	10	540
Yellow clay	85	105	Black sand	70	610
Cemented sand	15	120	Blue clay	20	630
Yellow clay	50	170	Black sand	20	650
Sand	15	185	Blue and red clay	120	770
Red clay	25	210	Black sand	60	830
Sand	5	215	Yellow clay	40	870
Red clay	22	237	Black sand	25	895
Cemented sand	13	250	Red clay	45	940
Yellow clay	5	255	Black sand	10	950
Sand	10	265	Red clay	30	980
Sandy clay	30	295	Sand	10	990
Sand	2	297	Red clay	20	1,010
Red clay	23	320	Sand	5	1,015
Sand	10	330	Red clay	20	1,035
Red clay	20	350	Sand	5	1,040
Sand	5	355	Red clay	40	1,080
Yellow clay	5	360	Sand	10	1,090
Sand (water)	52	412	Clay	35	1,125
Yellow clay	38	450	Sand and gravel (water)	15	1,140
Sand	25	475	Clay	10	1,150
Blue clay	3	478	Sand	125	1,275
Sand	7	485	Sandy clay	50	1,325
Yellow clay	3	488	Sandstone	2	1,327
Sand	10	498	Sand	3	1,330
Yellow clay	20	518			

28.2E.24.110a. Southern Pacific Co. (Strauss, well 2)

Sand	3	3	Cemented clay and sand in thin strata	20	367
Sandy soil	3	6	Sand	13	380
Caliche	6	12	Sandstone	2	382
Sand	8	20	Sand and clay in thin strata	38	420
Yellow clay	85	105	Sand	40	460
Cemented sand	15	120	Sand and clay in thin strata	23	483
Yellow clay	50	170	Clay	22	505
Sand	10	180	Soft blue clay	35	540
Clay	46	226	Soft cemented clay	25	565
Sand	22	248	Fine sand and clay	30	595
Clay	6	254	Clay	25	620
Sand	8	262	Sandy clay	70	690
Yellow sand	12	274	Clay with cement boulders	15	705
Clay	33	307			
Sand	13	320			
Packed sand	13	333			
Hard clay	14	347			

28.3E.25. Lippincott well

[Water-Supply Paper 919, p. 106]

Sand	49	49	Brown fine sand	42	410
Gravel	5	54	Blue sandy shale	43	453
Sand	31	85	Gumbo	17	470
Gravel	5	90	Fine sand	10	480
Sand	9	99	Shell lime	2	482
Broken gravel and sand	190	289	Gumbo	65	547
Coarse gravel and sand	21	310	Sandy shale	57	604
Very coarse gravel and sand (water test)	23	333	Gumbo and sand	218	822
Gravel, broken shale and sand	12	345	Hard sandy lime	3	825
Gravel, sand, and lime	10	355	Gumbo	40	865
Brown coarse sand	13	368	Hard sandy lime	3	868
			Very hard black lime	1	869

TX_MSJ_005592

Table 6.—*Drillers logs of wells in parts of Sierra and Dona Ana Counties, N. Mex.*—Continued

28.3E.25. Lippincott well—Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Lime, broken, with coarse gravel	71	940	Blue lime with seam	8	997
Hard gray lime	11	951	Cemented sand	7	1,004
Sandy limestone (some water)	3	954	Blue lime with sand seam	3	1,007
Blue lime	3	957	Yellow clay and sand seam (small flow of water)	10	1,017
Blue lime with sand seam	6	963	Soft yellow sandstone	9	1,026
Very hard solidified lime	1	964	Blue limestone	1	1,027
Sandy limestone	1	965	Clay, soft sandstone	7	1,034
Blue lime	2	967	Clay and yellow sand	3	1,037
Siliceous lime	3	970	Soft sandstone	20	1,057
Blue lime	4	974	Quicksand	5	1,062
Siliceous lime	3	977	Blue clay, sand	2	1,064
Blue lime with sand seam	9	986	Quicksand	10	1,074
Hard quartz	3	989			

29.1E.8.210a. Southern Pacific Co. (Noria, well 2)

Sand	40	40	Red clay and shale	35	500
Clay	5	45	Tough clay	10	510
Sand and gravel	235	280	Clay, shale, and packed sand	30	540
Red clay	95	375	Sand and boulders	11	551
Red clay and shale	30	405	Packed sand, clay, and shale	14	565
Shale and packed sand	30	435			
Sand, red clay, and shale	30	465			

29.1E.8.210b. Southern Pacific Co. (Noria, well 3)

Sand	3	3	Shale and shell rock	15	399
Chalk rock	12	15	Shale	19	418
Sand	85	100	Water sand	42	460
Fine sand	70	170	Shale	27	487
Sand and clay	110	280	Clay	18	505
Sand	83	363	Water sand	45	550
Clay	21	384	Clay and sand	15	565

29.2.6.230. Southern Pacific Co. (Mt. Riley, well 2)

[Well allowed to fill to 528 ft, August 1924]

Sand with streaks of soft white rock	110	110	Clay and gravel	10	560
Clay	60	170	Cemented gravel	5	565
Clay and sand	110	280	Cemented gravel, boulders	7	572
Sand (water)	20	300	Cemented boulders	10	582
Clay	25	325	Cemented gravel and boulders	33	615
Clay and gravel	95	420	Cemented gravel	5	620
Sand and gravel	7	427	Rock	10	630
Clay and gravel	106	533	Cemented gravel	85	715
Clay, gravel, loose rock	17	550			

29.4.9.100. Southern Pacific Co. (Malpais, well 1)

Clay	5	5	Clay	262	370
Malpais	103	108	Clay and sand	75	445

29.4.9.100a. Southern Pacific Co. (Malpais, well 2)

Caliche	12	12	Clay	42	365
Malpais boulder	20	32	Rock	1	366
Rock	56	88	Clay and sand	22	388
Clay and sand	98	186	Quicksand	5	393
Sandrock	13	199	Sand	34	427
Clay and sand	25	224	Hardpan	38	465
Clay	53	277	Clay	49	514
Clay and sand	46	323			

TX_MSJ_005593

Table 7.—*Analyses of ground waters in parts*

[Analyses by U. S. Geological Survey[1], unless otherwise noted.

Well location no.	Owner or name	Date of collection 1947	Depth of well (feet)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)
			Wells drilled in arroyo deposits or			
16.5.22.420...	O. B. Dawson.....	([2])	216	32	22	2.9
Do.....	.....do.....	([3])	216	.....	21	4.4
Do.....	.....do.....	June 7	216	25	22	2.5
16.5.23.300....	.....do.....	June 7	226	.....	.....	.....
Do.....	.....do.....	July 31	226	28	24	1.6
16.5.25.120...	U. S. Dept. Interior, Bur. Reclamation.	([4])	138	.....	53	7.3
17.5.14.212....	A. J. Osborn.....	July 14	121	30	38	3.1
17.5.14.441....	Earl Riggs.....	Aug. 15	80	.....	53	8.0
17.5.24.333....	E. W. Powers.....	Apr. 17	102	.....	60	8.3
17.5.26.212....	Mickey Plemmons.....	July 14	68	24	66	8.0
19.4.11.221....	Clyde Cowan.....	Apr. 17	74	.....	267	53.
20.1.26.210....	New Mexico Coll. of Agr. & Mech. Arts.	May 17[5]	284	73	34	13.
21.1.11.431....	C. C. Rice.....	Mar. 26[5]	150	.....	216	52.
22.1E.33.321..	K. H. Walker.....	Aug. 29	74	.....	158	27.
22.2E.13.411..	J. W. Daugherty.....	Aug. 26[5]	430	.....	34	7.
23.2E.6.323....	Las Cruces Country Club..	Aug. 13	200	.....	58	17.
23.2E.8.434....	City of Las Cruces, well 5.	May 6	300	.....	124	32.
Do.....	.....do.....	Mar. 25[5]	300	.....	134	36.
23.2E.17.210..	City of Las Cruces.....	([6])	([7])	.....	56	17.
23.2E.17.210a.	City of Las Cruces, well 2.	Mar. 25[5]	.....	.....	70	18.
24.3.5.330.....	H. S. Bissell.....	Mar. 25[5]	.....	.....	15	9.4
26.3E.19.311..	Leslie Hayes.....	Mar. 25[5]	132	.....	43	12.
26.1.4.410.....	Southern Pacific Co. (Afton).	([8])	702	.....	47	18.
26.1.25.410a..	Mrs. Annie Braidfoot.....	May 1	460	.....	5	3.2
27.1E.33.130..	.....do.....	May 1	453	.....	12	9.8
28.2E.24.110..	Southern Pacific Co. (Strauss).	([8])	950	.....	20	9.0
28.2E.24.110a.	.....do.....	May 1	705	.....	24	10.
1 mile west of Cerro de Muleros.	Dr. J. E. Laws.....	([9])	.....	.....	33	6.2
			Wells drilled in alluvial fill			
17.4.31.111....	Ben Luchini.....	July 14	71	20	157	21.
19.3.4.331.....	B. S. Thurman.....	Apr. 18	52	.....	138	30.
19.3.9.121a....	Village of Hatch.....	Aug. 12	70	.....	91	15.
19.3.10.333....	E. L. Cocks.....	Aug. 11	69	.....	200	29.
19.3.10.432....	Lee Stotts.....	Aug. 15	68	.....	86	15.
22.1E.26.214..	J. K. Nakayama.....	Aug. 27	100	.....	164	27.
22.1E.28.140..	T. L. Simpson.....	Aug. 13	242	.....	53	9.4
22.1E.28.310..	.....do.....	Aug. 13	42	.....	302	44.
22.1E.28.320..	.....do.....	Aug. 13	162	.....	98	17.
23.2E.18.141..	City of Las Cruces.....	([10])	.....	32	161	24.
Do.....	.....do.....	([11])	.....	27	150	27.
Do.....	.....do.....	([12])	.....	33	165	28.
23.2E.29.332..	Las Cruces Ice Co.....	Aug. 13	.....	.....	.....	.....
26.3.9.221.....	Berino Cotton Gin.....	Aug. 12	148	.....	142	45.
			Springs			
17.4.29.340....	Derry warm springs.....	Apr. 17	.....	.....	52	19.
21.1.10.213....	Radium Springs.....	May 17[5]	.....	71	142	23.

[1]Analysts: C. S. Howard, E. F. Williams, V. E. Arnold, L. S. Hughes.
[2]Dec. 19, 1945.
[3]June 14, 1946.
[4]Dec. 9, 1936.
[5]1948.
[6]May 11, 1939
[7]Hydrant water at Pueblo Courts. City water supply being obtained from 3 city wells, 294, 296, and 301 feet deep.

TX_MSJ_005594

of Sierra and Dona Ana Counties, N. Mex.

Parts per million except percent sodium and specific conductance]

Sodium and potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Total hardness as $CaCO_3$	Dissolved solids	Specific conductance (micromhos at 25 C)	Percent sodium
on mesa lands above valley floor									
59	168	37	12	0.8	1.1	67	250	350	66
59	169	36	13	1.2	.8	70	219	360	64
74	180	58	11	1.0	1.1	66	283	385	71
.....	180	.....	11	.....	.....	.....	.....	357	.....
73	180	52	13	1.2	1.3	66	283	360	70
35	207	44	10	1.7	11.	133	.....	.....	32
144	187	211	25	4.3	2.7	108	550	594	74
47	215	65	14	1.2	2.1	165	296	495	38
25	228	33	6	.2	9.1	184	254	449	23
53	218	103	14	.3	7.3	198	383	478	37
259	295	615	400	.3	1.5	884	1,740	2,640	39
90	181	145	18	.7	8.6	139	472	648	59
962	506	286	1,510	.....	2.3	753	3,280	5,760	74
96	347	279	98	.2	.....	505	829	1,260	29
30	120	65	9	.....	.6	114	205	349	36
69	174	90	90	.6	.3	214	411	719	41
94	232	227	153	.3	2.6	441	747	1,210	32
84	227	246	158	.....	.7	482	770	1,260	27
.....	177	90	66	.....	.....	210	.....	660	.....
63	180	126	76	.....	.6	248	442	761	36
139	370	41	20	.....	6.8	76	414	698	80
81	183	91	63	.....	.7	157	381	657	53
355	423	210	282	.....	.....	191	1,120	.....	80
300	492	121	42	7.9	18.	26	773	1,290	96
178	345	74	47	2.0	8.8	70	513	865	85
247	407	180	72	.....	.75	87	729	.....	86
240	365	195	69	1.5	1.2	101	731	1,180	84
132	188	156	50	.....	9.1	108	479	.....	73
of valley floor of Rio Grande									
296	316	666	119	.....	0.9	478	1,440	1,400	57
128	220	342	147	.4	2.5	468	896	1,380	37
86	213	193	71	.3	.1	288	561	897	39
140	354	399	153	.2	.8	618	1,100	1,650	33
85	237	179	56	.3	.3	276	538	858	40
142	337	376	108	.4	9.6	520	993	1,460	37
44	164	65	44	.4	.4	170	297	520	36
309	508	747	289	.1	4.7	934	1,950	2,740	42
52	188	98	120	.3	2.8	314	481	846	27
131	.....	268	112	.....	.....	501	943	.....	36
125	382	294	118	.....	.....	485	970	.....	36
125	.....	290	122	.....	.....	527	1,012	.....	34
.....	176	.....	42	.....	.....	.....	.....	500	.....
47	663	211	436	.1	.6	540	1,550	2,580	61
Springs—Continued									
303	370	309	160	5.8	2.0	208	1,030	1,650	76
1,160	427	265	1,660	4.6	2.0	449	3,540	6,060	86

[8] Sayre, A N., and Livingston, Penn, Ground-water resources of the El Paso area, Tex., U. S. Geol. Survey Water-Supply Paper 919, p. 121. Date of collection, Apr. 22, 1936.

[9] Idem Date of collection, July 17, 1936.

[10] City water supply being obtained from 2 wells, 75 and 100 feet deep, of El Paso Electric Co. Date of collection, 1930. Analyzed by C. W. Botkin, chemist, State College, N. Mex.

[11] See note 10. Date of collection, 1934?

[12] See note 10. Date of collection, Nov. 26, 1935.

TX_MSJ_005595

Table 8.—*Auger holes in 2 lines across Park Drain, Holt and Seale roads, Mesilla Valley, N. Mex.*

Hole location no.	Field no.[1]	Depth (feet)	Top of casing		Reference point (Top edge of Geological Survey washer)
			Elevation[2]	Above land surface (feet)	
24.2E.5.424	N 2,817 E	12.3	3,828.22	0	East side of 9th power pole east of Park Drain, north side of road, 1.2 ft northwest of well, elevation 3,828.83 ft.
24.2E.5.434	N 577 E	15	3,828.98	0.50	Northeast side of 2d power pole east of Park Drain, north side of road, 1.6 ft west of well, elevation 3,829.97 ft.
24.2E.5.441	N 1,501 E	8.5	3,824.27	0	East side of 5th power pole east of Park Drain, north side of road, 1.2 ft west of well, elevation 3,825.29 ft.
24.2E.8.114	N 1,783 W	10.5	3,828.38	.50	South side of 1st power pole east of State Highway 28, nortn side of road, 2 ft northeast of well, elevation 3,829.23 ft.
24.2E.8.121	N 960 W	14	3,828.08	1.00	West side of 4th power pole west of Park Drain, north side of road, 1.3 ft north of well, elevation 3,828.84 ft.
24.2E.8.122	N 358 W	9	3,823.33	0	West side of 2d power pole west of Park Drain, north side of road, 2 ft north of well, elevation 3,824.25 ft.
24.2E.8.211	N 74 W	11	3,823.65	0	West side of 1st power pole west of Park Drain, north side of road, 2 ft north of well, elevation 3,824.85 ft.
24.2E.9.333	S 1,583 W	11	3,820.90	0	Northwest side of 5th power pole west of Park Drain, north side of road, 1.5 ft south of well, elevation 3,821.76 ft.
24.2E.9.334	S 441 W	12	3,821.59	0	West side of 2d power pole west of Park Drain, north side of road, 1.5 ft northeast of well, elevation 3,822.71 ft.
24.2E.9.343	S 101 W	11.5	3,821.21	0	Northwest side of 1st power pole west of Park Drain, north side of road, 1.3 ft northeast of well, elevation 3,821.76 ft.
24.2E.9.434	S 2,335 E	9	3,819.32	0	East side of 2d power pole west of railroad, north side of road, 2 ft west of well, elevation 3,819.97 ft.
24.2E.16.121	S 152 E	13	3,821.87	1.50	West side of cottonwood tree, south side of road, 2 ft southeast of well, elevation 3,823.23 ft.
24.2E.16.122	S 565 E	12	3,821.98	0	Southwest side of catalpa tree, south side of road, 2 ft southeast of well, elevation 3,822.44 ft.
24.2E.16.211	S 1,067 E	11.5	3,821.42	0	(U. S. Bureau of Reclamation well 32)
24.2E.17.221	S 2,916 W	12	3,823.45	1.50	(U. S. Bureau of Reclamation well 33)

[1] Wells having numbers beginning with letter "N" are on the north (Seale) road; with letter "S" on the south (Holt) road. Figure indicates distance of the well, in feet, east (E) or west (W) from the Park Drain along the Seale and Holt roads.

[2] Above U. S. Bureau of Reclamation datum, which is 40 feet above mean sea level.

TX_MSJ_005596

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Table 9.—*Water levels in auger holes in 2 lines across Park drain, 1947–48. in feet below land surface*

Date		Field nos. of wells														
		N1783W	N960W	N358W	N74W	N577E	N1501E	N2817E	S2916W	S1583W	S441W	S101W	S152E	S565E	S1067E	S2335E
1947																
Feb.	14	12.02	11.80	8.50	9.14	13.09	7.93	11.15	9.68	9.53	11.12	11.13	10.33	11.78	10.63	8.43
	21	12.09	11.84	8.54	9.16	13.14	7.99	11.23*	[1]9.07	9.64	11.17	11.16	10.36	11.83	[1]10.88	8.50
	28	12.14	11.89	8.55	9.14	13.15	8.05	11.29	[1]9.03	9.72	11.19	11.11	10.33	11.84	[1]10.89	8.55
Mar.	7	12.13	11.89	8.55	9.27	13.17	8.08	11.34	9.90	9.75	11.20	11.14	10.34	11.86	11.22	8.60
	14	12.20	11.93	8.58	9.18	13.20	8.13	11.40	10.00	9.82	11.24	11.15	10.37	11.88	11.26	8.67
	28	11.49	11.57	8.35	9.00	13.19	8.18	11.43	9.89	9.69	11.13	11.02	10.27	11.86	11.28	8.71
Apr.	11	10.77	11.10	7.97	8.54	12.30	7.25	10.53	9.18	8.91	10.40	10.46	9.71	11.17	10.56	7.24
	24	10.34	10.52	7.63	8.34	12.19	7.02	10.29	8.56	8.58	10.21	10.29	8.47	10.89	10.02	6.42
May	9	10.07	10.32	7.52	7.45	12.05	6.87	10.16	8.40	8.41	10.12	10.35	9.41	10.72	9.84	6.51
	23	10.25	10.48	7.60	8.46	12.02	6.79	10.06	8.02	8.19	10.02	10.28	9.20	10.24	9.19	[1]5.37
June	6	10.23	10.48	7.62	8.52	12.04	6.77	10.05	7.80	8.02	10.01	10.36	9.31	10.33	9.17	5.44
	19	9.96	10.38	7.49	8.39	11.79	6.66	9.88	7.65	6.93	9.73	10.10	8.90	9.91	8.64	4.61
July	3	9.48	9.84	7.24	8.29	11.54	6.11	9.30	7.13	7.49	9.84	10.37	9.47	10.55	9.50	5.90
	17	9.28	9.91	7.18	8.11	11.27	5.66	8.53	6.79	7.37	9.45	9.96	8.72	9.66	8.79	4.50
Aug.	1	8.68	9.42	6.78	7.84	10.82	5.25	8.32	6.47	6.73	9.09	9.70	8.57	9.45	8.45	4.72
	15	8.41	9.29	6.65	7.74	10.26	4.68	7.83	5.36	6.11	8.86	9.66	8.68	9.54	8.57	5.46
	29	8.82	9.36	6.71	7.78	10.65	5.00	8.22	6.28	6.54	9.17	9.87	8.85	9.70	8.41	4.73
Sept.	12	9.02	9.60	6.90	7.90	11.09	5.57	8.75	5.55	6.20	8.98	9.85	8.90	9.79	8.60	5.40
	28	9.40	9.84	7.04	8.01	10.79	5.46	8.62	6.61	6.94	9.48	10.11	9.20	10.27	9.24	5.95
Oct.	10	9.70	10.07	7.23	8.17	11.44	5.95	9.19	.....	7.31	9.75	10.29	9.39	10.56	9.59	6.59
	24	10.16	10.37	7.44	8.40	11.75	6.29	9.55	[2]7.15	7.80	10.01	10.45	9.58	10.80	9.94	7.07
Nov.	7	10.49	10.61	7.62	8.49	12.01	6.60	9.80	.....	7.84	9.78	[1]10.52	9.70	10.98	10.16	7.19
	21	10.71	10.81	7.62	8.56	12.20	6.86	10.05	7.89	8.27	10.29	[1]10.59	9.75	11.02	10.11	[1]5.47
Dec.	5	10.94	10.96	7.82	8.67	12.24	7.09	10.29	8.16	8.37	10.37	10.62	9.59	10.90	9.98	7.15
	19	11.18	11.01	7.98	8.71	12.50	7.26	10.51	8.55	8.66	10.56	10.74	9.69	11.16	10.40	7.67
1948																
Jan.	2	11.31	11.22	8.05	8.78	12.63	7.42	10.69	8.88	8.89	10.70	10.76	9.80	11.34	10.61	7.94
	16	11.52	11.36	8.14	8.87	12.74	7.56	10.85	9.10	9.10	10.68	11.39	9.88	11.47	10.79	8.15
	30	11.70	12.51	8.22	8.91	12.81	7.71	11.00	9.44	9.30	10.97	[1]10.39	9.91	11.55	10.92	8.32
Feb.	13	.....	11.61	8.30	.....	12.90	7.85	11.13	9.67	9.48	11.05	11.03	10.10	11.70	11.04	8.47
	27	11.73	11.70	8.46	.....	12.99	7.97	11.27	9.91	9.77	10.99	11.06	10.03	11.71	11.10	8.57

TX_MSJ_005597

Table 9.—*Water levels in auger holes in 2 lines across Park drain, 1947–48, in feet below land surface*—Continued

Date	Field nos. of wells														
	N1783W	N960W	N358W	N74W	N577E	N1501E	N2817E	S2916W	S1583W	S441W	S101W	S152E	S565E	S1067E	S2335E
1948–Continued															
Mar. 12	Dry	11.79	8.45	Dry	13.04	8.07	11.43	10.14	9.84	11.20	10.97	10.12	11.74	11.16	8.72
26	Dry	11.91	8.47	Dry	13.04	7.88	11.49	10.15	9.88	11.22	11.05	9.77	11.50	11.15	8.73
Apr. 9	11.18	10.90	7.70	Dry	11.54	6.63	10.34	9.51	9.44	10.62	10.44	9.83	11.28	10.80	8.61

[1]Measurement uncertain.
[2]Estimated.

TX_MSJ_005598

Table 10.— *Water levels, in feet below land-surface datum, in auger well 23.2E.29.214*

[Measured at 5:00 p.m., 1947-48]

Location: Northeast corner of westernmost weather instruments shelter of New Mexico College of Agriculture and Mechanic Arts, State College, N. Mex.
Diameter: 2 inches; depth: 11 feet.
Measuring point: Top edge of hole in cap on casing, 5.22 feet below B. M. 102 U. S. C. and G. S. (3,844 feet above mean sea level), 0.25 foot above land-surface datum.
Reference point: Surface of northeast corner of concrete curbing for weather instruments shelter, 1.5 feet from well, 0.74 foot above land-surface datum.

Date	Water level	Date	Water level	Date	Water level	Date	Water level
1947		1947		1947		1947	
Feb. 19	10.07	May 8	9.69	July 6	9.07	Sept. 3	9.06
20	10.06	9	9.58	7	9.11	4	9.08
21	10.09	10	9.51	8	9.13	5	9.07
22	10.09	11	9.49	9	9.17	6	9.02
23	10.08	12	9.49	10	9.19	7	9.00
24	10.08	13	9.52	11	9.19	8	8.22
25	10.09	14	9.53	12	9.19	9	8.48
26	10.08	15	9.54	13	9.15	10	8.58
27	10.09	16	9.45	14	9.14	11	8.54
28	10.08	17	9.53	15	9.10	12	8.64
Mar. 1	10.06	18	9.55	16	9.05	13	8.68
2	10.05	19	9.59	17	9.10	14	8.58
3	10.04	20	9.60	18	9.15	15	8.51
4	10.03	21	9.63	19	9.15	16	8.51
5	10.05	22	9.60	20	9.06	17	8.47
6	10.07	23	9.63	21	9.02	18	8.49
7	10.08	24	9.53	22	9.05	19	8.63
8	10.09	25	9.55	23	9.10	20	8.67
9	10.09	26	9.55	24	9.11	21	8.69
10	10.10	27	9.55	25	9.05	22	8.73
11	10.10	28	9.56	26	9.01	23	8.76
12	10.10	29	9.61	27	8.94	24	8.80
13	10.11	30	9.43	28	8.95	25	8.84
14	10.12	31	8.64	29	8.97	26	8.87
15	10.12	June 1	9.03	30	9.01	27	8.90
16	10.13	2	9.12	31	8.80	28	8.93
17	10.14	3	9.23	Aug. 1	8.50	29	8.95
18	10.15	4	9.25	2	8.50	30	8.97
19	10.15	5	9.34	3	8.71	Oct. 1	8.99
20	10.15	6	9.35	4	8.79	2	9.00
21	10.15	7	9.35	5	8.85	3	9.05
22	10.15	8	9.33	6	8.90	4	9.05
23	10.15	9	9.31	7	8.92	5	9.07
24	10.15	10	9.33	8	8.91	6	9.11
25	10.15	11	9.33	9	8.89	7	9.12
26	10.16	12	9.33	10	8.89	8	9.15
27	10.17	13	9.29	11	8.90	9	9.18
28	10.16	14	9.23	12	8.94	10	9.18
29	10.15	15	9.25	13	8.95	11	9.21
30	10.13	16	9.23	14	8.95	12	9.23
31	10.11	17	9.31	15	8.95	13	9.25
Apr. 1	10.02	18	9.27	16	8.86	14	9.29
2	10.00	19	9.21	17	8.80	15	9.25
3	10.00	20	9.15	18	8.74	16	9.25
4	10.03	21	9.15	19	8.72	17	9.29
5	10.06	22	9.15	20	8.73	18	9.33
25	9.72	23	9.21	21	8.76	19	9.35
26	9.55	24	9.23	22	8.79	20	9.38
27	9.20	25	9.25	23	8.80	21	9.39
28	9.30	26	9.23	24	8.83	22	9.39
29	9.44	27	8.13	25	8.87	23	9.44
30	9.47	28	8.61	26	8.88	24	9.49
May 1	9.52	29	8.75	27	8.92	25	9.49
2	9.56	30	8.81	28	8.95	26	9.50
3	9.59	July 1	8.95	29	8.96	27	9.50
4	9.62	2	9.03	30	8.98	28	9.45
5	9.62	3	8.99	31	9.00	29	9.41
6	9.62	4	9.11	Sept. 1	9.02	30	9.46
7	9.67	5	9.11	2	9.03	31	9.51

TX_MSJ_005599

Table 10.—*Water levels, in feet below land-surface datum, in auger well 23.2E.29.214*—Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
1947		1947		1948		1948	
Nov. 1	9.54	Dec. 11	9.86	Jan. 20	10.09	Apr. 5	10.04
2	9.55	12	9.88	21	10.10	12	10.05
3	9.56	13	9.90	22	10.11	19	9.91
4	9.58	14	9.90	23	10.12	26	9.75
5	9.61	15	9.90	24	10.13	May 3	9.65
6	9.61	16	9.91	25	10.13	10	9.55
7	9.62	17	9.92	26	10.13	17	9.55
8	9.63	18	9.92	Feb. 10	10.17	24	9.60
9	9.64	19	9.92	11	10.17	31	9.85
10	9.64	20	9.94	12	10.17	June 7	9.85
11	9.65	21	9.92	13	10.18	14	9.95
12	9.65	22	9.95	14	10.20	21	9.75
13	9.66	23	9.95	15	10.21	28	9.95
14	9.68	24	9.94	16	10.21	July 5	9.99
15	9.70	25	9.95	17	10.21	12	9.89
16	9.69	26	9.96	18	10.22	19	9.91
17	9.69	27	9.96	19	10.23	26	10.03
18	9.70	28	9.97	20	10.23	Aug. 2	9.94
19	9.71	29	9.97	21	10.24	9	9.85
20	9.72	30	9.97	22	10.25	16	9.73
21	9.73	31	9.99	23	10.25	23	9.84
22	9.75	1948		24	10.26	30	9.71
23	9.75	Jan. 1	9.99	25	10.26	Sept. 6	9.75
24	9.75	2	9.99	26	10.25	13	9.75
25	9.76	4	10.00	27	10.25	20	9.78
26	9.76	5	10.00	28	10.15	27	9.76
27	9.77	6	10.01	29	10.05	Oct. 4	9.88
28	9.78	7	10.01	Mar. 1	10.15	11	9.90
29	9.79	8	10.01	2	10.15	18	9.85
30	9.79	9	10.02	3	10.23	25	9.89
Dec. 1	9.80	10	10.04	4	10.25	Nov. 1	9.98
2	9.81	11	10.04	5	10.26	8	9.99
3	9.83	12	10.04	6	10.27	15	10.00
4	9.84	13	10.05	7	10.27	22	10.04
5	9.84	14	10.06	8	10.28	29	10.03
6	9.84	15	10.06	9	10.28	Dec. 6	10.06
7	9.84	16	10.07	15	10.32	13	10.10
8	9.84	17	10.08	22	10.35	20	10.11
9	9.85	18	10.09	29	10.35	27	10.14
10	9.87	19	10.09				

TX_MSJ_005600

Table 11.—*Water levels in wells in Rincon and Mesilla Valleys, N. Mex., 1946–48, in feet below land-surface datum*

Date	Location no. and owner					
	16.5.25.211	16.5.25.343	17.4.30.133a	17.4.31.111	17.4.32.112	17.5.10.442
	U. S. Bureau of Reclamation	Arley Osborn	W. B. Cantrell	Ben Luchini	Ray Painter	Arley Osborn
1946						
Nov. 22	19.29	33.13	.....	.....	.....	.....
Dec. 18	19.59	33.28	.....	.....	.....	.....
1947						
Jan. 8	19.44	33.34	.....	.....	.....	.....
Feb. 20	16.80	33.36	.....	8.88	7.72	.....
Apr. 17	11.30	33.28	13.32	5.83	[1]6.40	15.94
May 27, 28	12.44	32.60	12.37	5.79	7.01	15.32
July 3	13.61	32.35	11.89	5.13	6.35	16.85
Aug. 1	15.23	32.61	11.05	4.81	6.75	17.17
Aug. 30	16.68	32.67	11.29	5.48	6.63	[2]16.55
Sept. 27	17.83	32.86	11.52	7.17	6.85	16.84
Oct. 25	18.63	33.28	13.19	7.95	7.26	16.47
Dec. 2	19.46	33.71	14.45	8.51	7.39	15.66
1948						
Feb. 9, 14	19.43	34.21	15.48	9.09	.....	15.36
Mar. 22	20.92	34.27	.....	.....	.....	15.25

TX_MSJ_005601

Table 11.—*Water levels in wells in Rincon and Mesilla Valleys, N. Mex., 1946–48, in feet below land-surface datum*— Continued

Date	Location no. and owner					
	17.5.14.212	17.5.14.231	17.5.24.333	17.5.26.212	17.5.26.242	19.3.4.331
	Arley Osborn	Felix Lara	E. W. Powers	Mickey Plemmons	Lloyd Welch	B. S. Thurman
1946						
Nov. 22, 23	.....	58.73	28.23	.....	.....	6.25
Dec. 18	.....	58.85	[3]28.64	.....	.....	.....
1947						
Jan. 8	.....	58.96	[3]28.92	.....	.....	.....
Feb. 20	.....	59.17	[3]29.40	.....	.....	6.70
Mar. 3	58.45	.....	.....	.....	.....	.....
Apr. 17	60.76	59.37	.....	43.99	36.60	4.93
May 27, 28	[4]79.80	59.24	28.48	43.65	35.94	5.15
July 3	60.04	59.15	28.29	42.64	35.90	[4]11.45
Aug. 1	60.00	59.15	28.02	43.50	35.77	5.30
Aug. 30	59.88	59.07	27.98	42.94	[4]43.87	.....
Sept. 27	60.43	59.04	27.90	42.97	35.32	.....
Oct. 25	61.22	59.24	28.54	43.37	35.71	.....
Dec. 2	61.79	59.48	29.45	44.11	36.42	.....
1948						
Feb. 14	62.62	59.83	30.46	45.11	37.40	.....
Mar. 22	.....	60.02	30.51	.....	37.57	.....

TX_MSJ_005602

Table 11.—*Water levels in wells in Rincon and Mesilla Valleys, N. Mex., 1946–48, in feet below land-surface datum*—Continued

Date	Location no. and owner				
	19.3.4.331a	19.4.11.211	23.2E.29.143	23.2E.29.243b	23.2E.29.243c
	B. S. Thurman	Clyde Cowan	New Mexico A. & M. College	New Mexico A. & M. College	New Mexico A. & M. College
1946					
Nov. 14, 22, 23	6.25	11.92	12.82	.....	.....
Dec. 14, 18,	.....	12.28	13.17	34.00	.....
1947					
Jan. 14	.....	.....	13.37	.....	.....
Feb. 15, 20	6.70	12.97	13.53	34.38	30.35
Mar. 7	.....	.....	[3]13.54	.....	.....
Apr. 16, 17	4.86	[4]20.54	13.20	34.34	30.24
May 23, 26, 27	5.02	[3]13.80	12.84	34.10	30.11
July 3	[5] 6.22	.....	12.93	33.55	29.70
Aug. 1	5.17	[4]12.58	[4]23.04	33.39	31.04
Aug. 30	4.92	10.69	12.96	33.23	29.39
Sept. 27, 29	5.73	11.32	12.34	33.22	30.92
Oct. 25	6.58	12.04	13.08	33.74	29.89
Dec. 2, 3,	6.96	12.50	13.38	34.18	30.38
1948					
Feb. 10, 14	7.20	13.25	13.55	34.54	30.63
Mar. 25	.....	.....	13.63	[5]34.81	[5]32.47

[1] Nearby field irrigated recently.
[2] New measuring point, not exactly correlated with previous one.
[3] Well had been pumped.
[4] Well being pumped.
[5] Nearby well being pumped.

TX_MSJ_005603

Table 12.—*Records of large-diameter wells near or on the valley floor of the Rio Grande in Rincon and Mesilla Valleys*

Sheet and tract: letters and numbers refer to Irrigable area and property maps of Elephant Butte Irrigation District, U S. Bureau of Reclamation—Rio Grande project.
Owner or name: NMAC refers to New Mexico College of Agriculture and Mechanic Arts.
Topographic situation: A, arroyo bed; F, valley floor; M, mesa surface; S, alluvial side slope or arroyo slope.
Altitude: A, determined by aneroid; T, determined from U. S. Geological Survey topographic quadrangle maps.
Type of well: Dd, dug and drilled; Dr, drilled; Du, dug; J, jetted.
Depth of well: reported.
Water level: reported figures given to nearest foot.
Type of pump: AL, air lift; C, centrifugal; Pl, plunger; T, turbine.
Kind of power: B, butane engine; D, diesel engine; E, electric motor; G, gasoline engine; T, tractor engine; W, wind.
Discharge rate: E, estimated; M, measured; R, reported.
Drawdown: E, estimated; M, measured; R, reported.
Use of water: A, abandoned; D, domestic; I, irrigation; II, intended irrigation; M, municipal, RR, railroads; S, stock; U, unused, equipped with pump.

TX_MSJ_005605

Table 12.—*Records of large-diameter wells near or on the valley*

No.	Well location no.	Sheet	Tract	Owner or name	Driller	Date completed	Topographic situation
							Rincon Valley, Sierra
1	16.5.23.300	.....	.....	O. B. Dawson.....	Mickey Plemmons..	April 1947..	S
2	16.5.25.120	A	.....	U. S. Bureau of Reclamation.	George Cook.....	1936.....	A
3	16.5.25.211	A	.....	.....do.....	.....	.....do.....	A
4	16.5.25.341	A	.....	A. J. Osborn.....	Mickey Plemmons..	July 1947....	S
5	16.5.25.343	A	.....	.....do.....	George Cook.....	March 1946	S
6	17.4.30.133a	C	22	W. B. Cantrell....	Toby Tipton.....	March 1947	F
7	17.4.31.111	C	48	Ben Luchini.....	.....do.....	December... 1946.	F
8	17.4.32.112	C	37	Ray Painter.....	Mickey Plemmons..	February..... 1947.	F
9	17.5.10.442	B	.....	A. J. Osborn.....	.....do.....	.....do.....	M
10	17.5.14.212	B	.....	.....do.....	.....do.....	March 1947	S
11	17.5.14.231	B	.....	Felix Lara.....	Harrison.....	1946.....	A
12	17.5.14.441	B	53B	Earl Riggs.....	Mickey Plemmons..	July 1947....	S
13	17.5.23.442	C	.....	Marsella Fritz.....	.....do.....	1934 (?).....	S
14	17.5.23.442a	C	.....	.....do.....	Marsella Fritz.....	February.... 1948.	S
15	17.5.24.331	C	.....	Tod Robison.....	Harliss.....	1934.....	S
16	17.5.24.333	C	.....	E. W. Powers.....	George Cook.....	April 1946..	S
17	17.5.25.123	C	25	G. P. Black.....	Mickey Plemmons..	October..... 1947.	F
18	17.5.25.134	C	25	.....do.....	.....do.....	.....do.....	F
19	17.5.26.212	C	.....	Mickey Plemmons.	..... do.....	March 1947	S
20	17.5.26.242	C	.....	Lloyd Welch.....	.....do.....	February..... 1947.	S

No.	Well location no.	Pump			Yield		Drawdown below static level	
		Type	Size (in.)	Kind of power	Rate (gpm)	Date of measurement	Amount	Duration of test (hr)
								Rincon Valley, Sierra
1	16.5.23.300	T	8	G	850 M	June 5, 1947.....	115.00 M	4
2	16.5.25.120	AL	.....	G	13 R	1936.....	21 R	48
3	16.5.25.211	None	None	None	.....	.....	.....	.....
4	16.5.25.341	None	None	None	125 R	July 14, 1947....	100 (?) R	2
5	16.5.25.343	T	6	G	250 E	July 15, 1947....	.....	.....
6	17.4.30.133a	T	8	T	.....	.....	.....	.....
7	17.4.31.111	T	10	B	1,000 M	July 18, 1947...	14.2 M	9
8	17.4.32.112	T	6	G	800 R	February 1947...	14 R	4
9	17.5.10.442	None	None	None	.....	.....	.....	.....
10	17.5.14.212	T	6	G	250 E	July 23, 1947...	22.6 M	6
11	17.5.14.231	None	None	None	500 R	1946.....	.....	.....
12	17.5.14.441	C	4	E	800 R	July 1947.....	19 R	10
13	17.5.23.442	C	4	G	250-300 E	Aug. 1, 1947....	10 R	4
14	17.5.23.442a	T	.....	.....	.....	.....	.....	.....
15	17.5.24.331	C	6	T	450 E	Aug. 1, 1947...	12 R	5
16	17.5.24.333	T	8	G	650 M	July 25, 1947...	20.5 M	5
17	17.5.25.123	T	8	G	860 M	Dec. 2, 1947...	.....	40
18	17.5.25.134	T	8	T	780 M	.....do.....	.....	3
19	17.5.26.212	T	6	G	225 M	June 4, 1947....	20.00 M	2
20	17.5.26.242	T	8	G	700 G	July 24, 1947...	8.5 M	8

TX_MSJ_005606

floor of the Rio Grande in Rincon and Mesilla Valleys—Continued

Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed: Depth to top of bed (ft)	Principal water-bearing bed: Thickness (ft)	Principal water-bearing bed: Character of material	Depth to which well is cased (ft)	Water level: Below land surface (ft)	Water level: Date of measurement
County, N. Mex.									
4,280 A	Dr	226	18	186	12	Gravel	215	Flows	June 5, 1947
4,194 T	Dr	138	6				107	24.12	Nov. 22, 1946
4,181 T	Dr	32	10					19.29	Do.
4,180 T	Dr	127	10				127	27.20	July 3, 1947
4,182 T	Dr	152	12	38			131	32.22	June 21, 1946
4,140 T	Dr	97	18	12	43	Sand and gravel	69	13.32	Apr. 17, 1947
4,113 T	Dr	71	14	10	43	do	65	8.88	Feb. 20, 1947
4,110 T	Dr	80	12				80	7.72	Do.
4,260 A	Dr	207	15±				None	15.94	Apr. 17, 1947
4,188 T	Dr	121	10				121	58.45	Mar. 3, 1947
4,180 T	Dr	100 (?)	12					58.73	Nov. 22, 1946
4,140 T	Dd	80	12				80 (?)	13.90	Aug. 1, 1947
4,140 T	Dd	65	6						
4,140 T	Dr								
4,140 T	Dd	74	14				74	28.	Aug. 1, 1947
4,140 T	Dr	101	12	55	18	Sand and gravel		28.23	Nov. 23, 1946
4,120 T	Dr	59	18			do		14.65	Feb. 14, 1948
4,120 T	Dr	64	18			do		12.77	Do.
4,160 T	Dd	68	10			do	68	43.99	Apr. 17, 1947
4,152 T	Dr	85	12	57	27	Gravel	85	36.60	Do.

Specific capacity (gpm/ft)	Use of water	Measuring point: Description	Measuring point: Height above (+) or below (-) land-surface datum (ft)	Remarks
County, N. Mex.—Continued				
63	I	Top of casing	0.00	Temperature 75 F. Artesian flow 125 gpm estimated June 5, 1947. See analysis.
0.6	D	Bottom of air-line elbow	+4.00	See analysis.
	A	Top of casing	+3.00	Used during construction of Caballo Dam.
1.2	II	do	+.60	Quantity insufficient for irrigation.
	I	do	+.25	Depth 131 ft measured July 1947.
	II	do	+4.00	
70	I	Top west edge of 3-in. pipe in concrete.	+.83	Temperature 67 F.
57	II	Top of extended casing	+.85	
	A	Land surface	+.00	Water level can be lowered to 70 ft by bailer.
11	I	Top of casing	+.30	Temperature 69 F. See analysis.
	II	do	+1.38	
42	I	Land surface	.00	Dug 18 ft. Test pumped at date of completion.
25	I			Temperature 67 F. Diameter of pit 72 in.
	I			About 10 ft west of well 17.5.23.442.
38	I	Bottom of N-S 8x8 in. pump support, east side of well.	.00	Temperature 67 F. Diameter of pit 72 in.
32	I	Top of casing	+.50	Temperature 67 F. See analysis.
	I	do	.00	
	I	do	1.00	Temperature 64 F.
11	I	Bottom of pump base flange.	+1.00	Temperature 67 F. Diameter of pit 60 in. See analysis.
82	I	Top of casing	+.50	Temperature 67 F.

TX_MSJ_005607

Table 12.—*Records of large-diameter wells near or on the valley*

No.	Well location no.	Sheet	Tract	Owner or name	Driller	Date completed	Topographic situation
							Rincon Valley, Dona Ana
21	18.4.5.214	D	1B	W. A. Prater		1946	F
22	18.4.17.312	D	145	W. B. Engler	Toby Tipton	July 1947	F
23	18.4.17.411	D	144C	Fred Riggs	Mickey Plemmons	December 1947.	F
24	18.4.35.231	E	120	A. A. Franzoy	Toby Tipton	August 1947	F
25	19.2.3.122			A. T. & S. F. Ry.	P. D. Wynne	January 1932	S
26	19.3.4.331	G		B. S. Thurman	Mickey Plemmons	July 1946	F
27	19.3.4.331a	G		do	do	1946	F
28	19.3.5.	G		do	Marsella Fritz	January 1948	F
29	19.3.9.121	G	10	Village of Hatch		1933	F
30	19.3.9.121a	G	10	do	Claude Kight	July 1947	F
31	19.3.10.333	G	113	E. L. Cocks	Mickey Plemmons	do	F
32	19.3.10.432	G	89	Lee Stotts	do	August 1947	F
33	19.3.15.443	G	169B	I. W. Smallwood	Toby Tipton	February 1947.	F
34	19.4.3.234	F		D. L. Oliver	Claude Kight	June 1947	S
35	19.4.11.221	F	73	Clyde Cowan	Mickey Plemmons	October 1946	S
							Mesilla Valley, Dona
36	21.1E.30.323	2	11	B. W. Vermillon		Mar. 1948	F
37	21.1E.31.322	2	23	Rudolph Garcia		Jan. 1948	F
38	21.1E.31.412	2	22	Edgar Rhodes	Morrison Bros.	do	F
39	21.1.11.431	1		C. C. Rice	Jack Daniels	Mar. 1948	M

No.	Well, location no.	Pump			Yield		Drawdown below static level	
		Type	Size (in.)	Kind of power	Rate (gpm)	Date of measurement	Amount	Duration of test (hr)
								Rincon Valley, Dona Ana
21	18.4.5.214	C	3	G	280 R			
22	18.4.17.312	T	6	T				
23	18.4.17.411	C	6	G				
24	18.4.35.231	T	8	G	1,000 R			
25	19.2.3.122	T		E	225 R	January 1932	14 R	
26	19.3.4.331	T	6	G	660 M	Apr. 18, 1947	8.9	96
27	19.3.4.331a	None	None	None	400 R	1946		
28	19.3.5							
29	19.3.9.121	None	None	None	120 R			
30	19.3.9.121a	C	1¼	E	150 E	Aug. 1, 1947	2.1 M	⅓
31	19.3.10.333	T	10	G	600 E	Aug. 11, 1947	10.0 M	¼
32	19.3.10.432	T	10	G	700 E	Aug. 15, 1947	10.4 M	3
33	19.3.15.443	T	8	T	250 E	Apr. 17, 1947		
34	19.4.3.234	C	6	T	500 R	June 1947	5 R	8
35	19.4.11.221	T	8	T	700 M	July 24, 1947	12 M	4
								Mesilla Valley, Dona Ana
36	21.1E.30.323	T	8	G	1,000 R			
37	21.1E.31.322	T	8	T	1,200 R		11 R	
38	21.1E.31.412				1,000 R		30 R	
39	21.1.11.431	T	8	D				

TX_MSJ_005608

floor of the Rio Grande in Rincon and Mesilla Valleys—Continued

Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed: Depth to top of bed (ft)	Principal water-bearing bed: Thickness (ft)	Principal water-bearing bed: Character of material	Depth to which well is cased (ft)	Water level: Below land surface (ft)	Water level: Date of measurement
County, N. Mex.									
4,107 T	Du	20	.....	.....	.....	.....	.....	13.40	Feb. 14, 1948
4,095 T	Dr	70	12	5	60	Sand and gravel	70	5.34	Aug. 11, 1947
								9.65	Feb. 14, 1948
4,092 T	Dr	70	12	.....	.....	.....	.....	8.3	Dec. 2, 1947
4,070 T	Dr	68	12	10	38	Sand and gravel	60	6.92	Aug. 15, 1947
.....	Dr	260	14	.....	.....	.....	260	120.	January 1932
4,052 T	Dr	52	10	.....	.....	Sand and gravel.	52	6.25	Nov. 22, 1946
4,052 T	Dr	35	12	.....	.....	.....	35	6.25	Do.
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4,050 T	Dr	32	8	.....	.....	Fine sand.....	32	3.38	Aug. 1, 1947
4,050 T	Dr	70	7	53	15	Gravel.....	67	3.38	Do.
4,049 T	Dr	69	12	42	12	.....do.....	69	4.98	Aug. 11, 1947
								8.57	Feb. 14, 1948
4,049 T	Dr	68	12	.....	.....	Sand.....	68	9.13	Aug. 27, 1947
								11.71	Feb. 14, 1948
4,040 T	Dr	53	12	10	30	Sand and gravel.	53	5.65	Feb. 20, 1947
4,075 T	Dr	68	8	22	46	Fine sand.....	68	8.49	June 12, 1947
4,080 T	Dr	74	10	16	54	Fine and coarse sand.	74	11.92	Nov. 23, 1946
Ana County, N. Mex.									
.....	Dr.	.....	14.	.....	.....	.....	.....	9.42	Mar. 26, 1948
3,943 T	Dr	100	12	.....	.....	.....	.....	10.55	Feb. 12, 1948
3,945 T	Dr	77	16	50	25	Gravel.....	75	9.58	Do.
4,020 T	Dr	150	12	.....	.....	.....	.....	64.00	Mar. 26, 1948

Specific capacity (gpm/ft)	Use of water	Measuring point: Description	Measuring point: Height above (+) or below (-) land-surface datum (ft)	Remarks
County, N. Mex. —Continued				
.....	I	Top of wooden cribbing.....	+1.50	Pit, 5 by 9 ft.
.....	I	Top of casing.....	+1.00	
.....	I	Land surface.....	.00	Water level measured while being drilled.
.....	I	Top of casing.....	.00	
16	M, RR	.....	.....	Rincon domestic supply.
74	I	Top of casing.....	+2.00	Temperature 60 F. See analysis.
.....	A	.....do.....	+.37	78 ft from well 19.3.4.331.
.....	I	.....	.....	
.....	A	Top of casing.....	+.80	Well sanded.
71	M	.....do.....	+.70	Temperature 62 F. Emergency use only. Two pumps. See analysis.
60	I	.....do.....	.00	Temperature 65 F. See analysis.
67	I	..... do.....	+1.00	Temperature 65 F. See analysis.
.....	I	Top edge of casing....	+1.00	Temperature 63 F. Insufficient power.
100	I	Top of casing.....	-5.40	
58	I	.....do.....	-.90	Temperature 66 F. See analysis.
County, N. Mex. —Continued				
.....	I	Top of casing.....	+.75	
110	I	.....do.....	+.50	
33	II	.....do.....	+2.00	
.....	I	.....do.....	+1.25	See analysis.

TX_MSJ_005609

Table 12.— *Records of large-diameter wells near or on the valley*

No.	Well location no.	Sheet	Tract	Owner or name	Driller	Date completed	Topographic situation
							Mesilla Valley, Dona Ana
40	21.1.13.323	1	7	Isaac Rhodes	Morrison Bros.	1948	F
41	21.1.14.433	1	4A1	Roy Black			F
42	22.1E.8.421	3	37	Carl Nakayama	Jack Doherty	August 1947.	F
43	22.1E.8.421a	3	37	do	McBee	October 1947.	F
44	22.1E.10.413	4		E. A. Knight	Joe Clary	September 1947.	S
45	22.1E.15.343	4	37A	Clifford Hare	Morrison Bros.	December 1947.	F
46	22.1E.15.431	4	40	Claude Tharp	Joe Clary	September 1947.	F
47	22.1E.21.211	4	12B2	Rudolph Garcia		1906	F
48	22.1E.22	4	35B(?)	do		November 1947.	F
49	22.1E.26.214	5	21	J. K. Nakayama	Joe Clary	August 1947.	F
50	22.1E.27.411	5	32	J. W. Taylor	Morrison Bros.	February 1948.	F
51	22.1E.28.142	4	63A	T. L. Simpson		November 1947.	F
52	22.1E.33.321	5	89	K. H. Walker	Jack Daniels	August 1947.	F
53	23.1E.1.414	7	68	R. L. Mayse		1948	F
54	23.1E.1.423	7	70	J. O. Gomez	Jack Daniels	January 1948.	S
55	23.1E.1.443	9	2	L. B. Linbeck	do	September 1947.	F
56	23.1E.2.143	7	8A	Tatman	Morrison Bros.	March 1948	F
57	23.1E.4.413	6	16	J. A. Griffin	do	do	F
58	23.1E.9.411	8	1	Raymond Macaw	do	do	F
59	23.1E.10.442	7	56	Tsuyuko Yanaga	McBee	September 1947.	F

TX_MSJ_005610

floor of the Rio Grande in Rincon and Mesilla Valleys—Continued

Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed			Depth to which well is cased (ft)	Water level	
				Depth to top of bed (ft)	Thickness (ft)	Character of material		Below land surface (ft)	Date of measurement
County, N. Mex.—Continued									
3,960 T	Dr	215	16	48	10	Gravel		12.4	Feb. 12, 1948
3,960 T	Dr								
3,925 T	Dr	175(?)	14				80	8.30	Dec. 5, 1947
								8.46	Feb. 12, 1948
3,925 T	Dr		16					12.23	Do.
3,945 T	Dr	132	12	40	22	Sand and gravel.	116	21.45	Sept. 11, 1947
3,925 T	Dr	108	16			do		11.87	Feb. 12, 1947
3,920 T	Dr	75	12					11.15	Dec. 5, 1947
								11.58	Feb. 12, 1948
3,920 T	Dd	197	6					9.56	Dec. 5, 1947
								10.41	Feb. 12, 1948
	Dr	130							
3,915 T	Dr	100	12	30	34	Sand and gravel.	93	15.	August 1947
3,920 T	Dr	107	16	48	59	do	107		
3,920 T	Dr	80	16	55	25	Gravel		11.19	Dec. 5, 1947
								12.43	Feb. 12, 1948
3,925 T	Dr	74	10	22	52	Sand and gravel.	74	14.64	Aug. 12, 1947
3,910 T	J	60	3					15.46	Feb. 12, 1948
3,915 T	Dr	100	14					21.27	Do.
3,905 T	Dr	75	12					17.08	Dec. 5, 1947
								17.53	Feb. 12, 1948
	Dr		14						
	Dr	90	14						
	Dr	90	14						
3,900 T	Dr	95	16	50	15	Small gravel		13.98	Dec. 5, 1947
								14.85	Feb. 11, 1948

TX_MSJ_005611

Table 12.—*Records of large-diameter wells near or on the valley*

No.	Well location no.	Pump			Yield		Drawdown below static level	
		Type	Size (in.)	Kind of power	Rate (gpm)	Date of measurement	Amount	Duration of test (hr)
								Mesilla Valley, Dona Ana
40	21.1.13.323	.....	.....	.....	.....	.....	.....	.....
41	22.1.14.433	.....	.....	.....	.....	.....	.....	.....
42	22.1E.8.421	T	10	G	900 E	Oct. 10, 1947.....	26 M	10±
43	22.1E.8.421a	None	None	None	.....	.....	.....	.....
44	22.1E.10.413	T	8	T	.....	.....	.....	.....
45	22.1E.15.343	T	10	G	2,000 R	.....	30 R	.....
46	22.1E.15.431	T	8	T	800 R	.....	.....	.....
47	22.1E.21.211	T	10	T	1,000 R	1947.....	16 R	.....
48	22.1E.22	None	None	None	.....	.....	.....	.....
49	22.1E.26.214	T	8	T	1,000 E	Aug. 29, 1947....	16 R	.....
50	22.1E.27.411	T	.....	.....	.....	.....	.....	.....
51	22.1E.28.142	T	10	T	1,200 R	February 1948.....	.....	.....
52	22.1E.33.321	T	8	T	800 R	1947.....	30 M	.....
53	23.1E.1.414	AL	.....	.....	Poor	.....	.....	.....
54	23.1E.1.423	T	8	T	1,000 R	.....	.....	.....
55	23.1E.1.443	T	6	T	600 R	.....	.....	.....
56	23.1E.2.143	T	10	.....	.....	.....	.....	.....
57	23.1E.4.413	.....	.....	.....	.....	.....	.....	.....
58	23.1E.9.411	.....	.....	.....	.....	.....	.....	.....
59	23.1E.10.442	T	8	T	1,200 R	.....	.....	.....

TX_MSJ_005612

floor of the Rio Grande in Rincon and Mesilla Valleys—Continued

Specific capacity (gpm/ft)	Use of water	Measuring point: Description	Measuring point: Height above (+) or below (-) land-surface datum (ft)	Remarks
County, N. Mex.—Continued				
.....	II	.....	.....	Depth at time of water-level measurements.
.....	II	.....	.....	
35	I	Top of casing.....	.00	Temperature 62 F.
.....	II	.....do.....	+.50	About 120 feet north of well 22.1E.8.421.
.....	I	.....do.....	+.40	Sand filled well when tested.
67	I	..... do.....	+1.50	
.....	I	..... do.....	+1.25	
63	I	Base of pump.....	-1.00	Pit; diameter 18 ft, depth 30 ft. Old Shalem Colony well; see W.S.P. 188, p. 45.
.....	II	.....	.....	
63	I	.....	.....	Temperature 63 F. See analysis.
.....	II	.....	.....	Well sanded.
.....	I	Top of casing.....	-1.00	Reportedly poor quality.
27	II	.....do.....	+2.85	See analysis.
.....	II	.....do.....	+1.75	Two wells about 30 ft apart.
.....	I	.....do.....	+1.00	
.....	I	.....do.....	+.75	
.....	I	.....	.....	
.....	I	.....	.....	
.....	I	.....	.....	
.....	I	Top of casing.....	.00	

TX_MSJ_005613

Table 12.—*Records of large-diameter wells near or on the valley*

No.	Well location no.	Sheet	Tract	Owner or name	Driller	Date completed	Topographic situation
							Mesilla Valley, Dona Ana
60	23.1E.13.144	9A	157	Hadley Street well, Las Cruces.	Frank Dickinson.....	June 1947...	F
61	23.1E.13.244	9A	.....	A. T. & S. F. Ry., well 2.	A. A. Riggs.....	November 1925.	F
62	23.1E.21.314	10	82A	O. McElyea.....	Jack Daniel.....	November 1947.	F
63	23.1E.21.314a	10	82A	.....do.....	.....do.....	.....do.....	F
64	23.1E.26.311	10	56	Victor Ginther.....	Victor Ginther.....	1948.....	F
65	23.1E.35.231	10	64	Harry Tashiro.....	McBee.....	August 1947	F
66	23.1E.35.421	10	64	Tashiko Tashiro....	.....do.....	September... 1947.	F
67	23.1E.36.333	12	33A1	Stahman Farms Inc., well 2.	J. F. Williams.....	November 1947.	F
68	23.2E.6.323	9	.....	Las Cruces Country Club.	Andy Rominger.....	1925 (?).....	M
69	23.2E.6.332	9	.....	Mrs. Fay Sperry....	R. D. Sidey.....	March 1940..	M
70	23.2E.8.434	.....	.....	City of Las Cruces, well 5.	Frank Dickinson.....	May 1947....	M
71	23.2E.17.210	.....	.....	City of Las Cruces, well 1.	McCollough.....	1936 (?).....	M
72	23.2E.17.210a	.....	.....	City of Las Cruces, well 2.	.....	.....	M
73	23.2E.17.210b	.....	.....	City of Las Cruces, well 3.	Dickinson brothers.....	November 1938.	M

No.	Well location no.	Pump			Yield		Drawdown below static level	
		Type	Size (in.)	Kind of power	Rate (gpm)	Date of measurement	Amount	Duration of test (hr)
								Mesilla Valley, Dona Ana
60	23.1E.13.144	None	None	None	.....	.....	.....	.....
61	23.1E.13.244	C	2	E	230 R	November 1925...	9 R	.....
					64 M	Nov. 16, 1946....	3.9 M	16
62	23.1E.21.314	T	8	G	1,200 R	.....	.....	.....
63	23.1E.21.314a	T	10	G	1,500 R	.....	.....	.....
64	23.1E.26.311	.....	.....	.....	.....	.....	.....	.....
65	23.1E.35.231	T	8	G	1,100 R	.....	.....	.....
66	23.1E.35.421	T	8	G	700 R	.....	.....	.....
67	23.1E.36.333	T	10	G	1,000 R	.....	65 (?)R	5
68	23.2E.6.323	T	4	E	150 R	.....	13 R	24
69	23.2E.6.332	.....	.....	.....	45 R	March 1940.....	10 R	.....
70	23.2E.8.434	T	6	E	250 E	May 13, 1947.....	12.6 M	96
71	23.2E.17.210	T	6	E	250 M	Apr. 3, 1947.....	.....	.....
72	23.2E.17.210a	T	6	E	205 M	.....do.....	10 (?)M	.....
73	23.2E.17.210b	T	6	E	270 M	.....do.....	.....	.....

TX_MSJ_005614

floor of the Rio Grande in Rincon and Mesilla Valleys— Continued

Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed: Depth to top of bed (ft)	Principal water-bearing bed: Thickness (ft)	Principal water-bearing bed: Character of material	Depth to which well is cased (ft)	Water level: Below land surface (ft)	Water level: Date of measurement
County, N. Mex.—Continued									
3,895 T	Dr	175	14	110	55	Sand and small gravel.	170	11.34	July 31, 1947
3,895 T	Dd	82	13	.....	.....	Sand and boulders.	87	15.	November 1925
								12.25	Nov. 13, 1946
3,898 T	Dr	90	12	.....	.....	.....	.....	10.87	Dec. 5, 1947
								11.63	Feb. 11, 1948
3,898 T	Dr	90	12	.....	.....	.....	.....	10.94	Dec. 5, 1947
								10.93	Feb. 11, 1948
3,880 T	Du	.....	120	.....	.....	.....	.....	10 R	February 1948
3,878 T	Dr	80	16	.....	.....	.....	74	10.68	Dec. 4, 1947
								11.50	Feb. 10, 1948
3,878 T	Dr	80	16	.....	.....	.....	.....	12.84	Dec. 4, 1947
								13.81	Feb. 10, 1948
3,878 T	Dr	99	14	.....	.....	.....	.....	13.43	Dec. 4, 1947
								14.30	Feb. 10, 1948
3,959 A	Dd	190	8	.....	.....	.....	190	77.8	Apr. 10, 1947
3,950 T	Dr	133	8	.....	.....	.....	133	65	March 1940
4,057 L	Dr	300	13	200	55	Sand and gravel.	285	185.09	Apr. 15, 1947
								189.28	Oct. 8, 1947
								186.71	Dec. 3, 1947
4,042 A	Dr	294	10	.....	.....	.....	294	170.±	1936 (?)
4,050 A	Dr	296	10	.....	.....	.....	296	192.12	May 14, 1947
4,048 A	Dr	301	10	.....	.....	Sand and gravel.	292	160.±	November 1938

Specific capacity (gpm/ft)	Use of water	Measuring point: Description	Measuring point: Height above (+) or below (-) land-surface datum (ft)	Remarks
County, N. Mex.—Continued				
.....	M	Top of casing.....	+0.50	
26	RR	Top of valve.....	-11.51	Original depth 251 ft, backfilled to 82 ft for best water.
16				
.....	I	Top of casing.....	.00	
.....	I	.....do.....	+.50	200± ft east of well 23.1E.21.314.
.....	II	.....	.....	
.....	I	Top of casing.....	+.50	Reportedly poor quality.
.....	I	.....do.....	+.25	Filled with sand to 70 (-) ft.
15	I	.....do.....	+1.00	
12	I	Top of 8 by 8 pump supports...	+.70	See analysis.
45	DI	.....	.....	Irrigates yard.
20	M	Top of casing.....	+.50	See analysis.
.....	M	.....	.....	
20	M	Top of concrete floor.	.00	See analysis.
.....	M	.....	.....	

TX_MSJ_005615

Table 12.—*Records of large-diameter wells near or on the valley*

No.	Well location no.	Sheet	Tract	Owner or name	Driller	Date completed	Topographic situation
							Mesilla Valley, Dona Ana
74	23.2E.17.210c	.....	.....	City of Las Cruces, well 4.	Dickinson brothers..	1940 (?).....	M
75	23.2E.17.210d	.....	.....	City of Las Cruces, well 6.	Frank Dickinson.....	November... 1947.	M
76	23.2E.20.412	11	.....	B. B. Evans.....	Dutch Chandler.....	1937.....	S
77	23.2E.28.113	11	.....	NMAC, domestic... well 1.	.....	1906.....	S
78	23.2E.29.143	11	59	NMAC, Irrig. Eng.. well 3.	R. D. Sidey.....	June 1935....	F
79	23.2E.29.243	11	.....	NMAC, domestic... well 2	.....	1932 (?).....	S
80	23.2E.29.243a	11	.....	NMAC, domestic... well 3.	Dickinsqn brothers..	1938.....	S
81	23.2E.29.243b	11	.....	NMAC.....	.....do.....	November... 1946.	S
82	23.2E.29.243c	11	.....	NMAC, domestic... well 4.	..... do.....	February..... 1947.	S

No.	Well location no.	Pump			Yield		Drawdown below static level	
		Type	Size (in.)	Kind of power	Rate (gpm)	Date of measurement	Amount	Duration of test (hr)
							Mesilla Valley, Dona Ana	
74	23.2E.17.210c	T	6	E	310 M	Apr. 3, 1947.....	.....	.....
75	23.2E.17.210d	T	6	E	290 M	Feb. 12, 1948....	.....	.....
76	23.2E.20.412	C	6	E	200 R	1937.....	..... 3 R	.....
77	23.2E.28.113	Pl	.....	E	100 R	1946.....	16 R	.....
78	23.2E.29.143	T	8	E	1,270 M	Nov. 18, 1946...	13 M	24
79	23.2E.29.243	Pl	.....	E	100 R	1946.....	.....	.....
80	23.2E.29.243a	Pl	.....	E	100 R	.....do.....	.....	.....
81	23.2E.29.243b	None	None	None	.....	.....	.....	.....
82	23.2E.29.243c	None	None	None	.....	.....	.....	.....

TX_MSJ_005616

floor of the Rio Grande in Rincon and Mesilla Valleys—Continued

Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed: Depth to top of bed (ft)	Principal water-bearing bed: Thickness (ft)	Principal water-bearing bed: Character of material	Depth to which well is cased (ft)	Water level: Below land surface (ft)	Water level: Date of measurement
County, N. Mex.—Continued									
4,048 A	Dr	298	10	.....	.....	.....	298	.....	.....
.....	Dr	300±(?)	12	.....	.....	.....	.....	184.54	Dec. 3, 1947
								184.91	Feb. 12, 1948
								184.90	Mar. 25, 1948
3,935 A	Dd	70	12	50	20	Gravel.....	70	56	April 1947
3,942 T	Dd	110	12	.....	.....	.....	110	75	1946
3,883 L	Dr	50	16	.....	.....	Sand and gravel.....	50	12.82	Nov. 14, 1946
3,899 T	Dd	228	4	.....	.....	.....	228	28	1932
3,906 T	Dd	428	8	.....	.....	.....	.....	35	1938
3,903 L	Dr	83	18	55	20	Sand and large gravel...	81	34.00	Dec. 14, 1946
3,898 L	Dr	305	14	.....	.....	.....	286	30.35	Feb. 15, 1947

Specific capacity (gpm/ft)	Use of water	Measuring point: Description	Measuring point: Height above (+) or below (-) land-surface datum (ft)	Remarks
County, N. Mex.—Continued				
.....	M	.....	.....	
.....	M	Edge of 3-in. sloping pipe in concrete base.	+.82	
67	I	.....	.....	Dug to 50 ft to water level, 1937.
6	D	.....	.....	Dug to 70 ft to water in 1906, 326 gpm, drawdown 21 ft, 1906. Swimming pool and emergency use.
98	I	Top of rib inside pump shell.	+1.50	Yield, 1,625 gpm; drawdown, 18.5 ft when drilled.
.....	D	.....	.....	Pit, depth 28 ft.
.....	D	.....	.....	Pit, depth 35 ft.
.....	II	Top of casing.....	+.80	
.....	D	.....do.....	+.50	Intended for domestic.

TX_MSJ_005617

Table 12.—*Records of large-diameter wells near or on the valley*

No.	Well location no.	Sheet	Tract	Owner or name	Driller	Date completed	Topographic situation
							Mesilla Valley, Dona Ana
83	23.2E.30.412b	11	74	NMAC, Horticultural well 3.	R. D. Sidey	May 1935	F
84	23.2E.30.412c	11	74	NMAC, Horticultural well 4.	Layne Texas	November 1947.	F
85	23.2E.31.213	11	129	NMAC, Agronomy well 1.	do	do	F
86	24.1E.1.111	12	33A1	Stahmann Farms, Inc., well 1.	J. F. Williams	August 1947.	F
87	24.1E.1.144	12	33A2	Stahmann Farms, Inc., well 3.	do	December 1947.	F
88	24.2E.5.234	13	18C	L. Beyers		January 1948.	F
89	24.2E.5.422	13	18A	E. L. Terry	Jack Daniels	October 1947.	F
90	24.2E.15.231	15	14	Dave Vickers	Morrison Bros.	February 1948.	F
91	24.2E.22.444	15	63A	W. E. Evans		November (?) 1947.	F
92	24.3E.31.430	17		Paul Price		October 1946.	S
93	25.2E.2.221	17	72A1B	W. H. Walters	Joe Clary	November 1947.	F

No.	Well location no.	Pump			Yield		Drawdown below static level	
		Type	Size (in.)	Kind of power	Rate (gpm)	Date of measurement	Amount	Duration of test (hr)
								Mesilla Valley, Dona Ana
83	23.2E.30.412b	None	None	None	250 E	November 1946.		
84	23.2E.30.412c	T	8	E	695 R	November 1947.	21 R	
85	23.2E.31.213	T	8		1,100 R	do	40 R	
86	24.1E.1.111	T	8		1,200 R	1947	60 R	
87	24.1E.1.144	None	None	None				
88	24.2E.5.234	T	8	T				
89	24.2E.5.422	T	8	T	800 R			
90	24.2E.15.231							
91	24.2E.22.444	T	4					
92	24.3E.31.430	None	None	None	350 R	1946	19	
93	25.2E.2.221	T	6	T	600 R			

TX_MSJ_005618

floor of the Rio Grande in Rincon and Mesilla Valleys—Continued

Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed			Depth to which well is cased (ft)	Water level	
				Depth to top of bed (ft)	Thickness (ft)	Character of material		Below land surface (ft)	Date of measurement
County, N. Mex.—Continued									
3,885 T	Dd	71	12	.....	.....	Sand and gravel.	71	16.97	Dec. 3, 1947
								17.63	Feb. 12, 1948
3,885 T	Dr	95	14	26	60	do	92	16.89	Dec. 3, 1947
								17.53	Feb. 10, 1948
3,880 T	Dr	70	14	.....	.....	do	.....	13.16	Dec. 3, 1947
								14.13	Feb. 10, 1948
3,875 T	Dr	331	15	44	104	do	306	9.65	July 31, 1947
								14.02	Dec. 4, 1947
								14.93	Feb. 12, 1948
3,875 T	Dr	100	16	.....	.....	do	.....	12.48	Do.
3,870 T	Dr	60	12	.....	.....	.....	.....	.....	.....
3,870 T	Dr	80	12	.....	.....	Sand and gravel.	.....	10.92	Dec. 5, 1947
								11.57	Feb. 13, 1948
3,855 T	Dr	.....	16	.....	.....	.....	.....	.....	.....
3,853 T	Dr	80	10	.....	.....	.....	.....	13.16	Dec. 5, 1947
								13.97	Feb. 11, 1948
3,860 T	Dr	90	12	.....	.....	.....	90	41.78	Dec. 4, 1947
								42.97	Feb. 11, 1948
3,840 T	Dr	96	12	50	.....	Sand and gravel.	.....	11	December 1947

Specific capacity (gpm/ft)	Use of water	Measuring point		Remarks
		Description	Height above (+) or below (-) land-surface datum (ft)	
County, N. Mex.—Continued				
.....	A	Top of collar on casing.	-1.50	Reported 1,100 gpm in 1935; well now sanded.
33	I	Top of casing	+.50	About 120 ft northwest of well 3.
28	I	do	+1.75	
20	I	do	+.87	
.....	II	do	+.50	
.....	I	.....	.....	
.....	I	Top of casing	+.75	
.....	II	.....	.....	Being drilled Feb. 13, 1948, depth, 48 ft.
.....	II	Top of casing	+1.75	
18	II	do	+.50	
.....	I	.....	.....	

TX_MSJ_005619

Table 12.— *Records of large-diameter wells near or on the valley*

No.	Well location no.	Sheet	Tract	Owner or name	Driller	Date completed	Topographic situation
						Mesilla Valley, Dona Ana	
94	25.2E.4.422	18	6A	S. Y. Wilson	Schumaker	November 1947.	F
95	25.2E.24.413	20	39	W. H. Randle	do	October 1947.	F
96	25.3E.8.132	19	.....	Mrs. Fuller	.....	January.(?) 1948.	S
97	25.3E.19.331	21	83	W. E. Esslinger	McBee	November 1947.	F
98	26.3E.19.311	26	5	Leslie Hayes	Morrison Bros.	February 1948.	S
99	26.3E.19.432	26	12	Judo Yabumoto	Schumaker	October 1947.	F
100	26.3E.30.114	26	16	O. E. Egbert	Morrison Bros.	February 1948.	S
101	26.3E.31.123	26	57	Jack Cox	do	do	S
102	27.3E.5.414	28	13A1	L. G. Little	Jack Daniels	March 1948	F
103	27.3E.6.213	28	5	Chester Little	do	February 1948.	F
104	27.3E.15.143	30	7	Paul Price	Morrison Bros.	January 1948.	F
						Mesilla Valley, El	
105	28.3E.12.311	32	12-7	O. C. Coles	Payne	January 1948.	F
106	28.3E.25.424	33	4-2	J. H. Lundgren	.....	1947	F
107	28.3E.25.442	33	4-21A	J. M. Taylor	.....	do	F
108	28.3E.26.232	33	5-21	Erick Brandis	.....	do	F

No.	Well location no.	Pump			Yield		Drawdown below static level	
		Type	Size (in.)	Kind of power	Rate (gpm)	Date of measurement	Amount	Duration of test (hr)
							Mesilla Valley, Dona Ana	
94	25.2E.4.422	T	10	G	1,100 M	Dec. 4, 1947	42 M	4
95	25.2E.24.413	T	6	T	600 R	1947	35 R	.....
96	25.3E.8.132	T	8	G	.....	.....	.....	.....
97	25.3E.19.331	T	8	T	1,100 R	1948	33 R	.....
98	26.3E.19.311	T	8	G	600 R	do	11 R	.....
99	26.3E.19.432	T	8	T	900 R	1947	60 (?)R	.....
100	26.3E.30.114	None	None	None	800 R	1948	47 R	.....
101	26.3E.31.123	None	None	None	.....	.....	.....	.....
102	27.3E.5.414	T	10	G	1,500 M	Mar. 25, 1948	35	48
103	27.3E.6.213	T	8	G	1,100 E	do	34	4
104	27.3E.15.143	None	None	None	800 R	1948	40 R	.....
							Mesilla Valley, El	
105	28.3E.12.311	T	8	T	.....	.....	.....	.....
106	28.3E.25.424	T	4	G	.....	.....	.....	.....
107	28.3E.25.442	C	1½	E	.....	.....	.....	.....
108	28.3E.26.232	None	None	None	.....	.....	.....	.....

TX_MSJ_005620

floor of the Rio Grande in Rincon and Mesilla Valleys—Continued

Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed: Depth to top of bed (ft)	Principal water-bearing bed: Thickness (ft)	Principal water-bearing bed: Character of material	Depth to which well is cased (ft)	Water level: Below land surface (ft)	Water level: Date of measurement
County, N. Mex.—Continued									
3,840 T	Dr	95	20	50	.....	Sand and gravel.	.....	15.58	Dec. 4, 1947
3,823 T	Dr	130	12	.....	.....	.....	.....	8.57	Do.
								9.20	Feb. 11, 1948
3,845 T	Dr	.....	18	.....	.....	.....	.....	18.04	Do.
3,824 T	Dr	90	16	58	.....	Sand and gravel.	.....	9.36	Dec. 4, 1947
								9.90	Feb. 11, 1948
3,810 T	Dr	132	14	.....	.....	.....	.....	23.63	Do.
3,800 T	Dr	131	16	59	27	Gravel.....	90	10.17	Dec. 4, 1947
3,800 T	Dr	107	14	53	.....	Sand and gravel.	107	8.30	Feb. 11, 1948
3,800 T	Dr	90	16	52	20	.....do.....	.....	10	February 1948
.....	Dr	82	14	40	42	Gravel.....	82	13	March 1948
3,785 T	Dr	126	14	55	30	.....do.....	85	17	Do.
3,780 T	Dr	91	16	42	38	Sand and gravel.	.....	8.42	Feb. 11, 1948
Paso County, Tex.									
3,755 T	Dr	.....	.....	.....	.....	.....	.....	7.04	Feb. 11, 1948
.....	Dr	.....	.....	.....	.....	.....	.....	.....	.....
.....	Dr	60	8	.....	.....	.....	.....	.....	.....
.....	Dr	64	8	.....	.....	Fine sand.....	.....	.....	.....

Specific capacity (gpm/ft)	Use of water	Measuring point: Description	Measuring point: Height above (+) or below (-) land-surface datum (ft)	Remarks
County, N. Mex.—Continued				
26	I	Base of pump.....	+1.00	Reported well improved to 1,500 gpm; drawdown, 22 ft, February 1948.
17	I	Top of casing.....	.00	
.....	I	.....do.....	+.50	
33	I	.....do.....	.00	
55	I	.....do.....	+2.00	Temperature 70.5 F. See analysis.
15	I	.....do.....	+.50	Well sanded in (?), measured 250 gpm; drawdown, 22 ft, February 1948.
17	II	.....do.....	+3.00	
.....	II	.....	.....	Being completed Feb. 13, 1948.
43	I	.....	.....	
32	I	.....	.....	
20	II	Top of casing.....	+2.00	
Paso County, Tex.				
.....	I	Top of casing.....	+1.50	A river pump located west of this well.
.....	I	.....	.....	Upper Valley Nursery.
.....	ID	.....	.....	
.....	II	.....	.....	

TX_MSJ_005621

Table 13.— *Records of wells principally above the valley*

Altitude: A, determined by aneroid barometer; T, determined from U. S. Geological Survey topographic quadrangle maps.
Type of well: Dd dug and drilled; Dr, drilled; Du, dug; J, jetted.
Depth of well: M, measured; otherwise reported.
Water level: Reported figures given to nearest foot.

No.	Well: Location no.	Well: Field name	Owner or name	Driller	Date completed
					Sierra County,
1	19.5.1	Mexican Querva	Homer Jones		1925
2	19.5.16.100	Twin Mills West	do		1900
3	19.5.28.300	Iron Mill	do	Andy Romenger	1917 (?)
					Dona Ana
4	18.1E.27.430	Red Lake	Jornada Experimental Range.		
5	18.4.5.211		C. W. Kight		1946 (?)
6	18.4.8.410	Brewster	Brewster	Elliott	1916
7	18.4.9.130	Hedgecock	R. F. Hedgecock	Schoptaugh	1945
8	18.4.34.211	Simms	Simms	Boggs	1940 (?)
9	18.4.35.221	Boggs	Boggs	do	1940
10	19.1E.1.221	Middle well	Jornada Experimental Range.	Turney	
11	19.2E.33.120	Headquarters West	do		
12	19.2E.33.120a		do		
13	19.2E.33.210	Headquarters East	do		1937
14	19.4E.31.420	Little well	do		
15	19.4.29.130	East well	Homer Jones	Andy Romenger	1917
16	19.4.30.240	Hackett Place	do	Boyd Lusk	1936
17	20.1E.4.120	West well	Jornada Experimental Range.		1906
18	20.1E.8.330	A. & M. Camp	New Mexico Coll. of Agr. and Mech. Arts.	Dutch Chandler Jim Sewell	1930

No.	Location no.	Depth to which well is cased (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Type of pump	Kind of power
						Sierra County,
1	19.5.1.		28.05	June 25, 1947	Pl	W
2	19.5.16.100		99.80	do	Pl	W
3	19.5.28.300		118.20	do	Pl	W
						Dona Ana
4	18.1E.27.430		195	April 1947	Pl	W
5	18.4.5.211		3 to 4	1946	C	E
6	18.4.8.410				None	
7	18.4.9.130	100	4.72	July 15, 1947	None	
8	18.4.34.211				None	
9	18.4.35.221	112	8	1940	Pl	E
10	19.1E.1.221	350	236.05	Apr. 17, 1947	Pl	W
11	19.2E.33.120				Pl	W
12	19.2E.33.120a				Pl	G
13	19.2E.33.210	355	239.50	Mar. 26, 1948	Pl	W
14	19.4E.31.420		100		Pl	W
15	19.4.29.130	30	160	1947	Pl	W
16	19.4.30.240				Pl	W
17	20.1E.4.120	300	290 to 300	1947	Pl	W
18	20.1E.8.330	356	290	do	Pl	W

TX_MSJ_005622

floor of the Rio Grande in Sierra and Dona Ana Counties, N. Mex.

Type of pump: AL, air lift; C, centrifugal; Pl, plunger; T, turbine.
Kind of power: B, butane engine; E, electric motor; G, gasoline motor; T, tractor engine; W, wind.
Use of water: A, abandoned; D, domestic; I, irrigation; RR, railroad; S, stock.

Topographic situation	Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed		
					Depth to top of bed (ft)	Thickness (ft)	Character of material
N. Mex.							
In arroyo bed	4,225 A	Du	40	60			Sand and gravel.
do	4,490 A	Du	118 M	50			Cemented conglomerate.
On mesa	4,500 A	Dr	138 M	6			Gravels.
County, N. Mex.							
do	4,355 A	Dr	350	6			Quicksand.
Valley floor	4,066 T	J	82	2½			
do	4,058 T	Dr	200 (?)	6			
do	4,059 T	J	100	2½			Sand and gravel.
do	4,036 T	J	245	2½			
do	4,036 T	J	214	3			
On mesa	4,350 A	Dr	350	6			Quicksand.
do	4,355 A	Dr					
do	4,350 A	Dr		6			
do	4,340 A	Dr	360	6	310	50	Quicksand and sandstone.
In canyon	5,235 A	Dr	103	6			
On mesa	4,440 A	Dr	180	6			
		Dr	160	12			
	4,360 A	Dr	390	6			
	4,395 A	Dr	373	6	295	78	Quicksand.

Use of water	Quality	Measuring point: Description	Measuring point: Height above (+) or below (-) land-surface datum (ft)	Remarks
N. Mex.—Continued				
S	Good	Top of tin well cover	+0.30	
S	do	Top of wooden well cover	+.50	Reportedly weak.
S	do	Top of casing	+1.00	
County, N. Mex.				
S	Fair			
D	do			Reportedly good quality for area.
A	Bad			
A	Poor	Top of casing	+5.80	Too hard for domestic use.
A	do			Clay from 70 to 110± ft and 112± to 245 ft. Rock 110± to 112± ft.
D	Good			
S	Fair	Top of casing	+1.43	
D, S				
D				
D, S	Good	Top of steel pipe clamps	+.50	
D, S				Abandoned Civilian Conservation Corps camp.
S	Good			Reported 18 gpm.
S	do			Well not visited. Reported 6 gpm.
S	Poor			Temperature 75 F.
S				

TX_MSJ_005623

Table 13.—*Records of wells principally above the valley floor of*

No.	Well: Location no.	Well: Field name	Owner or name	Driller	Date completed
					Dona Ana County,
19	20.1E.14.140	Co-op	Jornada Experimental Range.	Jim Sewell	February. 1936.
20	20.1E.35.220	Headquarters	New Mexico Coll. of Agr. and Mech. Arts.	do	1905 (?)
21	20.2E.28.330	South well	Jornada Experimental Range.		
22	20.3E.18.210	Taylor well	do		
23	20.3E.36.330	T. Gardner spring	W. F. Isaacs		
24	20.1.10.	Oakes	New Mexico Coll. of Agr. and Mech. Arts.		January. 1936.
25	20.1.11.310	Mayfield	do		
26	20.1.26.210	Selden	do		1900 (?)
27	20.1.30.330	Buckle Bar	do		1935
28	20.1.31.320		Beal	Schoptaugh	1942
29	20.1.31.320a		do	do	1945
30	20.2.13.330		C. H. Ward		1938
31	20.2.24.110		C. C. Rice	Smith	March. 1947.
32	20.2.25.230		Ernest Ward	Schoptaugh	1937
33	20.2.25.230a		do		1931
34	20.2.34.		Beal	Schoptaugh	1943
35	20.4.6.210	Hackett	Homer Jones	Lusk	1935
36	20.5.8.220	Headquarters	do		
37	21.1E.15.230	Wagner	New Mexico Coll. of Agr. and Mech. Arts.		
38	21.1E.22.240	Cleofos	do		1900 (?)

No.	Location no.	Depth to which well is cased (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Type of pump	Kind of power
						Dona Ana County,
19	20.1E.14.140	356	325 319.74	February 1936 Mar. 26, 1948	Pl	W
20	20.1E.35.220	356	290	1947	Pl	W, G
21	20.2E.28.330	365 (?)	230	do	Pl	W
22	20.3E.18.210	400	360.00	Mar. 18, 1947	None	
23	20.3E.36.330		Flowing	Mar. 4, 1947		
24	20.1.10.	316				
25	20.1.11.310	366	355	1947	Pl	W
26	20.1.26.210	267 (?)	267	do	Pl	W
27	20.1.30.330	18	13	do	Pl	W
28	20.1.31.320	45	20	do	Pl	W
29	20.1.31.320a		14	do	Pl	W
30	20.2.13.330	26	24	do	Pl	W
31	20.2.24.110		17	do	Pl	Hand
32	20.2.25.230	70	38	do	Pl	W
33	20.2.25.230a	21	16	do	Pl	W
34	20.2.34.		20 to 25		Pl	W
35	20.4.6.210	7	120	1947	Pl	W
36	20.5.8.220	0	53.95	June 24, 1947	Pl	W, G
37	21.1E.15.230	0	4	1947	Pl	W
38	21.1E.22.240	0	6		Pl	W

TX_MSJ_005624

the Rio Grande in Sierra and Dona Ana Counties, N. Mex. — Continued

Topographic situation	Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed: Depth to top of bed (ft)	Principal water-bearing bed: Thickness (ft)	Principal water-bearing bed: Character of material
N. Mex. —Continued							
.....	4,415 A	Dr	356	6	348	8	Sandstone.
.....	4,390 A	Dr	373	6	295	78	Quicksand.
.....	4,325 A	Dr	365	6	.....	.....	Do.
.....	4,455 A	Dr	499	6	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	Dr	320	6	312	8	Quicksand.
.....	4,380 A	Dr	369	6	355	.....	Do.
.....	4,335 A	Dr	284	6	267	17+	Do.
.....	.....	Dd	18	4	.....	.....	Gravel.
.....	4,010 A	Dr	93	6	45	.....	Sand and gravel.
.....	4,006 A	J	59	6	59	.....	Do.
.....	.....	Du	26	6	0	26	Do.
.....	.....	J	119	3	97+	.....	Sand.
Floor of arroyo.....	4,023 A	Dr	70	6	68	2	Gravel.
Valley floor.....	4,010 A	Du	21	8	.....	.....	Sand and gravel.
In Broad Canyon.....	.....	Dr	124	6	.....	.....	Do.
.....	4,475 A	Dr	160	6	.....	.....	Gravels.
.....	4,440 A	Du	60	.....	0	60	Do.
Floor of arroyo.....	4,525 T	Du	16	60 (?)	0	16	Do.
.....do.....	4,520 T	Du	20	60 (?)	0	15	Do.

Use of water	Quality	Measuring point: Description	Measuring point: Height above (+) or below (-) land-surface datum (ft)	Remarks
N. Mex. —Continued				
S	Good	Top of casing.....	+0.90	
D, S	.....do....	.....	.....	Reported 9 gpm.
S	Poor	.....	.....	
A	.....	Top of casing.....	+1.00	
S	Fair	.....	.....	Spring; flow estimated 5 gpm; has sulphur taste. Temperature 58 F.
.....	.....	.....	.....	Well not located.
S	.....	.....	.....	
S	.....	.....	.....	See analysis.
S	.....	.....	.....	
D, S	Hard	.....	.....	Water salty at 93 ft.
D, S	.....	.....	.....	Water hit at 59 ft below clay.
D, S	Salty	.....	.....	
D, S	Good	.....	.....	Salt water at 97 ft.
S	Salty	.....	.....	Reported good yield.
D, S	Hard	.....	.....	
S	Good	.....	.....	
S	.....do....	.....	.....	
D, S	.....do....	Top of pipe clamps.....	+1.45	Temperature 67 F. Luna County.
S	.....	.....	.....	Dry in summer, weak.
S	.....	.....	.....	Reported 14-ft drawdown. Winter springs cased in for supply.

TX_MSJ_005625

Table 13.—*Records of wells principally above the valley floor of*

No.	Well: Location no.	Well: Field name	Owner or name	Driller	Date completed
					Dona Ana County,
39	21.2E.12.222	Parker	Edwin Parker	J. F. Williams	April 1947.
40	21.2E.15.244	Stuart	Jornada Range Reserve		
41	21.2E.25.430	East Headquarters	W. F. Isaacs		June 1907.
42	21.2E.25.430a	West Headquarters	do		1899
43	21.3E.25.430	Home	Ollie Isaacs		1900
44	21.4E.30.230	Merrimac mine spring.	do (?)	American Smelting & Refining Co.	
45	21.1.9.230		O. F. Smith		
46	21.2.31.440	Adobe	H. S. Bissell		
47	22.1E.28.140		T. L. Simpson	Jeff Chandler	
48	22.1E.26.310		do		
49	22.1E.28.320		do		
50	22.2E.13.411		J. W. Daugherty	Boone	March 1948.
51	22.2E.31.340		W. F. Isaacs	Dutch Chandler	1920
52	22.3E.2.240		Henry Olson		
53	22.3E.2.410		S. A. Walter	Dickinson brothers	1931
54	22.3E.2.420		Bert Holmes		1946
55	22.3E.11.320		E. J. Isaacs	Ed Boone	1939
56	22.3E.23.320	West well	do		1922
57	22.3E.23.320a	East well	do	Ed Boone	1939
58	22.3E.26.420	Mine house spring.	do		

No.	Location no.	Depth to which well is cased (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Type of pump	Kind of power
					Dona Ana County,	
39	21.2E.12.222	420 (?)	294	July 1947	Pl	G
40	21.2E.15.244					
41	21.2E.25.430		300	1947	Pl	W
42	21.2E.25.430a		290.50	Feb. 26, 1947	Pl	W
43	21.3E.25.430	75	75	1947	Pl	W
44	21.4E.30.230		Flowing	Mar. 5, 1947		
45	21.1.9.230		30.07	May 26, 1947	Pl	W
46	21.2.31.440		90		Pl	W
47	22.1E.28.140	242	5		C	E
48	22.1E.28.310	42	5		C	E
49	22.1E.28.320	162	5		C	E
50	22.2E.13.411	430	375.04	Mar. 26, 1948	None	
51	22.2E.31.340		164.00	Mar. 18, 1947	Pl	W
52	22.3E.2.240	10± (?)	187	1947.	Pl	W
53	22.3E.2.410	150	140	do	Pl	W
54	22.3E.2.420	50	115.30	Mar. 5, 1947	Pl	W
55	22.3E.11.320	40	135	1947	Pl	W
56	22.3E.23.320	122	135	do	Pl	W
57	22.3E.23.320a	40	135	do	Pl	W
58	22.3E.26.420		Flowing	Mar. 12, 1947		

TX_MSJ_005626

the Rio Grande in Sierra and Dona Ana Counties, N. Mex. — Continued

Topographic situation	Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed: Depth to top of bed (ft)	Principal water-bearing bed: Thickness (ft)	Principal water-bearing bed: Character of material
N. Mex. —Continued							
.....	4,370 T	Dr	631	6	335	165	Sandstone (?).
.....	4,290 T	Dr	250	4 ½	.....	.....	.....
On mesa.....	4,360 T	Dr	342	6	320	5	Gravel.
.....do.....	4,360 T	Dr	325	4	320	5	Do.
.....	5,190 T	Dr	75	6	.....	.....	.....
Slope of San Andres..	5,500 T	Dr	125 (?)	.....	.....	.....	.....
In canyon.....	.....	Dr	.....	6	.....	.....	.....
In Rolling Hills	4,710 T	Dr	180	6	.....	.....	.....
Valley floor	.....	J	242	2 ½	.....	.....	Sand and gravel.
.....do.....	.....	Dr	42	4	5	37	Do.
.....do.....	.....	J	162	2 ½	150	.....	Do.
On mesa.....	4,450	Dr	430	6	386	.....	Do.
Between arroyos.....	4,060 A	Dr	175	6	165	10	Gravel.
In San Augustine Pass, Organ Mountains.	5,110 T	Dr	198	6	187	.....	Limestone and shale (?).
.....do.....	5,030 T	Dd	155	6	.....	.....	Limestone (?).
.....do.....	5,090 T	Dr	200	6	.....	.....	Limestone and shale (?).
At foot of Organ Mountains.	4,890 T	Dr	204	6	.....	.....	Do.
.....do.....	4,935 T	Dd	212	6	.....	.....	Do.
.....do.....	4,935 T	Dr	204	6	.....	.....	Do.
In canyon.....	5,360 T	.....	.....	.....	.....	.....	.....

Use of water	Quality	Measuring point: Description	Measuring point: Height above (+) or below (-) land-surface datum (ft)	Remarks
N. Mex. —Continued				
II	.....	.....	.....	Reported 40 gpm.
A	.....	.....	.....	Plugged.
D, S	Good	.....	.....	Reported 30 gpm.
D, S	.....do.....	Top of 4 by 4 pipe clamps.	+1.5	Reported by Lee, W. T., Water-Supply Paper 188. Pumps dry.
D, S	Hard	.....	.....	Well bottoms in old mine tunnel.
S	.....do.....	.....	.....	Core test. Other core tests in immediate vicinity. Small flow.
D, S	.....	Top of casing.....	+1.20	
D, S	Good	.....	.....	
D, S	.....do.....	.....	.....	Reported 15 gpm. See analyses.
D, S	Poor	.....	.....	Reported 15 gpm. See analysis.
D, S	Good	.....	.....	See analysis.
.....	.....do.....	Top of collar on casing	+1.50	Temperature 76.5 F. See analysis.
S	Fair	Top of pipe column.....	+4.30	
D	Mineral taste.	.....	.....	
D, S	Hard	.....	.....	
D, S	.....do.....	Top of casing.....	+1.30	
S	.....do.....	.....	.....	
D, S	.....do.....	.....	.....	Dug 112 ft, reported 12 gpm.
D, S	.... do.....	.....	.....	
S	.....do.....	.....	.....	Spring, flow 2 to 3 gpm estimated; does not go dry.

TX_MSJ_005627

Table 13.— *Records of wells principally above the valley floor of*

No.	Well: Location no.	Well: Field name	Owner or name	Driller	Date completed
					Dona Ana County,
59	22.1.19.330	Hawkins	H. S. Bissell		
60	22.2.21.330	Big Gap	do		
61	22.3.16.340	Little Mills North	do		
62	22.3.16.340a	Little Mills South	do		
63	22.4.10.230	Monterey well	Weldon Burris	E. H. Boone	
64	22.4.19.340		do	Herman MacElhaney.	1929
65	23.1E.30.210		Norwood		
66	23.2E.6.332a		Fay Sperry	Dickinson brothers.	
67	23.2E.7.320		Will Washington		1947
68	23.2E.29.332		Las Cruces Ice Co.	Lee Burdick	
69	23.2E.30.441		Ray Langford	Jeff Chandler	1945
70	23.2E.30.443		Milos Rath	do	
71	23.3E.1.340	Hayner resort	F. M. Hayner		
72	23.3E.12.230		R. E. Boyd		1938
73	23.3E.13.330		E. J. Isaacs		
74	23.3E.21.310		do		1907
75	23.1.15.211		Picacho Oil & Gas Syn.		1941

No.	Location no.	Depth to which well is cased (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Type of pump	Kind of power
						Dona Ana County,
59	22.1.19.330		151.00	Feb. 4, 1947	Pl	W
60	22.2.21.330	277	235.60	do	Pl	W
61	22.3.16.340	75	12.00	Feb. 5, 1947	Pl	W
62	22.3.16.340a	75				
63	22.4.10.230	383	310	1942 (?)	Pl	W
64	22.4.19.340	224	211	do	Pl	W,G
65	23.1E.30.210		297.65	Feb. 6, 1947	Pl	W,E
66	23.2E.6.332a		65		Pl	W
67	23.2E.7.320	67	57.60	Apr. 10, 1947	Pl	W
68	23.2E.29.332	224	16		C	E
69	23.2E.30.441	268	11		C	E
70	23.2E.30.443	157	17		C	E
71	23.3E.1.340		0.30	Mar. 13, 1947	Pl	G
72	23.3E.12.230		69	1947	Pl	W
73	23.3E.13.330		65	do	Pl	W
74	23.3E.21.310	100 (?)	200		Pl	W
75	23.1.15.211		550		None	

TX_MSJ_005628

the Rio Grande in Sierra and Dona Ana Counties, N. Mex. — Continued

Topographic situation	Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed		
					Depth to top of bed (ft)	Thickness (ft)	Character of material
N. Mex. —Continued							
Flat plain	4,460 T	Dr	180	8			
Gap in range of hills	4,610 T	Dr	280	6			Sand and gravel.
	4,610 T	Dr		6			Alluvial fill.
W. side of draw	4,610 T	Dr	75	6			Do.
Magdalena Draw	4,815 T	Dr	383	4½			Do.
In draw		Dr	224	5½	220		
Bluff above valley floor	4,180 T	Dr	330	6			
do	3,950 T	Dr	130		130	5	Sand.
Slope off Rio Grande valley	3,940 T	Dd	67	5			Gravel and sand.
Valley floor		Dr	224	4½			
do		J	268	3			Sand and gravel.
		J	157	2½	148	9	
In Ice Canyon	5,650 T	Du	9				Arroyo gravel.
do	5,780 T	Du					
	5,600 T	Dr	70-75				Arroyo gravel.
	4,590 T	Dr	220	6			
On mesa	4,480 T	Dr	3,196	8			

Use of water	Quality	Measuring point		Remarks
		Description	Height above (+) or below (-) land-surface datum (ft)	
N. Mex. —Continued				
S		Top of casing	+0.50	Reported 6 to 8 gpm.
S		do	+1.80	Reported 6 gpm.
S		do	+.70	
S				
S	Good			Reported 4 to 5 gpm.
D, S	Fair			Water warm, slight mineral taste.
D		Top of casing	+.70	
D	Good			Reported total dissolved solids, upper water 2,130 ppm, lower water 720 ppm.
D	do	Top of casing	+1.95	
Ice	do			Reported 10 gpm, 12-ft drawdown. See analysis.
D	do			Reported 6 gpm. Reported total dissolved solids 300 ppm; hardness 150.
D	do			
D, S		Top of well curb	+3.2	Reported 12 gpm. Well about 100 ft behind dam across arroyo.
S				
S	Good			Reported 10 gpm; pumps dry in 2 hours.
S	do			Reported 3 gpm.
A	Poor			Oil test. Total dissolved solids, reported 5,430 ppm.

TX_MSJ_005629

Table 13.—*Records of wells principally above the valley floor of*

No.	Well: Location no.	Well: Field name	Owner or name	Driller	Date completed
					Dona Ana County,
76	23.1.32.330	Dickinson	H. S. Bissell	Dickinson brothers	1935
77	23.2.13.310	Headquarters East	do	Payne	
78	23.2.13.310a	Headquarters West	do	do (?)	
79	23.2.23.330	Horse Trap	do		
80	23.2.27.330	Little Gap East	do		
81	23.2.27.330a	Little Gap West	do		
82	23.3.4.140	Kerr	do	Payne	1947
83	23.3.9.330	Le Febre	do		
84	23.3.20.420	Temple East	do		
85	23.3.20.420a	Temple West	do		
86	23.4.18.111		L. F. Burris		
87	23.4.18.310		do		
88	23.4.26.440	Mimms	do		1916
89	23.4.32.144		State of New Mexico	Al Kimball	1936
90	24.3E.31.230	Mossman ranch	Paul Price		1900 (?)
91	24.1.22.120		Norwood		
92	24.3.4.420	Brass	H. S. Bissell	Payne	
93	24.3.5.330	Highway	do		
94	24.3.6.320		Andy Coldiron	Bob Payne	1941
95	24.3.6.430		F. C. Leach		1926

No.	Location no.	Depth to which well is cased (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Type of pump	Kind of power
					Dona Ana County	
76	23.1.32.330	165	350		Pl	W
77	23.2.13.310		130 (?)		Pl	W
78	23.2.13.310a	180	117.70	Feb. 4, 1947	Pl	W,G
79	23.2.23.330				Pl	W
80	23.2.27.330	180	148.00	Feb. 4, 1947	Pl	W
81	23.2.27.330a	172	149.20	do	Pl	W
82	23.3.4.140	1,005 (?)	4.20	Feb. 5, 1947	Pl	W,G
83	23.3.9.330	80	30.50	do	None	
84	23.3.20.420		54.20	do	Pl	W
85	23.3.20.420a		85.60	do	Pl	W
86	23.4.18.111	0	14	1942	Pl	W,G
87	23.4.18.310	0	18	do	None	
88	23.4.26.440		78.40	Feb. 7, 1947	Pl	W,G
89	23.4.32.144				None	
90	24.3E.31.230	130	90		Pl	W
91	24.1.22.120		300.00+	Feb. 10, 1947	Pl	W,G
92	24.3.4.420		333		Pl	W
			300.00+	Feb. 5, 1947		
93	24.3.5.330		78.15	do	Pl	W
94	24.3.6.320	117	98	1942 (?)	Pl	W
95	24.3.6.430	135	99.35	Feb. 17, 1947	Pl	W

TX_MSJ_005630

the Rio Grande in Sierra and Dona Ana Counties, N. Mex.—Continued

Topographic situation	Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing level		
					Depth to top of bed (ft)	Thickness (ft)	Character of material
N. Mex.—Continued							
.....	4,410 T	Dr	501	8	430	71	Sand.
On mesa.....	4,420 T	Dr	200	6	.....	.....	.....
.....do.....	4,420 T	Dr	180	6	.....	.....	.....
.....	4,460 T	Dr	177	8	.....	.....	.....
.....	4,470 T	Dr	180	6	.....	.....	.....
Between hills.....	4,470 T	Dr	172	6	.....	.....	.....
.....	4,480 T	Dr	1,005	6	.....	.....	.....
West side of Mason Draw.	4,450 T	Dr	80	6	.....	.....	.....
.....do.....	4,390 T	Dr	.....	6	.....	.....	.....
.....do.....	4,400 T	Dr	366	6	.....	.....	.....
Goodsight Draw.....	.....	Du	18	.....	.....	.....	Caliche and gravel.
.....do.....	.....	Du	20	.....	.....	.....	.....
.....	4,360 T	Dr	200(?)	6	.....	.....	.....
.....	.....	Dr	280	.....	.....	.....	.....
On slope of valley....	3,930 T	Dr	130	5¼	108	22	Quicksand.
.....	4,220 T	.....	.....	6	.....	.....	.....
.....	4,360 T	Dr	366	6	.....	.....	.....
West side of Mason Draw...	4,330 T	Dr	.....	6	.....	.....	.....
.....	4,330 T	Dr	138	6	60	40	Dark sand.
.....	4,325 T	Dr	135	6	.....	.....	.....

Use of water	Quality	Measuring point		Remarks
		Description	Height above (+) or below (-) land-surface datum (ft)	
N. Mex.—Continued				
S	Good	.....	.....	Reported 4 gpm.
D, S	.....	.....	.....	
D, S	.....	Top of casing.....	+0.70	Reported 12 to 14 gpm.
S	.....	.....	.....	
S	.....	Top of casing.....	+1.25	Reported 10 to 12 gpm.
S	.....	Top of pipe clamps.....	+.85	Do.
S	.....	Top of casing.....	+1.85	Reported 4 to 5 gpm.
A	Good	.....do.....	+1.45	Very weak well.
S	.....	.....do.....	+1.50	
S	.....	.....do.....	+.65	Weak well.
D, S	Good	.....	.....	Three windmill wells at this location.
.....	.....	.....	.....	South of Burris headquarters.
S	Good	Top of casing.....	+.80	Reported 7 gpm.
.....	.....	.....	.....	No water.
S	Poor	.....	.....	Estimated 25 gpm.
D, S	.....	.....	.....	
D, S	.....	.....	.....	Reported 4 gpm.
S	.....	Top of casing.....	+2.60	Temperature 69 F. See analysis.
D, S	Good	.....	.....	
D	.....do....	Top of casing.....	+1.10	

TX_MSJ_005631

Table 13.—*Records of wells principally above the valley floor of*

No.	Well: Location no.	Well: Field name	Owner or name	Driller	Date completed
					Dona Ana County,
96	24.3.7.410	Works well	John Biggs	Zeke Mordyke	1929 (?)
97	24.3.8.310	West Line	H. S. Bissell	Bob Payne	1936
98	24.3.25.230	Aden wells	do		
99	24.4.2.111		L. F. Burris	B. Armstrong	1941-42
100	24.4.12.220	Phillips	Phillips	E. H. Boone	1934-35
101	24.4.12.230	Biggs ranch	John Biggs	Strickland	1936 (?)
102	24.4.12.322		do	E. H. Boone	1928 (?)
103	25.1E.6.330		L. E. Bowman		1942 (?)
104	25.1E.19.240		do		
105	25.2E.28.220		Fred Nunn (?)	Bob Payne	
106	25.2E.31.130		do		1916
107	25.3E.22.120	Hutchins	Paul Price		1900
108	25.2.12.240	Perry	Ben F. Perry	Shell Norwood	1890 (?)
109	25.2.30.320	R. T. ranch	Johnson Bros.		1946
110	25.3.2.220	Aden station	H. S. Bissell		
111	25.3.10.240		Johnson Bros.	Bob Payne	1947
112	25.4.10.120	O. D. ranch, North well.	do	Andy Romenger	1900 (?)
113	25.4.22.110	O. D. ranch, South well.	do		
114	26.1E.18.220	Nunn ranch	Fred Nunn		1915
115	26.2E.17.240		R. A. Gardner	U. S. Grazing Service.	1942
116	26.2E.31.410		do		1917
117	26.3E.9.221		Berino Cotton Gin		July 1947
118	26.3E.11.111		Paul Price		1943

No.	Location no.	Depth to which well is cased (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Type of pump	Kind of power
						Dona Ana County,
96	24.3.7.410		100+	1942 (?)	Pl	W
97	24.3.8.310		169.19	Mar. 25, 1948	Pl	W
98	24.3.25.230		178.80	Feb. 11, 1947	None	
99	24.4.2.111	0	136.56	Sept. 16, 1942		
100	24.4.12.220	170	96.31	Feb. 7, 1947	Pl	W,G
101	24.4.12.230		91.28	do	Pl	W
102	24.4.12.322	130	120	1942 (?)	Pl	W,G
103	25.1E.6.330		300.00+	Feb. 11, 1947	Pl	W
104	25.1E.19.240		375		Pl	W,G
105	25.2E.28.220	100	104.65	Apr. 29, 1947	Pl	W
106	25.2E.31.130	360	350 to 360		None	
107	25.3E.22.120	185	155		Pl	W,G
108	25.2.12.240	398	383	1947	Pl	W,G
109	25.2.30.320	217	217		Pl	W
110	25.3.2.220		444 (?)		Pl	W
			300.00+	Feb. 11, 1947		
111	25.3.10.240	30	120	1947	Pl	W
112	25.4.10.120		185.95	Feb. 7, 1947	Pl	W
113	25.4.22.110		121.20	do	Pl	W
114	26.1E.18.220	437	390		Pl	W,G
115	26.2E.17.240		321		Pl	W
116	26.2E.31.410	338	317		Pl	W
117	26.3E.9.221	148	4	1947	G	E
118	26.3E.11.111	50	15		Pl	W

TX_MSJ_005632

the Rio Grande in Sierra and Dona Ana Counties, N. Mex.—Continued

Topographic situation	Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed: Depth to top of bed (ft)	Principal water-bearing bed: Thickness (ft)	Principal water-bearing bed: Character of material	Use of water	Quality	Measuring point: Description	Measuring point: Height above (+) or below (-) land-surface datum (ft)	Remarks
N. Mex.—Continued												
Mason Draw	4,315 T	Dr	140				Gravel.	D, S	Good			Weak well.
	4,325 T	Dr	262	6				S		Top of casing	+1.50	Reported 3 gpm.
	4,550 T	Dr		7				A		do	+.75	North well of 3 wells.
	4,320 T	Dr	480		265					Ground surface		
	4,320 T	Dr	170	4	140	30	Sand and gravel.	D	Good	Top of casing	+.45	
On mesa	4,310 T	Dr	200 (?)	6	140	60	Do.	D, S		do	+1.00	Southwesternmost of 2 wells.
		Dr	130	6				S				Hit malpais; strong well.
On mesa	4,210 T	Dr	400±	6				S				Reported 10 to 12 gpm.
	4,160 T	Dr	400±	6				D, S				
	3,920 T	Dr	120	7				D, S	Good	Top of casing	+.75	Reported 5 to 7 gpm.
	4,170 T	Dr	360	6				A				Plugged.
	3,980 T	Dr	185	8	170	15	Clay and fine sand.	S	Good			Reported 40 gpm.
	4,225 T	Dr	398	6				S	do			Reported 8 gpm.
	4,280 T	Dr	217	6	200	17	Sand.	D, S	do			
	4,480 T	Dr	444	8	506	21		S				Reported 5 gpm.
	4,420 T	Dr	527	8			Gravel.					
	4,220 T	Dr	200	6			Sand and gravel.	S	Bad			
	4,170 T	Dr	300+	6			Do.	S	Good	Top of concrete	+1.10	North well of 2 wells.
	4,210 T	Dr	440	6	400	40	Quicksand.	S		Top of pipe clamps	+2.00	
	4,125 T	Dr	340	6	320	20	Sand.	D, S	Good	Top of casing	+.50	Reported 18 gpm, drawdown 1 to 2 ft.
	4,125 T	Dr	338	8	317	21	Do.	S	do			
Valley floor		J	148	2½	148		Do.	S	do			
	3 860 T	Dr	50	4			Sand and gravel.	D	do			Reported 12 gpm, hardness 120 ppm.
								D, S				

TX_MSJ_005633

Table 13.— *Records of wells principally above the valley floor of*

No.	Well: Location no.	Well: Field name	Owner or name	Driller	Date completed
					Dona Ana County,
119	26.1.4.320	Afton well	Mrs. Annie Braidfoot	Shell Norwood	1943
120	26.1.4.410	Afton	Southern Pacific Co.	RR. employees	August 1918.
121	26.1.16.330	Malpais Norwood	Mrs. Annie Braidfoot	Shell Norwood	
122	26.1.25.410	Headquarters New	do	do	1946
123	26.1.25.410a	Headquarters Old	do	do	
124	27.1E.11.330	Lanark No. 1	Southern Pacific Co.		1899
125	27.1E.11.330a	Lanark No. 2	do		1900
126	27.1E.11.330b	Lanark No. 3	do		1900
127	27.1E.17.210	Lanark	Mrs. Annie Braidfoot	Bob Payne	1944
128	27.1E.33.130	Payne	do	do	1941
129	27.1.8.340	Kilbourne Hole	do		
130	27.1.26.430		do		
131	27.1.32.120	Little Hole well	do	Shell Norwood	1910 (?)
132	27.2.2.320	North wells	do	Bob Payne	1946
133	28.2E.24.110	Strauss, well 1	Southern Pacific Co.		1917
134	28.2E.24.110a	Strauss, well 2	do		1918
135	28.2E.24.110b	Strauss, well 3	do		1945
136	28.2E.31.340		R. A. Gardner		1910 (?)
137	28.3E.3.121		Ramon Morales	Ramon Morales	1936
138	28.3E.5.140		R. A. Gardner		

No.	Location no.	Depth to which well is cased (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Type of pump	Kind of power
						Dona Ana County,
119	26.1.4.320	445	445		Pl	G
120	26.1.4.410	702	385	August 1918	AL	S
121	26.1.16.330	445	406	1947	Pl	G
122	26.1.25.410	450	450	do	Pl	G
123	26.1.25.410a	450	430	do	Pl	G
124	27.1E.11.330	950	365	1899	None	
125	27.1E.11.330a	615	365	1900	None	
126	27.1E.11.330b	646	365	do	None	
127	27.1E.17.210	396 (?)	390	1944	Pl	W,G
128	27.1E.33.130	453 (?)	450	1941	Pl	W
129	27.1.8.340					
130	27.1.26.430	314 (?)	310		Pl	W,G
			286.39	Mar. 7, 1947		
131	27.1.32.120	280	280		Pl	W
132	27.2.2.320	406	400 (?)		Pl	G
133	28.2E.24.110	975	342	1917	AL	Steam
			340	1941		
134	28.2E.24.110a	705	342	1918	AL	Steam
			330	1941		
135	28.2E.24.110b	507	328	1945	T	E
136	28.2E.31.340	335	325		Pl	W,G
			298.5	May 6, 1947		
137	28.3E.3.121	140	15	1947	C	E
138	28.3E.5.140	110	80-85		Pl	W
			52.36	Aug. 28, 1947		

TX_MSJ_005634

the Rio Grande in Sierra and Dona Ana Counties, N. Mex.— Continued

Topographic situation	Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed		
					Depth to top of bed (ft)	Thickness (ft)	Character of material
N. Mex.—Continued							
.....	4,210 T	Dr	445	6	.....	.....	.....
.....	4,210 T	Dr	702	14	385	130	Fine sand.
Depression in malpais.	4,210 T	Dr	445	6	.....	.....	Sand.
.....	4,190 T	Dr	460	5	.....	.....	Do.
.....	4,190 T	Dr	450	6	.....	.....	Do.
.....	4,170 T	Dr	950	10	754	31	Do.
.....	4,170 T	Dr	615	12	415	185	Do.
.....	4,170 T	Dr	646	10	425	.....	Do.
On mesa.....	4,170 T	Dr	396	6	.....	.....	.....
.....do.....	4,150 T	Dr	453	6	.....	.....	.....
.....	3,945 T	Dr	.....	.....	.....	.....	.....
.....	4,090 T	Dr	314	6	.....	.....	.....
Depression in malpais.	4,030 T	Dr	280	6	.....	.....	.....
On mesa.....	4,200 T	Dr	406	6	.....	.....	.....
.....	4,110 T	Dr	975	14	360	52	Sand.
.....	4,110 T	Dr	705	15	382	101	Do.
.....	4,110 T	Dr	550	8 (?)	.....	.....	Do.
.....	4,110 T	Dr	400	7	325	75	Do.
.....	3,765 T	Dr	140	2½	140	.....	Do.
.....	3,820 T	Dr	110	6	100	10	Gravel.

Use of water	Quality	Measuring point		Remarks
		Description	Height above (+) or below (-) land-surface datum (ft)	
N. Mex.—Continued				
S	Good	.....	.....	Reported 10 gpm.
RR	Poor	.....	.....	Water did not rise. Reported 100 gpm, drawdown 15 ft.
S	Good	.....	.....	Reported 7 gpm.
D,S	.....do.....	.....	.....	Reported 7 gpm. See analysis.
D,S	.....do.....	.....	.....	Reported 8 gpm.
A	.....	.....	.....	Well abandoned and covered.
A	Fair	.....	.....	Reported 33 gpm. Water struck at 415 ft. Well abandoned and covered.
A	.....do.....	.....	.....	Reported 33 gpm. Water struck at 425 ft. Well abandoned and covered.
S	Good	.....	.....	Reported 15 gpm.
S	.....do.....	.....	.....	See analysis.
A	Bad	.....	.....	Abandoned, not fit for use.
S	Good	Top of casing.....	+0.50	Reported 15 gpm.
.....	.....	.....	.....	
S	.....do.....	.....	.....	
S	.....do.....	.....	.....	Reported 12 gpm.
RR	Fair	.....	.....	Water struck at 360 ft. Original depth 1,330 ft in 1907. Reported 30 gpm, drawdown 110 ft.
RR	.....do.....	.....	.....	Water struck at 382 ft. Reported 40 gpm, drawdown 120 ft. See analysis.
RR	.....	.....	.....	Reported 250 gpm, drawdown 16 ft.
S	.....	Top of casing.....	+.30	
D,S	Good	.....	.....	El Paso County, Tex.
D,S	.....	Top of casing.....	.00	

TX_MSJ_005635

Table 13.— *Records of wells principally above the valley floor of*

No.	Well: Location no.	Well: Field name	Owner or name	Driller	Date completed
					Dona Ana County
139	29.1E.6.110	.....	R. A. Gardner.....	.....	.....
140	29.1E.8.210a	Noria, well 2.....	Southern Pacific Co.....	Layne & Bowler, Inc.	April..... 1914.
141	29.1E.8.210b	Noria, well 3.....	.....do.....	.....do.....	December 1916.
142	29.3E.12.300	.....	J. A. Wilson.....	J. A. Wilson.....	1926.....
143	29.4E.7.440	.....	Archie Bond.....	Archie Bond.....	1925 (?)..
144	29.2.6.230	Mt. Riley, well 2	Southern Pacific Co.....	.....	December 1914.
145	29.2.12.240	Potrillo.....	.....do.....	.....	.....
146	29.4.9.100	Malpais, well 1...	.....do.....	W. McLees.....	1903.....
147	29.4.9.100a	Malpais, well 2...	.....do.....	RR. employees..	1909.....

No.	Location no.	Depth to which well is cased (ft)	Well level: Below land surface (ft)	Well level: Date of measurement	Type of pump	Kind of power
						Dona Ana County,
139	29.1E.6.110	.....	265	.....	Pl	W
140	29.1E.8.210a	565	321	1914.....	AL	Steam
141	29.1E.8.210b	560	320 (?)	1916.....	AL	Steam
142	29.3E.12.300	.....	147.80	Aug. 28, 1947.....	Pl	W
143	29.4E.7.440	60	44.26	.....do.....	Pl	W
144	29.2.6.230	518	278 278	1914..... 1941	Pl	Diesel
145	29.2.12.240	.....	220	.....	.....	.....
146	29.4.9.100	370	267	1903.....	None	.....
147	29.4.9.100a	479	255	1909.....	None	.....

TX_MSJ_005636

the Rio Grande in Sierra and Dona Counties, N. Mex.—Continued

Topographic situation	Altitude above sea level (ft)	Type of well	Depth of well (ft)	Diameter of well (in.)	Principal water-bearing bed			Use of water	Quality	Measuring point		Remarks
					Depth to top of bed (ft)	Thickness (ft)	Character of material			Description	Height above (+) or below (-) land-surface datum (ft)	
N. Mex.—Continued												
.....	4,130 T	Dr	400	7	.....	.....	.....	S	Good	.....	.....	
.....	4,120 T	Dr	565	13	.....	.....	.....	RR	Poor	.....	.....	Water struck at 425 ft. Reported 20 gpm, drawdown 100 ft.
.....	4,120 T	Dr	560	18	418	42	Sand.	A	.....	.....	.....	Water struck at 418 ft. Reported 23 gpm.
.....	3,895 T	Dr	190	4	.....	.....	.....	D, S	.....	Top of casing.....	+1.50	
.....	3,790 T	Dr	60	6	.....	.....	.....	D	Good	.....do.....	+2.00	
.....	4,110 T	Dr	528	13	280	20	Sand.	RR	....do....	.....	.....	Temperature 65 F. 574 ppm total dissolved solids. Reported 22 gpm, drawdown 100 ft. Original depth 715 ft.
.....	4,247 T	Dr	240	.....	.....	.....	.....	A	.....	.....	.....	See Water-Supply Paper 188, p. 40.
.....	4,125 T	Dr	445	6	.....	.....	.....	A	.....	.....	.....	770 ppm total dissolved solids. Reported 18 gpm.
.....	4,125 T	Dr	514	10	387	39	Sand.	A	.....	.....	.....	Water struck at 387 ft. Reported 5 gpm.

TX_MSJ_005637

INDEX

Page

Abstract..... 1-3
Access to the area..... 10-12
Acknowledgments..... 7-8
Acreage irrigated, table of.....138-140
Aden station well, depth to water..... 29
Afton, wells at..... 81-82, 149, 152-153
Agricultural College, precipitation at..... 13, 14, 64
Agricultural College, wells of..... 63, 82, 83, 95, 96, 103-104, 105, 108-109, 161, 174-177, 180-183
See also New Mexico College of Agriculture and Mechanic Arts.
Altitudes of topographic features..... 15-17
American Dam..... 17
Analyses of water..... 83, 86, 88, 152-153
Anthony Drain, transmissibility determined from flow of..... 101, 102
Aquifer, hydrologic characteristics of.. 90-103
specific yield of..... 102-103
Archer, Albert, well of..... 83
Arnold, V. E., analyses by..... 152-153
Artesian wells..... 22-23
Atchison, Topeka and Santa Fe Railway, wells of..... 95, 96, 144, 146, 166-167, 172-173
Auger holes, maps showing..... pls. 2, 3
measurements in..... 56 154
water-level measurements in..... 97-102, 155-156

Beal well..... 182-183
Berino, change in quality of water.... 82, 83
Berino Cotton Gin, well of..... 148, 190-191
Beyers, L., well of..... 176-177
Biggs, John, wells of..... 190-191
Biggs ranch, well log..... 148
Bissell, H. S., well logs..... 146, 148
wells of..... 29, 30, 152-153, 184-185, 186-187, 188-189, 190-191
Black, G. P., wells of..... 26, 164-165
Black, Roy, well of..... 168-171
Black Mountain..... 16
Boggs well..... 26, 143, 180-181
Bond, Archie, well of..... 194-195
Botkin, C. W., analyses by.. 83, 88, 152-153
Bowman, Frank, well of..... 83
Bowman, L. E., well of..... 190-191
Boyd, R. E., well of..... 186-187
Braidfoot, Mrs. Annie, wells of..... 29, 30, 81-82, 152-153, 192-193
Brandis, Erick, well of..... 178-179
Brewster well..... 180-181
Burris, L. F., wells of..... 188-189, 190-191
Burris, Weldon, well of..... 186-187
Bryan, Kirk, quoted..... 25

Caballo Dam, flow passing..... 136
precipitation at..... 13, 64
Caballo Mountains..... 16
Caballo Reservoir, capacity of..... 17
releases from..... 137
Canals, map of..... pls. 2, 3
Canal waste..... 41-42, 43
Cantrell, W. B., well of..... 26, 143, 159, 164-165

Page

Chamberino Drain, quality of water in..... 86, 87
Chemical quality of water..... 79-90
Climate..... 12-14
Cocks, E. L., well of..... 26, 58, 152-153, 166-167
Coldiron, Andy, well of..... 188-189
Coles, O. C., well of..... 178-179
Consumptive use of water, for crops..... 51
Corralitos ranch, well, depth to water in..... 29
Cowan, Clyde, well of... 26, 82, 152-153, 161, 166-167
well of, driller's log..... 144
Cox, Jack, well of..... 178-179

Daugherty, J. W., well of..... 81-82, 152-153, 184-185
Dawson, O. B., well of..... 143, 152-153, 164-165
Del Rio Drain, quality of water in... 86, 87
transmissibility determined from flow of..... 100-101, 102
Depth to water, in upland areas..... 27-31, 190-195
in valley fill..... 52-58
Derry, warm springs near..... 17, 81, 152-153
Diversions, comparisons of..... 43, 138
differences in computations of..... 51
distribution of..... 40-41, 138-140
relations to drain flow..... 45-50
to canals of the Rio Grande project.. 40
Domestic water supplies.....105-107
Doña Ana Mountains..... 16, 31
Drain flow, departures from average... 49
effect of pumping on..... 116-121, 123
relation to diversion..... 45-50
Drains, analyses of water in..... 85, 86
flow in..... 36, 43, 96-102, 141
map of..... pls. 2, 3
flow of, table..... 141-142
flow of, transmissibility determined from..... 96-102
system of, in the Rio Grande project..... 18
Drought periods, supplemental pumping of water.....121-129

East Drain, quality of water in..... 84-85, 86, 87, 88
East Potrillo Mountains..... 16
Egbert, O. E., well of..... 178-179
Elephant Butte Irrigation District..... 4, 20, 21, 115, 122, 124
Elephant Butte Reservoir, capacity of... 17
effect of storage of water in..... 67
first diversions from..... 53
Elmendorf, H. B., well of..... 83
El Paso gaging station, flow passing..... 136
El Paso Valley..... 17, 138, 140
Engler, well of..... 26, 58
Esslinger, W. E., well of..... 178—179
Evans, B. B., well of.....174—175
Evans, W. E., well of.....176—177
Evaporation..... 78

TX_MSJ_005639

Page
Evapotranspiration in waterlogged areas... 115

Field work..... 4-5
Flow of drains. *See* Drains.
Fluctuations of water levels, effect of irrigation on..... 58-64
effect of precipitation on..... 64
effect of transpiration on..... 65
Franklin Mountains..... 16
Franzoy, A. A., wells of..... 26, 166-167
Fritz, Marsella, well of..... 164-165
Fuller, Mrs., well of..... 178-179
Future studies, recommendations for.. 132-133

Gaging stations, location of..... 17-18
Garcia, Rudolf, wells of..... 105, 166-167, 168-171
Gardner, R. A., wells of..... 30, 190-191, 192-193, 194-195
Gary, well of..... 26
Geography..... 10-15
Geology..... 21-26
Ginther, Victor, well of..... 172-173
Gomez, J. O., well of..... 168-171
Griffin, J. A., well of..... 168-171
Ground water, accretion..... 36-37
analyses of..... 152-153
areas of discharge..... 114
areas of rejected discharge..... 114
direction of movement..... 31, 65-66
discharge of..... 77-79
domestic use of..... 105-107
early use of, for irrigation..... 103-105
in upland areas..... 27-37
in valley fill..... 52-79
movement and flow of..... 31-37
pumping of..... 114-116
recharge of..... 37-38, 76-77
relation of drain flow and diversions to recharge..... 45-50
source of..... 37-38, 66-77
types..... 81-82
Ground-water divide..... 31, 32-33

Hare, Clifford, well of..... 168-171
Harvey, Paul, well of..... 84
Hatch, N. Mex., domestic water supply of..... 106
precipitation..... 13
wells..... 26, 58, 166-167
Hayes, Leslie, well of..... 152-153, 178-179
Hayner, F. M., well of..... 186-187
Hedgecock, R. F., well of..... 26, 180-181
Herrington ranch well..... 30, 32-33
Hill area, water table contours for..... 74, 75
Holmes, Bert, well of..... 184-185
Hot Springs. *See* Truth or Consequences.
Howard, C. S., analyses by..... 152-153
Hueco Bolson, gradient of water table..... 35
recharge to ground water in..... 37
Hughes, L. S., analyses by..... 152-153

Igneous rocks, effect on depth to water. 28-29
Industries..... 12
International Boundary and Water Commission..... 17, 67-68
International Dam..... 17, 40
Introduction..... 4-10
Irrigated land, amount of, in early years..... 52-53
increase in acreage..... 53
Rio Grande project.... 18, 20, 21, 138-140
Irrigation water, as recharge of ground water..... 76-77

Page
Irrigation wells, development of..... 107
early use of..... 103-105
future development of..... 110-114
performance of..... 107-110
Isaacs, E. J., wells of... 184-185, 186-187
Isaacs, Ollie, wells of..... 184-185
Isaacs, W. F., well of. 30, 182-183, 184-185

Johnson Bros., wells of..... 190-191
Jones, Homer, well of..... 180-181, 182-183
Jornada del Muerto, depth to water in.. 27-28
description of..... 15, 21
quality of water..... 81-82
Jornada Experimental Range, depth to water..... 28
movement of ground water..... 31
wells..... 180-185
Juarez, Ciudad de..... 39
Valle de..... 17, 40, 138

Kight, C. W., well of..... 180-181
Knight, E. A., well of..... 145, 168-171

La Mesa, depth to water..... 28-30
description..... 15, 21
geology..... 21
stratigraphic section..... 23-24
La Mesa area, wells..... 81-82
See also individual well owners.
La Mesa Drain, quality of water..... 86, 87
Lanark wells, depths to water..... 30, 32
logs..... 149
Land classification..... 18-20, 111-113, 115
Land subject to construction charges.... 18-19
Langford, Ray, well of..... 83, 186-187
Lara, Felix, well of..... 63, 160, 164-165
Las Cruces, water supply..... 105-106
water supply, quality of..... 83, 84, 88-89
wells at..... 22, 25, 172-175
well logs..... 146-147
Las Cruces Country Club, well of..... 82, 83, 116, 152-153, 172-173
Las Cruces Ice Co., well of.... 83, 152-153, 186-187
Las Cruces Lateral, seepage from.... 76, pl. 8
Laws, Dr. J. E., well of..... 152-153
Leach, F. C., well of..... 188-189
Leasburg Canal, seepage from..... 74-76
Leasburg Dam..... 17, 85, 86, 136, 138
Leasburg Drain, quality of water in.... 85, 86
Linbeck, L. B., well of..... 168-171
Lippincott well..... 24, 84, 150-151
Literature cited..... 135-136
Little, Chester, wells of..... 149, 178-179
L. G., well of..... 178-179
Location of the area..... 10, 11
Location of wells, recommendations. 130-131
Locke, Tom, well of..... 83
Luchini, Ben, well of..... 26, 58, 95, 96, 152-153, 159, 164-165
well log..... 143
Lundgren, J. H., well of..... 178-179

Macaw, Raymond, well of..... 168-171
McElyea, O., well of..... 172-173
Malpais well, depth to water in.. 29, 192-193
log..... 151
Mayse, R. L., well of..... 168-171
Mesilla Park, change in quality of water with depth..... 82, 83
rise of water table at..... 53-54
water supply..... 106
Mesilla Valley, altitude of..... 15
changes in water levels..... 52-57, 58-61

TX_MSJ_005640

Page
Mesilla Valley, depth to water..... 28, 52-53
gradient of the water table..... 66
irrigation wells in..... 108-109, 110
location of wells for irrigation..... 120-121
new land susceptible to irrigation by ground water..... 113
quality of water..... 81-90
seepage losses from Rio Grande in.. 71, 72
suspended land in..... 111-113
thickness of sediments in..... 25
water conditions in..... 38-50
See also Records.
Mesquite Drain, transmissibility determined from flow of..... 101, 102
Mimbres Mountains..... 16
Morales, Ramon, well of..... 192-193

Nakayama, Carl, well of..... 168-171
J. K., well of..... 145, 168-171
New Mexico College of Agriculture and Mechanic Arts, analyses of ground water at..... 152-153
domestic water supply..... 106
measurements in auger hole..... 157-158
well logs..... 22, 144, 147
See also Agricultural College.
Noria wells, depths to water..... 30, 32
logs..... 151
Norwood wells..... 186-187, 188-189
Numbering system for wells..... 8-9
Nunn, Fred, well of..... 190-191

Oliver, D. L., well of..... 26, 166-167
Olson, Henry, well of..... 184-185
Organ Mountains..... 16, 17, 28
Organ Needle..... 15
Osborn, A. J., wells of... 26, 63, 81-82, 95, 96, 108, 152-153, 159, 160, 164-165
well log..... 143

Painter, Ray, well of..... 58, 159, 164-165
Park Drain, profiles of water table..... 97, 98
transmissibility determined from flow of..... 99
Parker, Edwin, well of..... 24, 145, 184-185
Percha Dam..... 17, 136, 138
Perry, Ben. F., well of..... 190-191
Phillips well..... 190-191
Picacho Drain, transmissibility determined from flow of..... 100, 102
Picacho Mountain..... 16
Picacho Oil and Gas Syndicate, well of..... 24, 186-187
well log..... 145-146
Plemmons, Mickey, well of..... 26, 81, 152-153, 160, 164-165
Population of the area..... 10
Powers, E. W., well of..... 26, 63, 81-82, 152-153, 160, 164-165
well log..... 143
Prater, W. A., well of..... 58, 166-167
Precipitation, amount..... 12-14, 64
as recharge to ground water..... 77
effect of, on water levels..... 64
Previous investigations..... 5-7
Price, Paul, wells of..... 176-177, 178-179, 188-189, 190-191
well log..... 149
Purpose of the investigation..... 4
Pumping, effect on flow of drains... 116-121, 123
effect on water table..... 116
supplemental, cost of..... 129-130
supplemental, in periods of drought..... 121-129
Pumping, with normal supply of surface water..... 128-129
Pumping equipment.. 103-104, 105, 163-195
Pumping ground water..... 114-116
Pumping tests..... 92-96

Quality of water, analyses of... 83, 86, 88, 152-153
factors determining..... 79-82
variation in, with depth..... 82-84
variations areally..... 84-88
Quaternary fill, thickness of..... 25-26

Radium Springs..... 17, 82, 85, 152-153
Randle, W. H., well of..... 178-179
Rath, Milos, well of..... 186-187
Reclamation, Bureau of, measurements in auger holes.... 60, 97, 100
Bureau of, seepage runs by..... 69
Bureau of, well log..... 143, 144
Reclamation Bureau, wells of..... 63, 159, 164-165
Records..... 136-195
Rhodes, Edgar, well of..... 166-167
Isaac, well of..... 25, 144, 168-171
Rice, C. C., well of..... 25, 82, 85, 152-153, 166-167, 182-183
Riggs, Earl, well of..... 152-153, 164-165
Fred, well of..... 58, 166-167
Riley, Mount..... 16, 33
Rincon, domestic water supply..... 106
Rincon Drain, transmissibility determined from flow of..... 100, 102
Rincon Valley, altitude of..... 15
diversion of water to..... 40
gradient of the water table..... 66
irrigation wells in..... 108, 110
land susceptible to irrigation by ground water..... 113
location of wells for irrigation.... 120-121
quality of water..... 84-88, 89
reported depth to clay..... 26
seepage loss from Rio Grande in.... 71, 72
suspended land in..... 111-113
thickness of sediments in..... 25-26
water conditions in..... 38-50
See also Records.
Rio Grande, analyses of water in..... 85, 86
annual flow and depletion..... 136
degradation of the riverbed..... 68-69
flow of..... 70
gains and losses in flow of..... 71-73
maintainence of flow in..... 16
seepage from..... 66-73
Rio Grande project, area included in... 17
diversion of water to..... 138-140
funds for..... 21
gaging stations..... 17-18
land classification in..... 18-20
land irrigated..... 18, 20, 21, 138-140
system of drains..... 18
water storage for..... 17
River depletions..... 44
Robison, Tod, well of..... 164-165
Robledo Mountain..... 16, 31

San Andres Mountains..... 16, 31
Santa Fe formation, character of..... 21-24
water from..... 81-82, 89
SCC land. *See* Land subject to construction charges.
Schofield, Carl S., analyses of water by.. 86
Scope of investigation..... 5
Sediments, description of..... 22-24
Pleistocene and Recent..... 24
thickness of..... 24-27

TX_MSJ_005641

Page

Seepage from canals..... 42, 73-76
from the river..... 66-73
of ground water to the river..... 78
Seepage losses.....42-43, 67, 71, 72-76
Seepage runs.....38-39, 42, 69, 71, 78
Selden Canyon..... 16
Selden Drain, analyses of water in..... 82, 86
quality of water in..... 85, 86
Shalam Colony, wells of..... 104-105
See also Garcia, Rudolf, wells of.
Sierra de las Uvas, depth to water..... 28
Simms well.....26, 180-181
Simpson, T. L., wells of..... 82, 83, 109, 168-171, 184-185
Smallwood, I. W., well of..... 26, 58, 144, 166-167
Smith, O. F., well of..... 184-185
Sodium, percent, analyses of..... 152-153
percentage in water, significance of.... 81
Southern Pacific Co., wells of....24, 30, 32, 81-82, 152-153, 192-193, 194-195
well logs..... 149, 150, 151
Specific conductance.....79-80, 153
Specific yield of aquifer..... 102-103
Sperry, Fay, well of.. 82, 83, 146, 172-173, 186-187
Spring Canyon Arroyo..... 106
Springs..... 17, 152-153
Stahman Farms, Inc., well..... 25, 172-173, 176-177
well log..... 148
State College. *See* New Mexico College of Agriculture and Mechanic Arts.
Stotts, Lee, well of.... 58, 152-153, 166-167
Stratigraphic section..... 23-24
Strauss, wells at.....30, 81-82, 150, 152-153
Summary..... 133-135
Surface water, shortage of in dry years..... 52
Suspended land, classification of..... 18-19
irrigation of..... 111-114
transpiration from..... 115

Tashiro, Harry, well of..... 172-173
Tashiko, well of..... 172-173
Tatman, well of..... 168-171
Taylor, J. M., well of..... 84, 178-179
J. W., well of..... 168-171
Temperature..... 12
Terry, E. L., well of..... 176-177
Tharp, Claude, well of..... 168-171
Three Saints Lateral, seepage from..76, pl. 9
Thurman, B. S., well of...92, 96, 152-153, 160, 161, 166-167
Tierra Blanca Creek, quality of water from..... 81
Topography..... 15-17
Tortugas Mountain..... 16
Transmissibility, coefficient of..35, 91, 92-102
methods of determining..... 90-92
Transpiration, effect of, on water levels..... 65

Page

Transpiration of ground water..... 78-79
reduction of..... 115-116
Tributary valleys..... 16
Truth or Consequences, N. Mex..... 10

Unit diversions from canals..... 41

Valley fill, ground water in..... 52-79
Vermillon, B. W., well of..... 166-167
Vickers, Dave, well of..... 176-177

Walker, K. H., well of.....82, 152-153, 168-171
Walter, S. A., well of..... 184-185
Walters, W. H., well of..... 176-177
Ward, C. H., well of..... 182-183
Ward, Ernest, well of..... 182-183
Washington, Will, well of..... 186-187
Wastage from canals to drains..... 45
Water, delivered to farms..... 43
Water level, rise of, cause..... 53
Water levels, changes in..... 53-65
diurnal fluctuations..... 65
in auger holes..... 155-158
in wells..... 159-161
Water storage for Rio Grande project..... 17
Water supply, required amount..... 50-52
Water table, configuration of..... 32-35
effect of continuous pumping on.....116
fluctuations of..... 58-65
gradient of.....33-36, 66, 96-102
profiles of..... 98, pl. 4
Water-table contours, maps..74, 75, pls. 1, 5-7, 9
Welch, Lloyd, well of..... 26, 63, 95-96, 143, 160, 164-165
Well logs..... 143-151
Well-numbering system..... 8-9
Wells, above valley floor, records of. 180-195
distance from river or drain..... 120
domestic..... 106-107
for irrigation..... 107-114
gravel packing in..... 109-110
large-diameter, records of..... 163-179
location of.....120, 130-131
maps showing..... pls. 1, 2, 3
performance of..... 107-110
power for..... 109
records of..... 163-195
West Drain, quality of water in..... 86, 87
transmissibility determined from flow of..... 100, 102
West Potrillo Mountains..... 16
White, Tex., change in quality of water at depth..... 84
Williams, E. F., analyses by..... 152-153
Wilson, J. A., well of..... 194-195
S. Y., well of..... 178-179

Yabumoto, Judo, well of..... 148, 178-179
Yanaga, Tsuyuko, well of..... 168-171

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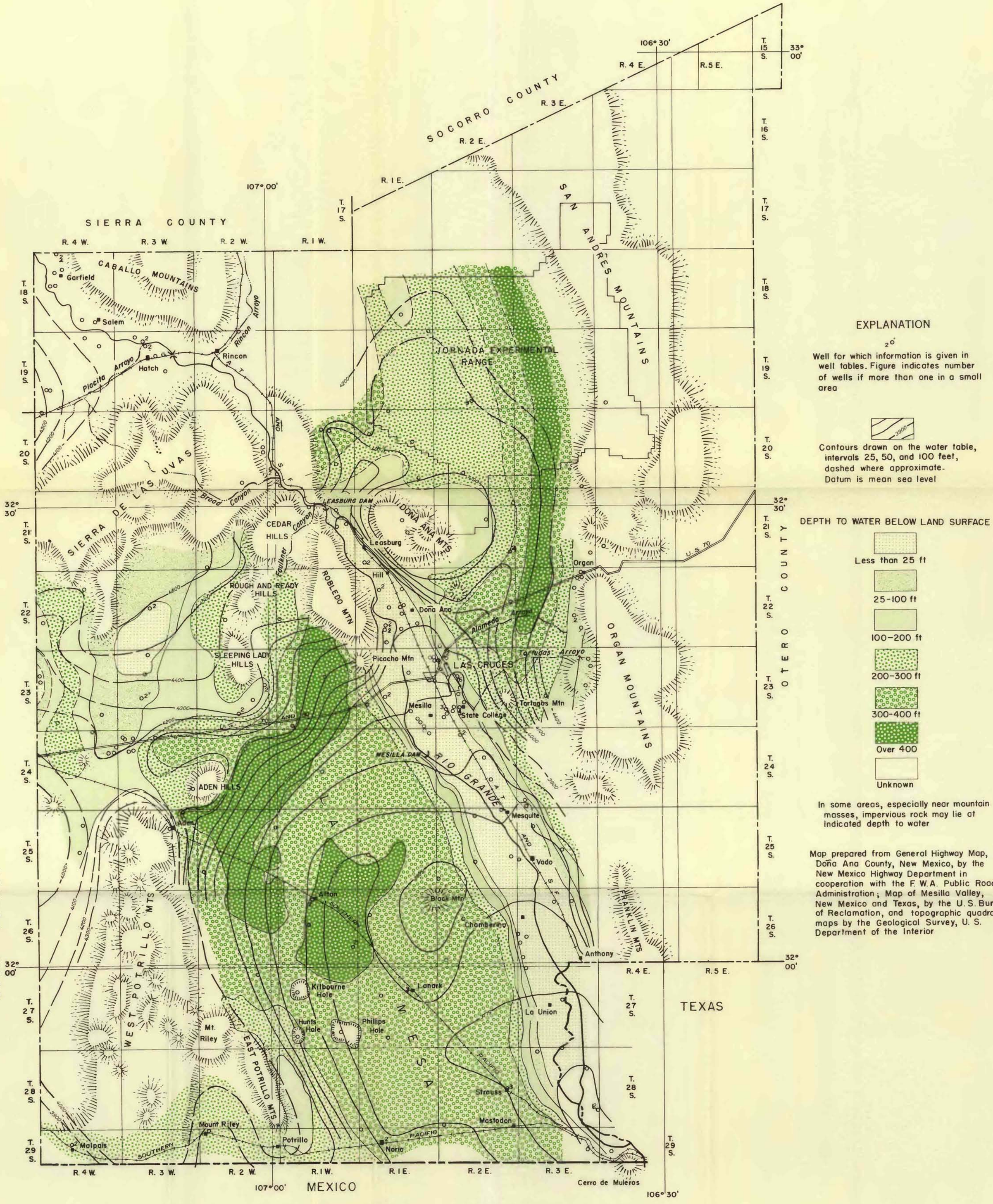
WATER-SUPPLY PAPER 1230 PLATE 1



EXPLANATION

2° Well for which information is given in well tables. Figure indicates number of wells if more than one in a small area

3900 Contours drawn on the water table, intervals 25, 50, and 100 feet, dashed where approximate. Datum is mean sea level

DEPTH TO WATER BELOW LAND SURFACE

- Less than 25 ft
- 25-100 ft
- 100-200 ft
- 200-300 ft
- 300-400 ft
- Over 400
- Unknown

In some areas, especially near mountain masses, impervious rock may lie at indicated depth to water

Map prepared from General Highway Map, Doña Ana County, New Mexico, by the New Mexico Highway Department in cooperation with the F. W.A. Public Roads Administration; Map of Mesilla Valley, New Mexico and Texas, by the U. S. Bureau of Reclamation, and topographic quadrangle maps by the Geological Survey, U. S. Department of the Interior

MAP OF DONA ANA COUNTY, NEW MEXICO, SHOWING CONTOURS ON THE WATER TABLE, DEPTH TO WATER, AND WELLS FOR WHICH INFORMATION WAS OBTAINED, 1947

5 0 10 Miles

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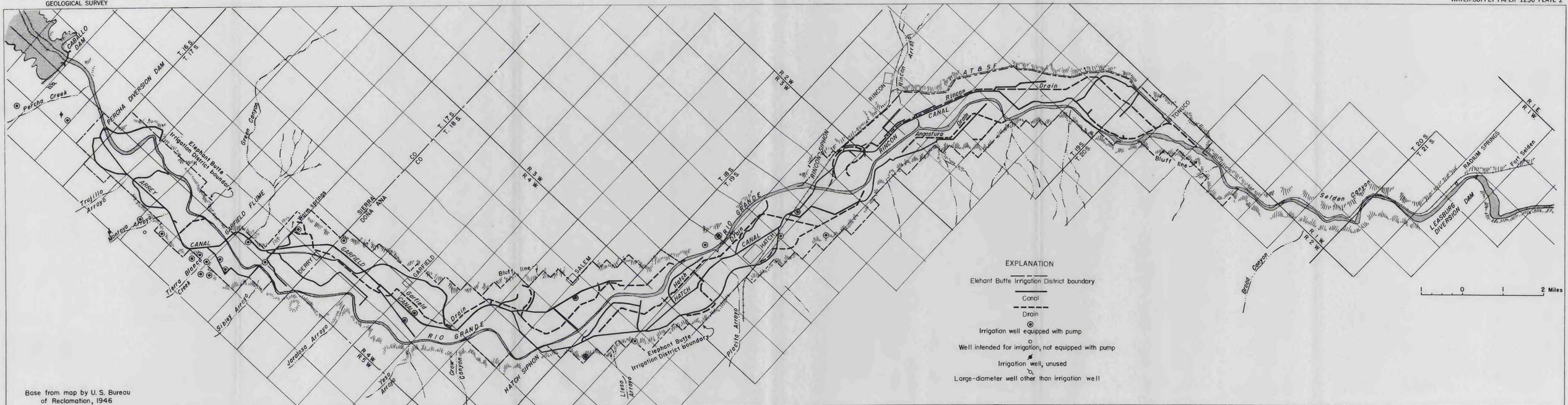

EXPLANATION

Elehant Butte Irrigation District boundary

Canal

Drain

Irrigation well equipped with pump

Well intended for irrigation, not equipped with pump

Irrigation well, unused

Large-diameter well other than irrigation well

Base from map by U. S. Bureau of Reclamation, 1946

MAP OF RINCON VALLEY, NEW MEXICO, SHOWING CANALS, DRAINS, AND WELLS FOR WHICH INFORMATION IS GIVEN IN WELL TABLES

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MAP OF MESILLA VALLEY, NEW MEXICO, SHOWING CANALS, DRAINS, AUGER HOLES, AND WELLS FOR WHICH INFORMATION IS GIVEN IN WELL TABLES

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UNITED STATES DEPARTMENT OF THE INTERIOR
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Note:

Measurements in 1904 and 1905 by C. S. Slichter, in observations on the ground waters of Rio Grande Valley: U. S. Geol. Survey Water-Supply Paper 141, pp. 26, 27, 1905.

Other measurements by U.S. Bureau of Reclamation supplemented by observations by Division of Agricultural Engineering and New Mexico State College Experiment Station in wells 1 to 10.

Measurements in June 1927 mode in open borings.

Profile of water table for September 1919 scaled from water table map from U. S. Bureau of Reclamation.

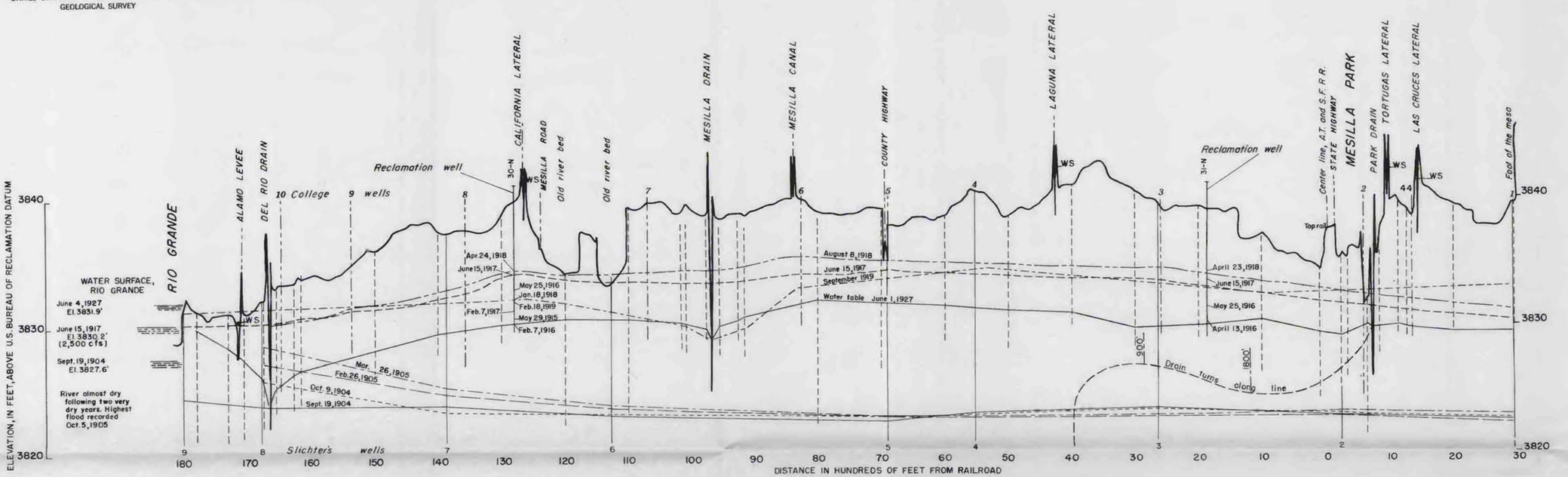
Mesilla Drain constructed July 1919.
Park Drain constructed May 1920.
Del Rio Drain constructed March 1923.

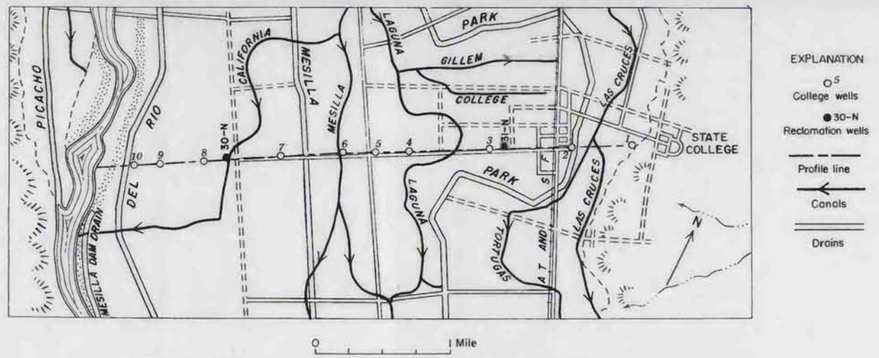
Adopted from drawing by U. S. Bureau of Reclamation, June 20, 1927.

EXPLANATION

Open borings

W S
Water surface





SKETCH SHOWING LOCATION OF PROFILE LINE ACROSS VALLEY

PROFILES OF WATER TABLE IN VICINITY OF MESILLA PARK, NEW MEXICO

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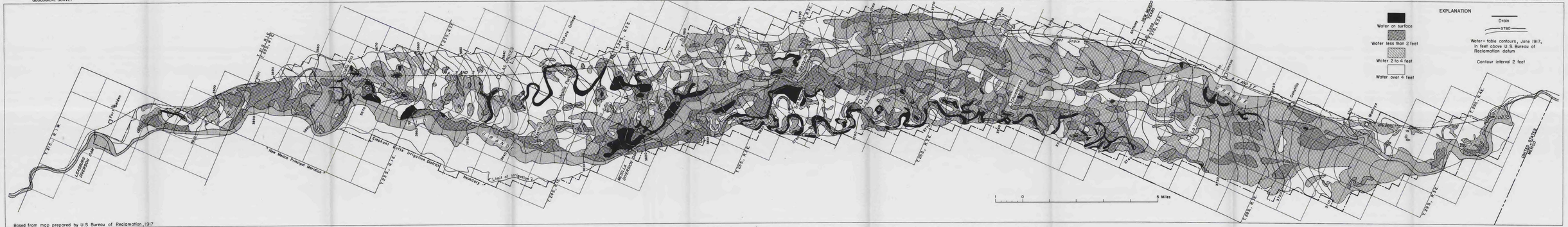

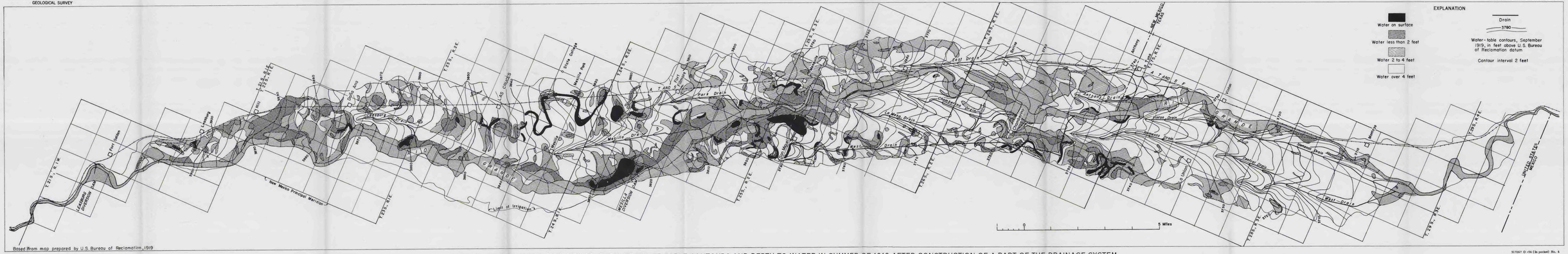

MAP OF MESILLA VALLEY, NEW MEXICO, SHOWING WATER-TABLE CONTOURS AND DEPTH TO WATER IN SUMMER OF 1919 AFTER CONSTRUCTION OF A PART OF THE DRAINAGE SYSTEM

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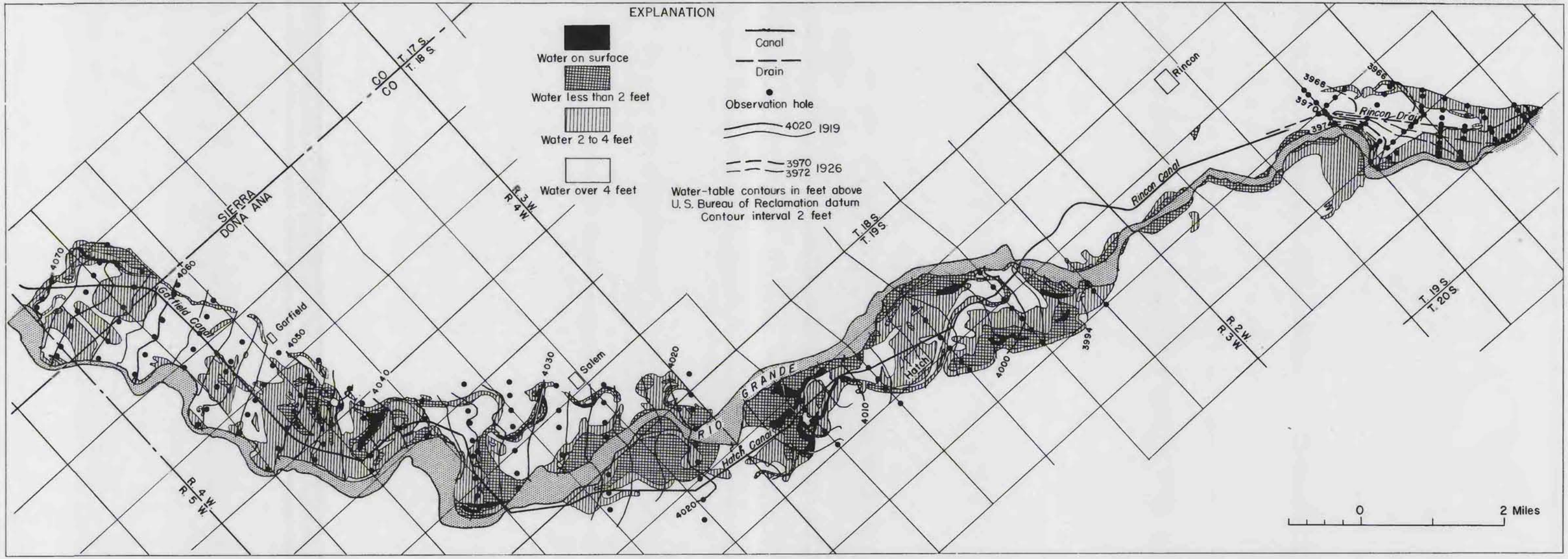
WATER-SUPPLY PAPER 1230 PLATE 7



Base from maps prepared by U.S. Bureau of Reclamation

MAP OF RINCON VALLEY, NEW MEXICO, SHOWING WATER-TABLE CONTOURS AND DEPTH TO WATER IN SUMMER OF 1919 AND 1926

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UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER-SUPPLY PAPER 1230 PLATE 8

1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948

DEPTH TO WATER, IN FEET, BELOW TOP OF CASING

22.1E.9.333 No. 6

22.1E.35.443 No. 16

23.1E.1.234 No. 17 (225)

No. 27

23.2E.16.211 No. 32

No. 33 24.2E.17.221

No. 37 24.2E.18.211

No. 40 24.2E.23.133

Bartlett

Opitz 26.3E.16.444

Montoya(230)

No. 6

No. 16

No. 17 (225)

No. 27 23.1E.35.221

No. 32

No. 33

No. 37

No. 40

25.2E.25.322 Bartlett

Opitz

28.3E.26.244 Montoya (230)

Note: Well designations taken from U.S.Bureau of Reclamation. Number in parentheses is that given to well in Rio Grande Joint Investigation. Location of wells given on Plate1

WATER LEVELS, AS MEASURED MONTHLY BY THE U. S. BUREAU OF RECLAMATION IN 11 AUGER HOLES IN THE MESILLA VALLEY, NEW MEXICO, SHOWING SEASONAL AND LONG-TERM CHANGES

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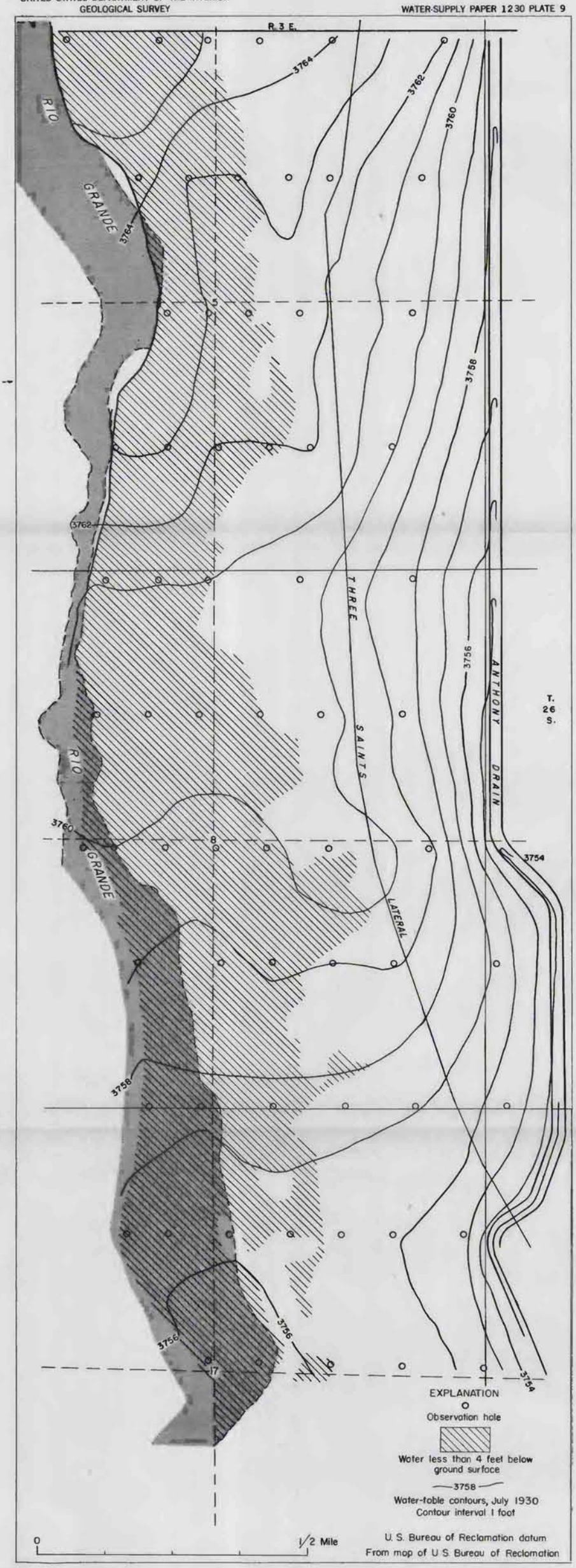
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER-SUPPLY PAPER 1230 PLATE 9



WATER-TABLE CONTOURS SHOWING SEEPAGE FROM THREE SAINTS LATERAL TO ANTHONY DRAIN

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RG 267 RECORDS OF THE SUPREME COURT OF THE UNITED STATES

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No._____, Original

STATE OF TEXAS,

Plaintiff

v.

STATE OF NEW MEXICO, ET AL,

Defendants

MOTION FOR LEAVE TO FILE COMPLAINT AND COMPLAINT

ORIGINAL

TX_MSJ_005656

IN THE

Supreme Court of the United States

OCTOBER TERM, 1951

No._____, Original

STATE OF TEXAS,

Plaintiff

v.

STATE OF NEW MEXICO, ET AL,

Defendants

MOTION FOR LEAVE TO FILE COMPLAINT

Now comes the State of Texas, by its Attorney General, and moves the Court for leave to file the Complaint submitted herewith. The State of Texas seeks to bring this suit under the authority of Article III, Section 2, Clause 2 of the Constitution of the United States.

PRICE DANIEL
Attorney General of Texas

TX_MSJ_005657

STATEMENT IN SUPPORT OF MOTION

The purpose of the litigation is to resolve the controversy between the plaintiff, the State of Texas, and the defendants, the State of New Mexico and the Middle Rio Grande Conservancy District, its directors, Oscar M. Love, Loyal D. Betty, Emiliano Castillo, John T. Cook, and L. G. Zartman, and its chief engineer, Hubert Ball, all residents of New Mexico, growing out of the actions of the defendants in storing, diverting, and using the waters of the Rio Grande in contravention of the Rio Grande Compact between said States.

Plaintiff seeks to restrain the State of New Mexico and its citizens, and particularly the Middle Rio Grande Conservancy District, the directors and chief engineer thereof, and their engineers and agents, from storing waters of the Rio Grande and its tributaries in reservoirs in New Mexico constructed after 1929 above San Marcial, New Mexico, except to the extent permitted by said Rio Grande Compact, and from diverting and using in New Mexico waters of the Rio Grande and its tributaries allocated to Texas by said Compact, and to require said defendants to deliver water in the Rio Grande at San Marcial, New Mexico, in the quantities specified by said Compact, and otherwise to comply with the terms of said Compact; and for other relief prayed for in said Complaint.

For several years, defendants, to the irreparable injury of plaintiff and its citizens, have refused to deliver to plaintiff the water which the Compact requires to be delivered and have publicly indicated their intention not to adhere to the

terms of the Compact in the future. Accordingly, it is believed that the rights of the State of Texas and its citizens can be protected only by a decree of this Court granting the relief prayed for in the Complaint.

It is respectfully submitted that the Motion for Leave to File the Complaint should be granted.

PRICE DANIEL
Attorney General of Texas

TX_MSJ_005658

HENRY & EVANS
JUDSON & REYBURN-IRGH

IN THE

Supreme Court of the United States

OCTOBER TERM, 1951

No._____, Original

STATE OF TEXAS,

Plaintiff

v.

STATE OF NEW MEXICO, ET AL,

Defendants

COMPLAINT

The State of Texas, by its Attorney General, brings this suit against the defendants, the State of New Mexico and the Middle Rio Grande Conservancy District, a quasi-municipal corporation, organized under the laws of New Mexico, its directors, Oscar M. Love, Loyal D. Betty, Emiliano Castillo, John T. Cook, and L. G. Zartman, and its

TX_MSJ_005659

chief engineer, Hubert Ball, all of whom are residents of New Mexico, and for its cause of action states:

I

The jurisdiction of this Court is invoked under Article III, Section 2, Clause 2 of the Constitution of the United States.

II

The Rio Grande rises in part in the State of Colorado and in part in the State of New Mexico, and flows through those States into the State of Texas and along its common boundary with the Republic of Mexico. The lands in Texas in the valley of the Rio Grande above Fort Quitman, Texas, are semi-arid and lie within that portion of the semi-arid region of the United States in which irrigation is indispensable for the successful cultivation of land and the production of crops thereon. The waters of the Rio Grande are used for the irrigation of lands in each of the States of Colorado, New Mexico, and Texas, and are fully appropriated for such purposes above Fort Quitman, Texas. Waters of the Rio Grande for use in Texas are stored in the Elephant Butte and Caballo Reservoirs, located in the southern portion of New Mexico, and constitute "Project Storage," as hereinafter defined.

III

Controversies among the three States concerning a division of Rio Grande waters commenced during the latter part of the nineteenth century and continued for many years. These controversies resulted in the filing of *Texas v. New Mexico,* 308 U. S. 510. In order to settle these controversies and to remove all causes of future controversy between these States and between citizens of one of these States and citizens of

another State with respect to the use of the waters of the Rio Grande above Fort Quitman, Texas, the States of Colorado, New Mexico, and Texas entered into the Rio Grande Compact, providing for an equitable apportionment among the three States of the waters of the Rio Grande above Fort Quitman, Texas. This Compact was signed at Santa Fe, New Mexico, March 18, 1938, was ratified and approved by the State of Colorado (Colorado Laws 1939, ch. 146, p. 489), by the State of New Mexico (New Mexico Laws 1939, ch. 33, p. 59), and by the State of Texas (Texas Acts 1939, 46th Leg., Vol. 2, ch. 3, p. 531), and the consent and approval of Congress to said Compact was given by Public Law No. 96, May 31, 1939, Chapter 155 (53 Stat. 785). A copy of said Compact is attached hereto, marked "Exhibit A," and made a part of this Complaint. When the Compact was completed, the Master in *Texas v. New Mexico* recommended that the complaint be dismissed because the Compact, which he included in his report, equitably settled the controversies between the States. This Court confirmed the Master's report and dismissed the complaint.

IV

Article I of the Compact contains the following definitions of the terms used in the hereinafter quoted portions of Article VI and in Articles VII and VIII of the Compact:

"(b) 'The Commission' means the agency created by this Compact for the administration thereof.

"(g) 'Annual Debits' are the amounts by which actual deliveries in any calendar year fall below scheduled deliveries.

"(h) 'Annual Credits' are the amounts by which actual deliveries in any calendar year exceed scheduled deliveries.

"(i) 'Accrued Debits' are the amounts by which the

TX_MSJ_005660

sum of all annual debits exceeds the sum of all annual credits over any common period of time.

"(j) 'Accrued Credits' are the amounts by which the sum of all annual credits exceeds the sum of all annual debits over any common period of time.

"(k) 'Project Storage' is the combined capacity of Elephant Butte Reservoir and all other reservoirs actually available for the storage of usable water below Elephant Butte and above the first diversion to lands of the Rio Grande Project, but not more than a total of 2,638,860 acre-feet.

"(l) 'Usable Water' is all water, exclusive of credit water, which is in project storage, and which is available for release in accordance with irrigation demands, including deliveries to Mexico.

"(o) 'Actual Release' is the amount of usable water released in any calendar year from the lowest reservoir comprising project storage.

"(p) 'Actual Spill' is all water which is actually spilled from Elephant Butte Reservoir, or is released therefrom for flood control, in excess of the current demand on project storage and which does not become usable water by storage in another reservoir; provided, that actual spill of usable water can not occur until all credit water shall have been spilled."

V

Article VI of the Compact provides in part as follows:

"ARTICLE VI

"Commencing with the year following the effective date of this Compact, all credits and debits of Colorado and New Mexico shall be computed for each calendar year; provided,

that in a year of actual spill no annual credits nor annual debits shall be computed for that year.

"In the case of New Mexico, the accrued debit shall not exceed 200,000 acre-feet at any time except as such debit may be caused by hold-over storage of water in reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and San Marcial. Within the physical limitations of storage capacity in such reservoirs, New Mexico shall retain water in storage at all times to the extent of its accrued debit. In computing the magnitude of accrued credits or debits, New Mexico shall not be charged with any greater debit in any one year than the sum of 150,000 acre-feet and all gains in quantity of water in storage in such year.

"The Commission by unanimous action may authorize the release from storage of any amount of water which is then being held in storage by reason of accrued debits of Colorado or New Mexico; provided, that such water shall be replaced at the first opportunity thereafter."

Article VII of said Compact provides as follows:

"ARTICLE VII

"Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs constructed after 1929 whenever there is less than 400,000 acre-feet of usable water in project storage; provided, that if the actual releases of usable water from the beginning of the calendar year following the effective date of this Compact, or from the beginning of the calendar year following actual spill, have aggregated more than an average of 790,000 acre-feet per annum, the time at which such minimum stage is reached shall be adjusted to compensate for the difference between the total actual release and releases at such average rate;

provided, further, that Colorado, or New Mexico, or both, may relinquish accrued credits at any time, and Texas may accept such relinquished water, and in such event, the State, or States, so relinquishing shall be entitled to store water in the amount of the water so relinquished."

Article VIII of said Compact provides as follows:

"ARTICLE VIII

"During the month of January of any year the Commissioner for Texas may demand of Colorado and New Mexico, and the Commissioner for New Mexico may demand of Colorado, the release of water from storage reservoirs constructed after 1929 to the amount of the accrued debits of Colorado and New Mexico, respectively, and such releases shall be made by each at the greatest rate practicable under the conditions then prevailing, and in proportion to the total debit of each, and in amounts, limited by their accrued debits, sufficient to bring the quantity of usable water in project storage to 600,000 acre-feet by March first, and to maintain this quantity in storage until April thirtieth, to the end that a normal release of 790,000 acre-feet may be made from project storage in that year."

VI

Commencing with the year 1948, the defendants have repeatedly violated the Compact and particularly the quoted provisions of Articles VI, VII, and VIII, in the following respects, to-wit:

(1) On January 1, 1948, the accrued debit of New Mexico was 176,800 acre-feet. The quantity of usable water in project storage was less than 600,000 acre-feet continuously from January 1 to April 30, 1948, inclusive. Demand for the release of debit water was made by the Commissioner

for Texas to the Commissioner for New Mexico on January 27, 1948, pursuant to Article VIII of the Compact, but no water was released from storage in compliance with this demand. On January 1, 1948, the quantity stored in El Vado Reservoir on the Rio Chama in New Mexico, being a principal tributary of the Rio Grande between Lobatos and San Marcial, New Mexico, was 5,500 acre-feet; at the end of January, it was 5,800 acre-feet; at the end of February, 7,200 acre-feet; at the end of March, 21,100 acre-feet; and at the end of April, 94,900 acre-feet. The failure and refusal to release water in compliance with such demand was in violation of Article VIII of the Compact.

(2) In August, 1948, New Mexico requested permission to release for use in the Middle Rio Grande Conservancy District of New Mexico 25,000 acre-feet of debit water owing by such State, which debit water was stored in El Vado Reservoir on the Rio Chama in New Mexico, and such release was authorized by the Rio Grande Compact Commission in accordance with the fourth unnumbered paragraph of Article VI of the Compact. New Mexico did actually release from El Vado Reservoir, and divert and use thereafter for its own purposes above San Marcial, 38,000 acre-feet of debit water owed by it to Texas and stored in El Vado Reservoir, an amount 13,000 acre-feet in excess of that authorized to be released. El Vado Reservoir was built after 1929 and is owned and operated by the Middle Rio Grande Conservancy District, one of the defendants herein. It is the principal reservoir in New Mexico constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and San Marcial. The release and use by New Mexico of 13,000 acre-feet in excess of the amount authorized was violative of the third and fourth unnumbered paragraphs of Article VI of said Compact.

(3) On January 1, 1949, the accrued debit of New

Mexico was 286,400 acre-feet. The quantity of usable water in project storage was continuously less than 600,000 acre-feet from January 1 to April 30, 1949, inclusive. Release of debit water was demanded of New Mexico by the Commissioner for Texas on January 13, 1949, pursuant to Article VIII of the Compact. Release of water from El Vado Reservoir pursuant to this demand did not commence until February 15, 1949. Such releases were terminated on April 3, and thereafter additional water was impounded in El Vado Reservoir, and on April 30 the quantity in storage in that reservoir was 102,800 acre-feet. If the entire quantity of water in El Vado Reservoir had been released by New Mexico pursuant to this demand and not diverted above San Marcial, the amount of usable water in project storage would still not have exceeded 600,000 acre-feet on April 30, 1949. Such failure and refusal to release water at the greatest rate practicable until April 30, in compliance with such demand, was in violation of Article VIII of the Compact.

(4) At the end of the year 1950, the accrued debit of New Mexico was 263,100 acre-feet, of which 29,700 acre-feet was caused by hold-over storage, leaving a balance of 233,400 acre-feet, which was 33,400 acre-feet greater than the maximum permitted by the third unnumbered paragraph of Article VI.

(5) On January 1, 1951, the accrued debit of New Mexico was 263,100 acre-feet. The quantity of usable water in project storage was continuously less than 600,000 acre-feet from January 1, 1951, to April 30, 1951, inclusive. On January 9, 1951, the Commissioner for Texas demanded the release of debit water from New Mexico, pursuant to Article VIII of the Compact. The release of such water was not commenced until February 10, 1951, and was terminated on February 16, 1951. The flow of Rio Chama was thereafter stored, and on April 30, 1951, 29,440 acre-feet of water

was impounded in El Vado Reservoir. Such failure to release water at the greatest rate practicable until April 30, in compliance with the demand made by the Commissioner for Texas, was in violation of Article VIII of said Compact.

At the annual meeting of the Rio Grande Compact Commission held on February 23, 1951, the Commissioner for New Mexico proposed that in consideration of the fact that the accrued debit of New Mexico at the end of 1950 was greater than permitted by the Compact, and in view of the shortage of water in project storage, the outlets of El Vado Reservoir should be kept fully open throughout the 1951 irrigation season. Such proposal was approved by the Commission, but the Middle Rio Grande Conservancy District disregarded this action and the outlets of El Vado were not fully opened at any time during the irrigation season.

(6) On or about the first day of April, 1951, the amount of usable water in project storage became less than 400,000 acre-feet, and has since continuously been less than that amount. This shortage of water in project storage from which the Texas supply is received brought into effect the provision of Article VII of the Compact providing that: "Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs constructed after 1929 whenever there is less than 400,000 acre-feet of usable water in project storage." On January 1, 1951, there had been no accumulated overdraft on project storage requiring adjustment of the 400,000 acre-feet limit, as set forth in Article VII of the Compact. Nevertheless, after the amount of usable water in project storage had dropped below 400,000 acre-feet, on or about the first day of April, 1951, and until June 2, 1951, defendants did increase the amount of water in storage in El Vado Reservoir, which was constructed after 1929. The aggregate amount of such increase was 55,000 acre-feet, which was in violation of Article VII of said Compact.

(7) Since June 2, 1951, in spite of the fact that New Mexico had at that time an accrued debit of 263,100 acre-feet, an amount greater than the combined capacity of all reservoirs in New Mexico above San Marcial, water was released from El Vado Reservoir by defendants without authorization by the Commission and was diverted and used by New Mexico above San Marcial. Such action was in violation of the third unnumbered paragraph of Article VI, wherein it is provided: "Within the physical limitations of storage capacity in such reservoirs, New Mexico shall retain water in storage at all times to the extent of its accrued debit. . . ."

(8) During 1951, repeated demands were made by the Rio Grande Compact Commissioner for New Mexico upon the Middle Rio Grande Conservancy District that they comply with the terms of the Rio Grande Compact. Each of these demands was wholly or partially disregarded.

VII

The above violations of the Compact were made against the repeated protests of the Rio Grande Compact Commissioner for Texas, and said Rio Grande Compact Commissioner for Texas, acting within his official capacity, took every action and gave every notice required of him, or of the State of Texas, under the Compact to protect the interests of the State of Texas and its citizens thereunder. The supply of water required by the Compact to be delivered by New Mexico into Elephant Butte Reservoir for the benefit of the State of Texas has been seriously diminished as a result of these violations of the Compact on the part of the defendants, and the supply of water to the lands within Texas in the Rio Grande Valley above Fort Quitman has been correspondingly diminished as a result of such violations, to the great and irreparable damage of the State of Texas and its citizens.

VIII

Further, the above acts and omissions of the defendants are violative of the solemn obligations of New Mexico and of the rights of Texas as set out in said Compact, to the manifest wrong, injury, and oppression of the State of Texas and of its citizens and owners of lands within its boundaries. These violations have been deliberately and repeatedly made and manifest an intention upon the part of the defendants to continue such violations, and such violations will in all reasonable probability continue, unless the defendants are enjoined and restrained by this Court from committing such violations and are required to adhere to and carry out the terms of said Compact. In truth and in fact the Chief Engineer and Directors of the Middle Rio Grande Conservancy District have made statements indicating their intention not to adhere to the terms of said Compact, and on or about May 26, 1951, the Board of Directors of said District adopted the following Resolution:

> "WHEREAS, the terms of the Rio Grande Compact having been discussed and the members of the Board being familiar therewith, and
>
> "WHEREAS, the Board recognizes the responsibility of the State Engineer under the Rio Grande Compact, but because of the shortage of water and the dire necessity of the people of the Middle Rio Grande Conservancy District, NOW, THEREFORE, be it resolved, that the policy of the Board is to take care of the need of the farmers of the Middle Rio Grande Conservancy District insofar as it is possible with the limited supply of water available."

IX

At the close of the irrigation season on September 12, 1951,

there was only 17,500 acre-feet in Elephant Butte Reservoir and only 4,400 acre-feet in Caballo Reservoir. Largely because of the repeated violations of the Compact by the defendants, there is at the present time a wholly insufficient amount of water in project storage for the irrigation of lands in Texas, and in order to prevent a serious emergency and to provide an adequate supply of water for the irrigation of lands in Texas during the season of 1952, and thereafter, it is imperative that the defendants should be required immediately to allow water to flow into project storage and to comply with the Compact during the coming irrigation season and thereafter.

X

Unless the rights of the State of Texas and its citizens under the Rio Grande Compact are enforced by this Court, defendants will continue to wrongfully store, divert, and use waters of the Rio Grande in violation of the rights of the State of Texas and its citizens under said Compact, and the State of Texas and its citizens will suffer irreparable injury for which they have no adequate remedy except by this action.

WHEREFORE, plaintiff prays that a preliminary injunction issue restraining the State of New Mexico and the Middle Rio Grande Conservancy District, its directors, chief engineer, engineers, agents, and representatives from increasing the amount of water in storage in El Vado Reservoir, or any other reservoir constructed on the Rio Grande or its tributaries after 1929 in New Mexico above San Marcial, whenever and so long as there is less than 400,000 acre-feet of usable water in project storage, as provided by Article VII of said Compact; and that, upon final hearing, a decree be entered enjoining the State of New Mexico and the Middle Rio Grande Conservancy District, its directors, chief

engineer, engineers, agents, and representatives from storing water in El Vado Reservoir, or any other reservoir constructed on the Rio Grande or its tributaries after 1929 in New Mexico above San Marcial, whenever and so long as there is less than 400,000 acre-feet of usable water in project storage, as provided by Article VII of said Compact; and that said defendants be enjoined and restrained from diverting and using, within the State of New Mexico above San Marcial, any of the waters of the Rio Grande or its tributaries allocated to and due Texas under the Rio Grande Compact; that said defendants, their engineers, agents, and representatives, be further enjoined and restrained from diverting or using the waters of the Rio Grande or its tributaries in New Mexico above San Marcial until the accrued debit of New Mexico shall be not in excess of 200,000 acre-feet, except as such debit may be caused by holdover storage of water in reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and San Marcial; that said defendants be required to release water from storage reservoirs constructed after 1929 in New Mexico above San Marcial to the amount of the accrued debit of New Mexico at the greatest rate practicable under the conditions then prevailing, whenever at the beginning of any year the quantity of usable water in project storage is less than 600,000 acre-feet and when the Commissioner for Texas during the month of January of any such year demands such release of New Mexico, sufficient to bring the quantity of usable water in project storage to 600,000 acre-feet by March 1, and to maintain this quantity in storage until April 30; and that the Court retain jurisdiction to make such further orders as may be necessary to enforce its decree, and specifically for

the appointment of a water master to enforce the provisions of the decree of this Court in the event the decree is violated by the defendants, or any of them; and for such other and further relief to which plaintiff may be entitled in equity and good conscience.

Price Daniel

PRICE DANIEL
Attorney General of Texas

THE STATE OF TEXAS
COUNTY OF EL PASO

BEFORE ME, the undersigned authority, on this day personally appeared LOUIS A. SCOTT, Rio Grande Compact Commissioner for the State of Texas, who, being duly sworn deposes and says:

That he has read the foregoing Complaint; that he knows the contents of said Complaint; and that the facts and statements therein contained are true and correct.

Louis A. Scott

LOUIS A. SCOTT

SWORN TO AND SUBSCRIBED before me this the 27th day of October, 1951.

Anne Doyle

Notary Public, in and for
El Paso County, Texas.

NOTARY PUBLIC STATE OF TEXAS COUNTY OF EL PASO

ANNE DOYLE, Notary Public, El Paso County Texas. My Commission Expires June 1, 1953

EXHIBIT "A"

RIO GRANDE COMPACT

The State of Colorado, the State of New Mexico, and the State of Texas, desiring to remove all causes of present and future controversy among these States and between citizens of one of these States and citizens of another State with respect to the use of the waters of the Rio Grande above Fort Quitman, Texas, and being moved by considerations of interstate comity, and for the purpose of effecting an equitable apportionment of such waters, have resolved to conclude a Compact for the attainment of these purposes, and to that end, through their respective Governors, have named as their respective Commissioners:

For the State of Colorado—M. C. Hinderlider
For the State of New Mexico—Thomas M. McClure
For the State of Texas—Frank B. Clayton

who, after negotiations participated in by S. O. Harper, appointed by the President as the representative of the United States of America, have agreed upon the following articles, to-wit:

ARTICLE I.

(a) The State of Colorado, the State of New Mexico, the State of Texas, and the United States of America, are hereinafter designated "Colorado," "New Mexico," "Texas," and the "United States," respectively.

(b) "The Commission" means the agency created by this Compact for the administration thereof.

(c) The term "Rio Grande Basin" means all of the territory drained by the Rio Grande and its tributaries in Colorado, in New Mexico, and in Texas above Fort Quitman, including the Closed Basin in Colorado.

(d) The "Closed Basin" means that part of the Rio Grande Basin in Colorado where the streams drain into the

San Luis Lakes and adjacent territory, and do not normally contribute to the flow of the Rio Grande.

(e) The term "tributary" means any stream which naturally contributes to the flow of the Rio Grande.

(f) "Transmountain Diversion" is water imported into the drainage basin of the Rio Grande from any stream system outside of the Rio Grande Basin, exclusive of the Closed Basin.

(g) "Annual Debits" are the amounts by which actual deliveries in any calendar year fall below scheduled deliveries.

(h) "Annual Credits" are the amounts by which actual deliveries in any calendar year exceed scheduled deliveries.

(i) "Accrued Debits" are the amounts by which the sum of all annual debits exceeds the sum of all annual credits over any common period of time.

(j) "Accrued Credits" are the amounts by which the sum of all annual credits exceeds the sum of all annual debits over any common period of time.

(k) "Project Storage" is the combined capacity of Elephant Butte Reservoir and all other reservoirs actually available for the storage of usable water below Elephant Butte and above the first diversion to lands of the Rio Grande Project, but not more than a total of 2,638,860 acre feet.

(l) "Usable Water" is all water, exclusive of credit water, which is in project storage and which is available for release in accordance with irrigation demands, including deliveries to Mexico.

(m) "Credit Water" is that amount of water in project storage which is equal to the accrued credit of Colorado, or New Mexico, or both.

(n) "Unfilled Capacity" is the difference between the total physical capacity of project storage and the amount of usable water then in storage.

(o) "Actual Release" is the amount of usable water released in any calendar year from the lowest reservoir comprising project storage.

(p) "Actual Spill" is all water which is actually spilled from Elephant Butte Reservoir, or is released therefrom for flood control, in excess of the current demand on project storage and which does not become usable water by storage in another reservoir; provided, that actual spill of usable water cannot occur until all credit water shall have been spilled.

(q) "Hypothetical Spill" is the time in any year at which usable water would have spilled from project storage if 790,000 acre feet had been released therefrom at rates proportional to the actual release in every year from the starting date to the end of the year in which hypothetical spill occurs; in computing hypothetical spill the initial condition shall be the amount of usable water in project storage at the beginning of the calendar year following the effective date of this Compact, and thereafter the initial condition shall be the amount of usable water in project storage at the beginning of the calendar year following each actual spill.

ARTICLE II.

The Commission shall cause to be maintained and operated a stream gaging station equipped with an automatic water stage recorder at each of the following points, to-wit:

(a) On the Rio Grande near Del Norte above the principal points of diversion to the San Luis Valley;
(b) On the Conejos River near Mogote;
(c) On the Los Pinos River near Ortiz;
(d) On the San Antonio River at Ortiz;
(e) On the Conejos River at its mouths near Los Sauces;
(f) On the Rio Grande near Lobatos;
(g) On the Rio Chama below El Vado Reservoir;
(h) On the Rio Grande at Otowi Bridge near San Ildefonso;

TX_MSJ_005667

(i) On the Rio Grande near San Acacia;
(j) On the Rio Grande at San Marcial;
(k) On the Rio Grande below Elephant Butte Reservoir;
(l) On the Rio Grande below Caballo Reservoir.

Similar gaging stations shall be maintained and operated below any other reservoir constructed after 1929, and at such other points as may be necessary for the securing of records required for the carrying out of the Compact; and automatic water stage recorders shall be maintained and operated on each of the reservoirs mentioned, and on all others constructed after 1929.

Such gaging stations shall be equipped, maintained and operated by the Commission directly or in cooperation with an appropriate Federal or State Agency, and the equipment, method and frequency of measurement at such stations shall be such as to produce reliable records at all times.

ARTICLE III.

The obligation of Colorado to deliver water in the Rio Grande at the Colorado-New Mexico State Line, measured at or near Lobatos, in each calendar year, shall be ten thousand acre feet less than the sum of those quantities set forth in the two following tabulations of relationship, which correspond to the quantities at the upper index stations:

DISCHARGE OF CONEJOS RIVER

Quantities in thousands of acre feet

Conejos Index Supply (1)	Conejos River at Mouths (2)
100	0
150	20
200	45
250	75
300	109
350	147
400	188

450	232
500	278
550	326
600	376
650	426
700	476

Intermediate quantities shall be computed by proportional parts.

(1) Conejos Index Supply is the natural flow of Conejos River at the U. S. G. S. gaging station near Mogote during the calendar year, plus the natural flow of Los Pinos River at the U. S. G. S. gaging station near Ortiz and the natural flow of San Antonio River at the U. S. G. S. gaging station at Ortiz, both during the months of April to October, inclusive.

(2) Conejos River at Mouths is the combined discharge of branches of this river at the U. S. G. S. gaging stations near Los Sauces during the calendar year.

DISCHARGE OF RIO GRANDE EXCLUSIVE OF CONEJOS RIVER

Quantities in thousands of acre feet

Rio Grande at Del Norte (3)	Rio Grande at Lobatos less Conejos at Mouths (4)
200	60
250	65
300	75
350	86
400	98
450	112
500	127
550	144
600	162
650	182

TX_MSJ_005668

700	204
750	229
800	257
850	292
900	335
950	380
1000	430
1100	540
1200	640
1300	740
1400	840

Intermediate quantities shall be computed by proportional parts.

(3) Rio Grande at Del Norte is the recorded flow of the Rio Grande at the U. S. G. S. gaging station near Del Norte during the calendar year (measured above all principal points of diversion to San Luis Valley) corrected for the operation of reservoirs constructed after 1937.

(4) Rio Grande at Lobatos less Conejos at Mouths is the total flow of the Rio Grande at the U. S. G. S. gaging stations near Lobatos, less the discharge of Conejos River at its Mouths, during the calendar year.

The application of those schedules shall be subject to the provisions hereinafter set forth and appropriate adjustments shall be made for (a) any change in location of gaging stations; (b) any new or increased depletion of the runoff above inflow index gaging stations; and (c) any transmountain diversions into the drainage basin of the Rio Grande above Lobatos.

In event any works are constructed after 1937 for the purpose of delivering water into the Rio Grande from the Closed Basin, Colorado shall not be credited with the amount of such water delivered, unless the proportion of sodium ions shall be less than forty-five percent of the total positive ions

in that water when the total dissolved solids in such water exceeds three hundred fifty parts per million.

ARTICLE IV.

The obligation of New Mexico to deliver water in the Rio Grande at San Marcial, during each calendar year, exclusive of the months of July, August and September, shall be that quantity set forth in the following tabulation of relationship, which corresponds to the quantity at the upper index station:

DISCHARGE OF RIO GRANDE AT OTOWI BRIDGE AND AT SAN MARCIAL EXCLUSIVE OF JULY, AUGUST AND SEPTEMBER

Quantities in thousands of acre feet

Otowi Index Supply (5)	San Marcial Index Supply (6)
100	0
200	65
300	141
400	219
500	300
600	383
700	469
800	557
900	648
1000	742
1100	839
1200	939
1300	1042
1400	1148
1500	1257
1600	1370
1700	1489
1800	1608
1900	1730

2000	1856
2100	1985
2200	2117
2300	2253

Intermediate quantities shall be computed by proportional parts.

(5) The Otowi Index Supply is the recorded flow of the Rio Grande at the U. S. G. S. gaging station at Otowi Bridge near San Ildefonso (formerly station near Buckman) during the calendar year, exclusive of the flow during the months of July, August and September, corrected for the operation of reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and Otowi Bridge.

(6) San Marcial Index Supply is the recorded flow of the Rio Grande at the gaging station at San Marcial during the calendar year exclusive of the flow during the months of July, August and September.

The application of this schedule shall be subject to the provisions hereinafter set forth and appropriate adjustments shall be made for (a) any change in location of gaging stations; (b) depletion after 1929 in New Mexico at any time of the year of the natural runoff at Otowi Bridge; (c) depletion of the runoff during July, August and September of tributaries between Otowi Bridge and San Marcial, by works constructed after 1937; and (d) any transmountain diversions into the Rio Grande between Lobatos and San Marcial.

Concurrent records shall be kept of the flow of the Rio Grande at San Marcial, near San Acacia, and of the release from Elephant Butte Reservoir, to the end that the records at these three stations may be correlated.

ARTICLE V.

If at any time it should be the unanimous finding and determination of the Commission that because of changed

physical conditions, or for any other reason, reliable records are not obtainable or cannot be obtained, at any of the stream gaging stations herein referred to, such stations may, with the unanimous approval of the Commission, be abandoned, and with such approval another station, or other stations, shall be established and new measurements shall be substituted which, in the unanimous opinion of the Commission, will result in substantially the same results, so far as the rights and obligations to deliver water are concerned, as would have existed if such substitution of stations and measurements had not been so made.

ARTICLE VI.

Commencing with the year following the effective date of this Compact, all credits and debits of Colorado and New Mexico shall be computed for each calendar year; provided, that in a year of actual spill no annual credits nor annual debits shall be computed for that year.

In the case of Colorado, no annual debit nor accrued debit shall exceed 100,000 acre feet, except as either or both may be caused by holdover storage of water in reservoirs constructed after 1937 in the drainage basin of the Rio Grande above Lobatos. Within the physical limitations of storage capacity in such reservoirs, Colorado shall retain water in storage at all times to the extent of its accrued debit.

In the case of New Mexico, the accrued debit shall not exceed 200,000 acre feet at any time, except as such debit may be caused by holdover storage of water in reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and San Marcial. Within the physical limitations of storage capacity in such reservoirs, New Mexico shall retain water in storage at all times to the extent of its accrued debit. In computing the magnitude of accrued credits or debits, New Mexico shall not be charged with any

greater debit in any one year than the sum of 150,000 acre feet and all gains in the quantity of water in storage in such year.

The Commission by unanimous action may authorize the release from storage of any amount of water which is then being held in storage by reason of accrued debits of Colorado or New Mexico; provided, that such water shall be replaced at the first opportunity thereafter.

In computing the amount of accrued credits and accrued debits of Colorado or New Mexico, any annual credits in excess of 150,000 acre feet shall be taken as equal to that amount.

In any year in which actual spill occurs, the accrued credits of Colorado, or New Mexico, or both, at the beginning of the year shall be reduced in proportion to their respective credits by the amount of such actual spill; provided, that the amount of actual spill shall be deemed to be increased by the aggregate gain in the amount of water in storage, prior to the time of spill, in reservoirs above San Marcial constructed after 1929; provided, further, that if the Commissioners for the States having accrued credits authorize the release of part, or all, of such credits in advance of spill, the amount so released shall be deemed to constitute actual spill.

In any year in which there is actual spill of usable water, or at the time of hypothetical spill thereof, all accrued debits of Colorado, or New Mexico, or both, at the beginning of the year shall be cancelled.

In any year in which the aggregate of accrued debits of Colorado and New Mexico exceeds the minimum unfilled capacity of project storage, such debits shall be reduced proportionally to an aggregate amount equal to such minimum unfilled capacity.

To the extent that accrued credits are impounded in reservoirs between San Marcial and Couchesne, and to the extent that accrued debits are impounded in reservoirs above

San Marcial, such credits and debits shall be reduced annually to compensate for evaporation losses in the proportion that such credits or debits bore to the total amount of water in such reservoirs during the year.

ARTICLE VII.

Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs constructed after 1929 whenever there is less than 400,000 acre feet of usable water in project storage; provided, that if the actual releases of usable water from the beginning of the calendar year following the effective date of this Compact, or from the beginning of the calendar year following actual spill, have aggregated more than an average of 790,000 acre feet per annum, the time at which such minimum stage is reached shall be adjusted to compensate for the difference between the total actual release and releases at such average rate; provided, further, that Colorado or New Mexico, or both, may relinquish accrued credits at any time, and Texas may accept such relinquished water, and in such event the state, or states, so relinquishing shall be entitled to store water in the amount of the water so relinquished.

ARTICLE VIII.

During the month of January of any year the Commissioner for Texas may demand of Colorado and New Mexico, and the Commissioner for New Mexico may demand of Colorado, the release of water from storage reservoirs constructed after 1929 to the amount of the accrued debits of Colorado and New Mexico, respectively, and such releases shall be made by each at the greatest rate practicable under the conditions then prevailing, and in proportion to the total debit of each, and in amounts, limited by their accrued debits, sufficient to bring the quantity of usable water in project storage to 600,000 acre feet by March first and to

maintain this quantity in storage until April thirtieth, to the end that a normal release of 790,000 acre feet may be made from project storage in that year.

ARTICLE IX.

Colorado agrees with New Mexico that in event the United States or the State of New Mexico decides to construct the necessary works for diverting the waters of the San Juan River, or any of its tributaries, into the Rio Grande, Colorado hereby consents to the construction of said works and the diversion of waters from the San Juan River, or the tributaries thereof, into the Rio Grande in New Mexico, provided the present and prospective uses of water in Colorado by other diversions from the San Juan River, or its tributaries, are protected.

ARTICLE X

In the event water from another drainage basin shall be imported into the Rio Grande Basin by the United States or Colorado or New Mexico, or any of them jointly, the State having the right to the use of such water shall be given proper credit therefor in the application of the schedules.

ARTICLE XI.

New Mexico and Texas agree that upon the effective date of this Compact all controversies between said States relative to the quantity or quality of the water of the Rio Grande are composed and settled; however, nothing herein shall be interpreted to prevent recourse by a signatory state to the Supreme Court of the United States for redress should the character or quality of the water, at the point of delivery, be changed hereafter by one signatory state to the injury of another. Nothing herein shall be construed as an admission by any signatory state that the use of water for irrigation causes increase of salinity for which the user is responsible in law.

ARTICLE XII.

To administer the provisions of this Compact there shall be constituted a Commission composed of one representative from each state, to be known as the Rio Grande Compact Commission. The State Engineer of Colorado shall be ex-officio the Rio Grande Compact Commissioner for Colorado. The State Engineer of New Mexico shall be ex-officio the Rio Grande Compact Commissioner for New Mexico. The Rio Grande Compact Commissioner for Texas shall be appointed by the Governor of Texas. The President of the United States shall be requested to designate a representative of United States to sit with such Commission, and such representative of the United States, if so designated by the President, shall act as Chairman of the Commission without vote.

The salaries and personal expenses of the Rio Grande Compact Commissioners for the three States shall be paid by their respective States, and all other expenses incident to the administration of this Compact, not borne by the United States, shall be borne equally by the three States.

In addition to the powers and duties hereinbefore specifically conferred upon such Commission, and the members thereof, the jurisdiction of such Commission shall extend only to the collection, correlation and presentation of factual data and the maintenance of records having a bearing upon the administration of this Compact, and, by unanimous action, to the making of recommendations to the respective States upon matters connected with the administration of this Compact. In connection therewith, the Commission may employ such engineering and clerical aid as may be reasonably necessary within the limit of funds provided for that purpose by the respective States. Annual reports compiled for each calendar year shall be made by the Commission and transmitted to the Governors of the signatory States on or

before March first following the year covered by the report. The Commission may, by unanimous action, adopt rules and regulations consistent with the provisions of this Compact to govern their proceedings.

The findings of the Commission shall not be conclusive in any court or tribunal which may be called upon to interpret or enforce this Compact.

ARTICLE XIII

At the expiration of every five year period after the effective date of this Compact, the Commission may, by unanimous consent, review any provisions hereof which are not substantive in character and which do not affect the basic principles upon which the Compact is founded, and shall meet for the consideration of such questions on the request of any member of the Commission; provided, however, that the provisions hereof shall remain in full force and effect until changed and amended within the intent of the Compact by unanimous action of the Commissioners and until any changes in this Compact are ratified by the legislatures of the respective states and consented to by the Congress, in the same manner as this Compact is required to be ratified to become effective.

ARTICLE XIV.

The schedules herein contained and the quantities of water herein allocated shall never be increased nor diminished by reason of any increases or diminution in the delivery or loss of water to Mexico.

ARTICLE XV.

The physical and other conditions characteristic of the Rio Grande and peculiar to the territory drained and served thereby, and to the development thereof, have actuated this Compact and none of the signatory states admits that any

provisions herein contained establishes any general principle or precedent applicable to other interstate streams.

ARTICLE XVI.

Nothing in this Compact shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties or to the Indian tribes, or as impairing the rights of the Indian Tribes.

ARTICLE XVII.

This Compact shall become effective when ratified by the legislatures of each of the signatory states and consented to by the Congress of the United States. Notice of ratification shall be given by the Governor of each state to the Governors of the other states and to the President of the United States, and the President of the United States is requested to give notice to the Governors of each of the signatory states of the consent of the Congress of the United States.

IN WITNESS WHEREOF, the Commissioners have signed this Compact in quadruplicate original, one of which shall be deposited in the archives of the Department of State of the United States of America and shall be deemed the authoritative original, and of which a duly certified copy shall be forwarded to the Governor of each of the signatory States.

Done at the City of Santa Fe, in the State of New Mexico, on the 18th day of March, in the year of our Lord, One Thousand Nine Hundred and Thirty-eight.

M. C. Hinderlider
Thomas M. McClure
Frank B. Clayton

APPROVED:
S. O. Harper

RG 267 RECORDS OF THE SUPREME COURT OF THE UNITED STATES

ORIGINAL JURISDICTION CASE FILES, 1792-2005

1957 (BEGIN TX v. MN #9)

to

1957

Box 459 **PI 139** **Entry 26**

TX_MSJ_005674

RG 267 Entry 26 TX v NM #9

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IN THE

Supreme Court of the United States

OCTOBER TERM, 1951

No....., Original

STATE OF TEXAS,

Plaintiff

v.

STATE OF NEW MEXICO, ET AL,

Defendants

RETURN OF DEFENDANTS TO RULE TO SHOW CAUSE

TX_MSJ_005676

IN THE

Supreme Court of the United States

OCTOBER TERM, 1951

No. ....., Original

STATE OF TEXAS,

Plaintiff

v.

STATE OF NEW MEXICO, ET AL.,

Defendants.

RETURN OF DEFENDANTS TO RULE TO SHOW CAUSE

In response to the rule to show cause why leave to file the complaint tendered herein should not be granted, the defendants, jointly and severally, say:

I.

The United States of America is an indispensable party to the suit because:

(a) There are within the Rio Grande Basin in the State of New Mexico above San Marcial approximately 13,598 Indians belonging to some eighteen Pueblos. The United States has plenary control over these Indians and their Pueblos by virtue of the New Mexico Enabling Act (Act of June 20, 1910, 36 Stat. 557), the Constitution of New Mexico, Art. XXI, Sec. 2, and the Pueblo Lands Act (Act of June 7, 1934, 43 Stat. 636, 25 U.S.C.A. sec. 331, note). See also *U.S. v. Sandoval*, 231 U.S. 28; *U.S. v. Candelaria*, 271 U.S. 432. The rights of the Indians and the obligations of

TX_MSJ_005677

the United States to them are recognized by Article XVI of the Rio Grande Compact which reads thus:

> "Nothing in this Compact shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties or to the Indian tribes, or as impairing the rights of the Indian tribes."

The United States acting through the Secretary of the Interior has entered into a contract with the defendant Middle Rio Grande Conservancy District for the benefit of the Indians whereby certain facilities of the District are utilized to effectuate water deliveries to the Indians. Compliance with the resolution of the Rio Grande Compact Commission that the outlet gates of El Vado Reservoir be kept open during the 1951 season, as averred in Article VI (5) of the complaint, was protested by the Secretary of the Interior in his letter of March 27, 1951, a copy of which, marked Exhibit A, is attached hereto and by this reference made a part hereof.

(b) By its Convention with Mexico concluded May 21, 1906 (34 Stat. 2953) the United States is obligated to deliver to Mexico 60,000 acre feet of water annually in the bed of the Rio Grande above the city of Juarez, Mexico. Article XVI of the Rio Grande Compact, quoted *supra,* provides that nothing in the Compact shall be construed as affecting the obligations of the United States to Mexico under existing treaties. Water so delivered to Mexico comes from and through Elephant Butte Reservoir, the construction of which was contemplated by the 1906 Convention.

(c) The United States has constructed in New Mexico on the Rio Grande below San Marcial the Elephant Butte Reservoir which had an original capacity of 2,638,860 acre-feet and the Caballo Reservoir which when built had a capacity of 345,900 acre-feet. Below Elephant Butte and Caballo Reservoirs is the Rio

Grande Irrigation Project of the Bureau of Reclamation, Department of the Interior. Through facilities constructed by the Bureau of Reclamation water stored in Elephant Butte and Caballo Reservoirs is distributed to an area of 85,955 acres in New Mexico and 64,120 acres in Texas, according to 1950 figures. Prior to the construction of Elephant Butte Reservoir the dependable natural flow of the Rio Grande between San Marcial and Fort Quitman was fully appropriated under state laws. Rights to the use of water stored in Elephant Butte Reservoir on said land in Texas above Fort Quitman is based upon and exists solely by reason of contracts entered into between the Secretary of the Interior, acting for the United States, on the one hand, and the water users, or representatives of the water users, on the other hand. The Rio Grande Compact does not attempt to make any apportionment between the New Mexico area and the Texas area below Elephant Butte. In any proceeding to apportion between the two states the right to the use of such water the United States is an indispensable party because the United States has constructed and operates the facilities which store such water and make it available to such areas. Without such storage, water would be available to irrigate but an insignificant portion of the irrigated land in Texas above Fort Quitman because the natural dependable flow of the river below San Marcial was over-appropriated before 1906 and without the storage in Elephant Butte and Caballo Reservoirs no substantial quantity of water would be available for use in Texas.

(d) The Flood Control Act of 1948 (Act of June 30, 1948) in its Title II, Sec. 201, approves and authorizes, with certain limitations, the comprehensive plan for the Rio Grande Basin as set forth in the report of the Chief of Engineers dated April 5, 1948, and in the report of the Bureau of Reclamation dated November 21, 1947, all in substantial accord with the agreement approved by the Secretary of the Army and the Acting Secretary of the Interior on November

TX_MSJ_005678

21, 1947. Pursuant thereto the Secretary of the Interior has entered into a contract with the Middle Rio Grande Conservancy District for the acquisition by the United States of certain works and water rights of that District, including El Vado Dam and Reservoir. A copy of that contract, marked Exhibit B, is attached hereto and by this reference made a part hereof. By reason of the aforesaid law and contract the United States has a direct interest in the ownership and operation of El Vado Reservoir. By its complaint the State of Texas seeks a decree which will by the use of injunctive process control the storage and release of water from El Vado Reservoir. Such a decree, if entered, would affect the property and rights of the United States.

II.

The complaint does not present a justiciable controversy because:

(a) Adverse natural conditions beyond the control of the defendants have affected the ability of New Mexico to comply with the Compact while at the same time permitting the use of an inadequate quantity of water in the Middle Rio Grande Valley of New Mexico. Water was beneficially used and consumed in the Middle Rio Grande Valley many years before the construction of the Rio Grande Reclamation Project which serves the Texas lands above Fort Quitman. Recognizing the existence of such adverse natural conditions, Texas, New Mexico, and Colorado jointly supported the Middle Rio Grande Project which was authorized by the Congress in the Flood Control Act of 1948. Work is now in progress under that project. The channel improvements and water use facilities included within that project are the only known methods by which man may so improve the adverse natural conditions as to restore the stream to the condition in which it was at the time of the execution of the Rio Grande Compact. All this is well known to

Texas. Judicial relief will not correct the physical situation.

(b) No facts are alleged to show that the State of Texas has been deprived of its equitable share of the benefits arising from the flow of the Rio Grande. The Rio Grande Compact makes no apportionment of the use of such waters between the States of Texas and New Mexico. The allegations of the failure of New Mexico to make deliveries at San Marcial as required by the Compact and of the improper storage and release of water from El Vado Reservoir are insufficient to sustain a claim of injury to the State of Texas.

(c) No facts are alleged showing a serious injury of substantial magnitude to the State of Texas and its citizens.

(d) No facts are alleged showing that the administration of El Vado Reservoir and of the Rio Grande above San Marcial during the years complained of was not necessary and proper to assure compliance with the provisions of Article XVI of the Rio Grande Compact which is quoted above and which relates to the obligations of the United States to Mexico and to the Indians.

(e) There is no allegation that the storage and release of water from El Vado during the years complained of deprived the State of Texas and its citizens of any specific needed quantities of water. For all that appears in the complaint, the demands of the Texas Member of the Rio Grande Compact Commission were *pro forma* for the purpose of the record. Mere technical compact violations are insufficient to sustain an original action.

(f) There is no allegation that the New Mexico debits averred in the complaint were the results of actions taken by the defendants. There is no allegation of any excessive use or increased use of Rio Grande water in New Mexico. There is no allegation of waste of water by New Mexico or any of its water users.

TX_MSJ_005679

New Mexico and its water users may not be held accountable for drought and other adverse natural conditions which have diminished the flow of the Rio Grande and its tributaries.

(g) No facts are alleged which sustain any allegation that New Mexico threatens to violate the Rio Grande Compact in the future. The claim of threat is based solely upon an alleged resolution of the Middle Rio Grande Conservancy District. This did not constitute a threat, and is now meaningless, as the District has contracted to convey El Vado Reservoir and its other works and water rights to the United States. Attached hereto, marked Exhibit C, and by this reference made a part hereof, is an affidavit of the State Engineer of New Mexico which states that the gates of El Vado Reservoir are now open and it is his intent that they will remain open until they may be closed in compliance with the provisions of the Rio Grande Compact, or until the Rio Grande Compact Commission unanimously approves of their closing, or until the United States demands such closing to protect the rights of the Indian Tribes or Mexico.

III.

There is a misjoinder of parties defendant and claims in that the complainant asserts a claim against the State of New Mexico, and other and different claims against the Middle Rio Grande Conservancy District and against the individuals who constitute the Board of Directors of that District and against the individual who is Chief Engineer of that District. This constitutes a misjoinder and makes the complaint multifarious because:

(a) The District and the individual defendants were not parties to the Rio Grande Compact and may not be held liable for violations thereof;

(b) The State of New Mexico, as *parens patriae,* will stand in judgment for all of its water users in an original interstate action;

(c) The State of Texas may assert in the Courts of New Mexico any claim which it has against the Middle Rio Grande Conservancy District or the individual defendants and obtain adequate and proper relief. In this regard the State of New Mexico avers that its courts are open to the State of Texas for any such action which it may see fit to bring.

IV.

By seeking injunctive relief relating to the storage and release of water in El Vado Reservoir, located approximately 335 miles from the southern boundary line of the State of New Mexico, and to the delivery of water at San Marcial, located approximately 165 miles from the southern boundary line of the State of New Mexico, the State of Texas is in effect asserting a claim by the New Mexico area below San Marcial against the New Mexico area above San Marcial. This is in violation of Article XI of the Amendments to the Constitution of the United States. The State of Texas may complain only of a failure of New Mexico to deliver at the Texas-New Mexico state line water to which Texas is entitled. When the complainant enlarges its demand and claim to include a large area of New Mexico, it improperly includes matters which are beyond the original jurisdiction of the United States Supreme Court and which are intrastate in character and subject to determination by the Courts of the State of New Mexico.

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WHEREFORE, the defendants having shown cause, ask that the Rule be discharged and that leave to file the complaint be denied.

Respectfully submitted,

JOE L. MARTINEZ,
Attorney General of the State of New Mexico

FRED E. WILSON,
Special Assistant Attorney General of the State of New Mexico
Attorneys for the State of New Mexico

MARTIN A. THREET,
D. A. MACPHERSON, JR.
Attorneys for the Middle Rio Grande Conservancy District, Oscar M. Love, Loyal D. Betty, Emiliano Castillo, John T. Cook, L. G. Zartman, and Hubert Ball.

STATE OF NEW MEXICO
COUNTY OF BERNALILLO . . . . ss:

Before me, the undersigned notary public, on this day personally appeared John H. Bliss, State Engineer of the State of New Mexico, who being duly sworn, deposes and says: That he has read the foregoing Return of Defendants to Rule to Show Cause; that he knows the contents thereof, and that the statements of fact contained therein are true and correct.

John H. Bliss
JOHN H. BLISS

Subscribed and sworn to before me this 15th day of December, 1951.

J. G. Whitehouse
Notary Public

My commission expires: September 18, 1952.

"EXHIBIT A" TO RETURN

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON

March 27, 1951

My dear Mr. Johnson:

Reresentatives of the Area Office of the Bureau of Indian Affairs, Albuquerque, New Mexico, have brought to the attention of the Commissioner of Indian Affairs the decision of the Rio Grande Comact Commission made at its meeting at Santa Fe, New Mexico, on February 23 and 24, 1951, which reads:

> "In consideration of the fact that the accrued debit of New Mexico at the end of 1950 was greater than that permitted by the compact, and in view of the shortage of water in Project Storage, the New Mexico Commissioner proposed and the Commission concurred that the outlets of El Vado Reservoir shall be kept fully open throughout the 1951 irrigation season."

The Indians of the Pueblos of Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, and Isleta have first and prior water rights under the decision of the Supreme Court in the *Winters* case, 207 U.S. 564, for the irrigation of their lands. The Indians of these Pueblos receive their water through the works of the Middle Rio Grande Conservancy District. The district and the United States entered into a contract for this purpose pursuant to the Acts of Congress of February 14, 1927 (44 Stat. 1098) and March 13, 1928 (45 Stat. 312). There are a total of 20,242.05 acres of Indian lands involved. See 25 CFR 129.

It appears that the rights of the Indians would be adversely affected by carrying out the purposes of the

TX_MSJ_005681

Commission's resolution. It is not believed that the Commission intended by its action to infringe upon the prior water rights of the Indians. This belief is strengthened by the provisions of Article XVI of the Compact, which reads:

> "Nothing in this Compact shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties, or to the Indian Tribes, or as impairing the rights of the Indian Tribes."

This communication is to invite your attention to the situation that has arisen by reason of the adoption of the resolution and to request that the Commission take such further action with respect to the resolution as will prevent any interference with the prior vested water rights of the Pueblo Indians. Your prompt response will be appreciated.

Copies of this communication are being sent to the members of the Rio Grande Compact Commission, namely, Mr. M. C. Hinderlider, State Engineer, Denver, Colorado, Mr. John H. Bliss, State Engineer, Santa Fe, New Mexico, and Mr. Louis A. Scott, El Paso, Texas.

Sincerely yours,

(Signed) OSCAR L. CHAPMAN,
Secretary of the Interior

Hon. Berkeley Johnson
Chairman, Rio Grande Compact Commission
Santa Fe, New Mexico

I herewith certify that this is a true and correct copy of letter from the Secretary of Interior to Mr. Berkeley Johnson.

(Signed) LOUIS A. GARCIA,
Notary Public

My commission expires August 10, 1954.

(NOTARIAL SEAL)

"EXHIBIT B" TO RETURN

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CONTRACT BETWEEN UNITED STATES AND THE MIDDLE RIO GRANDE CONSERVANCY DISTRICT FOR REHABILITATION AND CONSTRUCTION OF PROJECT WORKS, AND REPAYMENT OF REIMBURSABLE CONSTRUCTION COSTS THEREOF

This contract made this 24th day of September, 1951 in pursuance of the Act of Congress of June 17, 1902 (32 Stat. 388), and acts amendatory thereof and supplementary thereto and particularly the Acts of Congress of June 30, 1948, (62 Stat. 1171) and Act of May 17, 1950 (64 Stat. 163), all collectively herein styled the Federal Reclamation Law, between the United States of America, herein styled the UNITED STATES, and the Middle Rio Grande Conservancy District, a body corporate and political division of the State of New Mexico having its principal office in the City of Albuquerque, State of New Mexico acting herein pursuant to the Conservancy District Reclamation Contract Act as amended, herein styled the DISTRICT.

WITNESSETH THAT:

EXPLANATORY RECITALS

2. WHEREAS, The District has constructed and is now operating certain works for the storage, diversion and distribution of waters of the Rio Grande for irrigation and drainage of arid lands and the protection of lands within the District and within the six Pueblos dealt with in the contract of December 14, 1928, between the United States and the said District, from the hazard of river floods, and;

3. WHEREAS, said river has aggraded its bed to the point where drainage and distribution works of the District are seriously impaired, resulting in the seepage of large

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areas of District lands and the consequent waste of water which could otherwise be beneficially used in the irrigation of District lands, and;

4. WHEREAS, investigators have developed a comprehensive plan for the control of the Rio Grande in the reach thereof extending approximately from the Colorado-New Mexico State boundary line to the Caballo Reservoir, and under such plan there has been assigned to the Department of the Interior, among other things, those parts having to do with the degradation of the bed of the river and relief of District lands from their present seeped condition, and for the saving of District water now wasting as a result of impairment of the District drains and for the protection of lands within the District from the hazards of floods, which plan is referred to in House Document No. 243 of the 81st Congress, 1st Session, and by Act of Congress of May 17, 1950 (64 Stat. 163), the Secretary is authorized to construct the Middle Rio Grande Project to accomplish such plan as modified by such authorizing act, and;

5. WHEREAS, the authorizing acts of Congress contemplate as a condition precedent to construction of that part of such plan assigned to the Department of Interior, Bureau of Reclamation, the entering into of a repayment contract between the United States and the District whereby the United States will undertake to construct the project and the District will agree to pay the reimbursable construction cost thereof, and;

6. WHEREAS, in pursuance of Chapter 37, Laws of New Mexico, 1935, the District has set up and established a Conservation and Development fund for the following purposes:

(a) For the redemption, purchase and development of lands in the District which have been sold to the State of New Mexico for nonpayment of taxes.

(b) And for such other purposes as in the discretion of the Board of Directors may be deemed necessary; and

7. WHEREAS, there are within the exterior boundaries

of the District the Pueblo Indian lands referred to in Article 2 of this contract which lands and water rights recognized therefor are not under the jurisdiction of, or subject to the laws of New Mexico governing the District and for which the total share of the cost of works constructed by the District for the benefit and use of the Pueblos have been paid in full to the District. The payment made to the District, covered among other rights the Indians' interest in and to the El Vado Storage Reservoir and other works constructed by the District. The Indian lands are entitled to the use of waters of the Rio Grande and its tributaries and are served by the storage, diversion and distribution works constructed by the District, and have shared with District lands the cost of operation and maintenance of certain of such works by contracts, the last of which is dated February 10, 1947, between the District and the United States, pursuant to the Acts of Congress approved March 13, 1928 (45 Stat. 312), August 27, 1935 (49 Stat. 887), June 20, 1938 (52 Stat. 779), and April 24, 1946 (60 Stat. 121),

NOW, THEREFORE, it is agreed as follows:

DEFINITION OF TERMS

8. The following terms as used in this contract shall have the meaning set forth immediately opposite thereof as follows:

United States:	The United States of America.
District:	The Middle Rio Grande Conservancy District.
Project:	That Part of the comprehensive plan assigned for construction by the Bureau of Reclamation, Department of the Interior by Agreement, dated July 25, 1947 referred to in House Document No. 243 of the 81st Congress, 1st Session.

TX_MSJ_005683

Construction: The term construction, as used in this contract, shall consist of rehabilitation and extension of the irrigation and drainage system of the District, rehabilitation and repair of El Vado Dam, repairs to diversion dams and related irrigation and drainage structures; acquisition of outstanding bonds; and rectification of the Rio Grande Channel.

Construction cost notice: Any notice furnished the District by the contracting officer announcing completion of construction of the project and setting forth the actual or estimated reimbursable construction costs of the project.

Contracting Officer: The Secretary of the United States Department of the Interior or his duly authorized representative.

District works: Those structures, reservoirs, ditches and canals now constructed and operated by the District and those to be constructed or rehabilitated under the terms of this contract for the storage, diversion and distribution of water for use in the District, and the drainage of lands, together with rights of way therefor and for operation thereof.

Transferred works: District works, operation and maintenance of which are turned over to the District for operation and maintenance.

Reserved works: District works, operation and maintenance of which are retained in the United States.

Irrigable lands: Irrigable lands shall be as subsequently expressed and defined in Article 40 of this contract.

UNITED STATES WILL CONSTRUCT WORKS

9. To the extent funds are, and may be made available therefor, the United States will within the limitations of this contract construct the Project comprising the following features:

(a) Acquire through the District at prices satisfactory to the Contracting Officer, the outstanding bonds, evidencing the present bonded obligation of the District.

(b) Rehabilitate and extend the irrigation and drainage system of the District including the El Vado Dam and Reservoir. Before undertaking any such rehabilitation work, the United States shall submit its program and plan therefor annually in advance thereof to the District for consultation and advice.

(c) Rectify the channel of the Rio Grande in the Middle Rio Grande Valley, including the Espanola Valley and the Hot Springs area; also dredging from near the south boundary of the District into the Elephant Butte Reservoir. Provided, that the features of the project above designated and their order of construction may be varied, and as thus varied, constructed in the order, all as determined by the contracting officer.

DISTRICT TO CONTINUE ASSESSMENTS DURING CONSTRUCTION PERIOD

10. Until completion of construction of the project, as determined by issuance of the construction cost notice the

TX_MSJ_005684

District agrees, unless a different method is sooner mutually agreed upon by the contracting parties, to continue to make assessments and collections for all purposes against the property in the District subject thereto, and after the beginning of construction of the reimbursable portion of the project as determined by the Contracting Officer, it shall:

(a) After deducting from such collections of operation and Maintenance assessments, the reasonably necessary costs of administration of the affairs of the District, pay to the United States so much of the balance of such collections of operation and maintenance assessments as may be required to meet its costs of operating and maintaining the project work during construction.

(b) After paying from such collections of Construction or Sinking Fund assessments, principal of, and interest maturing on, such of the District bonds as may not have been acquired and transferred to the United States, the District shall pay annually the balance of such collections of Construction or Sinking Fund assessments to the United States to be applied at the time of issuance of the construction cost notice upon the reimbursable construction charges payable by the District hereunder. Provided that, so long as there are outstanding District bonds not acquired and transferred to the United States, the District shall be permitted to retain so much of the collections from Construction or Sinking Fund assessments as it shall estimate will be required to pay the principal of any such bonds maturing during the following calendar year together with interest maturing on all such outstanding bonds during such following calendar year.

ESTIMATED REIMBURSABLE COST

11. The costs of features (a) and (b) in Article 9 described are estimated on the basis of the 1947 price index as not in excess of $18,000,000 of which $1,467,000 is allocated as the estimated cost of the share of Indian lands within the

District area, which amount or any amount so allocated shall not be reimbursable. When there shall have been made expenditures equal to the amount determined by the Contracting Officer as necessary for the construction of said features, they shall be deemed to have been completed within the meaning of this contract. In the event that the amount required for completion of construction of said features exceeds the above estimates, the District agrees to repay up to a maximum of $10,440,000 for features described in Article 9 (b), exclusive of the cost of constructing works for the benefit of Indian lands within the District area, and in addition thereto the costs incurred by the United States in acquiring said bonds through the District as described in Article 9 (a) hereof, not exceeding a maximum of $7,560,000, provided however that in the event the United States does not acquire and cancel said bonds of the District on or before January 1, 1952, at the option of the District the maximum obligation of the District hereunder may be reduced by the amount of interest and principal required to be paid by the District on its bonds accruing after said date, and the construction work to be performed under Article 9 (b) hereof shall be reduced accordingly. Provided further that no expenditures shall be made on said features in excess of the District's obligation as herein provided unless additional funds are made available therefor and the District shall have entered into a suitable contract for payment to the United States of said additional costs.

PAYMENT OF REIMBURSABLE CONSTRUCTION COSTS

12. At the termination of construction as determined by the Contracting Officer, as in Article 11 hereof provided, he shall give the District notice thereof which shall set forth (1) the actual costs of constructing features of the project described in subparagraphs (a) and (b) of Article 9; (2) the amount of such costs to be repaid by the District; (3) the credits to the District for payment to the United States of the net proceeds from collection of assessments during the construction period as provided in Article 10 hereof, and the balance thereof shall be payable by the District to the

TX_MSJ_005685

United States in forty (40) consecutive annual installments, each of which may be paid one-half thereof on February 1 and the other on August 1 of each year commencing with the year succeeding that in which such construction cost notice is given, if given prior to September 1; otherwise commencing with the second year succeeding that in which such notice is given.

Provided that if a final determination of such costs and of the District's obligation hereunder cannot be made at the time such notice is given, said notice shall contain an estimate of such obligation, which shall determine the amount of installments payable by the District until such time as the actual obligation of the District can be determined and notice of such determination is given to the District, at which time any difference between the estimated and actual obligation of the District shall be spread equally as a charge or credit as the case may require over the installments maturing following the issuance of such construction cost notice.

OPERATION AND MAINTENANCE OF DISTRICT WORKS

13. The District works will be operated and maintained in the following manner:

(a) Commencing within seven (7) months after appropriations become available for carrying on the work described in subparagraphs (a) and (b) of Article 9 hereof, the United States will operate and maintain the District works during construction on payment by the District to the United States in advance, the estimated cost thereof as set forth in a notice to be given by the Contracting Officer to the District. Provided, that the District is maintaining at El Vado Dam and Reservoir certain recreation facilities and it may continue during the term of this contract to operate, construct, reconstruct and maintain any and all such facilities at its sole cost and responsibility and will save and hold the United States and its officers and agents, harmless from any and all claims for damages incident

to or arising out of its construction, reconstruction, operation and maintenance of such facilities. Provided further, that any and all such facilities and the operation and maintenance thereof shall not interfere with the repair, operation and maintenance of such dam and reservoir by the United States for the purposes as in this contract provided.

(b) Simultaneous with, or at any time following, the issuance of the construction cost notice, the contracting officer may issue a notice to the District requiring it to assume the operation and maintenance of transferred works and the District agrees within 6 months following the issuance of such notice to accept the operation and maintenance of such transferred works. By like notice the Contracting Officer may terminate the agency of the District in the operation and maintenance of any or all such transferred works, and within 6 months following the issuance of such notice the United States may again take over and assume the operation and maintenance of any or all such transferred works as reserved works.

(c) No substantial change shall be made by the District in any of the transferred works without first obtaining the written consent of the Contracting Officer. The District shall promptly make any and all repairs to the transferred works which in the opinion of the Contracting Officer are deemed necessary for their proper care, operation and maintenance. If at anytime in the opinion of the Contracting Officer, any part of the transfered works shall from any cause be in a condition unfit for service, he may order the water turned out and shut off from that part of the District works until in his opinion, such works are put into proper condition for service. In case of neglect or failure of the District to make such repairs United States may cause such repairs to be made and charge the cost thereof to the District, which charge the District shall pay in the manner provided in Article 16 hereof.

(d) At all times during the operation and maintenance

TX_MSJ_005686

of any district works by the United States the Contracting Officer will on or before May 1 of the year preceding that in which operation and maintenance charges therefor shall become due and payable, issue a notice to the District setting forth an estimate of the costs to the United States of so operating and maintaining such works and the District agrees to pay the amount of such estimates, one-half thereof on or before February 1 and the remainder on or before August 1 of the year for which such operation and maintenance charges accrue. Provided that if the present method of assessment and collection now in use by the District is changed, the dates on which the semi-annual installments herein specified are payable shall be as then agreed upon by the Contracting Officer and the District. If the amount set forth in said notices and paid to the United States for operation and maintenance of such works is insufficient for that purpose the Contracting Officer may at any time issue a supplemental notice to the District stating that additional funds will be required therefor and the amount set forth therein shall be due and payable from the District to the United States on the date or dates set forth in such notice. At the end of each year in which the United States operates and maintains any such works the Contracting Officer will provide the District with a statement of the actual costs of operation and maintenance thereof and any amount by which the estimate exceed the actual costs will be taken into consideration in estimating the costs of operating and maintaining of such works payable by the District for the next succeeding year.

(e) In the event and to the extent funds are continued to be made available by appropriation to pay the Indian share of the cost of operation and maintenance of the District Works, allocated to the newly reclaimed Indian lands as provided in the contract referred to in Article 7 hereof, the District will be relieved in like amount of its obligations to pay the cost of operation and maintenance of the District works. In the event of failure of appropriations to meet the Indian share of the cost of

operation and maintenance of the District Works the District shall pay the entire cost thereof; provided, however, that the contracting parties hereto agree to use their best efforts to obtain continuing appropriations from the Congress for the purposes expressed in this paragraph, but in any event the duty of the District or the operator of said works to deliver the water to which the Indian lands are entitled and to do the operation and maintenance work for the benefit of Indian lands shall not be changed by the provisions hereof so as to affect adversely the rights of the Indians or Indian lands.

NON-REIMBURSABLE FEATURES OF THE PROJECT

14. The work described in Article 9(c) or so much thereof as is deemed necessary by the Contracting Officer and for which appropriations may become available shall be constructed by the United States. The District shall not be obligated to pay the construction, operation and maintenance costs of such works: Provided, that the District will cause to be furnished without cost to the United States all necessary rights of way for such work of river channel rectification within the project to the upper end of the Elephant Butte Reservoir, and will save and hold the United States harmless from any and all claims for damages arising out of or occurring in connection with the rectification of the river channel within the limits of the project above described, providing that nothing herein contained shall be construed to hold the District responsible for death, personal injuries or damages to personal property suffered or sustained to persons or property in connection with the actual construction work of such rectification. Provided further, that the United States will make available without cost to the District rights of way for such works over public lands of the United States as in the opinion of the Contracting officer may be practicable.

TX_MSJ_005687

INSPECTION OF TRANSFERRED WORKS

15. The contracting officer may cause to be made from time to time a reasonable inspection of the transferred works to ascertain whether the terms of this contract are being satisfactorily carried out by the District. The actual expense of such inspection shall be paid by the District to the United States in the manner provided in Article 16 hereof.

DISTRICT TO PAY MISCELLANEOUS COSTS

16. In addition to the payments of reimbursable construction costs and operation and maintenance costs required to be made by the District under this contract, the District shall pay to the United States on or before August 1 of the year following that in which the same shall have been incurred and statement rendered therefor, the costs of repairs and inspection of transferred works as provided in Articles 13 and 15 hereof.

COMPUTATION OF COSTS

17. The costs of the project which shall be the basis of determining the District's obligation hereunder shall embrace all expenditures of whatsoever kind in connection with, growing out of, or resulting from construction, operation and maintenance of the reimbursable features of the project including the cost of labor, material, equipment, engineering and legal work, superintendence, administration and overhead, acquisition of District's outstanding bonds and all costs incident thereto, rights of way, property damage and damage of all kinds; provided that the amount chargeable to the District for project investigations, engineering, legal work, superintendence, administration and overhead, performed prior to June 30, 1950, shall not exceed the sum of $265,626; provided further, that the costs of project investigations, engineering, legal work, superintendence, administration and overhead, performed after June 30, 1950 which the District is obligated to repay shall be limited to the actual costs incurred in reference to features within the District boundaries as are described in Article 9, Sections (a) and (b).

INTEREST UPON DELINQUENCY IN PAYMENT

18. Every payment of money required to be made by the District to the United States under this contract which shall remain unpaid after the same shall have become due, shall bear interest at the rate of six percent per annum until paid, and the District hereby agrees to pay said interest.

AGREED CHARGES A GENERAL OBLIGATION OF THE DISTRICT

19. The District as a whole is obligated to pay to the United States the full amount or amounts herein agreed upon according to the terms stated, notwithstanding the individual default in the payment to the District by individual property owners of assessments, tolls or other charges levied by the District.

LEVY OF TAXES AND ASSESSMENTS FIXING OF RATES AND TOLLS

20. The District agrees that it will cause to be levied and collected all necessary taxes and assessments and cause to be fixed or established all necessary charges, rates and tolls and that it will use all its powers and resources, including the taxing power and the power to levy special assessments, and the power to withhold delivery of water, to collect and pay to the United States and to make payments promptly on the due dates thereof of all amounts which the District by provisions of this contract are obligated to pay to the United States.

ALL BENEFITS CONDITIONED ON PAYMENT

21. Should any assessment or assessments required by the terms of this contract and levied against any tract of land or water user in the District be judicially determined to be irregular or void or the District or its officers be enjoined or restrained from making or collecting any assessments upon such land as provided for herein, then such tract or water user shall have no right to any of the benefits of this contract

TX_MSJ_005688

and no water made available through the works constructed or rehabilitated by the United States hereunder shall be delivered to or for such tract of land or water user. Should the District fail to levy or collect the necessary taxes or assessments to pay to the United States the amounts herein agreed to be paid, or should any such levy of taxes or assessments, rates or tolls made by the District be judicially determined to be irregular or void, then the Contracting Officer may proceed to assess the construction and operation and maintenance charges for the use of water, in the manner provided for in the said Federal Reclamation Laws and may require payment thereof as a condition precedent to the delivery of water, or may himself make an apportionment of any construction or operation and maintenance indebtedness of the District to the United States among the various users of water in the District and may issue public notices to the full extent authorized under any of said Reclamation laws; and the Contracting Officer may, upon notice to the District require that no water furnished from any works constructed by the United States shall be delivered to or for any tract or tracts of land or water user in the District until the construction and operation and maintenance charges at the rates and upon the terms and conditions provided for herein, or in the said public notices hereafter issued, shall have been paid or prepaid to the United States. Contract or contracts, if any, between the District and the water users for the use and distribution of water from the said project works shall provide that such use and distribution of water from the said project works shall be subject to the terms of this contract. In the event that any assessment, rates or tolls levied by the District for the purpose of meeting the payments provided for in this contract is judicially determined to be irregular or void on account of the failure or neglect of the District to comply with any legal requirement or on account of any legal defect in the proceedings of the District, or for any other reason, the District is hereby authorized as fiscal agent of the United States to collect on account of the land on which such defective assessment, rates or tolls is levied and from the owners thereof and other water users under contract, the proportionate share of the charges provided herein, applicable to such land and water

users and to require payment thereof as a condition precedent to the delivery of water; and the District shall promptly pay over all such operation and maintenance or rental charges if any as from time to time become due to the United States. It is further agreed that the payment of construction, operation and maintenance charges at the rate and upon the terms and conditions provided for herein or in the public notices provided for herein and applicable to the land in question and other users of water under contract, is a prerequisite to the right to receive water from any of the works constructed by the United States; and no irregularity in levying taxes, assessments, rates or tolls by the District nor lack of authority in the District whether affecting the validity of District taxes, assessments, rates or tolls or not shall be held to authorize or permit any water user or the District to demand or receive water made available through irrigation works constructed or rehabilitated by the United States hereunder unless construction and operation and maintenance charges at the rates and upon the terms and conditions provided for herein or in said public notices have been paid by such water user.

REFUSAL OF WATER IN CASE OF DEFAULT

22. No water shall be furnished to the District or by the District to or for the use of any lands or water users therein during any period in which the District may be in arrears in the payment of charges accruing under this contract. No water shall be furnished to or by the District pursuant to this contract for land or water users, in arrears in the payment to the District of any assessments, tolls or other charges of the District levied or established by the District for the purpose of raising revenues to pay its obligation to the United States under this contract. The provisions of this article are not exclusive and any action taken pursuant hereto shall not preclude the United States from exercising any other remedy to enforce collection of any amounts due hereunder.

TX_MSJ_005689

UNITED STATES NOT LIABLE FOR WATER SHORTAGES

23. Should there ever occur a shortage in the quantity of water which normally would be available through and by means of said project works constructed in connection therewith, in no event shall any liability accrue therefor against the United States, or any of its officers, agents or employees for any damage direct or indirect arising therefrom and the payments to the United States provided for herein shall not be reduced because of any such claimed shortage or damage.

CONSERVATION AND DEVELOPMENT FUND

24. The assets of the Conservation and Development Fund and the accretions thereto, shall remain in the possession of and under the control of the District and the District agrees to continue the use of such fund for the purposes and in the manner in which it has heretofore been used; including its use as a reserve fund to meet emergent major repairs for which operation and maintenance funds are not immediately available. Provided, that if any part of such fund is used to make major repairs to project works as determined by the Contracting Officer to be necessary, the District shall thereafter increase operation and maintenance assessments to the extent it deems necessary to produce funds with which to restore to the Conservation and Development fund the monies used to make such major repairs and such increased operation and maintenance assessments shall be continued for such period of time as may be reasonably necessary in the opinion of the Board of Directors of the District.

GUARANTY FUND TO BE MAINTAINED

25. Pursuant to Chapter 50, Laws of New Mexico, 1931, the District established and has maintained a Guaranty Fund as provided therein and it is agreed that the District shall continue to maintain said Guaranty Fund in accordance with the provisions of said Chapter 50, Laws of New Mexico, 1931; provided, however, that upon acquisition of all bonds by the United States, the Guaranty Fund will be applied to the reimbursable costs of the project.

DISTRICT WILL CALL AND CONVEY OUTSTANDING BONDS AND PROJECT WORKS TO THE UNITED STATES

26. The District shall perform the service of calling all of its outstanding bonds for purchase by the United States at prices satisfactory to the Contracting Officer. The District shall convey to the United States with title satisfactory to the Contracting Officer such of the District works now owned by the District, as shall be required to be conveyed to the United States as determined by the Contracting Officer. But this contract is executed upon the express understanding and condition that while the legal title to the District works conveyed to the United States under the terms of this contract or by any separate instruments executed pursuant to its terms may continue thereafter in the United States, upon full compliance by the District with all covenants required to be performed by it under the terms hereof, including the repayment in full to the United States of all sums of money and at times, and on conditions as herein provided, and on consent of Congress, the United States will reconvey to the District all District works transferred to the United States, under the provisions of this contract, and additions thereto; Provided, however, that any such reconveyance shall not adversely affect any common property right of the United States held for and on behalf of the Pueblo Indians.

RIGHTS OF WAY

27. The United States shall not commence construction of any feature of the project within the boundaries of the District until all necessary rights of way therefor have been secured, or satisfactory contracts entered into for the purchase thereof; Provided, that the United States will use in construction of the project so much of its public lands and rights of way reserved to it by the Act of August 30, 1890 (26 Stat. 391), as the Contracting Officer may find practicable. Rights of way for the rectification of the river channel above the Elephant Butte Reservoir shall be supplied by the District without cost to the United States as provided in

TX_MSJ_005690

Article 14 hereof. All other rights of way required for constructing the reimbursable features of the project shall be acquired as hereinafter provided and payment made therefor by the United States and costs thereof in the amount so paid shall be a part of the reimbursable construction costs of the project.

Upon request of the Contracting Officer, the District shall negotiate for the acquisition of project rights of way, using for that purpose such forms of contracts and deeds and other land title papers as may be required by the Contracting Officer and as to such acquisitions effected by purchase, at prices satisfactory to the Contracting Officer. In case rights of way may not be acquired by agreement with its owners, the District shall, as requested by the Contracting Officer procure the same by exercise of the District's power of eminent domain. On payment of award in condemnation and when title to lands being condemned vests in the District, it will convey the same to the United States, and the District shall be paid therefor that amount fixed by the award as in such condemnation action. Expenses of the District in acquiring such rights of way by action in condemnation shall be paid to the District on the basis of semi-annual statements submitted by the District and shall be charged as a part of the project reimbursable construction costs.

PROJECT WATER SUPPLY

28. The District has made certain water filings including filings for storage and use of water in the El Vado Reservoir and it shall cause any and all such filings made in the name of the District to be assigned to the United States for beneficial use in the project and for Indian lands in the project area, and which shall be held primarily for domestic, irrigation and municipal use in the project and for Indian land in the project area, and for such use and development of hydroelectric energy by the United States as may be made of the waters thus appropriated, incident to the storage, carriage and distribution to and for such domestic irrigation and municipal use.

There is claimed and reserved by the United States for

the use of the District and the Indians for domestic, irrigation and municipal uses all of the increment, waste, seepage and return flow water which may result from the construction and operation of the project.

The District may, subject to approval of the Contracting Officer, or the Contracting Officer may to the extent now or hereafter authorized by law and insofar as can be done without adversely affecting Indian rights, contract for the disposal of a part of the project water supply for any use not detrimental to the primary uses herein specified; Provided, that all payments collected by the District shall be paid over promptly to the United States, for credit upon any unpaid obligations of the District under this contract.

TITLE TO REMAIN IN UNITED STATES

29. Title to all works constructed by the United States under this contract and to all such works as are conveyed to the United States by the provisions hereof, shall, as provided in Article 26, be and continue to be vested in the name of the United States until otherwise provided for by Congress, notwithstanding the transfer hereafter of any such works to the District for operation and maintenance.

CHANGES IN ORGANIZATION OF DISTRICT

30. While this contract is in effect no change shall be made in the District either by inclusion or exclusion of lands by partial or total consolidation with another District, by proceedings to dissolve or otherwise except upon the Contracting Officer's written assent thereto.

UNITED STATES NOT LIABLE FOR DISTRICT'S ACTS

31. The District shall hold the United States, its officers and agents harmless as to any and all damage which may in any manner result from acts of the District or any of its officers or agents, in the operation and maintenance of the transferred works by the District.

TX_MSJ_005691

LIMITATION ON AREA TO BE FURNISHED WATER

32. The irrigation water supply furnished through the project works constructed or rehabilitated in pursuance of this contract shall be delivered in accord with the excess land provisions of the Federal Reclamation laws and regulations of the Secretary promulgated thereunder; Provided, that nothing in such regulations shall interfere with any vested water right as provided in Section 8 of the Reclamation Act of June 17, 1902 (32 Stat. 388), and in Section 203 Title II, Flood Control Act of June 30, 1948 (62 Stat. 1171).

DISTRICT TO KEEP BOOKS AND RECORDS AND REPORT CROP AND OTHER DATA

33. To such extent and in such manner and form as may be prescribed by the Contracting Officer, the District shall establish and maintain accounts and other books and records and furnish to the Contracting Officer reports and statements as to information contained therein pertaining to accounts and financial transactions by the District, crops and livestock produced on the land served by the District works, also the annual water supply and the disposition of the same, a report thereon to be furnished to the Contracting Officer annually on or before December 31.

INDIAN LANDS

34. Nothing in this contract shall be construed to abrogate or impair existing obligations of the United States or any agency thereof, including obligations to furnish water for irrigation and obligations to any Indian or tribe or band of Indians, whether based on treaty, agreement or Act of Congress.

The status of the Indian lands and water rights in relation to the Conservancy District and the Bureau of Reclamation shall not be changed whether the works of said District are operated by the District or by the Bureau of Reclamation.

Nothing in this contract contained shall be construed to

affect adversely the rights of Indians under existing contracts between the United States on behalf of said Indians and the District or under existing laws of the United States relating to the rights of said Indians. Moreover, the priority of right and the quantity of water to which the Indians are entitled shall not be adversely affected and are saved to the Indians by the provisions hereof, and every paragraph and provision of this contract shall be so interpreted and construed as to save such rights unimpaired. It is also agreed that none of the provisions in paragraphs 20, 21 or 22 hereof shall apply to Indian lands or Indian water rights or affect adversely the right of the Indians to have delivered to their lands the water they are entitled to. It is further agreed that nothing in paragraph 32 hereof relating to the excess land provisions of the Federal Reclamation laws and regulations promulgated thereunder shall be construed as applying to the lands or water rights of the Indians.

INSPECTION OF BOOKS AND RECORDS

35. Subject to applicable Federal laws and regulations, the proper officers or agents of the District shall have full and free access at all reasonable times, to the project account books and official records of the Bureau of Reclamation relating to construction, operation and maintenance of project works with the right at any time during office hours to make copies thereof and the proper representatives of the United States shall have similar rights in respect to the account books of the District.

SECRETARY ARBITER OF DISPUTES INVOLVING QUESTIONS OF FACT

36. In the event of disputes between the parties hereto arising out of this Contract involving questions of fact, and insofar as the provisions hereof require a determination of fact to be made, the Contracting Officer is hereby designated as the arbiter of such questions, and as the one required to make such determination of facts. His decision thereon, however, shall not be conclusive and binding upon the District until after the Secretary of Interior has given the

TX_MSJ_005692

District formal hearing in reference to such dispute or disputes, if the District shall so request, and until the Secretary, after such hearing, has given his decision thereon in writing.

CONTINGENT UPON APPROPRIATIONS

37. The expenditures of any money or the performance of any work by the United States herein provided for which may require appropriations of money by Congress shall be contingent upon such appropriations. The failure of Congress to so appropriate funds shall not relieve the District from any obligations under this contract and no liability shall accrue against the United States in case such funds are not so appropriated; Provided, it is the intent and purpose of both parties to this Contract that the acquisition and cancellation by the United States of the outstanding bonds, evidencing the present bonded obligations of the District, as provided in Article 9 (a) of this Contract, shall be accomplished at the earliest date possible in order that:

(a) The present method of assessment under the Conservancy Act may be discarded and the more equitable method of assessment adopted, as provided herein under the terms of the Conservancy District Reclamation Contract Act and the Federal Reclamation Law.

(b) Savings may be made to the District and the United States by the elimination of interest payments on the outstanding bonds.

PERTINENT PROVISIONS OF CONSERVANCY ACT —TO APPLY TO LANDS OF THE UNITED STATES STATE OF NEW MEXICO AND ITS POLITICAL SUBDIVISIONS WITHIN THE DISTRICT

38. In pursuance of the provisions of Section 77-3105 New Mexico Statutes Annotated (1941), and the provisions of the Conservancy Act of New Mexico relating to the assessment and levies made thereunder to pay the District's obligations to the United States in pursuance of this con-

tract, the provisions of Sections 77-2701 to 77-3024 inclusive, New Mexico Statutes Annotated (1941 Comp.) shall apply to the District in the operation of this contract with the United States.

DETERMINATION OF IRRIGABLE AREA

39. For the purpose of this contract and within the purpose and intent of Section 77-3106, New Mexico Statutes (1941 Comp.), Annotated, the lands of the District which were classified as agricultural lands by the court proceedings confirming the District's original appraisal in 1929 in pursuance of provisions of Article 28 of Chapter 77- New Mexico Statute (1941 Comp.), Annotated, except such of said lands so classified which have subsequently been withdrawn from water use because of urban development, or withdrawn by Court Order, all as shown on the records of the District, shall be deemed the irrigable lands of the project and this contract constitutes the determination of that fact as required of the Contracting Officer by the provisions of Section 77-3106, New Mexico Statutes (1941 Comp.), Annotated. Provided, however, that such determination so required shall be effective only on the issuance of the construction cost notice to the District.

Provided further, that the District may with the consent of owner of lands having water rights appurtenant thereto, and of the Contracting Officer, make a distribution of the District water supply in pursuance of the provisions of Section 77-3115 New Mexico Statutes (1941 Comp.), Annotated, and in accordance with applicable Acts of Congress and regulations thereunder and particularly the Act of Congress of December 5, 1924 (43 Stat. 703, 43 U. S. C. 462) providing for an equitable apportionment of construction costs of a project so that all irrigable lands may as far as practicable bear the burden of such cost according to their productive value. The Contracting Officer will provide the District a classification of lands in the District hereby determined as irrigable only within the intent and purposes of Section 77-3106, New Mexico Statutes (1941 Comp.), Annotated, as hereinabove provided, for the use of the District in making

TX_MSJ_005693

a proper distribution of its water supply and assessment of benefits on the basis of the productive value of such lands.

ASSURANCES RELATING TO VALIDITY OF CONTRACT

40. Upon the execution of this contract the District shall prosecute to final judgment and decree, proceedings in the conservancy court and all appellate courts of competent jurisdiction, if necessary, for a judicial confirmation of this contract and for a judgment and decree judging this contract legal and valid and binding upon the District. The District shall furnish the United States for its files certified copies of such confirmation proceedings and copies of all proceedings relating to the organization of the District as may be required by the Contracting Officer. This contract shall not be binding upon the United States until the District has completed action to the satisfaction of the Contracting Officer, required under the provisions of this article.

DISCRIMINATION AGAINST EMPLOYEES OR APPLICANTS FOR EMPLOYMENT PROHIBITED

41. The District shall not discriminate against any employee or applicant for employment because of race, creed, color or national origin, and shall require an identical provision to be included in contracts relating to the performance of this contract. This provision, however, does not refer to, extend to, or cover the activities of the District which are not related to or involved in the performance of this contract.

OFFICIALS NOT TO BENEFIT

42. No Member of or Delegate to Congress or Resident Commissioner shall be admitted to any share or part of this contract or to any benefit that may arise herefrom but this restriction shall not be construed to extend to this contract if made with a corporation or company for its general benefit.

IN WITNESS WHEREOF the parties hereto have

caused this instrument and a counterpart thereof to be duly executed the day and year first hereinabove written.

THE UNITED STATES OF AMERICA

H. E. ROBBINS,
Contracting Officer.

MIDDLE RIO GRANDE CONSERVANCY DISTRICT

OSCAR M. LOVE,
President.

ATTEST:

ROSCOE D. MANNING,
Secretary of the Middle Rio Grande Conservancy District.

(SEAL)

TX_MSJ_005694

RESOLUTION

WHEREAS, on the 21st day of September, 1951, there was submitted to the Board of Directors of the Middle Rio Grande Conservancy District, a final draft of the Contract between the Middle Rio Grande Conservancy District and the United States of America, the same being identified as that certain Contract entitled, "CONTRACT BETWEEN THE UNITED STATES AND THE MIDDLE RIO GRANDE CONSERVANCY DISTRICT FOR REHABILITATION AND CONSTRUCTION OF PROJECT WORKS, AND REPAYMENT OF REIMBURSABLE CONSTRUCTION COSTS THEREOF," and

WHEREAS, the attorneys employed by the District, viz: Fred E. Wilson, Martin A. Threet and D. A. Macpherson, Jr., by letter dated September 21, 1951, recommend that such Contract be approved by the Board of Directors of the Middle Rio Grande Conservancy District, and that such Contract be duly executed as provided by law;

THEREFORE, BE IT RESOLVED by the Board of Directors of the Middle Rio Grande Conservancy District, that the final draft of the Contract between the Middle Rio Grande Conservancy District and the United States be, and the same hereby is, approved; and the President and Secretary of the Board of Directors of the Middle Rio Grande Conservancy District be, and they hereby are, authorized to execute, in triplicate, the final draft of such Contract.

BE IT FURTHER RESOLVED, that the final draft of such Contract, so executed in triplicate, be transmitted by the Secretary of the Board of Directors of the Middle Rio Grande Conservancy District to the designated agent of the United States for his approval and signature.

ADOPTED this 21st day of September, 1951.

/s/ OSCAR M. LOVE,
President.

ATTEST:

/s/ ROSCOE D. MANNING,
Secretary.

* * * * * *

CERTIFICATE

I, the undersigned Secretary of the Middle Rio Grande Conservancy District hereby certify that the above and foregoing is a true, full and complete copy of a resolution duly proposed, seconded, put and carried by unanimous vote of the members of the Board of Directors of the said Middle Rio Grande Conservancy District at a special meeting of said Board held in the office of said District in the City of Albuquerque, New Mexico, on the 21st day of September, 1951, at which said meeting a quorum of said Board was present and voting.

IN WITNESS WHEREOF, I have hereunto subscribed my name this 25th day of September, 1951, and have affixed the seal of said District to this certificate.

/s/ ROSCOE D. MANNING,
Secretary of the Middle Rio Grande Conservancy District.

(SEAL)

* * * * * *

(Photostatic copies of the contract and resolution above set forth, certified as true and correct by Roscoe D. Manning, are on file with the Clerk of the U. S. Supreme Court.)

TX_MSJ_005695

"EXHIBIT C" TO RETURN

State of New Mexico
County of Bernalillo . . . ss:

John H. Bliss, being first duly sworn, on oath deposes and says:

1. That he is the duly appointed, qualified, and acting State Engineer of the State of New Mexico and as such is the New Mexico Commissioner on the Rio Grande Compact Commission. For more than fifteen years he has investigated and studied conditions in the Rio Grande Basin above Fort Quitman, Texas. During each year of that period he has made many personal examinations of the Rio Grande river and valley in New Mexico. In his official capacities he has supervised the making, compilation and correlation of records of stream flows, water storage, water diversions, and other water usages of and from the Rio Grande in New Mexico. As State Engineer he is the official charged with the duty and responsibility of administering the water laws of New Mexico.

2. In 1942 Elephant Butte Reservoir spilled. Under the Rio Grande Compact this wiped out all credits and debits. Since 1942 there has been no spill and New Mexico by reason of adverse natural conditions has been unable to meet the Compact schedule for deliveries at San Marcial. These adverse conditions include the following: the aggradation of the river channel, the lack in effectiveness of the constructed drainage systems because of such aggradation, the water logging of large areas in the valley because of the aggradation of the channel and the unavoidable deterioration of the drainage systems, and the loss of large quantities of water through transpiration by water-loving, native vegetation, principally salt cedars, in swamped and seeped areas. Such conditions may be improved by the degradation and channelization of the stream bed, the construction of effective drains, the periodic scouring of the stream bed to prevent aggradation, and the construction and operation of certain reservoirs to control floods and silt.

3. The Middle Rio Grande Project of the Bureau of Reclamation and the Corps of Engineers is designed to alleviate the conditions above mentioned and to rehabilitate the Middle Rio Grande area. In his opinion the authorized works will, when constructed, accomplish the desired purpose.

4. In addition to the conditions heretofore mentioned, there has been a drought in the New Mexico portion of the Rio Grande Basin which has resulted in below normal stream flows for a number of years and which culminated in stream flows in 1950 which were but 37% of the long time average, and in 1951 25% of the same average. To show such drought conditions he has prepared from records of the United States Geological Survey and the National Resources Committee a table which is attached hereto as Appendix A and made a part of this affidavit. The statistics contained in Appendix A were compiled from the official public records noted thereon. The following is submitted in explanation of the table:

> Drought conditions in New Mexico since 1942 can best be illustrated by comparison of the drought period run-off, in a stream unaffected by changing development, with its long-time record. There has been no appreciable change in development within the Chama River Basin for nearly 100 years, with the exception of the construction of El Vado Reservoir which stores water for release into the Rio Grande. The stream records can easily be corrected to adjust for the operations of El Vado.
>
> There is no long period record on the Chama. However, the stations on the Rio Grande immediately above and below the confluence of the Chama with the Rio Grande have long period records. The difference between these two records on the Rio Grande represents the flow of the Chama River for practical purposes.
>
> Average long period differences (1890-1951) and those for the years 1943 through 1951 (water year

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quantities) are set out in the accompanying table entitled "Indication of Magnitude of 1943-1951 Drought Conditions—New Mexico."

It will be noted that in the nine years only two (1945 and 1949) have approached normal and that the average for the nine years is only 63% of normal.

5. During these years of drought in the Rio Grande area above Elephant Butte, the lands below Elephant Butte have received practically a normal supply in every year except 1951. A table showing this is attached as Appendix B and made a part hereof. The statistics appearing in this table were compiled from official public records of the United States Geological Survey and the National Resources Committee. The following statement explains the table:

In the table showing Relation of Long-Time Average Water Supplies to 1943-1951 Drought Conditions, the flow of the Rio Grande at Otowi Bridge represents the water that is available to the Middle Rio Grande area, exclusive of the lower tributaries. This is approximately 4/5ths of the total water available on the average during a long period.

The data show that in the critical drought period from 1943 through 1951 only three years exceeded the long-time average run-off at Otowi; that five of the nine years were less than 59% of the average, and that the average for the drought period was only 69% of the normal.

During the same period releases from Project Storage in Elephant Butte and Caballo Reservoirs averaged 96% and there was substantial hold-over storage in every year except the present year of 1951. In only one year did releases for lands served by the Project drop below 90%, that being the 59% release in 1951.

The table shows further that husbanding of water resources did not commence until 1946 when storage

dropped below 1,000,000 acre feet. In that same year the water supply for the New Mexico area above Elephant Butte Reservoir was only 35%.

6. After the Rio Grande Compact Commission adopted in 1951 the resolution referred to in Paragraph VI (5), p. 13, of the complaint, icing conditions for a time made it impossible to keep El Vado gates open. Then, the Secretary of the Interior by his letter of March 27, 1951, protested the action of the Commission on the ground that it infringed on the rights of the Indians. The operation of El Vado in 1951 constituted an effort by the Conservancy District to make the best possible use of the available water. El Vado Reservoir was completely drained of water on August 6, 1951. Since then the gates have continuously remained open.

7. Because of the extreme conditions which existed in 1951 the State of New Mexico, the Middle Rio Grande Conservancy District, and the Elephant Butte Irrigation District jointly advanced $90,000.00 and with that sum dredged a pilot channel through the San Marcial swamps to permit water which had been retarded by natural barriers to flow into Elephant Butte Reservoir.

8. The Middle Rio Grande Project of the Bureau of Reclamation and the Corps of Engineers is now under construction. Contracts have been let and work is in progress for the channelization of a 22 mile stream section in the San Marcial area.

9. The position of New Mexico is that the Rio Grande Compact is inviolable. As State Engineer, the affiant states that the gates of El Vado Reservoir are now open and it is his intent that they will remain open until there is either the required storage in Elephant Butte, or unanimous action of the Rio Grande Compact Commission authorizing the closing of the gates, or a demand made by the United States upon the basis of Article XVI of the Rio Grande Compact.

TX_MSJ_005697

Dated at Albuquerque, New Mexico, this 15th day of December, 1951.

John H. Bliss

JOHN H. BLISS

Subscribed and sworn to before me this 15th day of December, 1951.

J. G. Whitehouse

Notary Public

(Seal)

My commission expires: September 18, 1952.

APPENDIX A

INDICATION OF MAGNITUDE OF 1943-1951 DROUGHT CONDITIONS NEW MEXICO

	Recorded Run-off of Rio Grande at Otowi Bridge Less Embudo (a) (1000 AF)	Per Cent of 1890-1951 Average
1890-1951 Average	845.9	100
1943	284.6	59
1944	421.0	87
1945	482.3	99
1946	145.4	30
1947	276.0	57
1948	395.7	81
1949	467.9	96
1950	180.3	37
1951	120.4	25
1943-1951 Average	308.2	63

(a) Rio Grande gaging station at Otowi Bridge is a short distance below the confluence of the Chama River; the station at Embudo is a short distance above the mouth of the Chama. The resulting difference is substantially the flow of the Chama River, principal New Mexico tributary.

Records for 1890-1935 from Regional Planning, Part VI, Upper Rio Grande, February, 1938, National Resources Committee, pages 159 and 160; those for 1936-1949 from United States Geological Survey Water Supply Papers Nos. 808, 828, 858, 878, 898, 928, 958, 978, 1008, 1038, 1058, 1088, 1118,and 1148; and for 1950 and 1951 from provisional records of United States Geological Survey District Office, Santa Fe, New Mexico.

All records are on a water year basis, and are corrected for operation of El Vado reservoir 1935 through 1951.

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APPENDIX B

RELATION OF LONG-TIME AVERAGE WATER SUPPLIES TO 1943-1951 DROUGHT CONDITIONS

	Run-off of Rio Grande at Otowi Bridge (a) (1,000 AF)	Percent of 1890-1951 Average	Releases from Project Storage (c) (1,000 AF)	Percent of 790,000 AF (e) Normal Release	Quantities in Project Storage End of Year (c) (1,000 AF)
Average 1890-1935	1,353.0				
1936	981.3				
1937	1,684.3				
1938	1,286.6				
1939	846.0				
1940	565.0				
1941	2,416.4				
1942	(b) 2,323.3				
1943	703.1	54	913.4	116	1,431.0
1944	1,336.5	103	867.9	110	1,497.7
1945	1,151.5	89	884.5	112	1,210.6
1946	453.7	35	765.8	97	719.4
1947	750.3	58	726.6	92	449.6
1948	1,389.4	107	743.0	94	591.5
1949	1,327.5	102	713.1	90	685.6
1950	527.4	41	721.1	91	321.3
1951	367.3	28	468.4	59	(d) 50.0
Average 1890-1951	1,296.0	100			
Average 1943-1951	889.6	69	756.0	96	

(a) Records on a water year basis; 1890-1935 average represents recorded run-offs at Otowi Bridge with missing data estimated by correlation with adjacent gaging stations, page 160, Regional Planning, Part VI—Upper Rio Grande, February 1938, National Resources Committee; records for 1936-1949 from United States Geological Water Supply Papers Nos. 808, 828, 858, 878, 898, 928, 958, 978, 1008, 1038, 1058, 1088, 1118 and 1148; and those for 1950 and 1951 from provisional records of United States Geological Survey District Office, Santa Fe, New Mexico. Records from 1935-1951 corrected for El Vado reservoir operation.

(b) Elephant Butte reservoir spilled in 1942 cancelling all compact debits and credits.

(c) Annual values, 1943-1949, from records of United States Geological Survey; 1950 and 1951 are provisional records of Geological Survey.

(d) Estimated from preliminary records of Bureau of Reclamation; 43,100 acre feet in storage December 1, 1951.

(e) Compact permits normal annual release of 790,000 acre feet from project storage.

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John Demspey Papers
file 235-245,246-254,255-257
Serial Number 6401

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PUBLIC WORKS COMMITTEE 1957-58
Middle Rio Grande River - 85th Cong
Elephant Butte Dam #245

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STATE OF NEW MEXICO

OFFICE OF STATE ENGINEER

ORDER DECLARING THE
RIO GRANDE UNDERGROUND WATER BASIN

WHEREAS, the waters of underground streams, channels, artesian basins, reservoirs, or lakes, having reasonably ascertainable boundaries, are public waters and are subject to appropriation for beneficial use, and

WHEREAS, all natural waters flowing in streams and water-courses, whether such be perennial or torrential, within the State of New Mexico, belong to the public and are subject to appropriation for beneficial use, and

WHEREAS, the State Engineer has determined from scientific investigation that an underground basin exists in the Rio Grande Valley, the area and boundaries of which basin are reasonably ascertainable, and

WHEREAS, the waters of said basin are interrelated with the flow of the Rio Grande Stream System, so that such underground waters are a substantial source of the flow of said stream system, and

WHEREAS, the waters of the Rio Grande Stream System are fully appropriated, and

NOW, THEREFORE, IT IS HEREBY DECLARED that the lands described hereinafter comprise an underground water basin, to be known as the RIO GRANDE UNDERGROUND WATER BASIN, subject to the New Mexico statutes, and the rules and regulations of the State Engineer:

Beginning at a point where the New Mexico-Colorado State Line intersects Longitude 105° 30' West; thence south along Longitude 105° 30' West to its intersection with Latitude 36° 54' North; thence west along Latitude 36° 54' North to its intersection with Longitude 105° 33' West; thence south along Longitude 105° 33' West to its intersection with the Carson National Forest Boundary; thence south along the Carson National Forest Boundary to the southeast corner of Section 33, Township 30 North, Range 13 East; thence west along section line to the southeast corner of Section 32, Township 30 North, Range 13 East; thence south along section lines to the southeast corner of Section 20, Township 29 North, Range 13 East; thence southwest along the Carson National Forest Boundary to the northeast corner of Section 6, Township 28 North, Range 13 East; thence south along section lines to the southeast corner of Section 30, Township 28 North, Range 13 East; thence west along section line to the southwest corner of Section 30, Township 28 North, Range 13 East; thence south along range line to its intersection with the north boundary of the Arroyo Hondo Grant; thence northeast along the north boundary of the

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Arroyo Hondo Grant to the northeast corner of said Grant; thence south along the east boundary of the Arroyo Hondo Grant to its intersection with the Carson National Forest Boundary; thence south and east along the Carson National Forest Boundary to its intersection with Longitude 105° 30' West; thence south along Longitude 105° 30' West to its intersection with Latitude 36° 20' North; thence west along Latitude 36° 20' North to its intersection with the west boundary of the Cristobal De La Serna Grant; thence southwest along the west boundary of the Cristobal De La Serna Grant to its intersection with the north section line of Section 32, Township 24 North, Range 12 East; thence west along section lines to the southeast corner of Section 27, Township 24 North, Range 11 East; thence south along section line to the southeast corner of Section 34, Township 24 North, Range 11 East; thence west along township line to the southeast corner of Section 32, Township 24 North, Range 11 East; thence south along section line to the southeast corner of Section 5, Township 23 North, Range 11 East; thence west along section line to the southeast corner of Section 6, Township 23 North, Range 11 East; thence south along section line to the southeast corner of Section 7, Township 23 North, Range 11 East; thence west along section line to the southeast corner of Section 12, Township 23 North, Range 10 East; thence south along range line to its intersection with the north boundary of the Sebastian Martin Grant; thence west along the north boundary of the Sebastian Martin Grant to its intersection with Longitude 105° 56' West; thence south along Longitude 105° 56' West to its intersection with the north boundary of Township 21 North, Range 9 East; thence east along township line to the northeast corner of Section 1, Township 21 North, Range 9 East; thence south along range line to the northeast corner of Section 25, Township 21 North, Range 9 East; thence east along section lines to the intersection with the west boundary of the Nuestra Senora Del Rosario San Fernando Santiago Grant; thence south along the west boundary of the Nuestra Senora Del Rosario San Fernando Santiago Grant to the northeast corner of Section 4, Township 20 North, Range 10 East; thence south along section lines to the intersection with the north boundary of the Santo Domingo De Cundiyo Grant; thence northeast along the boundary of the Santo Domingo De Cundiyo Grant to the northeast corner of said Grant; thence south along the boundary of the Santo Domingo De Cundiyo Grant to the southeast corner of said Grant; thence northwest along the boundary of the Santo Domingo De Cundiyo Grant to its intersection with the east section line of Section 28, Township 20 North, Range 10 East; thence south along section lines to the southeast corner of Section 33, Township 19 North, Range 10 East; thence west along section line to the northeast corner of Section 5, Township 18 North, Range 10 East; thence south along section lines to the intersection with the north boundary of the Juan De Gabaldon Grant; thence south to a point being the intersection of the east section line of Section 5, Township 17 North, Range 10 East and the south boundary of the Juan De Gabaldon Grant; thence south along section lines to the northeast corner of the City of Santa Fe Grant; thence south along the east boundary of the City of Santa Fe Grant to the southeast corner of said Grant; thence west along the south boundary of the City of Santa Fe Grant to its intersection with the west boundary of Sebastian De Vargas Grant; thence south along the west boundary of the Sebastian De Vargas Grant to its intersection with the south boundary of Township 16 North, Range 9 East; thence west along township line to the southeast corner of Section 32, Township 16 North, Range 9 East; thence south along section lines to the southeast corner of Section 32, Township 15 North, Range 9 East; thence west along township line to the northeast corner of Section 4, Township 14 North, Range 6 East; thence south along section lines to the southeast corner of Section 16, Township 14 North, Range 6 East; thence west along section lines to the southwest corner of

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Arroyo Hondo Grant to the northeast corner of said Grant; thence south along the east boundary of the Arroyo Hondo Grant to its intersection with the Carson National Forest Boundary; thence south and east along the Carson National Forest Boundary to its intersection with Longitude 105° 30' West; thence south along Longitude 105° 30' West to its intersection with Latitude 36° 20' North; thence west along Latitude 36° 20' North to its intersection with the west boundary of the Cristobal De La Serna Grant; thence southwest along the west boundary of the Cristobal De La Serna Grant to its intersection with the north section line of Section 32, Township 24 North, Range 12 East; thence west along section lines to the southeast corner of Section 27, Township 24 North, Range 11 East; thence south along section line to the southeast corner of Section 34, Township 24 North, Range 11 East; thence west along township line to the southeast corner of Section 32, Township 24 North, Range 11 East; thence south along section line to the southeast corner of Section 5, Township 23 North, Range 11 East; thence west along section line to the southeast corner of Section 6, Township 23 North, Range 11 East; thence south along section line to the southeast corner of Section 7, Township 23 North, Range 11 East; thence west along section line to the southeast corner of Section 12, Township 23 North, Range 10 East; thence south along range line to its intersection with the north boundary of the Sebastian Martin Grant; thence west along the north boundary of the Sebastian Martin Grant to its intersection with Longitude 105° 56' West; thence south along Longitude 105° 56' West to its intersection with the north boundary of Township 21 North, Range 9 East; thence east along township line to the northeast corner of Section 1, Township 21 North, Range 9 East; thence south along range line to the northeast corner of Section 25, Township 21 North, Range 9 East; thence east along section lines to the intersection with the west boundary of the Nuestra Senora Del Rosario San Fernando Santiago Grant; thence south along the west boundary of the Nuestra Senora Del Rosario San Fernando Santiago Grant to the northeast corner of Section 4, Township 20 North, Range 10 East; thence south along section lines to the intersection with the north boundary of the Santo Domingo De Cundiyo Grant; thence northeast along the boundary of the Santo Domingo De Cundiyo Grant to the northeast corner of said Grant; thence south along the boundary of the Santo Domingo De Cundiyo Grant to the southeast corner of said Grant; thence northwest along the boundary of the Santo Domingo De Cundiyo Grant to its intersection with the east section line of Section 28, Township 20 North, Range 10 East; thence south along section lines to the southeast corner of Section 33, Township 19 North, Range 10 East; thence west along section line to the northeast corner of Section 5, Township 18 North, Range 10 East; thence south along section lines to the intersection with the north boundary of the Juan De Gabaldon Grant; thence south to a point being the intersection of the east section line of Section 5, Township 17 North, Range 10 East and the south boundary of the Juan De Gabaldon Grant; thence south along section lines to the northeast corner of the City of Santa Fe Grant; thence south along the east boundary of the City of Santa Fe Grant to the southeast corner of said Grant; thence west along the south boundary of the City of Santa Fe Grant to its intersection with the west boundary of Sebastian De Vargas Grant; thence south along the west boundary of the Sebastian De Vargas Grant to its intersection with the south boundary of Township 16 North, Range 9 East; thence west along township line to the southeast corner of Section 32, Township 16 North, Range 9 East; thence south along section lines to the southeast corner of Section 32, Township 15 North, Range 9 East; thence west along township line to the northeast corner of Section 4, Township 14 North, Range 6 East; thence south along section lines to the southeast corner of Section 16, Township 14 North, Range 6 East; thence west along section lines to the southwest corner of

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section 18, Township 14 North, Range 6 East; thence south along range line to the southeast corner of Section 12, Township 13 North, Range 5 East; thence west along section line to its intersection with the north boundary of the Town of Tejon Grant; thence west along the north boundary of the Town of Tejon Grant to the northwest corner of said Grant; thence south along the west boundary of the Town of Tejon Grant to its intersection with the north boundary of the San Antonio De Las Huertas Grant; thence west along the north boundary of the San Antonio De Las Huertas Grant to the northwest corner of said Grant; thence south along the west boundary of the San Antonio De Las Huertas Grant to its intersection with the south boundary of Township 13 North, Range 5 East; thence west along township line to the northeast corner of Section 1, Township 12 North, Range 4 East; thence south along range line to the southeast corner of Section 36, Township 12 North, Range 4 East; thence west along township line to the northeast corner of Section 2, Township 11 North, Range 4 East; thence south along section lines to the intersection with the north boundary of the Elena Gallegos Grant; thence east along the north boundary of the Elena Gallegos Grant to the northeast corner of said Grant; thence south along the east boundary of the Elena Gallegos Grant to the southeast corner of said Grant; thence west along the south boundary of the Elena Gallegos Grant to its intersection with the east boundary of Township 11 North, Range 4 East; thence south along range line to its intersection with the boundary of Valencia and Torrance Counties; thence south along the boundary between Valencia and Torrance Counties to its intersection with the south boundary of the Lo De Padilla Grant; thence west along the south boundary of the Lo De Padilla Grant to the northeast corner of Section 29, Township 7 North, Range 4 East; thence south along section lines to the intersection with the northern boundary of the Tome Claim; thence west along the northern boundary of the Tome Claim to its intersection with Longitude 106° 35' West; thence south along Longitude 106° 35' West to its intersection with the south boundary of the Tome Claim; thence west along the south boundary of the Tome Claim to its intersection with Longitude 106° 37' West; thence south along Longitude 106° 37' West to its intersection with Latitude 34° 20' North; thence west along Latitude 34° 20' North to its intersection with Longitude 106° 45' West; thence south along Longitude 106° 45' West to its intersection with the south boundary of Township 1 South, Range 2 East; thence west along township line to the northeast corner of Section 1, Township 2 South, Range 1 East; thence south along range line to its intersection with the north boundary of the Bosque Del Apache Migratory Waterfowl Refuge; thence east along the north boundary of the Bosque Del Apache Migratory Waterfowl Refuge to the northeast corner of said Refuge; thence southwest along the east and south boundary of the Bosque Del Apache Migratory Waterfowl Refuge to the intersection with the east boundary of the Pedro Armendariz Grant No. 33; thence southeast along the east boundary of the Pedro Armendariz Grant No. 33 to its intersection with Latitude 33° 40' North; thence west along Latitude 33° 40' North to its intersection with Longitude 106° 56' West; thence south along Longitude 106° 56' West to its intersection with Latitude 33° 35' North; thence west along Latitude 33° 35' North to its intersection with Longitude 107° 00' West; thence south along Longitude 107° 00' West to its intersection with the boundary of Socorro and Sierra Counties; thence west along the boundary between Socorro and Sierra Counties to the west bank of the Rio Grande; thence south along the west bank of the Rio Grande to its intersection with the east section line of Section 34, Township 13 South, Range 4 West; thence north along section lines to the southeast corner of Section 22, Township 13 South, Range 4 West; thence west along section lines to the southwest corner of Section 19, Township 13 South, Range 4 West; thence north along range line to the northwest corner of Section 6, Township 11 South, Range 4 West; thence east along township

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Section 18, Township 14 North, Range 6 East; thence south along range line to the southeast corner of Section 12, Township 13 North, Range 5 East; thence west along section line to its intersection with the north boundary of the Town of Tejon Grant; thence west along the north boundary of the Town of Tejon Grant to the northwest corner of said Grant; thence south along the west boundary of the Town of Tejon Grant to its intersection with the north boundary of the San Antonio De Las Huertas Grant; thence west along the north boundary of the San Antonio De Las Huertas Grant to the northwest corner of said Grant; thence south along the west boundary of the San Antonio De Las Huertas Grant to its intersection with the south boundary of Township 13 North, Range 5 East; thence west along township line to the northeast corner of Section 1, Township 12 North, Range 4 East; thence south along range line to the southeast corner of Section 36, Township 12 North, Range 4 East; thence west along township line to the northeast corner of Section 2, Township 11 North, Range 4 East; thence south along section lines to the intersection with the north boundary of the Elena Gallegos Grant; thence east along the north boundary of the Elena Gallegos Grant to the northeast corner of said Grant; thence south along the east boundary of the Elena Gallegos Grant to the southeast corner of said Grant; thence west along the south boundary of the Elena Gallegos Grant to its intersection with the east boundary of Township 11 North, Range 4 East; thence south along range line to its intersection with the boundary of Valencia and Torrance Counties; thence south along the boundary between Valencia and Torrance Counties to its intersection with the south boundary of the Lo De Padilla Grant; thence west along the south boundary of the Lo De Padilla Grant to the northeast corner of Section 29, Township 7 North, Range 4 East; thence south along section lines to the intersection with the northern boundary of the Tome Claim; thence west along the northern boundary of the Tome Claim to its intersection with Longitude 106° 35' West; thence south along Longitude 106° 35' West to its intersection with the south boundary of the Tome Claim; thence west along the south boundary of the Tome Claim to its intersection with Longitude 106° 37' West; thence south along Longitude 106° 37' West to its intersection with Latitude 34° 20' North; thence west along Latitude 34° 20' North to its intersection with Longitude 106° 45' West; thence south along Longitude 106° 45' West to its intersection with the south boundary of Township 1 South, Range 2 East; thence west along township line to the northeast corner of Section 1, Township 2 South, Range 1 East; thence south along range line to its intersection with the north boundary of the Bosque Del Apache Migratory Waterfowl Refuge; thence east along the north boundary of the Bosque Del Apache Migratory Waterfowl Refuge to the northeast corner of said Refuge; thence southwest along the east and south boundary of the Bosque Del Apache Migratory Waterfowl Refuge to the intersection with the east boundary of the Pedro Armendariz Grant No. 33; thence southeast along the east boundary of the Pedro Armendariz Grant No. 33 to its intersection with Latitude 33° 40' North; thence west along Latitude 33° 40' North to its intersection with Longitude 106° 56' West; thence south along Longitude 106° 56' West to its intersection with Latitude 33° 35' North; thence west along Latitude 33° 35' North to its intersection with Longitude 107° 00' West; thence south along Longitude 107° 00' West to its intersection with the boundary of Socorro and Sierra Counties; thence west along the boundary between Socorro and Sierra Counties to the west bank of the Rio Grande; thence south along the west bank of the Rio Grande to its intersection with the east section line of Section 34, Township 13 South, Range 4 West; thence north along section lines to the southeast corner of Section 22, Township 13 South, Range 4 West; thence west along section lines to the southwest corner of Section 19, Township 13 South, Range 4 West; thence north along range line to the northwest corner of Section 6, Township 11 South, Range 4 West; thence east along township

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line to the southwest corner of Section 34, Township 10 South, Range 4 West; thence north along section lines to the northwest corner of Section 3, Township 9 South, Range 4 West; thence east along township line to the southwest corner of Section 31, Township 8 South, Range 3 West; thence north along range line to the northwest corner of Section 19, Township 8 South, Range 3 West; thence east along section lines to the northwest corner of Section 22, Township 8 South, Range 3 West; thence north along section lines to the northwest corner of Section 3, Township 8 South, Range 3 West; thence east along township line to the southwest corner of Section 36, Township 7 South, Range 3 West; thence north along section lines to the intersection with Latitude 33° 45' North; thence east along Latitude 33° 45' North to its intersection with Longitude 107° 00' West; thence north along Longitude 107° 00' West to its intersection with the north boundary of the Pedro Armendariz Grant No. 34; thence east along the north boundary of the Pedro Armendariz Grant No. 34 to its intersection with the west boundary of Township 5 South, Range 1 West; thence north along range line to its intetsection with the south boundary of the Sevilleta Grant; thence west along the south boundary of the Sevilleta Grant to its intersection with Longitude 107° 00' West; thence north along Longitude 107° 00' West to the north boundary of the Sevilleta Grant; thence east along the north boundary of the Sevilleta Grant to the west boundary of Township 2 North, Range 1 West; thence north along range line to the southeast corner of Section 36, Township 6 North, Range 2 West; thence west along township line to the southwest corner of Section 34, Township 6 North, Range 2 West; thence north along section lines to the southwest corner of Section 34, Township 7 North, Range 2 West; thence west along township line to the southwest corner of Section 35, Township 7 North, Range 3 West; thence north along section line to its intersection with the boundary of the Antonio Sedillo Grant; thence north along the west boundary of the Antonio Sedillo Grant to the northwest corner of said Grant; thence east along the north boundary of the Antonio Sedillo Grant to its intersection with the west boundary of Township 9 North, Range 1 West; thence north along range line to its intersection with the south boundary of the Bernabe M. Montano Grant; thence east along the south boundary of the Bernabe M. Montano Grant to the southeast corner of said Grant; thence north along the east boundary of the Bernabe M. Montano Grant to its intersection with the north boundary of Township 11 North, Range 1 West; thence east along township line to the southwest corner of Section 31, Township 12 North, Range 1 East; thence north along range line to the northwest corner of Section 6, Township 12 North, Range 1 East; thence east along township line to its intersection with the west boundary of the Town of Alameda Grant; thence north along the west boundary of the Town of Alameda Grant to the northwest corner of said Grant; thence east along the north boundary of the Town of Alameda Grant to its intersection with the west boundary of Township 13 North, Range 2 East; thence north along range line to the northwest corner of Section 6, Township 13 North, Range 2 East; thence east along township line to the southwest corner of Section 31, Township 14 North, Range 3 East; thence north along range line to the northwest corner of Section 6, Township 14 North, Range 3 East; thence east along township line to the southwest corner of Section 31, Township 15 North, Range 5 East; thence north along range line to the northwest corner of Section 19, Township 16 North, Range 5 East; thence east along section lines to the intersection with the west boundary of the Pueblo Cochiti Grant; thence north along the west boundary of the Pueblo Cochiti Grant to the northwest corner of said Grant; thence east along the north boundary of the Pueblo Cochiti Grant to its intersection with the west boundary of Township 17 North, Range 6 East; thence north to the southwest corner of the Bandelier National Monument; thence north along the Santa Fe National

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Forest Boundary to its intersection with the west boundary of Township 19 North, Range 6 East; thence north along range line to its intersection with the Santa Fe National Forest Boundary; thence northeast along the Santa Fe National Forest Boundary to its intersection with Longitude 106° 15' West; thence north along Longitude 106° 15' West to its intersection with Latitude 36° 10' North; thence west along Latitude 36° 10' North to its intersection with the west boundary of the Juan Jose Lobato Grant; thence north along the west boundary of the Juan Jose Lobato Grant to its intersection with Latitude 36° 15' North; thence east along Latitude 36° 15' North to its intersection with Longitude 106° 15' West; thence north along Longitude 106° 15' West to its intersection with the north boundary of the Juan Jose Lobato Grant; thence east along the north boundary of the Juan Jose Lobato Grant to the northeast corner of said Grant; thence south along the east boundary of the Juan Jose Lobato Grant to its intersection with the north boundary of Township 24 North, Range 7 East; thence east along township line to its intersection with the east bank of the Rio Grande; thence north along the east bank of the Rio Grande to its intersection with the New Mexico-Colorado State Line; thence east along the New Mexico-Colorado State Line to its intersection with Longitude 105° 30' West being the point of beginning.

WITNESS my hand and the official seal of my office this 29th day of November, A. D., 1956.

S. E. Reynolds
State Engineer

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RG 267 RECORDS OF THE SUPREME COURT OF THE UNITED STATES

ORIGINAL JURISDICTION CASE FILES, 1792-2005

1957 (BEGIN TX v. MN #9)

to

1957

Box 459 **PI 139** **Entry 26**

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LOW LIGNIN

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RG 267 Entry 26 TX v. NM #5

NO. 9 ORIG. - STATE OF TEXAS V. STATE OF NEW MEXICO, ET AL.
Filed April 28, 1952.

Bill in equity.

Water rights - Suit to enjoin the State of New Mexico and other defendants from alleged wrongful storing, diversion and use of the waters of the Rio Grande in violation of the rights of the State of Texas under the Rio Grande Compact, a Compact entered into by the States of Texas, New Mexico and Colorado providing for an equitable apportionment among the three States of the waters of the Rio Grande above Fort Quitman, Texas.

2/25/57 (352 U.S. 991) Motion to amend bill of compliant denied. Motion to dismiss granted and the bill of complaint dismissed because of the absence of the United States as an indispenable party.

/ 354 U.S.918.
6/17/57 Court awarded Special Master $25000 fee and $7611.27 expenses. (Texas-50%) New Mexico(25%) Middle Rio Grande Conservancy District (25%)/

Suggest that it be stricken from docket.

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Sandy
52

STANDLEY

6-24-58

NAME

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076-89-0004 6-25

076-89-0004-00006

B-12.2.6.3 Tri-State Rio Grande Compact Commission

4 of

OCT 1966 thru MAR 1977

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IN THE
SUPREME COURT OF THE UNITED STATES
OCTOBER TERM, 1966

NO. ———, Original

STATE OF TEXAS AND
STATE OF NEW MEXICO,

Plaintiffs

v.

THE STATE OF COLORADO,

Defendant

MOTION FOR LEAVE TO FILE COMPLAINT
AND COMPLAINT

Come The State of Texas and The State of New Mexico, by their respective Attorneys General, and move this Court for leave to file the Complaint submitted herewith. The States of Texas and New Mexico seek to bring this suit under the authority of Article III, Section 2, Clause 2 of the Constitution of the United States.

BOSTON E. WITT
Attorney General of New Mexico

WAGGONER CARR
Attorney General of Texas

By ----------
HAWTHORNE PHILLIPS
First Assistant Attorney
General of Texas
P. O. Box "R"
Capitol Station
Austin, Texas 78711
Attorneys for the States of
Texas and New Mexico

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STATEMENT IN SUPPORT OF MOTION

The Rio Grande is an interstate stream flowing in or through Colorado, New Mexico and Texas. The rights of these states in the River are defined by the Rio Grande Compact of 1938, an agreement binding on all three states and duly approved by Congress. The lands in Texas and in New Mexico in the valley of the Rio Grande above Fort Quitman, Texas, are semi-arid and lie within that portion of the semi-arid region of the United States in which irrigation is indispensable for the successful cultivation of land and the production of crops thereon. The waters of the Rio Grande are used for the irrigation of lands and for other purposes in each of the States of Colorado, New Mexico, and Texas, and are fully appropriated above Fort Quitman, Texas.

For several years Colorado, to the irreparable injury of plaintiffs and their citizens, has violated the Rio Grande Compact by its failure to deliver water at the Colorado-New Mexico state line in accordance with the terms of that agreement. Repeated demands by the plaintiff states have failed to persuade Colorado to reduce its debt to them or meet its annual commitments under the Compact. Therefore, the States of New Mexico and Texas bring this action to require the State of Colorado to deliver water in the Rio Grande at the Colorado New Mexico state line as provided by the Compact, and otherwise to comply with the terms of said Compact. Unless the relief prayed for is granted, the plaintiff states will be deprived in the future, as in the past several years, of the benefits of the Compact and the waters to which their citizens are entitled.

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The original jurisdiction of this Court is invoked under Article III, Section 2, Clause 2, of the United States Constitution. Under the decisions of this Court in *Nebraska v. Wyoming*, 325 U.S. 589, 616 and *Hinderlider v. LaPlata Co.*, 304 U.S. 92, the present case is a proper one for the exercise of this jurisdiction.

It is believed that the rights of the States of New Mexico and Texas to the waters of the Rio Grande can be protected only by a decree of this Court granting the relief prayed for in the Complaint.

It is respectfully submitted that the Motion for Leave to File the Complaint should be granted.

Boston E. Witt
Attorney General of New Mexico

Waggoner Carr
Attorney General of Texas

By _____
Hawthorne Phillips
First Assistant Attorney
General of Texas

P. O. Box "R"
Capitol Station
Austin, Texas 78711

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IN THE

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1966

NO. ———, Original

STATE OF TEXAS AND
STATE OF NEW MEXICO,
Plaintiffs

v.

THE STATE OF COLORADO,
Defendant

COMPLAINT

The States of Texas and New Mexico by their Attorneys General bring this suit against the defendant, State of Colorado and for their cause of action state:

I.

The jurisdiction of this Court is invoked under Article III, Section 2, Clause 2 of the Constitution of the United States.

II.

The Rio Grande is a river system rising in part in the State of Colorado and in part in the State of New Mexico, and flows through those states into the State of Texas and along the common boundary of Texas and the Republic of Mexico.

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III.

In order to equitably apportion the waters of the Rio Grande above Fort Quitman, Texas, the States of Colorado, New Mexico and Texas signed the Rio Grande Compact on the 18th of March, 1938. The Compact was ratified thereafter by the legislatures of the three states and was consented to and approved by the United States of America by Act of Congress. A copy of the Rio Grande Compact is attached hereto as Exhibit "A" and by this reference is made a part hereof.

IV.

Article III of the Rio Grande Compact imposes upon the State of Colorado an obligation to deliver water in the Rio Grande at the Colorado-New Mexico state line in each calendar year in accordance with the schedules of delivery contained therein.

In every calendar year in the Period 1952 through 1965, except 1958, the State of Colorado has failed, neglected and refused to deliver water at the Colorado-New Mexico state line in accordance with the schedules in Article III, as shown in the following table:

Deliveries
1952-1965

Year	Delivery Obligation	Actual Delivery	Annual Departure From Delivery Obligation
1952	622.1	468.1	Dr. 154.0
1953	140.2	122.1	Dr. 18.1
1954	120.1	59.6	Dr. 60.5
1955	118.6	63.1	Dr. 55.5
1956	133.5	70.6	Dr. 62.9
1957	601.1	444.9	Dr. 156.2
1958	349.4	362.5	Cr. 13.1

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RG 76
Entry #

1959	109.2	88.4	Dr. 20.8
1960	260.1	201.0	Dr. 59.1
1961	223.9	169.2	Dr. 54.7
1962	403.1	316.2	Dr. 86.9
1963	94.5	72.6	Dr. 21.9
1964	133.9	57.6	Dr. 76.3
1965	630.2	500.6	Dr. 129.6

Dr. — Debit.
Cr. — Credit.
All quantities in thousands of acre-feet.

V.

Article VI of the Rio Grande Compact provides that no accrued debit of the State of Colorado shall exceed 100,000 acre-feet of water, except by reason of hold-over storage of water in reservoirs constructed after 1937 in the drainage basin of the Rio Grande above the Lobatos gaging station. The State of Colorado has continuously violated Article VI in that throughout the period 1953 through 1965 the accured debit of the State of Colorado has exceeded said limitation, and such accrued debit at December 31, 1965 was 939,900 acre-feet of water, as shown in the following tabulation:

ACCRUED DEBIT OF COLORADO

1952-1965

Year	Debit Water In Storage At End Of Year	Allowable Debit Per Article VI	Adjustments Required By Compact	Actual Accrued Debit At End Of Year
1952	0.3	100.3	Dr. 0.3	153.3
1953	0.3	100.3	0	171.1
1954	0.3	100.3	0	231.9
1955	0.7	100.7	Cr. 0.2	287.2
1956	3.9	103.9	Cr. 0.2	349.9
1957	32.4	132.4	Dr. 0.1	506.2
1958	35.3	135.3	Cr. 0.7	492.4
1959	6.0	106.0	Cr. 0.2	513.0
1960	6.1	106.1	Cr. 0.4	571.7

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RG 76
Entry #

1961	5.4	105.4	Cr. 0.3	626.1
1962	4.6	104.6	Cr. 0.6	712.4
1963	3.9	103.9	Dr. 0.1	734.4
1964	3.7	103.7	Dr. 0.1	810.8
1965	17.7	117.7	Cr. 0.5	939.9

Dr. — Debit
Cr. — Credit
All quantities in thousands of acre-feet

VI.

The State of Colorado has established by its past conduct that it will not observe the terms and conditions of the Rio Grande Compact unless forced by this Court to comply. Grave and irreparable injury to the States of Texas and New Mexico and to the citizens of these states who were entitled to receive and use water under the terms and conditions of the Rio Grande Compact has been caused by the acts and conduct of the State of Colorado, its officers, citizens and political subdivisions in failing, neglecting and refusing to deliver the agreed quantities of water in the Rio Grande at the Colorado-New Mexico state line. Grave and irreparable injury will be suffered in the future by the States of Texas and New Mexico and their citizens unless equitable relief is afforded by this Court to prevent the State of Colorado, its officers, citizens and political subdivisions from withholding and using water which they have heretofore contracted and agreed to deliver under the terms and conditions of the Compact.

VII.

The States of Texas and New Mexico respectfully present that the only remedy available to them to enforce the terms and conditions of the Rio Grande Com-

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Entry #

pact against the State of Colorado is through the equitable powers of this Court.

WHEREFORE, the States of Texas and New Mexico respectfully pray that the Court issue its decree commanding the State of Colorado, its officers, agents, citizens and political subdivisions to deliver water in the Rio Grande at the Colorado-New Mexico state line in accordance with the requirements of the Rio Grande Compact, and further, requiring the State of Colorado to eliminate her accrued debit under the Compact and providing for such other and further relief as the Court may deem appropriate; and that the Court provide for the enforcement of its decree by any means deemed appropriate including, but not limited to, the appointment of a water master empowered to control the diversion, storage and use of Rio Grande Basin water within the State of Colorado.

Boston E. Witt
Attorney General of New Mexico

Waggoner Carr
Attorney General of Texas

By _____
Hawthorne Phillips
First Assistant Attorney
General of Texas

P. O. Box "R"
Capitol Station
Austin, Texas 78711

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PROOF OF SERVICE

I, HAWTHORNE PHILLIPS, one of the Attorneys for the Complainants (States of Texas and New Mexico) herein, and a member of the Bar of the Supreme Court of the United States hereby certify that on the 30th day of September, 1969, I served copies of the foregoing Motion for Leave to File and Complaint on the Governor of the State of Colorado and the Attorney General of Colorado by mailing to each of them a copy thereof duly addressed envelope with first-class postage prepaid, to each of the following in this cause:

Honorable John A. Love — Governor of the State
Governor of Colorado
State Capitol
Denver, Colorado 80203

Honorable Duke W. Dunbar — Attorney General of the State
Attorney General of Colorado
104 State Capitol Building
Denver, Colorado 80203

HAWTHORNE PHILLIPS

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EXHIBIT "A"

RIO GRANDE COMPACT

The State of Colorado, the State of New Mexico, and the State of Texas, desiring to remove all causes of present and future controversy among these States and between citizens of one of these States and citizens of another State with respect to the use of the waters of the Rio Grande above Fort Quitman, Texas, and being moved by considerations of interstate comity, and for the purpose of effecting an equitable apportionment of such waters, have resolved to conclude a Compact for the attainment of these purposes, and to that end, through their respective Governors, have named as their respective Commissioners:

For the State of Colorado—M. C. Hinderlider
For the State of New Mexico—Thomas M. McClure
For the State of Texas—Frank B. Clayton

who, after negotiations participated in by S. O. Harper, appointed by the President as the representative of the United States of America, have agreed upon the following articles, to-wit:

ARTICLE I.

(a) The State of Colorado, the State of New Mexico, the State of Texas, and the United States of America, are hereinafter designated "Colorado," "New Mexico," "Texas" and the "United States," respectively.

(b) "The Commission" means the agency created by this Compact for the administration thereof.

(c) The term "Rio Grande Basin" means all of the territory drained by the Rio Grande and its tributaries in Colorado, in New Mexico, and in Texas above Fort Quitman, including the Closed Basin in Colorado.

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RG 76
Entry #

(d) The "Closed Basin" means that part of the Rio Grande Basin in Colorado where the streams drain into the San Luis Lakes and adjacent territory, and do not normally contribute to the flow of the Rio Grande.

(e) The term "tributary" means any stream which naturally contributes to the flow of the Rio Grande.

(f) "Transmountain Diversion" is water imported into the drainage basin of the Rio Grande from any stream system outside of the Rio Grande Basin, exclusive of the Closed Basin.

(g) "Annual Debits" are the amounts by which actual deliveries in any calendar year fall below scheduled deliveries.

(h) "Annual Credits" are the amounts by which actual deliveries in any calendar year exceed scheduled deliveries.

(i) "Accrued Debits" are the amounts by which the sum of all annual debits exceeds the sum of all annual credits over any common period of time.

(j) "Accrued Credits" are the amounts by which the sum of all annual credits exceeds the sum of all annual debits over any common period of time.

(k) "Project Storage" is the combined capacity of Elephant Butte Reservoir and all other reservoirs actually available for the storage of usable water below Elephant Butte and above the first diversion to lands of the Rio Grande Project, but not more than a total of 2,638,860 acre feet.

(l) "Usable Water" is all water, exclusive of credit water, which is in project storage and which is available for release in accordance with irrigation demands, including deliveries to Mexico.

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RG 76
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(m) "Credit Water" is that amount of water in project storage which is equal to the accrued credit of Colorado, or New Mexico, or both.

(n) "Unfilled Capacity" is the difference between the total physical capacity of project storage and the amount of usable water then in storage.

(o) "Actual Release" is the amount of usable water released in any calendar year from the lowest reservoir comprising project storage.

(p) "Actual Spill" is all water which is actually spilled from Elephant Butte Reservoir, or is released therefrom for flood control, in excess of the current demand on project storage and which does not become usable water by storage in another reservoir; provided, that actual spill of usable water cannot occur until all credit water shall have been spilled.

(q) "Hypothetical Spill" is the time in any year at which usable water would have spilled from project storage if 790,000 acre feet had been released therefrom at rates proportional to the actual release in every year from the starting date to the end of the year in which hypothetical spill occurs; in computing hypothetical spill the initial condition shall be the amount of usable water in project storage at the beginning of the calendar year following the effective date of this Compact, and thereafter the initial condition shall be the amount of usable water in project storage at the beginning of the calendar year following each actual spill.

ARTICLE II.

The Commission shall cause to be maintained and operated a stream gaging station equipped with an

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RG 76
Entry #

automatic water stage recorder at each of the following points, to-wit:

(a) On the Rio Grande near Del Norte above the principal points of diversion to the San Luis Valley;
(b) On the Conejos River near Mogote;
(c) On the Los Pinos River near Ortiz;
(d) On the San Antonio River at Ortiz;
(e) On the Conejos River at its mouths near Los Sauces;
(f) On the Rio Grande near Lobatos;
(g) On the Rio Chama below El Vado Reservoir;
(h) On the Rio Grande at Otowi Bridge near San Ildefonso;
(i) On the Rio Grande near San Acacia;
(j) On the Rio Grande at San Marcial;
(k) On the Rio Grande below Elephant Butte Reservoir;
(l) On the Rio Grande below Caballo Reservoir.

Similar gaging stations shall be maintained and operated below any other reservoir constructed after 1929, and at such other points as may be necessary for the securing of records required for the carrying out of the Compact; and automatic water stage recorders shall be maintained and operated on each of the reservoirs mentioned, and on all others constructed after 1929.

Such gaging stations shall be equipped, maintained with an appropriate Federal or State Agency, and the equipment, method and frequency of measurement at such stations shall be such as to produce reliable records at all times.

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RG 76
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ARTICLE III.

The obligation of Colorado to deliver water in the Rio Grande at the Colorado-New Mexico State Line, measured at or near Lobatos, in each calendar year, shall be ten thousand acre feet less than the sum of those quantities set forth in the two following tabulations of relationship, which correspond to the quantities at the upper index stations:

DISCHARGE OF CONEJOS RIVER

Quantities in thousands of acre feet

Conejos Index Supply (1)	Conejos River at Mouths (2)
100	0
150	20
200	45
250	75
300	109
350	147
400	188
450	232
500	278
550	326
600	376
650	426
700	476

Intermediate quantities shall be computed by proportional parts.

(1) Conejos Index Supply is the natural flow of Conejos River at the U. S. G. S. gaging station near Mogote during the calendar year, plus the natural flow of Los Pinos River at the U. S. G. S. gaging station near Ortiz and the natural flow of San Antonio River

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RG 76
Entry #

at the U. S. G. S. gaging station at Ortiz, both during the months of April to October, inclusive.

(2) Conejos River at Mouths is the combined discharge of branches of this river at the U. S. G. S. gaging stations near Los Sauces during the calendar year.

DISCHARGE OF RIO GRANDE EXCLUSIVE OF CONEJOS RIVER

Quantities in thousands of acre feet

Rio Grande at Del Norte (3)	Rio Grande at Lobatos less Conejos at Mouths (4)
200	60
250	65
300	75
350	86
400	98
450	112
500	127
550	144
600	162
650	182
700	204
750	229
800	257
850	292
900	335
950	380
1000	430
1100	540
1200	640
1300	740
1400	840

Intermediate quantities shall be computed by proportional parts.

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RG 76
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(3) Rio Grande at Del Norte is the recorded flow of the Rio Grande at the U. S. G. S. gaging station near Del Norte during the calendar year (measured above all principal points of diversion to San Luis Valley) corrected for the operation of reservoirs constructed after 1937.

(4) Rio Grande at Lobatos less Conejos at Mouths is the total flow of the Rio Grande at the U. S. G. S. gaging station near Lobatos, less the discharge of Conejos River at its Mouths, during the calendar year.

The application of these schedules shall be subject to the provisions hereinafter set forth and appropriate adjustments shall be made for (a) any change in location of gaging stations; (b) any new or increased depletion of the runoff above inflow index gaging stations; and (c) any transmountain diversions into the drainage basin of the Rio Grande above Lobatos.

In event any works are constructed after 1937 for the purpose of delivering water into the Rio Grande from the Closed Basin, Colorado shall not be credited with the amount of such water delivered, unless the proportion of sodium ions shall be less than forty-five percent of the total positive ions in that water when the total dissolved solids in such water exceeds three hundred fifty parts per million.

ARTICLE IV.

The obligation of New Mexico to deliver water in the Rio Grande at San Marcial, during each calendar year, exclusive of the months of July, August and September, shall be that quantity set forth in the following tabulation of relationship, which corresponds to the quantity at the upper index station:

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DISCHARGE OF RIO GRANDE AT OTOWI BRIDGE AND AT SAN MARCIAL EXCLUSIVE OF JULY, AUGUST AND SEPTEMBER

Quantities in thousands of acre feet

Otowi Index Supply (5)	San Marcial Index Supply (6)
100	0
200	65
300	141
400	219
500	300
600	383
700	469
800	557
900	648
1000	742
1100	839
1200	939
1300	1042
1400	1148
1500	1257
1600	1370
1700	1489
1800	1608
1900	1730
2000	1856
2100	1985
2200	2117
2300	2253

Intermediate quantities shall be computed by proportional parts.

(5) The Otowi Index Supply is the recorded flow of the Rio Grande at the U. S. G. S. gaging station at Otowi Bridge near San Ildefonso (formerly station

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Entry #

near Buckman) during the calendar year, exclusive of the flow during the months of July, August and September, corrected for the operation of reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and Otowi Bridge.

(6) San Marcial Index Supply is the recorded flow of the Rio Grande at the gaging station at San Marcial during the calendar year exclusive of the flow during the months of July, August and September.

The application of this schedule shall be subject to the provisions hereinafter set forth and appropriate adjustments shall be made for (a) any change in location of gaging stations; (b) depletion after 1929 in New Mexico at any time of the year of the natural runoff at Otowi Bridge; (c) depletion of the runoff during July, August and September of tributaries between Otowi Bridge and San Marcial, by works constructed after 1937; and (d) any transmountain diversions into the Rio Grande between Lobatos and San Marcial.

Concurrent records shall be kept of the flow of the Rio Grande at San Marcial, near San Acacia, and of the release from Elephant Butte Reservoir, to the end that the records at these three stations may be correlated.

ARTICLE V.

If at any time it should be the unanimous finding and determination of the Commission that because of changed physical conditions, or for any other reason, reliable records are not obtainable or cannot be obtained, at any of the stream gaging stations herein referred to, such stations may, with the unanimous approval of the Commission, be abandoned, and with such

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RG 76
Entry #

approval another station, or other stations, shall be established and new measurements shall be substituted which, in the unanimous opinion of the Commission, will result in substantially the same results, so far as the rights and obligations to deliver water are concerned, as would have existed if such substitution of stations and measurements had not been so made.

ARTICLE VI.

Commencing with the year following the effective date of this Compact, all credits and debits of Colorado and New Mexico shall be computed for each calendar year; provided, that in a year of actual spill no annual credits nor annual debits shall be computed for that year.

In the case of Colorado, no annual debit nor accrued debit shall exceed 100,000 acre feet, except as either or both may be caused by holdover storage of water in reservoirs constructed after 1937 in the drainage basin of the Rio Grande above Lobatos. Within the physical limitations of storage capacity in such reservoirs, Colorado shall retain water in storage at all times to the extent of its accrued debit.

In the case of New Mexico, the accrued debit shall not exceed 200,000 acre feet at any time, except as such debit may be caused by holdover storage of water in reservoirs constructed after 1929 in the drainage basin of the Rio Grande between Lobatos and San Marcial. Within the physical limitations of storage capacity in such reservoirs, New Mexico shall retain water in storage at all times to the extent of its accrued debit. In computing the magnitude of accrued credits or debits, New Mexico shall not be charged with any greater debit in any one year than the sum of 150,000 acre feet

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and all gains in the quantity of water in storage in such year.

The Commission by unanimous action may authorize the release from storage of any amount of water which is then being held in storage by reason of accrued debits of Colorado or New Mexico; provided, that such water shall be replaced at the first opportunity thereafter.

In computing the amount of accrued credits and accrued debits of Colorado or New Mexico, any annual credits in excess of 150,000 acre feet shall be taken as equal to that amount.

In any year in which actual spill occurs, the accrued credits of Colorado, or New Mexico, or both, at the beginning of the year shall be reduced in proportion to their respective credits by the amount of such actual spill; provided, that the amount of actual spill shall be deemed to be increased by the aggregate gain in the amount of water in storage, prior to the time of spill, in reservoirs above San Marcial constructed after 1929; provided, further, that if the Commissioners for the States having accrued credits authorize the release of part, or all, of such credits in advance of spill, the amount so released shall be deemed to constitute actual spill.

In any year in which there is actual spill of usable water, or at the time of hypothetical spill thereof, all accrued debits of Colorado, or New Mexico, or both, at the beginning of the year shall be cancelled.

In any year in which the aggregate of accrued debits of Colorado and New Mexico exceeds the minimum unfilled capacity of project storage, such debits shall

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be reduced proportionally to an aggregate amount equal to such minimum unfilled capacity.

To the extent that accrued credits are impounded in reservoirs between San Marcial and Couchesne, and to the extent that accrued debits are impounded in reservoirs above San Marcial, such credits and debits shall be reduced annually to compensate for evaporation losses in the proportion that such credits or debits bore to the total amount of water in such reservoirs during the year.

ARTICLE VII.

Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs constructed after 1929 whenever there is less than 400,000 acre feet of usable water in project storage; provided, that if the actual releases of usable water from the beginning of the calendar year following the effective date of this Compact, or from the beginning of the calendar year following actual spill, have aggregated more than an average of 790,000 acre feet per annum, the time at which such minimum stage is reached shall be adjusted to compensate for the difference between the total actual release and releases at such average rate; provided, further, that Colorado or New Mexico, or both, may relinquish accrued credits at any time, and Texas may accept such relinquished water, and in such event the state, or states, so relinquishing shall be entitled to store water in the amount of the water so relinquished.

ARTICLE VIII.

During the month of January of any year the Commissioner for Texas may demand of Colorado and New Mexico, and the Commissioner for New Mexico may

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demand of Colorado, the release of water from storage reservoirs constructed after 1929 to the amount of the accrued debits of Colorado and New Mexico, respectively, and such releases shall be made by each at the greatest rate practicable under the conditions then prevailing, and in proportion to the total debit of each, and in amounts, limited by their accrued debits, sufficient to bring the quantity of usable water in project storage to 600,000 acre feet by March first and to maintain this quantity in storage until April thirtieth, to the end that a normal release of 790,000 acre feet may be made from project storage in that year.

ARTICLE IX.

Colorado agrees with New Mexico that in event the United States or the State of New Mexico decides to construct the necessary works for diverting the waters of the San Juan River, or any of its tributaries, into the Rio Grande, Colorado hereby consents to the construction of said works and the diversion of waters from the San Juan River, or the tributaries thereof, into the Rio Grande in New Mexico, provided the present and prospective uses of water in Colorado by other diversions from the San Juan River, or its tributaries, are protected.

ARTICLE X.

In the event water from another drainage basin shall be imported into the Rio Grande Basin by the United States or Colorado or New Mexico, or any of them jointly, the State having the right to the use of such water shall be given proper credit therefor in the application of the schedules.

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ARTICLE XI.

New Mexico and Texas agree that upon the effective date of this Compact all controversies between said States relative to the quantity or quality of the water of the Rio Grande are composed and settled; however, nothing herein shall be interpreted to prevent recourse by a signatory state to the Supreme Court of the United States for redress should the character or quality of the water, at the point of delivery, be changed hereafter by one signatory state to the injury of another. Nothing herein shall be construed as an admission by any signatory state that the use of water for irrigation causes increase of salinity for which the user is responsible in law.

ARTICLE XII.

To administer the provisions of this Compact there shall be constituted a Commission composed of one representative from each state, to be known as the Rio Grande Compact Commission. The State Engineer of Colorado shall be ex-officio the Rio Grande Compact Commissioner for Colorado. The State Engineer of New Mexico shall be ex-officio the Rio Grande Compact Commissioner for New Mexico. The Rio Grande Compact Commissioner for Texas shall be appointed by the Governor of Texas. The President of the United States shall be requested to designate a representative of United States to sit with such Commission, and such representative of the United States, if so designated by the President, shall act as Chairman of the Commission without vote.

The salaries and personal expenses of the Rio Grande Compact Commissioners for the three States shall be paid by their respective States, and all other expenses

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incident to the administration of this Compact, not borne by the United States, shall be borne equally by the three States.

In addition to the powers and duties hereinbefore specifically conferred upon such Commission, and the members thereof, the jurisdiction of such Commission shall extend only to the collection, correlation and presentation of factual data and the maintenance of records having a bearing upon the administration of this Compact, and, by unanimous action, to the making of recommendations to the respective States upon matters connected with the administration of this Compact. In connection therewith, the Commission may employ such engineering and clerical aid as may be reasonably necessary within the limit of funds provided for that purpose by the respective States. Annual reports compiled for each calendar year shall be made by the Commission and transmitted to the Governors of the signatory States on or before March first following the year covered by the report. The Commission may, by unanimous action, adopt rules and regulations consistent with the provisions of this Compact to govern their proceedings.

The findings of the Commission shall not be conclusive in any court or tribunal which may be called upon to interpret or enforce this Compact.

ARTICLE XIII.

At the expiration of every five year period after the effective date of this Compact, the Commission may, by unanimous consent, review any provisions hereof which are not substantive in character and which do not affect the basic principles upon which the Com-

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pact is founded, and shall meet for the consideration of such questions on the request of any member of the Commission; provided, however, that the provisions hereof shall remain in full force and effect until changed and amended within the intent of the Compact by unanimous action of the Commissioners and until any changes in this Compact are ratified by the legislatures of the respective states and consented to by the Congress, in the same manner as this Compact is required to be ratified to become effective.

ARTICLE XIV.

The schedules herein contained and the quantities of water herein allocated shall never be increased nor diminished by reason of any increases or diminution in the delivery or loss of water to Mexico.

ARTICLE XV.

The physical and other conditions characteristic of the Rio Grande and peculiar to the territory drained and served thereby, and to the development thereof, have actuated this Compact and none of the signatory states admits that any provisions herein contained establishes any general principle or precedent applicable to other interstate streams.

ARTICLE XVI.

Nothing in this Compact shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties or to the Indian tribes, or as impairing the rights of the Indian Tribes.

ARTICLE XVII.

This Compact shall become effective when ratified by

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the legislatures of each of the signatory states and consented to by the Congress of the United States. Notice of ratification shall be given by the Governor of each state to the Governors of the other states and to the President of the United States, and the President of the United States is requested to give notice to the Governors of each of the signatory states of the consent of the Congress of the United States.

IN WITNESS WHEREOF, the Commissioners have signed this Compact in quadruplicate original, one of which shall be deposited in the archives of the Department of State of the United States of America and shall be deemed the authoritative original, and of which a duly certified copy shall be forwarded to the Governor of each of the signatory States.

Done at the City of Santa Fe, in the State of New Mexico, on the 18th day of March, in the year of our Lord, One Thousand Nine Hundred and Thirty-eight.

M. C. Hinderlider
Thomas M. McClure
Frank B. Clayton

APPROVED:
S. O. Harper

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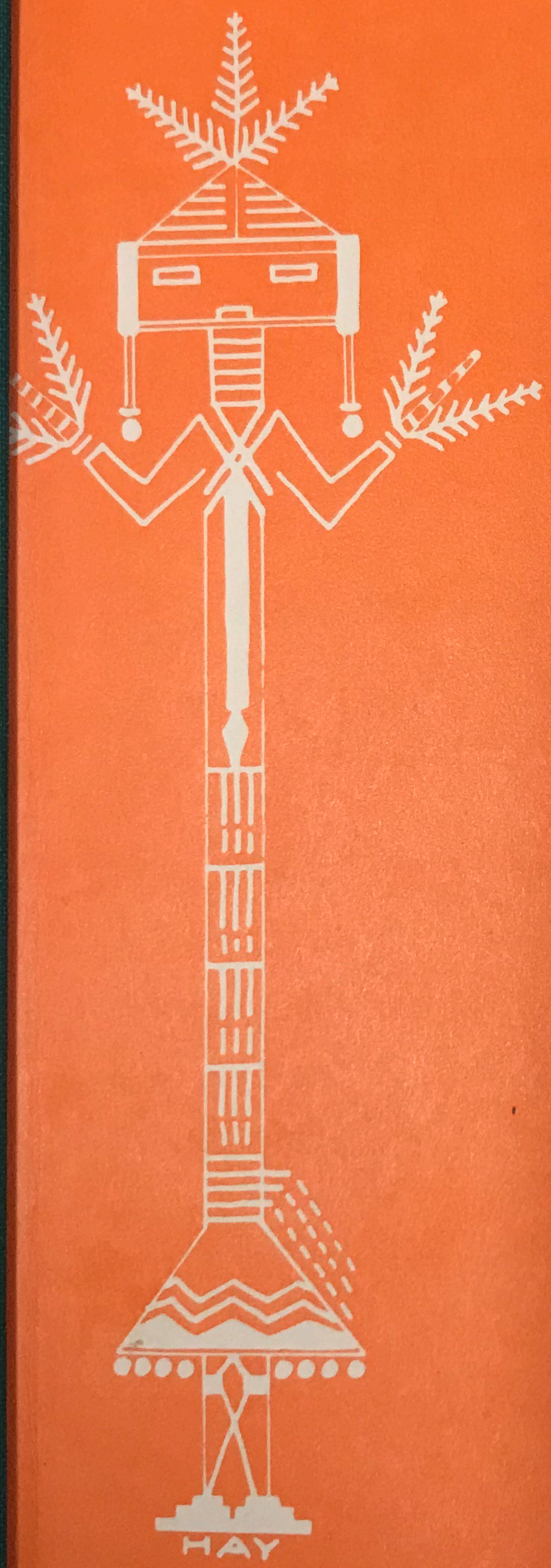

International Water Law Along the Mexican-American Border

Edited by:

CLARK S. KNOWLTON

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The University of Texas at El Paso
1968

International Water Law Along the Mexican-American Border

International Water Law Along the Mexican-American Border

A Symposium held during the forty-fourth annual meeting of the Southwestern and Rocky Mountain Division of the American Association for the Advancement of Science.

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Statement of Purpose of the Committee on Desert and Arid Zones Research

Objectives of the Committee are to encourage the study of phenomena affecting and affected by human occupation of arid and semiarid regions, primarily within the areas represented by the Southwestern and Rocky Mountain Division of A.A.A.S. This is interpreted to include educational and research activities, fundamental and applied, that may further understanding and efficient use of our arid lands.

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ILLUSTRATIONS

1. Map of Rio Grande (Bravo) Basin, compiled by D. D. MacPhail . *vi*
2. Chart Rio Grande-El Paso Valley Inflows and Outflows and Dissolved Solids Content, compiled by Ted Henderson . . . 3
3. Map of the Rio Grande (Bravo) Compact, S. E. Reynolds, April, 1968 5

CONTENTS

Introduction . . . . . *ix*
Clark S. Knowlton, University of Utah, Center for the Study of Social Problems, Salt Lake City, Utah.

I *History and Functions of Joint Mexican-American Public Bodies Regulating and Allocating Water Resources along the Rio Grande (Bravo)* 1
J. F. Friedkin, United States Commissioner, International Boundary and Water Commission.

II *Historia de los Acuerdos entre México y los Estados Unidos para el Aprovechamiento de las Aguas del Río Bravo (Grande)* . 8
(History of Mexican-American Treaties Covering Water Allocations)
Ing. David Herrera Jordán, Comisión Internacional de Limites y Aguas.

III *División de las Aguas del Río Bravo (Grande) entre México y los Estados Unidos* 16
(Present Division of Water Resources along the Border between Mexico and the United States)
Ing. Jenaro Paz Reyes, Comisión Internacional de Límites y Aguas.

IV *Major United States Water Problems Along the International Boundary Reach of the Rio Grande (Bravo)* 26
Ted E. Henderson, Chief, Office of Water Control, International Boundary and Water Commission.

V *Evolution of Mexican Water Law* 37
Ing. Antonio Rodríguez Langone, Director, Aprovechamientos Hidráulicos, Secretaría de Recursos Hidráulicos de México.

VI *Evolution of American Law as to Surface Waters in the Southwest, with Special Reference to the Rio Grande (Bravo)* . 43
Marvin E. Whittington, Counsel, International Boundary and Water Commission.

VII *The Rio Grande Compact* 48
S. E. Reynolds, State Engineer, State of New Mexico.

Spanish/English and English/Spanish Summaries follow each essay. These translations were written by Professor John M. Sharp of the Modern Languages Department, The University of Texas at El Paso.

VII

The Rio Grande Compact

S. E. Reynolds

State Engineer,
State of New Mexico

Introduction

Controversies involving interstate streams may be resolved by any one of several procedures. When the controversy involves private persons, who are citizens of different states, the matter may be adjudicated by a federal district court. An example is the 1935 decree of the Federal District Court for the District of Arizona (Globe Equity No. 59) which adjudicated rights to the waters of the Gila River in Arizona and in the Virden Valley of southwestern New Mexico.

The settlement of controversies over interstate waters in a federal district court is a troubled area because the states responsible for the administration of water and water rights are not before the court and the effect of the decree is at best uncertain.

When the controversy is between states, or between a state and citizens of another state, the Supreme Court of the United States has original jurisdiction. The binding effect of the decrees of this court on the state and all of its citizens overcomes the objection to federal district court decisions. By its decisions, the Supreme Court seems to have established the rule that the interstate streams of the west are subject to the doctrine of equitable apportionment. Under this doctrine, the upstream state does not have the right to the use of all of the waters arising within its borders and the downstream state cannot require the delivery of all of the natural flow of the stream. Priority of appropriation is only one of the elements to be considered in arriving at an equitable apportionment even when both of the contesting states apply the doctrine of prior appropriation in the administration of their waters. The court will consider the economy based on the development and use of water, the public welfare and other factors in determining the issues.

The use of waters of interstate streams can be apportioned among competing states by federal legislation. An example of this mechanism is the Boulder Canyon Project Act (45 Stat. 1057) which apportioned waters of the main stream of the Colorado River below Lee Ferry among the States of California, Arizona and Nevada.

War, of course, is a common method of resolving controversies among sovereignities and, in his darker moments, the State Engineer has sometimes felt that war is the only practical answer to many of our interstate water problems. This forthright solution is, however, forbidden by Article I of the nation's Constitution.

This remark is not entirely facetious. In 1939 the Governor of New Mexico ordered the State Police, the only armed forces at his disposal for the purpose at hand, to break the locks put on headgates in the Virden Valley by the Federal District Court's Water Commissioner. He directed the Chief of State Police to use whatever force was necessary to prevent the Water Commissioner from interfering with the administration of water in New Mexico. Fortunately, there were further court proceedings and the issue was put to rest before any shots were fired in anger.

The legal basis of all interstate stream compacts is found in Section 10 of Article I of the Constitution of the United States. This section permits a state to consummate an agreement or compact with another state with the consent of Congress. These interstate agreements are our most profound law and may supersede state statutes.

The negotiation of compacts is at best a difficult procedure requiring a blending of diplomatic, engineering and legal talent. It is essential that the lawyers involved in the negotiations fully comprehend the engineering aspects of the negotiation and that the engineers have a clear conception of the legal considerations. Unless this is so, inequities and ambiguities which will be the subject of future controversies find their way into the compact.

Compacting as a procedure for the resolution of interstate controversies has been criticized because the states cannot maintain the trained diplomatic corps required and because a relatively small number of persons negotiate and resolve issues of tremendous importance to diverse local interests not adequately represented in the negotiations. The requirement for compacts to be ratified by the legislature of each state concerned and approved by the Congress largely overcomes these objections.

It is generally agreed that compact negotiations are preferable to judicial procedures for the resolution of controversies over interstate waters. I accept this view, particularly for the reason that the pattern of negotiations can be so much more flexible than the set of rules which our courts must follow. As a consequence, the prospects for an equitable solution more nearly satisfactory to all affected interests are improved.

To support the view that the interstate compact is preferred, it can be pointed out that New Mexico's interstate waters are governed by seven compacts, the decree of the Supreme Court in Arizona vs. California and two federal district court decrees. Almost all of New Mexico's surface water resources are subject to the terms of interstate compacts. One of our streams, the La Plata River, which is tributary to the San Juan River in northwestern New Mexico, is subject to the terms of three compacts,

the Colorado River Compact of 1922, the La Plata River Compact and the Upper Colorado River Basin Compact.

While I advocate the interstate compact as the mechanism for resolving interstate water controversies, I should point out that the compact negotiator must be prepared to accept as his reward the opprobium and scorn of his constituents. The people – particularly the citizens of the upstream states – almost universally complain that they were "sold down the river;" the harsher complainants say that the negotiator sold the river.

Perhaps the most controversial and misunderstood water compact to which New Mexico is a party, the Rio Grande Compact now in force, was executed in Santa Fe on March 18, 1938 by commissioners representing Colorado, New Mexico, Texas and the United States. Its signing was preceded by half a century of controversy over apportionment of Rio Grande water among users in the three signatory states and Mexico. Its operation has done much to solve the problems associated with interstate and international use of the river's flows.

Some treatment of the history of the river might give a framework helpful in the discussion of the philosophy and terms of the Rio Grande Compact.

Historical

Until very recently, the economy of the Rio Grande Basin above Fort Quitman in Texas was based almost exclusively on agriculture. Precipitation is scarce throughout the cultivated areas of the basin, and irrigation is required for successful growing of crops. Irrigation along the river and many of its tributaries was initiated by Indians several centuries before the coming of the white man, and in many areas it has continued until the present.

The basin's recorded history began with its exploration by Coronado in 1540. During the 17th and 18th centuries, Spanish colonization in New Mexico and in Texas as far south as Fort Quitman was accompanied by an expansion of irrigation farming – the irrigators diverting water directly from streams and springs into crude *acequia* or ditch systems. Cultivation by white men in the San Luis Valley in Colorado was begun in the early 1850's, but it was not until about 1880 that extensive development for irrigation occurred. Most large canal and ditch systems now in use in the San Luis Valley were in existence in 1890. By 1937, 600,000 acres were irrigated in Colorado from the Rio Grande and its tributaries.

In the early 1890's water shortages in the Mesilla and El Paso Valleys led farmers near Juarez, Mexico, to complain to their government. Mexico registered formal complaint with the U. S. Department of State and advanced claims for damages in excess of $30 million, alleging that the

Mexican shortages were due to diversions from the river in Colorado and New Mexico.

The United States through the International Boundary Commission thereupon instituted an investigation of conditions, two products of which were the "Rio Grande Embargo" of 1896 and the Mexican Treaty of 1906. The "embargo" was an order by the Secretary of the Interior which stalled further large-scale development of Rio Grande water for irrigation in Colorado and New Mexico through suspension of action on applications for water-project rights-of-way across public lands. Under terms of the Mexican treaty, and in return for relinquishment of all claims for damages, the United States guaranteed to Mexico annual delivery in perpetuity of 60,000 acre-feet of water in the Rio Grande at the head of the *Acequia Madre* near Juarez, with the provision that the nations would share water shortages in times of drought.

Both to insure fulfillment of the Mexican treaty and to develop an interstate reclamation project in the Elephant Butte-Fort Quitman reach of the river, the United States in 1907 modified the Rio Grande embargo to permit construction of Elephant Butte Dam by the U. S. Reclamation Service (now Bureau of Reclamation).

The Rio Grande embargo had been vigorously opposed in Colorado. By 1896, little storage had been developed to serve irrigation projects in the San Luis Valley. During the latter part of many growing seasons irrigators were frequently diverting the entire flow of the river and its tributaries, and still the supply was short. Storage of winter flows and flood flows was a requisite for development of new irrigation, and even for maintenance of existing irrigation. But Federal action in withholding rights-of-way for water projects rendered impossible the development of storage of any magnitude.

As modified in 1907, the embargo allowed consideration of applications for rights-of-way for water projects wherein the rights of the applicants had been initiated prior to March 1, 1903, the date on which the Rio Grande Project began active operation. Under this modification, irrigators in the San Luis Valley were able to proceed with limited development of new storage. Rio Grande, Santa Maria and Continental Reservoirs, having a combined capacity of 121,000 acre-feet, were completed by 1926. La Jara and Terrace Reservoirs on La Jara and Alamosa Creeks, with combined capacity of about 32,000 acre-feet, were completed in the same general period, as were Sanchez on Culebra Creek at 103,000 acre-feet and Mountain Home and Smith on Trinchera Creek with a combined capacity of 26,000 acre-feet.

Elephant Butte Dam, with an original impounding capacity of 2,639,000 acre-feet, was completed in 1916, along with other works of the resulting Rio Grande Irrigation Project which included 88,000 acres in the Elephant

Butte Irrigation District in New Mexico and 67,000 acres in the El Paso County Water Improvement District No. 1 in Texas. Both districts depend on Elephant Butte Reservoir for storage, and community of interest united irrigators in the two districts in competition with upstream diverters, even though they were citizens of different states.

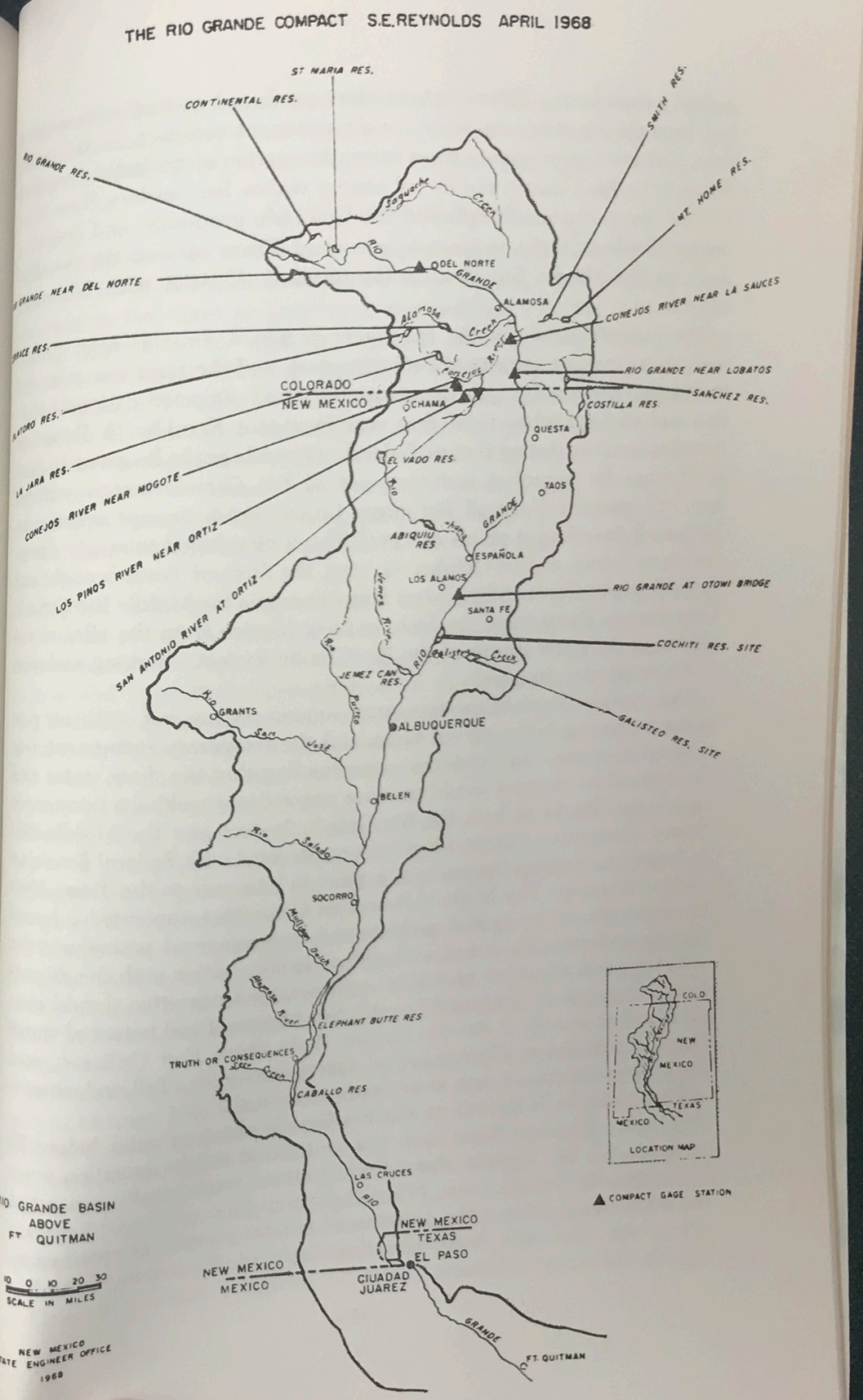
By 1918, much New Mexico land in the Middle Valley between Cochiti and San Antonio, irrigated under old community *acequia* systems, had become water-logged and thousands of acres of once-productive cropland had been abandoned – principally because of a rising water table, aggravated by silt deposition aggrading the riverbed, with resultant large-scale waste of water to evapotranspiration.

Enabling legislation was enacted, and in 1925 (the year in which the embargo of 1896 was finally lifted, over New Mexico's vigorous protests) the Middle Rio Grande Conservancy District was organized as a political subdivision of the State of New Mexico.

The district's plan for installation of flood control, drainage, and irrigation facilities was approved in 1928, and active construction was begun in 1930. The project works, including El Vado Reservoir on the Rio Chama with a capacity of 198,000 acre-feet, were completed in 1935. Costs of construction, met through sale of bonds to the Federal Reconstruction Finance Corporation, amounted to about $9 million.

Meanwhile, with development of storage for irrigation moving ahead in both Colorado and New Mexico, competition for use of the river's flow among users in Texas and the two up-river states was increasing and sentiment was developing in favor of attempting to negotiate an interstate compact which would apportion the river's waters among users in the disputant states and provide in each state a basis for establishment of firm water rights upon which financial investments in irrigation works might be based. Early in 1923, the legislatures of Colorado and New Mexico enacted statutes authorizing appointment of representatives to an interstate water commission. Texas followed suit; Congress consented to the formation of such a commission; the President designated a representative to safeguard the rights of the United States; and negotiations looking to the framing of a Rio Grande compact were begun.

In 1929, an agreement was reached which was temporary in nature and which did not attempt to apportion the river's waters. Its principal articles provided that during the five-year term of the agreement: 1) neither Colorado nor New Mexico would increase diversions or storage until such time as resulting depletions should be offset by increase of drainage return, 2) the three states would maintain streamflow-gauging stations and exchange records of measurements, and 3) before expiration of the temporary agreement, a permanent compact providing for apportionment of the river's waters would be drawn and entered into.



Half a decade of additional negotiation produced no further agreement and brought the states no nearer to a permanent compact. In the meantime, Colorado continued to press for authorization of projects to regulate flows of the Rio Grande and its tributaries within her borders; New Mexico and Texas vigorously opposed the Colorado proposals; and irrigators below Elephant Butte in New Mexico and Texas viewed the development in the Middle Rio Grande Conservancy District with increasing concern.

The expiration date of the temporary compact, June 1, 1935, passed with no permanent agreement being reached, and the term was extended to October 1, 1937. By 1935, the controversy had attracted national attention and on September 13 of that year President Franklin D. Roosevelt issued a mandate stating that no federal approval should be given to "any application for a project involving use of Rio Grande waters without securing from the National Resources Committee a prompt opinion on it from all the relevant points of view." This action failed to satisfy downstream irrigators, and on October 24, 1935, the State of Texas brought suit in the Supreme Court of the United States to enjoin the Middle Rio Grande Conservancy District and the State of New Mexico from the alleged depletion of the water supply of the Rio Grande Project, charging violation of the temporary compact.

The extended term of the temporary agreement ran out, with no permanent compact being agreed upon, and the temporary instrument was allowed to expire – but with the understanding that the three states and the Federal government would continue negotiations seeking a permanent agreement. Works of both the Rio Grande Project and the Middle Rio Grande Conservancy District had been constructed with Federal financing and with the Federal Government moving to intervene in the Texas-New Mexico litigation. The National Resources Committee appointed a board to review the hydra-headed problem and to recommend procedures for finding a solution. The board advised that, in cooperation with the disputant states and a number of Federal agencies, the Committee should conduct a thorough and impartial investigation of present and potential water and land resources of the Rio Grande Basin above Fort Quitman, and that it should obtain all other factual data necessary for a full understanding of the problems of each of the states concerned.

Fort Quitman is located on the Rio Grande about 70 miles below El Paso. After Elephant Butte Dam was constructed and its operation commenced, the Rio Grande above Fort Quitman was virtually separated hydrologically from the river below that point. Thus a compact between the states could achieve the objective of removing causes of controversy among the states with its considerations limited to the waters of the Rio Grande above Fort Quitman.

Agreement on the nature and scope of the investigation was reached at a conference of states and agencies in Santa Fe in February 1936 and field work was initiated in April 1936 to continue into 1937.

Rio Grande Compact of 1938

The study was one of the most comprehensive and detailed investigations ever made of a river basin in the West. A final report of its findings, delivered to the states in June 1937, was published by the National Resources Committee in 1938 as Regional Planning Part VI – The Rio Grande Joint Investigation in the Upper Rio Grande Basin in Colorado, New Mexico, and Texas. Its data provided a basis for further negotiation, and led to the signing of the compact in March 1938. The agreement was ratified by the legislature of Colorado on February 21, 1939, and by the legislatures of New Mexico and Texas on March 1, 1939. Congress consented to its terms on May 13, 1939 (in Public Act 96, 76th Congress), and on the same day President Franklin D. Roosevelt signed it into Federal Law.

Adoption of the compact, of course, terminated the pending litigation. In accordance with its provisions, the compact is administered by a four-man commission composed of the State Engineers of Colorado and New Mexico and appointed representatives of Texas and the United States. The Federal representative acts as chairman without vote, and all actions of the body must be by unanimous vote of the other three commissioners. The costs of administration not borne by the United States are shared equally by the three states.

During the 30 years it has been in operation, the Rio Grande Compact has been pretty thoroughly maligned – particularly in recent years in Colorado and in portions of New Mexico – largely because its terms are not generally understood.

Perhaps the most common public misconception of the Rio Grande Compact is that it requires the upstream states to deliver to the downstream states a fixed amount of water each year, come drought or come flood, and that the compact is, therefore, inequitable and impossible to comply with.

In fact, the basic objective of the negotiators was to preserve the status quo as of 1929. The equities developed in the river by each state were defined by a study of the pre-compact conditions of flow in each state. On the basis of this study, schedules were drawn to establish the outflow which must be maintained at each level of water supply. The water supply is determined from readings at upstream index gauges. The outflow required is small when the flow at the index gauges is small and is larger in years of good runoff when the flow at the index gauges is high.

Colorado's annual obligation to deliver water at Lobatos near the

Colorado-New Mexico stateline is established each year by the supply indicated by a gauge on the main stem of the Rio Grande at Del Norte, Colorado, and three other gauges located on the Conejos River and two of its tributaries, the Los Pinos River and the San Antonio River.

New Mexico's obligation to deliver water to Elephant Butte Reservoir is established each year by the flow of the river at Otowi gauge, located on the Rio Grande near Espanola below the confluence of Rio Chama and Rio Grande.

A few numbers might be useful to give a concept of the water supply involved and the effect of the schedules. The average annual flow of the Rio Grande at Otowi gauge is about 1 million acre-feet. In a year in which the flow at Otowi gauge is 1 million acre-feet, New Mexico is obligated to deliver 621,000 acre-feet, or 62 percent at Elephant Butte. In a year when the flow is only 400,000 acre-feet, about the minimum of record, New Mexico is obliged to deliver only 228,000 acre-feet, or 57 percent. At a flow of 3 million acre-feet for the year, New Mexico's obligation is 2.6 million acre-feet or about 86⅔% of the total of the flow at Otowi.

There is a potential for increased use above the index gauges used to determine the annual supply in the river and increased uses could affect the schedules to the detriment of the downstream states. For example, the Otowi gauge is about 100 miles of the Colorado line and there is considerable opportunity for new uses from the Rio Grande and its tributaries above Otowi that would deplete the runoff at that point. For this reason, the compact provides for appropriate adjustment of the schedules to reflect changes in depletion above the index gauges. For example, if there are new uses in New Mexico that deplete the flow of the Rio Grande at Otowi gauge the amount of this depletion must be added to the measured flow before entering the schedule to determine New Mexico's obligation.

It was the objective of the negotiators not to preclude any increase in depletion above Otowi gauge but to cause the effect of any such increased depletion to fall on users in New Mexico above Elephant Butte Reservoir, rather than on users below.

It is important to understand that while the New Mexico delivery obligation is set by the flow at Otowi, we don't meet our obligation only with water that actually passes Otowi gauge. The obligation is met to a considerable extent with tributary inflow to the river below the index gauge. Therefore, in years in which the tributary inflow below Otowi departs materially from the normal relationship to the flow at Otowi gauge, it is to be expected that New Mexico will underdeliver or overdeliver to the downstream users. That is, in years of abundant snowfall and spring runoff, with lots of water passing Otowi gauge, followed by a dearth of summer thundershowers, which produce most of the inflow below Otowi, New Mexico likely will underdeliver.

Such vagaries of weather are reflected in the records of pre-compact flow conditions and are provided for by the system of debits and credits for deliveries established in the compact.

Under this system, New Mexico is allowed to accrue debits up to 200,000 acre-feet and Colorado is allowed debits to 100,000 acre-feet. These debt limits may be exceeded to the extent that they are caused by holdover storage in reservoirs constructed after 1929 in New Mexico or reservoirs constructed after 1937 in Colorado. However, water stored in such reservoirs in each state must be retained in storage to the extent of the state's accrued debit. This "debit water" in storage cannot be released for use by the debtor state without the unanimous consent of the compact commissioners and must be held for release on demand by the downstream states made in accordance with the compact.

In computing debits and credits, New Mexico may not be charged with any greater debit in any one year than the sum of 150,000 acre-feet and all gains for the year in the quantity of water in storage in New Mexico above Elephant Butte Reservoir. With respect to both states, any annual credit in excess of 150,000 acre-feet must be taken as equal to that amount.

The compact clearly recognizes the priority of Elephant Butte Reservoir, which was completed in 1916, over reservoirs constructed in Colorado or New Mexico after 1929. Bear in mind here that El Vado Dam and Reservoir, the only storage works of the Middle Rio Grande Conservancy District, were constructed in 1935. When there is less than 400,000 acre-feet of water in storage in Elephant Butte and Caballo Reservoirs, which the compact defines as "project storage," neither Colorado nor New Mexico may increase the amount of water in storage in reservoirs constructed after 1929.

During January of any year, Texas may demand of New Mexico and Colorado, and New Mexico may demand of Colorado, releases from reservoirs constructed after 1929 to the extent of the respective debits of the upstream states. The releases must be made at the greatest rate practicable and in amounts limited by the accrued debits, sufficient to bring the quantity of water in Elephant Butte and Caballo Reservoirs to 600,000 acre-feet by March 1 and to maintain that quantity in storage until April 30th.

The original compact schedules set New Mexico's delivery point at the San Marcial gauge just above Elephant Butte Reservoir. This original schedule excluded the flow during July, August and September from the index supply measured at Otowi and from New Mexico's delivery as measured at San Marcial. In 1948, by a resolution of the compact commission, the delivery point was moved to the gauge below Elephant Butte Dam, and the schedules were modified to include the flow for the entire year in the supply and delivery determinations. New Mexico's annual

delivery is defined by the resolution as the flow passing the gage below the dam plus or minus the net gain or loss in storage in Elephant Butte Reservoir in the year.

An important effect of this change in delivery point was to make evaporation from Elephant Butte Reservoir a liability of the water users above Elephant Butte. However, the new schedule adjusted the inflow-outflow relationship so that New Mexico's delivery obligation was not substantially altered by this shift in liability or by the accounting of the flows for 12 months instead of nine.

For accounting purposes, the delivery credits of the upstream states are stored in Elephant Butte Reservoir. These credits are reduced annually by the deduction of a proportionate part of the annual evaporation from the reservoir. In the event that Elephant Butte and Caballo Reservoirs fill and spill when Colorado and New Mexico have credits, the water spilled is deemed to be credit water. The accrued credits of the upstream states are reduced by the amount of spill in proportion to their respective credits.

On the other hand, in any year in which the aggregate of the accrued debits of Colorado and New Mexico exceeds the minimum unfilled capacity of Elephant Butte and Caballo Reservoirs, the debits are reduced proportionately to an aggregate amount equal to the minimum unfilled capacity. In any year in which there is actual spill of water from project storage, the minimum unfilled capacity is zero and all accrued debits that Colorado and New Mexico had at the beginning of that year are cancelled.

The seemingly complex provisions governing the operation of reservoirs were designed to recognize the priority of Elephant Butte Reservoir, but at the same time permit a coordinated operation of reservoirs in the Rio Grande Basin to mutually benefit the three states.

An example might help to illustrate this point. Assume for this purpose, that New Mexico has eradicated her debt and in a year of abundant tributary inflow below Otowi gage has achieved a credit of 100,000 acre-feet. In the next spring runoff, the Middle Rio Grande Conservancy District could store at least this amount in El Vado Reservoir for use on district lands without regard to the priority of Elephant Butte Reservoir. In effect, tributary inflows which could not be controlled for the benefit of the Middle Rio Grande District were caught and stored to the credit of the district in Elephant Butte Reservoir and then transferred by exchange to the junior upstream reservoir. This exchange can be effected, of course, only if there is more than 400,000 acre-feet exclusive of credit water available in "project storage."

The Rio Grande Compact makes no specific reference to ground water. However, the inflow-outflow mechanism for determining delivery obligations makes the control of groundwater appropriations in the upstream

states essential for the protection of existing surface water rights in those states and the preservation of their ability to meet the compact commitments.

Surface waters and ground waters in the Rio Grande Valley are intimately related. At some points, the surface flows feed the ground water reservoirs and, at other points, the groundwater reservoirs discharge into the stream. Along the mainstream of the river, the situation generally is one in which groundwater discharge contributes to surface flow. Annual groundwater accretion to the river's mainstream in the reach between the Colorado line and Elephant Butte Reservoir amounts to 200,000 to 300,000 acre-feet.

Heavy, sustained pumping from the groundwater reservoir would cut off this accretion and ultimately would reverse the water table gradient so that the water now flowing into the stream and constructed drains would disappear into the groundwater reservoir. These hydrologic facts of life, coupled with imminent large-scale developments of groundwater for agricultural and municipal and industrial uses in New Mexico above Elephant Butte led the State Engineer in 1956 to assume jurisdiction over appropriations of groundwater in the Rio Grande Valley along the river's mainstream and the lower reaches of its tributaries by proclaiming the boundaries of an underground water basin which extends from the Colorado line to Elephant Butte Dam. The action was taken both to protect the existing water rights in New Mexico and to preserve the state's ability to meet its compact obligations.

Under present administration of the Rio Grande Underground Water Basin, the drilling of wells for groundwater appropriations is permitted, but it is required that surface water usage under existing rights be retired to the extent that is necessary to offset the effects of groundwater pumpage on the fully appropriated surface water supply.

Of great significance is the fact that the upstream states implicitly committed themselves not only to protect the river flows against the enterprise of man, but also to protect those flows against the forces of nature. If drainage works and the river channel are allowed to deteriorate and non-beneficial plants are allowed to proliferate so that losses increase below the inflow index stations, water will be lost and deliveries will depart from the pre-compact inflow-outflow relationship upon which the delivery schedules are based unless beneficial use by man in the upstream states is curtailed.

On the other side of the coin, there was a significant amount of non-beneficial consumptive use of water in the upstream states under the historic conditions upon which the compact schedules were based. Improvements in drainage and channel conditions and the eradication and control of non-beneficial plants to reduce those historic losses would result

in an increase in the supply available under the compact for appropriators in the upstream states.

A fact often unappreciated is that under the compact about 57% of the water released from Elephant Butte Reservoir for use in the United States is used in New Mexico below Elephant Butte Reservoir on about 90,000 acres of our finest agricultural lands. That is, the compact does not, in fact, apportion water between New Mexico and Texas; rather, the allocation is between water users in New Mexico above Elephant Butte on the one hand and water users in New Mexico and Texas below Elephant Butte on the other.

The agricultural development in the Elephant Butte Irrigation District makes an important contribution to the state's economy. Thus, selfish economic incentive, as well as moral responsibility, is involved in meeting our compact commitments.

Full appreciation of this aspect of the compact might help you to account for some occasional, apparently schizophrenic behavior on the part of the New Mexico State Engineer.

Taking into account the fact that more than half of the water New Mexico delivers under the compact is used within her own borders, outflow to Texas in the Rio Grande is about equal to inflow from Colorado; and New Mexico actually is permitted to use from the river about what she puts into it. From what I've said about the fundamental objectives of the compact and the manner in which its delivery schedules were constructed, it should be evident that this circumstance is only coincidential.

Of particular interest at this symposium is the compact's recognition of and provision for the international obligations of the United States. Article XIV provides that: "The schedules herein contained and the quantities herein allocated shall never be increased nor diminished by reason of any increase or diminution in the delivery or loss of water to Mexico." Article XVI provides that: "Nothing in this compact shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties, or to the Indian Tribes, or as impairing the rights of the Indian Tribes." Provisions of this nature were probably necessary for Congressional ratification.

At the outset, I expressed the view that the interstate compact is to be preferred over litigation in the resolution of controversies over interstate streams. I would not try to persuade you that the interstate compact precludes litigation — the record does not permit it.

The compact's water delivery schedules became effective on January 1, 1940. Unusually heavy precipitation in the fall of 1941 and the spring of 1942 filled Elephant Butte and Caballo Reservoirs to capacity and water stored to the credit of the States of Colorado and New Mexico was spilled.

hus, at the end of its third year of operation, the compact appeared to e functioning as its architects had intended.

By the late '40s, it was becoming apparent that the works of the Middle io Grande Conservancy District could not provide adequate flood protecon for the middle valley, that channel aggradation and the deterioration f the drainage system and the encroachment of non-beneficial plants on e water supply were causing enormous losses in the reach between ochiti Dam and Elephant Butte Reservoir. It was also clear that the iddle Rio Grande Conservancy District lacked the resources to effecvely attack these problems.

A Bureau of Reclamation report released in 1947 indicated that about ,000 acres of *bosque* and wetted sands between Cochiti and Elephant utte Reservoir were consuming an average of more than 300,000 acreet of water annually.

In 1948, the Middle Rio Grande Project was authorized by the Congress. he plan provided for construction of flood control reservoirs on the Rio rande and its major tributaries in New Mexico, an extensive program f channel rectification and levee improvement, the restoration of irrigaon works and the installation of an effective drainage system within the onservancy district.

At the end of 1943, New Mexico's debt was 59,000 acre-feet and by the nd of 1951, her compact water debt had reached 331,000 acre-feet. In ctober of 1951, Texas brought action in the United States Supreme Court gainst New Mexico and the Middle Rio Grande Conservancy District, harging violation of the compact. The suit asked that the defendants be njoined from operating reservoirs otherwise than in accordance with the ompact and that the defendants be restrained from diverting any of the aters of the Rio Grande until New Mexico's accrued water debt had been educed to 200,000 acre-feet.

New Mexico asked for dismissal of the action, principally on the ground hat the United States was an indispensable party to the suit because of he water rights of Indian irrigators in the Rio Grande Valley in New Mexico. The United States declined to intervene because it saw an adinistrative solution at hand through the construction and operation of he authorized Middle Rio Grande Project. In February of 1957, the upreme Court granted New Mexico's Motion to Dismiss "because of he absence of the United States as an indispensable party."

By the end of 1952, New Mexico's accrued debits totalled 453,200 acreeet. It was about this time that the effect of the work being done under he Middle Rio Grande Project authorized in 1948 began to be evident. t can be shown that if New Mexico had had no debt at the end of 1952, ur deliveries and debt status would have been in strict compliance with he compact from that time through 1967. Last year, New Mexico accrued

a credit of 41,800 acre-feet and at the end of 1967 our debt stood at 382,400 acre-feet.

In contrast with the situation confronting New Mexico, Colorado, during the period 1943-51, had been able to meet her schedule of compact water deliveries without difficulty. However, after 1950, Colorado's deliveries began to decline and, since the end of 1952, Colorado's accrued debit has exceeded the limit of 100,000 acre-feet specified in the compact.

At the end of 1965, Colorado's accrued debit stood at 939,900 acre-feet and on October 3, 1966, Texas and New Mexico filed an action against Colorado in the Supreme Court. The plaintiffs' complaint asks the Court to command the State of Colorado to deliver water in the Rio Grande at the Colorado-New Mexico state line in accordance with the requirements of the Rio Grande Compact and to eliminate her accrued debit under the compact. The United States has filed a motion for leave to intervene and a complaint. The three states have joined in a request that the case be left pending under an indefinite continuance conditioned on Colorado meeting every year the delivery obligation established by the schedules of Article III of the compact and taking effective actions calculated to implement that delivery.

Conclusion

Despite the troubled history of the Rio Grande since 1938, the Rio Grande Compact is an accomplishment which does much credit to its architects. It reflects great engineering, legal and diplomatic talent. By its rules, it has established the degree of certainty and the pressure of incentive needed to encourage investments for the improved management and use of the waters of Rio Grande above Fort Quitman.

The author gratefully acknowledges the assistance of Mr. Philip B. Mutz, Staff Engineer, New Mexico Interstate Stream Commission, and Mr. Dee Linford, Technical Editor, New Mexico State Engineer Office, in the preparation of this paper.

* * * *

SPANISH SUMMARY

By J. M. Sharp

El Pacto del Río Bravo (Grande)

En la "Introducción" de su trabajo, *El Pacto del Río Bravo* (Grande), el ng. S. E. Reynolds, Ingeniero Estatal de Nuevo México, describe y apre- ia brevemente los varios medios de los cuales se han valido los tres Estados imítrofes del Río Bravo (Grande) para resolver sus conflictos sobre el provechamiento y división equitativa de las aguas de esta corriente. En- re estos medios se cuentan la litigación ante la Corte Suprema, la legisla- ión y hasta la guerra. De todos estos recursos, los que han producido los esultados más satisfactorios son los pactos interestatales, a pesar de que ean difíciles de negociar (en vista del hecho de que los Estados no mantie- en ningún cuerpo diplomático profesional), y de que han sido mal enten- idos en muchos casos por los ciudadanos.

A continuación, en la sección titulada, "Esbozo histórico" *("Historical")*, l Ing. Reynolds nos recuerda la problemática de la división equitativa de as aguas del Río Bravo (Grande) desde tiempos remotos. En esta región, as primeras obras de riego remontan a los siglos diecisiete y dieciocho; a ines del siglo diecinueve, los agricultores del Valle de Juárez hicieron re- lamaciones formales, por conducto de su gobierno, contra los Estados Unidos con motivo de la escasez de agua ocasionada por el aprovechamien- o excesivo de las aguas del Río Bravo (Grande) río arriba; por esto, el Embargo del Río Bravo (Grande) del año 1896 y el Tratado de 1906 sus- pendieron la construcción de nuevas obras de riego en Nuevo México y Co- orado, garantizándole a México la entrega de 60,000 pies-acres anualmen- e. El Embargo fue modificado en años posteriores para permitir la cons- rucción, en 1907, de vasos de almacenamiento en el Valle de San Luis (Colorado), y la Presa El Elefante (Nuevo México), en 1916. La forma- ión del Distrito de Conservación del Río Bravo (Grande) Medio en 1925, que realizó nuevos proyectos de almacenamiento de agua, acrecentó la competencia entre Texas, Nuevo México y Colorado por el uso de las aguas de este río. Por este motivo se hacía cada vez más urgente resolver el pro- blema jurídico de la división equitativa de las aguas del Río. Una comisión hidráulica interestatal, establecida por Colorado y Nuevo México en 1923, logró redactar una convención temporal de cinco años, la cual, sin embargo, no produjo ningunos resultados duraderos. Al vencer esta convención, la Comisión Nacional de Recursos intervino en la cuestión, llevando a cabo una investigación de los recursos hidráulicos del Río Bravo (Grande) aguas arriba de Fort Quitman.

En la sección siguiente de su trabajo, titulada, "El Pacto del Río Bravo (Grande) de 1938," el Ing. Reynolds hace notar que a base del trabajo de

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THE RIO GRANDE COMPACT

S. F. REYNOLDS
STATE ENGINEERS

STATE ENGINEER #2062
RIO GRANDE BASIN
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THE RIO GRANDE COMPACT

S. E. REYNOLDS

April 29, 1968

INTRODUCTION

Controversies involving interstate streams may be resolved by any one of several procedures. When the controversy involves private persons who are citizens of different states, the matter may be adjudicated by a federal district court. An example is the 1935 decree of the Federal District Court for the District of Arizona (Globe Equity No. 59) which adjudicated rights to the waters of the Gila River in Arizona and in the Virden Valley of southwestern New Mexico.

The settlement of controversies over interstate waters in a federal district court is a troubled area because the states responsible for the administration of water and water rights are not before the court and the effect of the decree is at best uncertain.

When the controversy is between states, or between a state and citizens of another state, the Supreme Court of the United States has original jurisdiction. The binding effect of the decrees of this court on the state and all of its citizens overcomes the objection to federal district court decisions. By its decisions, the Supreme Court seems to have established the rule

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that the interstate streams of the west are subject to the doctrine of equitable apportionment. Under this doctrine, the upstream state does not have the right to the use of all of the waters arising within its borders and the downstream state cannot require the delivery of all of the natural flow of the stream. Priority of appropriation is only one of the elements to be considered in arriving at an equitable apportionment even when both of the contesting states apply the doctrine of prior appropriation in the administration of their waters. The court will consider the economy based on the development and use of water, the public welfare and other factors in determining the issues.

The use of waters of interstate streams can be apportioned among competing states by federal legislation. An example of this mechanism is the Boulder Canyon Project Act (45 Stat. 1057) which apportioned waters of the main stream of the Colorado River below Lee Ferry among the States of California, Arizona and Nevada.

War, of course, is a common method of resolving controversies among sovereignties and in his darker moments, the State Engineer has sometimes felt that war is the only practical answer to many of our interstate water problems. This forthright solution is, however, forbidden by Article I of the nation's Constitution.

This remark is not entirely facetious. In 1939 the Governor of New Mexico ordered the State Police, the only armed forces at

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his disposal for the purpose at hand, to break the locks put on headgates in the Virden Valley by the Federal District Court's Water Commissioner. He directed the Chief of State Police to use whatever force was necessary to prevent the Water Commissioner from interfering with the administration of water in New Mexico. Fortunately, there were further court proceedings and the issue was put to rest before any shots were fired in anger.

The legal basis of all interstate stream compacts is found in Section 10 of Article I of the Constitution of the United States. This section permits a state to consummate an agreement or compact with another state with the consent of Congress. These interstate agreements are our most profound law and may supersede state statutes.

The negotiation of compacts is at best a difficult procedure requiring a blending of diplomatic, engineering and legal talent. It is essential that the lawyers involved in the negotiations fully comprehend the engineering aspects of the negotiation and that the engineers have a clear conception of the legal considerations. Unless this is so, inequities and ambiguities which will be the subject of future controversies find their way into the compact.

Compacting as a procedure for the resolution of interstate controversies has been criticized because the states cannot maintain the trained diplomatic corps required and because a relatively

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small number of persons negotiate and resolve issues of tremendous importance to diverse local interests not adequately represented in the negotiations. The requirement for compacts to be ratified by the legislature of each state concerned and approved by the Congress largely overcomes these objections.

It is generally agreed that compact negotiations are preferable to judicial procedures for the resolution of controversies over interstate waters. I accept this view, particularly for the reason that the pattern of negotiations can be so much more flexible than the set of rules which our courts must follow. As a consequence, the prospects for an equitable solution more nearly satisfactory to all affected interests are improved.

To support the view that the interstate compact is preferred, it can be pointed out that New Mexico's interstate waters are governed by seven compacts, the decree of the Supreme Court in Arizona vs. California and two federal district court decrees. Almost all of New Mexico's surface water resources are subject to the terms of interstate compacts. One of our streams, the La Plata River, which is tributary to the San Juan River in northwestern New Mexico, is subject to the terms of three compacts, the Colorado River Compact of 1922, the La Plata River Compact and the Upper Colorado River Basin Compact.

While I advocate the interstate compact as the mechanism for resolving interstate water controversies, I should point out that

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the compact negotiator must be prepared to accept as his reward the opprobium and scorn of his constituents. The people -- particularly the citizens of the upstream states -- almost universally complain that they were "sold down the river"; the harsher complainants say that the negotiator sold the river.

Perhaps the most controversial and misunderstood water compact to which New Mexico is a party, the Rio Grande Compact now in force, was executed in Santa Fe on March 18, 1938 by commissioners representing Colorado, New Mexico, Texas and the United States. Its signing was preceded by half a century of controversy over apportionment of Rio Grande water among users in the three signatory states and Mexico. Its operation has done much to solve the problems associated with interstate and international use of the river's flows.

Some treatment of the history of the river might give a framework helpful in the discussion of the philosophy and terms of the Rio Grande Compact.

HISTORICAL

Until very recently, the economy of the Rio Grande Basin above Fort Quitman in Texas was based almost exclusively on agriculture. Precipitation is scarce throughout the cultivated areas of the basin, and irrigation is required for successful growing of crops. Irrigation along the river and many of its

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tributaries was initiated by Indians several centuries before the coming of the white man, and in many areas it has continued until the present.

The basin's recorded history began with its exploration by Coronado in 1540. During the 17th and 18th centuries, Spanish colonization in New Mexico and in Texas as far south as Fort Quitman was accompanied by an expansion of irrigation farming - the irrigators diverting water directly from streams and springs into crude acequia or ditch systems. Cultivation by white men in the San Luis Valley in Colorado was begun in the early 1850's, but it was not until about 1880 that extensive development for irrigation occurred. Most large canal and ditch systems now in use in the San Luis Valley were in existence in 1890. By 1937, 600,000 acres were irrigated in Colorado from the Rio Grande and its tributaries.

In the early 1890's water shortages in the Mesilla and El Paso Valleys led farmers near Juarez, Mexico, to complain to their government. Mexico registered formal complaint with the U. S. Department of State and advanced claims for damages in excess of $30 million, alleging that the Mexican shortages were due to diversions from the river in Colorado and New Mexico.

The United States through the International Boundary Commission thereupon instituted an investigation of conditions, two products of which were the "Rio Grande Embargo" of 1896 and the

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Mexican Treaty of 1906. The "embargo" was an order by the Secretary of the Interior which stalled further large-scale development of Rio Grande water for irrigation in Colorado and New Mexico through suspension of action on applications for water-project rights-of-way across public lands. Under terms of the Mexican treaty, and in return for relinquishment of all claims for damages, the United States guaranteed to Mexico annual delivery in perpetuity of 60,000 acre-feet of water in the Rio Grande at the head of the Acequia Madre near Juarez, with the provision that the nations would share water shortages in times of drought.

Both to insure fulfillment of the Mexican treaty and to develop an interstate reclamation project in the Elephant Butte-Fort Quitman reach of the river, the United States in 1907 modified the Rio Grande embargo to permit construction of Elephant Butte Dam by the U. S. Reclamation Service (now Bureau of Reclamation).

The Rio Grande embargo had been vigorously opposed in Colorado. By 1896, little storage had been developed to serve irrigation projects in the San Luis Valley. During the latter part of many growing seasons irrigators were frequently diverting the entire flow of the river and its tributaries, and still the supply was short. Storage of winter flows and flood flows was a requisite for development of new irrigation, and even for maintenance of

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existing irrigation. But Federal action in withholding rights-of-way for water projects rendered impossible the development of storage of any magnitude.

As modified in 1907, the embargo allowed consideration of applications for rights-of-way for water projects wherein the rights of the applicants had been initiated prior to March 1, 1903; the date on which the Rio Grande Project began active operation. Under this modification, irrigators in the San Luis Valley were able to proceed with limited development of new storage. Rio Grande, Santa Maria and Continental Reservoirs, having a combined capacity of 121,000 acre-feet, were completed by 1926. La Jara and Terrace Reservoirs on La Jara and Alamosa Creeks, with combined capacity of about 32,000 acre-feet, were completed in the same general period, as were Sanchez on Culebra Creek at 103,000 acre-feet and Mountain Home and Smith on Trinchera Creek with a combined capacity of 26,000 acre-feet.

Elephant Butte Dam, with an original impounding capacity of 2,639,000 acre-feet, was completed in 1916, along with other works of the resulting Rio Grande Irrigation Project which included 88,000 acres in the Elephant Butte Irrigation District in New Mexico and 67,000 acres in the El Paso County Water Improvement District No. 1 in Texas. Both districts depend on Elephant Butte Reservoir for storage, and community of interest united irrigators in the two districts in competition with upstream diverters, even though they were citizens of different states.

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By 1918, much New Mexico land in the Middle Valley between Cochiti and San Antonio, irrigated under old community acequia systems, had become water-logged and thousands of acres of once-productive cropland had been abandoned -- principally because of a rising water table, aggravated by silt deposition aggrading the riverbed, with resultant large-scale waste of water to evapotranspiration.

Enabling legislation was enacted, and in 1925 (the year in which the embargo of 1896 was finally lifted, over New Mexico's vigorous protests) the Middle Rio Grande Conservancy District was organized as a political subdivision of the State of New Mexico.

The district's plan for installation of flood control, drainage, and irrigation facilities was approved in 1928, and active construction was begun in 1930. The project works, including El Vado Reservoir on the Rio Chama with a capacity of 198,000 acre-feet, were completed in 1935. Costs of construction, met through sale of bonds to the Federal Reconstruction Finance Corporation, amounted to about $9 million.

Meanwhile, with development of storage for irrigation moving ahead in both Colorado and New Mexico, competition for use of the river's flow among users in Texas and the two upriver states was increasing and sentiment was developing in favor of attempting to negotiate an interstate compact which would apportion the

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river's waters among users in the disputant states and provide in each state a basis for establishment of firm water rights upon which financial investments in irrigation works might be based. Early in 1923 the legislatures of Colorado and New Mexico enacted statutes authorizing appointment of representatives to an interstate water commission. Texas followed suit, Congress consented to the formation of such a commission, the President designated a representative to safeguard the rights of the United States, and negotiations looking to the framing of a Rio Grande compact were begun.

In 1929, an agreement was reached which was temporary in nature and which did not attempt to apportion the river's waters. Its principal articles provided that during the five-year term of the agreement 1) neither Colorado nor New Mexico would increase diversions or storage until such time as resulting depletions should be offset by increase of drainage return, 2) the three states would maintain streamflow-gaging stations and exchange records of measurements, and 3) before expiration of the temporary agreement a permanent compact providing for apportionment of the river's waters would be drawn and entered into.

Half a decade of additional negotiation produced no further agreement and brought the states no nearer to a permanent compact. In the meantime, Colorado continued to press for authorization of projects to regulate flows of the Rio Grande and its tributaries within her borders, New Mexico and Texas vigorously opposed the

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Colorado proposals, and irrigators below Elephant Butte in New Mexico and Texas viewed the development in the Middle Rio Grande Conservancy District with increasing concern.

The expiration date of the temporary compact, June 1, 1935, passed with no permanent agreement being reached, and the term was extended to October 1, 1937. By 1935 the controversy had attracted national attention and on September 13 of that year President Franklin D. Roosevelt issued a mandate stating that no federal approval should be given to "any application for a project involving use of Rio Grande waters without securing from the National Resources Committee a prompt opinion on it from all the relevant points of view." This action failed to satisfy downstream irrigators, and on October 24, 1935, the State of Texas brought suit in the Supreme Court of the United States to enjoin the Middle Rio Grande Conservancy District and the State of New Mexico from the alleged depletion of the water supply of the Rio Grande Project, charging violation of the temporary compact.

The extended term of the temporary agreement ran out, with no permanent compact being agreed upon, and the temporary instrument was allowed to expire - but with the understanding that the three states and the Federal government would continue negotiations seeking a permanent agreement. Works of both the Rio Grande Project and the Middle Rio Grande Conservancy District had been constructed with Federal financing and with the Federal

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Government moving to intervene in the Texas-New Mexico litigation the National Resources Committee appointed a board to review the Hydra-headed problem and to recommend procedures for finding a solution. The board advised that, in cooperation with the disputant states and a number of Federal agencies, the Committee should conduct a thorough and impartial investigation of present and potential water and land resources of the Rio Grande Basin above Fort Quitman, and that it should obtain all other factual data necessary for a full understanding of the problems of each of the states concerned.

Fort Quitman is located on the Rio Grande about 70 miles below El Paso. After Elephant Butte Dam was constructed and its operation commenced, the Rio Grande above Fort Quitman was virtually separated hydrologically from the river below that point. Thus a compact between the states could achieve the objective of removing causes of controversy among the states with its considerations limited to the waters of the Rio Grande above Fort Quitman.

Agreement on the nature and scope of the investigation was reached at a conference of states and agencies in Santa Fe in February 1936 and field work was initiated in April 1936 to continue into 1937.

RIO GRANDE COMPACT OF 1938

The study was one of the most comprehensive and detailed investigations ever made of a river basin in the West. A final report

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of its findings, delivered to the states in June 1937, was published by the National Resources Committee in 1938 as Regional Planning Part VI - The Rio Grande Joint Investigation in the Upper Rio Grande Basin in Colorado, New Mexico, and Texas. Its data provided a basis for further negotiation, and led to the signing of the compact in March 1938. The agreement was ratified by the legislature of Colorado on February 21, 1939, and by the legislatures of New Mexico and Texas on March 1, 1939. Congress consented to its terms on May 13, 1939 (in Public Act 96, 76th Congress), and on the same day President Franklin D. Roosevelt signed it into Federal law.

Adoption of the compact, of course, terminated the pending litigation. In accordance with its provisions, the compact is administered by a four-man commission composed of the State Engineers of Colorado and New Mexico and appointed representatives of Texas and the United States. The Federal representative acts as chairman without vote, and all actions of the body must be by unanimous vote of the other three commissioners. The costs of administration not borne by the United States are shared equally by the three states.

During the 30 years it has been in operation, the Rio Grande Compact has been pretty thoroughly maligned - particularly in recent years in Colorado and in portions of New Mexico - largely because its terms are not generally understood.

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Perhaps the most common public misconception of the Rio Grande Compact is that it requires the upstream states to deliver to the downstream states a fixed amount of water each year, come drought or come flood and that/the compact is, therefore, inequitable and impossible to comply with.

In fact, the basic objective of the negotiators was to preserve the status quo as of 1929. The equities developed in the river by each state were defined by a study of the pre-compact conditions of flow in each state. On the basis of this study, schedules were drawn to establish the outflow which must be maintained at each level of water supply. The water supply is determined from readings at upstream index gages. The outflow required is small when the flow at the index gages is small and is larger in years of good runoff when the flow at the index gages is high.

Colorado's annual obligation to deliver water at Lobatos near the Colorado-New Mexico stateline is established each year by the supply indicated by a gage on the main stem of the Rio Grande at Del Norte, Colorado, and three other gages located on the Conejos River and two of its tributaries, the Los Pinos River and the San Antonio River.

New Mexico's obligation to deliver water to Elephant Butte Reservoir is established each year by the flow of the river at Otowi gage, located on the Rio Grande near Espanola below the confluence of Rio Chama and Rio Grande.

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A few numbers might be useful to give a concept of the water supply involved and the effect of the schedules. The average annual flow of the Rio Grande at Otowi gage is about 1 million acre-feet. In a year in which the flow at Otowi gage is 1 million acre-feet, New Mexico is obligated to deliver 621,000 acre-feet, or 62 percent at Elephant Butte. In a year when the flow is only 400,000 acre-feet, about the minimum of record, New Mexico is obliged to deliver only 228,000 acre-feet, or 57 percent. At a flow of 3 million acre-feet for the year, New Mexico's obligation is 2.6 million acre-feet or about 86½% of the total of the flow at Otowi.

There is a potential for increased use above the index gages used to determine the annual supply in the river and increased uses could affect the schedules to the detriment of the downstream states. For example, the Otowi gage is about 100 miles south of the Colorado line and there is considerable opportunity for new uses from the Rio Grande and its tributaries above Otowi that would deplete the runoff at that point. For this reason, the compact provides for appropriate adjustment of the schedules to reflect changes in depletion above the index gages. For example, if there are new uses in New Mexico above Otowi that deplete the flow of the Rio Grande at Otowi gage the amount of this depletion must be added to the measured flow before entering the schedule to determine New Mexico's obligation.

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It was the objective of the negotiators not to preclude any increase in depletion above Otowi gage but to cause the effect of any such increased depletion to fall on users in New Mexico above Elephant Butte Reservoir, rather than on users below.

It is important to understand that while the New Mexico delivery obligation is set by the flow at Otowi, we don't meet our obligation only with water that actually passes Otowi gage. The obligation is met to a considerable extent with tributary inflow to the river below the index gage. Therefore, in years in which the tributary inflow below Otowi departs materially from the normal relationship to the flow at Otowi gage, it is to be expected that New Mexico will underdeliver or overdeliver to the downstream users. That is, in years of abundant snowfall and spring runoff, with lots of water passing Otowi gage, followed by a dearth of summer thundershowers, which produce most of the inflow below Otowi, New Mexico likely will underdeliver.

Such vagaries of weather are reflected in the records of pre-compact flow conditions and are provided for by the system of debits and credits for deliveries established in the compact.

Under this system, New Mexico is allowed to accrue debits up to 200,000 acre-feet and Colorado is allowed debits to 100,000 acre-feet. These debt limits may be exceeded to the extent that they are caused by holdover storage in reservoirs constructed after 1929 in New Mexico or reservoirs constructed

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after 1937 in Colorado. However, water stored in such reservoirs in each state must be retained in storage to the extent of the state's accrued debit. This "debit water" in storage cannot be released for use by the debtor state without the unanimous consent of the compact commissioners and must be held for release on demand by the downstream states made in accordance with the compact.

In computing debits and credits, New Mexico may not be charged with any greater debit in any one year than the sum of 150,000 acre-feet and all gains for the year in the quantity of water in storage in New Mexico above Elephant Butte Reservoir. With respect to both states, any annual credit in excess of 150,000 acre-feet must be taken as equal to that amount.

The compact clearly recognizes the priority of Elephant Butte Reservoir, which was completed in 1916, over reservoirs constructed in Colorado or New Mexico after 1929. Bear in mind here that El Vado Dam and Reservoir, the only storage works of the Middle Rio Grande Conservancy District, were constructed in 1935. When there is less than 400,000 acre-feet of water in storage in Elephant Butte and Caballo Reservoirs, which the compact defines as "project storage", neither Colorado nor New Mexico may increase the amount of water in storage in reservoirs constructed after 1929.

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During January of any year, Texas may demand of New Mexico and Colorado, and New Mexico may demand of Colorado, releases from reservoirs constructed after 1929 to the extent of the respective debits of the upstream states. The releases must be made at the greatest rate practicable and in amounts limited by the accrued debits, sufficient to bring the quantity of water in Elephant Butte and Caballo Reservoirs to 600,000 acre feet by March 1 and to maintain that quantity in storage until April 30th.

The original compact schedules set New Mexico's delivery point at the San Marcial gage just above Elephant Butte Reservoir. This original schedule excluded the flow during July, August and September from the index supply measured at Otowi and from New Mexico's delivery as measured at San Marcial. In 1948, by a resolution of the compact commission, the delivery point was moved to the gage below Elephant Butte Dam, and the schedules were modified to include the flow for the entire year in the supply and delivery determinations. New Mexico's annual delivery is defined by the resolution as the flow passing the gage below the dam plus or minus the net gain or loss in storage in Elephant Butte Reservoir in the year.

An important effect of this change in delivery point was to make evaporation from Elephant Butte Reservoir a liability of the water users above Elephant Butte. However, the new

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schedule adjusted the inflow-outflow relationship so that New Mexico's delivery obligation was not substantially altered by this shift in liability or by the accounting of the flows for 12 months instead of nine.

For accounting purposes, the delivery credits of the upstream states are stored in Elephant Butte Reservoir. These credits are reduced annually by the deduction of a proportionate part of the annual evaporation from the reservoir. In the event that Elephant Butte and Caballo Reservoirs fill and spill when Colorado and New Mexico have credits, the water spilled is deemed to be credit water. The accrued credits of the upstream states are reduced by the amount of spill in proportion to their respective credits.

On the other hand, in any year in which the aggregate of the accrued debits of Colorado and New Mexico exceeds the minimum unfilled capacity of Elephant Butte and Caballo Reservoirs, the debits are reduced proportionately to an aggregate amount equal to the minimum unfilled capacity. In any year in which there is actual spill of water from project storage, the minimum unfilled capacity is zero and all accrued debits that Colorado and New Mexico had at the beginning of that year are cancelled.

The seemingly complex provisions governing the operation of reservoirs were designed to recognize the priority of Elephant Butte Reservoir, but at the same time permit a coordinated operation of reservoirs in the Rio Grande Basin to mutually benefit

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the three states.

An example might help to illustrate this point. Assume for this purpose, that New Mexico has eradicated her debt and in a year of abundant tributary inflow below Otowi gage has achieved a credit of 100,000 acre feet. In the next spring runoff, the Middle Rio Grande Conservancy District could store at least this amount in El Vado Reservoir for use on district lands without regard to the priority of Elephant Butte Reservoir. In effect, tributary inflows which could not be controlled for the benefit of the Middle Rio Grande District were caught and stored to the credit of the district in Elephant Butte Reservoir and then transferred by exchange to the junior upstream reservoir. This exchange can be effected, of course, only if there is more than 400,000 acre-feet exclusive of credit water available in "project storage".

The Rio Grande Compact makes no specific reference to ground water. However, the inflow-outflow mechanism for determining delivery obligations makes the control of ground water appropriations in the upstream states essential for the protection of existing surface water rights in those states and the preservation of their ability to meet the compact commitments.

Surface waters and ground waters in the Rio Grande Valley are intimately related. At some points, the surface flows feed the ground water reservoirs and, at other points, the ground water reservoirs discharge into the stream. Along the mainstem

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of the river, the situation generally is one in which groundwater discharge contributes to surface flow. Annual ground water accretion to the river's mainstem in the reach between the Colorado line and Elephant Butte Reservoir amounts to 200,000 to 300,000 acre-feet.

Heavy, sustained pumping from the groundwater reservoir would cut off this accretion and ultimately would reverse the water table gradient so that the water now flowing into the stream and constructed drains would disappear into the groundwater reservoir. These hydrologic facts of life, coupled with imminent large-scale developments of groundwater for agricultural and municipal and industrial uses in New Mexico above Elephant Butte led the State Engineer in 1956 to assume jurisdiction over appropriations of ground water in the Rio Grande Valley along the river's mainstem and the lower reaches of its tributaries by proclaiming the boundaries of an underground water basin which extends from the Colorado line to Elephant Butte Dam. The action was taken, both to protect the existing water rights in New Mexico and to preserve the state's ability to meet its compact obligations.

Under present administration of the Rio Grande Underground Water Basin, the drilling of wells for groundwater appropriations is permitted, but it is required that surface water usage under existing rights be retired to the extent that is necessary to offset the effects of groundwater pumpage on the fully appropriated surface water supply.

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Of great significance is the fact that the upstream states implicitly committed themselves not only to protect the river flows against the enterprise of man, but also to protect those flows against the forces of nature. If drainage works and the river channel are allowed to deteriorate and non-beneficial plants are allowed to proliferate so that losses increase below the inflow index stations, water will be lost and deliveries will depart from the pre-compact inflow-outflow relationship upon which the delivery schedules are based unless beneficial use by man in the upstream states is curtailed.

On the other side of the coin, there was a significant amount of non-beneficial consumptive use of water in the upstream states under the historic conditions upon which the compact schedules were based. Improvements in drainage and channel conditions and the eradication and control of non-beneficial plants to reduce those historic losses would result in an increase in the supply available under the compact for appropriators in the upstream states.

A fact often unappreciated is that under the compact about 57% of the water released from Elephant Butte Reservoir for use in the United States is used in New Mexico below Elephant Butte Reservoir on about 90,000 acres of our finest agricultural lands. That is, the compact does not, in fact, apportion water between New Mexico and Texas; rather, the allocation is between water users in New Mexico above Elephant Butte on the one hand and

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water users in New Mexico and Texas below Elephant Butte on the other.

The agricultural development in the Elephant Butte Irrigation District makes an important contribution to the state's economy. Thus, selfish economic incentive, as well as moral responsibility is involved in meeting our compact commitments.

Full appreciation of this aspect of the compact might help you to account for some occasional, apparent schizophrenic behaviour on the part of the New Mexico State Engineer.

Taking into account the fact that more than half of the water New Mexico delivers under the compact is used within her own borders, outflow to Texas in the Rio Grande is about equal to inflow from Colorado and New Mexico actually is permitted to use from the river about what she puts into it. From what I've said about the fundamental objectives of the compact and the manner in which its delivery schedules were constructed, it should be evident that this circumstance is only coincidental.

Of particular interest at this symposium is the compact's recognition of and provision for the international obligations of the United States. Article XIV provides that: "The schedules herein contained and the quantities herein allocated shall never be increased nor diminished by reason of any increase or diminution in the delivery or loss of water to Mexico." Article XVI provides that: "Nothing in this compact shall be construed as affecting

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the obligations of the United States of America to Mexico under existing treaties, or to the Indian Tribes, or as impairing the rights of the Indian Tribes." Provisions of this nature were probably necessary for Congressional ratification.

At the outset, I expressed the view that the interstate compact is to be preferred over litigation in the resolution of controversies over interstate streams. I would not try to persuade you that the interstate compact precludes litigation -- the record does not permit it.

The compact's water delivery schedules became effective on January 1, 1940. Unusually heavy precipitation in the fall of 1941 and the spring of 1942 filled Elephant Butte and Caballo Reservoirs to capacity and water stored to the credit of the States of Colorado and New Mexico was spilled. Thus, at the end of its third year of operation, the compact appeared to be functioning as its architects had intended.

By the late '40s, it was becoming apparent that the works of the Middle Rio Grande Conservancy District could not provide adequate flood protection for the middle valley, that channel aggradation and the deterioration of the drainage system and the encroachment of non-beneficial plants on the water supply were causing enormous losses in the reach between Cochiti Dam and Elephant Butte Reservoir. It was also clear that the Middle Rio Grande Conservancy District lacked the resources to effectively attack these problems.

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A Bureau of Reclamation report released in 1947 indicated that about 80,000 acres of bosque and wetted sands between Cochiti and Elephant Butte Reservoir were consuming an average of more than 300,000 acre-feet of water annually.

In 1948, the Middle Rio Grande Project was authorized by the Congress. The plan provided for construction of flood control reservoirs on the Rio Grande and its major tributaries in New Mexico, an extensive program of channel rectification and levee improvement, the restoration of irrigation works and the installation of an effective drainage system within the conservancy district.

At the end of 1943, New Mexico's debt was 59,000 acre-feet and by the end of 1951, her compact water debt had reached 331,000 acre-feet. In October of 1951, Texas brought action in the United States Supreme Court against New Mexico and the Middle Rio Grande Conservancy District, charging violation of the compact. The suit asked that the defendants be enjoined from operating reservoirs otherwise than in accordance with the compact and that the defendants be restrained from diverting any of the waters of the Rio Grande until New Mexico's accrued water debt had been reduced to 200,000 acre-feet.

New Mexico asked for dismissal of the action, principally on the ground that the United States was an indispensable party to the suit because of the water rights of Indian irrigators in the Rio Grande Valley in New Mexico. The United States declined

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to intervene because it saw an administrative solution at hand through the construction and operation of the authorized Middle Rio Grande Project. In February of 1957, the Supreme Court granted New Mexico's Motion to Dismiss "because of the absence of the United States as an indispensable party."

By the end of 1952, New Mexico's accrued debits totalled 453,200 acre-feet. It was about this time that the effect of the work being done under the Middle Rio Grande Project authorized in 1948 began to be evident. It can be shown that if New Mexico had had no debt at the end of 1952, our deliveries and debt status would have been in strict compliance with the compact from that time through 1967. Last year, New Mexico accrued a credit of 41,800 acre-feet and at the end of 1967 our debt stood at 382,400 acre-feet.

In contrast with the situation confronting New Mexico, Colorado, during the period 1943-51 had been able to meet her schedule of compact water deliveries without difficulty. However, after 1950, Colorado deliveries began to decline and, since the end of 1952, Colorado's accrued debit has exceeded the limit of 100,000 acre-feet specified in the compact.

At the end of 1965, Colorado's accrued debit stood at 939,900 acre-feet and on October 3, 1966, Texas and New Mexico filed an action against Colorado in the Supreme Court. The plaintiffs' complaint asks the Court to command the State of Colorado to deliver water in the Rio Grande at the Colorado-New Mexico state line in

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accordance with the requirements of the Rio Grande Compact and to eliminate her accrued debit under the compact. The United States has filed a motion for leave to intervene and a complaint. The three states have joined in a request that the case be left pending under an indefinite continuance conditioned on Colorado meeting every year the delivery obligation established by the schedules of Article III of the compact and taking effective actions calculated to implement that delivery.

CONCLUSION

Despite the troubled history of the river since 1938, the Rio Grande Compact is an accomplishment which does much credit to its architects. It reflects great engineering, legal and diplomatic talent. By its rules, it has established the degree of certainty and the pressure of incentive needed to encourage investments for the improved management and use of the waters of Rio Grande above Fort Quitman.

The author gratefully acknowledges the assistance of Mr. Philip B. Mutz, Staff Engineer, New Mexico Interstate Stream Commission, and Mr. Dee Linford, Technical Editor, New Mexico State Engineer Office, in the preparation of this paper.

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Colorado's Snow Melt Reaching El Paso

A Status Report on No. 29 Original, U. S. Supreme Court

By VINCE TAYLOR of Austin

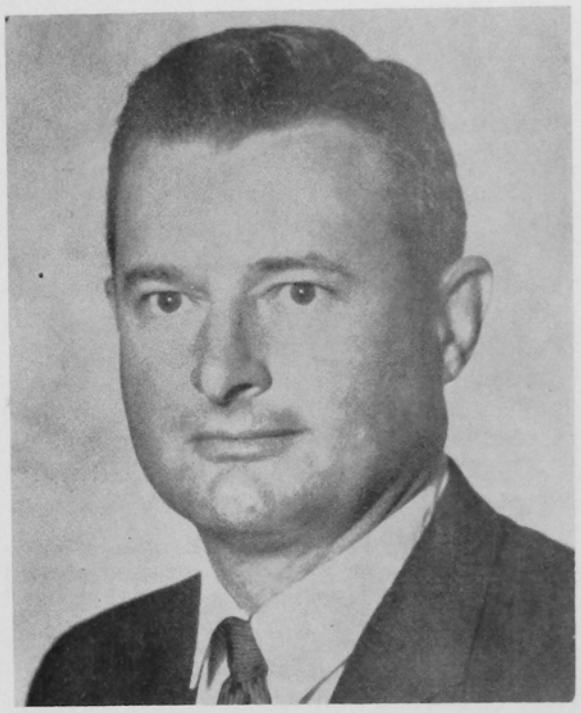
In May, 1967, Vol. 30, No. 5, Texas Bar Journal, Water for Texas, Rio Grande Compact, the problems arising from the Compact were discussed. At that time the suit had been filed and the battle lines were drawing tight. A status report is in order.

In the Fall of 1967, Colorado again ordered irrigation ditch headgates lowered and by the end of the year had delivered within approximately 17,000 acre feet of Compact schedule. Meanwhile, much activity has transpired in conferences, conservation plans in the San Luis Valley and legal maneuvers.

On February 13, 1967, the Supreme Court invited the United States to file a brief stating the views of the United States. On March 15, then Solicitor General Thurgood Marshall formally requested of Clerk John F. Davis permission to respond by April 13, 1967. Counsel for all three states consented to the granting of his request. Two days later, this request was granted.

In his seven-page *Memorandum for the United States,* filed April 14, 1967, Thurgood Marshall disappointed Texas and New Mexico. He had seriously read Colorado's brief in opposition and emphasized her contention (1) Indispensability of the United States as a party to the suit, (2) Unenforceability and need for reform of the Compact, (3) Existence of Administrative Solution. He concluded:

> **"We suggest, therefore, that the Court stay any further action in this case for six months, until October 16, 1967. That would afford a reasonable time for the interested parties to demonstrate the feasibility and imminence of an equitable administrative solution. In the meantime, the United States will explore the matter of an administrative solution in conjunction with the three states. If at the end of this period it appears that the matter can be resolved only by litigation, we shall then inform the court whether the United States will intervene."**



VINCE TAYLOR brings readers up to date on a joint state action by New Mexico and Texas that means water for dry West Texas.

On May 1, 1967, the Court's Clerk, by air mail, asked Attorney General Crawford C. Martin of Texas:

> **"Please advise this office if it is your intention to file a brief in opposition to the memorandum filed by the Solicitor General, and date."**

Texas, on behalf of itself and New Mexico immediately replied that a brief, with required copies, would leave our office by May 15.

On May 12, 1967, a 107-page, burnt orange bound, brief went out in 60 copies to the court and copies to all parties. It was entitled *"Response of Texas and New Mexico to Colorado's Brief in Opposition,*

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VINCE TAYLOR

Mr. Taylor is an Assistant Attorney General of Texas, serving in the Water Division. He is serving under the fourth Attorney General since he has been on the staff.

Mr. Taylor was born on the Fayette-Gonzales County line. He received his B.A. and LL.B. degrees from the University of Texas and was admitted to the bar in 1941. A Lieutenant Colonel, AFR Staff Judge Advocate, he was state Commander of the American Legion in 1962-63, and he is a former city attorney of Smithville.

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and to the Memorandum for the United States." Actual argument and authorities covered 29 pages, tersely put to demolish all of Colorado's points and to advise the Solicitor General of Plaintiffs' strong disagreement with his suggestions.

Colorado meanwhile was pulling from dusty shelves quarter-century-old studies of the San Luis Valley water problems, attempting to organize a new Valley Conservation district and discussing needy legislation. Texas and New Mexico continued to check operations in Colorado and maintained the pressure. Various states began to inquire about the lawsuit.

On June 5, 1967, the Court entered a brief order:

"This case is held without action on the motion for leave to file a bill of complaint until October 16, 1967, or further order of the Court."

On October 4, 1967, the three states met in Washington with government representatives in a probing session. Colorado argued for further delays. At the suggestion of the Justice Department, Plaintiff states made a five-point proposal:

1. Withdrawal by Colorado of her objection to Plaintiffs' motion for leave to file complaint.
2. Notification by the Solicitor General to the Court that the United States will intervene if the Court holds it to be an indispensable party.
3. Filing by Colorado an answer upon the Court's granting Plaintiffs' motion.
4. Thereafter filing in the Court jointly by the three states a stipulation that case be held in abeyance so long as Colorado makes water deliveries according to the Rio Grande Compact.
5. That United States express concurrence to the Supreme Court.

Dated October 4, mailed out of the Justice Department offices, the proposal was to be responded to by Colorado and the United States on or before November 1, 1967. Acting Solicitor General, Ralph S. Spritzer on October 6, informed the Court of pending negotiations and asked time extension until November 1, as filing date for the report due October 16 by the United States. Naturally, the Court granted the request on October 10.

On October 26, Louis F. Claiborne, Assistant to the Solicitor General, submitted a proposed memorandum designed to dull the "sharpened edge" of the suit by providing dismissal of No. 29 if no default by Colorado occurs before 1973. Colorado waited until October 27 to respond. Her response materially changed the October 4 proposal. Before Plaintiffs' tempers sparked, Colorado meanwhile read the Solicitor General's proposed memorandum and quickly dated a letter November 1 to all parties adopting the Government's suggestion but enclosed a clarification "redraft." The *whispering wires* between three states and the nation's capitol became loud for about a week.

With patience worn thin, Texas Attorney General Crawford C. Martin wired the new Solicitor General, Dean Erwin H. Griswold, on October 31, 1967, with copy to Colorado:

"RE TEXAS AND NEW MEXICO V. COLORADO NO. 29 ORIGINAL, COLORADO HAS MADE NO AFFIRMATIVE AND TIMELY RESPONSE TO OCTOBER 4, 1967, PROPOSAL BY TEXAS AND NEW MEXICO, COLORADO'S LETTER OF OCTOBER 27 IS NOT A GOOD FAITH RESPONSE AND HAS MOOTED EFFORTS BY SOLICITOR GENERAL AND TEXAS-NEW MEXICO. THEREFORE THE OCTOBER 4 PROPOSAL BY TEXAS AND NEW MEXICO IS WITHDRAWN. TEXAS INSISTES ON FAVORABLE SPEEDY ACTION BY THE UNITED STATES SUPREME COURT TO GRANT MOTION FOR LEAVE TO FILE COMPLAINT AND FOR REMEDIES PRAYED. WE URGE GOVERNMENT TO ALLOW OUR DAY IN COURT."

On November 1, the new Solicitor General filed a Memorandum for the United States. It covered three pages, including footnotes, and Plaintiffs felt they had a shoe in the door.

". . . During the intervening months, the parties have consuled among themselves and with representatives of the United States. These discussions have advanced the likelihood of developing a feasible plan for constructing the Closed Basin Project alluded to in our previous memorandum. In addition, the State of Colorado has undertaken measures which may

(Continued on Page 871)

4. Extension was for ing principal and uncolle

(COMMENT: This se ganized crime from pr of credit, and it is n loans which are legal real issue is the esta benchmark of 45% as inclusion of this rate i of interest considered ceptable, then the atter as Code would be difficu

TITLE III — RE GARNIS

Sec. 301. Findings and

(See comment below.)

Sec. 302. Definitions

A. "Earnings"—compe for personal services, wages, salary, commisis cludes periodic payments ment program.

B. "Disposable Earni ing after the deduction any amounts required b

C. "Garnishment"—an cedure through which ea are required to be withl debt.

Sec. 303. Restriction o

A. Maximum part earnings for any week may not exceed:

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2. Amount by which for that week exceeds wage prescribed by F less.

B. Restrictions do not
1. Court order for s
2. Order from Bankr
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Sec. 304.

No employer may di son of garnishment.

Sec. 306.

State laws prohibiti valid.

(COMMENT: Since wage garnishment u section will have Should State law b necessity, be in con limitation.)

TITLE IV — NAT ON CONSU

Membership
Compensation
Duties
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NEW MEXICO V. COLO-
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n Page 871)

4. Extension was for more than $100 including principal and uncollected finance charges.

(COMMENT: This section is to prevent organized crime from profiting from extensions of credit, and it is not thought to prohibit loans which are legal under State law. The real issue is the establishing of a Federal benchmark of 45% as an annual rate. If the inclusion of this rate indicates the upper level of interest considered by Congress to be acceptable, then the attempt to conform the Texas Code would be difficult indeed.)

TITLE III — RESTRICTION ON GARNISHMENT

Sec. 301. Findings and Purpose

(See comment below.)

Sec. 302. Definitions

A. "Earnings"—compensation paid or payable for personal services, whether denominated wages, salary, commisison, bonus, etc., and includes periodic payments for pensions or retirement program.

B. "Disposable Earnings"—that part remaining after the deduction from those earnings of any amounts required by law to be withheld.

C. "Garnishment"—any legal or equitable procedure through which earnings of any individual are required to be withheld for payment of any debt.

Sec. 303. Restriction on Garnishment

A. Maximum part of aggregate disposable earnings for any week subject to garnishment may not exceed:

1. 25% of his disposable earnings for that week.

2. Amount by which his disposable earnings for that week exceeds 30 times the minimum wage prescribed by Federal law, whichever is less.

B. Restrictions do not apply to:
1. Court order for support of any person.
2. Order from Bankruptcy Court.
3. Debt due on State or Federal Tax.

Sec. 304.

No employer may discharge employee by reason of garnishment.

Sec. 306.

State laws prohibiting garnishment are still valid.

(COMMENT: Since State laws prohibit any wage garnishment until after judgment, this section will have no application in Texas. Should State law be amended, it would, of necessity, be in conformity with the Federal limitation.)

TITLE IV — NATIONAL COMMISSION ON CONSUMER FINANCE

Membership
Compensation
Duties
Powers
Administrative arrangements

(COMMENTS: All of these areas are left to the Federal Reserve Board for details. It would be composed of 3 members of House of Representatives, 3 members of the Senate and 3 public members appointed by the President of the United States. This is a study commission to review the whole field of consumer credit with view as to what further Federal legislation is necessary. It will also study the adequacy of State regulations and set up a staff to conduct hearings and reviews.)

TITLE V — GENERAL PROVISIONS

Provisions of Act take effect upon enactment, except:

Title I, Chapter 2 and 3 effective July 1, 1969.
Title III effective July 1, 1970.

Colorado's Snow

(Continued from Page 832)

well prevent any future default in its obligations under the Compact. *Unfortunately, however,* the progress made to date does not enable us to assure the Court that the problems underlying this litigation have been or will shortly be fully resolved—*unlike the situation* in *Texas v. Mexico,* 352 U.S. 991, where we were able to advise that an administrative solution to the controversy was imminent.

"*In these circumstances, we are reluctant* to adopt a course that would prevent the plaintiff States from obtaining a judicial *determination of their claim that Colorado has violated the Compact.* To lift the bar to the suit resulting from the indispensability of the United States, *We accordingly advise* the *Court of our willingness to intervene as a party to the litigation.*[1] Cf. *Arizona v. California,* 344 U.S. 919, 373 U.S. 546. If leave to file the complaint is granted and the plaintiffs remain unwilling to postpone prosecution of the suit after the defendant has filed its answer,[2] *the United States then will promptly* move to intervene *to assert the federal interests potentially affected.* See Sup. Ct. Rule 9(2); F.R.

Lucile P. Lacy
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Civ.P., Rule 24(a) . . ." (Emphasis added.)

1. Leave to file an original bill of complaint may be granted without resolving the question of the indispensability of the United States as a party. See *Texas v. New Mexico*, leave to file complaint granted, 343 U.S. 932, complaint dismissed because of the absence of the United States as an indispensable party, 352 U.S. 991. *In the present case*, however, *the issue of indispensability is mooted by our undertaking to intervene should the plaintiffs wish to press the suit*—assuming leave to intervene is granted.

2. It may be that, if they obtain leave to file their complaint and further progress toward an administrative solution of the dispute is achieved, *the plaintiff States will agree to a stay of further judicial proceedings for a reasonable time*. The United States will continue its efforts to secure an amicable resolution of the underlying problems and will promptly advise the Court should such a development appear imminent."

The good news came to Plaintiffs on December 11. The Court used five lines to issue the message:

"The motion for leave to file the bill of complaint is granted and the State of Colorado is allowed sixty days to answer. Mr. Justice Marshall took no part in the consideration or decision of this motion."

Colorado filed answer and counterclaim against New Mexico. Colorado was trying to expand issues while Texas-New Mexico was determined to limit the care to one of breach of contract. But, Plaintiffs at this point felt strongly that Colorado could be knocked out on grounds that she failed to file timely response. At the annual Compact meeting in Santa Fe, February 14-15, 1968, the three states discussed settlement, and subsequently Colorado asked for another high-level Washington Conference with Dean Griswold. This meeting took place on March 19, 1968, and was limited to legal staffs by the states. At this meeting Colorado handed out a proposal dated March 14, pleaded and admitted for the first time that she could comply with the Compact, that she wants to comply and has the legal authority to compel compliance in the San Luis Valley. Tempers were mild and smiles

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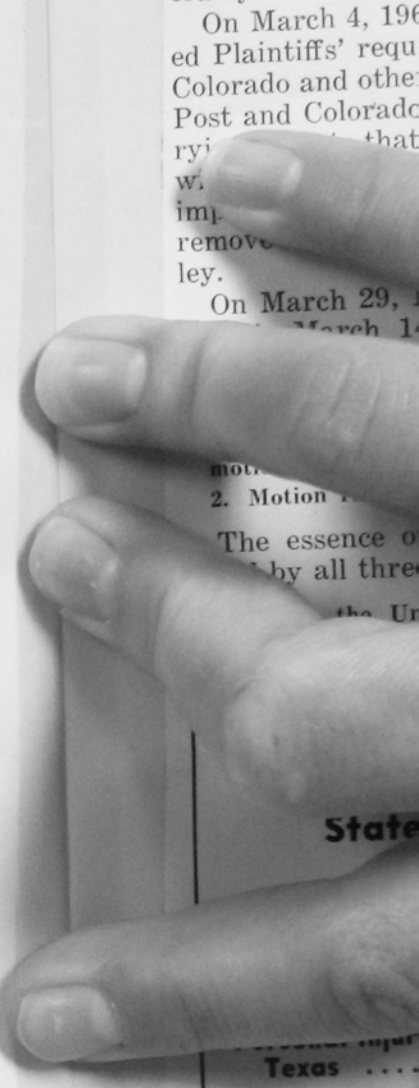

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Of the State Bar of Texas
(Civil Matters)

The emphasis in the new State Bar Minimum Fee Schedule is not on the document prepared but on the transaction involved—the responsibilities imposed on the lawyer in protecting and advancing the interests of the client in a particular business transaction. For example, the Schedule does not specify a fee for the preparation of a deed or a will; it prescribes the minimum fee for representing a client in a real estate transaction and for estate planning.

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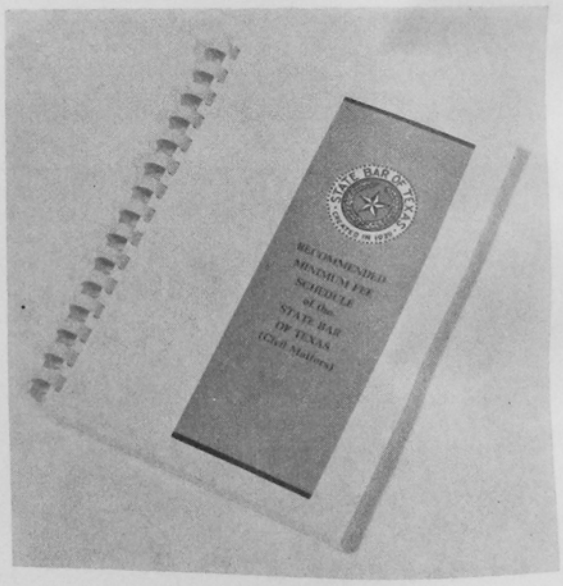

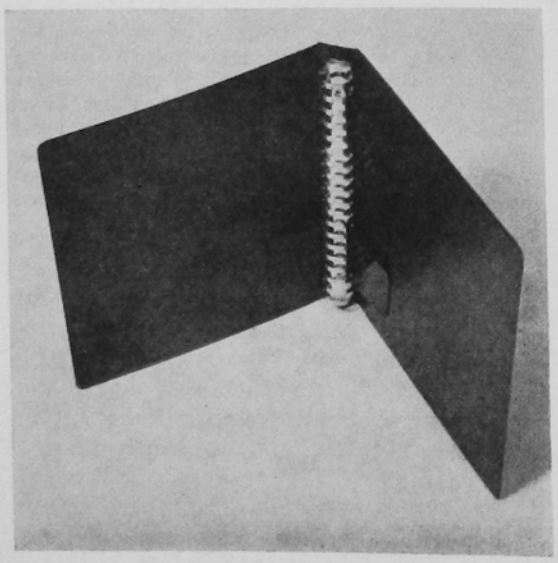

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abundant—but Texas stood firm that at this point Plaintiffs must have assurance that the United States will intervene, preferably as Plaintiff.

On March 4, 1968, the Court had granted Plaintiffs' request for leave to reply to Colorado and otherwise plead. The Denver Post and Colorado news media began carrying reports that Colorado might comply with the Compact by reducing diversion, improve drains of water-logged areas and remove water-loving brush from the Valley.

On March 29, 1968, Plaintiffs took Colorado's March 14 proposal, redrafted it and submitted it in two parts, to the United States and Colorado:

> 1. Memorandum of the parties relative to the motion for continuance.
> 2. Motion for Continuance.

The essence of the memorandum executed by all three states provides:

> (a) That the United States intervene.
> (b) That Colorado agrees to deliver water in accordance with Act III of the Rio Grande Compact.
> (c) That the litigation be held in abeyance so long as Colorado does comply.
> (d) That Plaintiffs receive from Colorado complete reports on deliveries and on measures taken to comply, and reserve the right to trigger the action if Colorado fails to comply.

Unfortunately, Colorado on March 29, submitted a proposal that Plaintiffs took as a departure of understandings made and agreed upon. Plaintiffs in effect, issued an ultimatum on April 2. Quick phone calls cleared the misunderstandings.

On April 17, 1968, the states filed typed copies of their Joint Motion for Continuance and Memorandum of the Parties. This was followed by printed copies and the Solicitor General filed for the United States Motion for Leave to Intervene *as Plaintiff*, Complaint in Intervention, and Memorandum for the United States. The Supreme Court granted all on May 6, 1968, and Texas is in Court, with water from the Colorado snow melt reaching El Paso.

There was one final but important business left. Plaintiffs knew they needed testimony of valuable witnesses who may not be around if it becomes necessary to trigger the action. The question: How to perpetuate evidence in an original action? It just isn't done. The proposal was put to Dean Griswold and came the reply:

> "The Court having today granted both our motion to intervene and the motion of the three States to continue the case, I take up the suggestion for perpetuating testimony advanced in your letter of April 26. Although we know of no prior instance in which depositions have been taken in original cases without express order of the Court, it is our view, confirmed by the Clerk of the Supreme Court, that under Rule 9(2) of the Court's Rules which refers us to the Rules of Civil Procedure, there can be no objection to the perpetuation of testimony in a pending case if all parties agree. See F. R. Civ. P., Rules 26(a), 29."

All parties executed a stipulation, lodged it with the Supreme Court and evidence preserving began in harmony in the Alamosa, Colorado, District Court Room on July 22. The first session completed, further sessions will take place within six months, saving the expense and time of a Special Master.

Those who doubted joint state action, were pleasantly, and some unpleasantly, surprised to find that New Mexico and Texas could join in a desperate cause that means water for dry far West Texas.

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TEXAS VS. COLORADO

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TEXAS & NEW MEX. v. COLO.

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

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IN THE SUPREME COURT OF THE UNITED STATES

October Term 1967

STATE OF TEXAS and STATE OF NEW MEXICO, Plaintiffs, vs. STATE OF COLORADO, Defendant.	]	NO. 29, ORIGINAL Deposition of: RAYMOND A. HILL Taken December 4, 1968. Denver, Colorado.

VESTA WINE
STENOTYPE REPORTER
DENVER, COLORADO

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REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

IN THE SUPREME COURT OF THE UNITED STATES

October Term 1967

STATE OF TEXAS and STATE OF NEW MEXICO, Plaintiffs, vs. STATE OF COLORADO, Defendant.	NO. 29, ORIGINAL Deposition of: RAYMOND A. HILL Taken December 4, 1968.

The deposition of RAYMOND A. HILL taken pursuant to stipulation of counsel in the Meeting Room, Capitol Life Center, Denver, Colorado, commencing at 9 o'clock a.m., Wednesday, December 4, 1968, before VESTA WINE, Notary Public and Certified Shorthand Reporter, State of Colorado.

A P P E A R A N C E S:

VINCE TAYLOR, Assistant Attorney General, State of Texas, Austin, Texas; and LOUIS A. SCOTT, Attorney, Rio Grande Compact Commissioner, El Paso, Texas, appearing on behalf of the State of Texas.

F. HARLAN FLINT, PAUL BLOOM, CLAUD MANN, Attorneys, State Engineer's Office, Santa Fe, New Mexico, appearing on behalf of the State of New Mexico.

GLENN G. SAUNDERS and JOHN DICKSON, Special Assistants to the Attorney General, State of Colorado, appearing on behalf of the State of Colorado.

DONALD W. REDD, Attorney, Division of Lands and

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Natural Resources, Department of Justice, appearing on behalf of the United States Government.

RAPHAEL J. MOSES, Attorney, Boulder, Colorado, appearing on behalf of Colorado Water Conservation Board.

ROBERT S. WHAM and ROBERT M. GORDON, JR., Attorneys, appearing on behalf of Rio Grande Water Conservation District.

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REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

IN THE SUPREME COURT OF THE UNITED STATES

October Term, 1967

STATE OF TEXAS AND STATE OF NEW MEXICO	)	
vs.	)	NO. 29, ORIGINAL
STATE OF COLORADO	)	

STIPULATION AND AGREEMENT
TO PERPETUATE EVIDENCE

The States of Texas, New Mexico and Colorado, joined by the United States, agree that:

1. Sworn evidence, both oral and documentary, may be preserved through oral and written interrogatories of witnesses by any of the parties. The parties will agree on some reasonable and convenient times and places for securing such evidence during the pendency of this Cause. Parties shall have an opportunity to cross-examine any witness and all responses shall be reduced to writing. This provision may be aided by use of pertinent court rules.

2. Original testimony signed and sworn to by a witness may be filed with the Clerk of this Court, accompanied by exhibits referred to in such testimony. Originals or copies may be offered in evidence in any further proceedings in this Cause. All evidence obtained by use of this stipulation shall be subject to pertinent objections.

3. Further testimony of a witness may be taken at a trial. Evidence secured pursuant to this stipulation may also be offered.

4. Evidence may include those parts of any prepared statement by any witness whose testimony, the parties agree, should be received in that form.

DATED this ninth day of May, 1968.

Attorney of Record for
The State of Colorado

Attorney of Record for the
States of Texas and New Mexico

For the United States

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P R O C E E D I N G S

MR. TAYLOR: At this point let the record show that this deposition is taken in compliance with and under the stipulated agreement to perpetuate testimony dated the 9th day of May, 1968, correct copies of which will be inserted into the original and all copies of the deposition, which I take it all parties have.

Let the record show that Texas and New Mexico will introduce into evidence Hill Exhibit No. 1 entitled "Development of the Rio Grande Compact of 1938," which will be identified by the witness and testified to, and that with the original deposition Exhibit No. 1 will be attached thereto and filed and that insofar as additional copies for this deposition are concerned, the respective interested parties or their attorneys will use the correct copies which have heretofore been furnished to them by Mr. Hill and mailed to them on or about the 6th day of November, 1968.

RAYMOND A. HILL

being first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. TAYLOR:

Q Please give your name, address and occupation, Mr. Hill.

A My name is Raymond A. Hill. My home address is 1200 California Street, San Francisco, California. My office

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address is 120 Montgomery Street, San Francisco. I am a consulting civil engineer in private practice, have been for approximately 50 years.

Q Mr. Hill, I am handing you what has been marked as Hill Exhibit No. 1, and I ask you to turn to page -- they are unnumbered pages -- to the unnumbered third page, which is entitled "Personal History of Raymond A. Hill" and consisting of that page and the two following pages. I will ask you to state whether or not those pages contain your accurate personal history, including your education, your business associations, your professional associations, your Federal Government assignments, your Federal Court engagements, your State Government engagements, Foreign Governments and Agencies, and Other General Practice?

A It does.

Q All right, sir.

MR. SAUNDERS: And if the intent is to qualify Mr. Hill as an expert in the field of engineering, I think everyone recognizes that he is such, and we certainly do in this case.

MR. TAYLOR: That was the intent for which it was offered. Thank you, Mr. Saunders.

Q [By Mr. Taylor] Mr. Hill, I will ask you to state whether or not at the request of the Attorney General of Texas you prepared a true and correct history of the development

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of the Rio Grande Compact of 1938.

A I did.

Q You are referred to Hill Exhibit No. 1, which is in front of you. I will ask you to examine it and tell me whether or not that document is the true and correct history of the development of the Rio Grande Compact of 1938 that I referred to in my previous question.

A It is. The report entitled "Development of the Rio Grande Compact of 1938" was prepared by me, and to the best of my knowledge and belief, it is a true and accurate history of the negotiations leading up to the Compact.

Q All right. Now, Mr. Hill, reviewing with you the exhibit which you have identified as Hill Exhibit No. 1, the second page consists of an affidavit that you signed in the presence of a notary public, is that correct?

A That is correct.

Q And then the next three unnumbered pages are the personal history of Raymond Hill - yourself - that you have already testified to, is that correct?

A That's correct.

Q And then you have a page entitled "Development of theRio Grande Compact of 1938," with your name on the bottom as consulting engineer, San Francisco, California, is that correct?

A Yes, that is the title page.

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Q And the next two unnumbered pages are entitled "Table of Contents." Is it true that that is the true and correct Table of Contents of Exhibit No. 1?

A Yes. It is a Table of Contents of the report which follows.

Q Then the next unnumbered page is a Foreword and at the bottom you have "Raymond A. Hill," is that correct?

A That is correct.

Q And then the first numbered page is entitled "Introduction," is that correct?

A That is correct.

Q All right, sir. And that introduction consists of ten numbered pages, is that correct?

A Yes, Pages 1 through 10, inclusive.

Q All right, sir. Now then, is it true, then, that the subsequent pages numbered 11 through 63 is your report?

A Let me correct the previous statement. The introduction, as such, actually runs only through the top of page 5.

Q All right, sir, the top of page 5.

A The Compact of 1929 is actually an introductory chapter, but it is not so listed in the Table of Contents, and that runs just one page. Then there is another introductory chapter, "First action of Texas vs. New Mexico," starting on page 6 and running through page 10.

Q Through page 10. Then starting with page 11 you

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have covered the subject "Rio Grande Joint Investigation" up to page 15, is that correct?

A That is correct.

Q And then on page 15 you have the "Basic Positions of States," listing the position of Colorado on page 16, New Mexico on 17 and 18, and the Texas position on page 19, is that correct?

A Yes.

Q All right. Then you devote pages 20 to 23 to the development of schedules, is that correct?

A It starts there, but it goes beyond page 23, carries through as the main chapter.

Q To page 32, is that correct?

A Actually, Mr. Taylor, as shown in the Table of Contents, the development of schedules commences on page 20. There are subdivisions of that, Colorado schedules commencing on page 23, the New Mexico schedules commencing on page 27, the allotment of Texas commencing on page 34. The next main subdivision of the report commences on page 39.

Q All right, sir. And then from page 39 through 59 will you tell us what subjects you cover?

A Commencing on page 39 there are other provisions of the 1938 Compact, that is in respects other than the schedules, which are "General and Administrative Provisions" on page 39; Article VI of the Compact commencing on page 43, with

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

subdivisions, "Cancellation of Credits and Debits," page 47, "Minimum Unfilled Capacity" on page 48, "Actual Spill" commencing on page 52, "Hypothetical Spill" commencing on page 54.

"Article VII of Compact", discussion begins on page 56, "Article VIII of Compact" on page 58.

The next division of the report is a summary, or summation, of the preceding material, which commences on page 59. Then commencing on page 64 there is simply a reproduction of the Rio Grande Compact for convenience of reference, and on page 76 a reproduction of the Resolution adopted in 1948, which affects New Mexico deliveries, and that concludes the report.

Q Page 79 is your last page, is that correct?

A Yes, 79 is the last page of the report.

Q Mr. Hill, tell us whether or not you were present at the various events and on the various occasions to which you refer with respect to the meeting of the engineer advisers and the Commissioners and the Joint Investigating Committee representatives?

A To the best of my knowledge, I was present at all meetings from the commencment of the Rio Grande Joint Investigation through the negotiation of the Compact, and with one or two exceptions all meetings of the Commission since that time.

Q All right, sir. Now, Mr. Hill, taking pages 1 through 63 of the report which is Hill Exhibit No. 1, if I

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were to ask you line by line, page by page, as to the truth and correctness of the contents of your report, tell me whether or not your answers would be the same as they appear in that report.

A The answer would be the same.

Q And then tell me whether or not this document that you hold there, Hill Exhibit No. 1, relative to the development of the Rio Grande Compact of 1938, whether or not that is your testimony as to the true and correct development of the Rio Grande Compact of 1938?

A It is.

Q Now, you testified that you were present at all or nearly all of the meetings of the engineer advisers and of the representatives of the investigating committees during the process of the development of the Rio Grande Compact of 1938. Tell me, if youcan recall, who the engineer advisers and who the attorneys or other representatives were present representing the State of Colorado.

A The senior representative at all times was Mr. Hinderlider, who was State Engineer of Colorado, and had been for a substantial period of time. To the best of my recollection, he did not attend a number of the meetings of the Rio Grande Joint Investigation studies but he did attend all meetings during the period of negotiation of the Compact. His principal engineer adviser was Royce J. Tipton, a consulting

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

engineer of Denver, Colorado, a man who, unfortunately, died a year ago, but a man of very high reputation and long experience. There were others representing Colorado but Mr. Tipton carried the brunt of the negotiations so far as the engineers were concerned. Mr. Hinderlider was Commissioner at all times.

There were a number of attorneys involved. The only one that took a real active part, and that was continuous, was George Corlett, an attorney from, I think Monte Vista in the San Luis Valley, who was also representing the interests taking water from the Rio Grande into the Closed Basin.

There were from time to time attorneys representing other units of the San Luis Valley but with a lapse of thirty years and not knowing them personally, I would hesitate to say who they were. I don't know when Mr. Moses joined the team, but he perhaps was there.

Then there were staff members from the State Engineer's Office of Colorado who participated in many of the meetings, but the lead was Mr. Hinderlider, and Mr. Tipton, with Mr. Corlett as the primary legal adviser.

Q Would you be in position to tell us the qualification of those people, the type of people they were in their respective professions?

A Well, Mr. Hinderlider was an engineer. At that time I guess he was close to 60. He had been in private practice and also had been State Engineer, had been State Engineer for

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an extended period of time. He was well recognized in the engineering profession as a competent engineer, particularly in the field of civil engineering in water resource developments, and he was considered to be one of the deans of the State Engineer's group. I don't think there was any question that Mr. Hinderlider was a very capable person who was far from being a politician. He was filling a technical job and filling it with technical competence.

Mr. Royce Tipton was one of the outstanding engineers in this field, with background in the San Luis Valley of Colorado from his early days, his school days. He was born in Leadville or somewhere near that area, lived in the San Luis Valley, and then during the period of the early thirties he was selected by the Public Works Administration or one of the agencies at that time to head up one of the investigation teams that reviewed the water supply all over the United States. He was given the area of East Texas and Arkansas because the policy was that a man not be appointed to the area in which he lived, which would remove prejudice from any investigation. Mr. Tipton was one of about half a dozen so selected. He had been actively in private practice except for that period since the middle twenties until his death a year ago, and I considered him one of the ablest engineers in the field. Perhaps I am prejudiced because on work in Pakistan and Egypt we were partners.

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Q You don't really mean, though -- you are not prejudiced, you are telling us factually?

A I am prejudiced to the extent I liked the man personally, I admired his ability, and when I was looking for a partner I sought Mr. Tipton out, or he sought me out, to work jointly.

Q Would it be fair to say that these various people that you personally knew and personally know, including Mr. Ray Moses over there, who participated, let me say, in the creation of the Rio Grande Compact of 1938, were top quality people in their respective professions?

A I don't think I am exaggerating when I say I think Colorado was better represented than the other States.

Q Mr. Hill, at the Annual Meeting of the Compact Commissioners, which usually takes place in Santa Fe, the engineer advisers, as I understand it, from the respective States, the three States, Colorado, New Mexico and Texas, officially get together and make the calculations to arrive at correct debits and credits based on deliveries. Tell me whether or not you or your representatives have been present at each one of those meetings.

A You are speaking of the present Commission since the Compact?

Q Yes, sir.

A The Compact became operative in 1940. I believe

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that I was present at every meeting of the Compact Commission since its organization in 1940, excepting three. One was a meeting very early, an organizational meeting, in which the Commissioner for Texas said he didn't need an engineer to advise him, two others at intervals of perhaps five years. These meetings occurred coincident with my being out of the United States, and my long-term associate and partner until the firm was incorporated took my place at the meeting, but he was familiar with the matter. The computations that were made at the meetings I had not attended were reviewed at subsequent meetings. So I think for all practical purposes I can say that I have participated in, or at least reviewed those I did not participate in, all of the proceedings of the Commission from 1938 until February of 1968.

Q Do you remember the name of the individual engineer who represented you, you say?

A John Q. Jewett.

Q Do you know whether or not at these meetings, each one of these meetings, Colorado was also represented by a competent engineer adviser?

A Colorado consistently, and I do not believe there is an exception, has been represented at those meetings either by Mr. Tipton in the early years or by the Deputy of the State Engineer in later years. In the first few years Mr. Tipton personally participated as the engineer adviser to Mr.

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Hinderlider. Later, Mr. Tipton, due to the pressure of his own business, or other causes, was only there occasionally, but the Deputy of the State Engineer participated at all such times. I know of no meeting at which a representative of the State Engineer, either Mr. Tipton or one of the Senior Deputies from the State Engineer's staff, did not participate in these calculations.

MR. TAYLOR: Texas and New Mexico pass the witness.

CROSS-EXAMINATION

BY MR. SAUNDERS:

Q Mr. Hill, you have characterized the Colorado representatives; who did you represent?

A State of Texas.

Q At all times?

A At all times.

Q Mr. Tipton had an equally high regard and affection for you as you had for him, is that not correct?

A I assume so or else he wouldn't have been my partner on overseas work.

Q You must recognize the fact that when you represent a client, it is not considered generally that the client has any better representative in your field, I think you must have to admit that?

A I do not retract the statement I made. I think Colorado was better represented, was broader represented perhaps

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is a better term.

Q But you are considered a very capable representative yourself, are you not?

A Well, I so boast.

MR. FLINT: We so stipulate.

MR. SAUNDERS: I think we will all agree to that.

Q [By Mr. Saunders] The work you have done on Exhibit 1 you have testified is true and accurate, and would it be also correct to say that it is, however, limited by the fact that it contains only your own observations and your own experience and there may be circumstances or occurrences that did not come to your attention and you have not attempted to relate those?

A No. You will note, however, Mr. Saunders, that the bulk of the report is abstracts from the minutes of the meeting or abstracts of the reports by the engineering advisers to the Compact Commissioners. I have tried to keep out of this report my personal remembrances. I have tried to do it from the records which I fortunately had retained.

Q This does not contain, then, oral hearsay that may have come to your attention insofar as you possibly have been able to exclude such materials?

A No, nor does it include any conferences between Mr. Hinderliter and Mr. Tipton, for example. I may have been aware of those, but I didn't incorporate them.

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Q Fine. As a general matter, was there and has there continued to be an effort to relate the Compact to 1929 conditions?

A I am afraid I don't understand your question, Mr. Saunders.

Q In the course of negotiating a compact among States such as the Rio Grande Compact, is it not usual to reflect historic conditions in the thinking that goes into the making of the agreement which is ultimately called a compact?

A I think I can answer you most accurately by simply --

Q I am just going to your general knowledge, Mr. Hill

A I would rather use language which was prepared at leisure with ample time than to give you a statement that might be slightly contradictory, although not in intent.

Q Look at the top of page 20 of your report. Maybe that will give you a clue as to what I am talking about.

A I was referring to page 62 of the report, which I think answers your question, and before reading that one paragraph I would say during the negotiation the Commissioners instructed their engineering advisers and also their legal advisers, and the Commissioners themselves did not participate actively in negotiations until they had the reports of the others, they were sitting and acting almost like judges in the case. I am reading from page 62 in my exhibit. The engineering advisers were instructed "to prepare schedules of deliveries

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by Colorado and by New Mexico that would insure maintenance of the relationships of stream inflow to stream outflow that had prevailed under the conditions existent when the Compact of 1929 was executed. The Committee of Engineering Advisers was also instructed to provide for freedom of development of all water resources in the drainage basin of Rio Grande above Elephant Butte subject only to compliance with these schedules."

Q Again on that same page, the second sentence, is it not, which says the solution of the problems, now I quote, "was to hold to the principles of the 1929 Compact and to depart as little as practicable from its provisions"?

A That's correct.

Q And again this is referred to on page 20 of your report, at the top half of the page?

A You are referring to the quotation, page 20?

Q The material at the top half of the page, yes.

A Yes.

Q Now, in this same general connotation, you recollect that obligations of the United States, quite aside from any relationships between the three States, became involved in this matter, the obligations of the United States towards Mexico?

A Well, that is involved in the final wording of the Compact; the responsibility for that is made the burden on the lower state, the reason being that the upper states

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couldn't police it, maybe the lower state could.

Q Was there a recognition and also an expectation that the national obligations would not be met by individual states but would be met by the United States Government as a national government?

A No, I don't think that was the case, Mr. Saunders. The 790,000 acre-feet that was arrived at as the normal release, so defined in the Compact, included the water which was obligated to be delivered to Mexico under the Treaty of 1906, the 60,000 acre-feet in the Acequia Madre. So that the allotment on the downstream side of Elephant Butte was really seven hundred thirty for uses in the United States and sixty for uses in Mexico, and the provision that was incorporated was that if they used more than sixty in Mexico, it came out of the seven hundred thirty, but there was no consideration that the United States would separately do anything except divert into the Acequia Madre 60,000 acre-feet. There was no policing otherwise.

Q Now, you have put a rather narrow confine on my question and I would like to broaden the scope of it a little. You have been speaking in terms of water deliveries, and I would like to ask you to broaden the concept of the answer to general responsibility for furnishing the economic background to enable the States to improve their water situations severally, taking into account the fact, which I believe is the fact,

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that throughout the period of negotiation and operation under the Compact there has been an expectation on the part of each of the three States that the United States as a nation would be helpful economically to the States because of the involvement of the United States as a nation with the Republic of Mexico?

A Now we are really broadening. No, I can't subscribe to that, Mr. Saunders, because the obligation of Mexico was so long ago, and a relatively small amount of water, 60,000 out of 800,000, that the only person in the United States concerned with that was the poor Commissioner of the International Boundary Commission who had the responsibility of keeping peace with his counterpart, the Mexican Commissioner. So I don't think the obligations to Mexico really entered into anybody's thinking except the feeling at the time, in '38, that large amounts of water were taken by Mexico and if that was reduced, then Colorado should share in that reduction and New Mexico should share, and nobody could agree. So it was finally agreed and the Upper States said, "If you want to let them have more water, it is your water and it is your baby, don't bother us with it."

The other part of your question, whether the United States has contributed --

Q Not whether it has but whether or not --

A It was contemplated it would?

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Q --the States had expected and hoped that it would?

A Well, I think the answer is obvious. One Federal representative during the Rio Grande Joint Investigation referred to "the three sister States" and the Attorney General for New Mexico said "the three beggars."

Q Do you consider a federal taxpayer who asks for a dime of his money back to be a beggar?

A I said that is merely what the Attorney General for New Mexico said.

Q Oh, for the United States?

A No, no, for New Mexico.

Q I see. Remarkable.

A But it is quite evident that the people, Mr. Hinderlider and Mr. Tipton and particularly Mr. Corlett, expected that out of this would come construction of Wagon Wheel Gap Reservoir in Colorado and the Platoro Reservoir on the Conejos.

Q Anything in New Mexico or Texas?

A And in Texas -- no, not in Texas, but New Mexico, above Elephant Butte, the rehabilitation of the Middle Rio Grande was involved and it was expected that the United States would participate.

As far as below Elephant Butte is concerned, there was nothing except the Caballo Dam which had been authorized or perhaps I think under construction at the time, which was

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something for the benefit of the United States and not for the benefit of the project. The Rio Grande Project gained no benefit from the Caballo Reservoir.

Q As a matter of fact, has the United States contributed Federal funds toward the development of the Rio Grande River in any of the three States in a way which would affect the regimen of the stream?

A I would say primarily the work which the United States has participated in and contributed to in New Mexico has been to prevent deterioration of conditions, the primary purpose of it.

Q Regardless of the purpose, has it had an effect?

A It has prevented deterioration, yes.

Q Have the works in any way improved, deteriorated, or modified, in your opinion, the conditions on the Rio Grande River as they existed in 1929?

A Between the time of the Compact and ten years later, fifteen years later, in that period, conditions on the river had deteriorated, and the works that have been done, speaking generally now, have substantially restored the river to the conditions that prevailed, so far as depletions are concerned, as of 1929.

Q As of the present time, regardless of the contribution or who created the works, do you consider that the conditions on the Rio Grande River are the same or different

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with relation to the 1929 situation?

A You have to divide it now. Are you talking about Colorado or New Mexico?

Q The three States, all three. You have a general knowledge, I think.

A Yes, I have a general knowledge. I can't be too specific. As far as conditions downstream of Elephant Butte, which are in the New Mexico portion of the Rio Grande Project and in the Limitrophe section of the Rio Grande below El Paso, there has been a betterment of conditions due to the canalization of the river which has resulted in some reduction in losses of transportation. That canalization below El Paso was in effect or practically completed as of the time of the Compact. Canalization between --

Q As of the time of what Compact?

A The 1938 Compact. As of the 1929 Compact, of course, nothing had been done. So far as I am aware, there are no other works except this recent channel improvement at El Paso involving the boundary dispute, but that has no material effect on water one way or the other. In the Middle Rio Grande Valley: drainage has been provided in the Middle Rio Grande Valley, which is now a Federal Reclamation Project; channel works have been carried out which have corrected the deterioration, or in the process of correcting it. So the conditions are probably closer to the '29 conditions today

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than they were at any time in the last twenty years. In Colorado their progress has been only to the extent of people writing reports, there has been no physical work and there has been a deterioration of conditions which are, to use a term, man-made or natural, they are really neither one or the other, they are man-induced natural changes.

Q The word "deterioration," which you have used several times I think generally means an impairment from some previous situation. In what sense do you use the word "deterioration" in your testimony?

A In the same sense that one would refer to his automobile which is not being maintained and the steering knuckle bearings become rusty, and so forth, it is deteriorated. It can be restored to substantially its initial condition. It is a deterioration in the sense that a river that had one clean channel now has islands and brush, and it has several inefficient channels.

Q Now, deterioration, then, in the sense of the river would mean an impairment of the river from the standpoint of some useful purpose, would that be your sense?

A Well, in part, yes. I am using the deterioration of the river in the sense of an increase in depletion of flow between inflow to a valley and the outflow from a valley. It is conditions within that reach which have caused or been a contributory cause to increased depletion. In other words,

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channel deterioration is one. High ground water would be another. Vegetation, thick growths of vegetation, would be another.

Q So deterioration as you have used it, and I am not going to limit you, if you want to extend this, for goodness' sake, do so, I am just simply trying to bring out thoughts, Mr. Hill. As you have used the word "deterioration," it means at least an impairment of the total measurable flow over a long period of the Rio Grande River at various points along the stream. Now, have the changed conditions along the stream changed the regimen of the stream so that the flows available occur in a different pattern than they would have under the 1929 conditions?

A If you are referring to, for example, the availability of flows of the Rio Grande at Del Norte, I have no knowledge, or I doubt the existence of any material change that would affect those.

Q Anywhere on the river, any change that you would say would affect the availability of water at any particular point on the river which would be different from 1929?

A Well, at Lobatos there has been a change, but that is not a point of use, that is a point of delivery because there has been a diminution of supply at that point. At the points of diversion in the Middle Rio Grande Valley there has been no substantial change from '29 conditions except

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those resulting from storage in El Vado Reservoir on the Chama and the short-term regulation of flood control storage which has little bearing on the diversions into the canals of the Middle Rio Grande Valley. The principal change in the Middle Rio Grande Valley is the relative reduction of the flows in the Rio Grande proper at Lobatos. At Elephant Butte, or releases from Elephant Butte, the short-term variations have no significance because the reservoir is large. The overall supply available from Elephant Butte has been affected, and adversely, by the lessening of the flows coming downstream. Below Elephant Butte I know of no change that has had any substantial effect on the ability to divert water.

Q I don't want to limit you in any way by asking a specific question, but you have mentioned Elephant Butte. Have changes on the river made the likelihood of spill at Elephant Butte any different since 1929 than they would have been prior to 1929?

A I wish I could visualize the spill at Elephant Butte. It would solve quite a few of our problems. But, specifically, in trying to answer your question, Mr. Saunders, the effect of the changes due to storage on the river is so small relative to the effect of reductions in deliveries, that you could almost disregard the storage effects. We are talking about total deficits on the river of over a million acre-feet, and the storage that has heretofore been used for

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

regulation is one or two hundred thousand acre-feet, and that is only temporary. It only runs for one season. The Elephant Butte Reservoir hasn't been close enough to the spill to make that a significant question. Some day in the future maybe it will.

Q That question had to do with whether or not changes on the river, man-made, since 1929, have affected the likelihood of spill at Elephant Butte.

A I think you are placing an unduly narrow construction on the '29, and that is why I read this statement --

Q Perhaps it is too narrow, but do you have an answer for the question?

A Within the limitations of your question, the answer is Yes.

Q And what, in your opinion, if you have formed one, is the extent of that change, and if you have not formed one, you certainly are free to state that fact.

A Well, quantitatively I would have to say I don't know. Qualitatively, I would say the effect has been materially less than had been contemplated at the time the Compact was negotiated in '38.

Q Quantitatively, would you have an opinion as to whether it is substantial or trivial or some adjective in between?

A It would approach the trivial.

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Q With respect to any natural changes which have occurred since 1929, have there been changes in the expectable spill from Elephant Butte and would they be trivial or substantial?

A The natural changes, which are primarily channel deterioration insofar as the river itself is concerned, have been substantial. I will answer it this way. If the Upper States had delivered water precisely in accordance with the schedules, there would be at least a million acre-feet more water in Elephant Butte Reservoir and the potential spill would, of course, have been much greater than it is today with only a few hundred thousand acre-feet in storage.

Q You have extended the question into a different area than it encompassed. Let's get back to the question. You have said that the channel changes are substantial from natural causes, and the question has to do with whether or not natural causes have changed the likelihood of spill from Elephant Butte substantially or in some lesser degree.

A Well, to the extent -- I think I have to answer it this way, Mr. Saunders -- to the extent that in Colorado, for example, the deterioration of the channel of the Rio Grande below Del Norte and the lower end of the Conejos Valley has caused losses which were not characteristic of the past, I think I would say there are natural changes, there are natural changes man-induced. In other words, man was contributory

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to them. Quantitatively, just what amount of the total depletion is due to that cause I am not in position to state, but it is a substantial portion of the total deficits.

Q And if that were not present, the capacity or the ability, let us say, of Elephant Butte to spill would be increased?

A I think the answer, if I follow your question, to the extent that those losses occurred that would not have otherwise occurred, the quantity of water in Elephant Butte is that much less; the unfilled capacity being greater, the likelihood of spill is less.

Q That's fine. I may be kind of persistent here. You and I know what you mean but when it comes out in the record and the lawyers start nit-picking it some day, possibly, it might not be so clear and that is why I keep persisting, not that I don't understand exactly what you have in mind, but I want it to be in the record, Mr. Hill, and if I restate it as I think it is and you don't believe it is that way, restate it, please, because I am simply trying to make it clear so that we are all thinking the same thing.

As I understand your answer, there have been substantial natural changes on the Rio Grande River in Colorado which have been contributed to by acts of man, so that there is substantially less water available to be present in Elephant Butte than otherwise would be the case, and this, then, has

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

created substantially less water in Elephant Butte so as to diminish, to that extent, the likelihood of its spill.

A Well, I would accept that with some qualification. First, the changes which you might term natural changes, in other words, increased evaporation, non-beneficial plant transpiration, these are changes in natural conditions that are man-induced. In other words, they are under the control of man and many of these changes have been caused by act of man. They are not natural conditions beyond the control of people to that extent, to be clear.

Now, the fact that a hundred thousand acre-feet a year more water entered Elephant Butte would result in greater likelihood of spill, subject, however, to this very practical subject: The Rio Grande Project has been shortened much more than a hundred thousand acre-feet a year, and even if that additional water had been put in Elephant Butte, I doubt whether there would be any more water in Elephant Butte on this, the 4th day of December, than there is in fact.

Q Why?

A Simply because the project has been from one hundred to two hundred thousand acre-feet of water short each year.

Q And you say even if it had not been and that additional water had been placed in Elephant Butte, there would still be just the same amount of water?

A Simply because if it had been there available to be

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used, it would have been used. The quantities of water released from Elephant Butte for irrigation of the Rio Grande Project have been limited for many years to what was in the reservoir and the fear of drawing it completely empty, and this year I am not sure of the exact figure, but in round numbers 400,000 acre-feet have been withdrawn from storage for irrigation use, which is little more than half what was considered normal. So if you put another 100,000 in, they would have used five hundred and ended up with the same amount of water today.

Q So that the total answer, really, is that considering natural, man-made, and combined modifications of the regimen of the Rio Grande River, any change in the likelihood of spill of Elephant Butte Reservoir which has occurred since 1929 is trivial rather than substantial?

A I would say as affecting the likelihood of spill, yes, it approaches the trivial.

MR. SAUNDERS: May we take about a five-minute break?

[Short recess taken.]

Q [By Mr. Saunders] To what extent, if any, do you believe that the changes in the Rio Grande River, from the top to the very bottom, whether by nature or by man or by a combination, have affected the debits or credits of Colorado under the Rio Grande Compact?

A Well, my opinion, Mr. Saunders, and I say this as

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

a general opinion based on general knowledge, not on detailed study or review of reports others have made. Without personal individual study but from my long contact in the matter, in my opinion, the changes that are purely natural, not man-induced, have been almost insignificant in their effect. The changes in non-beneficial uses of water between the index stations at the head of the valleys to the delivery stations at the lower end have been a major contributor to the debits. The other changes have been purely man's definitely increased uses and increases by changes in manner of use.

Now, quantitatively I can't give you a figure, but they are both substantial; and I think that as to the directly man-made depletions: the experience of the last two years, to which you refer in the Answer to the Complaint, the '66 and '67 records show that those changes are well within the power of Colorado, as evidenced by what has been done over the long period. Whether those two years are typical or not I don't know, but I think if I were going to make a guess, that is all it would be, that perhaps the effects are fifty-fifty. In other words, half of your debit has been due to changes in non-beneficial losses that are man-induced, or at least not man-corrected but possible of correction. The other half, roughly, is due to changes in use or the manner of use, which have resulted in depletions.

When I say fifty-fifty, I am leaving myself a wide

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

margin because I don't know. Something in that general range is perhaps reasonable.

Q Yes. If you were to give a very closely definitive answer to my question, you would have to make a detailed study, I would assume?

A Yes, I would have to do -- I know Mr. Tipton made a study some years ago, which I reviewed in a general way, but did not review in detail. If I were to make such a study, as to how much of the debit, which averaged about 70,000 acre-feet per year over the last 15 years, except the last two years --

MR. TAYLOR: Excuse me, did you say seven or seventy?

A Seventy. Of that seventy, a detailed study might show that thirty of it was due to increased depletions, evaporation, non-beneficial consumption along the river, and forty was due to increased uses or changes in manner of use, or it might be the other way around, but it would be in that general order of magnitude, so far as I can tell from general knowledge.

Q Now, your answer on its face has been confined to changes in Colorado, and of course, the question was broader, from one end to the other -

A You asked me as to the debits of Colorado.

Q That's right, but whether the changes in the river as a whole would have affected the debits and credits of Colorado, are there changes other than in Colorado which, in your opinion, would have had an effect on the debits and credits

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

of Colorado?

A No, there are no changes that have occurred downstream of Lobatos which have had any effect whatsoever on the calculated debits and credits of Colorado.

Q Or on what those debits or credits might have been in the absence of such changes downstream?

A Changes downstream have had no effect whatsoever.

Q Now, you are aware, of course, that the State of Colorado itself, the Army Engineers, the Bureau of Reclamation, have plans for certain works to be constructed in Colorado. In your opinion, would those works have a beneficial impact on the ability of Colorado to furnish water at the state line of New Mexico?

A Well, as a prelude to a specific answer, the Bureau of Reclamation has made studies of the so-called Closed Basin drain. They have made studies of drainage of certain other areas in the main stem of the Rio Grande, that is, south of the Closed Basin. I am not familiar with the Corps' program, but I am sure the Corps perhaps is considering some flood control levies or channelization, I am not aware specifically of that, but irrespective --

Q Let's assume you are correct, I believe that you are, it is channel work that the Corps is planning.

A But irrespective of what the agency may be, whether the State of Colorado, the local individual, or the Bureau of

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

Reclamation or the Corps of Engineers, there is no doubt in my mind that what you might call the rehabilitation of the deteriorated channel, the correction of the conditions that have been allowed to be built up over the years would, to a large degree, eliminate the accrual of debits by Colorado. I think it is possible and quite probable that those same measures, particularly if the Closed Basin drain is constructed, would not only result in eliminating the accrued debits, it would result in the accrual of credits, which in time would wipe out the debit that is now on the books. We are not talking about any tremendous works; we are talking about primarily a condition where things have been allowed to deteriorate, where non-beneficial uses have developed and with the elimination of those, the matter almost cures itself.

MR. SAUNDERS: We have no other questions.

MR. MOSES: I think I should clarify the record in one respect. At the time that the Compact was negotiated I was still enjoying the peaceful existence of a college career and it wasn't until some years later that I got involved with the trials and tribulations of the Rio Grande.

THE WITNESS: Well, if I may add, I said at the time I was not sure that you were there.

I knew Mr. Moses was present most of the time afterwards, but the only attorney of which I have positive recollection was George Corlett. I know there were others, but

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

no specific recollection.

MR. WHAM: I would simply say, since the record does show my presence here, I would like the record also to show it is necessary for me to leave at this point.

BY MR. REDD:

Q Mr. Hill, I call your attention to your statement on page 20 and on page 62 of your report where you stated that the objective in the negotiations was to base the uses on the 1929 conditions, is that correct?

A Yes, the primary instructions to the Committee of Engineers, of which I was a member, were to develop a relationship between the supply entering the valleys, each valley, and the outflows from the valley, and to develop schedules which would reflect that relationship as near as possible. That was the first instruction.

Q But in doing so, you contemplated improvements that would make more water available or could make more water available?

A Yes, that's exactly what I referred to in the second instruction, and it was the clear intent, I am positive, that we were instructed in the development of the schedules and in the provisions for operation. Article VI, for example, as drafted by the engineers, almost no change in the final text, was to provide for freedom of development between these points of upper index and lower index in each case, so that

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

each State would be free to change its use and the manner of use, each State would be free to provide storage, but subject always to the delivery in accordance with the schedules.

Colorado, for example, had been promoting the Wagon Wheel Gap Reservoir for many, many years, and all of the provisions in the Compact that referred to storage of water in the Reservoirs and how they would be operated were all to make it possible - for example, Wagon Wheel Gap - so the 200,000 acre-feet could be stored in Wagon Wheel Gap that otherwise would have passed over Elephant Butte and down the river and have been of no value to anybody. Obviously, you could not store that flood water in Elephant Butte, then pump it back to San Luis, it had to be stored in Wagon Wheel Gap.

So the whole theory of the thing, the premise under which the Compact was negotiated, that subject only to the maintenance of depletions that had occurred, subject only to not increasing those overall depletions, there is a freedom in each State to store, develop, improve or do anything else within that State. That was the whole intent.

Q Then if an individual State could make improvements which would eliminate non-beneficial uses, that would make more water available for them?

A For that State, yes, that was the purpose.

Q Now,most of your professional life has been devoted to water reclamation development, has it not?

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A Almost, not exclusively, but almost so, for all of the years of my professional life.

Q And you are pretty well aware of the mode of construction and the financing, and so forth, of most of the major projects in the United States, are you not?

A Yes.

Q Water reclamation projects?

A Yes, I have participated in quite a few.

Q Now, isn't it true that most of these projects have been financed by federal loans?

A The Federal Government has acted in many respects as a banker making loans that private interests would not make, and under terms of repayment which are more liberal than private bankers would do. That is the history of the reclamation developments. The Corps of Engineers has gone further in that flood control benefits are too widely disseminated to be chargeable to individuals. So they have been treated as, say, a national interest, and the local interests have been obligated to repay only the costs of land, and generally speaking, they have to provide the land in advance. So where the work is done by the Corps of Engineers, the local contributions are generally small, representing primarily the land that is used in these works, and it is only when there is a conservation benefit stemming from a flood control project that that allocation of costs is placed as a burden upon the people who

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directly benefit. Have I answered your question?

Q Yes. Now, you are familiar with the Rio Grande pretty well from its beginnings in Colorado down to where it empties into the Gulf of Mexico, are you not?

A Generally familiar with its full length. My degree of knowledge becomes greater as you go downstream, I am more intimately connected with it.

Q You mentioned Wagon Wheel Gap and you also mentioned the Closed Basin Project. Are there other projects that you are aware of that could be affected within the State of Colorado that would produce additional water that is now being wasted?

A Perhaps the one with the greatest return for the expenditure of money would be the canalization of the Rio Grade below Del Norte, the principal point of diversion, and the canalization of the Conejos, through the Lower Conejos Valley, where the river meanders out and spreads over wide areas, and there is very heavy loss. The first canalization was done on the river, when I speak of the river, I mean above Fort Quitman, Texas, because we are dealing with almost, physically as well as legally, a different river downstream. The first canalization was the boundary rectification project between El Paso and Fort Quitman, in which 140 miles of meandering river were converted into an 80-mile long channel, the losses from which were very much less, but that was basically a

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matter of avoiding constant shifting of the boundary. The next step on canalization of the river was between Caballo, at the upper end of the Rio Grande Project, down to El Paso; I was personally involved in that, made the layouts and appeared before the Committee of Congress at the time that plan was adopted. That was done to facilitate the delivery of irrigation water from project storage in the Caballo Reservoir, the lowest one, to the international boundary.

It was a project of the State Department, and legal authority for doing it, it is my understanding, and I believe correct, was to insure that the obligation of the United States to Mexico could be fulfilled, because there was a lot of loss in that reach of the river. The cost of that work was borne by the United States, some land provided by local interests, but primarily the cost was borne by the United States.

The developments upstream in New Mexico through the Middle Rio Grande Valley were commenced in the late twenties by the Middle Rio Grande Conservancy District building some levies, very weak levies, sand levies. Their drainage system was not adequate, they simply did not have the money. When the Bureau of Reclamation took it over a few years later -- I don't remember just when, but about 1950, maybe a little earlier, somewhere in there they took over this Project. The Corps of Engineers, operating under an Act of Congress which involved both the Federal Reclamation and the Corps of Engineers, a

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joint report -- these levies were strengthened, the drains were deepened, and the river was canalized in the lower reaches where there had been high losses and with substantial benefit. There was reduction in non-beneficial consumption.

The flood control reservoirs in New Mexico were for two purposes: One, flood protection to the major city of Albuquerque and other communities, and also to intercept sediments so the Rio Grande would degrade, lower the ground waters, and thereby reduce non-beneficial consumption of water.

Nothing has been done, so far as I know, above Lobatos in Colorado, Lobatos being a gaging station at the upper end of a narrow box canyon in lava not far from the State line. Above that point, so far as I know, nothing has yet been done to canalize the river, minimize losses, and that is the project which affords the greatest opportunity at the least dollar expenditure and probably would go a long ways in eliminating the difficulty we are now in.

Q In this canalization project, would the removal of water-loving plants, such as cottonwood trees, willows, so forth, be included?

A It would if they were within the channel. I don't think outside the channel. It isn't so much the trees that do it, of course they are large users, but there aren't too many trees per acre, except you get in what you call in New Mexico bosque, it used to be mesquite thickets, now it

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is called salt cedar. The main point is that the river is confined to a limited channel. That channel is kept clean and when confined, the river tends to move the sediments out of the bed of the river, lower the ground water, and that reduces the consumption of water from the trees that border it. So the channelization of the river from Del Norte to below the confluence of the Conejos and the lower end of the Conejos is something which has been sitting there available to be done for years; but I presume the question is, whose dollars?

Q Have you ever made any studies as to the amount of benefit per acre-foot of water from different types of irrigation, the way the water was applied to the soil?

A I don't think I follow your question.

Q Well, now, let me rephrase it, then. There are various ways of irrigation, of course there is flooding, there is sub-irrigation, sprinkling. Have you ever made any studies as to which of these are the most efficient in the amount of crop that is produced per acre-foot of water?

A I may have made studies, but I don't think you can apply any general rule. That which is most favorable in one area may not be in another, except I would say that the sub-irrigation is a practice that belongs in the last century, not in this century.

Q Generally speaking, this is very wasteful of

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water, is it not?

A It is wasteful of water simply because it brings the water close to the surface, and even though there is no vegetation, you get evaporation through the soil, and the other is, in the peculiar situation in Colorado, the waters which are diverted to bring the ground waters high, when they drain off they don't drain back to the river, they drain into the sump, and they are no longer usable.

MR. REDD: I have no further questions.

MR. FLINT: We have no questions.

MR. GORDON: No questions.

...Deposition closed at 11 o'clock a.m...

Raymond D. Lee

Subscribed and sworn to before me this 2nd day of January, 1969. My commission expires Feb 2, 1971

Mary Lou Damon
Notary Public within and for the State of California

MARY LOU DAMON
NOTARY PUBLIC - CALIFORNIA
CITY AND COUNTY OF SAN FRANCISCO
My Commission Expires February 2, 1971

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NOTARIAL CERTIFICATE

STATE OF COLORADO]
] SS
COUNTY OF DENVER]

I, VESTA WINE, a Notary Public and Certified Shorthand Reporter, State of Colorado, do hereby certify that pursuant to stipulation of counsel there came before me on the 4th day of December, 1968, at 9 o'clock a.m., at the Meeting Room, Capitol Life Center, Denver, Colorado, RAYMOND A. HILL, who was by me duly sworn to testify the truth in relation to the matters in controversy between the parties hereto; that said deposition was taken in stenotypy by me at the time and place hereinbefore set forth and was thereafter reduced to typewritten form by me personally, and that the same is a true and correct transcription of my stenotype notes then and there taken.

I further certify that I am not employed by, related to nor of counsel for any of the parties herein, nor otherwise interested in the outcome of this action.

IN WITNESS WHEREOF, I have affixed my signature and seal this 31st day of December, 1968.

My commission expires November 27, 1971.

Vesta Wine
Notary Public within & for
the State of Colorado

RIO GRANDE

ELEPHANT BUTTE DAM TO EL PASO, TEXAS

A study of streamflow depletion in the Rio Grande Valley between Elephant Butte Dam and El Paso, Texas, was undertaken using double mass diagrams and a streamflow correlation both of which were prepared from stream discharge records. Double mass diagrams were plotted for the following river reaches: below Elephant Butte Dam to El Paso, Texas; below Caballo Dam to El Paso; and Leasburg Dam to El Paso. In addition, a streamflow correlation was plotted using the discharge at Leasburg Dam against the discharge at El Paso.

The period of record used for each plot is given below:

1. Double Mass Diagram of annual flow - Rio Grande below Elephant Butte Dam vs. Rio Grande at El Paso, 1915-1982 (Figure 1).

2. Double Mass Diagram of annual flow - Rio Grande below Caballo Dam vs. Rio Grande at El Paso, 1938-1982 (Figure 2).

3. Double Mass Diagram of annual flow - Rio Grande at Leasburg vs. Rio Grande at El Paso, 1938-1982 (Figure 3).

4. Streamflow correlation of annual discharge - Rio Grande at Leasburg Dam vs. Rio Grande at El Paso, 1938-1982 (Figure 4).

Figure 1 describes the relationship between the flow of the Rio Grande below Elephant Butte Dam and the flow of the Rio Grande at El Paso, Texas, since storage began in Elephant Butte in 1915. The graph portrays three distinct periods. The first period, from 1915 to about 1925, indicates the depletion of flows in this reach during the development of Rio Grande Project land in New Mexico.

All of the project land was fully developed by about 1925. The second period shows a greater depletion rate after 1925 resulting from the full development of Rio Grande Project land in New Mexico. The third period begins in 1951 and corresponds with the start of the period of lowest water supply available from Elephant Butte Reservoir, which continued through 1957. Also during this period, extensive groundwater development was undertaken to provide a supplemental water supply to offset shortages to Rio Grande Project lands. This groundwater development has changed the flow regime established prior to 1951 such that a greater release is required from Elephant Butte Reservoir to achieve the same flow at El Paso. This new trend, which was established after the end of the drought of the 1950's, has continued to the present (1982).

Figure 2 describes the relationship between the flow of the Rio Grande below Caballo Dam and the flow of the Rio Grande at El Paso, Texas, since the completion of Caballo Dam in 1938. Caballo Dam is located 27 miles below Elephant Butte Dam. The effects of the drought of the 1950's and increased groundwater development are clearly evident in this plot. Since 1951 there has been a cumulative decrease in the streamflow reaching El Paso totalling 3.7 million acre-feet when compared to the pre-1951 relationship, an average of 112,500 acre-feet per year. Since 1957, the cumulative decrease in streamflow reaching El Paso has averaged 106,000 acre-feet per year.

Figure 3 describes the relationship between the flow of the Rio Grande at Leasburg Dam and the flow of the Rio Grande at El Paso, and shows that the greatest portion of the decrease in

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streamflow at El Paso since 1951 is the result of activities occurring below the Leasburg Diversion dam, which is located 45 miles below Caballo Dam. During the period 1951-1982, there has been a cumulative decrease in the streamflow reaching El Paso of 3.9 million acre-feet when compared to the pre-1951 relationship, an average of 94,000 acre-feet per year. Since 1957, the cumulative decrease in streamflow reaching El Paso has averaged 88,000 acre-feet per year.

Finally, Figure 4 also demonstrates the effects of the drought of the 1950's on the river. Of particular note is the year 1958, the first year of a normal water supply after the drought of the 1950's. The discharge at Leasburg in 1958 was comparable to flows during the 1938-1950 period, yet the amount of water reaching El Paso was about 120,000 acre-feet less than would have been delivered in the period prior to 1951.

In conclusion, all four figures used in this analysis show that the effects of the groundwater development below Elephant Butte Dam induced by the drought of the 1950's have significantly affected the amount of water reaching El Paso. The new relationship is well defined and has been continuous to the present (1982).

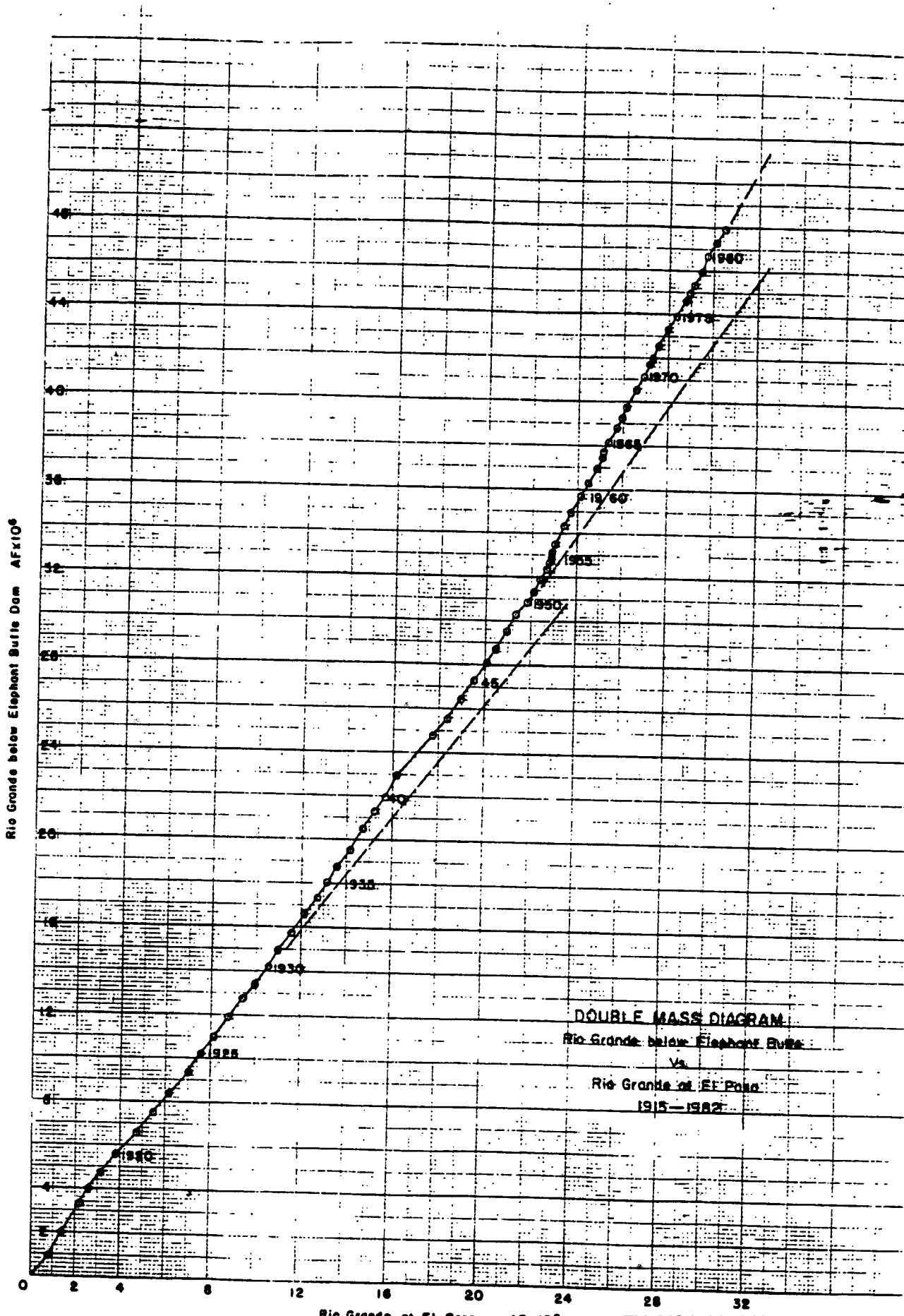

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FIGURE

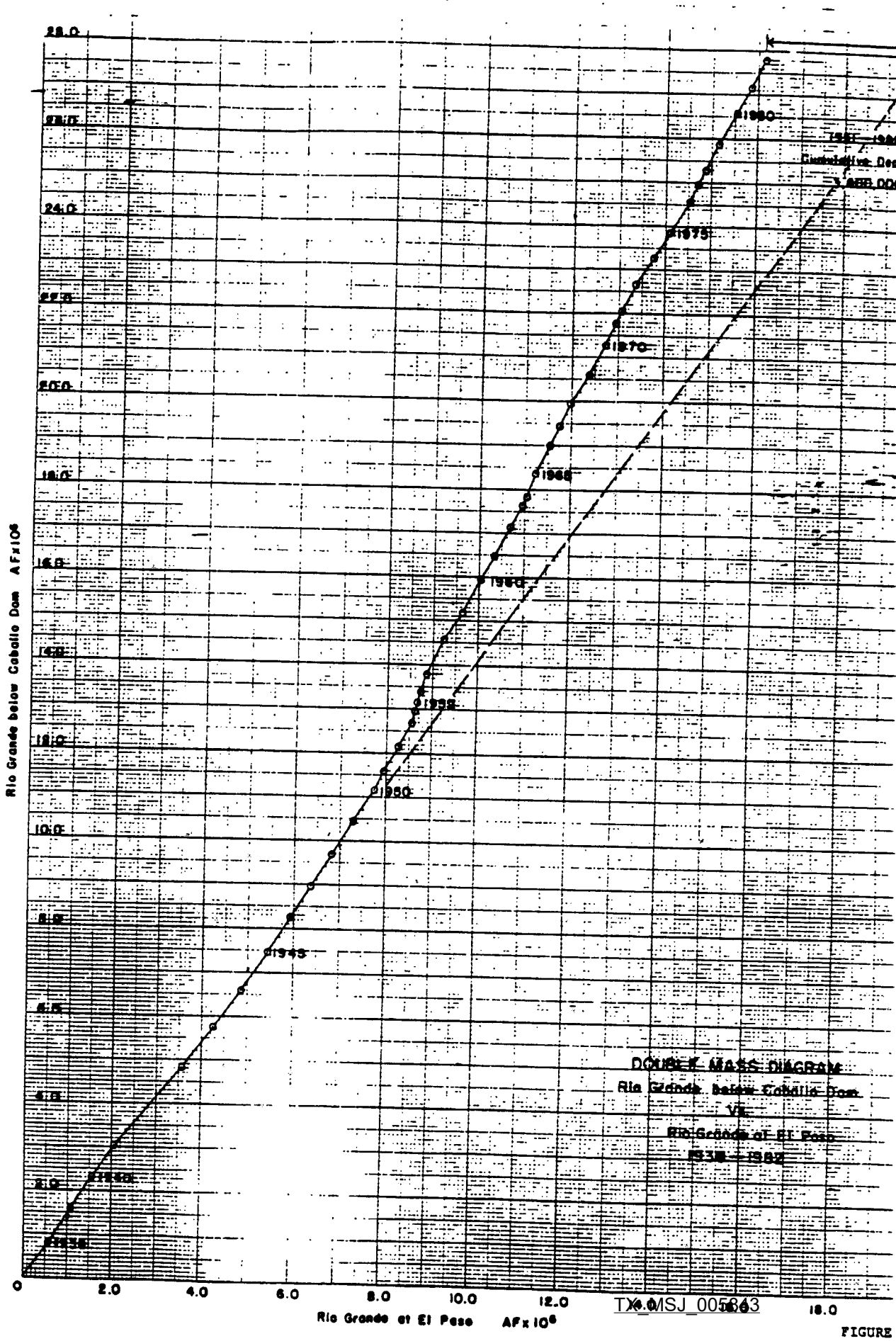

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FIGURE

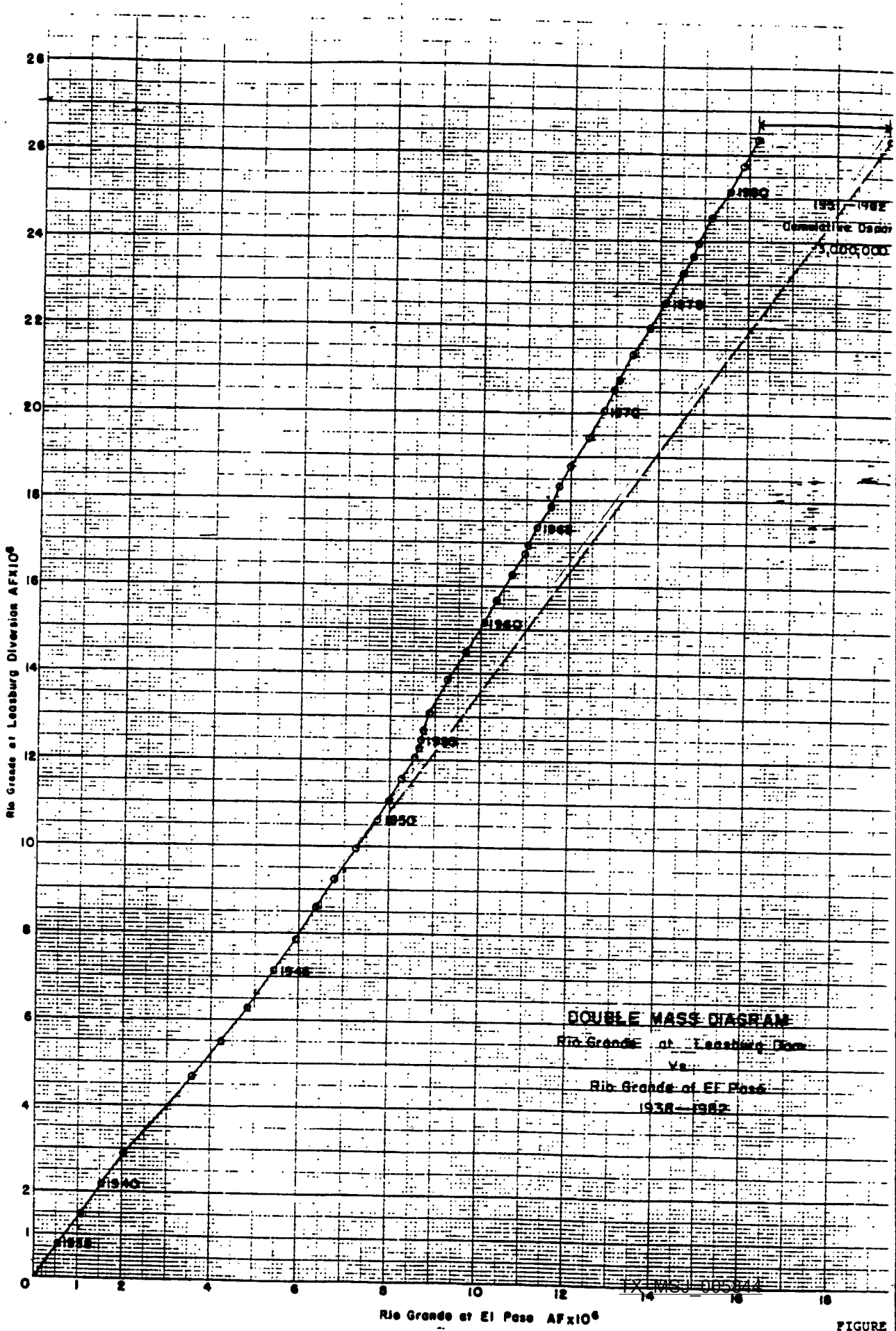

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FIGURE

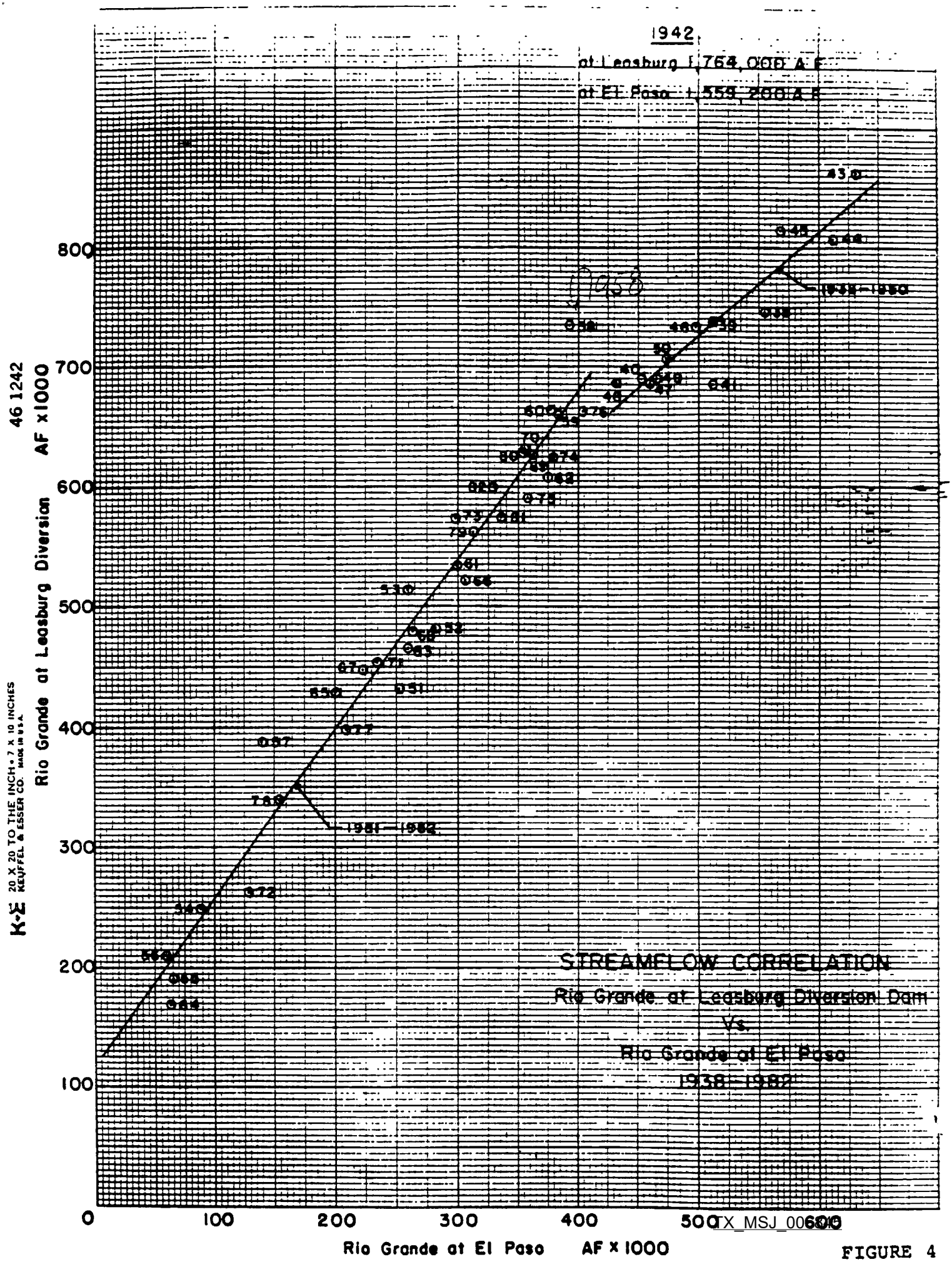

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FIGURE 4

University of Texas, El Paso, Library and Archives.
MS 555, Joseph F. Friedkin Papers.
Box 1, Folder 11.
Correspondence and data concerning Mesilla Valley pumping.
1982.

file:///C|/Users/hmiller/Desktop/Box1,%20Folder11.txt[4/8/2013 1:38:27 PM]

Water and American Government

The Reclamation Bureau, National Water Policy, and the West, 1902–1935

Donald J. Pisani

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CONTENTS

LIST OF MAPS / *ix*
PREFACE AND ACKNOWLEDGMENTS / *xi*

1. Saving Lost Lives
   Irrigation and the Ideology of Homemaking / *1*
2. The Perils of Public Works
   Federal Reclamation, 1902–1909 / *32*
3. Case Studies in Irrigation and Community
   Twin Falls and Rupert / *65*
4. An Administrative Morass
   Federal Reclamation, 1909–1917 / *96*
5. Boom, Bust, and Boom
   Federal Reclamation, 1917–1935 / *123*
6. Uneasy Allies
   The Reclamation Service and the Bureau of Indian Affairs / *154*
7. Case Studies in Water and Power
   The Yakima and the Pima / *181*
8. Wiring the New West
   The Strange Career of Public Power / *202*
9. Gateway to the Hydraulic Age
   Water Politics, 1920–1935 / *235*
10. Conclusion
    Retrospect and Significance / *272*

ABBREVIATIONS / *297*
NOTES / *299*
INDEX / *389*

Illustrations follow page 180.

TX_MSJ_005849

MAPS

1. Major U.S. rivers / *xix*
2. Federal reclamation projects as of 1928 / *xx*
3. Snake River irrigation, Central Idaho / *xxi*

TX_MSJ_005850

> cases mildly communistic effort, and where the sacrifices and privations of the pioneers who wrested the country from the wilderness had become a sort of glorified tradition, cannot help but feel an impatience with a class of people who in these days with infinitely more of material aid seem to have neither the courage, the skill, nor the patience to win a competence or at least a living out of irrigated agriculture.[91]

Critics of federal reclamation believed, with Frederick H. Newell, that a breakdown in the character of settlers had doomed the national irrigation program. No federal policy would work if farmers were unwilling to take responsibility for their own destiny.

Much to Mead's dismay, the most strident opposition to his policies came not from farmers in the eastern half of the nation but from the West. "Secretary Work is unwilling that we should have anything to do with legislation in aid of [planned] settlement unless we know there is practically unanimous support for it in the West," Mead noted in 1927. "We have advocated three bills of that character only to be ridiculed by western senators and congressmen. The Secretary is not willing to undergo that experience again." Two years later Mead predicted that "there will be no legislation this Congress, nor until the speculative element in the West becomes convinced that it is not possible to get money for new canals unless there is assurance that the water will be used after they are built." Save for postponing or excusing their debt to the national government, most westerners opposed any change in the Reclamation Act of 1902.[92]

Herbert Hoover and his secretary of the interior, Ray Lyman Wilbur, applauded Mead's demand that the states play a larger role in reclamation. Wilbur proposed that the central government relinquish control over the two hundred million acres of remaining unreserved public land to the states. Instead of laying out additional reclamation projects, the Reclamation Bureau should build dams and turn them over to the states—after the cost had been repaid from sales of power and water. The states would excavate canals and colonize the land. This proposal suggested that the federal government's role in the agricultural development would be much smaller in the 1930s than it had been in the first three decades of the twentieth century.[93]

In the early 1930s, federal reclamation hit rock bottom. Cultivated acreage on the government projects rose from 1.15 million acres in 1921 to 1.6 million in 1930, and crop prices showed a modest increase in the second half of the 1920s. But when the depression hit, prices plummeted, losing 50 percent of their value between 1930 and 1932. In the latter year, the average value of crops fell to $20.69 an acre, the lowest in the history of federal reclamation. Abandoned farms testified to the hard times. So did the number of renters. On the Carlsbad and Rio Grande Projects, in New Mexico, more than one-third of all farms were operated by tenants, and that number exceeded 50 percent on the Huntley Project, in Montana. The Recla-

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mation Bureau's income from repayments and other sources of revenue dried up. In 1930, Elwood Mead predicted that the modest ten-year construction program adopted by the bureau in 1927—a program that contemplated spending $80 million to finish old projects and launch a few new ones—would now take at least fifteen years to complete.[94]

Mead continued to push for reform. His annual report for 1930 summarized his main goals. Where possible, he wanted the projects turned over to water users to reduce the cost of administration. (The Salt River and Minidoka Projects had changed hands in 1917, and by the end of the 1920s the Reclamation Bureau administered only the Rio Grande, Carlsbad, Yuma, Orland, and Klamath Projects.) He also wanted all surveys of new projects, or extensions of old ones, to include an economic appraisal of the benefits *outside* the project boundaries. Such surveys would give the Reclamation Bureau data it could use in asking the states and local communities for financial help. No project should be undertaken unless *all* water users signed binding contracts to repay their debt to the government. This was part of the Reclamation Bureau's attempt to move away from individual contracts so that it could negotiate exclusively with institutions that represented the farmers, such as irrigation districts. Mead repeated that the only way to protect against land speculation—which robbed the bureau of any chance to predict what a project would cost—was for Congress to authorize it to purchase all surplus land within a proposed project. Finally, he urged Congress not to make special appropriations for reclamation. Construction expenditures should be restricted to revenue from sales of public lands, oil royalties, repayment of construction costs, and profits from hydroelectric power. The only exception was that in the case of the most distressed government projects, they should be refinanced using government funds—at 4 percent interest to the farmers.[95]

The Great Depression added to the dilemmas Mead and the Reclamation Bureau had faced in the 1920s: how to balance costs and benefits; how to assist states desperately in need of federal aid without worsening conditions on the existing projects; how to maintain some semblance of rational management in a political system that encouraged waste, greed, and shortsightedness; and how to plan for the future in a constitutional order that dispersed rather than concentrated power. In a nation desperately seeking work, how could the bureau prevent the approval of unnecessary projects when it had been unable to control western politicians during the 1920s, a decade known—perhaps inaccurately—for "fiscal restraint"?

From the beginning of its life, the Reclamation Bureau had tried to balance the competing goals of opening new land to irrigation and providing additional water to land already cultivated. When drought hit the West in 1929, a drought that in some places lasted until 1935 or 1936, the cries for supplemental water became shrill in communities scattered from the Cen-

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D. C. HENNY
NSULTING HYDRAULIC ENGINEER
SPALDING BUILDING

PORTLAND, OREGON January 9, 1926.

Mr. J. W. Taylor, President,

Elephant Butte Irrigation District,

Las Cruces, New Mexico.

Dear Mr. Taylor:

1. Your letters of December 19th and 22nd were laid aside during the closing rush of the old year's end, but were taken up for serious consideration a few days ago.

2. The immediate question before you is the attitude which the Districts should assume as to the inclusion of pumped mesa lands. This subject opens up rather important questions of general policy, both as considered by themselves and also in connection with pending legislation.

3. Additions of pumped lands, which will not affect the project water supply, may be made in two ways -

(a) by transfer of reservoir rights from less valuable valley lands to pumped lands

(b) by pumping from underground water sources below El Paso.

4. Pumping from underground source above El Paso will, I think, diminish practically to the same extent the flow reaching the International dam as would pumping from project canals. Pumping from such source below El Paso is equivalent to diversion from drains and will ultimately affect Hudspeth County lands only.

5. Additions of pumped lands which will not affect the project water supply are matters of internal policy and are excluded from further consideration in this study, the main object of which is to place before you the estimated results of increasing the acreage dependent on the project supply.

6. It is a matter of relative indifference whether increased draft results from additions to gravity lands as for instance including Hudspeth land in the Districts on an equal basis with all the other lands and supplying it from the Franklin Canal or from the inclusion of pumped lands taking project supply.

7. It is evident from the first that any addition to project demands will aggravate the very serious shortages which must in any event be faced during a cycle like 1898-1904. It may nevertheless be argued that a cycle of that character is so rare that additional losses suffered at such times are more than offset by the gains during the intervening long cycles of sufficient water supply. This question will be subjected to some test later.

8. It leads, however, to another question, as follows: in case extremely low cycles are ignored and water supply studies take into consideration solely periods such as followed after October 1, 1904, how much additional land could then be irrigated without facing shortage. To make this problem specific it might be based say on the assumption of an available storage capacity of 2,075,000 A.F.,as is likely to prevail in 1930,and of unchanged Colorado and Middle

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Rio Grande depletion.

9. The period which is most trying in that respect extends from July 1, 1912, to January 1, 1919, or to October 1, 1921. By reference to Plate IX of my Exhibit of June, 1925, it will be noted that with 155,000 A. under irrigation there would have been a total spill of 377,000 A.F. prior to 1919 and 1,356,000 A.F. from 1919 to October 1, 1921, or a total of 1,733,000 A.F., which if divided over the 9 years covering the period would in itself permit an addition to the annual draft of nearly 200,000 A.F. plus any amount of seepage and evaporation saved by reason of the maintenance of lower water levels in the reservoir.

10. A study was made of the total annual draft over and above the supply required for a 155,000 A. project. It was found that during the 9 years above mentioned an extra annual draft of 250,000 A.F. could have been sustained, leaving the reservoir full at the end of the period. This is illustrated on Fig. 1, Plate A, which shows the fluctuations of reservoir contents for an 155,000 A. project by dotted line and for such project with an additional annual draft of 250,000 A.F., as stated above, by solid line. There would in the latter case be a small spill (67,000 A.F.) at the end of the period.

11. It is thus shown that on the basis of consumptive use above El Paso of 2.50 A.F. per year and below El Paso of 4.50 A.F. per year, or say an average of 3.50 A.F., an additional area above 155,000 A. may be irrigated of about 70,000 A. without endangering the project water supply except in very low cycles. It will be seen from Fig. 1

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that even then the reservoir would never have dropped below a 483,000 A.F. content and consequently that a sufficient water supply would exist for 285,000 A. in spite of silting for a period lasting 25 years after 1930, or till 1955.

12. With such increased demands the tendency would, of course, be that when a dry cycle does come the reservoir would empty more quickly, the period of intense shortage would be lengthened, and the shortages themselves would be still more severe.

13. It is important that the effect at such times be understood as fully as possible so as to enable you to compare its disadvantage with the advantage of full supply to an enlarged acreage and of increased power output for the rest of the time. To that end Fig. 2, Plate A, was prepared.

14. This diagram shows reservoir operation during a dry cycle, 1898-1904, under three conditions -

(a) 155,000 A. irrigated

(b) 155,000 A. " and 50,000 A.F. additional annual draft

(c) 155,000 A. " and 250,000 A.F. additional annual draft.

15. It will be seen that under the three conditions above mentioned the reservoir would be empty at approximate dates as follows:

(a) October 1, 1901, and again June 1, 1904

(b) July 1, 1901, " " May 1, 1904

(c) August 1, 1900, " " Nov.15, 1903

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16. This gives some indication of the degree of aggravation of low cycle shortages in a period like 1898-1904. In itself, however, these dates are not a sufficient basis for judgment. The subject has, therefore, been studied in somewhat greater detail, as is shown on Plate B.

17. On this plate the outer lines of each blocked figure are intended to show the irrigation demands independent of estimated river carriage losses. The portions of the blocked figures colored white show the amounts and the periods of monthly shortages, which, as will be noted, become progressively greater as additional demands are imposed on the available supply.

18. In addition, below each figure is given the annual percentage of irrigation shortage, which, for convenience, are listed below:

	1900	1901	1902	1903	1904	Total
(a)	0%	10%	89%	0%	57%	156%
(b)	0	31	90	0	65	186
(c)	30	54	92	0	90	266

19. It may be possible for you to estimate by the aid of crop statistics the damage resulting from serious shortages and to convert the above percentages into dollar figures. I will make a guess myself, principally to show the method which might be followed, but I deem you and Mr. Harwell to be far more able to judge this matter than I am.

20. A distinction must be made between the interest of present water right owners and of the community as a whole.

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Taking cognizance of the latter only, the following figures may result:

	(a)	(b)	(c)	
(1) Area Irrigated	155,000	169,000	225,000	
(2) Low Cycle Aggregate Shortages	156%	186%	266%	
(3) Excess Shortage over (a)		30%	110%	
(4) Extra Crop Value Loss at $100 per acre		$5,070,000	24,750,000	
(5) Additional Water Released		50,000 AF	250,000 A.F.	
(6) Gain in Power Income at $750		$37,500	$187,500	
(7) Additional Acreage irrigated		14,000	70,000	
(8) Gain in Crop Value over interest on extra investment and water charges at $15 per A.		210,000	1,050,000	
(9) Total Annual Gain		247,500	1,237,500	during good years only
Assume Low Cycle Frequency		Cycle of 6 years in 40 years		
(10) Gain in 34 years		$8,400,000	$42,000,000	
(11) Loss in remaining 6 years		5,070,000	24,750,000	
(12) Balance of Gain in 40 years		3,330,000	17,250,000	
(13) Balance of Gain per year		83,000	431,000	

21. Thus with cycle frequency in 40 years there would be a decided gain to the community. However, it is important to consider the question from the standpoint of present district land owners having vested rights to reservoir storage. The loss to them during a low cycle would be their proportionate part of the losses figured in item ~~5~~ 4, which would be under condition (b) $4,650,000 and under (c) $17,100,000. The problem now is to estimate the corresponding gain.

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22. This must result mostly from additional power income and in some small degree from reduced maintenance and operation charges. As regards power income, an estimate may be made as follows:

	(a)	(b)	(c)
Release from Reservoir	750,000 A. F.	800,000 A.F.	1,000,000 A.F.
Net Power Income on basis $750 per 1000 A.F.	$562,500	$600,000	$750,000
Acreage in Project	155,000	169,000	225,000
Power Income per Acre	3.60	3.55	3.33

23. Instead of a gain, therefore, to your present constituents there would be a loss to them as to power income, which would probably be offset by gain through reduced maintenance and operation charges, leaving no balance of gain at all but confronting them with the probability of enormously increased crop damage during low cycles.

24. In the above estimates you may wish to change radically the crop value and crop damage figures. The assumption moreover of net power income per 1000 A.F. reservoir release of $750 is simply taken from your quotation of Mr. L. C. Hill's statement and may not be correct or may not apply in full to all extra power developed. However, in the main it shows the possibility on the one hand of gain to the community and on the other hand heavy loss to present water right owners if the project acreage having rights in Elephant Butte Reservoir water be increased.

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25. The problem as to the interest of present water right owners is little affected by the probable frequency of low cycles. Whether they come at 40 year intervals, as was tenatively assumed in the previous estimates, or more or less frequently, the farmers are due for heavy extra losses when they do come without any counter-balancing advantage in the meantime.

26. The probable frequency is nevertheless of great importance to them and also affects the problem materially if viewed solely from the community standpoint.

27. As time passes on and one year after another is added to the period of available water records without a repetition of a disastrous cycle the probability of lesser frequency increases so that we have now a period from 1895 to 1925 during which only one low cycle occurred with disastrous shortages for from 2 to 3 years during the cycle. For the present we may say that the probability is one cycle in 31 years.

28. Arguments presented by Colorado give a frequency of 67 years for a low year of the 1902 type at Del Norte. In the first place, you called my attention to the fact that the total percentage in this argument for all frequencies is only 50%, and if this is in error, as seems to me quite clear, the resultant frequency would be once in 34 years, and on that basis an early recurrence of a low Del Norte year is now becoming probable. In the second place, on your Districts we are dealing neither with Del Norte flow alone nor with a

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single year. It is the persistent succession of low years which should count and on that subject the Colorado figures give no estimate at all.

29. Recently I ran across an article, "Tree Rings and Climate," of Prof. A. E. Douglas in the July, 1925, number of "The Scientific Monthly," about whose general studies and deductions I had previously heard and with which you may be familiar. From this article I have abstracted a list of what may have been serious dry cycles in the past, as follows:

1573-1587	15 years
1682-1686	5 "
1729-1741	13 "
1748	1 "
1777-1782	6 "
1822	1 "
1879-1887	9 "
1902-1094	3 "

30. The above schedule reports 8 cycles, totaling 53 years, or 6.6 years average to the cycle, or twice the length of the 1898-1904 cycle listed by Douglas as only 3 years. Cycles of one year might be disregarded in view of large reservoir capacity. On the other hand, cycles of 13 and 15 years would be extraordinarily ruinous, so that 8 low year cycles may be estimated as having occurred during the period covered with average shortage probably worse than that of 1898-1904. The period covered is from 1573-1925, 352 years, which divided by 8 would make the average frequency 44 years.

31. From the above rather speculative considerations

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it may be reasonable to conclude for present purposes that the frequency average is 34 years of good water supply followed by a 6-year low cycle, as was done in the previous estimate, and the further conclusion may also be drawn that inclusion of additional lands in the project for the benefit of the community as a whole would take away valuable rights now vested in present district lands, and would work to their serious detriment.

32. It may be well also to inquire into the effect which the deliberate inclusion of additional lands with rights in Elephant Butte reservoir may have on pending water right litigation. If it be admitted in principle that the Elephant Butte reservoir is too large for the present District lands since its capacity was adjusted to the needs during low cycles and these cycles are so infrequent that from a practical standpoint they may be ignored, this admission will be avidly grasped by Colorado. But it will be argued that this should permit Colorado rather than the El Paso country to take more water annually from the stream.

33. It has been the strong point in our contention that the reservoir is not too large but rather too small for the present 155,000 A. Changing front on that subject now might well be fatal to our legal position.

34. I presume that legally and ethically your first consideration should be the interest of your constituents and on that basis I must strongly recommend against the present increase of reservoir water right lands over 155,000 acres.

Yours very truly,

D. C. Henny

c.c. Roland Harwell

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User Name: Christina Garro
Date and Time: Wednesday, December 11, 2019 12:57:00 PM PST
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1. *El Paso by Public Service Bd. v. Reynolds, 563 F. Supp. 379*
   Client/Matter: Texas/RG

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El Paso by Public Service Bd. v. Reynolds

United States District Court for the District of New Mexico

January 17, 1983

Civ. No. 80-730 HB

Reporter
563 F. Supp. 379 *; 1983 U.S. Dist. LEXIS 19988 **; 13 ELR 20755

THE CITY OF EL PASO, By and Through Its Public Service Board, RAY PEARSON, CARLTON C. HOMAN, JR., LOUIE GIALLANZA, CLINTON E. WOLF, and THOMAS D. WESTFALL, Plaintiffs, v. S. E. REYNOLDS, individually and as State Engineer of New Mexico, JEFF BINGAMAN, individually and as Attorney General of New Mexico, LALO GARZA, individually and as New Mexico District Attorney for Dona Ana County, Defendants, ELEPHANT BUTTE IRRIGATION DISTRICT, THE CITY OF LAS CRUCES, NEW MEXICO, and STAHMANN FARMS, INC., Defendant-Intervenors

Core Terms

Compact, groundwater, apportion, river, embargo, waters, irrigated, surface water, export, Basin, apportionment, delivery, parties, commerce clause, hydrologically, defendants', intervenors, transportation, contracts, shortage, surface, water supply, regulation, Reservoir, acre-feet, connected, rights, interstate commerce, water use, appropriators

Case Summary

Procedural Posture

Plaintiffs municipality and select residents brought an action against defendants foreign state and select officers and challenged the constitutionality of *N.M. Stat. Ann. § 72-12-19*. Numerous concerned parties became defendant intervenors.

Overview

The municipality challenged *N.M. Stat. Ann. § 72-12-19* as an unconstitutional violation of the *Commerce Clause* and sought an injunction. *N.M. Stat. Ann. § 72-12-19* prohibited the export of water from the state for the use of other states. The state contended that the statute was enforceable as a protection for its citizens. The court found that the statute was unconstitutional and therefore unenforceable. The court found that the foreign state could not show that it was acting in response to an immediate need or crisis that would have required such a limitation of the use of water. The court found that while the scarcity of water in the region may have justified limited, non-discriminatory burdens on interstate commerce, it could not support a total ban on interstate transportation of ground water. The court granted an injunction in favor of the municipality's position.

Outcome

The court enjoined the municipality from enforcement of the statue in question.

LexisNexis® Headnotes

Energy & Utilities Law > Discovery, Exploration & Recovery > Exploration Obligations & Rights

Governments > State & Territorial
Governments > Boundaries

Energy & Utilities Law > Discovery, Exploration & Recovery > General Overview

Energy & Utilities Law > Oil & Petroleum Products > General Overview

Governments > State & Territorial
Governments > Property > Water Rights

HN1 **Discovery, Exploration & Recovery, Exploration Obligations & Rights**

No person shall withdraw water from any underground source in New Mexico for use in any other state by drilling a well in New Mexico and transporting the water outside the state or by drilling a well outside the boundaries of New Mexico and pumping water from under lands lying within the boundaries of New Mexico; provided that nothing in this act prohibits the transportation of water by tank truck from an underground source in New Mexico to any other state where the water is used for exploration and drilling for oil or gas. The amount of water withdrawn from any one well for such exportation shall never exceed three acre-feet. N.M. Stat. Ann. § 72-12-19.

Governments > State & Territorial
Governments > Property > Water Rights

HN2 **Property, Water Rights**

Preamble: The state of Colorado, the state of New Mexico and the state of Texas, desiring to remove all causes of present and future controversy among these states and between citizens of one of these states and citizens of another state with respect to the use of the waters of the Rio Grande above Fort Quitman, Texas, and being moved by considerations of interstate comity, and for the purpose of effecting an equitable apportionment of such waters, have resolved to conclude a compact for the attainment of these purposes, Article XI: New Mexico and Texas agree that upon the effective date of this compact this section all controversies between said states relative to the quantity or quality of the water of the Rio Grande are composed and settled. N.M. Stat. Ann. § 72-15-23.

Governments > State & Territorial
Governments > Property > Water Rights

Transportation Law > Interstate Commerce > Balancing Tests

Transportation Law > Carrier Duties & Liabilities > Embargos

HN3 **Property, Water Rights**

In the absence of federal regulation, the states are not precluded from regulating either their water resources or interstate commerce in water. The validity of state statutes affecting interstate commerce in water is determined through application of the following standard. Where the statute regulates evenhandedly to effectuate a legitimate local public interest, and its effects on interstate commerce are only incidental, it will be upheld unless the burden imposed on such commerce is clearly excessive in relation to the putative local benefits. If a legitimate local purpose is found, then the question becomes one of degree. And the extent of the burden that will be tolerated will of course depend on the nature of the local interest involved, and on whether it could be promoted as well with a lesser impact on interstate activities.

Governments > State & Territorial
Governments > Licenses

Real Property Law > Water Rights > Beneficial Use

Governments > State & Territorial
Governments > Property > Water Rights

Real Property Law > Water Rights > General Overview

HN4 **State & Territorial Governments, Licenses**

The State Engineer has the responsibility for measuring, appropriating and distributing the public waters of the state. N.M. Stat. Ann. § 72-2-1. In a declared underground basin, would-be appropriators must apply to the State Engineer for a permit. He may grant the permit only if he finds that there are unappropriated waters available and that existing water rights would be unimpaired. N.M. Stat. Ann. § 72-12-3. The State Engineer monitors withdrawals from non-rechargeable aquifers to ensure that they have a reasonable life.

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Steve Hernandez, Stephen A. Hubert & William L. Lutz, Martin, Martin, Lutz & Cresswell, P.A., Las Cruces, New Mexico, For Intervenor Elephant Butte Irrigation District & Lalo Garza.

[2]** Robert B. Kelley, Frank N. Chavez, Deputy City Attorneys, City of Las Cruces, Las Cruces, New Mexico, For The City of Las Cruces Intervenor.

Ralph M. Richards, William Bivins, Bivins, Weinbrenner, Richards & Paulowsky P.A., Las Cruces, New Mexico, For Stahman Farms, Inc. Intervenor & Lalo Garza.

Judges: Bratton, Chief Judge.

Opinion by: BRATTON

Opinion

[*380] MEMORANDUM OPINION

This case raises the question of the constitutionality of New Mexico's prohibition of the out-of-state export of ground water referred to by the parties as "the New Mexico ground water embargo." Trial of the factual issues has been held at which the parties introduced the testimony of witnesses and numerous exhibits. In addition, a supplementary hearing was held at which the parties presented evidence in light of the decision of the Supreme Court in *Sporhase v. Nebraska, 458 U.S. 941, 102 S. Ct. 3456, 73 L. Ed. 2d 1254 (1982)*.

BACKGROUND

The Rio Grande River has its source in Colorado, flows through New Mexico, and forms the international boundary between Texas and Mexico before discharging into the Gulf of Mexico. Elephant Butte Reservoir sits astride the Rio Grande in New Mexico, approximately **[**3]** 100 miles north of the Texas border, and impounds water for the use of irrigators within the Rio Grande Project (hereinafter "the Project"), a federal reclamation project that services approximately 159,000 acres of land in New Mexico and Texas. Two large aquifers known as the Hueco and Mesilla Bolsons underlie portions of southern New Mexico, western Texas and the Republic of Mexico. The Lower Rio Grande Underground Water Basin consists of that part of the Mesilla Bolson in New Mexico declared by the New Mexico State Engineer, [1] thereby giving him regulatory jurisdiction over the acquisition of waters within the basin. The Hueco Underground Water Basin comprises that part of the Hueco Bolson in New Mexico similarly declared by the New Mexico State Engineer.

Plaintiff City of El Paso, **[**4]** with a population of approximately 450,000, is located on the Rio Grande in western Texas bordering the State of New Mexico. The individually named plaintiffs are residents of El Paso. The New Mexico State Engineer, the New Mexico

[1] The State Engineer can declare underground waters to be public waters, thereby bringing them under his control and supervision, if he finds that they have reasonably ascertainable boundaries. *§ 72-12-1 N.M.Stat.Ann.* (1978).

Attorney General and the District Attorney for Dona Ana County, New Mexico, are the state officials responsible for enforcing New Mexico laws regulating surface and ground waters. N.M. Stat. Ann. § 72-12-21 (1978).

Three parties have been granted leave to intervene as defendants. Defendant-Intervenor Elephant Butte Irrigation District (EBID) is an irrigation district incorporated and organized under New Mexico law to cooperate with the United States in the administration and distribution of irrigation water to member users within its boundaries pursuant to federal reclamation law. Specifically, the EBID has the responsibility of delivering water from the Rio Grande Project to the New Mexico recipients of the Project water. Defendant-Intervenor City of Las Cruces, New Mexico, is located on the Rio Grande River in southern New Mexico and is the second largest water user of the Lower Rio Grande Basin. Defendant-Intervenor Stahmann Farms, Inc., is a **[**5]** New Mexico corporation conducting farming operations within the EBID. It utilizes **[*381]** surface water from the Rio Grande Project and ground water from the Lower Rio Grande Basin for its crop production.

Water in the Southwest is a scarce natural resource. The availability of water, therefore, is critical to the economic development of both the municipal and agricultural communities in southern New Mexico and El Paso. El Paso now obtains its water supply from the surface waters of the Rio Grande and wells in the Hueco and Mesilla Bolsons in Texas. These sources of supply will be insufficient to meet the city's future needs, and it must arrange alternative water supplies to support its growing population and stimulate economic growth. The city has concluded that the most appropriate water sources are the Hueco and Mesilla Bolsons in New Mexico just across the state line. Accordingly, El Paso filed with the New Mexico State Engineer, pursuant to § 72-12-3 N.M.Stat.Ann. (1978), 326 applications for permits to appropriate up to 296,000 acre-feet of water annually from the Lower Rio Grande and Hueco Basins. The State Engineer denied all 326 applications on the ground that **[**6]** Article XVI, §§ 2 and 3 of the New Mexico Constitution precludes utilization of New Mexico ground water outside the borders of the state.

El Paso also owns a tract of land which straddles the New Mexico-Texas border and, as a New Mexico landowner, it can obtain a permit to appropriate ground water from its New Mexico land for domestic use pursuant to § 72-12-1 N.M.Stat. Ann. (1978). The city is prepared to use this water on its adjoining land in Texas. In addition, plaintiff Wolf has contracted to purchase New Mexico ground water for use on neighboring land he owns in Texas. Finally, plaintiffs contracted to purchase two thousand gallons of water from a New Mexico company that produces water from the Lea County Underground Basin in eastern New Mexico. Unlike the other sources from which plaintiffs propose to export water to El Paso, the Lea County Basin is not hydrologically connected to the Rio Grande. (The parties dispute whether this contract was revoked, but in view of the court's disposition of the merits it is irrelevant.)

A New Mexico statute which, with minor exceptions, expressly prohibits the transport of ground water from New Mexico for use in another state [2] is **[**7]** an absolute barrier to plaintiffs' use of ground water drawn from wells in New Mexico. Plaintiffs here seek both a declaration that New Mexico's ground water embargo is unconstitutional, whether it derives from the state constitution or N.M.Stat.Ann. § 72-12-19 (1978), and an injunction against its enforcement. As grounds therefor plaintiffs contend that the embargo violates the Commerce Clause of Article I of the United States Constitution.

[8]** JURISDICTIONAL ISSUES

Before addressing the merits it is necessary to dispose of several jurisdictional arguments raised by the defendants and intervenors. Defendants maintain that the court cannot rule on the constitutionality of the embargo because of a jurisdictional flaw. At different stages in these proceedings they have articulated their argument in terms of standing, justiciable controversy, the Eleventh Amendment and indispensable parties.

As a foundation for the argument, defendants claim that

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[2] In pertinent part the statute reads:

HN1[↑] No person shall withdraw water from any underground source in New Mexico for use in any other state by drilling a well in New Mexico and transporting the water outside the state or by drilling a well outside the boundaries of New Mexico and pumping water from under lands lying within the boundaries of New Mexico; provided that nothing in this act prohibits the transportation of water by tank truck from an underground source in New Mexico to any other state where the water is used for exploration and drilling for oil or gas. . . . The amount of water withdrawn from any one well for such exportation shall never exceed three acre-feet.

§ 72-12-19 N.M.Stat.Ann. (1978).

it is the Rio Grande Compact, not § 72-12-19, which is the true obstacle to El Paso's export of New Mexico's ground water. Thus, a decision on the constitutionality of the statute without adjudication **[*382]** of the Compact issue would be advisory only and would not settle the controversy. By defendants' concession, the argument depends on the validity of three factual assertions: (1) all of the waters in which El Paso has asserted an interest are Rio Grande waters; (2) the Rio Grande Compact apportions the surface waters of the Rio Grande between the states of New Mexico and Texas and controls the use of hydrologically related ground water; and (3) any taking of ground **[**9]** water is ultimately fully reflected in the flow of the river.

From this defendants then conclude that any withdrawal of ground water hydrologically connected with the Rio Grande will effect a reapportionment of the river between Texas and New Mexico, while the Compact can be amended properly only by agreement of the parties thereto or in an original action in the Supreme Court. The Compact, thus, would bar plaintiffs' asserted interests in the ground water in the Lower Rio Grande and Hueco Basins, forever preventing those interests from materializing and depriving plaintiffs of standing to challenge the constitutionality of the embargo statute. As a corollary, because the State Engineer could not recognize a water right that would undermine the Compact appropriation, he would not have occasion to enforce § 72-12-19, and the *Ex Parte Young, 209 U.S. 123, 52 L. Ed. 714, 28 S. Ct. 441 (1908)*, exception to the *Eleventh Amendment* is inapplicable.

Having advanced the proposition that the court must address the Rio Grande Compact, defendants then point out that the parties to the Compact -- the United States and the states of Colorado, New Mexico and Texas -- are indispensable to **[**10]** its construction. Of course, the United States cannot be joined without its consent, and the *Eleventh Amendment* bars joinder of the states. If the court declines to construe the Compact in the absence of the signatories, defendants insist that the entire action must be dismissed because, coming full circle, it is really the Compact that bars the export of the water El Paso seeks. Therefore, a decision on the constitutionality of the statute would be academic.

Defendants' jurisdictional argument suffers from many defects aside from its sheer complexity. First, as discussed below, the Rio Grande Compact does not apportion the surface waters of the Rio Grande below Elephant Butte between New Mexico and Texas. Second, even assuming the Compact protects surface water rights within the Rio Grande Project from impairment through pumping of hydrologically connected ground water, pumping can still be permitted. The State Engineer need only condition ground water permits to require offsets of the effects on the river through return flows or retirement of prior surface and/or ground water rights. Over 10,000 acres of land outside the Project are currently irrigated with Mesilla Bolson **[**11]** ground water; the retirement of these water rights would not alter the distribution of the water within the Project. The State Engineer can deal with these issues of impairment of Project rights and any required offsets in the state administrative well permit proceedings. *§ 72-12-3 N.M. Stat. Ann.* (1978).

Finally, under *Federal Rule of Civil Procedure 19* the Compact signatories are not indispensable parties. Not being parties to this action, they are not bound by the judgment herein. Although both defendants and intervenors urge dismissal under *Rule 19*, neither have demonstrated that plaintiffs have an adequate alternative remedy. In fact, if this action is dismissed for lack of indispensable parties, plaintiffs will be unable to challenge the constitutionality of New Mexico's ground water embargo by any other proceeding.

Intervenors make two additional jurisdictional arguments. They first assert that El Paso's attempt to appropriate the public waters of New Mexico is an action against the state itself which is barred by the *Eleventh Amendment*. The Supreme Court, in *Sporhase v. Nebraska*, expressly held that a state's espoused ownership of water is a legal fiction. *102 **[**12]** S. Ct. at 3462*. Furthermore, plaintiffs seek only prospective relief as permitted under *Ex Parte Young, 209 U.S. 123, **[*383]** 52 L. Ed. 714, 28 S. Ct. 441 (1908)* and *Quern v. Jordan, 440 U.S. 332, 59 L. Ed. 2d 358, 99 S. Ct. 1139 (1979)*.

Intervenors once again raise the argument that the United States, Texas and New Mexico are indispensable parties, since any ground water El Paso takes from the Lower Rio Grande or Hueco Basins will affect surface flows apportioned among Texas, New Mexico and Mexico. The court has ruled on this argument before. Memorandum Opinion at 2 (July 8, 1981). Plaintiffs do not here ask for water or water rights; the decision in this case will not result in an appropriation of New Mexico ground water by El Paso. The sole issue in this suit is the validity of New Mexico's ban on the export of ground water.

THE RIO GRANDE COMPACT

As discussed above, defendants have consistently maintained that the paramount obstacle to El Paso's export of New Mexico ground water is the Rio Grande Compact of 1938, 53 Stat. 785 (1939), because any ground water pumping by El Paso would take surface water apportioned to New Mexico under the Compact. Intervenors **[**13]** contend that the embargo statute merely implements the apportionment incorporated in the Compact and therefore cannot be deemed in contravention of the *Commerce Clause*.

Both facets of the Compact defense hinge entirely on the validity of two factual contentions: that the Compact (1) apportions the surface waters of the Rio Grande between New Mexico and Texas below Elephant Butte and (2) controls the use of hydrologically related ground water. In regard to the first contention, defendants argue that the words of the Compact as well as its history dictate the conclusion that the Compact effects an apportionment between New Mexico and Texas. The words on which defendants rely are contained in the preamble and Article XI; [3] the history follows.

[14]** In 1905 Congress authorized the construction of a dam on the Rio Grande to provide for the irrigation of lands in New Mexico and Texas as well as to enable the nation to meet forthcoming treaty obligations to Mexico. [4] Act of Feb. 25, 1905, 33 Stat. 814. On recommendation of the Reclamation Service the dam was constructed at Elephant Butte, 100 miles north of the New Mexico-Texas border, and the Rio Grande Project was born. Irrigation districts were formed to operate and maintain the irrigation works in the two states: the Elephant Butte Irrigation District in New Mexico and the El Paso County Water Improvement District No. 1 in Texas. The two irrigation districts and the Reclamation Service entered into water contracts for the irrigation of approximately 66,650 acres of land in Texas and 88,350 acres in New Mexico. This ratio of irrigated lands -- 57% in New Mexico and 43% in Texas -- has remained constant.

[15]** Increasing diversions of the Rio Grande in Colorado decreased the flow of the river above Elephant Butte in the 1920's, resulting in the appointment of a commission comprised of representatives from Colorado, New Mexico, Texas and the United States to apportion the waters of the river. The Rio Grande Compact of 1929, 46 Stat. 767 (1930), was the first product of this commission. An interim measure, it maintained **[*384]** the status quo on the river pending the negotiation of an ultimate compact and directed the state and federal commissioners to conclude an apportionment of the Rio Grande on the basis of the uses then existing in each state.

In 1938 the commission proceeded to apportion the waters of the river on the basis of detailed hydrologic information derived from extensive investigations of the river flow and use of the water which had been made by the Water Resources Committee. Under the resulting Rio Grande Compact of 1938, Colorado is obligated to make its delivery of water at the Colorado-New Mexico state line. Article III. In contrast, New Mexico is obligated to make delivery not at the New Mexico-Texas state line but "into Elephant Butte Reservoir." [5] Article **[**16]** IV. The Commission calculated that compliance by Colorado and New Mexico with the delivery schedules set forth in Articles III and IV would permit an average normal release from Elephant Butte Reservoir of 790,000 acre-feet per year, an amount sufficient to irrigate the Project lands in New Mexico and Texas and to honor the United States' obligation to Mexico.

On the basis of these undisputed historical facts defendants argue that the Rio Grande Compact of 1938

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[3] *HN2*[] Preamble: "The state of Colorado, the state of New Mexico and the state of Texas, desiring to remove all causes of present and future controversy among these states and between citizens of one of these states and citizens of another state with respect to the use of the waters of the Rio Grande above Fort Quitman, Texas, and being moved by considerations of interstate comity, and for the purpose of effecting an equitable apportionment of such waters, have resolved to conclude a compact for the attainment of these purposes, . . ."

Article XI: "New Mexico and Texas agree that upon the effective date of this compact [this section] all controversies between said states relative to the quantity or quality of the water of the Rio Grande are composed and settled; . . ."

§ 72-15-23 N.M.Stat.Ann. (1978).

[4] Pursuant to its convention with Mexico concluded May 21, 1906 (34 Stat. 2953), the United States is obligated to deliver to Mexico 60,000 acre feet of water annually, in the bed of the Rio Grande above the city of Juarez, Mexico.

[5] New Mexico's delivery obligation into Elephant Butte Reservoir is set forth in a complex schedule of deliveries that is based on the relationship between the amount of water in the Rio Grande above the principal agricultural areas in New Mexico and the inflow to Elephant Butte.

apportioned the waters of the Rio Grande between New Mexico and Texas below Elephant Butte. The significance of this argument becomes apparent only in light of the second contention defendants advance, which is that the Compact controls the use of ground water hydrologically **[**17]** connected to the apportioned surface water.

With the exception of the tankful of water plaintiffs contracted to purchase from Lea County, all the water which plaintiffs are prepared to export is hydrologically connected to the Rio Grande. Because the Rio Grande is a "losing stream" which feeds into the underlying, connected ground water, any withdrawal of ground water will eventually be reflected in depletion of the surface flow of the river.

The New Mexico State Engineer administers interrelated surface and ground waters as an integral unit. It is defendants' contention that to authorize any withdrawal of ground water connected to the Rio Grande without impairing prior vested surface water rights, particularly those of the irrigators in the EBID, the State Engineer would have to require the retirement of a comparable amount of existing surface use. Defendants predict that approval of all plaintiffs' applications would result in the complete demise of surface irrigation in the Rio Grande Project, both in New Mexico and Texas. Their particular objection, however, is to the retirement of any water rights within the EBID on the ground that this would be tantamount to a reapportionment **[**18]** of the Rio Grande in contravention of the Compact.

As stated at the outset, the success of defendants' Rio Grande Compact defense depends on the validity of two factual assertions: that the Compact (1) apportions the surface water of the Rio Grande between New Mexico and Texas and (2) controls the use of ground water hydrologically connected to the River. This court is unable to accept either. Neither the history of the Compact negotiations, the ultimate terms of the Compact, nor the defendants' subsequent interpretation and actions support the conclusion that the parties to the agreement intended it to apportion either the surface water of the river or the related ground water below Elephant Butte between New Mexico and Texas.

Defendants argue that it was impracticable to require delivery of Texas' equitable share of the water at the New Mexico-Texas state line because of the existence of Elephant Butte Reservoir 100 miles north of that line, which provided water for the entire Rio Grande Project spanning both states. They assert that the Compact negotiators **[*385]** availed themselves of the facilities at hand -- the existing works of the Project -- and relied on the United **[**19]** States Bureau of Reclamation as administrator of the Project to effectuate the apportionment between the states which is implicit in the Compact. Because the Compact itself nowhere enumerates the amount of Texas' equitable apportionment, defendants in turn rely on the initial contracts between the Reclamation Service and the irrigation districts to define the amounts of water allegedly apportioned to each state. Defendants conclude that the division by the Project Administrator of the water stored in Elephant Butte Reservoir between the 88,650 irrigated acres in New Mexico and 66,350 acres in Texas, or 57% to New Mexico and 43% to Texas, defines the states' respective entitlements.

It is unnecessary to accept defendants' labyrinthian argument for full meaning to be given to the words and history of the Compact. The preamble states that the purpose of the Compact is to effect an equitable apportionment of the waters of the Rio Grande; that it did. Article XI states that the Compact composed and settled all controversies between New Mexico and Texas relative to the quality and quantity of the water of the Rio Grande; this it also did. However, it did not apportion any specified **[**20]** amount of water to Texas below Elephant Butte.

Defendants concede that the Compact does not literally apportion the Rio Grande between New Mexico and Texas and that no language in the Compact expressly assigns any amount of water to the state of Texas. Indeed, on its face the Compact simply apportions the water of the river first between Colorado and the downstream states; it then apportions the remaining water between the New Mexican appropriators above Elephant Butte and the New Mexican, Texan and Mexican appropriators below Elephant Butte. While Colorado is required to make a scheduled delivery of water annually at the Colorado-New Mexico state line, New Mexico is not required to deliver anything at the New Mexico-Texas state line. New Mexico's only delivery obligation is set forth in Article IV of the Compact, which designates Elephant Butte Reservoir as the point of delivery.

The history of the Compact indicates that the real bargaining positions were taken by Colorado, the Middle Rio Grande Conservancy District water users

represented by New Mexico [6] and the Rio Grande Project water users represented by Texas. Jenkins, Myra Ellen, *The Rio Grande Compact of 1938* (to **[**21]** be published, 1982), pp. 51-56. Texas found itself in the position of protecting water rights of all the lands in the Project and, consequently, the users in the New Mexico section of the Project supported Texas' stance rather than New Mexico's. Id., p. 52. See also Hill, R., *Development of the Rio Grande Compact of 1938*, pp. 17-18.

This alignment is also reflected in the statements of the views of the states of New Mexico and Texas delivered by their respective commissioners at the September 28, 1937 meeting of the Compact Commission. Mr. McClure, the New Mexico Commissioner, presented the New Mexico position:

> New Mexico is willing to negotiate with Colorado and Texas for a permanent **[**22]** compact to equitably distribute the waters of the Rio Grande among the states on the basis of the following minimum requirements for the State of New Mexico:
>
> . . . .
>
> Second: New Mexico is willing to negotiate with the State of Texas as to the right to the use of water claimed by citizens of Texas under the Elephant Butte Project on the basis of fixing a definite amount of water to which said project is entitled. Provided, however, **[*386]** that upon the completion of the All-American Diversion Dam and canal, Mexico shall be limited strictly to treaty provision of 60,000 acre-feet per annum for use in the Republic of Mexico.

Mr. Clayton presented the Texas position:

> Although the State of Texas feels that it should share in the benefits from new works for the augmentation of the water supply of the Rio Grande, it will not insist thereon, provided that the States of Colorado and New Mexico will release and deliver at San Marcial a supply of water sufficient to assure the release annually from Elephant Butte Reservoir of 800,000 acre-feet of the same average quality as during the past ten years, or the equivalent of this quantity if the quality of the supply **[**23]** is altered by any developments upstream.

Proceedings of the Meeting of the Rio Grande Compact Commission, pp. 12-13 (Sept. 28, 1937).

Prior to the filing of this lawsuit the State Engineer publicly enunciated the position he now repudiates. In 1956 he delivered a paper at the New Mexico College of Agricultural & Mechanical Arts wherein he stated, "The compact does not, in fact, apportion the waters between New Mexico and Texas, but rather between the water users in New Mexico above Elephant Butte on one hand and the water users in Texas and New Mexico below Elephant Butte on the other hand." The State Engineer never contradicted this statement until defendants began formulating their defense to El Paso's complaint in the case at bar.

The state of New Mexico also took the position that the Compact does not apportion the Rio Grande between New Mexico and Texas in a motion and brief submitted to the United States Supreme Court in *Texas v. New Mexico*, Original No. 9. In a Motion for Return to Rule the state of New Mexico made the categorical statement: "The Rio Grande Compact makes no apportionment of the use of such waters between the States of Texas and New Mexico." Motion **[**24]** for Return to Rule at 5. New Mexico told the Supreme Court that,

> In view of the fact that there are in New Mexico over 85,000 acres of land below Elephant Butte which are watered from the Rio Grande, it cannot be said that the obligation imposed on New Mexico to make certain scheduled deliveries at San Marcial, 165 miles north of the New Mexico-Texas state line, is an apportionment of the waters of the Rio Grande between the states of Texas and New Mexico.

Brief in support of Return to Rule at 8.

Other statements of the same import are scattered throughout the Brief in Support of the Return to Rule.

Defendants claim that the Supreme Court rejected New Mexico's position in the Motion for Return to Rule and on two other occasions. *Texas v. New Mexico, 343 U.S. 932, 96 L. Ed. 1341, 72 S. Ct. 767 (1952)*; *Texas v. New Mexico, 308 U.S. 510, 84 L. Ed. 435, 60 S. Ct. 118 (1939)*; *Texas v. New Mexico, 352 U.S. 991, 1 L. Ed. 2d 540, 77 S. Ct. 552 (1957)*. None of these rulings contain or constitute a decision as to the proper interpretation of

[6] The Middle Rio Grande Valley of New Mexico is the 160 mile stretch of the river between Cochiti Dam and Elephant Butte Reservoir. Water appropriators in this section of the river are organized into the Middle Rio Grande Conservancy District, a corporation and political subdivision of the state of New Mexico.

the Rio Grande Compact.

The Compact apportions the river by requiring New Mexico to make deliveries at Elephant Butte **[**25]** according to a quantified in-flow, out-flow schedule. This is the apportionment sought by New Mexico and Texas in the Compact negotiations. This is the apportionment that defines the respective rights of the two states and that Texas has a right to enforce. *Texas v. New Mexico, 343 U.S. 932, 96 L. Ed. 1341, 72 S. Ct. 767 (1952)*. Contrary to defendants' contention, a decision that the Compact does not apportion the river below Elephant Butte does not mean that New Mexico, having made its delivery, could undermine it by pumping down the surface flow of the river below the point of delivery. This opinion does not address that issue at all.

Defendant-Intervenors take a slightly different tack. Bowing to the plain meaning of the Compact, they concede that it does not apportion the waters of the river below Elephant Butte. Like the defendants, however, intervenors also rely on the Project's division of the waters released from Elephant Butte to effect an apportionment **[*387]** not effected by the Compact. They contend that Texas is entitled only to that amount of water which is allocated to Texas lands by the Project Administrator.

Acceptance of intervenors' argument would **[**26]** require the further acceptance of a corollary not expressly enunciated by them, i.e., that the contracts between the Bureau of Reclamation and the farmers in the two irrigation districts effected an equitable apportionment of the waters of the river below Elephant Butte which is binding on the states of Texas and New Mexico. Although Congress can authorize the Secretary of the Interior to allocate interstate waters among states via contracts for water stored in federal reservoirs, the circumstances which led the Supreme Court to conclude that Congress had done just that in *Arizona v. California, 373 U.S. 546, 10 L. Ed. 2d 542, 83 S. Ct. 1468 (1963)* were vastly different from those at hand.

The court in *Arizona v. California* relied on the legislative history of the Boulder Canyon Project Act which clearly indicated that Congress intended the Secretary to allocate the waters of the Colorado River among the states of Arizona, California and Nevada through his contracts with water users in those states. *373 U.S. at 580*. Congress not only enumerated the amounts of the respective allocations to each state, it set standards for, and placed significant limitations on, the Secretary's **[**27]** power to distribute the waters. *373 U.S. at 584*. The Court also found that the provisions of the Act provided the machinery by which the Secretary could accomplish the apportionment it had so plainly authorized. *373 U.S. at 579*.

With the Boulder Canyon Project Act, Congress thus authorized the Secretary to effect an apportionment through contracts for reclamation water. The Secretary then proceeded to allocate the water in accordance with his congressional authorization. Intervenors do not argue that Congress intended, in the Act of 1905 authorizing the Rio Grande Project, to force an allocation of the Rio Grande upon Texas and New Mexico as a consequence of the Secretary's contracts with the farmers in the Project. There is, in fact, nothing in that act even remotely analogous to the provisions of the Boulder Canyon Project Act which led the Supreme Court to find congressional authorization of the Secretary's apportionment. There is simply no basis for the argument that the Secretary's contracts with the Project water users effected an equitable apportionment binding on Texas and New Mexico.

Where the court to find that the Rio Grande Compact apportions the river below Elephant **[**28]** Butte, the Compact defense still would fail if that apportionment did not control the use of hydrologically connected ground water. There is a hydrological connection between the surface flow of the Rio Grande and the ground water in the Hueco and Mesilla Bolsons. But the Compact makes no mention of ground water. The United States Bureau of Reclamation, manager of the Rio Grande Project, has never counted ground water used by irrigators within the EBID as part of the Project's water supply.

Even more telling is the fact that, prior to the filing of this suit, defendants never took the position that the Compact apportioned hydrologically connected ground water. The State Engineer did not even declare the Lower Rio Grande and Hueco Underground Basins until after El Paso filed its complaint. Prior to that time, there was no conjunctive management of the ground water in these basins and the surface water of the Rio Grande. Between the signing of the Compact in 1938 and the filing of this suit, thousands of wells were drilled into the Mesilla Bolson and up to 185,000 acre-feet of water per year were withdrawn, including the entire water supply for the City of Las Cruces. Yet no **[**29]** one ever claimed before now that these wells violated the Compact.

This is not to say that the State Engineer cannot or should not conjunctively manage the surface and ground water in the Lower Rio Grande system. If he does, however, he must apply it evenhandedly to both New Mexico and out-of-state appropriators.

[*388] If defendants' interpretation of the Compact were correct, interstate export of Hueco and Lower Rio Grande Underground Basin water could still be permitted without effecting a reapportionment if pumping could be offset without retiring EBID surface water rights. The success of defendants' Compact defense finally rests on their assertion that El Paso's proposed pumping can only be offset by requiring the retirement of Rio Grande Project surface water rights in New Mexico, which would alter the 57%-43% distribution of Project water between New Mexico and Texas. In addition to the possibility of retiring the ground water rights appurtenant to the 10,000 acres of non-Project lands in New Mexico mentioned earlier in this opinion, El Paso has suggested a number of alternative offsetting measures. Defendants have not shown that El Paso can offset the effects of **[**30]** its pumping only by retiring surface water rights of EBID irrigators. Issues of impairment of prior water rights -- surface or ground, within the Project or without -- and measures for offsetting impairments should be addressed in administrative hearings on plaintiffs' permit applications, not by an absolute embargo on the interstate export of ground water.

THE COMMERCE CLAUSE

At the January, 1982, trial of this case defendants and intervenors contended that the *Commerce Clause* did not render the embargo unconstitutional for three reasons: (1) water was not an article of commerce and, therefore, *commerce clause* analysis was inapplicable; (2) Congress had authorized the western states to impose otherwise impermissible burdens on commerce in ground water; and (3) New Mexico's exercise of plenary authority over its internal waters was a traditional governmental function beyond the reach of the *Commerce Clause*.

The Supreme Court's recent decision in *Sporhase v. Nebraska* has settled these issues. The Court ruled that water is an article of commerce and that Congress' longstanding deference to state water law did not demonstrate an intent to permit discrimination against interstate **[**31]** commerce in ground water. Nor are federal constitutional constraints suspended merely because a state claims public ownership of internal ground waters. Although such a claim "may support a limited preference for its own citizens in the utilization of the resource," *102 S. Ct. at 3464*, a state's asserted ownership of public waters within the state is only a legal fiction. *102 S. Ct. at 3462*.

The Court's disposition of these aspects of defendants' *Commerce Clause* defense does not settle the constitutionality of the New Mexico water embargo. The Court in *Sporhase* recognized that, ***HN3***[⬆] in the absence of federal regulation, the states are not precluded from regulating either their water resources or interstate commerce in water. The validity of state statutes affecting interstate commerce in water is determined by applying the standard set out in *Pike v. Bruce Church, Inc., 397 U.S. 137, 142, 25 L. Ed. 2d 174, 90 S. Ct. 844 (1970)*:

> Where the statute regulates evenhandedly to effectuate a legitimate local public interest, and its effects on interstate commerce are only incidental, it will be upheld unless the burden imposed on such commerce is clearly excessive in relation **[**32]** to the putative local benefits. [Citation omitted.] If a legitimate local purpose is found, then the question becomes one of degree. And the extent of the burden that will be tolerated will of course depend on the nature of the local interest involved, and on whether it could be promoted as well with a lesser impact on interstate activities.

New Mexico's embargo bars the export of ground water absolutely; it is an explicit barrier to interstate commerce. Facially discriminatory, it is subject to the strictest scrutiny. Defendants must demonstrate that the embargo serves a legitimate local purpose, that it is narrowly tailored to that purpose and that there are no adequate non-discriminatory alternatives. *Hughes v. Oklahoma, 441 U.S. 322, 336, 60 L. Ed. 2d 250, 99 S. Ct. 1727 (1979)*. The purpose defendants advance for New Mexico's overall system of ground water regulation is to **[*389]** conserve and preserve the state's internal water supply. They point to the state's longstanding water management laws, institutions, policies and public expenditures as evidence that the purpose is genuine.

Water has always been a highly valued resource in New Mexico because of the **[**33]** state's aridity. Consequently, the use of water in New Mexico has long been subject to strict regulation and control under a comprehensive system of water rights laws and institutions. Chapter 72, N.M.Stat.Ann. (1978). In fact, New Mexico was a pioneer in ground water

management. The state's declared ground waters are public waters, § 72-12-1 N.M.Stat.Ann. (1978), subject to appropriation for beneficial use, § 72-12-2 N.M.Stat.Ann. (1978). **HN4**[↑] The State Engineer has the responsibility for measuring, appropriating and distributing the public waters of the state. § 72-2-1 N.M.Stat.Ann. (1978). In a declared underground basin, would-be appropriators must apply to the State Engineer for a permit. He may grant the permit only if he finds that there are unappropriated waters available and that existing water rights would be unimpaired. § 72-12-3 N.M.Stat.Ann. (1978). The State Engineer monitors withdrawals from non-rechargeable aquifers to ensure that they have a reasonable life. *Mathers v. Texaco, Inc., 77 N.M. 239, 421 P.2d 771 (1966)*.

Taken as a whole, New Mexico's scheme of water regulation demonstrates a genuine effort to promote optimum utilization of its diminishing **[**34]** water resources. This effort "is unquestionably legitimate and highly important." *102 S. Ct. at 3463*. While it may justify limited, non-discriminatory burdens on interstate commerce, it cannot support a total ban on interstate transportation of ground water.

In *Sporhase* the Supreme Court recognized the long-standing *Commerce Clause* distinction "between economic protectionism, on the one hand, and health and safety regulation, on the other." *102 S. Ct. at 3464*. This distinction gives a state the power "to shelter its people from menaces to their health or safety" but not "to retard, burden or constrict the flow of . . . commerce for their economic advantage. . . ." *H. P. Hood v. DuMond, 336 U.S. 525, 533, 69 S. Ct. 657, 93 L. Ed. 865 (1949)*. Thus, the Supreme Court held that a state may discriminate in favor of its citizens only to the extent that water is essential to human survival. Outside of fulfilling human survival needs, water is an economic resource. For purposes of constitutional analysis under the *Commerce Clause*, it is to be treated the same as other natural resources.

Constitutional restrictions on the ability of the states to burden the flow of interstate commerce **[**35]** in natural resources lie at the heart of our national solidarity and prosperity. It was the anarchy and commercial warfare between the states which emerged after the Revolutionary War that led to the Constitutional Convention. Having experienced the rivalries and disruptions caused by economic barriers and retaliations, the necessity for centralized regulation of commerce among the states was obvious to the Founders. *H. P. Hood v. DuMond, 336 U.S. at 533-534*. The fifty states cannot operate as separate economic units. Our material success depends on the vigilant maintenance of the principle that our economic unit is the entire nation.

Defendants and intervenors do not maintain that the embargo's purpose is to promote the health and safety of New Mexico's citizens. They do not maintain that the state is now experiencing a shortage of water for health and safety needs or will do so in the near future. The estimated state-wide demand for water for public health and safety purposes by the year 2020 is only 220,000 acre-feet per year, while New Mexico's ultimate renewable supply is estimated to be 2.2 million acre-feet per year.

The State Engineer testified that the purpose **[**36]** of the embargo is "to make maximum beneficial use of water in New Mexico." Defendants believe this is a legitimate objective because the state's water supply is insufficient to meet all projected requirements. Specifically, they predict that by or before the year 2020 there will be a state-wide **[*390]** consumptive use shortage of at least 626,000 acre-feet per year.

This predicted shortage is based on what defendants define as reasonable "public welfare" needs, including water requirements for municipalities, industry, irrigated agriculture, energy production, fish and wildlife, and recreation. Aside from the amount necessary for public health and safety, these are requirements for water related to economic activities. In essence, defendants recognize no limits on the future uses for which New Mexico should be able to preserve ground water. However, to extend the state's power to discriminate to all potential uses of water would remove ground water from *Commerce Clause* constraints. The policy of maximizing all "public welfare" uses of water in New Mexico, and the furthering of that policy by prohibiting interstate commerce in ground water, is tantamount to economic protectionism.

[37]** This is not, as defendants and intervenors claim, a double standard which restricts New Mexico to a water supply only sufficient to fulfill its human survival needs while allowing El Paso to blossom in unrestrained economic prosperity. It is simply the necessary application of the fundamental principle that our Constitution "was framed upon the theory that the peoples of the several states must sink or swim together, and that in the long run prosperity and salvation are in union and not division." *Baldwin v. G.A.F. Seelig, 294 U.S. 511, 523, 79 L. Ed. 1032, 55 S.*

Ct. 497 (1935).

Nor does it mean that New Mexico cannot undertake reasonable water planning. The state can and should carry on its policy of furthering the maximum beneficial use of the water supply. The absence of an embargo statute will not create havoc in New Mexico's system of ground water regulation. It will not result in unrestricted out-of-state use or uncontrolled transfers of water. Interstate usage of water can be restricted and controlled to the same extent as intrastate usage. El Paso has stated repeatedly that, if the State Engineer approves its well permit applications, it will abide by all provisions **[**38]** of New Mexico water law.

Defendants insist that New Mexico's water laws have no extraterritorial effect, and, therefore, the State Engineer cannot control El Paso's use of exported water. In *Sporhase* the Court held that a state could impose the same withdrawal and use restrictions on out-of-state users as it does on its own citizens. 102 S. Ct. at 3465. Under § 72-12-3 N.M. Stat. Ann. (1978) the State Engineer can condition any permit granted to El Paso to require that the city cooperate with New Mexico officials for the purpose of ensuring that all exported water is put to beneficial use. City of Roswell v. Berry, 80 N.M. 110, 112, 452 P.2d 179 (1969). The State Engineer's ability to enforce New Mexico's water regulations lies in his power to suspend or revoke El Paso's permits to withdraw ground water. § 72-12-14 N.M. Stat. Ann. (1978). If the city does not comply with either the conditions of its permits or New Mexico's water laws, the State Engineer can terminate El Paso's pumping.

Defendants also raise the specter of the wholesale "drying up" of southern New Mexico if El Paso is permitted to export the water it seeks. New Mexico, however, already contemplates that **[**39]** its irrigated agriculture will gradually be cannabalized as market forces transfer water to municipal and industrial use. Thus defendants' only objection is to the retirement of agricultural water uses to accommodate non-New Mexican municipal and industrial uses. Under the Commerce Clause, New Mexico cannot practice such discrimination.

If the embargo's purpose were to conserve and preserve the water supply for the health of New Mexico's citizens and not the health of its economy, it still would be unconstitutional because it is not narrowly tailored to achieve that purpose. As stated before, there is no present or imminent shortage of water in New Mexico for health and safety needs. In fact, the State Engineer testified that New Mexico is far from the time when water will be a limiting factor on the state's growth.

[*391] Assuming that such shortages were foreseeable and that New Mexico could constitutionally preserve its water to meet future shortages, the embargo is not a means to that end. The embargo only prevents the transfer of ground water out of the state; it places no restrictions on in-state use. Under New Mexico's ground water laws the State Engineer cannot **[**40]** deny an application for a ground water right if there is unappropriated water available and other rights will be unimpaired. § 72-12-3 N.M. Stat. Ann. (1978). The state's policy of "maximum beneficial use" envisions putting as much water to beneficial use as soon as possible. If New Mexico ever is faced with a shortage of water for health and safety purposes, the state's current water code, including the embargo, will not ensure that there is an adequate supply in reserve to meet the need.

In *Sporhase* the Supreme Court found Nebraska's reciprocity provision was not narrowly tailored to the conservation/preservation rationale because it prevented export when water was locally abundant and its most beneficial use was in another state. The Court suggested that an arid state could possibly overcome this defect if it suffers a water shortage as a whole and "the intrastate transfer of water from areas of abundance to areas of shortage is feasible regardless of distance." 102 S. Ct. at 3465.

Although the estimates vary widely, there is no question that the Hueco and Mesilla Bolsons contain millions of acre-feet of water, which far exceed local needs. At the present time the most **[**41]** economically productive use of this excess water is across the New Mexico-Texas state line. Municipal and industrial water uses are more economically productive than other uses. For example, they will support seventy times as many people as water applied to irrigated agriculture. El Paso is the economic hub of an interstate region which includes southern New Mexico; it is the major trade center and contains the area's principal employers. If El Paso were in New Mexico defendants probably would agree with plaintiffs that the most beneficial and economically productive use of the Hueco and Mesilla Bolson ground water is in El Paso for the simple reason that what is good for El Paso is good for the entire region, including southern New Mexico.

Defendants have attempted to show that this locally abundant ground water could be transported to other

areas of New Mexico that are experiencing water shortages. They point to examples of water transportation projects that now exist or are being planned. But none of these projects involve plans for the intrastate transfer of Hueco and Mesilla Bolson ground water. The state has not made any plans for the intrastate transportation of this **[**42]** water. Prior to this suit defendants assumed that this water would be used locally, and that still appears to be the prevailing belief.

Aside from the fact that there are no plans for intrastate transportation of Hueco and Mesilla Bolson ground water at the present, defendants have failed to show that such transportation is "feasible regardless of distance." *102 S. Ct. at 3465*. The feasibility envisioned by the Supreme Court must include economic considerations because, from a purely engineering standpoint, it is now possible to transport water over enormous distances. Defendants presented evidence that at some uncertain future date it may be economically feasible to transport the Hueco and Mesilla Bolson water elsewhere in New Mexico, but possible, or even probable, future economic feasibility cannot satisfy the standard set in *Sporhase*. So drastic and burdensome a measure as a total ban on interstate commerce in ground water can only be justified if it is narrowly tailored to times and places of shortage.

The purpose of the embargo is to promote New Mexico's economic advantage. Even if the purpose were conservation and preservation, as defendants maintain, the embargo does **[**43]** not significantly advance the conservation and preservation of water. It certainly is not narrowly tailored to achieve that purpose and cannot survive strict scrutiny.

[*392] The court recognizes that the conservation and preservation of water is of the utmost importance to the citizens of New Mexico. Defendants' and intervenors' desire to retain the ground water in the Lower Rio Grande and Hueco Basins for the use of New Mexicans, therefore, is certainly understandable. Nevertheless, the New Mexico ground water embargo violates the *Commerce Clause of the United States Constitution*, and an Order will be entered herein enjoining the defendants from enforcing it.

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1. *El Paso by Public Service Bd. v. Reynolds, 597 F. Supp. 694*
   Client/Matter: Texas/RG

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El Paso by Public Service Bd. v. Reynolds

United States District Court for the District of New Mexico

August 3, 1984

CIV No. 80-730 HB

Reporter
597 F. Supp. 694 *; 1984 U.S. Dist. LEXIS 24568 **; 15 ELR 20259

THE CITY OF EL PASO, By and Through its Public Service Board, RAY PEARSON, CARLTON C. HOMAN, JR., LOUIE GIALLANZA, CLINTON E. WOLF, and THOMAS D. WESTFALL, Plaintiffs, v. S. E. REYNOLDS, individually and as State Engineer of New Mexico, PAUL G. BARDACKE, individually and as Attorney General of New Mexico, LALO GARZA, individually and as New Mexico District Attorney for Dona Ana County, Defendants; ELEPHANT BUTTE IRRIGATION DISTRICT, THE CITY OF LAS CRUCES, NEW MEXICO, and STAHMANN FARMS, INC., Defendant-Intervenors

Core Terms

public welfare, conservation, groundwater, export, interstate commerce, appropriations, factors, Basin, in-state, domestic, shortage, criterion, Commerce, hydrological, transfers, interstate, transport, detrimental, moratorium, embargo, Bolson, waters, Compact, burdens, out-of-state, permits, surface water, water use, impermissibly, water rights

Case Summary

Overview

The court held that the limitation of water exports to those which were not contrary to the conservation of water within the state and were not otherwise detrimental to the public welfare of the citizens of New Mexico did not render N.M. Stat. Ann. § 72-12B-1C facially unconstitutional. The court concluded that the consideration by the state engineer of the six factors listed at § 72-12B-1D when acting on applications for new appropriations of water to be used outside New Mexico did not violate the *Commerce Clause*. However, the court held that the utilization of the conservation and public welfare criteria and the six factors listed at N.M. Stat. Ann. § 72-1B-1D to evaluate applications for domestic wells and transfers of existing rights where the water was to be used outside the state created an unconstitutional burden on interstate commerce. The court held that H.B. 12 had an illegitimate protectionist purpose and was facially unconstitutional. Further, the court concluded that the Rio Grande Compact and state constitutional issues were not moot and were reaffirmed.

Procedural Posture

Plaintiff city brought an action against defendant state officials, challenging the constitutionality of two regulations that dealt with the out-of-state use of ground water. The city further sought the reentry of portions of a prior memorandum opinion that dealt with the Rio Grande Compact and state constitutional issues. The state officials contended that those issues were moot.

Outcome

In the city's action against the state officials, challenging the constitutionality of regulations, the court found that one regulation was facially unconstitutional. The court found that the other regulation created an unconstitutional burden on interstate commerce. Further, the court reaffirmed the previous Rio Grande Compact and state constitutional issues, finding that

they were not moot.

LexisNexis® Headnotes

Governments > Legislation > Interpretation

HN1[] **Legislation, Interpretation**

Statutes should be construed so as to avoid unconstitutional results.

Governments > State & Territorial
Governments > Property > Water Rights

HN2[] **Property, Water Rights**

The New Mexico State Engineer may deny permits for in-state water use if, in his opinion, approval thereof would be contrary to public interest. *N.M. Stat. Ann. § 72-5-7* (1978).

Governments > State & Territorial
Governments > Property > Water Rights

HN3[] **Property, Water Rights**

A state may not limit water exports merely to protect local economic interests. This is true even though the health of the state's economy has a direct bearing on the public welfare of its citizens.

Constitutional Law > Congressional Duties & Powers > Commerce Clause > General Overview

Transportation Law > Interstate Commerce > Balancing Tests

Transportation Law > Interstate Commerce > Per Se Invalidity

HN4[] **Congressional Duties & Powers, Commerce Clause**

When a state exercises a preference for its citizens under the rubric of protecting their public welfare and economic interests are implicated, the resulting burden on interstate commerce must be weighed against the putative, noneconomic local benefits. If the public welfare criterion is used to effectuate simple economic protectionism, a per se rule of invalidity will be applied. If it is used to promote a legitimate purpose with only incidental burdens on interstate commerce, the court must try to accommodate the competing local and national interests. If equally effective, less burdensome alternatives are available, the state must use them.

Governments > State & Territorial
Governments > Property > Water Rights

Transportation Law > Interstate Commerce > Balancing Tests

HN5[] **Property, Water Rights**

A state may favor its own citizens in times and places of shortage. Of course, this does not mean that a state may limit or bar exports simply because it anticipates that one day there will not be enough water to meet all future uses. Even some of the most water-abundant states predict shortages at some future date. The preference envisioned must be limited to the times and places where its exercise would not place unreasonable burdens on interstate commerce relative to the local benefits it produces.

Constitutional Law > Congressional Duties & Powers > Commerce Clause > General Overview

Transportation Law > Interstate Commerce > Balancing Tests

HN6[] **Congressional Duties & Powers, Commerce Clause**

Factors which inform the determination whether a state's preference for its own citizens reasonably or unreasonably burdens interstate commerce are the degree to which the state claims public ownership of ground water and whether the availability of the water is in part the result of the state's conservation efforts. These factors, as with those relating to the extent of shortages and the public welfare interests being protected, cannot be evaluated in a vacuum.

Governments > State & Territorial
Governments > Property > Water Rights

HN7 **Property, Water Rights**

In the regulation of water a state may exercise a limited preference for its own citizens in times and places of shortage. Logically, such a preference can only be implemented by keeping or "conserving" within the state water that would otherwise go out. A state may, therefore, "conserve" water within its borders for the use of its citizens to the same limited extent that it may prefer its citizens in the utilization of the resource.

Constitutional Law > Congressional Duties & Powers > Commerce Clause > General Overview

HN8 **Congressional Duties & Powers, Commerce Clause**

Commerce Clause analysis of a state's exercise of a preference for its own citizens in the utilization of scarce water resources is a complex inquiry; it must be made case-by-case.

Energy & Utilities Law > Financing > Grants & Reservations > General Overview

Governments > State & Territorial
Governments > Property > Water Rights

HN9 **Financing, Grants & Reservations**

While a state may constitutionally regulate water usage to promote the conservation of water and the public welfare of its citizens, it may not require interstate commerce to shoulder the entire burden of furthering those interests. There is no legitimate reason to deny interstate transfers and domestic wells if detrimental to those interests yet permit intrastate transfers and domestic wells when they are detrimental to them.

Constitutional Law > Congressional Duties & Powers > Commerce Clause > General Overview

HN10 **Congressional Duties & Powers, Commerce Clause**

A statute need not openly disclose an avowed purpose to discriminate against interstate commerce, though, to violate the *Commerce Clause*. The stated purposes may be feigned, pretextual or illusory. It is the duty of the court to look behind the legislative recitals of purpose to discover the true purpose of a challenged statute.

Constitutional Law > Congressional Duties & Powers > Commerce Clause > General Overview

HN11 **Congressional Duties & Powers, Commerce Clause**

A state statute, however, may be invalid because of its protectionist purpose as well as its discriminatory effect. The balancing test presupposes that the statute being tested has a legitimate local purpose. Thus, evenhandedness does not validate an illegitimate purpose.

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Judges: Howard Bratton, J.

Opinion by: BRATTON

Opinion

[*696] MEMORANDUM OPINION

The City of El Paso et al. filed this suit in 1980 seeking a declaratory judgment that New Mexico's embargo on the out-of-state use of ground water, *N.M. Stat. Ann. § 72-12-19* (1978), impermissibly burdened interstate commerce in contravention of the *Commerce Clause of the United States Constitution*. Defendants, the state officials responsible for enforcing New Mexico's water laws, responded that it was the Rio Grande Compact and the state constitution, not the embargo statute, which blocked El Paso's proposed ground water exports, making *§ 72-12-19* irrelevant. Defendants also denied that the embargo statute impermissibly burdened interstate commerce.

On January 17, 1983, **[**3]** the Court issued its Memorandum Opinion disposing of these issues. *City of El Paso v. Reynolds, 563 F. Supp. 379 (D.N.M. 1983)*. The Court rejected defendants' interpretation of the Rio Grande Compact, held that it was immaterial whether the water embargo was based on the state constitution or a state statute and found that the embargo violated the *Commerce Clause*. Accordingly, the embargo was declared unconstitutional, and defendants were enjoined from enforcing it.

On February 22, 1983, the New Mexico Legislature enacted S.B. 295 which repealed *§ 72-12-19*, enacted provisions dealing with the out-of-state use of water and otherwise amended New Mexico's water code. Following enactment of S.B. 295 defendants appealed this court's decision to the Tenth Circuit. Defendants also urged the Court of Appeals to hold that S.B. 295 had rendered the entire case moot and to order the case dismissed. Instead, the Court of Appeals vacated the Judgment and remanded the entire matter "for fresh consideration **[*697]** of the respective rights and obligations of the parties in light of whatever intervening changes of law and circumstance are relevant." The Court of Appeals gave this court **[**4]** "full and complete latitude" to enter a judgment appropriate to the new circumstances. Approximately two months after remand, in February, 1984, the New Mexico Legislature enacted a two year moratorium on new appropriations of ground water hydrologically connected to the Rio Grande below Elephant Butte. H.B. 12.

In its Second Amended and Supplemental Complaint, El Paso challenges the constitutionality of both S.B. 295 and H.B. 12. El Paso also asks the court to reenter those portions of the prior Memorandum Opinion dealing with the Rio Grande Compact and state constitutional issues, matters which defendants claim are moot. The parties now present for decision the issues of mootness and the facial constitutionality of S.B. 295 and H.B. 12. The factual background for this suit having been set out in the earlier Memorandum Opinion, the court turns directly to the issues.

Senate Bill 295

With *§ 72-12-19* the Court analyzed and applied *Sporhase v. Nebraska, 458 U.S. 941, 73 L. Ed. 2d 1254, 102 S. Ct. 3456 (1982)* and other Supreme Court cases interpreting the *Commerce Clause* as they related to an absolute embargo on interstate commerce in ground water. On its face the statute **[**5]** now under review purports to effect a dramatic change in New Mexico law. By repealing *§ 72-12-19*, New Mexico purportedly abjured its attempts to prohibit water exports. The present statute sets out conditions under which water can be exported. *Commerce Clause* analysis of this type of statute is materially different from that which applies to an explicit barrier to interstate commerce. The Court's discussion in the prior Memorandum Opinion of the *Commerce Clause* as it applied to *§ 72-12-19* is not applicable to S.B. 295 and, therefore, is superseded by that which follows.

S.B. 295 made numerous changes in New Mexico's water laws which are codified at different sections of its water code. It repealed *§ 72-12-19*. It deleted the words "within the state of New Mexico" from § 72-12-18 which formerly provided that "all underground waters of the

state of New Mexico are hereby declared to be public waters and to belong to the public of the state of New Mexico and to be subject to appropriation for beneficial use *within the state of New Mexico*." S.B. 295 amended N.M. Stat. Ann. § 72-12-3E (Cum.Supp. 1984) by requiring the State Engineer to find that a proposed appropriation "is not **[**6]** contrary to conservation of water within the state and is not detrimental to the public welfare of the state" before granting a permit for a new appropriation for *in-state* use of ground water from a declared basin. Finally, S.B. 295 enacted *N.M. Stat. Ann. § 72-12B-1* (Cum. Supp. 1984) which purports to permit and regulate the out-of-state use of ground water. (The complete text of *§ 72-12B-1* is given at Appendix A.) The statute contains a severability provision.

It is the export statute, *§ 72-12B-1*, to which El Paso addresses its constitutional challenge. It requires the State Engineer to find that El Paso's export of water from the Mesilla and Hueco Bolsons "would not impair existing water rights, is not contrary to the conservation of water within the state and is not otherwise detrimental to the public welfare of the citizens of New Mexico" before he may approve the City's applications. § 72-12B-1C. The statute also directs the State Engineer to consider six additional factors when acting upon applications for export. § 72-12B-1D. The first four factors involve an analysis of the effect of the proposed export on in-state shortages. The last two factors involve an evaluation **[**7]** of the applicant's water supply and demand and the alternate sources of water supply available to the applicant in the state of import. The statute empowers the State Engineer to condition export permits and provides that applicants must comply with New Mexico's water laws.

[*698] El Paso claims that the export statute is unconstitutional because it facially discriminates against water exportation in several respects. The parties have reserved for future proceedings all issues regarding the constitutionality of the statute as applied. The court first addresses the City's contention that allowing exports only when they are "not contrary to the conservation of water within the state and [are] not otherwise detrimental to the public welfare of the citizens of New Mexico" unconstitutionally discriminates against interstate commerce.

The Conservation and Public Welfare Criteria

El Paso argues that the "conservation of water within the state" criterion prohibits the interstate use of water -- water that is transported outside the State is not conserved or kept within it. It further argues that conversely, any in-state use of ground water, again by definition, cannot be contrary **[**8]** to the conservation of water within the state. If this simplistic interpretation of the conservation criterion in § 72-12B-1C is correct, then that provision by itself would unconstitutionally prohibit export of any ground water from New Mexico. *Hughes v. Oklahoma, 441 U.S. 322, 337, 60 L. Ed. 2d 250, 99 S. Ct. 1727 (1979)*; *El Paso v. Reynolds, supra.* So interpreted, the criterion would also directly contradict the statement at § 72-12B-1A that "under appropriate conditions the out-of-state transportation and use of [New Mexico's] public waters is not in conflict with . . . the conservation of its waters." The remainder of the statute presumably would be superfluous under such an interpretation.

The conservation criterion cannot be interpreted so literally. Such a construction would be contrary to the rule that ***HN1***[⬆] statutes should be construed so as to avoid unconstitutional results. 2A D. Sands, Statutes and Statutory Construction, § 45.11 (4th Ed. 1973). By bringing the conservation criterion into conflict with the remainder of the statute which purports to permit water exportation, El Paso's interpretation violates other precepts of statutory construction, i.e., the various **[**9]** provisions of a statute should be construed so as to be consistent with each other and so that no part is rendered superfluous. *Atchison, Topeka & Santa Fe Railway Co. v. United States, 617 F.2d 485, 493 (7th Cir. 1980)*; *Hughes Air Corp. v. Public Utilities Comm'n, 644 F.2d 1334, 1338 (9th Cir. 1981)*; *National Insulation Transportation Committee v. Interstate Commerce Commission, 221 U.S. App. D.C. 192, 683 F.2d 533, 537 (D.C. Cir. 1982)*. Any plausible interpretation of the conservation criterion which is consistent with these rules must be preferred over an interpretation that violates them. Such an interpretation is readily apparent.

By permitting exportation of ground water only when it is "not contrary to the conservation of water within the state" the statute acknowledges the fact that New Mexico cannot legislate as to ground water that is not found within the State. The phrase "water within the state" defines the water which is to be conserved; it does not dictate that all the State's waters must be retained within its borders. This interpretation of the conservation criteria in § 72-12B-1C brings it into alignment with the declaration at § 72-12B-1A that the export **[**10]** of water may not be contrary to the conservation of New Mexico's waters. If applied in a

manner which does not unduly burden interstate commerce, the regulation of ground water appropriations for the purpose of promoting conservation is constitutionally permissible. *Sporhase, 458 U.S. at 954* - 957.

On its face, S.B. 295 appears to apply the conservation and public welfare criteria evenhandedly, at least to new appropriations. As amended, § 72-12-3E, which deals with applications for new in-state appropriations of ground water from declared basins, now mirrors the requirements for approval of out-of-state appropriations in § 72-12B-1C. Under both § 72-12-3E and § 72-12B-1C the State Engineer must deny applications for new in-state and out-of-state appropriations if the proposed use is **[*699]** "contrary to the conservation of water within the state [or] detrimental to the public welfare of the state." El Paso contends that this evenhandedness is only superficial because for in-state uses these criteria are meaningless.

El Paso is correct that New Mexico's general policy has been to put as much water to use within the State as soon as possible, the converse of conservation, **[**11]** at least as to underground waters. In addition, prior to the passage of S.B. 295, the constitution and laws of New Mexico have not been construed to authorize prioritization of uses of underground waters. All uses have been considered beneficial uses, equally beneficial to the public welfare, with the first in time having the better right. *N.M. Const. art. XVI, Sections 2* and *3*. Both parties take the position that S.B. 295 does not change these principles insofar as they apply to in-state water uses. Therefore, that issue need not now be addressed.

It is unclear at this time how the conservation and public welfare criteria will be applied to in-state appropriations. New Mexico's surface water statutes, though, contain a similar criterion: ***HN2***[⬆] the State Engineer may deny permits for in-state use "if, in his opinion, approval thereof would be contrary to public interest." *N.M. Stat. Ann. § 72-5-7* (1978). Only one case has construed this criterion. *Young & Norton v. Hinderlider, 15 N.M. 666, 110 P. 1045 (1910)*. In that case both the defendant Hinderlider and the plaintiffs Young & Norton had filed applications to appropriate the same water from the La Plata River. Both parties wished **[**12]** to construct a storage reservoir for the purpose of irrigating land in San Juan County. The reservoir proposed by Hinderlider was larger and contemplated the irrigation of almost three times the acreage as the Young project. Hinderlider's application was first in time. The Territorial Engineer rejected Hinderlider's application and approved Young's, on the ground that Hinderlider's proposed project was more expensive, that irrigation thereunder would cost more per acre than under the Young project, and that the Young project was more within the available water supply.

Hinderlider appealed to the Board of Water Commissioners which held that the statute authorized the Territorial Engineer to deny the first application and approve the second if he found that the Hinderlider project was contrary to the "public interest," but it construed the "public interest" to encompass only health and safety concerns. The New Mexico Supreme Court also found that the prior appropriation doctrine did not prevent the Territorial Engineer from preferring the later application if the application which was first in time was contrary to the "public interest." [1] The court further found, however, that the **[**13]** "public interest" was not limited to public health or safety concerns but also permitted the Territorial Engineer to protect the public against fraudulent or excessively expensive irrigation projects. *Young, 15 N.M. at 677-680*.

The State Engineer and state courts may consider the conservation and public welfare criteria equivalent to the "public interest" standard in *§ 72-5-7* and construe them accordingly. In light of the *Young* decision, which gives substance in one context to the "public interest" criterion, it cannot be concluded that the conservation and public welfare **[**14]** criteria are on their face meaningless as applied to in-state uses. But, however the criteria are applied to in-state water uses, the statute does not on its face direct the State Engineer to apply them differently to out-of-state uses.

El Paso contends that "the public welfare of the citizens of New Mexico" is an intrinsically discriminatory criterion precluding evenhanded regulation of water usage. **[*700]** This contention rests on the assumption that a state may not decide whether to allow any particular export on the basis of the public welfare of its own citizens.

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[1] The *Young* decision predates the adoption of the New Mexico constitution in 1911. The prior appropriation doctrine, however, has always determined the priority of water rights in New Mexico. The state constitutional provisions and statutes declaring prior appropriation to be the basis and measure of the right to use water were "merely declaratory of the prior existing law." ***Yeo v. Tweedy, 34 N.M. 611, 614, 286 P. 970 (1929)***.

The Supreme Court in *Sporhase* examined a public welfare criterion very similar to New Mexico's. Neb. Rev. Stat. § 46-613.01 (1978). The Court held that a facial examination of the first three conditions of Nebraska's water export statute did not indicate that they impermissibly burdened interstate commerce. 458 U.S. at 957. One of those conditions was that "the withdrawal of the ground water requested . . . is not otherwise detrimental to the public welfare."

El Paso tries to distinguish the Nebraska and New Mexico public welfare criteria on the basis that the Nebraska statute did not limit the public welfare **[**15]** with which it was concerned to that of its own citizens. El Paso argues that the qualifying phrase "of the citizens of New Mexico" is intrinsically discriminatory because it directs the State Engineer to disregard the public welfare of noncitizens. There is no real distinction between the Nebraska public welfare criterion approved by the Supreme Court and the New Mexico public welfare criterion. Although not expressly stated, surely the public welfare the Nebraska statute attempts to protect is that of Nebraska's citizens. The Supreme Court apparently assumed so. The Court's conclusion that a state may, under certain circumstances, give a limited preference to its own citizens in the utilization of scarce water resources would have been unnecessary if the Nebraska statute did not regulate interstate water transfers according to the public welfare of the citizens of Nebraska.

The Court reached that conclusion in the process of applying the test set out in Pike v. Bruce Church, 397 U.S. 137, 142, 25 L. Ed. 2d 174, 90 S. Ct. 844 (1970) to determine the facial validity of the first three conditions of the Nebraska statute. First, the Court found that the Nebraska statute had the **[**16]** legitimate purpose of conservation and preservation of ground water. It then compared the first three conditions imposed on interstate transfers with the restrictions placed on intrastate transfers and found that they might well regulate evenhandedly. The Court went on to declare itself "reluctant to condemn as unreasonable measures taken by a State to conserve and preserve for its own citizens this vital resource in times of severe shortage." The Court then discussed several factors which led to its reluctance and which must be considered in determining whether the burdens on commerce imposed by state ground water regulations are reasonable or unreasonable when weighed against the local interests they advance.

Although the court in *Sporhase* did not delineate the extent to which a state may prefer its own citizens in the utilization of water, it provided some guidelines. ***HN3***[⬆] A state may not limit water exports merely to protect local economic interests. 458 U.S. at 956. This is true even though the health of the state's economy has a direct bearing on the public welfare of its citizens. Baldwin v. Seelig, 294 U.S. 511, 522-523, 79 L. Ed. 1032, 55 S. Ct. 497 (1935); West v. Kansas **[**17]** Natural Gas Co., 221 U.S. 229, 255, 55 L. Ed. 716, 31 S. Ct. 564 (1911). Other than excluding economic interests, however, the Court did not limit the public welfare interests a state may protect by regulating interstate commerce in ground water.

On its face, § 72-12B-1C does not direct the State Engineer to deny applications for exports that would be detrimental only to the economic interests of New Mexico's citizens. "Public welfare" is a broad term including health and safety, recreational, aesthetic, environmental and economic interests. Admittedly, except to the extent that it refers to bare human survival, every aspect of the public welfare has economic overtones. This does not mean that New Mexico may constitutionally exercise a limited preference for its citizens only when their survival is at stake. The Supreme Court in *Sporhase* did not equate "public welfare" with "human survival." However, ***HN4***[⬆] when the State exercises a preference for its citizens under the rubric **[*701]** of protecting their public welfare and economic interests are implicated, the resulting burden on interstate commerce must be weighed against the putative, noneconomic local benefits. Pike **[**18]** , 397 U.S. at 142. If the public welfare criterion is used to effectuate simple economic protectionism, a per se rule of invalidity will be applied. Philadelphia v. New Jersey, 437 U.S. 617, 623-4, 57 L. Ed. 2d 475, 98 S. Ct. 2531 (1978). If it is used to promote a legitimate purpose with only incidental burdens on interstate commerce, the Court must try to accommodate the competing local and national interests. Id. If equally effective, less burdensome alternatives are available, the State must use them. Hughes v. Oklahoma, 441 U.S. 322, 337, 60 L. Ed. 2d 250, 99 S. Ct. 1727 (1979).

HN5[⬆] A state may favor its own citizens in times and places of shortage. Sporhase, 458 U.S. at 956-597. Of course, this does not mean that a state may limit or bar exports simply because it anticipates that one day there will not be enough water to meet all future uses. Even some of the most water-abundant states predict shortages at some future date. The preference envisioned by the Supreme Court must be limited to the times and places where its exercise would not place

unreasonable burdens on interstate commerce relative to the local benefits it produces.

On the other hand, it would be unreasonable **[**19]** to require a state to wait until it is in the midst of a dire shortage before it can prefer its own citizens' use of the available water over out-of-state usage. A limited preference which could not be exercised until water resources were almost depleted would be no preference at all. If the limited preference is to be meaningful the states must be permitted to prefer local usage while there is still water to conserve. The proximity in time of a projected shortage, the certainty that it will occur, its predicted severity, and whether alternative measures could prevent or alleviate the shortage are all factors which must be weighed when balancing the local interests served by the exercise of a preference against the burdens it places on interstate commerce.

New Mexico need not wait until the appropriate time and place of shortage arises to enact a statute limiting exports. The State may enact a law to provide for future contingencies. If facially valid, any constitutional attack on such a statute for violation of the *Commerce Clause* must await its application.

Other ***HN6***[⬆] factors which inform the determination whether a state's preference for its own citizens reasonably or unreasonably **[**20]** burdens interstate commerce are the degree to which the state claims public ownership of ground water and whether the availability of the water is in part the result of the state's conservation efforts. *Sporhase, 458 U.S. at 956-957*. These factors, as with those relating to the extent of shortages and the public welfare interests being protected, cannot be evaluated in a vacuum. Only when the defendants exercise a preference for the citizens of New Mexico can the local benefits from the preference be weighed against the resulting burden on interstate commerce.

El Paso argues that it is not necessary to await application of the statute because the evidence of legislative intent shows that the "public welfare" criterion directs the State Engineer to limit exports in order to minimize in-state shortages for local economic advantage. The City points to definitions of "the public welfare of the state of New Mexico" offered by the defendants and utilized by the court when the embargo statute was under review as evidence that the Legislature intended "public welfare" to include economic interests.

Prior to the passage of S.B. 295 the State Engineer testified, and defendants argued, **[**21]** that the public welfare of the citizens of New Mexico required the conservation and preservation of all available water for in-state use. Defendants maintained that they could retain New Mexico's ground water for any purpose related to the public **[*702]** welfare, including purposes which were predominantly economic. The Court found that this policy was impermissible economic protectionism. If defendants' past construction of the "public welfare" were incorporated into § 72-12B-1C, the statute would constitute an unconstitutional embargo. The Court must reject constructions which render the statute unconstitutional if there are plausible interpretations which avoid constitutional conflicts. 2A D. Sands, Statutes and Statutory Construction, *supra*.

S.B. 295 was obviously passed in direct response to the Court's decision that "the policy of maximizing all 'public welfare' uses of water in New Mexico, and the furthering of that policy by prohibiting interstate commerce in ground water," was unconstitutional. The New Mexico Legislature in S.B. 295 explicitly disavowed defendants' position that the public welfare justified an absolute embargo. Defendants themselves now disavow **[**22]** their former position, arguing that the "public welfare" arguments they advanced when defending the embargo are irrelevant to the meaning of the term as used in S.B. 295. Under these circumstances, it cannot be assumed that the Legislature intended to incorporate the same impermissible economic protectionism into S.B. 295 that made *§ 72-12-19* unconstitutional. The term "public welfare" includes many interests, some of which the State may legitimately advance by regulating water exportation. The statutory use of the term is not forbidden since it can be narrowed by construction in this court, in the state administrative proceedings and in the state courts.

El Paso contends that the "conservation" criterion is also inherently discriminatory. As with the City's attack on the "public welfare" criterion, this too rests on the assumption that New Mexico may not constitutionally regulate ground water withdrawals solely to minimize shortages within the State for the well-being of its citizens. El Paso relies on *West v. Kansas Natural Gas Co., 221 U.S. 229, 55 L. Ed. 716, 31 S. Ct. 564 (1911)* and *Pennsylvania v. West Virginia, 262 U.S. 553, 67 L. Ed. 1117, 43 S. Ct. 658 (1923)*, where **[**23]** Oklahoma and West Virginia statutes, which had as their avowed purpose the "conservation" of natural gas within those states for the present and future use of their citizens, were held unconstitutional. The Court found that this

was only "conservation" in a commercial sense, "-- the business welfare of the state, as coal might be, or timber." *West, 221 U.S. at 255*. The Court found it irrelevant that the states' supplies of natural gas were rapidly waning and were no longer sufficient to supply local needs.

Sporhase carves an exception to this precedent when the states regulate scarce water resources. As discussed above, the Court in *Sporhase* held that ***HN7***[⬆] in the regulation of water a state may exercise a limited preference for its own citizens in times and places of shortage. *458 U.S. at 956-957*. Logically, such a preference can only be implemented by keeping or "conserving" within the state water that would otherwise go out. A state may, therefore, "conserve" water within its borders for the use of its citizens to the same limited extent that it may prefer its citizens in the utilization of the resource.

The Six Factors of § 72-12B-1D

At subsection 72-12B-1D the export **[**24]** statute lists six factors the State Engineer must consider when acting upon any application to export ground water. The statute does not require the State Engineer to consider these factors with regard to in-state uses of ground water. El Paso charges that this is facial discrimination which violates the *Commerce Clause*.

The first four factors require the State Engineer to determine whether there are water shortages within the State which could be alleviated by the intrastate transportation of the water sought for export. There is a legitimate reason for requiring that this determination be made before granting a permit to export water. If the State Engineer is to constitutionally exercise a preference for the citizens of New **[*703]** Mexico in accordance with the precepts enunciated in *Sporhase* he must first determine if there is a shortage within the State. The State Engineer must consider such factors as whether there is a shortage in the area of export or elsewhere in the State, whether it is economically and technologically feasible to transport the water to areas experiencing a shortage, and whether there is an actual intent to transport the water.

The fifth and sixth **[**25]** factors require an evaluation of the export applicant's water supply, the demand placed on that supply and the alternative sources of supply available to the applicant in the state of import. There is also a legitimate reason for requiring consideration of these factors before permitting the exportation of ground water. A state may favor its own citizens in the utilization of scarce water resources "unless the burden imposed on [interstate] commerce is clearly excessive in relation to the putative local benefits." *Pike v. Bruce Church, 397 U.S. at 142*. The local benefits cannot be weighed against the burdens on commerce without knowledge of the export applicant's need for the water relative to that of prospective in-state users.

HN8[⬆] *Commerce Clause* analysis of the State's exercise of a preference for its own citizens in the utilization of scarce water resources is a complex inquiry; it must be made case-by-case. Each of the six factors listed at § 72-12B-1D informs the determination whether the burdens on commerce imposed by state ground water regulation are reasonable or unreasonable. Consequently, it cannot be said that consideration of these factors by the State Engineer when **[**26]** acting upon an application for export impermissibly discriminates against interstate commerce.

Interstate Transfers and Domestic Wells

The conservation and public welfare criteria apply to all interstate uses of ground water -- new appropriations from declared and undeclared basins, new surface water appropriations, transfers of water rights, and supplemental and domestic wells. In-state, the conservation and public welfare criteria apply only to new appropriations from declared basins. El Paso charges that this discriminatory treatment is unjustified and imposes an impermissible burden on interstate commerce.

El Paso has not filed any applications to appropriate surface water or ground water from undeclared basins. [2] Nor does it presently seek a permit for a supplemental well. The City has no standing, therefore, to attack the application of the conservation and public welfare criteria to appropriations from these sources.

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[2] Although El Paso asserts in its latest brief that it owns a surface water right in New Mexico which it intends to use in Texas, the paragraph in the Second Amended and Supplemental Complaint to which the City cites does not explicitly support this claim. The court is unaware of any evidence in the record which does. At this stage in the litigation the court cannot simply assume that El Paso owns a surface water right.

[27]** Plaintiffs do have a personal stake in the determination whether the conservation and public welfare criteria may constitutionally be applied to interstate transfers and domestic wells. The City owns a tract of land which straddles the Texas-New Mexico border and it intends to drill a domestic well in the New Mexico portion for use by a tenant on the Texas portion of the tract. One of the individual plaintiffs has purchased a water right which permits him to divert and use ground water from four existing wells in New Mexico. He intends to transport this water to Texas for use there. Plaintiffs have standing to challenge the application of the conservation and public welfare criteria to their attempts to export water from domestic and transfer wells and this issue is ripe for adjudication.

By requiring the State Engineer to consider the interests of the conservation of water and the public welfare of the citizens of New Mexico when acting on **[*704]** applications to export water from domestic and transfer wells but not when acting on applications for in-state transfers and domestic wells, S.B. 295 discriminates on its face against interstate commerce. Consequently, the statute **[**28]** is subject to the strictest scrutiny. Defendants must show that the disparate treatment of intrastate and interstate transfers and domestic wells serves a legitimate local purpose, that it is narrowly tailored to that purpose and that there are no adequate nondiscriminatory alternatives. *Hughes v. Oklahoma, 441 U.S. at 337*. Defendants have not met this burden.

Under S.B. 295 no permit to transfer a water right or drill a domestic well may be granted if the use of the water is (1) out-of-state and (2) contrary to the conservation of water and public welfare of the citizens of New Mexico. In-state, no permit to transfer a water right or drill a domestic well can be denied on the ground that it would be contrary to the conservation of water or detrimental to the public welfare. These factors are irrelevant with regard to in-state transfers and domestic wells. *N.M. Stat. Ann. § 72-12-1* and *72-12-7* (1978).

There may be circumstances in which the interstate transfer of a water right would be detrimental to the public welfare of the citizens of New Mexico while the intrastate transfer of the same right would not. In such an instance it may not be an unreasonable burden on interstate **[**29]** commerce to deny the interstate transfer but permit the intrastate transfer of the water right. S.B. 295 sweeps too broadly though. The intrastate transfer may also be detrimental to the public welfare yet the State Engineer is powerless to deny it on that ground.

HN9[] While the State may constitutionally regulate water usage to promote the conservation of water and the public welfare of its citizens, it may not require interstate commerce to shoulder the entire burden of furthering those interests. There is no legitimate reason to deny interstate transfers and domestic wells if detrimental to those interests yet permit intrastate transfers and domestic wells when they are detrimental to them. The application of the conservation and public welfare criteria to interstate transfers and domestic wells is not narrowly tailored to effectuate its purpose and it, therefore, impermissibly burdens interstate commerce.

It follows that the State Engineer may not consider the six factors listed at § 72-12B-1D when acting on applications for interstate transfers and domestic wells. These factors are relevant only because they bear on the determination whether the conservation of water and the public **[**30]** welfare of the citizens of New Mexico are affected by a proposed water use and, if they are, whether the State may constitutionally prefer its own citizens in the utilization of the resource. As the State Engineer will be enjoined from considering the conservation or public welfare criteria when acting upon applications for interstate transfers or domestic wells, consideration of the six factors would serve no purpose.

House Bill 12

In the same session that S.B. 295 was passed, the New Mexico legislature passed S.B. 300 which directed the Governor, after consultation with the State Engineer and the Attorney General, to appoint a committee to study the impact on the State's water resources of "recent court decisions concerning water and interstate commerce." The decision holding New Mexico's embargo statute unconstitutional had been entered approximately two months prior to the passage of S.B. 300. The Governor appointed counsel for former defendant Attorney General Bingaman to chair the Committee. S.B. 300 directed the Attorney General and State Engineer to provide staff and support facilities for the Committee, which they did. The Committee's Report was presented to the **[**31]** Governor and the Legislative Council prior to the 1984 legislative session. In his address to the 36th New Mexico Legislature, Second Session, 1984, the Governor asked the Legislature to act upon the following four recommendations made by the Committee: (1) **[*705]** seek Congressional action to allow states to maintain their water resources within their boundaries; (2) seek a compact between Texas and New Mexico to clarify the

division of surface and related ground water of the Rio Grande below Elephant Butte; (3) fund a study of the possibility of appropriating to the State all unappropriated ground water should the "first two proposals fail to protect us;" (4) place a five year moratorium on new ground water permits in the Mesilla Bolson.

The Committee presented as rationale for the recommended moratorium that such a measure would give the State time to develop good hydrological information, to negotiate the recommended compact with Texas, to obtain Congressional authorization of an embargo, and to study the possibility of State entry into the water market. The Report analyses the economic implications for New Mexico of the four recommended actions and concludes that "the principal **[**32]** consequences would be to exclude prospective out-of-state water users, such as El Paso, from access to New Mexico ground water." Following the receipt of the Report, the Legislature enacted H.B. 12.

H.B. 12 stays for two years the granting of new appropriations of ground water hydrologically related to the Rio Grande at or below Elephant Butte, i.e. the Hueco and Mesilla Bolsons. (The complete text of the statute is given at Appendix B.) Actually, the moratorium is of little practical consequence. H.B. 12 does not prevent the State Engineer from proceeding with the consideration of El Paso's applications; all administrative hearings necessary to the granting or denying of the applications may be held. The administrative proceedings could conceivably outlast the moratorium. Unquestionably, if this court's ruling is appealed, the stay will have expired long before there is a final determination of its constitutionality. Nevertheless, the issue is properly presented and must be addressed.

The statute recites that a stay is necessary to ensure competent administration of the subject ground water because (1) there is a deficiency of hydrological information as to the ground water, (2) **[**33]** the pending applications for the water far exceed the supply, and (3) the allocation between New Mexico and Texas of the surface water of the Rio Grande needs further clarification. If bona fide, these would be legitimate purposes. ***HN10***[↑] A statute need not openly disclose "an avowed purpose to discriminate against interstate [commerce]," though, to violate the *Commerce Clause*. *Dean Milk Co. v. City of Madison, 340 U.S. 349, 354, 95 L. Ed. 329, 71 S. Ct. 295 (1951)*. The stated purposes may be feigned, pretextual or illusory. *Foster Fountain Packing Co. v. Haydel, 278 U.S. 1, 10, 49 S. Ct. 1, 73 L. Ed. 147 (1928)*; *Raymond Motor Transportation, Inc. v. Rice, 434 U.S. 429, 449-450, 54 L. Ed. 2d 664, 98 S. Ct. 787 (1978)* (Blackmun, J., concurring). It is the duty of the court to look behind the legislative recitals of purpose to discover the true purpose of a challenged statute.

H.B. 12 states that a "deficiency of hydrological information" hinders or prevents the competent administration of the ground water in the Hueco and Mesilla Bolsons. Defendants point to the ongoing United States Geological Survey ("USGS") study of these bolsons as evidence that there is a deficiency of **[**34]** hydrological information. Unquestionably, there is some uncertainty as to the hydrological characteristics -- the transmissivity and storage coefficient -- of the Mesilla Bolson. The information now available is not exact and, hopefully, the USGS study will much increase the knowledge of the aquifer. The same can be said, however, of a number of other basins throughout the State where no moratorium on new appropriations has been deemed necessary. Annual Report of the State Engineer of New Mexico, June 30, 1983, pp. 20-24. Dozens of permits for new appropriations have been granted in some of these basins in spite of the uncertainty of the hydrological data. *Id, p. 11*.

Furthermore, the State Engineer must utilize some values for transmissivity and **[*706]** the storage coefficient when evaluating the effects of any new well drilled in the Mesilla Bolson. Yet the New Mexico Legislature apparently did not deem the lack of exactitude as to these factors significant enough to halt the drilling of transfer or supplemental wells.

Defendants do not contend that there is insufficient hydrological data as to the Hueco Bolson. From the evidence before the Court, the current USGS study does **[**35]** not appear to involve the Hueco Bolson at all. Thus, this alleged purpose has no relevance to the administration of the Hueco Basin.

Also revealing is the fact that defendants acknowledge that the USGS study will be far from complete by February, 1986. The lack of information which allegedly requires the stay, therefore, will not be available by the time the stay expires. In any event, El Paso is required to establish in the administrative proceedings on its permit applications that there is unappropriated water available in the Hueco and Lower Rio Grande Underground Basins and that no prior rights will be impaired. The State Engineer can address the

sufficiency of El Paso's proof in the light of any significant uncertainty as to the relevant hydrological data.

H.B. 12 states that the stay is necessary because "the amount sought to be appropriated in pending applications far exceeds available supplies." As with the "deficiency of hydrological data," this justification does not apply to the Hueco Basin. Other than El Paso's, there are very few pending applications for appropriations from the Hueco Basin. Defendants do not dispute that the Hueco Basin contains 6.2 million acre feet **[**36]** of appropriable water. The amount of water sought by the pending applications, other than El Paso's, is minimal in comparison, as is the 3300 acre feet of water now being withdrawn annually.

There has been a glut of applications for permits to appropriate ground water from the Mesilla Bolson since El Paso filed its applications. Although the exact amount of recoverable water in the Mesilla Bolson is unknown, the pending applications may exceed the unappropriated supply. The staying of new appropriations to deal with this circumstance, however, is a procedure which circumvents the prior appropriation doctrine on which New Mexico has always relied to determine who has the right to use the water available. Under this doctrine the first applicant in line is not denied a water right simply because there may not be enough water for subsequent applicants. Thus, heretofore, whenever the potential demand threatened to exceed the unappropriated supply of water from any particular source, New Mexico's water laws required the State Engineer to consider applications in the order in which they had been filed, granting permits until there was no more unappropriated water. The only factor that **[**37]** distinguishes the Hueco and Mesilla Bolsons which would explain their special treatment is that El Paso has filed applications for export from those aquifers.

The third reason H.B. 12 gives for the stay is that "the allocation of surface water between the states of New Mexico and Texas needs further clarification." Once again, this has little relevance insofar as it concerns the Hueco Basin. The State Engineer's chief hydrologist testified that the minor effect on the Rio Grande in New Mexico caused by pumping from the Hueco Basin would probably not materially affect the day-to-day administration of that Basin.

In sum, the three concerns listed by the New Mexico Legislature as motivation for the stay are inapplicable to the Hueco Basin; the stay does nothing to ensure the competent administration of that Basin. In its Report the Committee identified only the Mesilla Bolson as "the area of primary interest" for the recommended moratorium. The application of the stay to the Hueco Basin, therefore, is unwarranted. The inclusion of the Hueco Basin within the reach of the moratorium casts doubt on the legitimacy of the Legislature's concerns with regard to the Lower Rio Grande Underground **[**38]** Basin. Again, the one thing the two Basins do have in **[*707]** common is that El Paso has filed applications to appropriate from both of them. Thus, the moratorium statute on its face discloses an impermissible, discriminatory purpose. Consideration of the circumstances surrounding the passage of H.B. 12 only substantiates the conclusion that the true purpose of the statute is to prevent El Paso from obtaining any ground water from New Mexico.

The purpose of blocking interstate commerce in ground water is, of course, a protectionist purpose. Defendants maintain that the moratorium does not offend the *Commerce Clause* because it regulates evenhandedly, i.e., it stays new appropriations for in-state use as well as for export. ***HN11***[↑] A state statute, however, may be invalid because of its protectionist purpose as well as its discriminatory effect. *Minnesota v. Cloverleaf Creamery Co., 449 U.S. 456, 471 n. 15, 101 S. Ct. 715, 66 L. Ed. 2d 659 (1981)*. The balancing test set out in *Pike v. Bruce Church, Inc., 397 U.S. at 142*, presupposes that the statute being tested has a legitimate local purpose. Thus, evenhandedness does not validate an illegitimate purpose.

Moreover, the evenhandedness **[**39]** of the moratorium is only superficial. The Committee analyzed the economic impact on New Mexico of a stay for five and ten years, respectively. It found an adverse economic effect on the state from a five year stay only under one unlikely scenario: all pending applications for the subject ground water are granted except one exceptionally large application for an irrigation water right, the irrigation water rights granted are put to immediate use, and the municipal and industrial rights granted are put to use after ten years. The Committee did not even address the possible economic impacts on New Mexico of a two year moratorium. The Report thus represents that a stay, even for five years, might possibly have no effect on the New Mexico economy while excluding El Paso from access to its ground water while the State pursues more permanent measures.

Even if H.B. 12 were deemed to regulate evenhandedly,

it quite clearly is intended to effectuate an illegitimate local purpose -- the complete blockage of interstate commerce in water. Its effects on interstate commerce are not incidental; they are calculated. The effect on interstate commerce is not minimal but substantial. Further, if the **[**40]** moratorium were not per se invalid because of its illegitimate purpose, it would fall under the *Pike* balancing test because it is not narrowly tailored to apply to basins where the deficiency of hydrological information, excessive demand and uncertainty of the apportionment of related surface water affect the administration of the ground water. H.B. 12 impermissibly burdens interstate commerce in violation of the *Commerce Clause of the United States Constitution* and it cannot be enforced.

Mootness

In the earlier stages of this litigation when *§ 72-12-19* was under consideration, defendants claimed that the Rio Grande Compact and the New Mexico Constitution prevented El Paso from obtaining any ground water in New Mexico. Defendants no longer raise these defenses. They contend, therefore, that the repeal of *§ 72-12-19* and enactment of *§ 72-12B-1* permitting ground water exportation render the Compact and state constitutional issues moot.

A large percentage of the efforts of the parties and the court have been directed towards the Compact and state constitutional issues. The New Mexico Legislature has demonstrated its reluctance to accept the Court's decision that the **[**41]** Compact does not apportion the Rio Grande between Texas and New Mexico below Elephant Butte by citing as a reason for H.B. 12 that "the allocation of surface water between the states of New Mexico and Texas needs further clarification." It is quite possible that defendants would find it expedient to again raise the Compact and state constitutional defenses if the Court did not reenter its rulings on these matters. They should not have to be relitigated between these parties at the trial level. *United States v. **[*708]** W.T. Grant Co., 345 U.S. 629, 97 L. Ed. 1303, 73 S. Ct. 894 (1953)*. The Court will reenter its findings of fact and conclusions of law as to the Rio Grande Compact and state constitutional issues.

Conclusion

In summation, the Court finds that the limitation of water exports to those which are "not contrary to the conservation of water within the state and [are] not otherwise detrimental to the public welfare of the citizens of New Mexico" does not render N.M. Stat. Ann. § 72-12B-1C (Cum. Supp. 1984) facially unconstitutional. The consideration by the State Engineer of the six factors listed at § 72-12B-1D when acting on applications for new appropriations **[**42]** of water to be used outside New Mexico does not violate the *Commerce Clause*. The utilization of the conservation and public welfare criteria and the six factors listed at § 72-1B-1D to evaluate applications for domestic wells and transfers of existing rights where the water is to be used outside the State creates an unconstitutional burden on interstate commerce. H.B. 12 has an illegitimate protectionist purpose and is facially unconstitutional. The Rio Grande Compact and state constitutional issues are not moot and are reaffirmed. The court's findings of fact and conclusions of law relating to the *Commerce Clause* and *N.M. Stat. Ann. § 72-12-19* in the Memorandum Opinion of January 17, 1983 are superseded by the findings and conclusions stated herein.

The parties have made a number of other arguments each of which the court has considered and found to be without merit. A Judgment in accordance with this Opinion will be entered herewith.

APPENDIX A

N.M. Stat. Ann. § 72-12B-1 (Cum. Supp. 1984).

APPLICATIONS FOR THE TRANSPORTATION AND USE OF PUBLIC WATERS OUTSIDE THE STATE.

A. The state of New Mexico has long recognized the importance of the conservation of its public waters **[**43]** and the necessity to maintain adequate water supplies for the state's water requirements. The state of New Mexico also recognizes that under appropriate conditions the out-of-state transportation and use of its public waters is not in conflict with the public welfare of its citizens or the conservation of its waters.

B. Any person, firm or corporation or any other entity intending to withdraw water from any surface or underground water source in the state of New Mexico and transport it for use outside the state shall apply to the state engineer for a permit to do so. The state engineer shall accept for filing and act upon all applications filed under this section in accordance with the provisions of this act. The state engineer shall require notice of the application and shall thereafter

proceed to consider the application in accordance with existing administrative law and procedure governing the appropriation of surface or ground water.

C. In order to approve an application under this act, the state engineer must find that the applicant's withdrawal and transportation of water for use outside the state would not impair existing water rights, is not contrary to the conservation of **[**44]** water within the state and is not otherwise detrimental to the public welfare of the citizens of New Mexico.

D. In acting upon an application under this act, the state engineer shall consider, but not be limited to, the following factors:

(1) the supply of water available to the state of New Mexico;

(2) water demands of the state of New Mexico;

(3) whether there are water shortages within the state of New Mexico;

(4) whether the water that is the subject of the application could feasibly be transported to alleviate water shortages in the state of New Mexico;

(5) the supply and sources of water available to the applicant in the state where the applicant intends to use the water; and

[*709] (6) the demands placed on the applicant's supply in the state where the applicant intends to use the water.

E. By filing an application to withdraw and transport waters for use outside the state, the applicant shall submit to and comply with the laws of the state of New Mexico governing the appropriation and use of water.

F. The state engineer is empowered to condition the permit to insure that the use of water in another state is subject to the same regulations and restrictions that **[**45]** may be imposed upon water use in the state of New Mexico.

G. Upon approval of the application, the applicant shall designate an agent in New Mexico for reception of service of process and other legal notices.

APPENDIX B

House Bill 12, 36th Legislature, 2d Session, 1984 Laws of New Mexico:

RELATING TO WATER; PROHIBITING FOR A CERTAIN PERIOD THE GRANTING OF PERMITS TO APPROPRIATE CERTAIN GROUND WATER; DECLARING AN EMERGENCY.

Section 1. CERTAIN GROUND WATER -- FINDING -- GRANT OF PERMITS -- STAY -- EXCEPTIONS. --

A. The state of New Mexico recognizes that with respect to ground water hydrologically related to the Rio Grande at or below Elephant Butte dam there is a deficiency of hydrologic information, the amount sought to be appropriated in pending applications far exceeds available supplies and the allocation of surface water between the states of New Mexico and Texas needs further clarification.

B. In the interest of ensuring competent administration of the ground water hydrologically related to the Rio Grande at or below Elephant Butte dam, a stay is declared on the granting of permits with respect to all pending and future applications to appropriate unappropriated **[**46]** ground water from aquifers hydrologically related to the Rio Grande at or below Elephant Butte dam. The stay shall be for a period of two years commencing on the effective date of this act.

C. Nothing in this section shall preclude the granting of permits:

(1) to appropriate unappropriated ground water for public health emergencies;

(2) to appropriate unappropriated ground water for domestic, stock water and other uses pursuant to *Section 72-12-1 NMSA 1978*; or

(3) to replace or change the location of existing wells.

Section 2. EMERGENCY. -- It is necessary for the public peace, health and safety that this act take effect immediately.

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1. *In re Applications of El Paso, 887 F.2d 1103*
   Client/Matter: Texas/RG

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In re Applications of El Paso

United States Court of Appeals for the District of Columbia Circuit

September 22, 1989, Argued ; October 20, 1989, Decided

No. 88-5357

Reporter
887 F.2d 1103 *; 1989 U.S. App. LEXIS 15897 **; 281 U.S. App. D.C. 112; 15 Fed. R. Serv. 3d (Callaghan) 22

IN THE MATTER OF THE APPLICATIONS OF THE CITY OF EL PASO, TEXAS, Nos. HU 12 THROUGH HU 71 AND LRG 92 THROUGH LRG 357, TO APPROPRIATE GROUND WATER FROM THE HUECO AND LOWER RIO GRANDE UNDERGROUND WATER BASINS. CITY OF EL PASO, APPELLANT v. S. E. REYNOLDS, STATE ENGINEER, et al.

Prior History: [1]** Appeal from the United States District Court for the District of Columbia, Misc. No. 88-00284.

Core Terms

district court, subpoenas, deposition, discovery, moot, constitutional question, pending appeal, issuance, requires, reasons, recusal, aides

Counsel: Richard D. Milvenan with whom P. M. Schenkkan, Neil W. Imus and Benjamin Phillips were on the brief, for Appellant.

Michael Davidson, Senate Legal Counsel, with whom Ken U. Benjamin, Jr., Deputy Senate Legal Counsel, and Morgan J. Frankel, Assistant Senate Legal Counsel, were on the brief, for Appellees, Senator Jeff Bingaman, et al.

Judges: Wald, Chief Judge, Buckley and Sentelle, Circuit Judges.

Opinion by: PER CURIAM

Opinion

[*1104] Opinion for the Court filed PER CURIAM:

This is an appeal from an order of the United States District Court for the District of Columbia quashing subpoenas issued at the request of the City of El Paso, Texas ("El Paso" or "the city") to a United States Senator and three of his legislative aides (collectively "appellees"). The District Court based its order on constitutional grounds. Because subsequent events rendered the matter moot during the pendency of this appeal, we will not reach the constitutional question, but will for the reasons more fully set out below affirm the District Court, vacating the decision of the constitutional question **[**2]** on mootness grounds.

I. BACKGROUND

El Paso has long been involved in a controversy with the state of New Mexico over the city's desire to withdraw groundwater from that state for use in the state of Texas. *See generally,* ***City of El Paso v. Reynolds, 563 F. Supp. 379 (D.N.M. 1983)***; *City of El Paso v. Reynolds, 597 F. Supp. 694 (D.N.M. 1984)*. In the round of litigation giving rise to the immediate controversy, El Paso applied to the New Mexico State Engineer for permits to make withdrawals from two New Mexico aquifers. After extended discovery and hearings, the State Engineer denied all of El Paso's applications. The city appealed the State Engineer's decision to New Mexico State District Court. When every judge in the District Court having venue over the controversy either voluntarily recused or otherwise became ineligible to

hear the case, the Chief Justice of the New Mexico Supreme Court designated Judge Manuel D. V. Saucedo to preside on June 6, 1988.

El Paso moved for change of venue and for recusal of the designated judge, assigning several reasons for his disqualification. Among its reasons, El Paso assigned Judge Saucedo's former employment **[**3]** in the office of United States Senator Jeff Bingaman of New Mexico. El Paso asserts, and it appears to be undisputed, that Senator Bingaman, as a Senator and formerly as Attorney General of the state of New Mexico, had been actively involved on New Mexico's side of the groundwater controversy.

On September 6, 1988, prior to Judge Saucedo's ruling on the Motion for Recusal, El Paso caused the issuance in the District of Columbia of deposition subpoenas for Senator Bingaman and three of his legislative aides. El Paso sought to depose the four on their knowledge of Judge Saucedo's knowledge of, and involvement in, the groundwater controversy. On September 12, 1988, the Senator and his aides filed a Motion for Protective Order seeking to quash the subpoenas. On September 15, 1988, the District Court quashed the subpoenas on the ground that the *Speech or Debate Clause of the United States Constitution, art. I, § 6, cl. 1*, prohibited this discovery of the Senator and his staff. On October 27, 1988, El Paso filed its Notice of Appeal from the order. The next day, October 28, Judge Saucedo denied El Paso's recusal motion. On March 2, 1989, during the pendency of the present appeal, Judge **[**4]** Saucedo dismissed El Paso's action in the New Mexico State District Court. El Paso appealed that decision in the state courts of New Mexico. The New Mexico appeal is currently pending.

II. ANALYSIS

In seeking to subpoena evidence by way of discovery deposition for use in proceedings in New Mexico, the City of El **[*1105]** Paso invoked *section 14-103 of the District of Columbia Code*. [1]

[5]** Upon receipt of the subpoenas, all prospective deponents moved the District Court for protective orders. All sought to have the District Court quash the subpoenas as violative of the Constitution of the United States, more particularly as inquiring into matters privileged from discovery under the *Speech or Debate Clause, U.S. Const., art. I, § 6, cl. 1*. After hearing argument, the District Court decided the constitutional question in favor of appellees and granted quashal of all four subpoenas. In due course, El Paso appealed.

In reviewing the decision of the District Court, we find that a resolution of the constitutional question is no longer necessary in the light of subsequent events. The statute under which the depositions were issued, *D.C. Code Ann. § 14-103*, specifies that "the testimony may be taken by leave of a judge of the United States District Court *in like manner and with like effect* as other depositions are taken in the United States district courts." (emphasis added). In District Court the "manner" and "effect" of taking and using "other depositions" is governed by Rules 26-*32*, *34*, and *37 of the Federal Rules of Civil Procedure*. At the time of the District **[**6]** Court hearing, a trial court proceeding was ongoing in the controversy in which El Paso sought the subpoenas, and the District Court quite properly looked to the provisions of Rule 26(c), governing the issuance of protective orders. The Court therefore explored the merits of the deponents' claim of constitutional privilege.

However, as we noted in Part I, *supra*, much has happened since the District Court's inquiry. Now, there is no longer a trial proceeding in aid of which a subpoena for discovery deposition may issue. It is that sort of subpoena that appellants pursued in the District Court. In the case of a discovery deposition, under the Federal Rules, "the attendance of witnesses may be compelled by subpoena as provided in *Rule 45*." *Fed.R.Civ.P. 30(a)*. The procedural requirements for the issuance of such a subpoena and the taking of such a deposition are quite simple. "Proof of service of a notice to take a deposition as provided in *Rules 30(b)* and *31(a)* constitutes a sufficient authorization for the issuance . . . of subpoenas for the persons named or described therein." *Fed.R.Civ.P. 45(d)(1)*. Now, however, the trial proceeding in which the discovery depositions were sought **[**7]** is on appeal. Depositions pending appeal are governed not by Rules 26, 30, and 45, but by *Rule 27*, titled "Depositions Before Action or

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[1] That statute in its entirety reads as follows:

> When a commission is issued or notice given to take the testimony of a witness found within the District of Columbia, to be used in an action pending in a court of a State, territory, commonwealth, possession, or place under the jurisdiction of the United States, the testimony may be taken by leave of a judge of the United States District Court in like manner and with like effect as other depositions are taken in United States district courts, or by leave of a judge of the Superior Court of the District of Columbia in the manner prescribed by the rules of that court.

Pending Appeal." Rule 27(b), "Pending Appeal," provides a deposition procedure, but only by leave of the trial court, and only for the purpose of perpetuating "testimony for use in the event of further proceedings. . . ." Subpoenas for deposition pending appeal are allowable only upon motion and a showing of, *inter alia*, "the substance of the testimony which [the movant] expects to elicit from each," of the witnesses and "the reasons for perpetuating their testimony." Fed.R.Civ.P. 27(b). Unlike the more or less automatic issuance of discovery deposition subpoenas pending trial, this rule requires a real showing of the need for the preservation of the evidence and a finding by the District Court that "the perpetuation of testimony pending appeal . . . is 'proper to avoid a failure or delay of justice.'" Lombard's, Inc. v. Prince Mfg., Inc., 753 F.2d 974, 976 (11th Cir. 1985) (quoting Fed.R.Civ.P. 27).

Appellants have made no such motion, alleged no such need, offered no such showing, and obviously there has been no occasion **[**8]** for the District Court to make any such finding or enter such order. The procedural propriety of the discovery subpoenas **[*1106]** before the District Court was evident at the time of the proceedings under review. At that point, the District Court was properly confronted with the constitutional question. We are not. The availability of discovery subpoenas of the Senator and his aides is now moot. There is no pending trial in which such discovery can be used. Granted, the question was not a moot one when the District Court confronted it. But, we must view the question of mootness as of the time the case is before this Court, not the District Court.

> Article III of the Constitution requires that there be a live case or controversy at the time that a federal court decides the case; it is not enough that there may have been a live case or controversy when the case was decided by the court whose judgment we are reviewing.

Burke v. Barnes, 479 U.S. 361, 363, 93 L. Ed. 2d 732, 107 S. Ct. 734 (1987). The constitutional validity of subpoenas now procedurally void presents no live case or controversy.

If El Paso still wishes to pursue the information **[**9]** in the hands of the Senator and his aides, then the only route available in the District Court is by compliance with Rule 27, and it is available only if the threshold requirements of that rule are met. We have no way of knowing whether El Paso even purports to be able to make such a showing or what the District Court's decision would be if they do. In short, that question simply is not before us.

The customary disposition of a case that has become moot on appeal requires that the judgment under review be vacated. United States v. Munsingwear, Inc., 340 U.S. 36, 39, 95 L. Ed. 36, 71 S. Ct. 104 (1950). "This disposition strip[s] the decision below of its binding effect." Deakins v. Monaghan, 484 U.S. 193, 200, 108 S. Ct. 523, 528, 98 L. Ed. 2d 529 (1988). Additionally, in an action commenced by the filing of a complaint, we would normally remand the case with direction to dismiss the complaint as moot. Munsingwear, 340 U.S. at 39. In the proceedings before the district judge in the present case, there was of course no complaint but only the subpoenas. Therefore, while we affirm the quashal of the subpoenas, we do so on grounds **[**10]** of mootness while directing that the decision be vacated insofar as it determines the constitutional question.

In reaching this conclusion, we are instructed by the oft-repeated adage that a "most fundamental principle of constitutional adjudication is not to face constitutional questions but to avoid them, if at all possible." United States v. Lovett, 328 U.S. 303, 320, 90 L. Ed. 1252, 66 S. Ct. 1073 (1946) (Frankfurter, J., concurring). In the present case, we would further note, while not necessary to our decision, that El Paso has contributed to the occurrence of mootness on appeal. Though the United States District Court granted the Motion for Protective Order on September 15, El Paso did not note its appeal until October 27. Even then, though Judge Saucedo denied El Paso's recusal motion on October 28, and did not dismiss the underlying action until March 2, 1989, El Paso never, either between September 15 and October 28 or between October 28 and March 2 of 1989, moved for expeditious consideration. While we do not normally favor such motions, Rule 7(h)(2) of the Rules of this Court provides for such a request by way of "Emergency Motion," and one might well **[**11]** have been filed in this case assigning as grounds the status of the underlying New Mexico action. We will not, of course, express in the abstract what our ruling would have been had such motion been filed, but the failure to pursue that possibility certainly blunts any complaint of injustice El Paso might have with our present ruling.

III. CONCLUSION

For the reasons set forth above, we determine that the issues giving rise to this appeal are now moot. We therefore affirm the quashal of the subpoenas, but remand this proceeding to the District Court for vacation

of its decision insofar as it determined the constitutional question.

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO-TEXAS

WATER ANNOUNCEMENT
August 1, 1951

Project storage today of 132,400 acre-feet, 52,500 acre-feet in Elephant Butte and 79,900 acre-feet in Caballo reservoirs, is the lowest since storage began in 1915. Average storage for this date is 1,161,900 acre-feet. Inflow during July was zero. Total inflow for the year to date of 81,300 acre-feet is only 9.3 per cent of the average for the period since 1895, and is the lowest since 1904.

Side inflow, or bank storage return to the reservoirs has not been of sufficient volume during July to consider an increase in the present allotment of 1.75 acre-feet per acre to water-right lands of the Project. In the event of sufficient inflow of any kind to the reservoirs that will permit an increase, immediate announcement will be made. Unless rainstorms occur which will substitute for irrigation on the Project or result in flood inflow to the reservoirs, present indications are that the reservoirs will be emptied early in September.

Water users who have pumps of good capacity that will supply their needs are requested to arrange for transfer of a part of their unused allotment water to those who are in need of additional water. If you are willing to negotiate a transfer, contact the Irrigation District office in Las Cruces, or El Paso, or the Project division offices of the Bureau of Reclamation at Las Cruces, or Ysleta.

L. R. Fiock
Project Manager

TX_MSJ_005897
EBID000467

STATEMENT ISSUED BY THE BOARD OF DIRECTORS OF THE ELEPHANT BUTTE IRRIGATION DISTRICT IN REGARD TO THE 1952 WATER SITUATION

January 11, 1952

The Board of Directors of the Elephant Butte Irrigation District wishes to bring to the attention of water users in the District several matters of importance in connection with the 1952 water supply situation.

In spite of favorable snow reports there remains a critical situation with reference to water for cotton planting. Spring runoff from melted snow ordinarily occurs too late for a satisfactory cotton planting irrigation. The amount of reservoir water available for cotton planting will depend entirely upon inflow between now and planting time. Such inflow cannot be accurately predicted.

The Board urges all irrigation well owners who are in a position to do so to agree to transfer all, or part, of such reservoir water as they may receive to tracts that do not have wells. If there is insufficient water in the reservoirs at cotton planting time this will be the only way in which it will be possible for all land to be planted, except by the transfer of pumped water.

The Board recommends that owners of farms that do not have irrigation wells begin making arrangements to obtain reservoir water, or pumped water, in sufficient amount to assure a planting irrigation. Even though it is too early to determine exactly how much reservoir water will be on hand at planting time, commitments to transfer part, or all, of such water as may be available should be obtained.

Spring runoff from snow, which ordinarily begins some time in May, depends upon melting conditions as well as upon the quantity of snow on the watershed. While snow reports are very encouraging at the present time, it is well to bear in mind that it is water in the reservoir, and not snow in the mountains, that really counts.

The Elephant Butte Irrigation District will again serve as a clearing house for the transfer of water from one owner to another during 1952. All water users who expect to have water for sale early in the season and who do not find buyers in their own communities are urged to list such water with the District so that it can be transferred.

Elephant Butte Irrigation District
Las Cruces, New Mexico

TX MSJ 005898
EBID000469

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO-TEXAS

Water Announcement
March 7, 1952

Project storage today is 108,600 acre-feet, of which 15,000 acre-feet must be retained in Elephant Butte Reservoir under Federal Court injunction.

It has been decided in consultation with the Elephant Butte Irrigation District, and the El Paso County Water Improvement District No. 1 to make a tentative allotment of 2.5 inches of water per acre to Rio Grande Project water-right lands. This allotment is based on the probable availability of about 100,000 acre-feet of storage water during the early spring irrigation period March-April. This volume of water, supplemented by anticipated return flow and the operation of private irrigation wells, should provide a satisfactory planting irrigation.

Water will be released from Caballo Reservoir on or a few days before March 20.

It is expected that the storage water available, plus the anticipated return flow, will be sufficient for a period of thirty-five days from the date of release. No guarantee of delivery after the thirty-five day period can be given at this time.

The uncertainty of return flow, river operations, and pumping during the early period of release may require further consideration of the allotment at the end of seven to fourteen days after the initial release. Should inflow during the thirty-five days of the tentative allotment be in appreciable volume, immediate consideration will be given any possible change in the allotment and announced as quickly as possible.

Every precaution will be observed in operations to hold losses to a minimum, and strict control as to volume of release and river operations will be required. Water users are solicited to use all possible means to hold delivery and conveyance losses to a minimum, and to carefully watch the size of their irrigation heads so that rapid farm irrigation can be effected. Those desiring water during the period are requested to place their orders with ditchriders as far in advance of desired delivery date as possible, as normal delivery after receipt of order may not be possible due to necessary strict operation control.

Only one delivery to flat rate, or owners of two acres and under, of water-right land will be made during the thirty-five-day period following the release from storage. Community ditch officials will be advised of the dates when water will be available in their ditches. Community areas are requested not to use water if their moisture condition from recent rains is good.

Water users who intend to use their pumps for all or a part of their planting requirement and are willing to transfer their allotment to other water-right lands should contact the Elephant Butte Irrigation District, or the Bureau of Reclamation in Las Cruces, and the El Paso County Water Improvement District in El Paso, or the Bureau of Reclamation office in Ysleta.

L.R. Fiock
Project Manager

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO-TEXAS

WATER ANNOUNCEMENT
April 7, 1952

Total Project storage today is 84,200 acre-feet of which 15,000 acre-feet is under Federal Court injunction. Storage the same day last year was 376,000 acre-feet; while average storage for this period of the year is about 1,100,000 acre-feet.

The inflow as estimated at the head of Elephant Butte reservoir for the months of January, February, and March has been about 66 per cent of the average for the period since 1895.

Spring inflow from melting snow has not yet developed in large volume, but the inflow of approximately 19,000 acre-feet since the gates were opened on March 20 plus that portion of the flow in the Rio Grande between Otowi Bridge and San Marcial that may reach the reservoir permits an increase in the allotment at this time. While the inflow is still disappointing, the small increase in allotment that can be made now should be of considerable benefit.

It has been decided in agreement with the Elephant Butte Irrigation District and the El Paso County Water Improvement District No. 1 that effective immediately the allotment is increased to a total of 0.35 acre-foot per acre of Project water-right lands; while this increase is slightly more than one and one-half inches, it remains below the average required of 0.73 acre-foot per acre for the first irrigation. The increase in allotment at this time does not guarantee that the water can be carried in the reservoir until summer; the spring inflow will of necessity determine what later allotments may be and what will be in storage for release during the summer months.

Water users with satisfactory irrigation wells are urged to transfer their allotment to those not having access to water from wells.

Announcement of increase in allotment will be made as rapidly as inflow to Elephant Butte reservoir will permit.

L. R. Fiock
Project Manager

TX MSJ 005900
EBID000473

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO-TEXAS

WATER ANNOUNCEMENT
March 1, 1954

Project storage today is 185,200 acre-feet. Storage today is about 17.5 per cent of the average for this date since storage began in 1915. On the same date last year storage was 470,600 acre-feet.

While the March 1 Snow Survey Report is not yet available, there has been nothing during the month of February to indicate a reversal of the drought weather pattern, with the result that it is quite likely the March 1 report will reflect conditions still below normal and the probable runoff, based on the March 1 condition, to be below average. A major change in the weather pattern is necessary during the period March to mid-May to produce appreciable runoff by July 1. Inflow to Elephant Butte during the winter months has been below average. Return flows to the river from the Project drainage system is exceptionally low, resulting in the flow of the Rio Grande at El Paso being the lowest since 1912.

It was decided in a meeting today with the Elephant Butte Irrigation District, and the El Paso County Water Improvement District No. 1 that the current low storage permits an allotment to the water-right repayment lands of the Project at this time of only 5 inches per acre. Any increase in the allotment will be dependent upon inflow to Elephant Butte reservoir, the possibility of which cannot be estimated at this time. Deliveries after July 1 are dependent on inflow of sufficient volume to maintain distribution system requirements.

It was also decided in the meeting that the gates at Caballo Reservoir will be opened on March 20, for the beginning of the 1954 irrigation season.

Deliveries to owners of two acres or under of water-right land will receive water once during the 45-day period following the opening of the gates on March 20. Deliveries to the community ditch localities will be made under schedules which are now being prepared. The schedules for the community ditch areas will be available shortly, and the ditchriders in the community areas will be able to advise as to the dates water deliveries will be made in these areas.

The outlook for water supply for the Project this year is discouraging; and unless greater than normal precipitation occurs between now and mid-May, the Project will experience the most severe water shortage during the current drought. Water users are urged to carefully plan their operations so that maximum benefit may be obtained from the minimum water available.

Farmers with good irrigation wells are requested to use them to the greatest extent possible as a source of supply and to make available for transfer their allotment water to those farmers who do not have satisfactory wells. Arrangements for such transfer may be made with the Elephant Butte Irrigation District office in Las Cruces, the Rio Grande Project division office in Las Cruces, the office of the El Paso County Water Improvement District No. 1 in El Paso, and the Rio Grande Project division office at Ysleta, Texas

W. F. Resch
Project Manager

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EBID000476

ELEPHANT BUTTE IRRIGATION DISTRICT
P. O. DRAWER 391
LAS CRUCES, NEW MEXICO

13

NAREMORA N. GUNAJI

January 4, 1962

Mr. Frank Brorilow
Department of Engineering
New Mexico State University
University Park, New Mexico

Dear Frank:

Mr. Naren Gunaji has furnished this District with copies of the final draft of a report on "Ground Water Conditions in Elephant Butte Irrigation District," dated November, 1961.

I have reviewed the report and wish to accept it on behalf of this District. The preparation of this report was admittedly a rather difficult assignment, inasmuch as it required the assimilation of a substantial amount of data drawn from numerous sources, together with considerable other information pertaining to the subject; and its analysis and presentation in a form that could be grasped by non-technical, as well as technical, readers. At the same time, it is recognized that the data and other information available were not sufficiently comprehensive to support detailed and final conclusions regarding all phases of the ground water situation in this District. I feel that Mr. Gunaji handled the assignment well and that he has made what will prove to be a valuable contribution to the study of ground water conditions and problems in this area. One of the valuable features of the report is that it brought up to date, and summarized within one volume, the essential features of the ground water situation in this District. The report also introduced such new conclusions on the subject as could be justified by available data and other information and, at the same time, pointed out that some of the conclusions drawn by previous writers on the subject of ground water conditions in this area have not been borne out by subsequent experience. The report places us in a position to proceed with more extensive studies at such time in the future as the District may feel that they are advisable and necessary.

On behalf of this District, I wish to express our appreciation to Mr. Gunaji for his work on the report and for his more than routine interest in the matter. We also wish to express our appreciation to your Department for its willingness for undertake the project that culminated in Mr. Gunaji's report.

Very truly yours

John L. Gregg
Treasurer-Manager

jg

cc-Mr. Naren Gunaji
Mr. John Clark

TX_MSJ_005902

NARENDRA N. GUNAJI

GROUND WATER CONDITIONS

IN

ELEPHANT BUTTE IRRIGATION DISTRICT

By

Narendra N. Gunaji
Civil Engineering Department

Engineering Experiment Station
New Mexico State University
University Park, New Mexico

November 1961

TX_MSJ_005903

TABLE OF CONTENT

	PAGE
Acknowledgment	1
Introduction	2
Location and Extent of the Area	4
Purpose and Scope of Investigations	4
Previous Investigations	5
Geology of the Area	10
Santa Fe Formation in the Elephant Butte Irrigation District	11
Principles of Ground Water Occurrence	12
Fluctuations of the Water Table	14
Seasonal Fluctuations	14
Long Term Fluctuations	15
Ground Water Reservoir and Its Characteristics	17
Return Flow of Drains in the Elephant Butte Irrigation District.	25
Quantity of Ground Water Available in Storage in the Elephant Butte Irrigation District	27
Quality of Ground Water in the Elephant Butte Irrigation District	31
Ground Water Observations at the Picacho Bridge	33
Summary and Conclusions	35
Recommendations for Future Ground Water Investigation in the Elephant Butte Irrigation District	38
Bibliography	42
Appendix	43

TX_MSJ_005904

ACKNOWLEDGMENT

I take this opportunity to express my profound appreciation to Mr. John L. Gregg, Treasurer-Manager of the Elephant Butte Irrigation District, who, from his excellent knowledge of the area under study, made many helpful criticisms and suggestions in the course of this investigation.

Appreciation is also expressed to Mr. Bruce A. Tschantz, who assisted in making field observations in test wells in the Picacho Bridge area.

In addition, I wish to acknowledge the financial assistance rendered by the Elephant Butte Irrigation District that made this study possible by the Engineering Experiment Station of New Mexico State University.

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GROUND WATER

IN

ELEPHANT BUTTE IRRIGATION DISTRICT

Introduction

Early irrigation development in the Elephant Butte Irrigation District was almost exclusively based on the use of surface water. However, during the recent period of insufficient surface water supply in the Rio Grande Basin, from 1951 to mid-1957, irrigation was dependent to a considerable extent on the available supply of ground water in the Elephant Butte Irrigation District.

During the above period of insufficient surface water supply, the coordinated use of surface and ground water for irrigation was practiced in the District. Ground water was extensively used to supplement a deficient surface water supply. The substantial quantity of ground water pumped without completely dewatering the aquifer is evidence of the large storage capacity of the ground water basin. There is little doubt that the future of the highly developed agricultural economy in the Elephant Butte Irrigation District is dependent upon the use of ground water as a supplemental supply when shortage of surface water occurs.

The Elephant Butte Irrigation District is located in the New Mexico portion of the Rio Grande Project, a Bureau of Reclamation project located in south central New Mexico and West Texas. The District contains a gross area of 112,500 acres, including 10,400 acres of right of way. Of this gross area, 90,600 acres have first class water rights, and 11,500 acres do not have water rights. The Elephant Butte Irrigation District is the water users' organization, formed for the purpose of cooperating with the United States Government in connection with the

United States Government in connection with the construction, operation, and maintenance of the project.

Water supply problems in the Elephant Butte Irrigation District originate principally from occasional prolonged droughts in the upper Rio Grande Basin of Colorado and New Mexico. These problems are becoming more acute because of the failure of the Rio Grande Compact to operate effectively in assuring the delivery of that portion of river flow to which the irrigated area below Elephant Butte Dam is entitled.

The effects of shortages in the surface water supply upon the Elephant Butte Irrigation District are shown in Table I by the fluctuation in the allotments of surface water available for delivery to the land during the last eleven years.

TABLE I

SURFACE WATER ALLOTMENTS
TO
ELEPHANT BUTTE IRRIGATION DISTRICT

Year	Allotment in Acre Feet Per Acre For Water Right Land in the District
1951	1.75
1952	2.75
1953	1.90
1954	0.50
1955	0.417
1956	0.392
1957	1.17
1958	4.00
1959	3.50
1960	3.25
1961	2.45

The normal use of water per acre ranges from 3.25 to 3.50 acre feet per acre delivered to first class water right land. As a result of the shortage in surface water allotments, ground water was extensively pumped from 1951 to 1957, in order to satisfy irrigation requirements. The pumping of ground water resulted in the lowering of the water table

in the District to a moderate extent. It also created interest regarding the source, extent, quality, and outflow of the ground water in the area.

Location and the Extent of the Area

The area covered by this report includes the Rincon and Mesilla Valleys in New Mexico and Mesilla Valley, Texas.

The Rincon and Mesilla Valleys, in the south central part of New Mexico, are two of the many widened parts of the Rio Grande Valley which are separated by narrows and canyons in the eroded channel. The Rincon Valley lies north of the Mesilla Valley in Sierra and Dona Ana Counties in New Mexico, while the Mesilla Valley is in Dona Ana County, New Mexico and El Paso County, Texas. Geographically, the Mesilla Valley is located in two different states. However, hydrologically, Mesilla Valley, New Mexico and Mesilla Valley, Texas are parts of the same hydrologic zone and ground water basin.

Purpose and Scope of the Investigations

Until 1951, irrigation with ground water was a minor factor in the Elephant Butte Irrigation District. Because of drought conditions several years following 1950, subnormal surface water supply made it necessary for individuals to drill about 1,200 irrigation wells in the District. These wells furnished a substantial portion of the total irrigation water supply. It was because of these wells that the agricultural economy in the District has been able to survive under drought conditions.

The normal water table was originally about eight feet below the surface of the ground. The extensive use of ground water during the period from 1951 to 1957, lowered the water table by approximately eight feet throughout the District. When the drought terminated in mid-1957

the average ground water level in observation wells was recorded at approximately sixteen feet below the surface of the ground. When the surface water supply returned to normal in 1958, pumping was discontinued and the water table returned to an elevation about two feet below the normal water table within a period of two years. This rapid recovery of the ground water table indicated that the principal water bearing strata are close to the ground surface and that it is highly permeable.

Since the quantity of ground water in the District is not definitely known, one purpose of this investigation is to attempt to determine the extent to which ground water resources can be developed without changing the storage and constants of the aquifer, and without seriously depleting ground water resources. It is believed that the water bearing strata extends outward underneath the adjoining mesas. Depths at which ground water is available below these wells currently used are not known. It is probable that ground water may be found below the depths from which water is now obtained. Available information concerning ground water is limited, incomplete, and uncoordinated.

Another purpose of this investigation is to study available information on ground water in the area and attempt to arrive at logical conclusions regarding the status of ground water problems in the area. These conclusions should be modified as more reliable data become available.

Previous Investigations

The earliest information available on ground water observations in the District was compiled by Slichter[1] in 1905. He reported the following:

1. The underflow of the Rio Grande at El Paso Gorge located north of the downtown business section of El Paso did not exceed 50 gallons per minute.

2. The gradient of the water table across the Mesilla Valley was determined during the investigation and changes in the gradient were caused by flows in the Rio Grande.

3. The principal source of recharge to ground water was the river, but a small amount, estimated at 0.515 cubic feet per second per mile, was derived from adjoining mesas.

4. Specific capacities of 12 test wells varied from a minimum of 6.00 gallons per minute to a maximum of 88.00 gallons per minute per foot of drawdown.

Lee[2] investigated ground water resources in the Rio Grande Valley in New Mexico and their development in 1907. Lee's conclusions were:

1. Ground water was probably discharged by evaporation.

2. Underground flow from La Mesa was in the direction of the Rio Grande rather than away from the river.

3. Underground water was found at approximately river level.

4. The water table changed elevation, to some extent, according to changes in the volume of water in the river.

Dunham[3] made an investigation in 1935 of the geology of the Organ Mountains, located east of the Rio Grande valley, and briefly noted ground water occurence in some mines.

The Rio Grande Joint Investigation, which was proposed in 1938 by the National Resources Committee[4] contains only a brief reference to ground water conditions in the Elephant Butte Irrigation District.

Conover[5] investigated ground water conditions in the Elephant Butte Irrigation District and adjacent areas of New Mexico in 1946. A summary of his finding is as follows:

1. Ground water in the valley fill originated mainly from

surface water; that is, seepage from canals and the river and excess water applied to irrigated lands. A portion also originated from adjoining mesa areas, and from precipitation upon the valley floor.

2. The quality of shallow ground water in the alluvium of the Rincon and Mesilla Valleys was slightly below that of drain water, but was satisfactory for most irrigation requirements. Dissolved solids generally decreased with the increased depty of wells except in a few areas in the lower end of the Mesilla Valley and in Selden Canyon, located immediately above the Mesilla Valley. Comparatively good quality water was obtained in surrounding mesa areas and arroyo beds.

3. Wells yielding sufficient water for irrigation could be developed throughout the major portion of the valley floors of the Rincon and Mesilla Valleys, with the probable exception of the Selden Canyon area and the southern end of the Mesilla Valley. Sanding of wells has occurred and special well construction might be necessary to avoid damage to wells.

4. Irrigation wells, generally of small capacity, can be developed in the arroyos and on the low bench land adjoining the valley areas. However, many wells in these areas may not produce a sufficient volume of water for irrigation.

5. Pumping of ground water will divert water from the drains and the river. The drains may practically stop flowing by the end of the summer in the first year of low surface water supply if enough wells are drilled and operated to furnish an adequate water supply for all lands.

6. If a greater proportion of reservior water were made available to the lower end of the Rio Grande project below El Paso, as compensation for reduction in flow of the drains caused by pumping in the Rincon

and Mesilla Valleys, a corresponding reduction in the diversion of reservior water above El Paso would be necessary.

7. Since no unused ground water recharge escapes from the project, and there is very little unused ground water discharge, only a small amount of water could be salvaged in the Rio Grande Project over a period of years by pumping in the Elephant Butte Irrigation District.

8. Assuming that the lower portion of the Rio Grande Project continues to receive released water in the same proportion to reservoir releases as in the past years, pumping of ground water would not result in additional water for the Elephant Butte Irrigation District and Mesilla Valley, Texas. On a year-to-year basis, if the amount of pumping exceeds the amount of the diverted drain flow, the excess water would come from ground water storage.

9. On a long-term basis, nearly all water removed from ground water storage must be replaced before the flow of the drains returns to normal.

10. With surface water supply available for diversion equal to 50 per cent of normal, about 70 per cent of the land in the District probably could be irrigated by careful use and control of surface water.

11. During a year in which the normal supply of surface water was deficient by 50 per cent, an additional acre-foot per acre would be needed to adequately irrigate water right land in New Mexico. To supply this deficit for 88,000 acres by pumping from wells would, because of distribution losses and reduction of flow of drains caused by pumping, require pumping 213,000 acre feet per year, assuming that the El Paso division receives its accustomed proportion of reservoir water.

12. Since pumping of ground water to supplement a deficient surface water supply would, in effect, save crops on 30 per cent of the

land that could not be irrigated by surface water in a year of 50 per cent of normal surface water supply, such pumping would result in an additional gross crop return of $15,800,000 over a five year period on the basis of the average annual gross crop return from 1937-1946, of $120 per acre.

13. The total number of wells required in a year of 50 per cent gravity supply is estimated to be about 220. The total cost, based on 1946 prices, would be about $3,190,000 on the basis of five year depreciation period, or $3,536,900 for an eight year depreciation period including all charges. These costs amount to approximately one-fifth of the estimated additional gross crop values realized over a five year period.

14. Estimated total cost per acre-foot of water pumped would be about $3.00, or about $7.25 per irrigated acre per year for the District.

15. Pumping of ground water on individual farms, in a year of deficient surface water supply, will ultimately reduce the water supply of the Rio Grande Project. If such a reduction were borne by the Elephant Butte Irrigation District and Mesilla Valley, Texas, it would be necessary to reduce deliveries of surface water to farms with wells in those areas in order to maintain proper deliveries to farms without wells.

16. The pumping of ground water for winter irrigation on the Rio Grande Project would effect a saving of water because transportation losses incurred in connection with winter releases are disproportionately large for the acreage irrigated.

17. About 15,000 acres of undeveloped and suspended land could be irrigated with ground water. Water pumped on these lands would, in a few years, reduce water available to existing irrigated lands by an

amount equal to consumptive use on suspended lands.

18. As pumping of ground water will affect the water supply of the project, especially in years of deficient surface water supply, continuous records should be kept on the volume of water pumped, water level measurements, and the location and performance of irrigation wells.

Geology of the Area

Available information indicates the unconsolidated and partly consolidated sediments of Tertiary and later ages underlie the Elephant Butte Irrigation District. The deposit consists of varying proportions of clay, silt, sand, and gravel that fill the deep rock trough between the mountains on each side of the valley. This deposit is most commonly known as the Santa Fe formation.

The oldest rock of the region is of Precambrian Age overlaid by Cambrian and Ordovician strata. Throughout the geologic period, subsequent to their formation, these rocks have been resistant to erosion and have formed highlands.

Dunham has recognized four erosion surfaces of the Lower Rio Grande Basin in New Mexico of which the Elephant Butte Irrigation District forms an integral part. These erosion surfaces are as follows:

1. The uppermost erosion surface - 700 feet above the present Rio Grande, represented by a small area of Sierra De Las Uvas west of Robledo Peak and the upper end of the Mesilla Valley.

2. The Jornada-La-Mesa surface - about 350 feet above the river and extending from San Marcial, New Mexico through Journada del Muerto and southward across La Mesa into Mexico.

3. The Picacho surface - 100 feet above the river and well developed around the base of Picacho Peak.

4. The present Rio Grande River plain.

Santa Fe Formation in the Elephant Butte Irrigation District

The Santa Fe formation is the most important and most extensive deposit in the Rio Grande depression of the Mesilla and Rincon Valleys. It conformably overlies earlier geological formations in the Rio Grande depression along its borders, but it has been removed by erosion from areas which have been deformed during, or since, the deposition of its sediments. The Santa Fe formation varies abruptly in lateral and vertical directions from coarse conglomerate and gravel to sand, silt, and clay. The gravel and sand strata are usually tan in color and commonly contain a large amount of interstitial silt. The silt and clay beds are usually reddish brown in color. The thickness of the formation is probably very extensive, although its only exposures are short sections in arroyo walls and its tributaries. Dunham reported the approximate depth of the Santa Fe formation as 4,000 (±) feet. However, in the Middle Rio Grande Valley the depth of the Santa Fe formation is reported as 4,800 feet.

The Santa Fe formation has been deformed by faulting and broad warping. Quaternary pediment gravel and alluvium unconformably overlie the various units of the Santa Fe formation and obscure much of the depression as well as stratography. Exhumed, interbedded flows of andesite and basalt interrupt the generally smooth pediments in some places. In places where erosion has been severe along the major drainage lines, the gravel has been stripped off and the wind has worked the sandier phase of the Santa Fe formation where the gravel has been removed. The general nature of the Santa Fe formation reveals that it may once have covered the entire area. Certainly the area was covered with pediment material, the remains of which are still present as caps on hills and ridges in the area. The residual materials which rest upon the pediments are included in the Santa Fe formation because it is not always possible to differentiate the sediments of the Santa Fe formation.

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These features are genetically a part of the formation in that they represent relatively quiescent stages following the sequence of deformation and sedimentation characteristics of the Santa Fe formation.

Principles of Ground Water Occurrence

The occurrence of water in the ground and its movement are governed by definite geological and physical principles. In order for water to occur in the ground, there must be spaces in the soil or alluvium for it to occupy. In origin these spaces can be primary, secondary, or both. Primary interstices, or pores, the more important type in this area, are the spaces between the particles of the Santa Fe formation. These spaces exist because the particles usually are not fitted together perfectly or cemented by geological processes which formed this strata. All types of interstices may be modified by geological processes which act after the original formation of interstices. Deposition of fine materials or precipitation of minerals from solution by ground water may reduce the size of the interstices; solution and removal of material may enlarge the pores.

The relative volume of pores determine how much water is contained in a given volume of alluvium. Permeable, uncemented alluvium, consisting of rounded particles, theoretically may possess as much as 43 per cent water. Clay and coarse grained sediment composed of irregular shaped particles may have higher porosities; however, the porosity of these sediments experienced in the field is between 10 to 25 per cent.

Nearly all ground water that can be used by man is in a state of motion. In order for water to move the pores must be interconnected; they also must be of a size large enough to permit the motion. Therefore, the size of the pores is one of the factors that influence the rate of flow of ground water. Not all water contained in the pores is free to

drain out by gravity. Some of it is retained in the smaller pores by capillary action. This water is called Specific Retention. The water that will drain out by gravity is called Specific Yield. Ground water flows through the permeable strata according to a simple law developed by Darcy[6] which states that the rate of flow is proportional to the hydraulic gradient, or the ratio of vertical fall to the length of the path taken by the water.

The level to which the ground is saturated with water is known as the ground water table or simply the water table. Above this level, the pores of soil are filled with air and water and part of the water may be moving downward to the water table. This water is normally derived from precipitation that falls directly on the surface or from seepage from streams. Therefore, the form of the water table in a uniform aquifer is in equilibrium with the rates of recharge, storage, and discharge. Difference in permeability in the aquifer affects the equilibrium and therefore changes the form of the water table.

Under natural conditions, the amount of water recharged to the ground and flowing underground is in dynamic equilibrium with the amount of water discharged from the aquifer. Therefore, the slope of the water table is an expression of this equilibrium and the water bearing characteristics of the aquifer. An increase in recharge must be accompanied by a rise in the water table, which in turn causes an increase in the rate of movement of the ground water under the increased head. Wells constitute artificial discharge that disturbs the natural equilibrium by withdrawing water from storage. This lowers the water table in the vicinity of the well, and the flow rate of water towards the well is increased. As the area over which the water table is lowered is increased, the water is diverted from its natural course, eventually reducing its natural discharge.

The valley fill is the principal aquifer in the Elephant Butte Irrigation District and is composed mostly of sediments of the Santa Fe group. Ground water in the valley fill is generally under water table conditions, but local artesian conditions and perched water table conditions may exist owing to the confinement of saturated gravel, or sand beds, between beds of silt and clay.

Fluctuations of the Water Table

The water table fluctuates as water is added to, or withdrawn from, the ground water reservoir. Water level fluctuation may be of two kinds: (1) seasonal and (2) long term. Heavy precipitation and irrigation with surface water diverted from streams tends to raise the water table, and drought and pumping will lower the water table.

The investigation of water table fluctuations in the District is based mainly on periodic water level measurements made by the Bureau of Reclamation in 39 observation wells in the Mesilla Valley. It should be noted that these wells are not distributed in such a manner as to give good coverage of the area. Therefore, the water levels obtained are not qualitiative; however, the observations give some idea regarding the nature of fluctuations of the water table. To get a true picture of how the water table fluctuates, these data should be supplemented by other wells on which the data might be secured.

Seasonal Fluctuations

Seasonal fluctuations of the ground water table in the District are such that the water levels are highest in the summer and lowest in the winter. Summer high water levels are characteristic of the area where land is irrigated by water diverted from the Rio Grande. Water levels in the irrigated areas are usually highest during the summer, immediately after the irrigation season, and lowest in the early spring before the

first application of irrigation water. Between irrigation seasons, water levels decline slowly as accumulated ground water moves through the water bearing material towards the river and drains.

Long Term Fluctuations

Long term fluctuations in the water table are shown by changes in water level elevation in the observation wells over a period of years. These fluctuations can be tied to specific causes. The decline in the water table in the Elephant Butte Irrigation District during the period 1951 to 1957, was due to the effects of prolonged surface water shortage accompanied by withdrawal of ground water by pumping. Long time fluctuations of ground water levels have definite effects on the flow of drains. Conover predicted that, as soon as heavy pumping began, flow in the drains would diminish; and, in the case of a 50 per cent deficient supply over a five year period, about eight or nine years would be required before the flow of drains would return to normal. Actual recovery from the effects of the drought of the 1950's has shown this prediction to be inaccurate. The maximum decline in the ground water table occurred in 1957, when it reached 16.75 feet below ground surface or 8.75 feet below the normal ground water levels. By 1958, the surface water supply had returned to normal and there was little pumping in the area. During the summer of 1958, the ground water table, as measured by observation wells, reached a high point of 9.75 feet below the ground surface. This indicates that flow of the drains recovered much earlier than was predicted in the Conover report. Long time fluctuations of the ground water table; its decline during the period of drought; and its quick recovery upon the return of surface water supply to normal, indicate the recharge capacity of the aquifer. (See Figure 1) These observations also indicate that there may be several sources of recharge in addition to surface water and seepage of excess irrigation water.

Ground Water Reservoir and Its Characteristics

The ground water reservoir exists in nature and its capacity is set by nature. Therefore, its capacity is unknown and cannot be determined easily. As pumping of ground water increases, the ground water reservoir is depleted and its safe yield becomes a most important consideration. One of the factors that determines safe yield is the capacity of the reservoir but, as stated above, it cannot be measured directly. However, during the period of development of ground water resources, data are accumulated concerning return flow, canal loss, precipitation, evaporation, consumptive use, change in water table elevation, annual pumping draft, stream flow, etc. All of these factors may not be applicable to each ground water basin, but from those that are applicable, when properly assembled and interpreted, it may be possible to determine safe yield without knowing the capacity of the aquifer.

"Safe yield" can be defined as the amount of water that can be withdrawn from ground water storage annually without producing undesired results. Undesired results include:

1. Exceeding the average annual recharge.
2. Lowering the ground water table so that a pumping lift is not economical.
3. Lowering the water table to the extent that intrusion of water of undesirable quality is permitted.
4. Interfering with the prior rights of others in an adjacent ground water basin.

In any hydrologic system, disposal must equal supply. This is fundamental to all physical processes. The supply of water to a unit, or reach, of a stream system is the surface flow and underflow into the unit and the precipitation falling on the unit. Final disposal is by

surface flow, or underflow, or both; by evaporation; or by artificial withdrawal. If final disposal is temporarily out of balance with the supply, storage in the reach of the stream changes.

Over a term of years the natural escape of ground water from a unit balances the natural supply to the unit. The amount that escapes at any particular time is governed by the elevation of the water table. When pumping is begun, the new additional draft causes the water table to lower and the natural outflow may decrease. At the same time, the lowered water table may induce greater supply because of greater percolation opportunity.

In the case of an underground reservoir, given a set of conditions which comply with the hydrologic equation, safe yield and other desired information can be determined. There are three variables involved: supply, draft, and change in the water table elevation. The requirement is that the variables should have minimum deviation from average values.

Several techniques have been used to correlate average changes in water levels with (1) discharge from the ground water reservoir; (2) recharge to the reservoir; and (3) the difference between recharge and discharge. If the discharge from ground water can be considered to be the yearly pumpage, then the change in the water levels can be correlated with pumpage. The approach is to determine graphically the draft that will cause no change in the average water level. Table II shows the estimated quantity of ground water pumped. The change in water levels is shown in Table III.

Figure 2 shows the average change in water level compared with the average annual draft. In an ideal basin these points would lie on a straight line. However, in actual cases, the points do not lie on a straight line. Therefore, a line is fitted to make the deviation from that line a minimum. This line intersects the line of zero change of

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TABLE II

ESTIMATED QUANTITY OF GROUND WATER PUMPED
IN E.B.I.D. DURING 1951-1960

(1) YEAR	(2) Acres IRRIGATED	(3) NORMAL WATER ALLOTMENT REQUIRED ACRE FT/ACRE	(4) ACTUAL WATER ALLOTMENT ACRE FT/ACRE	(5) NORMAL QUANTITY OF WATER REQUIRED FOR IRRIGATION ACRE FEET COL. 2 X COL. 3	(6) ACTUAL QUANTITY OF WATER SUPPLIED BY SURFACE WATER ACRE FEET COL. 2 X COL. 4	(7) ESTIMATED GROUND WATER PUMPED FOR IRRIGATION ACRE FEET COL. 5 - COL. 6
1951	101,065	3.5	1.75	353,727	176,863	176,864
1952	102,412	3.5	2.50	358,442	257,054	101,388
1953	103,741	3.5	1.90	363,093	198,145	164,940
1954	95,374	3.5	0.5	333,909	47,687	286,122
1955	95,666	3.5	.417	334,831	39,892	294,939
1956	90,060	3.5	.392	318,391	35,659	282,732
1957	91,739	3.5	1.17	321,086	107,334	213,752
1958	92,918	3.5	4.0	325,213	371,672	No Significant Pumping
1959	93,912	3.5	3.5	328,692	328,692	No Significant Pumping
1960	93,630	3.5	3.25	327.705	304,297	No Significant Pumping

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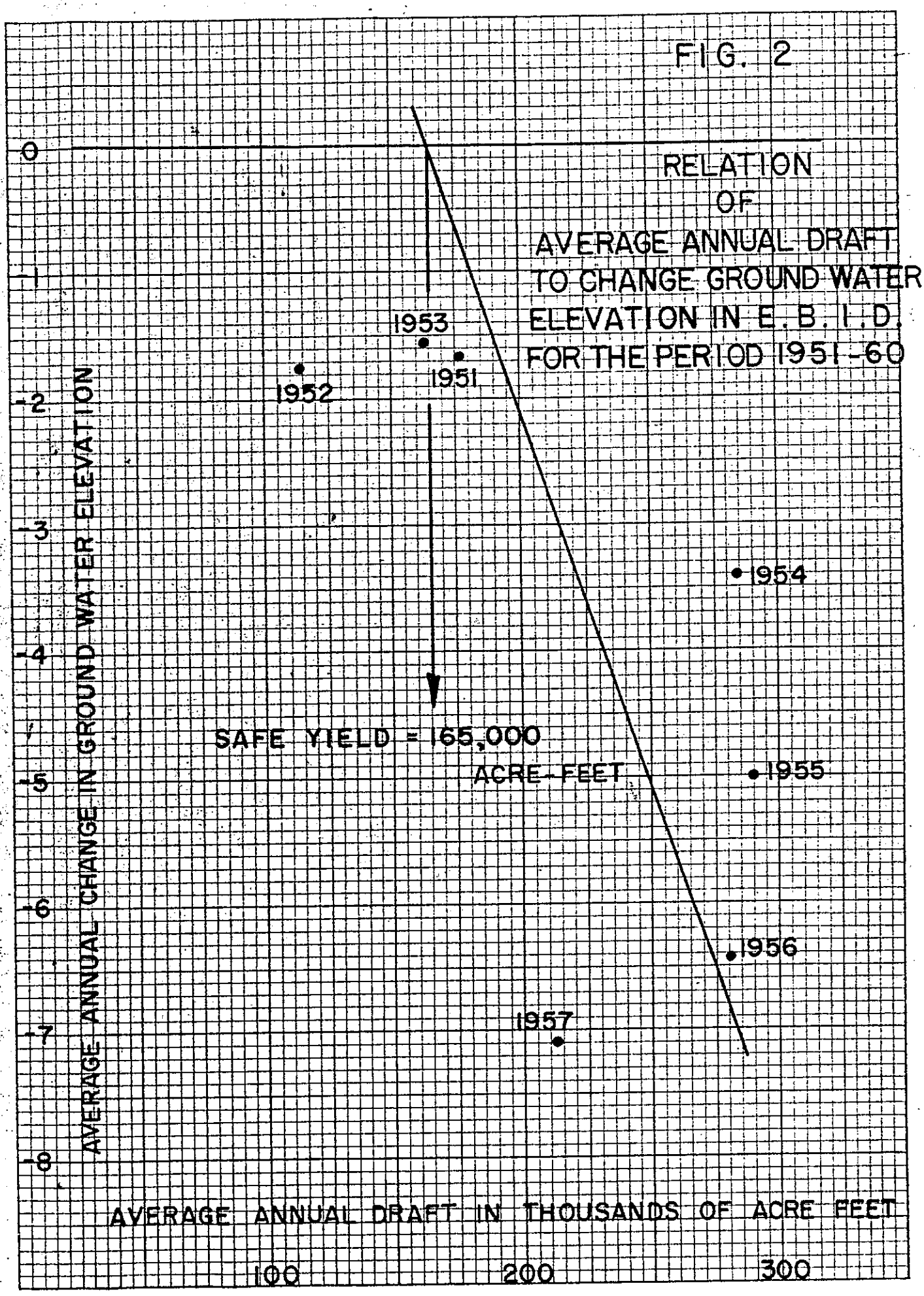
TABLE XII

ESTIMATED QUANTITY OF GROUND WATER PUMPED AND CHANGES IN WATER LEVEL FOR THE PERIOD 1951-1960 IN E.B.I.D.

YEAR	ESTIMATED QUANTITY OF GROUND WATER PUMPED IN ACRE FEET	AVERAGE CHANGE IN WATER LEVEL IN FEET DURING THE YEAR
1951	176,864	-1.65
1952	101,388	-1.75
1953	164,948	-1.55
1954	286,122	-3.40
1955	294,939	-5.00
1956	282,732	-6.40
1957	213,752	-7.05
1958	No Significant Pumping	-3.05
1959	No Significant Pumping	-1.55
1960	No Significant Pumping	-1.20



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the water table at a point where the annual draft is 165,000 acre feet, which is the safe yield. This indicates that if 165,000 acre feet of ground water are pumped annually, there may not be any significant change in the ground water table

The safe yield of the ground water basin may also be calculated by graphical correlation of the annual change in the water table and the net surface water contributions to the basin. The general approach is to determine the required net surface water contribution to the basin to maintain a constant ground water level.

The surface water supply to the Elephant Butte Irrigation District is provided by the Rio Grande and is augmented, when deficient, by pumping from wells. The computed net surface water supply contribution used in this analysis is the sum of all measurable sources of inflow, less all measurable or estimable items of outflow. The inflow to the Elephant Butte Irrigation District can be obtained from the records of Caballo Dam releases and the outflow from the District can be computed from the discharge records at the El Paso station. Subsurface inflow and outflow are believed to be of such minor amounts as to have no effect of the analysis or, at least, the difference between the two is assumed to be insignificant. Table IV shows the estimated quantity of net surface water contributions to the Elephant Butte Irrigation District and changes in ground water levels. For each season, the net surface water contribution to the District in acre feet per acre is plotted against the seasonal change in ground water elevation, in feet, as shown in Figure 3. A straight line is fitted to produce minimum deviations from that line.

Table IV shows the average area irrigated in the Elephant Butte Irrigation District during the 10-year period, 1951 to 1960. This average area is about 96,142 acres, which includes the Elephant Butte Irrigation District and Mesilla Valley, Texas, and the maximum variation

TABLE IV

ESTIMATED QUANTITY OF WATER RETAINED IN THE ELEPHANT BUTTE IRRIGATION DISTRICT FOR THE PERIOD 1951-1960 WITH AVERAGE ANNUAL CHANGES IN WATER TABLE

(1) YEAR	(2) CABALLO RELEASES IN ACRE FEET	(3) DISCHARGES AT EL PASO STATION IN ACRE FEET	(4) NET SURFACE WATER CONTRIBUTION TO EBID IN ACRE FEET COL.2 - COL. 3	(5) AREA IRRIGATED IN ACRES	(6) NET SURFACE WATER CONTRIBUTION PER ACRE IN ACRE FEET/ACRE COL. 4 ÷ COL. 5	AVERAGE CHANGE IN WATER LEVEL IN FEET
1951	469,450	252,000	217,450	101,065	2.15	-1.65
1952	543,975	283,680	260,295	102,412	2.54	-1.75
1953	528,628	264,500	264,128	103,741	2.55	-1.55
1954	244,165	93,725	150,440	95,375	1.58	-3.40
1955	219,157	67,089	152,068	95,666	1.59	-5.00
1956	246,140	57,481	188,659	90,969	2.07	-6.40
1957	397,103	139,571	257,532	91,739	2.80	-7.05
1958	737,125	392,863	344,362	92,918	3.70	-3.05
1959	687,414	385,810	301,604	93,912	3.20	-1.55
1960	705,162	377,350	327,812	93,630	3.50	-1.20
		AVE.	246,496	AVE. 96,142	AVE. 2.56	AVE. -3.26

NOTE:

1. Caballo Releases are obtained from U.S.B.R. through Elephant Butte Irrigation District
2. Discharges at the El Paso Station are obtained from the International Boundary and Water Commission through the Elephant Butte Irrigation District.
3. The area irrigated includes the Elephant Butte Irrigation District and Mesilla Valley, Texas.

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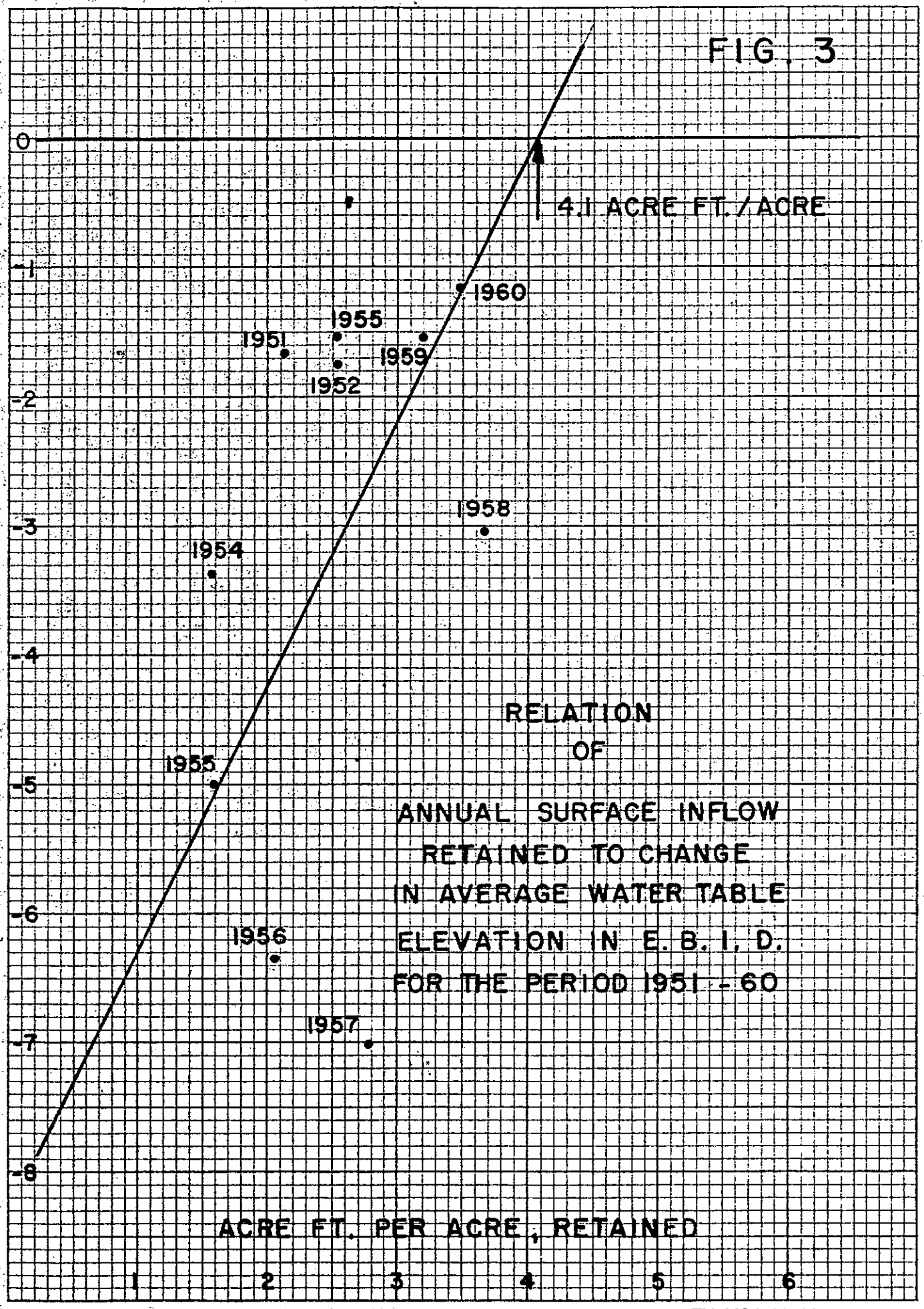

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from the average is about 7 per cent. The net annual average surface water contribution to the area was 246,496 acre feet, or 2.56 acre feet per acre irrigated. This is the average annual recharge and, therefore, the permissiblesustained yield for the 10-year period. With this average surface water contribution, however, the ground water level would have declined about 3.26 feet. See Table IV.

For zero change in ground water level, the graph in Figure 3 indicates that net surface water contribution to the basin should be 4.10 acre feet per acre per season or per year. If 4.10 acre feet per acre had been the net surface water contribution, the water table would have remained at constant elevation. Hence, 4.10 acre feet per acre, plus or minus any difference between subsurface inflow and outflow is the net water supply requirement for the area; a total of 4.10 x 96,142 acre feet for the 96,142 acres in the Elephant Butte Irrigation District and Mesilla Valley, Texas. Therefore, the average annual overdraft on the ground water of the unit for the last 10-year period is (4.10 x 96,142) - 246,946 = 147,636 acre feet.

Precipitation was not considered in the calculation because it was assumed in the above analysis that, in this area, a negligible amount would reach the ground water table.

This method is subject to error due to annual variation in irrigated acreage and actual consumptive use of crops, although multiplying the change in ground water elevation by the ratio of the gross investigation area to the seasonal irrigated acreage will reduce the magnitude of the error. This method of analysis is often more reliable when variation in the irrigated acreage is small and the percentage of land irrigated is high.

Return Flow of Drains in the Elephant Butte Irrigation District

To maintain the water table at a safe level below crop root zones, 236 miles of drains have been constructed in the Elephant Butte

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Irrigation District. Since surface water supplies for agricultural use in the District are limited, return flow of drains must be fully utilized wherever possible to supplement reservoir releases.

It is reported that the annual flow of drains in the Rincon Valley averages about 45 per cent of the average annual net diversion in the Rincon Valley. Average annual flow of drains in the Mesilla Valley is reported to be about 52 per cent of net diversion under normal water supply conditions.

Major factors that influence the flow of drains are as follows:

1. Consumptive Use - or the quantity of water per year in acre feet per acre of cropped land, absorbed by the crop and transpired or used directly in the building of plant tissues, together with that evaporated from the area.
2. Farm Water Use Efficiency - expressed as the ratio of the water consumptively used on the farms to that applied.
3. Conveyance Losses - water loss from the point of diversion to the point of delivery.
4. Operational Waste - these include releases to wasteways resulting from maintaining canal flows to meet fluctuating deliveries; overflows due to obstructions or leakage past gates and other structures.
5. Precipitation - as it affects irrigation requirements.
6. Depth to Water Table - to ascertain ground water conditions as loss of return flow within a basin may be of a temporary nature, due to storage in the underground reservoir.
7. Stream Flow Measurements - to provide accurate data on water available at selected points of diversions and a determination of river conveyance losses.

8. Time Requirement in Accrual of Return Flow for Re-Use - which entails determination of the rate of surface and underground flow governed by slope gradient, hydraulic gradient, the distance of travel and the permeability of the subsoil and substrata materials.

It is difficult to ascertain and to separate the individual effects of the above factors on the quantity of return flow of drains. A general relationship among surface water supplies, ground water elevations, and the volume of return flow of drains can be expected. However, from year to year this relationship will change.

Conover stated that the pumping of ground water will divert water from the drains and the River. Furthermore, he stated that the drains would practically stop flowing by the end of summer in the first dry year if enough pumps were installed to provide an adequate supplemental irrigation supply. He believed that on a long term basis nearly all water removed from storage must be replaced before the flow of drains will return to normal.

However, the drought during the years 1951 to 1957, provided results that differed somewhat from Conover's conclusions. Extensive pumping took place in the Elephant Butte Irrigation District during that period. Table V shows the estimated annual volumes of ground water pumped, and return flow of drains along with the fluctuations of the ground water table during the period from 1950 to 1960 inclusive. It shows that drain flow was probably diminished in proportion to changes in surface water allotments. Table V also indicates that the recovery of drain return flow was faster than anticipated by Conover.

Quantity of Ground Water Available in Storage in Elephant Butte Irrigation District.

In determining the quantity of water available in a ground

TABLE V

REPORTED RETURN FLOW OF DRAINS AND ESTIMATED QUANTITY OF GROUND WATER PUMPED AND GROUND WATER FLUCTUATIONS

YEAR	ESTIMATED GROUND WATER PUMPED IN E.B.I.D. IN ACRE FEET	RETURN FLOW OF DRAINS IN ACRE FEET		AVERAGE CHANGE IN GROUND WATER TABLE IN FEET*
		RINCON VALLEY	MESILLA VALLEY	MESILLA VALLEY
1950	No significant pumping	33,103	220,322	Nil
1951	176,864	16,530	125,750	-1.65
1952	101,388	16,040	87,380	-1.75
1953	164,948	12,890	86,010	-1.55
1954	286,122	4,120	32,730	-3.40
1955	294,939	1,750	9,700	-5.00
1956	282,732	646	4,560	-6.50
1957	213,752	1,089	8,071	-7.05
1958	No Significant pumping	9,960	64,431	-3.05
1959	No Significant pumping	25,270	125,320	-1.55
1960	No Significant pumping	26,900	164,790	-1.20

* NOTE: Normal water table in the District was approximately 3 feet below the surface of the ground for the period of 25 years, from 1924 to 1950.

water reservoir, the rate of recharge, amount of water in storage, and permeability of the aquifer must be considered. If water is removed from the reservoir faster than it is replenished, water levels will decline, eventually reaching a level at which it will no longer be economical to pump water from wells. However, if the reservoir is large and has considerable storage capacity, a long period may elapse before the water level becomes so low that it is necessary to seek other sources of supply.

It is evident that ground water was removed from storage during the drought period from 1951 to 1957, and that the ground water reservoir was depleted in the Elephant Butte Irrigation District. The rate of this depletion was chiefly dependent upon the rate of recharge. The life of the reservoir is limited by the amount and availability of the ground water in storage. The data available are not yet sufficient to determine these quantities accurately and only a preliminary estimate can be made. It is hoped that collection of data in the Elephant Butte Irrigation District may continue until accurate estimates of the amount and availability of ground water can be made.

In the Mesilla Valley, the extent of the ground water basin, and the zone of influence of pumping from the basin, are not known. The effective area can be approximated by assuming a reasonable value for average specific yield. Conover reported that specific yield for the Mesilla and Rincon Valleys is believed to be in the neighborhood of 25 per cent, and this value is used in the following calculation.

Ground water pumped in the Mesilla Valley during the period from 1951 to 1960 was estimated to be 1,253,380 acre feet. River losses during the same period in the Mesilla Valley were reported to be 472,086 acre feet in a study made by New Mexico State University on conveyance losses of the Rio Grande. Therefore, the ground water

pumped from storage is approximately 1,258,380 - 472,086 = 786,294 acre feet. During the same period the ground water level was lowered approximately eight feet below the normal ground water level elevation. Therefore, the following equation can be written:

Area of zone influence in acres multiplied by the decline in ground water table in feet = $\frac{\text{Estimated Quantity of ground water pumped from storage}}{\text{Specific Yield}}$

$$(\text{Area of Zone Influence}) \times 8 = \frac{786,294}{0.25}$$

Therefore:

$$(\text{Area of Zone Influence}) = \frac{786,294}{.25 \times 8} = 393,147 \text{ acres}$$

Assume that in case of extreme drought, the ground water would be lowered 25 feet below the normal ground water level. Therefore, the volume of soil drained is 393,147 x 25 = 9,828,675 acre feet. The factor 0.25 represents specific yield. The estimated quantity of ground water available in Mesilla Valley before the water level drops to 25 feet below the normal ground water is 2,457,143 acre feet. It is anticipated that it will take about 20 years to lower the ground water level 25 feet below the normal ground water level.

Similar calculations are made for the Rincon Valley. They are as follows:

$$(\text{Area of Zone Influence}) = \frac{262,360}{8 \times 0.25} = 131,180 \text{ acres}$$

Assuming that ground water would be lowered 25 feet in case of extreme drought, the volume of soil drained is 131,180 x 25, which equals 3,279,500 acre feet. Therefore the water released from storage is 3,279,500 x 0.25 = 819,875 acre feet. The estimated quantity of ground water available in the Rincon Valley before the water table drops to 25 feet below the normal ground water level is 819,875 acre feet. It is also anticipated that it will take about 20 years to lower the ground water level 25 feet below the normal ground water level.

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Quality of Ground Water in the Elephant Butte Irrigation District

In recent years it has been recognized that the quality of ground water is as important as quantity. As greater development and use of ground water continues, along with reuse of water, quality suffers unless methods are developed to maintain quality. The quality required of a ground water supply depends upon its purpose; thus, quality requirements for drinking water, industrial water, and irrigation water vary widely. To establish quality criteria, measures of chemical, physical, and bacterial constituents must be specified. Recommended limits of water quality can then be determined, serving as a guide for proper protection and development of the ground water basin.

Salts are added to ground water passing through soils by soluble products of soil weathering and of erosion by rainfall and flowing water. Excess irrigation water percolating to the water table may contribute a substantial amount of salt. Water passing through the root zones of cultivated areas usually contains saline concentrations several times that of applied irrigation water. In addition, soluble soil materials, fertilizers, and selective absorption of salts by plants will modify the salt concentration of percolating waters. Other factors governing increases in salinity include soil permeability, drainage facilities, quantity of water applied, crops, and climate. High salinities are found in soils and ground water of arid regions where leaching by rain water is not effective in diluting salt content.

The suitability of ground water for irrigation is contingent upon the effects of mineral constituents of the water on both plants and soils. Salts may harm plant growth physically by limiting the intake of water through modification of osmotic processes; or chemically, by metabolic reactions such as those caused by toxic constituents.

The effect of salts on soil cause changes in soil structure, permeability, and aeration, and indirectly affect plant growth. Specific limits of permissible salt concentrations for irrigation water cannot be stated because of wide variations in salinity tolerance among different plants; however, field plot studies of crops grown on soils that are artificially adjusted to various salinity levels provide valuable information relating to salt tolerance.

An important factor allied to the relation of crop growth to water quality is drainage. If a soil is open and well drained, crops may be grown on it by the application of large volumes of saline water; but, on the other hand, a poorly drained area in which good quality water is used may fail to produce satisfactory crops. Poor drainage causes salt concentration in the root zone to build up to toxic proportions.

In place of rigid limits of salinity for irrigation water, quality is commonly expressed by relative suitability. The suitability of saline water for irrigation water is based on measurements of electrical conductivity, sodium content, and boron concentration. Sodium concentration is important in classifying irrigation water because sodium reacts with the soil to reduce its permeability.

Analysis of ground water from 30 wells and 2 springs in the Rincon and Mesilla Valleys was reported by the Quality of Water Branch of the U.S. Geological Survey. Study of the data reveals that dissolved solids in the ground water in the Elephant Butte Irrigation District average about 1000 ppm with about 40 to 50 per cent sodium. According to the relative suitability of irrigation water this can be classified as "good to permissible". The quality of ground water varies according to depth and deeper wells yield better quality water. However, in the

lower end of the Mesilla Valley, quality of water becomes poor with depth. Generally, good quality water can be obtained at the upper end of the District. The quality of water obtained by wells in the Santa Fe formation flanking the valleys is generally of good quality, and is potable, with dissolved solids of about 500 to 700 ppm. In some locations concentration of fluoride is found which is higher than the safe limit of 1.5 ppm. Wells drilled in arroyo beds yielded superior quality water which has less than 300 ppm of dissolved solids, less than 200 ppm hardness, and only minor traces of fluorides. Side inflow from bordering mesas in the Mesilla Valley produces comparatively good quality water.

Ground Water Observations at Picacho Bridge

During the course of the River Loss Studies made by the Civil Engineering Department of New Mexico State University[7], 15 test wells were driven in the vicinity of the Highway 80 Picacho Bridge before the 1960 irrigation season. The locations of these wells are shown in Figure 4. These wells were originally driven to collect information concerning the ground water table adjacent to the river bed and to study the nature of seepage losses or gains in the vicinity of Picacho Bridge. The data on these wells are shown in the appendix along with the charts of average monthly ground water table profiles in the north, south, and northwest lines as observed during the irrigation season of 1961.

Study of data on these wells reveals the following information. The position of the water table relative to river stage and to ground surface determines relative seepage rates and how soon seepage may appear in the adjoining drains. Seepage to the water table from a short duration flood stage in the river may not affect surface conditions and

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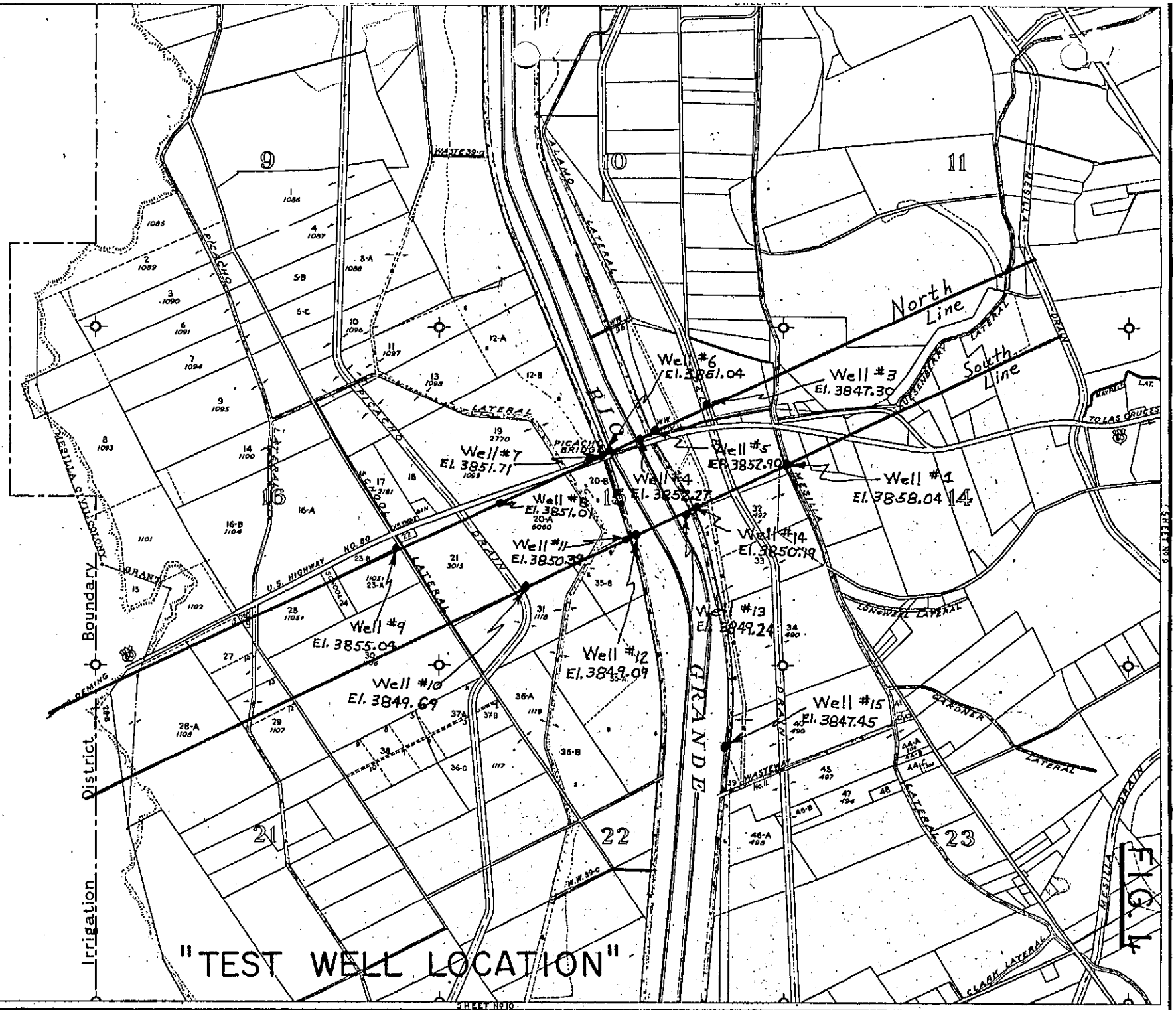

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EXPLANATION
Canals
Levees
Drains
Suspended Areas
Roads
Community and Private Ditches
High Land
Limits of

AUTHORITIES
Compiled from Topographic and Location Surveys by the Bureau of Reclamation. Property lines are from the best information available

SCALE
2000 Ft. to 1 Inch
0 500 1000 2000

PROPERTY NUMBERS
Project Serial No. of a Property is the Sheet No. followed by Tract No. thus, 8.29, 8 being the No. of this

BUREAU OF RECLAMATION - RIO GRANDE PROJECT
IRRIGABLE AREA AND PROPERTY MAP

MESILLA VALLEY
SHEET — 8

drain flow, whereas the same situation with a high water table may have a marked effect. The water table slopes along the Rio Grande and generally away from the river. Depths to the water table vary widely depending on location, season, river stage, and subsurface drainage facilities. It is observed that with the rise and fall of river stage, corresponding fluctuations occur in the adjoining water table. The magnitude of fluctuation decreases with the distance from the river and the time of the maximum height in the test wells lags according to the distance away from the river. The slope of the water table also affects seepage distribution away from the river. Seepage is more concentrated near the river with a reduction in concentration as the slope of the water table covers a larger portion of the total available head above the lowest point of the slope of the ground water table.

Summary and Conclusions

1. Ground water occurs beneath the area covered by the Elephant Butte Irrigation District and in general the water is unconfined and water table conditions exist in the area.

2. The principal water bearing strata are close to the ground surface and highly permeable.

3. Conclusions derived from older investigations, particularly those of Slichter and Lee, cannot be accepted because methods of investigation used are not acceptable by modern standards.

4. The ground water table slopes in the direction of river flow and away from the river bed.

5. Safe yield of the ground water basin in the District is 165,000 acre feet per year based on average yearly pumpage for the ten year period from 1951 to 1960.

6. The pumping of ground water will not necessarily divert water from the drains and river.

7. In spite of the fact that enough pumps were installed in the District to provide an adequate supplemental irrigation supply the drains did not stop flowing by the end of the summer in the first dry year.

8. The rate of recovery of drain return flow is faster than anticipated by previous investigators.

9. The characteristics of the aquifer are such that the ground water table, if lowered considerably, will rapidly return to its approximate normal elevation within a relatively short time after surface water supply returns to normal.

10. The estimated quantity of ground water available in the Mesilla Valley, above a point 25 feet below normal ground water elevation is 2,400,000 acre feet, and in the Rincon Valley, 800,000 acre feet.

11. The quality of ground water in the District is classified as "good to permissible" according to criteria of relative suitability of irrigation water.

12. Ground water should be used as a supplemental water supply for irrigation in years of deficient surface water supply. It appears that the quantity of water in ground water storage is sufficient to supply supplemental irrigation requirements for a drought period of ten years duration. However, continued use and reuse of ground water will result in an increase of salt content and will lower the quality of the water.

13. The Elephant Butte Irrigation District cannot totally abandon the use of surface water. It must maintain, and use, all of its surface water rights to the fullest extent possible. The District

cannot depend entirely upon ground water because its continued use for irrigation will materially increase the salt content.

14. The Rio Grande is not the only source of recharge to the ground water basin in the District. Recharge is received from adjoining mesa land, precipitation on the valley floor, and from various faults in the Santa Fe formation in the District. The exact amount of recharge from all of these sources cannot be evaluated separately in the absence of pertinent data.

15. Pumping of ground water in the District will lower the ground water table and will result in reduction of consumptive loss of water to phreatophytes and by evaporation.

RECOMMENDATIONS FOR A FUTURE GROUND WATER INVESTIGATION IN THE ELEPHANT BUTTE IRRIGATION DISTRICT

Maximum development of ground water resources for beneficial use requires research covering the ground water basin as a whole. By assuming a basin to be a large natural underground reservoir it is clear that utilization of ground water by one land owner affects the water supply of adjoining land owners. In order to maintain ground water resources indefinitely, a hydrologic equilibrium must exist between all waters entering and leaving the basin. At the same time, the economic, legal, and quality aspects of ground water must be considered. In terms of maximum development of all water resources in an area, there are economic benefits to be derived by coordinating the use of surface and ground waters. This concept of joint use requires investigation and planning for all new water resource developments, and improvement of the existing system of utilizing surface and ground waters.

In order to make a complete investigation of ground water in the Elephant Butte Irrigation District, on a basin-wide scale, the collection of comprehensive data should be undertaken. The following outline summarizes types of basic data required, and methods of analysis of such data for a basin-wide evaluation of ground water development. Some of the data are already available in the records of the Elephant Butte Irrigation District.

1. Surface Inflow and Outflow

These quantities are measurable by standard procedures. It may be necessary to install an additional gaging station to complete the data or to verify the data collected by other agencies.

2. Precipitation

Records of precipitation can be obtained from the U.S. Weather Bureau climatological data. Supplementary gages may be necessary to determine the variation of rainfall in the District.

3. Consumptive Use

All water, surface and subsurface, released into the atmosphere by processes of evaporation and transpiration is consumptive use. To compute this discharge from the District it may be necessary to make a land use, or cultural survey which will yield the amount of each type of water-consuming area. Unit values of consumptive use can then be determined.

4. Changes in Ground Water Storage

In practice, these changes are limited to the zone of saturation. Changes of water content can, and do, occur in the zone of aeration; however, they are difficult to determine on a field basis. These changes can be minimized by selecting periods of storage change in which the volumes of water in unsaturated storage at the beginning or ending of the irrigation season.

Determination of changes in ground water storage can only be made on the basis of an adequate knowledge of the occurrence of ground water in the District. A general study should be made of well logs in the District. The aquifer in the District should be delineated and its degree of confinement should be established. Information on ground water levels, pumping tests, and recharge should be collected and coordinated.

In obtaining the above information it may be necessary to drill a series of observation wells in a grid pattern about three-fourths of a mile apart in both the Rincon and Mesilla Valleys. These wells may be supplemented by records on test holes where required.

Periodically, water levels in these wells should be measured under conditions as nearly static as possible. A few control wells in the District should be equipped with automatic water level recorders. A map showing lines of equal change in the ground water table should be prepared showing the situations before and after the irrigation season. These data will make it possible to determine the total change in ground water storage.

5. Subsurface Inflow and Outflow

Subsurface inflow and outflow are very difficult to evaluate because they cannot be measured directly. However, direction of flow can be established from water table slopes. From estimates, or measurements of slopes, permeability of the strata, and cross sectional area of flow, the subsurface flow can be computed from Darcy's Law, which states that the rate of flow is proportional to the hydraulic gradient.

6. Ground Water Quality

From time to time, analysis should be made to determine the quality of the ground water supply from irrigation wells and observation wells. From this information the salt balance of ground water can be determined in the basin. Also, relative suitability of ground water for irrigation purposes can be evaluated. The information obtained may also indicate various sources of ground water and the nature of recharge.

7. Tracer Studies

Commercially available radio-active tracers can be used to determine the movement of ground water in the basin. The tracer studies can also be used to verify different sources of ground water recharge in the basin.

6. River Seepage Investigations

Electrical analog methods can be used, and hydraulic model investigations can be performed in the laboratory, to correlate field data for the purpose of determining seepage losses and the amount of recharge to ground water table for different reaches of the river in the District. This may definitely establish the contribution made by the river to recharge of the ground water basin.

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APPENDIX

E V A P O R A T I O N

FIG. 1

AVERAGE ANNUAL RAINFALL AND EVAPORATION AT N.M.S.U., U.S.W.B. STATION

R A I N F A L L

INCHES

50 75 100 20 10 0

AVE. G.W. DEPTH BELOW PIPE TOP IN FEET

8 9 10 11 12 13 14 15 16 17

110 100 90 80 70 60 50 40 30 20 10 0

MAR. JUNE SEPT DEC.

19 41 | 19 42 | 19 43 | 19 44 | 19 45 | 19 46 | 19 47 | 19 48 | 19 49 | 19 50 | 19 51 | 19 52 | 19 53 | 19 54 | 19 55 | 19 56 | 19 57 | 19 58 | 19 59 | 19 60

NOTE:

THE CURVE REPRESENTS AN AVERAGE OF ABOUT 40 OBSERVATION WELLS INSTALLED BY U.S.B.R. THESE WELLS ARE SCATTERED IN THE AREA AT RANDOM AND DO NOT GIVE A GOOD COVERAGE OF THE AREA.

GROUND-WATER DEPTHS SHOWN ARE REFERENCED TO THE TOPS OF TEST WELL PIPES. THE TOPS OF THESE PIPES AVERAGE ABOUT 1.46 FEET ABOVE NATURAL GROUND SURFACE. (INFORMATION OBTAINED FROM U.S.B.R. THROUGH E.B.I.D.)

AVERAGE DEPTH TO GROUND-WATER FOR MESILLA VALLEY

E.B.I.D. GROUNDWATER PROJECT
CIVIL ENGINEERING DEPARTMENT
NEW MEXICO STATE UNIVERSITY

20 YEARS BY MONTHS 359-210L
X 10 DIVISIONS
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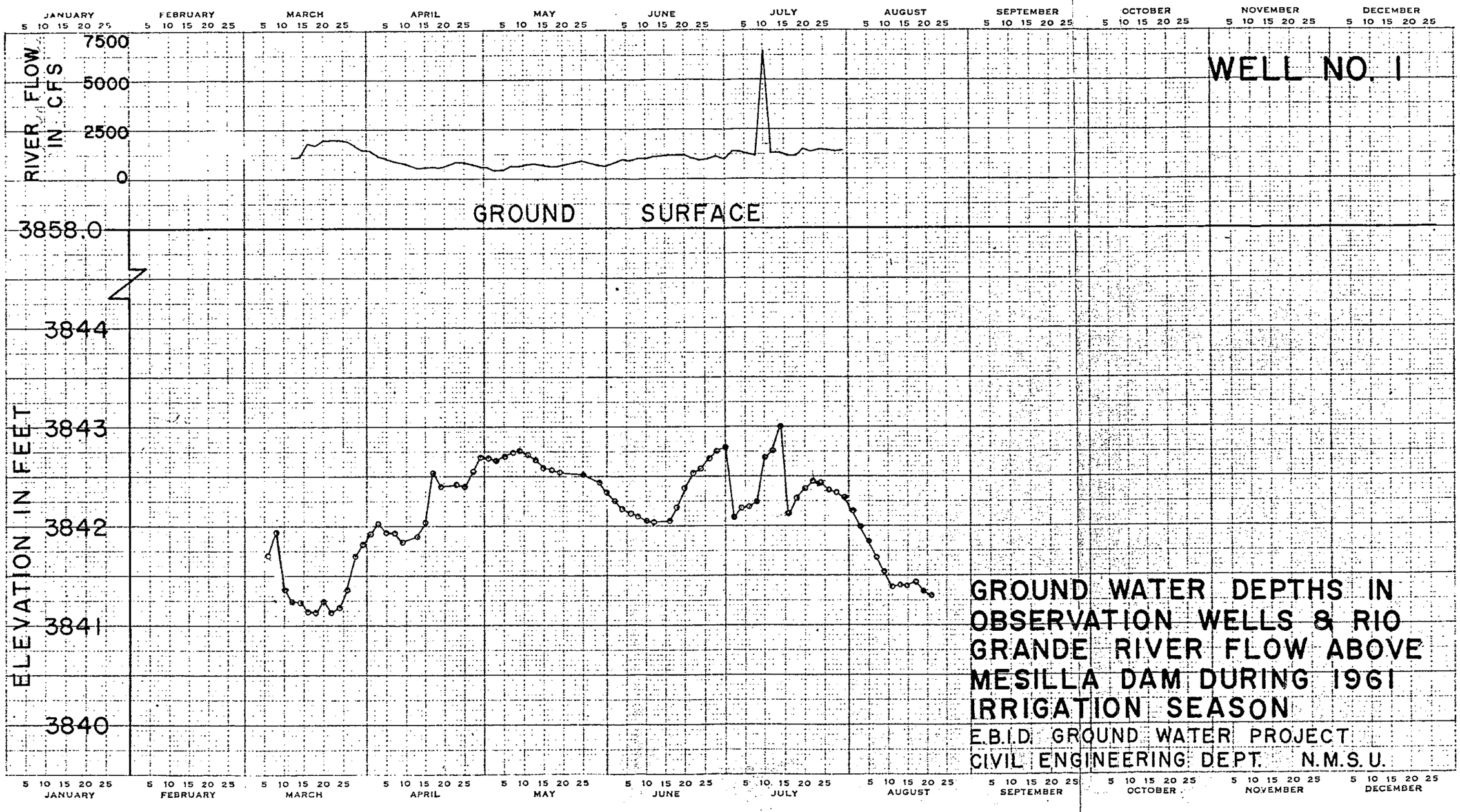

GROUND WATER DEPTHS IN OBSERVATION WELLS & RIO GRANDE RIVER FLOW ABOVE MESILLA DAM DURING 1961 IRRIGATION SEASON

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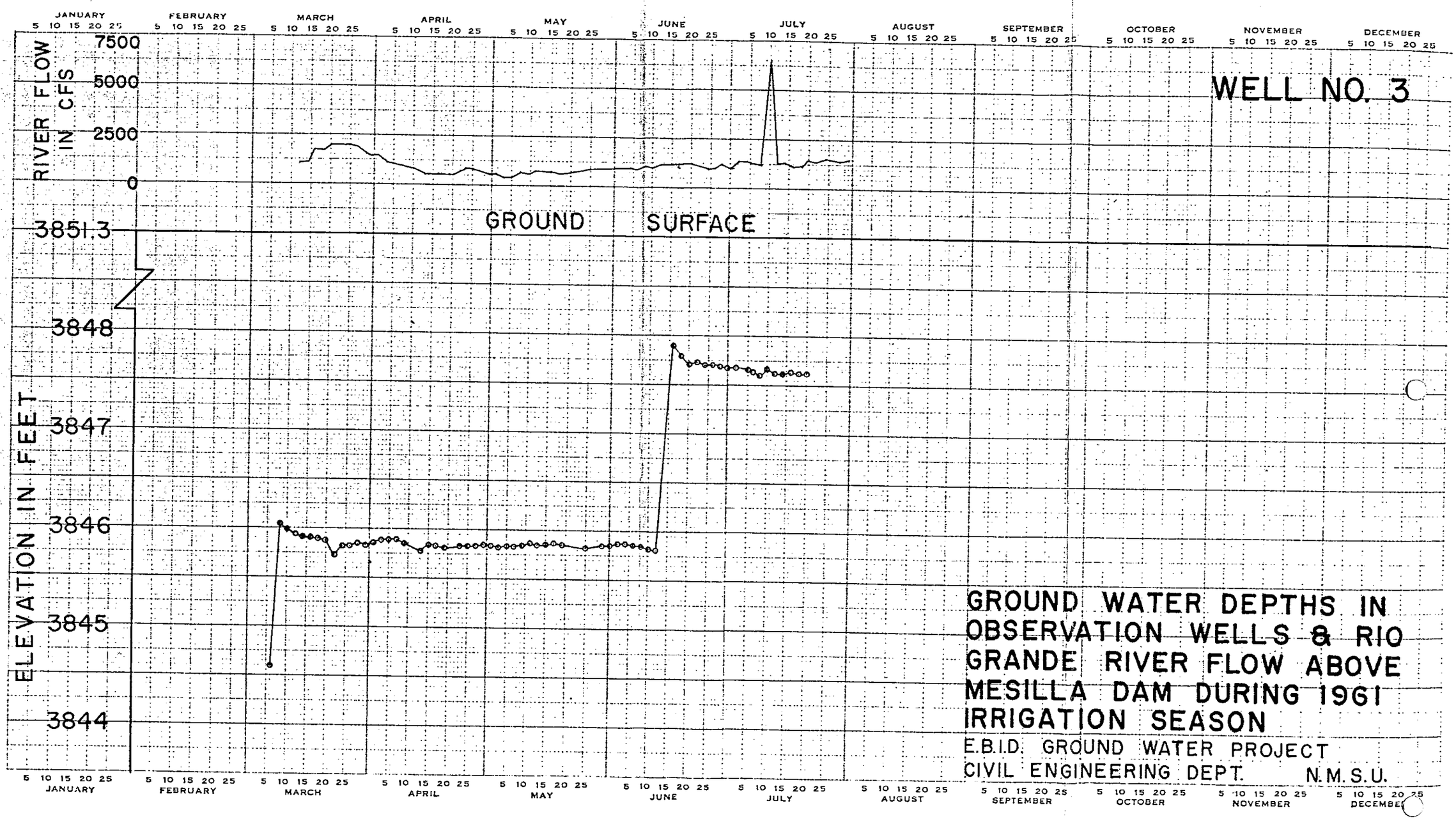

GROUND WATER DEPTHS IN OBSERVATION WELLS & RIO GRANDE RIVER FLOW ABOVE MESILLA DAM DURING 1961 IRRIGATION SEASON

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WELL NO. 4

RIVER FLOW IN C.F.S.

7500
5000
2500
0

GROUND SURFACE

ELEVATION IN FEET

3852.2
3850
3849
3848
3847
3846

JANUARY 5 10 15 20 25 | FEBRUARY 5 10 15 20 25 | MARCH 5 10 15 20 25 | APRIL 5 10 15 20 25 | MAY 5 10 15 20 25 | JUNE 5 10 15 20 25 | JULY 5 10 15 20 25 | AUGUST 5 10 15 20 25 | SEPTEMBER 5 10 15 20 25 | OCTOBER 5 10 15 20 25 | NOVEMBER 5 10 15 20 25 | DECEMBER 5 10 15 20 25

GROUND WATER DEPTHS IN OBSERVATION WELLS & RIO GRANDE RIVER FLOW ABOVE MESILLA DAM DURING 1961 IRRIGATION SEASON

E.B.I.D. GROUND WATER PROJECT
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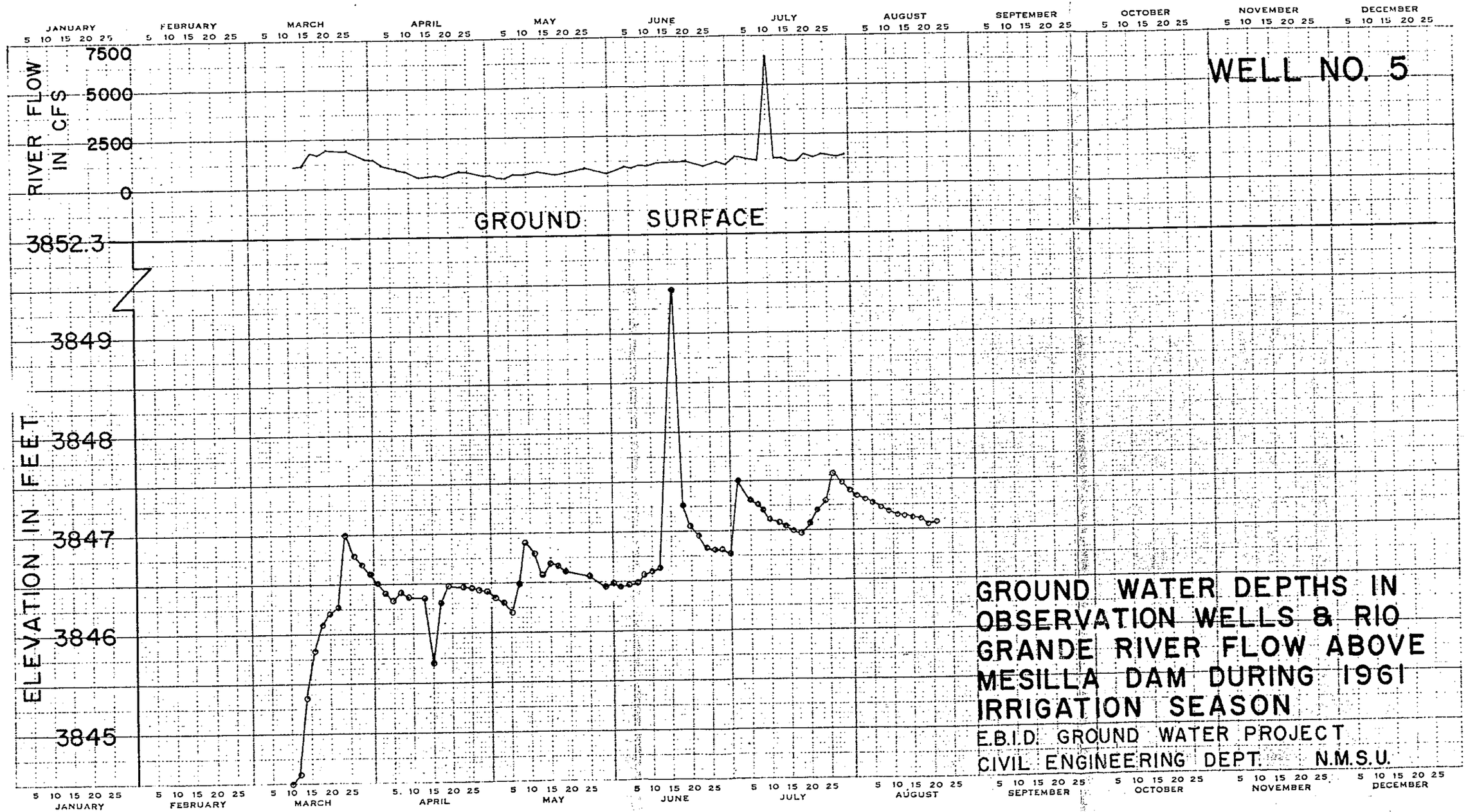

GROUND WATER DEPTHS IN OBSERVATION WELLS & RIO GRANDE RIVER FLOW ABOVE MESILLA DAM DURING 1961 IRRIGATION SEASON

E.B.I.D. GROUND WATER PROJECT
CIVIL ENGINEERING DEPT. N.M.S.U.

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WELL NO. 6

RIVER FLOW IN CFS: 7500, 5000, 2500, 0

ELEVATION IN FEET: 3851.3, 3850, 3849, 3848, 3847, 3846

GROUND SURFACE

JANUARY 5 10 15 20 25 | FEBRUARY 5 10 15 20 25 | MARCH 5 10 15 20 25 | APRIL 5 10 15 20 25 | MAY 5 10 15 20 25 | JUNE 5 10 15 20 25 | JULY 5 10 15 20 25 | AUGUST 5 10 15 20 25 | SEPTEMBER 5 10 15 20 25 | OCTOBER 5 10 15 20 25 | NOVEMBER 5 10 15 20 25 | DECEMBER 5 10 15 20 25

GROUND WATER DEPTHS IN OBSERVATION WELLS & RIO GRANDE RIVER FLOW ABOVE MESILLA DAM DURING 1961 IRRIGATION SEASON

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RIVER FLOW IN CFS: 7500, 5000, 2500, 0

GROUND SURFACE

ELEVATION IN FEET: 3851.7, 3849, 3848, 3847, 3846, 3845

WELL NO. 7

GROUND WATER DEPTHS IN OBSERVATION WELLS & RIO GRANDE RIVER FLOW ABOVE MESILLA DAM DURING 1961 IRRIGATION SEASON

E.B.I.D. GROUND WATER PROJECT

CIVIL ENGINEERING DEPT. N.M.S.U.

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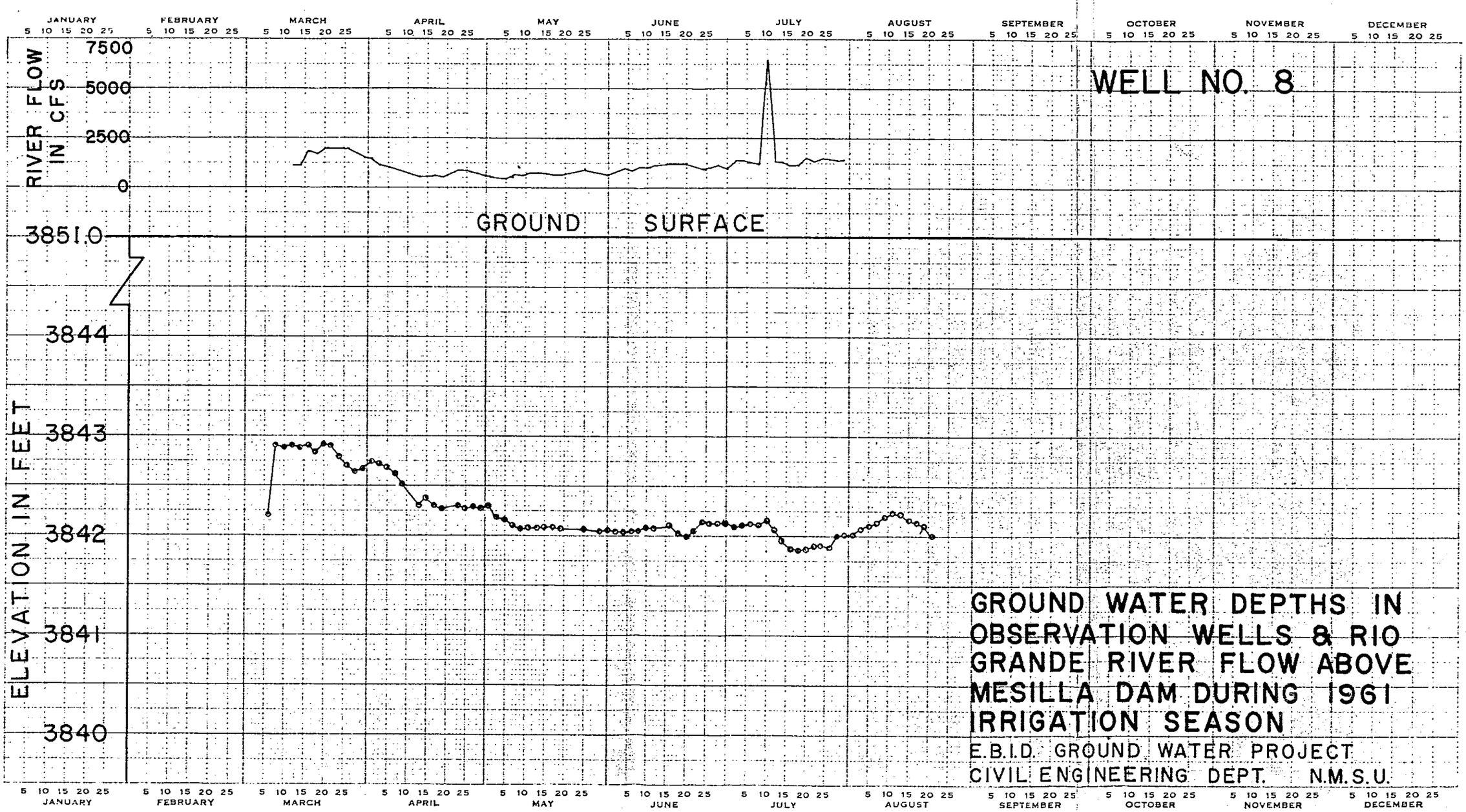

GROUND WATER DEPTHS IN OBSERVATION WELLS & RIO GRANDE RIVER FLOW ABOVE MESILLA DAM DURING 1961 IRRIGATION SEASON

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JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER

5 10 15 20 25

RIVER FLOW IN C.F.S.

7500
5000
2500
0

3855.0

GROUND SURFACE

3841

ELEVATION IN FEET

3840
3839
3838
3837

WELL NO. 9

GROUND WATER DEPTHS IN OBSERVATION WELLS & RIO GRANDE RIVER FLOW ABOVE MESILLA DAM DURING 1961 IRRIGATION SEASON

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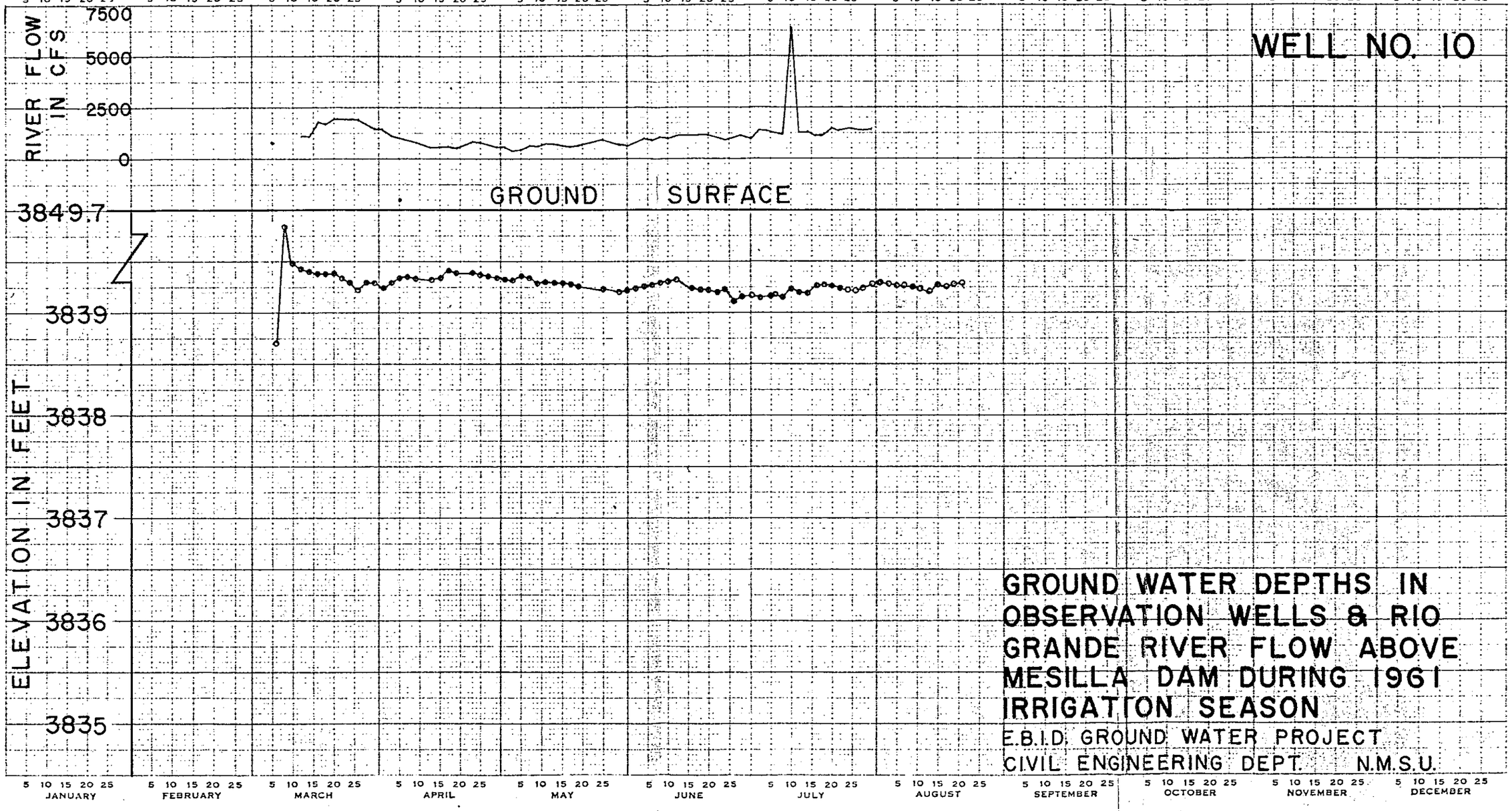

GROUND WATER DEPTHS IN OBSERVATION WELLS & RIO GRANDE RIVER FLOW ABOVE MESILLA DAM DURING 1961 IRRIGATION SEASON

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RIVER FLOW IN CFS: 7500, 5000, 2500, 0

ELEVATION IN FEET: 3850.3, 3847, 3846, 3845, 3844, 3843

GROUND SURFACE

WELL NO. 11

GROUND WATER DEPTHS IN OBSERVATION WELLS & RIO GRANDE RIVER FLOW ABOVE MESILLA DAM DURING 1961 IRRIGATION SEASON

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5 10 15 20 25

RIVER FLOW IN CFS
7500
5000
2500
0

GROUND SURFACE
3849.1

ELEVATION IN FEET
3848
3847
3846
3845
3844

WELL NO. 12

GROUND WATER DEPTHS IN OBSERVATION WELLS & RIO GRANDE RIVER FLOW ABOVE MESILLA DAM DURING 1961 IRRIGATION SEASON

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5 10 15 20 25

RIVER FLOW IN CFS

7500
5000
2500
0

GROUND SURFACE

3847.4

ELEVATION IN FEET

3847
3846
3845
3844
3843

WELL NO. 13

GROUND WATER DEPTHS IN OBSERVATION WELLS & RIO GRANDE RIVER FLOW ABOVE MESILLA DAM DURING 1961 IRRIGATION SEASON

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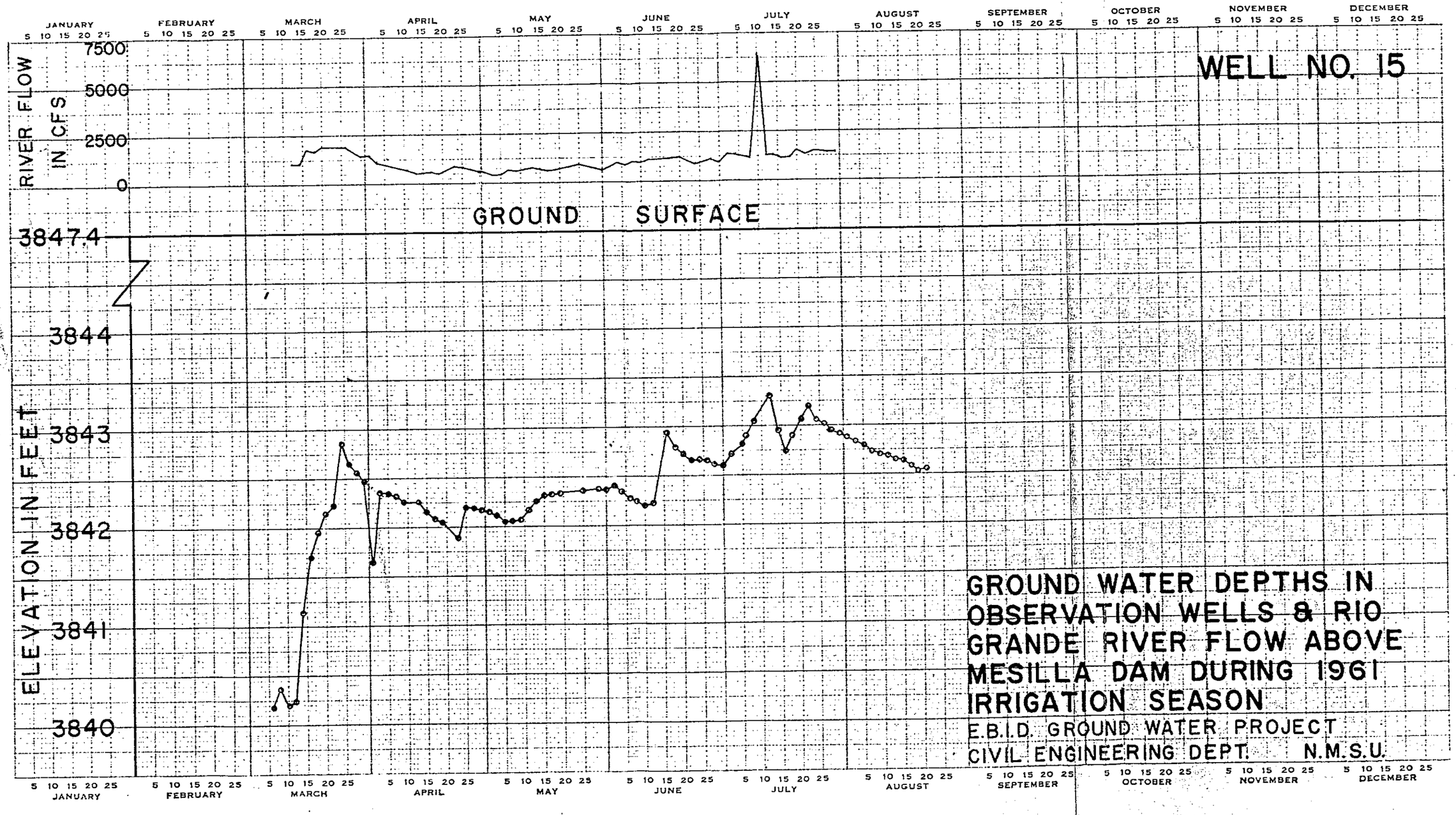

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OBSERVED GROUND WATER PROFILE IN TEST WELLS

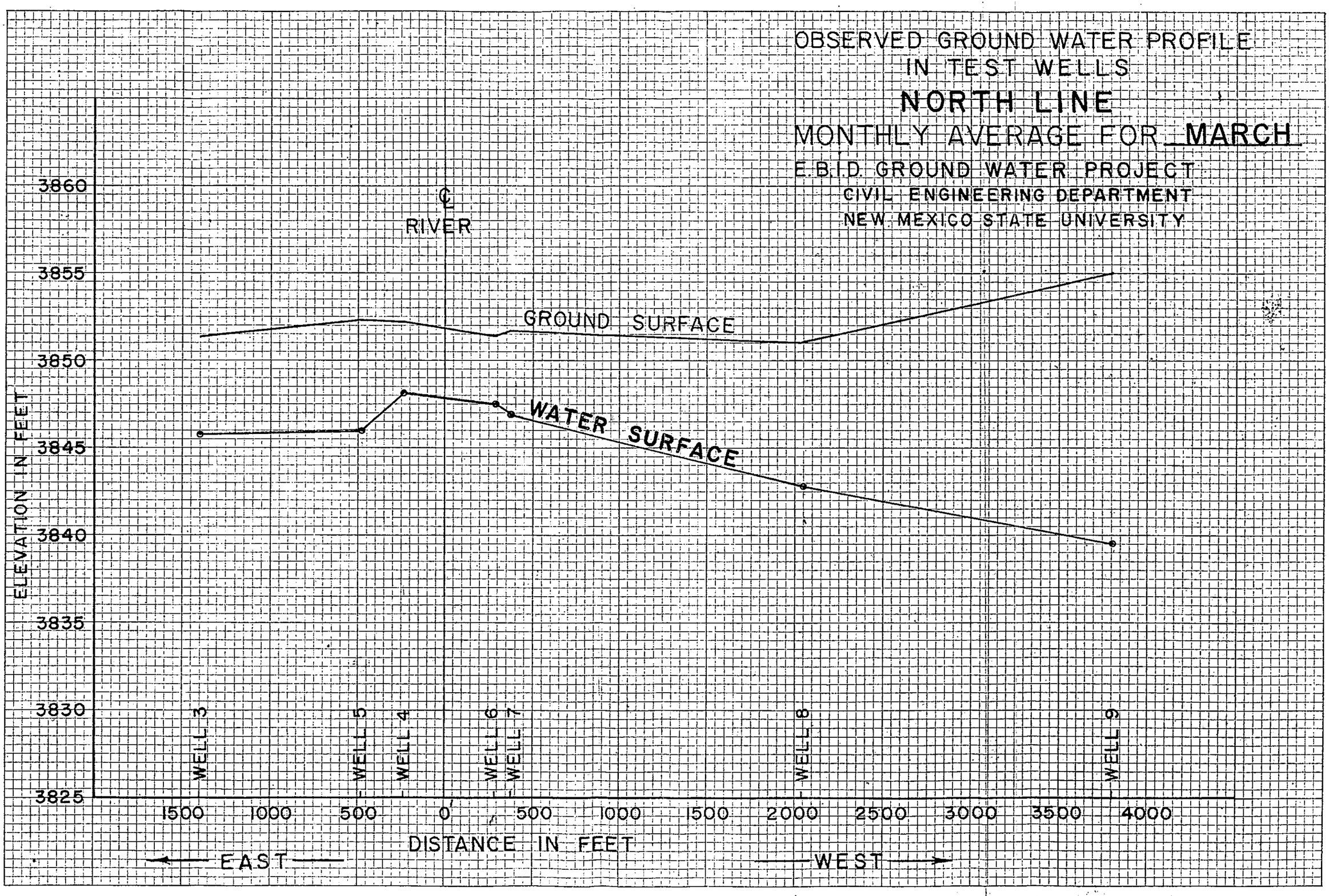
NORTH LINE

MONTHLY AVERAGE FOR MARCH

E.B.I.D. GROUND WATER PROJECT

CIVIL ENGINEERING DEPARTMENT

NEW MEXICO STATE UNIVERSITY



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OBSERVED GROUND WATER PROFILE IN TEST WELLS
SOUTH LINE
MONTHLY AVERAGE FOR MARCH

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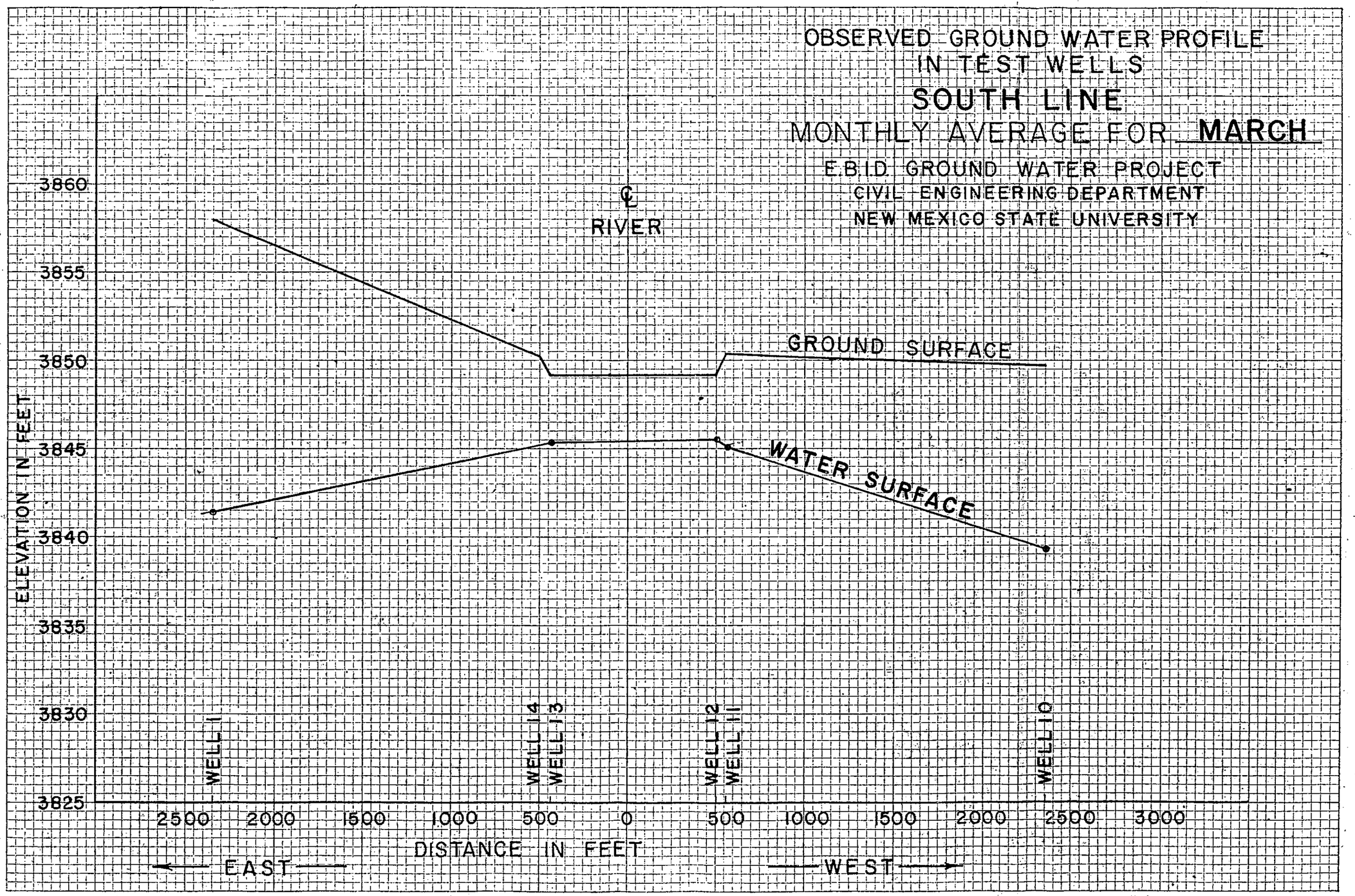

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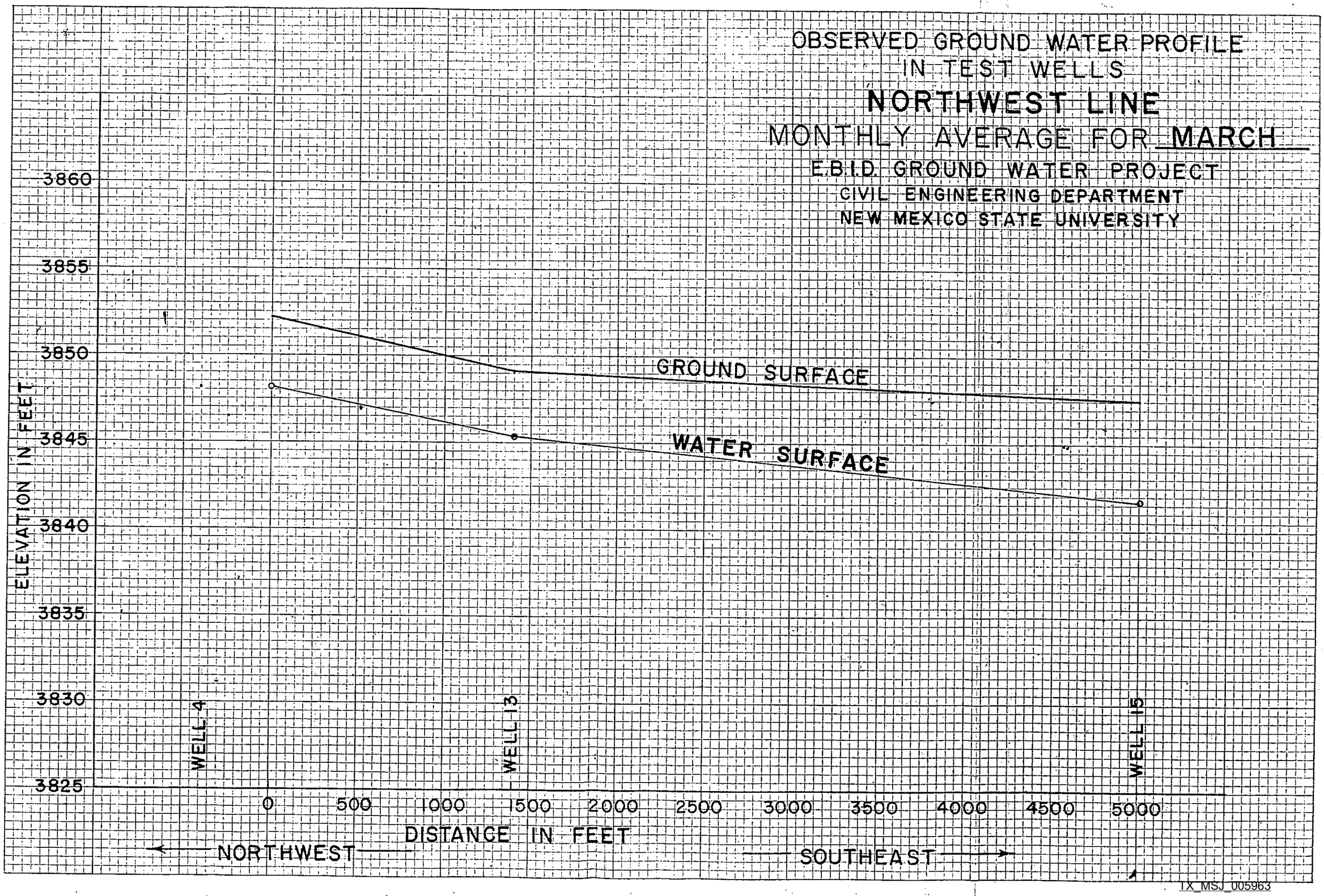
OBSERVED GROUND WATER PROFILE
IN TEST WELLS
NORTHWEST LINE
MONTHLY AVERAGE FOR MARCH
E.B.I.D. GROUND WATER PROJECT
CIVIL ENGINEERING DEPARTMENT
NEW MEXICO STATE UNIVERSITY



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OBSERVED GROUND WATER PROFILE
IN TEST WELLS
NORTH LINE
MONTHLY AVERAGE FOR APRIL

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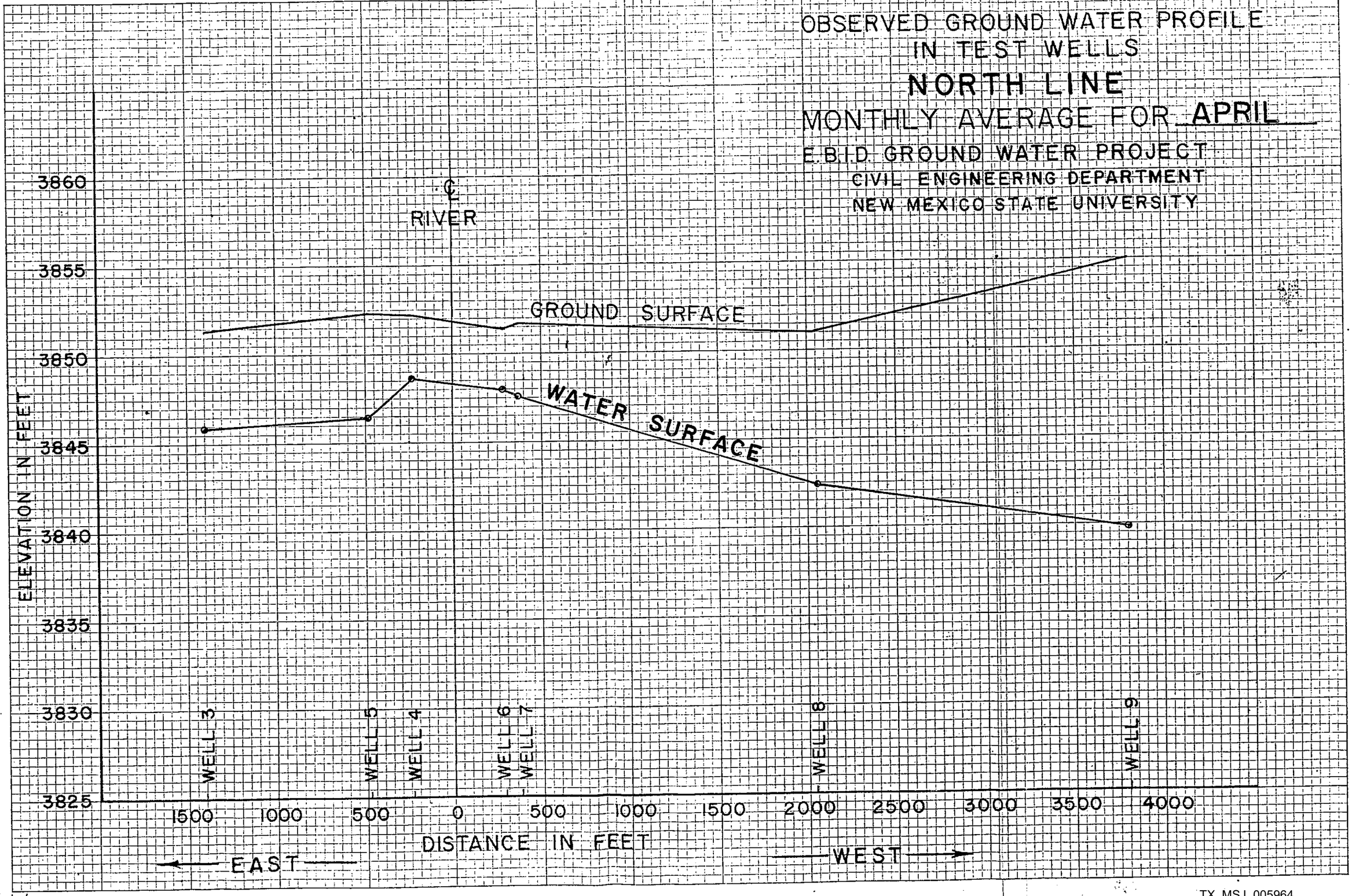
NEW MEXICO STATE UNIVERSITY



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OBSERVED GROUND WATER PROFILE IN TEST WELLS
SOUTH LINE
MONTHLY AVERAGE FOR APRIL

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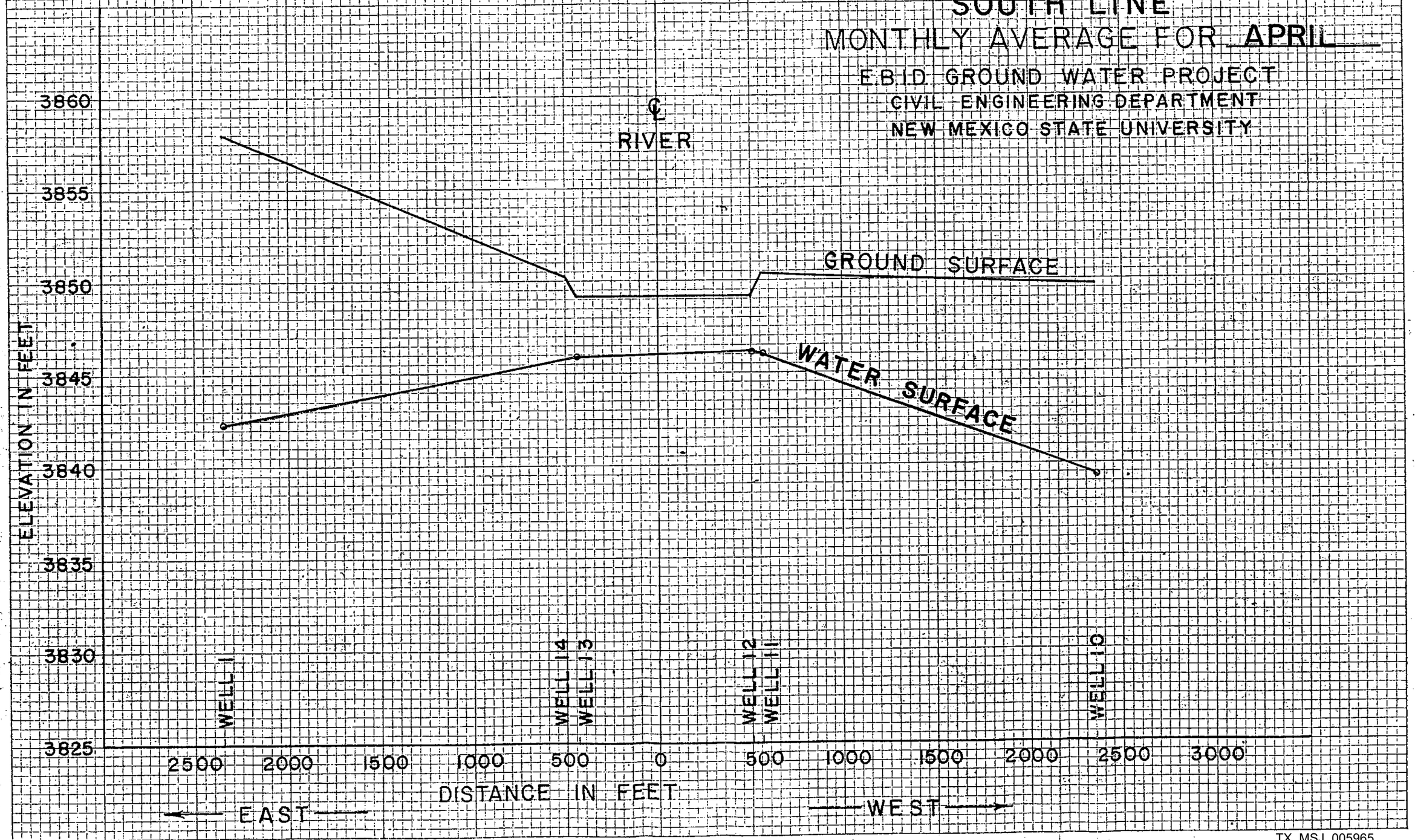

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OBSERVED GROUND WATER PROFILE
IN TEST WELLS
NORTHWEST LINE
MONTHLY AVERAGE FOR APRIL
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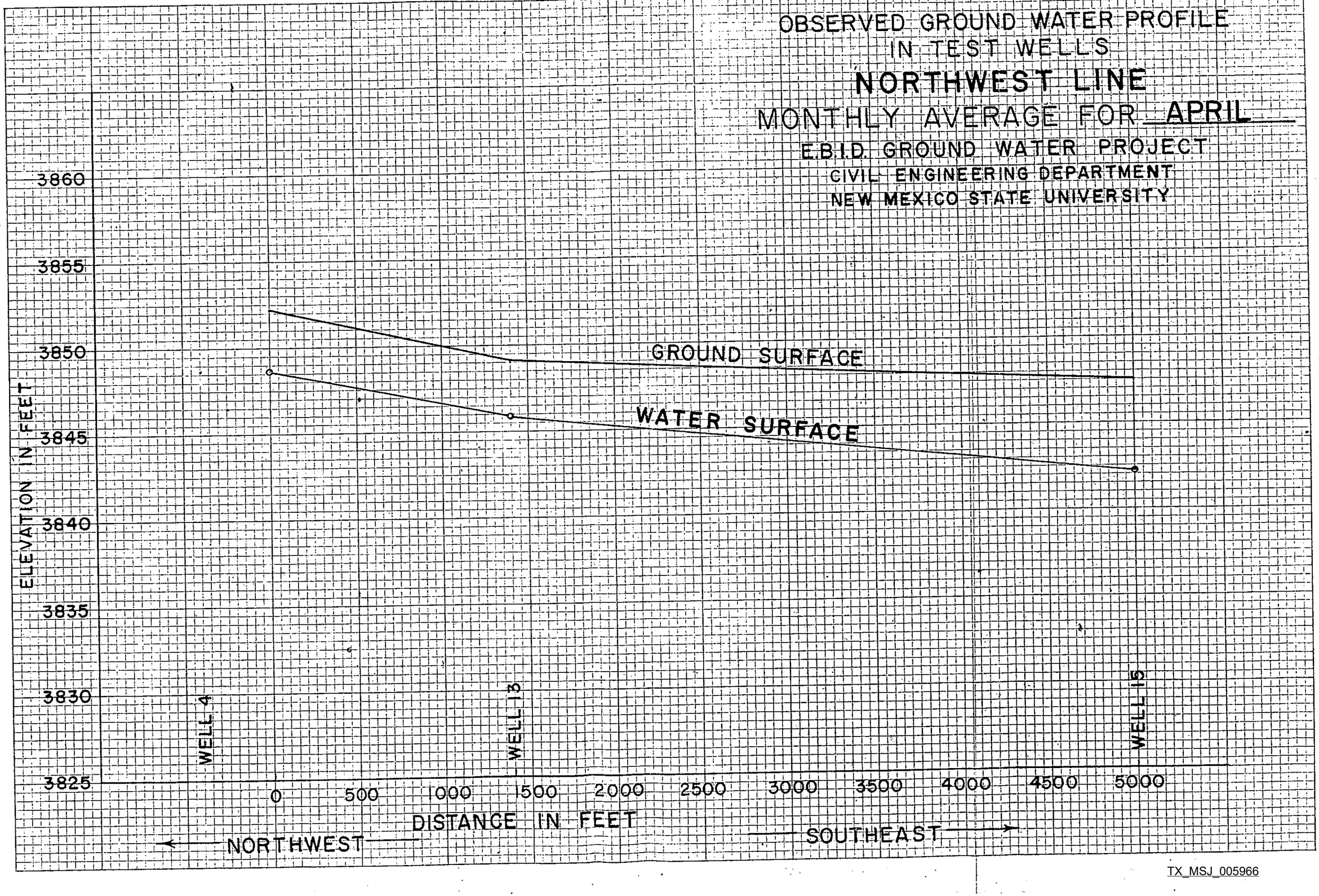
NEW MEXICO STATE UNIVERSITY



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OBSERVED GROUND WATER PROFILE IN TEST WELLS
NORTH LINE
MONTHLY AVERAGE FOR MAY

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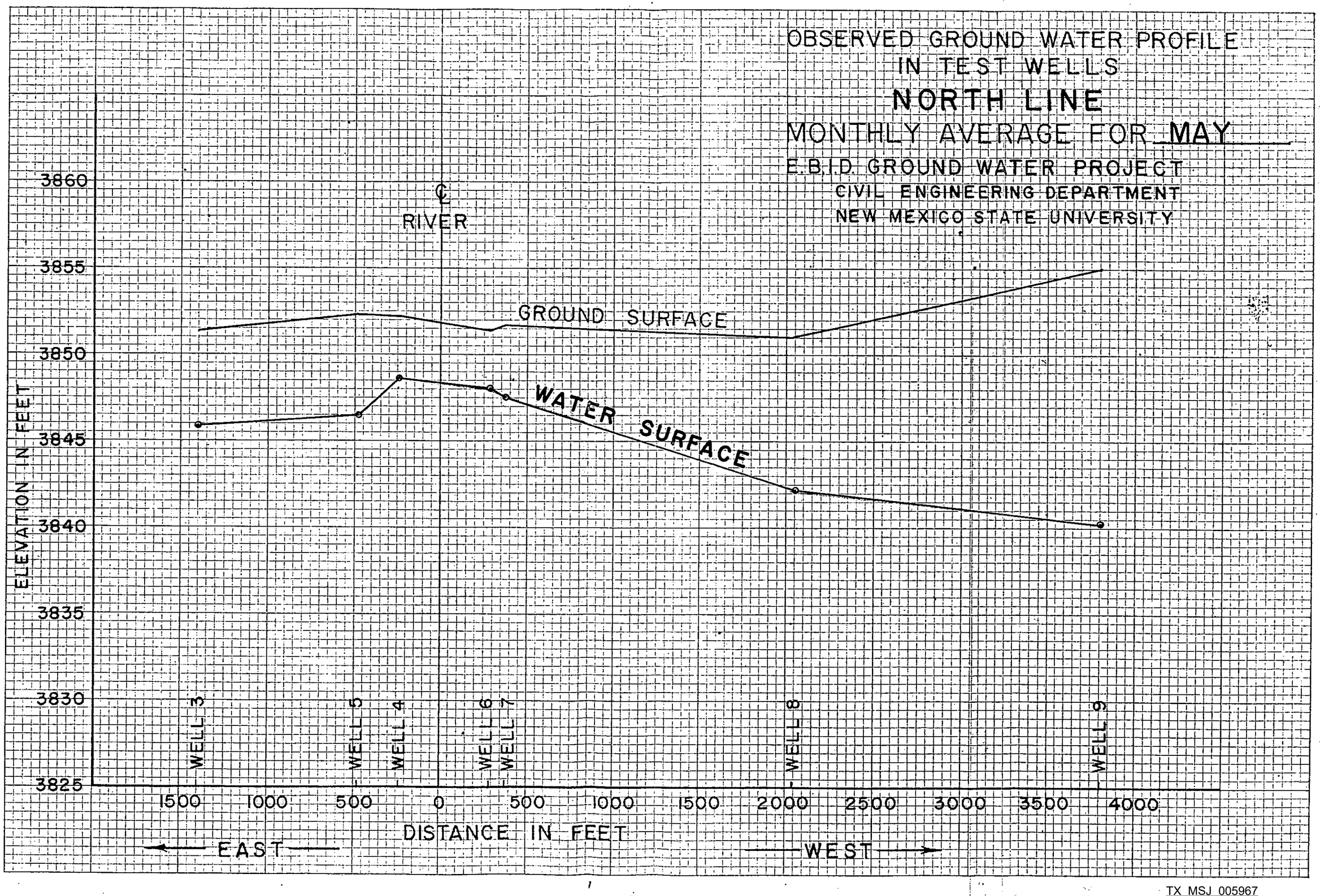

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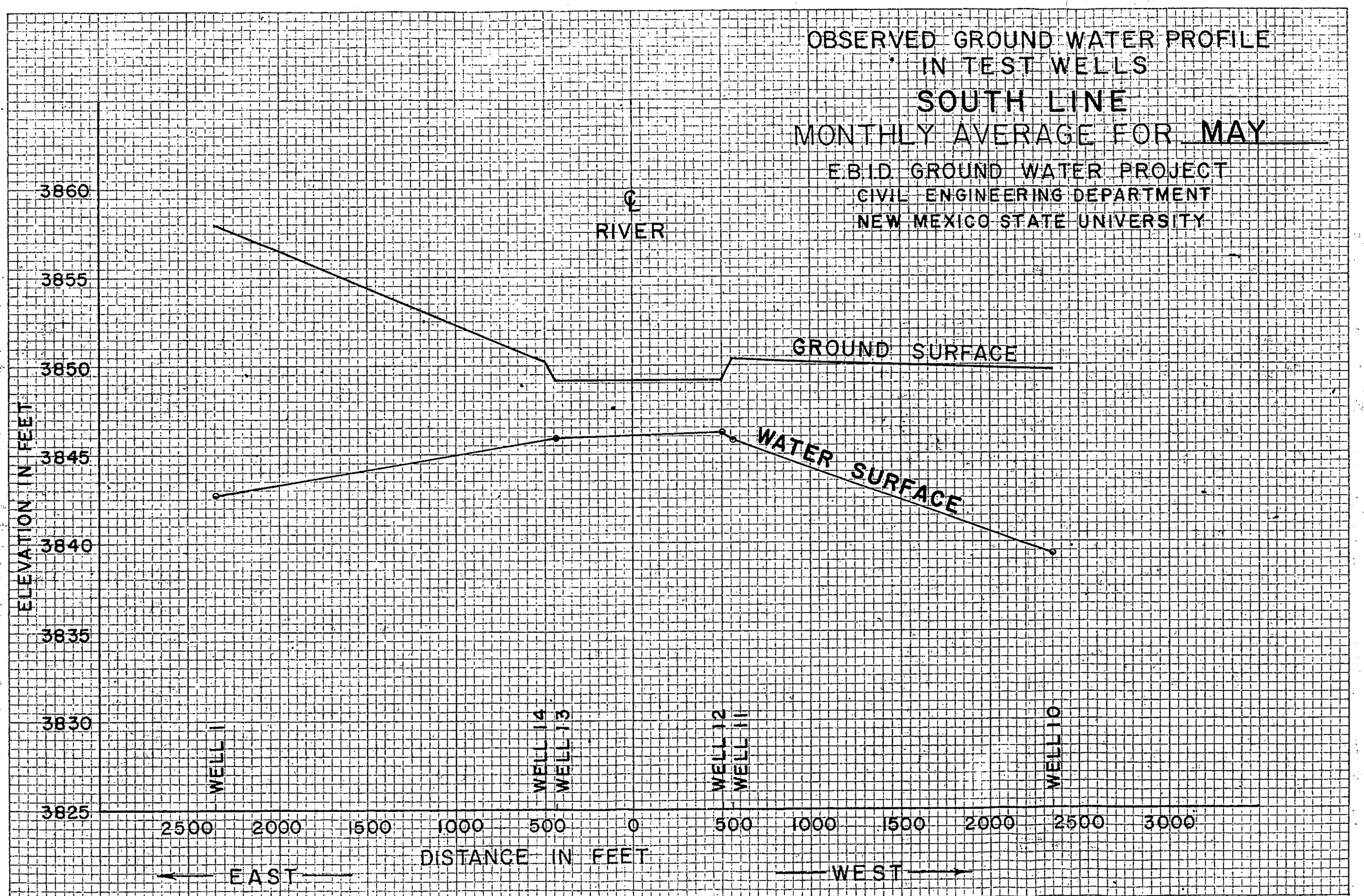

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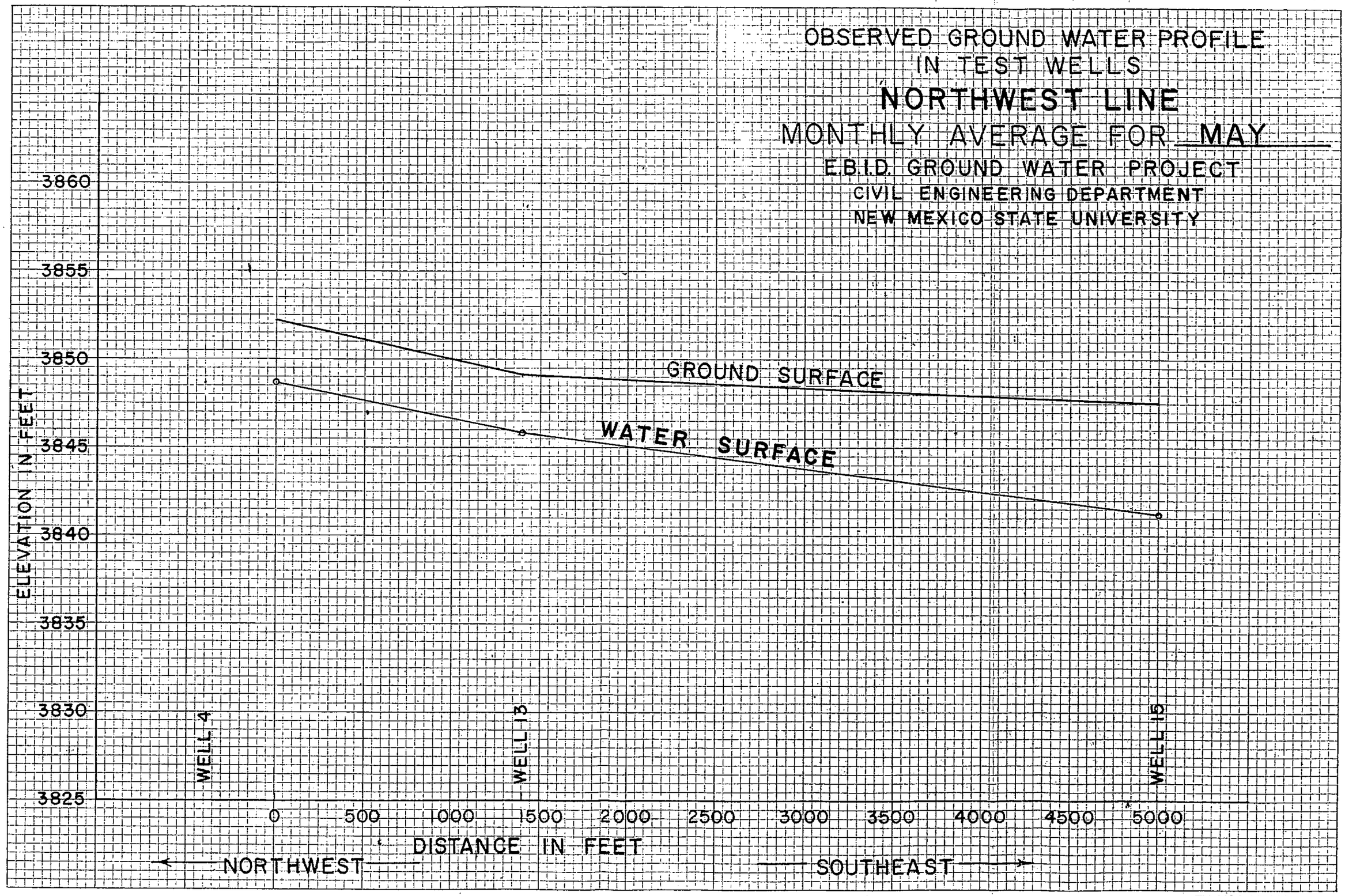
OBSERVED GROUND WATER PROFILE
IN TEST WELLS
NORTHWEST LINE
MONTHLY AVERAGE FOR MAY
E.B.I.D. GROUND WATER PROJECT
CIVIL ENGINEERING DEPARTMENT
NEW MEXICO STATE UNIVERSITY



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MADE IN U.S.A.

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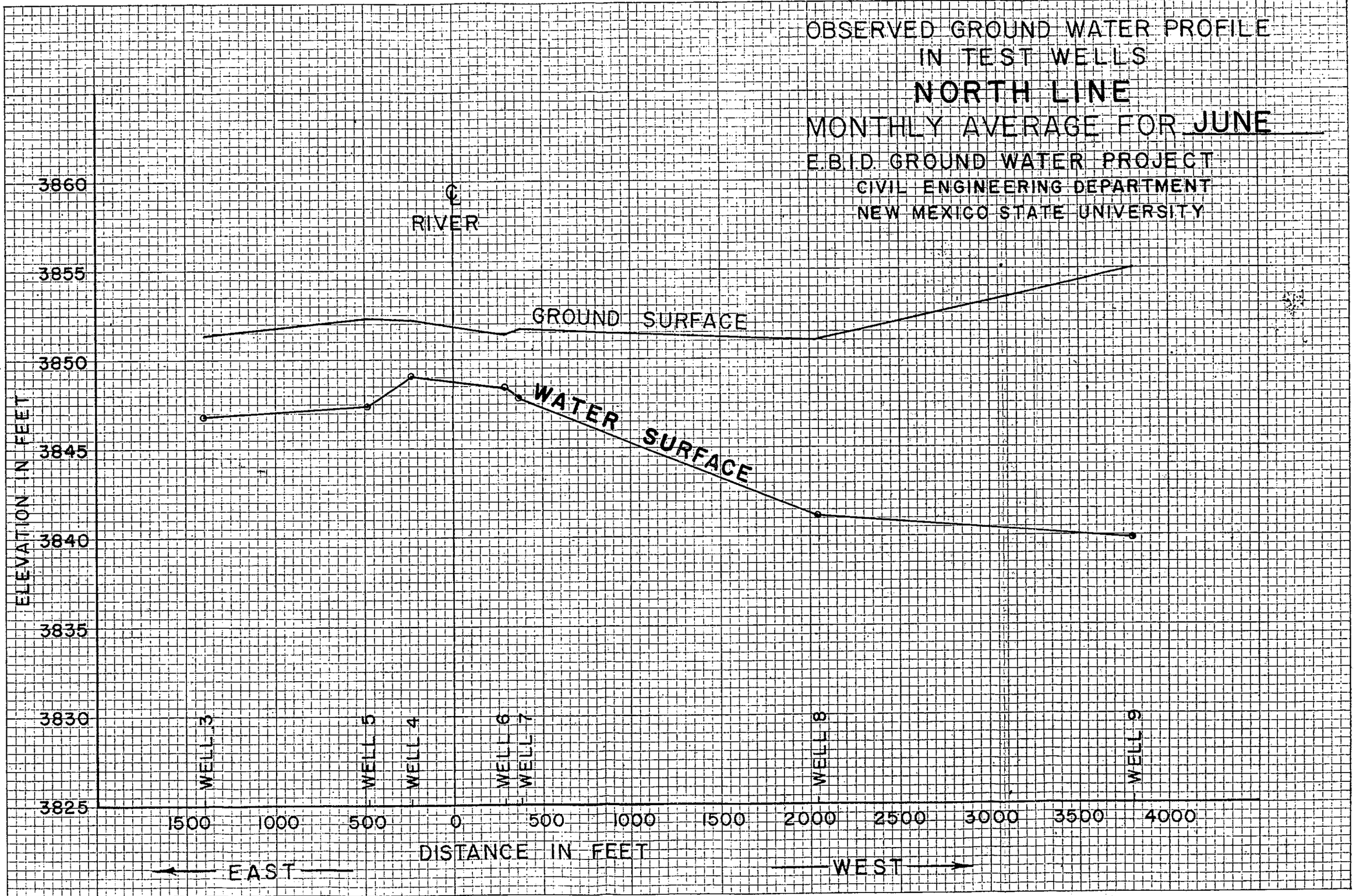
OBSERVED GROUND WATER PROFILE
IN TEST WELLS
NORTH LINE
MONTHLY AVERAGE FOR JUNE

E.B.I.D. GROUND WATER PROJECT
CIVIL ENGINEERING DEPARTMENT
NEW MEXICO STATE UNIVERSITY



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OBSERVED GROUND WATER PROFILE IN TEST WELLS

SOUTH LINE

MONTHLY AVERAGE FOR JUNE

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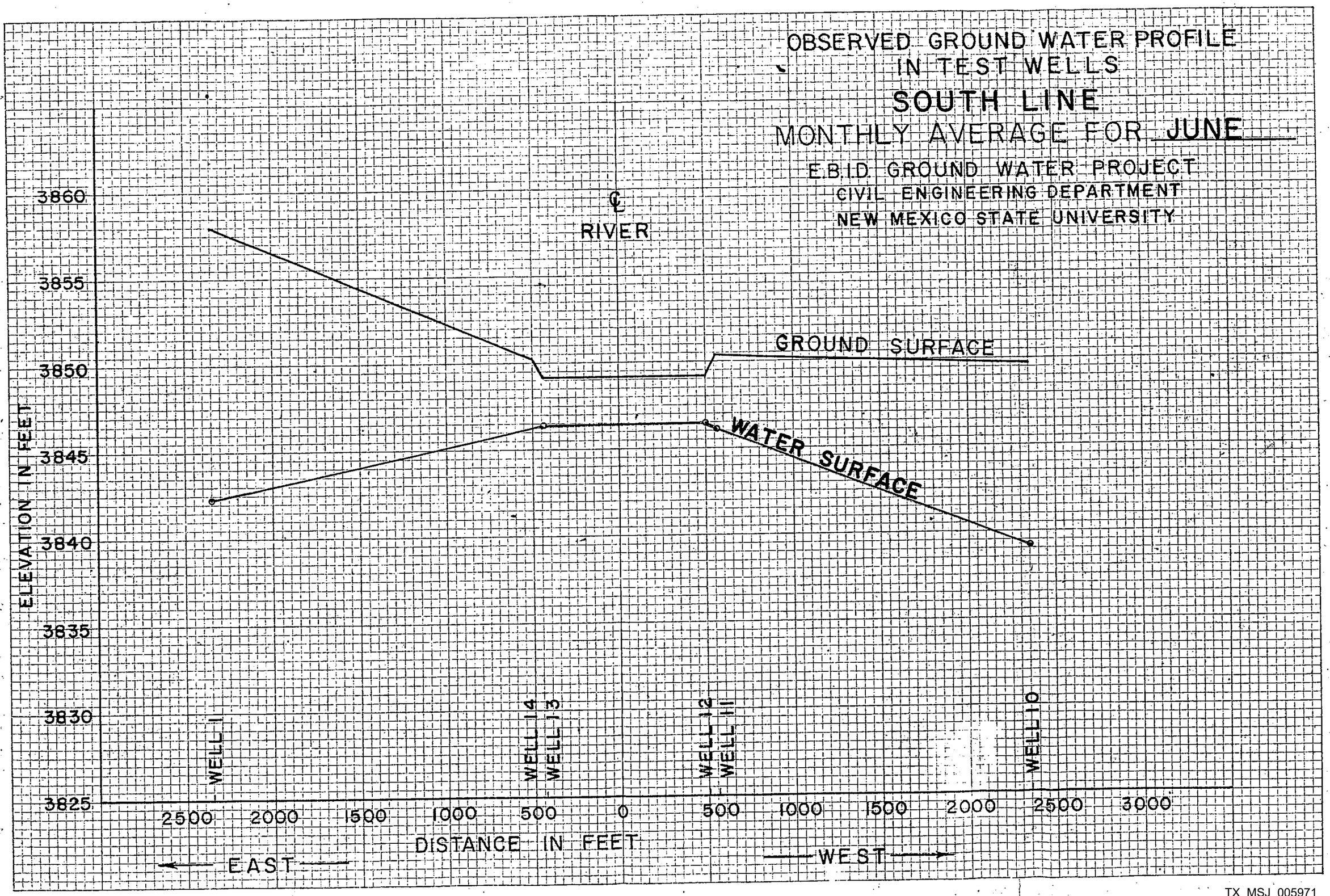
CIVIL ENGINEERING DEPARTMENT
NEW MEXICO STATE UNIVERSITY



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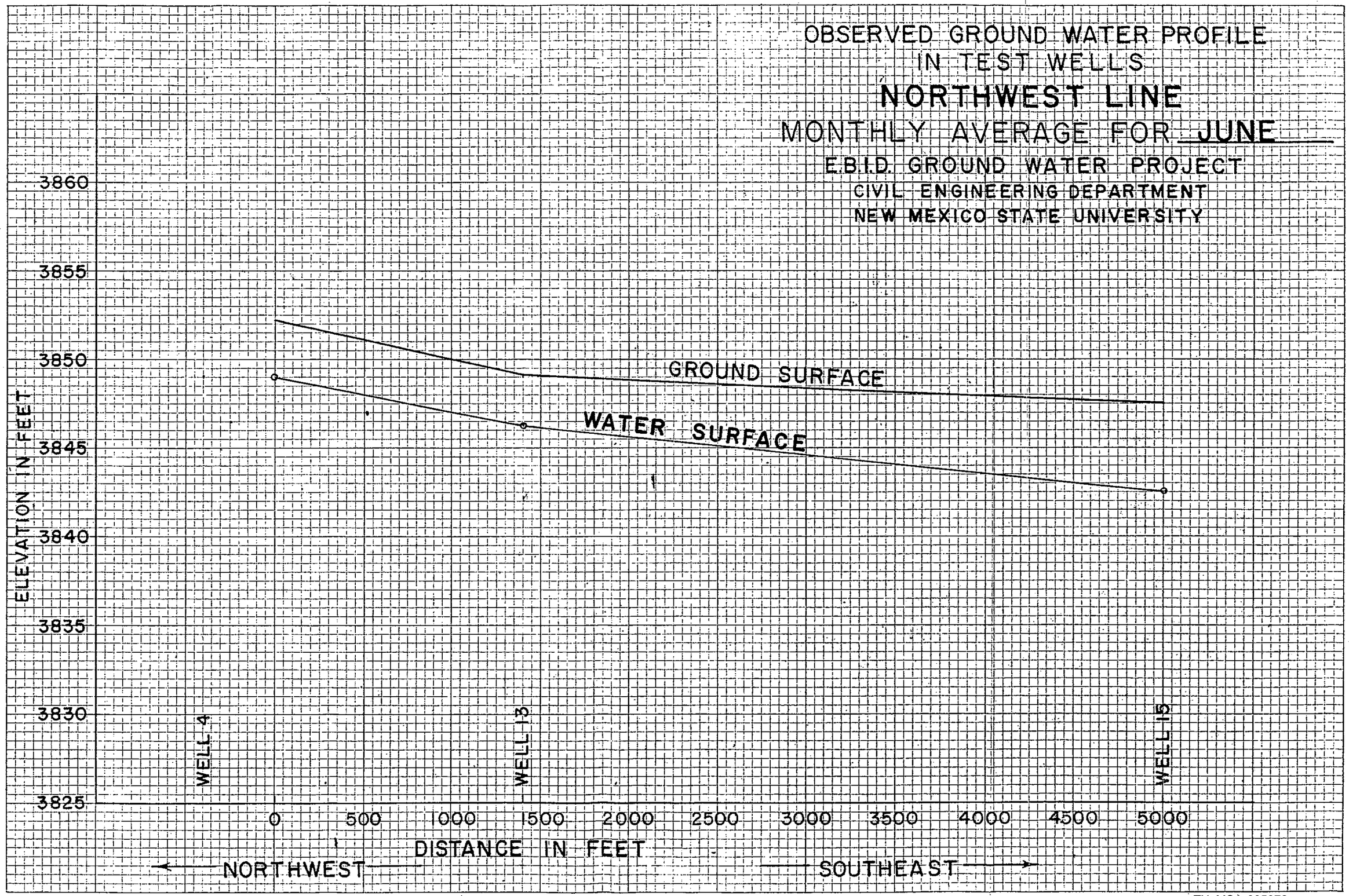
OBSERVED GROUND WATER PROFILE
IN TEST WELLS
NORTHWEST LINE
MONTHLY AVERAGE FOR JUNE
E.B.I.D. GROUND WATER PROJECT
CIVIL ENGINEERING DEPARTMENT
NEW MEXICO STATE UNIVERSITY



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10 X 10 to the inch.
MADE IN U.S.A.

TX_MSJ_005972

OBSERVED GROUND WATER PROFILE IN TEST WELLS

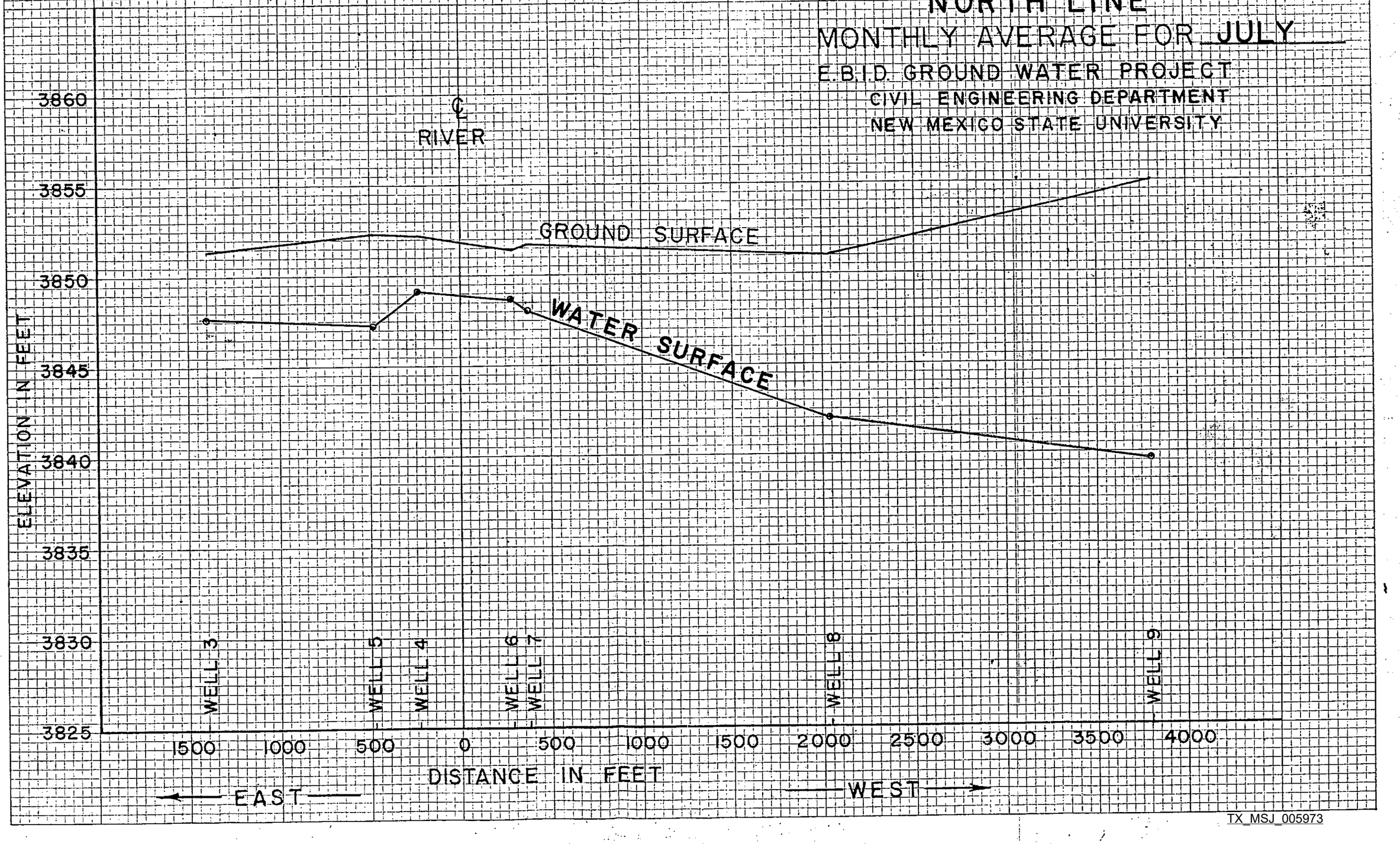
NORTH LINE

MONTHLY AVERAGE FOR JULY

E.B.I.D. GROUND WATER PROJECT

CIVIL ENGINEERING DEPARTMENT

NEW MEXICO STATE UNIVERSITY



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OBSERVED GROUND WATER PROFILE IN TEST WELLS
SOUTH LINE
MONTHLY AVERAGE FOR JULY

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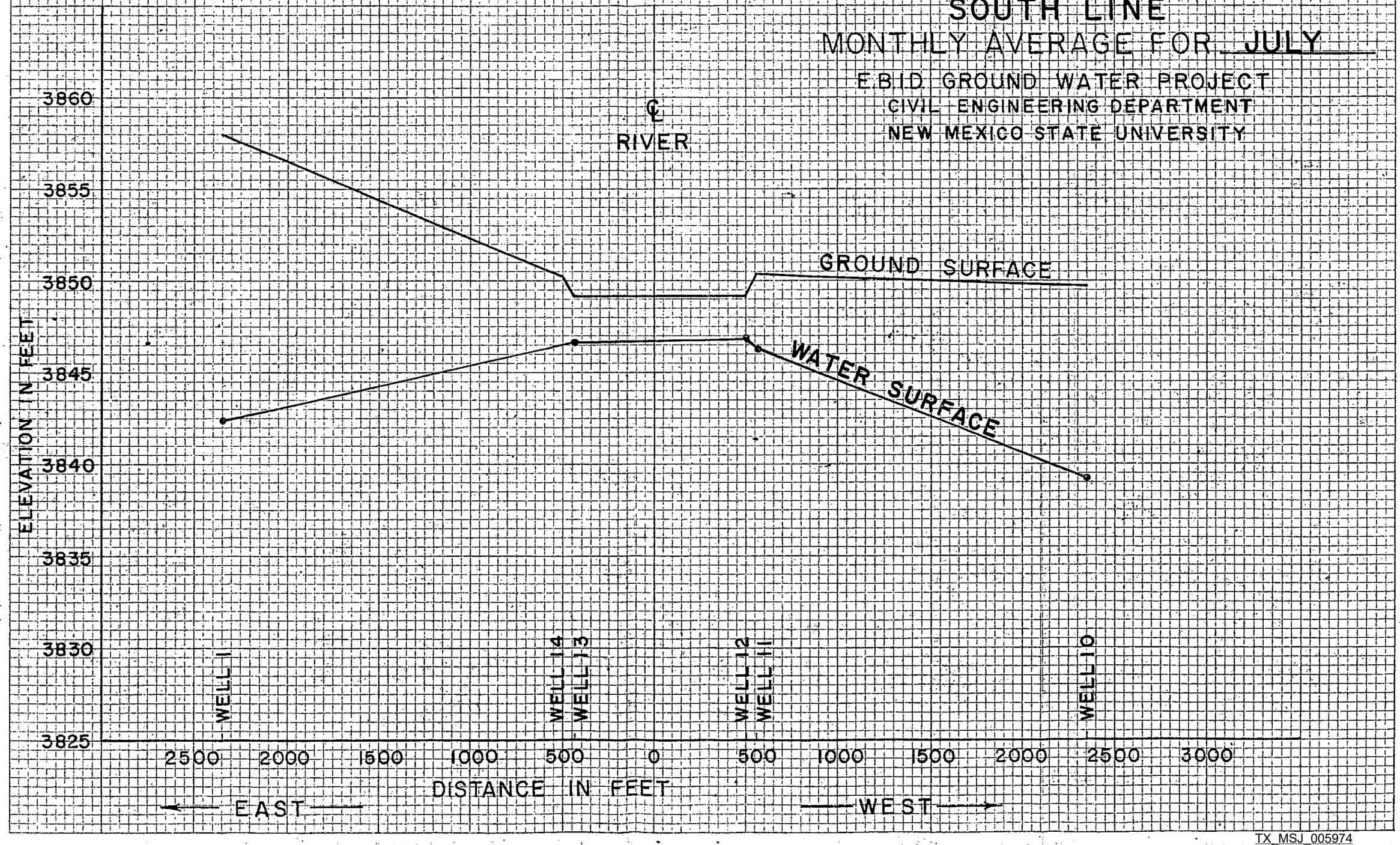
CIVIL ENGINEERING DEPARTMENT
NEW MEXICO STATE UNIVERSITY



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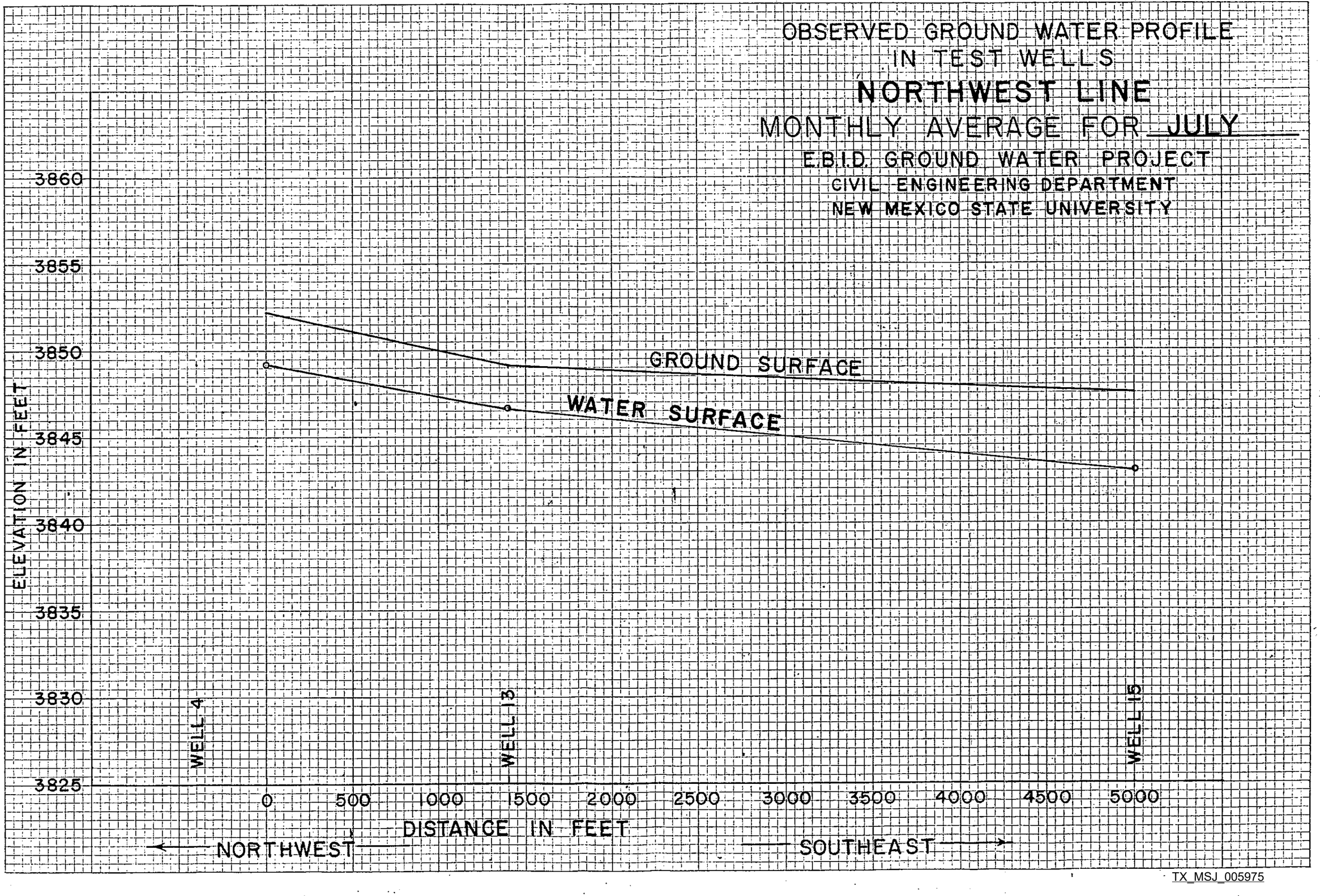
OBSERVED GROUND WATER PROFILE
IN TEST WELLS
NORTHWEST LINE
MONTHLY AVERAGE FOR JULY

E.B.I.D. GROUND WATER PROJECT
CIVIL ENGINEERING DEPARTMENT
NEW MEXICO STATE UNIVERSITY



350-SL KEUFFEL & ESSER CO.
10 X 10 to the Inch.
MADE IN U. S. A.

TX_MSJ_005975

OBSERVED GROUND WATER PROFILE
IN TEST WELLS
NORTH LINE
MONTHLY AVERAGE FOR AUGUST

E.B.I.D. GROUND WATER PROJECT
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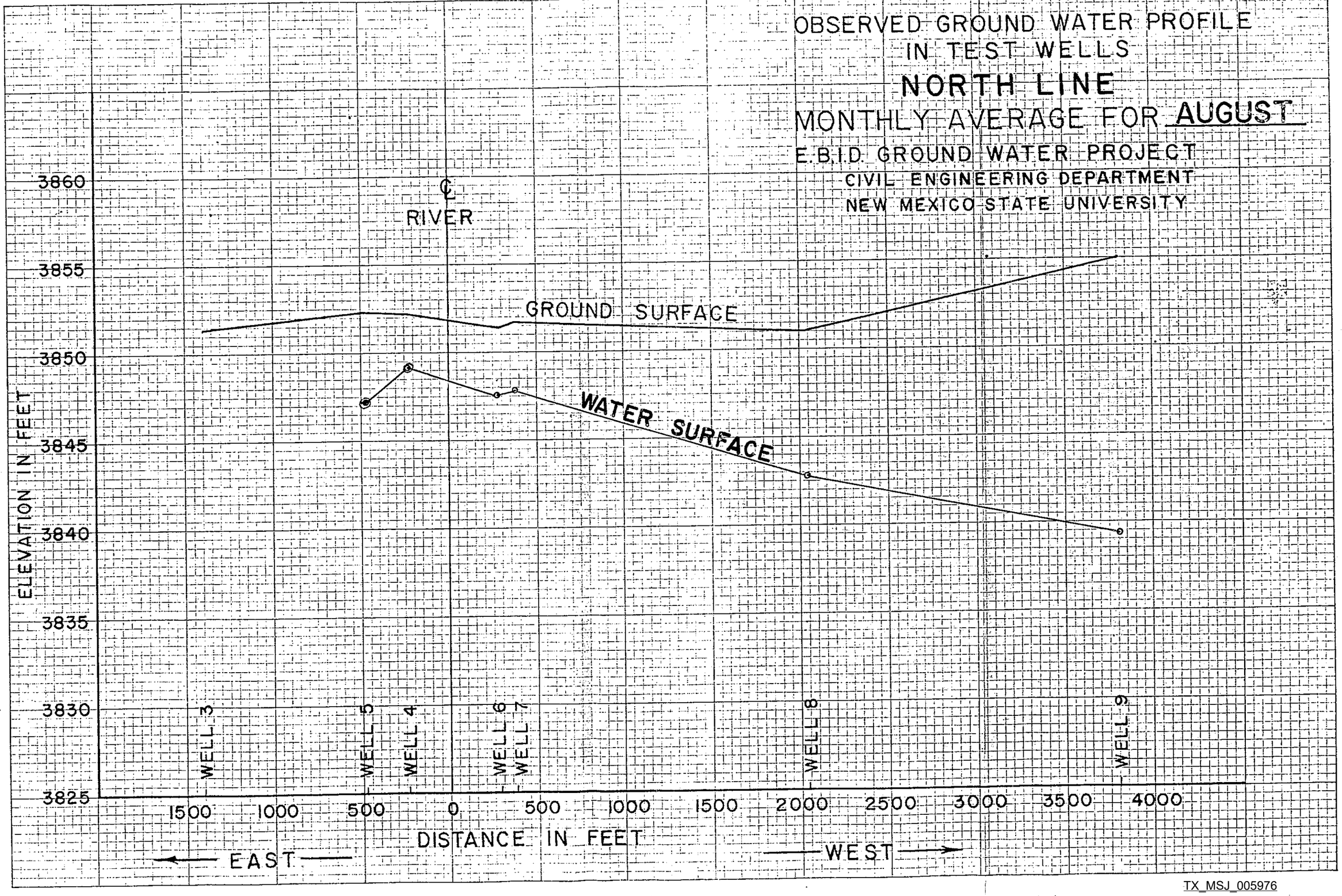

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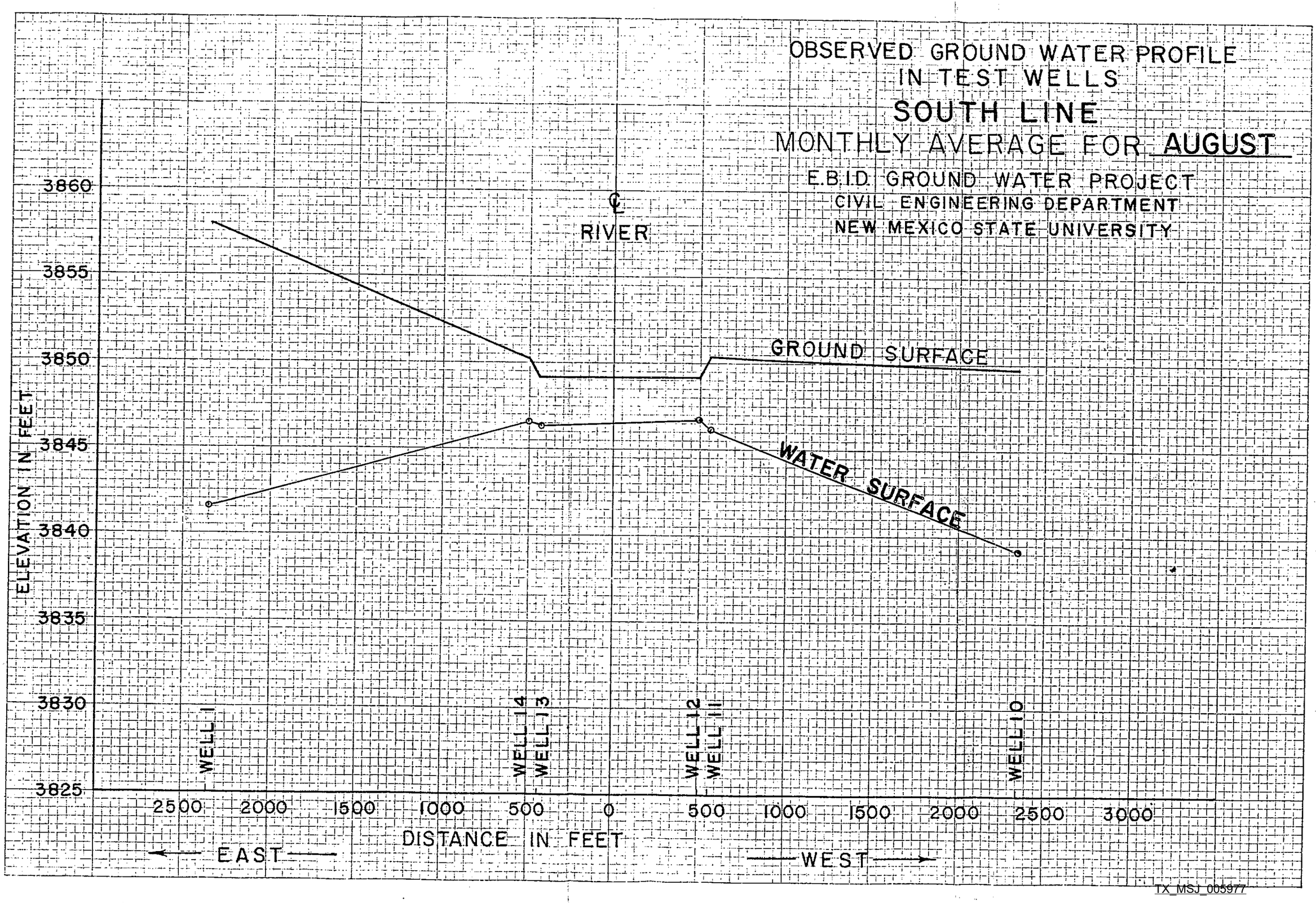

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IN TEST WELLS
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MONTHLY AVERAGE FOR AUGUST
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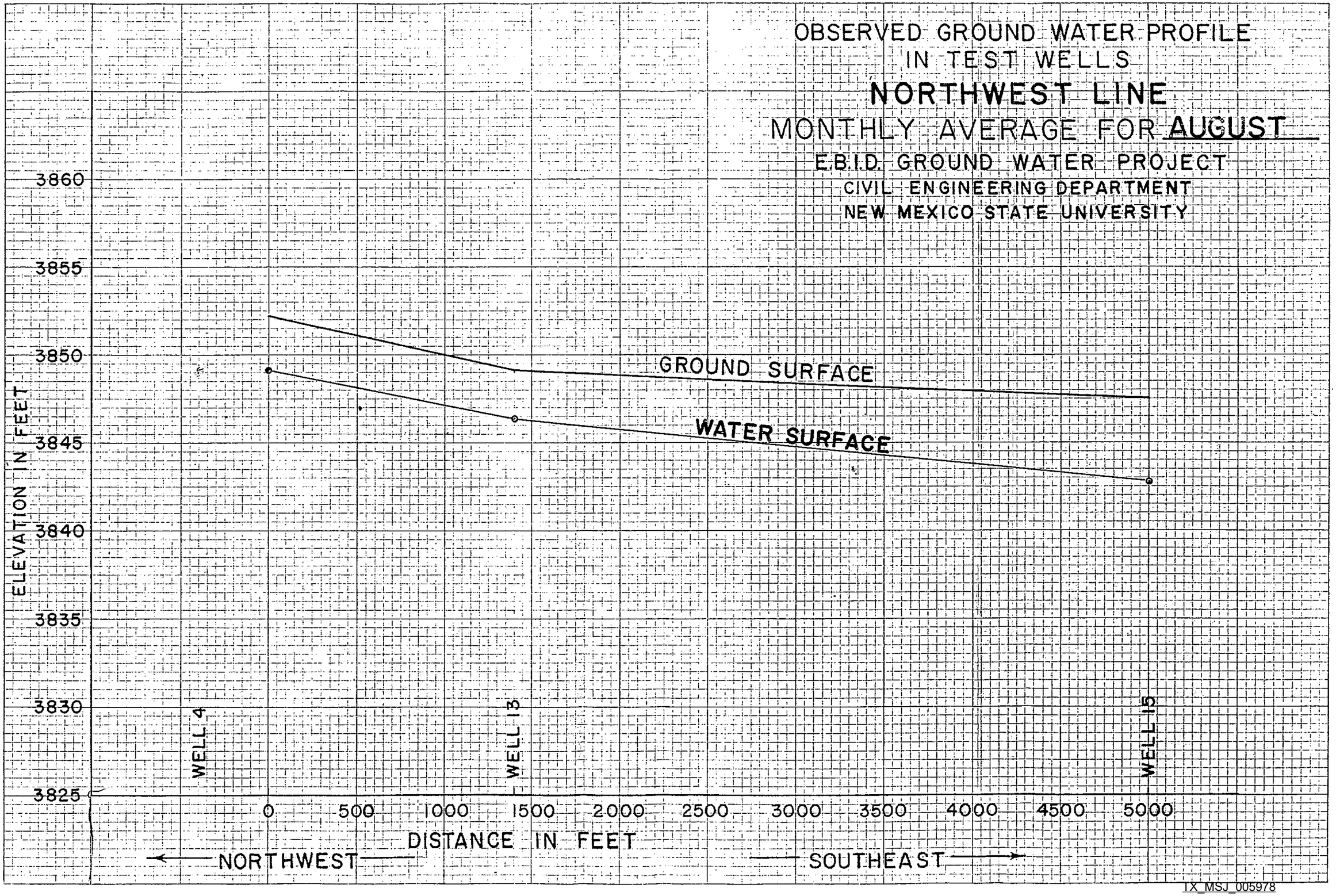

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Ground-Water Resources of the Lower Mesilla Valley Texas and New Mexico

By E. R. LEGGAT, M. E. LOWRY, *and* J. W. HOOD

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1669-AA

Prepared in cooperation with the Texas Water Commission and the city of El Paso



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CONTENTS

	Page
Abstract	AA1
Introduction	2
Purpose and scope of investigation	2
Location and extent of area	3
Previous investigations	3
Acknowledgments	5
Topography	5
Climate	5
Geology	6
Consolidated rocks	6
Unconsolidated deposits	9
Santa Fe group	9
Alluvium	12
Ground water	13
History of development	13
Occurrence and movement	14
Recharge	15
Discharge	17
Fluctuations of water levels	19
Characteristics of wells	26
Hydrologic characteristics of water-bearing materials	28
Ground water in storage	34
Quality of water	35
Ground water	35
Santa Fe group	36
Alluvium	37
Consolidated rocks	39
Surface water	40
Future development	44
Summary and conclusions	46
Selected references	48

TX_MSJ_005981

ILLUSTRATIONS

[Plates are in pocket]

PLATE 1. Map showing location of wells and drains in the lower Mesilla Valley, Tex. and N. Mex.
2. Geologic section *A–A'*, lower Mesilla Valley, Tex. and N. Mex.
3. Geologic section *B–B'*, lower Mesilla Valley, Tex. and N. Mex.
4. Approximate altitude of water levels in wells in the lower Mesilla Valley, January 1957.
5. Fluctuations of water levels in shallow wells in the lower Mesilla Valley, 1946–58.
6. Approximate change of the water table in the lower Mesilla Valley, 1953–59.
7. Fluctuations of water levels in wells in the El Paso city well field northwest of Canutillo, 1957–58.
8. Fluctuations of water levels in wells in the El Paso city well field northwest of Canutillo, 1958–59.

Page

FIGURE 1. Physiographic map of parts of Texas, New Mexico, and Mexico showing the location of the lower Mesilla Valley ... AA4
2. Monthly temperature at El Paso and monthly evaporation at Ysleta ... 7
3. Maximum, minimum, and mean monthly precipitation at El Paso, 1878–1958 ... 8
4. Annual pumpage of ground water in the lower Mesilla Valley, 1953–58 ... 19
5. Fluctuations of water levels due to variations in the load on an aquifer in selected wells in the El Paso city well field northwest of Canutillo, 1958 ... 21
6. Fluctuations of water level in well Q–176 (deep aquifer) due to pumping of well Q–180 (medium aquifer) in the El Paso city well field northwest of Canutillo, Nov. 10–Dec. 31, 1958 ... 22
7. Mean annual discharge of the Rio Grande below Caballo Dam, N. Mex., 1945–58 ... 25
8–10. Theoretical drawdown:
8. In an infinite aquifer (alluvium) due to pumping ... 31
9. 1,600 feet from a well pumping 1,000 gpm ... 32
10. In an infinite aquifer (Santa Fe group) due to pumping ... 33
11. Chloride content of water from wells in the alluvium and from the Rio Grande, 1952–57 ... 38
12. Average chemical quality of water from the Rio Grande at Leasburg Dam, N. Mex., and at El Paso, Tex ... 41
13. Quality and discharge of water in Montoya Drain, 1949–58 ... 42
14. Quality and discharge of water in Anthony Drain, 1949–58 ... 43
15. Increase in mineralization of water from the upper to the lower end of West Drain ... 44

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CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

GROUND-WATER RESOURCES OF THE LOWER MESILLA VALLEY, TEXAS AND NEW MEXICO

By E. R. LEGGAT, M. E. LOWRY, and J. W. HOOD

ABSTRACT

The lower Mesilla Valley extends southward from the vicinity of Anthony, Tex., to the gorge of the Rio Grande north of El Paso and westward from the Franklin Mountains to the east edge of La Mesa. The increase in the use of ground water for the public water supply of El Paso and for supplemental irrigation, when the surface-water allotments were inadequate, emphasized the need for an investigation of the ground-water resources of the lower Mesilla Valley.

The deep and medium aquifers in the Santa Fe group, whose maximum thickness is at least 2,000 feet, are the major sources of ground water for public supply. The alluvium (shallow aquifer), which supplies water chiefly for irrigation and to a lesser extent for industrial and municipal supply, has a maximum thickness of about 150 feet.

The Santa Fe group is recharged by precipitation on the surface of the uplands. The alluvium is recharged by seepage from drains, irrigation canals, and the river, from excess surface water applied to the land, from precipitation on the valley floor, and from the upward movement of water from the Santa Fe group.

Ground water is discharged by evapotranspiration in areas of high water table, by seepage to the drains and river, by underflow at the south end of the valley, and by wells. Except in the uplands, water in the Santa Fe is under confined (artesian) conditions; water in the alluvium is under unconfined (water-table) conditions.

Pumpage of ground water for irrigation and for the public supply of El Paso increased from 1951 through 1956. Irrigation pumpage decreased in 1957 and 1958, when surface-water allotments were increased. In 1958 the city of El Paso wells pumped an average of 6.8 million gallons per day from the deep and medium aquifers of the Santa Fe, an increase of 4.3 million gallons per day from the quantity pumped in 1957. The 1958 pumpage from the medium and deep aquifers is estimated to be about 50 percent of the annual recharge to the Santa Fe.

Aquifer tests in the El Paso city well field northwest of Canutillo indicate substantial leakage between the shallow, medium, and deep aquifers. The coefficients of transmissibility averaged about 60,000 gallons per day per foot in the deep aquifer, 35,000 in the medium aquifer, and 150,000 in the shallow aquifer.

The quantity of fresh water in storage in the Texas part of the valley is estimated to be 560,000 acre-feet, of which 150,000 acre-feet is in the alluvium.

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Less than half the fresh water in storage however, may be recovered by wells, owing to the possibility of salt-water contamination.

North and west of Canutillo, water in the medium and deep aquifers of the Santa Fe is satisfactory for municipal use. The water in the alluvium is relatively fresh but more mineralized than that in the Santa Fe. South of Canutillo, the water in the alluvium is highly mineralized but, generally, is of better quality than the water in the underlying Santa Fe.

Pumping from the medium and deep aquifers may result in the percolation of water of poor quality from the shallow aquifer. Large-scale pumping from the alluvium is possible because of large amounts of recharge from seepage of excess surface water applied to the land and from drain flow.

INTRODUCTION

PURPOSE AND SCOPE OF INVESTIGATION

The purpose of the investigation was to determine the quantity and quality of ground water available in the lower Mesilla Valley for the public supply of El Paso and for industrial and irrigation use. Fieldwork was begun in 1952 but was interrupted in December 1953. The investigation was resumed in 1957 and completed in December 1958. Well records, drillers' logs, sample logs, water-level measurements, and chemical analyses of samples of water on which this report is based are on file with the U.S. Geological Survey. The report contains maps showing the location of wells, the altitude of water levels in various wells, the approximate decline of the water table, and hydrographs showing the fluctuations of water levels in selected wells. Aquifer tests were made at the sites of 15 wells to determine the hydraulic characteristics of the water-bearing formations in the valley. During the course of the investigation, the geology of the valley was studied and geologic sections were prepared. Diagrams and tables show the quality of samples of water from selected wells, from the Rio Grande, and from drains. Wells are numbered to conform to a 10-minute grid system established during the ground-water investigation of the Hueco Bolson in 1954. The grids are identified by letters of the alphabet. Inside the grids the individual wells are numbered consecutively, beginning in the northwest corner. Because the fieldwork and preparation of the report were interrupted, however, it was not possible to maintain the consecutive numbering of the individual wells.

The investigation was made by the U.S. Geological Survey in cooperation with the Texas Board of Water Engineers and the city of El Paso and is part of a statewide program of ground-water investigation. The investigation was made under the administrative direction of A. N. Sayre and P. E. LaMoreaux, successive chiefs of the Ground Water Branch of the U.S. Geological Survey, and under the supervision of R. W. Sundstrom, district engineer in charge of ground-water investigations in Texas.

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LOCATION AND EXTENT OF AREA

The report area includes about 135 square miles in the southern part of the Mesilla Valley, extending from the vicinity of Anthony to the gorge of the Rio Grande about 4 miles north of El Paso. (See pl. 1 and fig. 1.) The lower Mesilla Valley is divided approximately in half by the Texas-New Mexico boundary line; data on several wells in New Mexico are included in the report. The towns of White Spur, Anthony, and Canutillo are near the east edge of the valley in Texas. The village of La Union, N. Mex., near the west edge, is directly across the valley from Canutillo. The valley is served by the Atchison, Topeka, and Santa Fe Railway, by U.S. Highway 80, and by several county roads.

El Paso, the largest city on the United States-Mexico border, lies on the south and southeast flanks of the Franklin Mountains. The population of the metropolitan area in 1957 was estimated to be 250,000. El Paso is a business, livestock, and railroad center, a port of entry from Mexico, and the headquarters of Fort Bliss and Biggs Air Force Base. Industries include smelters, oil refineries, cotton gins, oil mills, textile mills, breweries and soft-drink plants, food-processing plants, and creameries.

PREVIOUS INVESTIGATIONS

Ground-water conditions in the gorge of the Rio Grande north of El Paso and in parts of the Mesilla Valley were first described by Slichter (1905.) He investigated the underflow of the Rio Grande at the narrows above El Paso, the site of a proposed international dam. Lee (1907) in his report on the water resources of the Rio Grande Valley gave data on wells in the Mesilla Valley. He also discussed the quantity, source, and probable discharge of ground water in the Mesilla Valley. Sayre and Livingston (1945) discussed in detail the geology and ground-water resources of the El Paso area. The geologic descriptions of Sayre and Livingston have been most helpful and have been used freely in the geologic discussion in this report.

Other useful reports are by Dunham (1935) on the geology of the Organ Mountains; by Bryan (1938) on the geology and ground-water conditions of the Rio Grande depression; by Conover (1954) on the Rincon and Mesilla Valleys in New Mexico; and by Kottlowski (1958) on the geologic history of the Rio Grande near El Paso.

Ground-water studies at the Federal Correctional Institution near La Tuna were made in 1930, 1935, and 1937, but the reports were not published. Sundstrom (1952) prepared a report on the investigation made in 1952, which incorporated some of the data collected in the earlier investigations.

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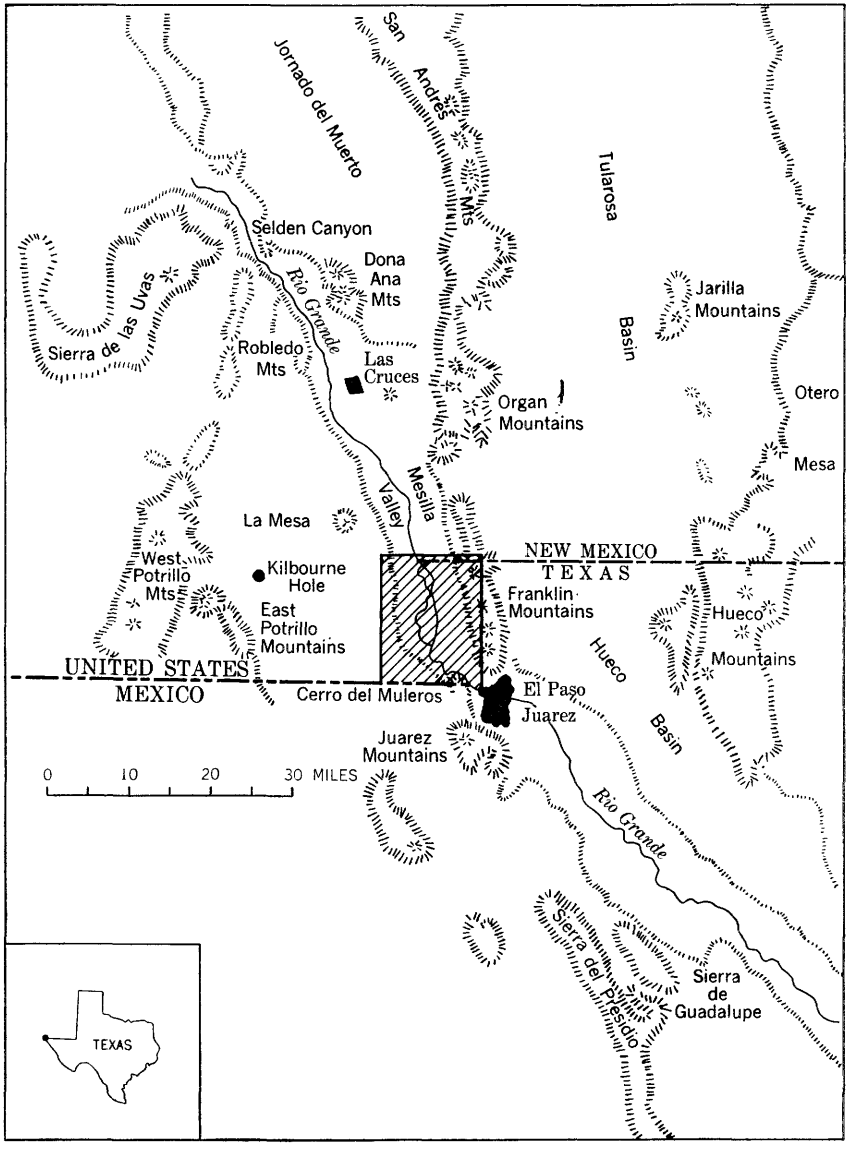

From West Texas Geological Society, 1958

FIGURE 1.—Physiographic map of parts of Texas, New Mexico, and Mexico showing the location of the lower Mesilla Valley.

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ACKNOWLEDGMENTS

The writers appreciate the cooperation and the information contributed by officials of the El Paso Public Service Board, the U.S. Bureau of Reclamation, the U.S. Soil Conservation Service, the International Boundary and Water Commission, and the El Paso Electric Co. The landowners and drillers in the area cooperated generously by furnishing well logs and data.

TOPOGRAPHY

The lower Mesilla Valley is cut into the unconsolidated deposits of La Mesa bolson. The steep-walled valley slopes at the rate of 4.5 feet per mile from the town of Anthony to the gorge of the Rio Grande. The relatively level valley floor ranges in width from less than a thousand feet at the gorge of the Rio Grande to 4.5 miles at Anthony. At the south end of the valley, the Rio Grande flows through a narrow gorge between the Franklin Mountains, which form the eastern boundary of the valley, and the Cerro de Muleros, a conical hill. Mount Franklin, the highest peak of the Franklin Mountains, rises to an altitude of 7,149 feet, about 3,400 feet above the Rio Grande flood plain. Sierra del Cristo Rey (altitude 4,576 feet), the highest point of the Cerro de Muleros, rises 845 feet above the Rio Grande.

The La Mesa surface, which is the second highest of four erosional surfaces recognized by Dunham (1935, p. 178–185), is a broad plain that extends as a nearly unbroken surface from Las Cruces, N. Mex., southward into Mexico. East of the Rio Grande the La Mesa surface consists of dissected pediments on the flanks of the Franklin Mountains. The various erosional surfaces are due to pedimentlike planation and local stream terracing. They were built up and dissected by tributary streams from the uplands and then graded to particular flood-plain levels of the Rio Grande. The lower surfaces are terrace levels, which are almost entirely the work of tributary streams (Kottlowski, 1958, p. 53).

CLIMATE

The lower Mesilla Valley is arid, and its climate is characterized by a wide range in temperature, low humidity, high evaporation, and low precipitation. According to U.S. Weather Bureau records, the mean annual temperature at El Paso from 1887 to 1958 was about 63° F. Figure 2 shows the average monthly temperature during this period. Large diurnal temperature changes are common. Summer temperatures during the day frequently rise to more than 90° F and occasionally to more than 100° F and dip to the 60's at night. Winter temperatures below freezing occur on an average of about 45 days per year. Small amounts of snow fall nearly every year but seldom remain on the

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ground for more than a few hours. The growing season, from the last killing frost in the spring to the first killing frost in the fall, averages about 200 days. Sandstorms occur at any time during the year; however, storm frequency and intensity are greatest in March and April.

The average relative humidity is less than 50 percent, indicating a high rate of evaporation. The evaporation from a free-water surface averages 107.43 inches, or about 12 times the average annual precipitation. Figure 2 shows the average monthly evaporation at Ysleta from 1948 to 1958.

Rainfall is insufficient for the growth of any except desert vegetation, and irrigation is necessary for crops, gardens, and lawns. The average annual precipitation at El Paso for the period 1878–1958 was 8.71 inches. More than half the precipitation is concentrated during the summer in brief but heavy thundershowers. Although the time distribution of rainfall is advanageous for agrciulture, the amount is inadequate and must be supplemented by irrigation from surface- or ground-water supplies. Figure 3 shows the maximum, minimum, and mean monthly precipitation at El Paso from 1878 to 1958.

GEOLOGY

The Mesilla Valley was formed by the downcutting of the Rio Grande in La Mesa bolson. La Mesa is a structural basin filled with unconsolidated or slightly consolidated deposits of Tertiary and Quaternary age derived from the erosion of bordering highlands. The highlands were reduced in late Tertiary time and later rejuvenated to form the present ranges.

The main body of sediments in the lower Mesilla Valley belong to the Santa Fe group of middle(?) Miocene to Pleistocene(?) age (Spiegel and Baldwin, 1963). Sediments of more recent age overlie the Santa Fe group as outwash-fan deposits, windblown deposits, and alluvium laid down by the Rio Grande. As the alluvium is derived from the erosion of the Santa Fe group and consequently shows similar characteristics, it is difficult to determine the contact between the alluvium and the Santa Fe.

CONSOLIDATED ROCKS

Consolidated rocks in and near the lower Mesilla Valley include both igneous and sedimentary rocks ranging in age from Precambrian to Tertiary. Most of the igneous rocks are Precambrian or Tertiary in age; the sedimentary deposits are pre-Tertiary. The largest areas of outcrop are in the Franklin and Organ Mountains. In the area between the Franklin Mountains and the Cerro de Muleros, andesite porphyry crops out. Cretaceous limestone and shale are exposed on

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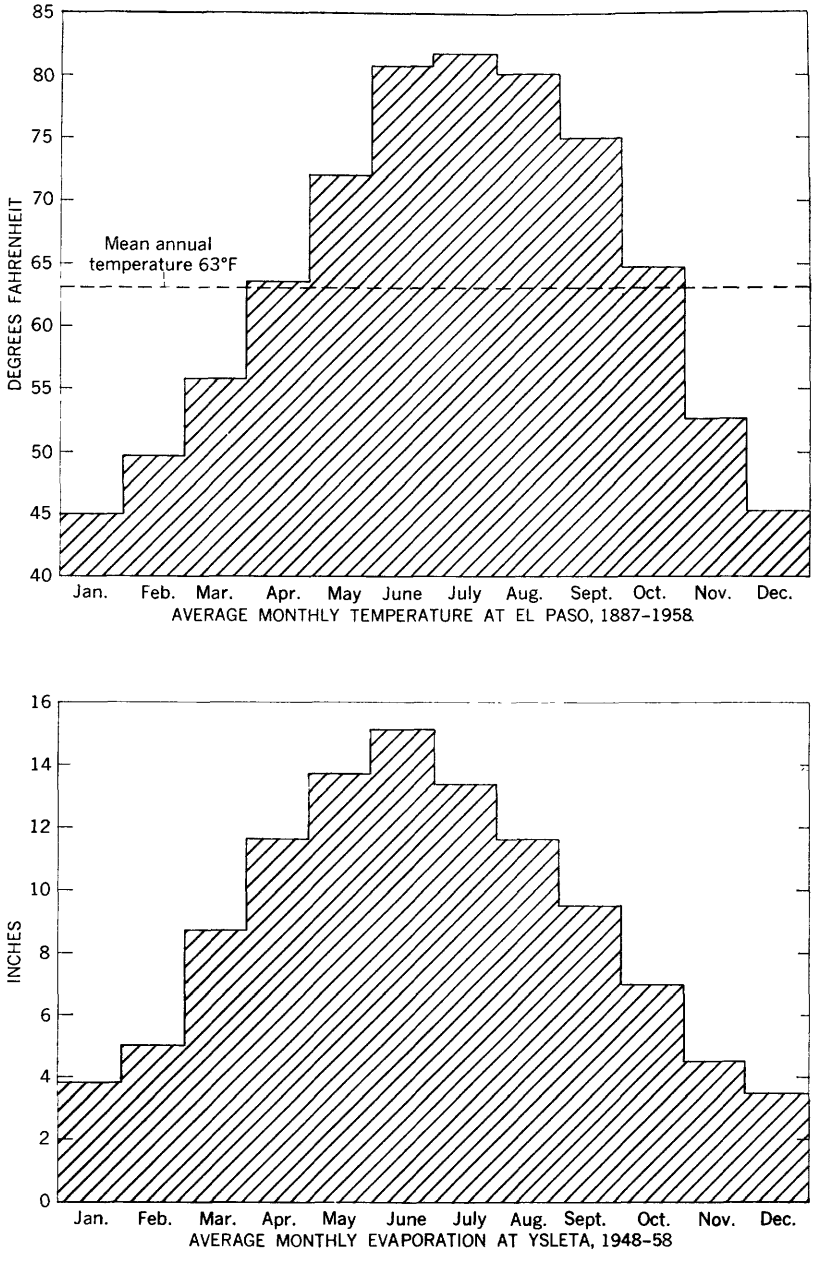

FIGURE 2.—Monthly temperature at El Paso and monthly evaporation at Ysleta, Tex. (From records of U.S. Weather Bureau.)

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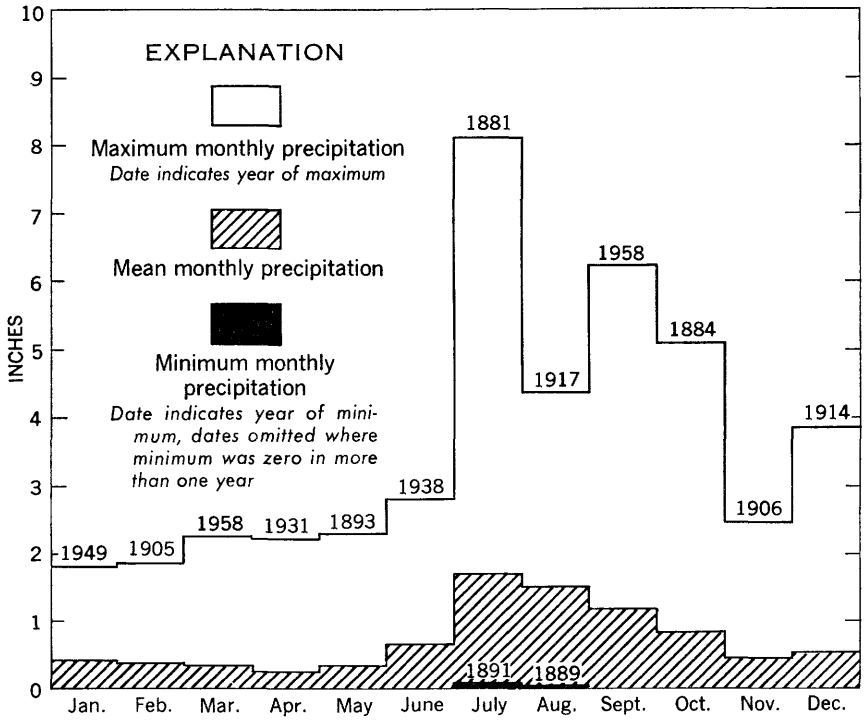

FIGURE 3.—Maximum, minimum, and mean monthly precipitation at El Paso, Tex., 1878–1958. (From records of U.S. Weather Bureau.)

the flanks of the igneous core of the Cerro de Muleros. The obstruction of the lower end of the valley by andesite, which was intruded prior to deposition of the Santa Fe group, materially affects the quality of water in the valley. Cretaceous sedimentary rocks are exposed around cores of Tertiary volcanic rocks (andesite porphyry) about 2 miles northeast of White Spur.

Most of the wells that penetrate consolidated rocks are either on the uplands between the flood plain and the Franklin Mountains north and northwest of the Cerro de Muleros or in the Rio Grande gorge. Several wells which range in depth from 83 to 1,573 feet and which have been drilled to the bedrock beneath the water-bearing Santa Fe group north and northwest of the Cerro de Muleros do not obtain water from consolidated rocks. Well U–59 in the gorge obtains a moderate supply of water satisfactory for industrial use from consolidated rocks of Cretaceous age.

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Several wells penetrated bedrock below varied thicknesses of alluvium in the upland east and southeast of White Spur. Well U–12, depth 1,690 feet, obtained water from limestone and sandstone at 1,590 feet. The well which reportedly yielded 200 gpm (gallons per minute) was abandoned because of the high fluoride content of the water. Six wells (Q–158 to Q–163) probably obtain small quantities of water from bedrock; however, it is possible that some of them obtain water from the overlying alluvium.

Well Q–138, depth 1,074 feet, known as Lippincott well in the south-central part of the valley, is reported to have flowed salty water. According to the driller's log, well Q–138 penetrated sandy zones in the bedrock below 822 feet that contained small quantities of water.

On the upland east of U.S. Highway 80, eight wells penetrated bedrock at depths ranging from 177 feet (Q–77) to 820 feet (Q–72). Only well Q–76 was tested; it yielded small quantities of potable water from "black rock," probably of Pennsylvanian age.

An abnormally high thermal gradient of ground water in the medium and deep aquifers of the Santa Fe group suggests that the temperature of the ground water is affected by the latent heat of the igneous rocks that are scattered throughout the area. In six wells in the medium and deep aquifers, the thermal gradient ranged from 1°F per 33 feet to 1°F per 41 feet, which is considerably greater than the thermal gradient in the Hueco Bolson.

In general, the consolidated rocks in the lower Mesilla Valley are not a source for moderate or large supplies of ground water.

UNCONSOLIDATED DEPOSITS

Unconsolidated deposits in the lower Mesilla Valley consist of sand, gravel, clay, silt, caliche, and conglomerate. According to Bryan (1938, p. 205), most of the sediments in La Mesa bolson belong to the Sante Fe group. The unconsolidated deposits contain the shallow, medium, and deep aquifers. Although these aquifers are discussed as separate water-bearing units, they are hydraulically connected. The shallow alluvial deposits and a part of the underlying Sante Fe group compose the shallow aquifer. The bulk of the Santa Fe group comprises the medium and deep aquifers.

SANTA FE GROUP

The Santa Fe group underlies the lower Mesilla Valley and is exposed in nearly all the arroyos between the flood plain and the Franklin Mountains and in the bluffs at the east edge of La Mesa. In the

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uplands east of the Rio Grande, the top of the Santa Fe, which consists mostly of coarse sand and gravel containing some caliche-cemented boulders, probably is correlative with the Pleistocene cap of the Santa Fe, as defined by Spiegel and Baldwin (1963). A thick series of red to brown silty clay and fine to medium sand or poorly consolidated sandstone and thick-bedded conglomerate underlies the coarse sediments.

Characteristic responses in electric logs of eight wells northwest of Canutillo suggest that the Santa Fe may be subdivided into two units. In electric logs, the curve on the right side of the baseline represents the relative resistivity of the individual beds. A deflection of the resistivity curve to the right (increase in resistance) usually indicates a fresh water-bearing sand. Sand beds containing brackish or salty water have low resistance and cause little or no deflection of the resistivity curve. The approximate base of fresh water was determined from interpretation of electric logs and from water analyses. It is not possible to determine on the basis of available data if the units can be correlated over a large part of the valley.

The lower unit (the deep aquifer of the well field northwest of Canutillo) is composed of unconsolidated fine to medium sand; the percentage of clay is smaller than in the upper unit. The low, but uniform, resistivity response in the well field suggests that the sand in the lower unit is uniform, thick bedded, and relatively free of interbedded shale or clay. The lower unit reaches a maximum thickness of at least 1,000 feet in well Q–178; electric logs indicate that the lower unit thickens to the north and west.

The upper unit of the Santa Fe, which contains the medium aquifer and a part of the shallow aquifer of the El Paso well field, is exposed in arroyos above the flood plain and in the bluffs of La Mesa. It consists of alternating layers of varied thickness of fine to coarse sand, gravel, and reddish-brown silty clay. Locally the sand is cross-bedded, lenticular, and predominantly medium grained. The fact that the clay is evenly bedded in many exposures along Mesa Road (U.S. 80) indicates that clay layers may extend laterally for considerable distances.

The following section near Anapra, Dona Ana County, N. Mex., was measured by Sayre (Sayre and Livingston, 1945, p. 32). The top 7 feet, consisting of sediments of Recent and Pleistocene age, is underlain by sediments of the upper part of the upper unit of the Santa Fe. The sand and gravel underlying the Recent and Pleistocene sediments may be equivalent to the Pleistocene cap of the Santa Fe group.

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	Feet
Topsoil, very sandy, reddish-buff, partly removed.	
Caliche, hard, dense, white; grades downward into very fine gray sand	7
Sand, moderately fine, light-gray, uncemented; contains layers of gravel and igneous-rock pebbles, mostly derived from lava flows	5
Clay, sandy, brown	1
Quartz sand, medium; mixed with pellets of calcium carbonate	.5
Sand, medium to coarse, salt and pepper	6
Clay, sandy, brown to gray	2
Sand, medium to coarse, light-gray, crossbedded; contains some coarse gravel	45
Sand, clayey, fine, massive, light-buff; contains irregular lenses of clean sand. Tubes of sand cemented with calcium carbonate are near the base	9
Sand, extremely fine, gray; layers of coarse sand near middle	14
Clay, gray, much disturbed and broken	1.3
Sand, medium, gray; laminated layers of alternating black and white sand near base	30
Sand, clayey, light-buff, crossbedded	1.5
Sand, medium, loose, gray	6
Sand, fine, buff to gray, crossbedded; pellets of clay and caliche on bedding planes	2.5
Covered; mostly sand	25
Clay, light-buff, and sandy clay	6
Sand, fine, light-gray, crossbedded	5
Clay, laminated, light-buff, and sandy clay	2.5
Sand, fine, gray, crossbedded	3
Clay, massive, light-buff	2.5
Sand, fine, massive, yellowish-buff, cemented; grades into gray sand near base; partly covered	30
Clay, chocolate-brown, and interbedded light-buff massive sandstone	11
Sand, brown, crossbedded, partly covered	10
Clay, silty, buff- to chocolate-brown	9
Total	234.8

In the flood plain, the upper unit reaches a depth of 470 feet in well Q–86, 678 feet in well Q–178, and possibly 1,100 feet in well Q–144. According to electric logs and drillers' logs, the maximum thickness of the upper unit is at least 1,000 feet and perhaps as much as 1,400 feet.

Electric logs and drillers' logs reveal that in the flood plain a thick-bedded limestone conglomerate underlies the lower unit but that east of the flood plain the conglomerate occurs within the Santa Fe. The conglomerate, derived from limestone that probably is of Cretaceous age (Virgil Barnes, oral communication, Feb. 27, 1957), has a maximum observed thickness of 160 feet in well Q–173. According to the electric and driller's logs of well Q–173, the conglomerate is underlain by clay, sand, and gravel. Although the sediments underlying the conglomerate probably are Santa Fe in age, they are not included in the lower unit. Plates 2 and 3 show that the conglomerate lies at a greater depth north and west of well Q–173. Well Q–178, depth

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1,705 feet, did not penetrate the conglomerate. The highly resistive zone between 1,280 and 1,380 feet in well Q–178 is an igneous sill underlain by sand, shale, and clay of the lower unit of the Santa Fe. The igneous rock penetrated by well Q–178 may be associated with the series of volcanic rocks interbedded with the Santa Fe group of sediments near Las Cruces, N. Mex.

The maximum thickness of the Santa Fe group in the lower Mesilla Valley is not known; unconsolidated sediments were penetrated to a depth of 1,705 feet in well Q–178. The original thickness of the unconsolidated sediments in the area, whose surface is about 300 feet lower than La Mesa, may have been about 2,000 feet. Because the sediments thicken toward the center of the basin, however, it is probable that the maximum thickness of the Santa Fe is considerably greater.

The medium and deep aquifers of the Santa Fe group are the major sources of ground water for public supply in the valley. Many wells obtain water from both the Santa Fe and the alluvium. Yields as large as 3,000 gpm of fresh water have been obtained from the Santa Fe north and northwest of Canutillo. South and southwest of Canutillo, the water in the Santa Fe is brackish or salty. Small to moderate quantities of fresh water have been obtained from the Santa Fe in the upland east of the Rio Grande, where the saturated thickness is much less.

ALLUVIUM

The alluvium consists of poorly sorted sand, gravel, clay, and silt, the thickest section of which is the valley fill in the flood plain. On La Mesa and the lower terraces, the alluvium is thin, generally consisting of a veneer of windblown sand or a cap of coarse gravel.

The maximum thickness of the alluvium is not known. Bryan (1938, p. 218) stated that the depth of gravel in the riverbed may be taken as a rough measure of the depth of scour in great floods. Because of the shifting riverbed, the gravel may be penetrated at different depths in wells that are relatively near together; thus, individual beds cannot be correlated from well to well. Conover (1954, p. 25) reported that the alluvium near Las Cruces, N. Mex., is about 220 feet thick. Slichter (1905, fig. 2) showed the maximum depth of the fill in the gorge to be not more than 86 feet. Gravel or very coarse sand was penetrated in 29 wells at depths ranging from 42 to 130 feet. Therefore, it may be assumed that the thickness of the alluvium probably does not exceed 150 feet.

The alluvium in the valley is the major source of ground water for irrigation and for industrial use. Yields as large as 3,015 gpm have been obtained. The water in the alluvium varies in quality. Generally, it is more mineralized than the water in the river or in the

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underlying Santa Fe, but south of Canutillo, the water in the alluvium is less mineralized than the water in the Santa Fe.

GROUND WATER

HISTORY OF DEVELOPMENT

Prior to 1950, the principal use of ground water in the lower Mesilla Valley was domestic. In 1922 the city of El Paso drilled two test wells in the south end of the valley. Chemical analyses of samples showed that the water in the two wells, one of which is known as the Lippincott well (Q–138), was too highly mineralized for most purposes. Mr. Paul Harvey, owner of the waterworks at White Spur, drilled several wells in the vicinity in search of water suitable for public supply. Of 11 wells drilled in 1946, only 8 produced water of satisfactory quality. In 1951 and 1952, the city of El Paso drilled six wells in the shallow aquifer about 1 mile northwest of Canutillo. The water was pumped into the river for delivery to the treatment plant in El Paso. Because of excessive transmission losses, however, a pipeline capable of delivering 20 mgd (million gallons per day) was built. In 1955, six more wells were drilled in the shallow-well field. The total capacity of the wells in the shallow-well field is about 15 mgd.

In 1953 nine test wells were drilled in the valley as a part of the cooperative exploratory program in the Hueco Bolson. The wells were electrically logged, and chemical analyses were made of water samples from various depths. As a result of the program, the city drilled six wells in the period 1956–58 about 3 miles northwest of Canutillo, five wells ranging in depth from 1,072 to 1,262 feet and one well 550 feet deep. The wells, which obtain water from the deep and medium aquifers, have a total capacity of about 16 mgd.

Small quantities of ground water were used as supplemental supplies for irrigation for many years before 1954. In 1946 only 2 large-capacity wells were being used; during the period 1946–50 the number of irrigation wells increased to 16. Because of the decrease of surface water in storage in Elephant Butte and Caballo Reservoirs, N. Mex., the use of ground water for irrigation as a supplement to surface water increased rapidly. During 1951, 54 irrigation wells were drilled; by the end of 1954, about 250 wells were used to irrigate 15,000 acres of cotton and alfalfa with 40,000 acre-feet of water (Smith, 1956, p. 10). In October 1957, the Bureau of Reclamation reported that approximately 205 irrigation wells were in operation.

The large-scale industrial use of ground water began in 1951, when the American Smelting and Refining Co. and the El Paso Electric

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Co. drilled 40 test wells in the south end of the valley. As a result of this program, a well field of 10 wells was developed. The industrial use of ground water increased each year, except in 1958, when the American Smelting and Refining Co. abandoned its well field.

OCCURRENCE AND MOVEMENT

The principles of the occurrence and movement of ground water in rocks have been described by Meinzer (1923a, p. 2–192; 1923b; 1942, p. 385–497) and Wenzel (1942) among others. The occurrence and movement of ground water in the lower Mesilla Valley are discussed briefly here.

In the lower Mesilla Valley, ground water occurs under water-table (unconfined) and artesian (confined) conditions. In the alluvium of the flood plain and the Santa Fe group in the uplands, water is unconfined and does not rise in wells above the level at which it is first found.

In the valley, where the relatively impermeable clay of the Santa Fe group probably retards the movement of water between the deep and shallow aquifers, the water is confined under sufficient pressure to cause it to rise above the water table in the shallow deposits and in some wells to cause it to flow. For example, in January 1957 the water level in well Q–172 rose 1.25 feet above the land surface and about 8 feet above the water table in the alluvium.

The general direction of ground-water flow in the uplands is toward the Rio Grande. Conover (1954, p. 32) stated "ground water does not flow southward under La Mesa to Mexico but rather, from the Mexican boundary * * * northward and eastward to the Rio Grande." There is a ground-water divide in the pass between the Organ and Franklin Mountains. West of the divide, ground water flows toward the Rio Grande.

Plate 4 shows by contour lines the configuration of the water table in the alluvium in the lower Mesilla Valley in 1957. The movement of ground water, which is at right angles to the contours, generally is toward the south, except where large or concentrated withdrawals of ground water have formed cones of depression. The depressions, roughly conical in shape, are produced in a water table or piezometric surface by pumping. The gradient of the water table in the alluvium from the town of Anthony to the 3,736-foot contour near the forge is about 4 feet per mile, approximately the same as that of the river. On La Mesa, the water-table gradient from Strauss, N. Mex., eastward to the 3,745-foot contour was about 7 feet per mile in 1953. In the deep-well field 3 miles northwest of Canutillo, the gradient of the piezometric surface was not obtained because of interference from pumping. The piezometric surface is the imaginary surface to which

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the artesian water will rise in tightly cased wells that penetrate the aquifer. It is probable, however, that the gradient approximates that of the water table in the shallow aquifer.

RECHARGE

Ground water in the lower Mesilla Valley is derived as follows: From direct infiltration of precipation; from seepage from canals and laterals from the Rio Grande; from irrigation water applied to the land; and from ground-water flow from the uplands.

Precipitation on the valley floor probably does not contribute appreciable quantities of water to the ground-water reservoir. Most of the precipitation occurs in showers during the summer, when the evaporation rate is high; it does not reach the water table except during wet periods.

Most of the recharge to the shallow ground-water reservoir is derived from seepage from canals, laterals, and from irrigation water applied to the land. The quantity derived from each source is difficult to determine, but Conover (1954, p. 77) estimated that during an average year the irrigation water applied to the land in excess of crop requirements was about 17 percent of the gross diversion from the Rio Grande. Guyton and Scalapino in a consulting report to the El Paso Public Service Board estimated the annual recharge from canals, laterals, and irrigated lands to be at least 2 acre-feet per acre of land irrigated and generally somewhat more, or at least 36,000 acre-feet. This amounts to about 50 percent of the water applied for irrigation. Before large withdrawals of ground water for irrigation, the water derived from seepage from canals, laterals, and irrigated lands actually was in transit to the drains and to the river. Conover (1954, p. 44) estimated that from 1930 to 1946 the average return of drain flow in the Mesilla Valley was 52 percent of the reported net diversion from the river.

When surface-water supplies are adequate, the Rio Grande is an effluent, or gaining, stream during most of the year and in effect is a drain for La Mesa bolson. As a result of large-scale pumping, however, the river temporarily becomes an influent, or losing, stream locally, where the water table is lower than the riverbed. In January 1953 the Rio Grande was effluent from Anthony south to the gorge. Losses from the river to the ground-water reservoir became evident in 1955; in 1957 they were considerable, owing to the large increase in the withdrawal of ground water for irrigation and public supply. For example, Duisberg (1957, p. 67) reported that transmission losses for the Rio Grande project below Caballo Reservoir were low before 1950, but that in 1955 they were about 65 percent and in 1956 about 75 percent of the flow.

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In addition, the city of El Paso in 1955 pumped about 10 mgd into the river for delivery to the treatment plant in the city. Duisberg (1957, p. 67) reported that the water flowed in the river for about 5 miles before returning to the ground-water reservoir. Plate 4 shows that the river in 1957 continued to lose water between Vinton Bridge and Canutillo, although it is effluent between Anthony and Vinton Bridge.

The river between Vinton Bridge and Canutillo forms the east edge of the El Paso shallow well field and is within the cone of depression created by withdrawals from the field. Because losses to or gains from the river change seasonally and yearly in rseponse to pumping and other factors, it is not possible to determine the amount of recharge to the ground-water reservoir that is derived from the Rio Grande.

The accretion of ground water to the lower Mesilla Valley from the adjoining uplands and from the upper Mesilla Valley is about 12,000 acre-feet per year, or 11 mgd. The average gradient of the water table in La Mesa between Strauss and the flood plain is approximately 7 feet per mile. If the transmissability (defined on p. AA28) of the sediments in this area is about 50,000 gpd per ft, somewhat less than the transmissability of the Santa Fe group in the valley, the flow toward the valley would be about 0.5 cfs (cubic feet per second) per lineal mile, or about 5 mgd from La Mesa to the river. The accretion of ground water from the uplands on the east side of the valley may be somewhat higher because of greater precipitation in the mountains and the greater permeability of the arroyo beds. Conover (1954, p. 36) estimated the average accretion from the uplands on the east side of the valley to be about 0.7 cfs per mile, or about 6 mgd.

In addition to the flow from the adjoining uplands, ground water from New Mexico enters the Texas part of the valley. It is estimated that approximately 5.3 mgd moves across the New Mexico State line at Anthony into the Texas part of the lower Mesilla Valley. The estimate is based on a gradient of 4.5 feet per mile and a transmissibility of 260,000 gpd per ft. If it is assumed that the gradient in the Santa Fe group is equivalent to that in the alluvium, approximately 2.2 mgd, or about 40 percent, of the water that enters the valley near Anthony is in the Santa Fe. Inasmuch as most of the recharge from the adjoining uplands is into the Santa Fe, it is estimated that the total natural recharge to the Santa Fe is about 13 mgd, or about 14,500 acre-feet per year. Thus, the annual natural recharge to the ground-water reservoir in the lower Mesilla Valley is at least 16 mgd, or nearly 18,000 acre-feet.

Although the three aquifers, as defined on page AA9, function as a single hydrologic system, water may move from one aquifer to another

in response to a change in pressure. Before 1957, water discharged from the shallow aquifer was replaced, in part, by water leaking from the underlying aquifers. Since pumping began from the medium and deep aquifers, however, water may move from the shallow to the deeper aquifers.

When the ground-water reservoir is full, any additional water becomes drain flow. When storage space is created by lowering the water table below the bed of the drains, drain flow represents a potential source of recharge to the ground-water reservoir.

DISCHARGE

Ground water is discharged from the lower Mesilla Valley as follows: By drains; by seepage into the Rio Grande; by evaporation from the drains, the river, and water-table ponds; by transpiration; by underflow at the south end of the valley; and from wells.

After release of water from Elephant Butte Reservoir in 1916 for irrigation, seepage from the river and canals caused a rise in the water table that necessitated construction of drains to prevent waterlogging. Conover (1954, p. 66) stated that the average gradient of the water table down the valley in 1954 was the same as it was in 1917, the effect of the drains having been an overall lowering of the water table. Thus, the net effect of the drains did not change the balance between natural recharge to and discharge from the ground-water reservoir.

The annual discharge, in acre-feet, of the Montoya Drain, which includes drain flow from the Nemexas and West Drains, is shown in the following table taken from records of the U.S. Bureau of Reclamation.

Year	Nemexas	West	Montoya [1]
1946	16, 690	54, 810	77, 760
1947	13, 610	42, 550	58, 890
1948	14, 910	40, 210	65, 830
1949	16, 460	46, 630	76, 580
1950	18, 190	43, 780	73, 100
1951	12, 020	25, 350	43, 760
1952	10, 240	16, 950	26, 940
1953	9, 370	14, 760	30, 920
1954	2, 380	3, 700	10, 200
1955	695	1, 080	4, 420
1956	490	824	3, 210
1957	908	1, 006	4, 300
1958	3, 740	3, 630	15, 660
Average	9, 200	22, 700	37, 000

[1] Also contains flow from Nemexas and West Drains.

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In the period 1946–58, drain flow ranged from 3,210 acre-feet in 1956 to 77,760 acre-feet in 1946, averaging 37,000 acre-feet. The average discharge from drain flow seems to be in the same order of magnitude as the recharge estimated from seepage from canals and laterals and excess irrigation water applied to the land. From 1946 to 1950, when surface-water supplies for irrigation were adequate, drain flow was relatively uniform. Between 1950 and 1957, drain flow decreased because of the decrease in surface-water allotments and the increase in use of ground water as a supplemental irrigation supply.

The amount of discharge of ground water by seepage into the Rio Grande in the lower Mesilla Valley has not been determined. Since 1950 the amount of ground water discharged by seepage into the river probably has decreased because of the increase in ground-water withdrawals for irrigation and the concomitant decline in the water table. In 1953 ground water was discharged to the river from north of Vinton Bridge to the gorge, but in 1957 seepage to the Rio Grande was confined to that part of the river north of Vinton Bridge.

Discharge of ground water by underflow at the gorge is small. According to Slichter (1905, p. 13), ground-water flow in the alluvium in the gorge did not exceed 11,200 cubic feet per day, or 94 acre-feet annually.

Prior to large-scale irrigation with surface water, a great part of the ground water in the valley was discharged by evapotranspiration. The average annual discharge of ground water by evapotranspiration was balanced approximately by the average annual natural recharge.

Before 1951 the amount of water pumped from wells was small because most of the irrigated land had surface-water rights, and the surface-water supply from Elephant Butte Reservoir was adequate. From 1951 to 1957, pumpage for irrigation increased markedly because of a shortage of surface water available for irrigation. In addition, large amounts of ground water were pumped for municipal and industrial supplies.

Annual irrigation pumpage of ground water is considered to be the difference between the surface-water allotment and the quantity of water required for irrigation. Figure 4 shows the total annual pumpage from the ground-water reservoir in the lower Mesilla Valley from 1953 to 1958, including municipal and industrial pumpage.

The increase in pumpage of ground water from 24,000 acre-feet in 1953 to 59,500 acre-feet in 1956 is due mainly to the decrease in surface-water allotment from 1.9 acre-feet to 0.39 acre-foot per acre during this period. In 1957 and 1958, ground-water pumpage was estimated to be 46,000 and 17,000 acre-feet, respectively. This decrease was due to the above-normal precipitation and a concomitant increase in sur-

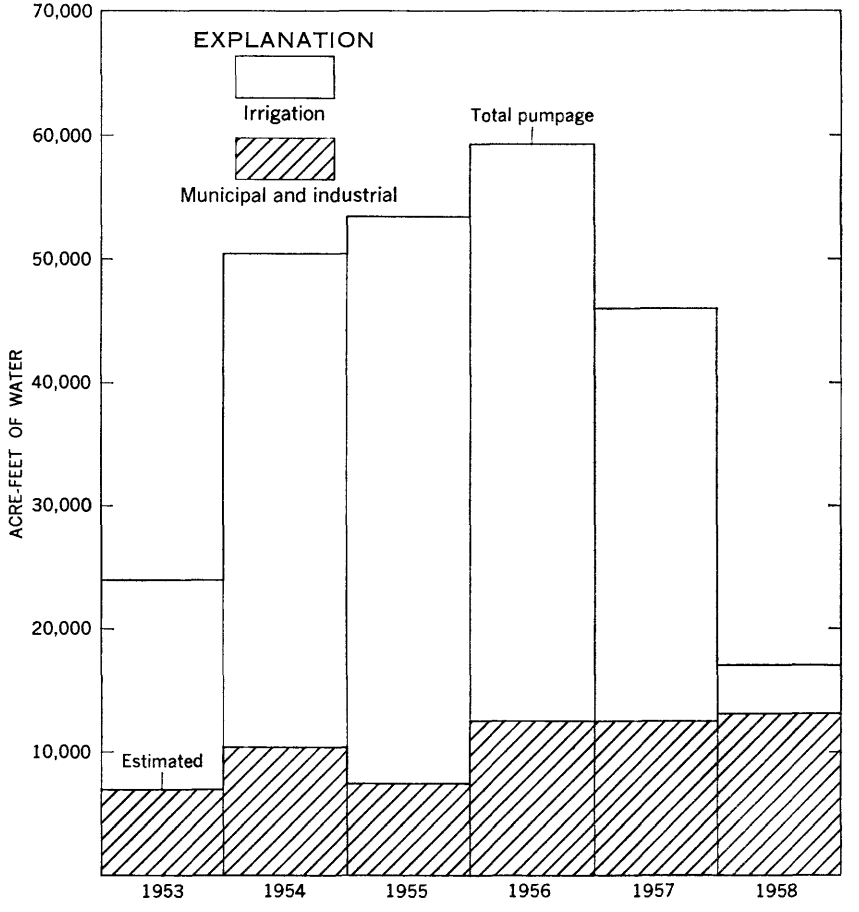

FIGURE 4.—Annual pumpage of ground water in the lower Mesilla Valley, 1953–58.

face-water allotment during this period. According to the records of the U.S. Bureau of Reclamation, surface-water allotments in 1957 and 1958 were 1.1 and 4.0 acre-feet per acre, respectively.

Before 1957 most of the pumpage in the lower Mesilla Valley was from the alluvium. In 1957 the city of El Paso pumped approximately 3,120 acre-feet of water from the deep and medium aquifers of the Santa Fe. In 1958 pumpage from the Santa Fe by the city increased to 8,100 acre-feet, or about 6.8 mgd.

FLUCTUATIONS OF WATER LEVELS

The water levels in wells in the lower Mesilla Valley fluctuate almost continuously, the magnitude of the fluctuations being greater in the medium and deep aquifers than in the shallow. Fluctuations that are not the result of pumping generally are smaller than those caused by pumping. These include fluctuations caused by changes in

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atmospheric pressure, loading and unloading the aquifer, earthquakes, and changes in the rates of natural recharge and discharge.

Fluctuations caused by changes of atmospheric pressure have a rhythmic pattern and are inverse to the change in pressure; that is, as the barometric pressure rises, water levels decline. The effect of the changes of atmospheric pressure on water levels is due to the ability of the less permeable beds in the aquifer to resist the transmission of changes in barometric pressure. The full effect of the pressure change is transmitted directly down the well, however, and the water level fluctuates accordingly. This is due to intervening relatively impermeable clay layers that act as partial barriers to the passage of water between the aquifers.

Figure 5 shows fluctuations of water level due to variations in the load on an aquifer in selected wells in the city of El Paso well field. The water levels in wells Q–176 (deep aquifer), Q–180 (medium aquifer), and Q–182 (shallow aquifer) fluctuate in response to wells pumping from different aquifers.

Figure 5 shows that when well Q–173 in the deep aquifer was shut down the water level instantly declined in well Q–182 in the shallow aquifer. Soon after well Q–173 was shut down, the water level in Q–182 gradually returned to approximately its initial position. The starting of pumping in well Q–180 in the medium aquifer caused a sharp rise of 0.85 foot in the water level in Q–182. Within 15 minutes after pumping began in Q–180, the water level in Q–182 started to decline; within 24 hours the water level returned to its initial position. While pumping from the medium aquifer continued, the water level in the alluvium continued to decline. During the same test, the water level in Q–176 in the deep aquifer at first declined, but within a few minutes rose about 0.6 foot; about 9 hours after pumping started from the medium aquifer, the water level in Q–176 began a gradual decline.

Figure 6 shows that after 15 days of continuous pumping from the medium aquifer, the water level in Q–176 declined 1.6 feet below a point extrapolated on the trend of the water level prior to the start of pumping; this decline indicates movement of water from the deep aquifer to the medium. The water level in well Q–180 (medium aquifer) responded instantly to the shutting down of well Q–173 in the deep aquifer (fig. 5). At first the decline in well Q–180 was rapid but decreased slowly until shortly after pumping started. The water in well Q–180 returned to its original level soon after the sharp initial decline because of a decrease in barometric pressure. The water level then resumed its decline, although at a rate somewhat less than before Q–173 was shut down.

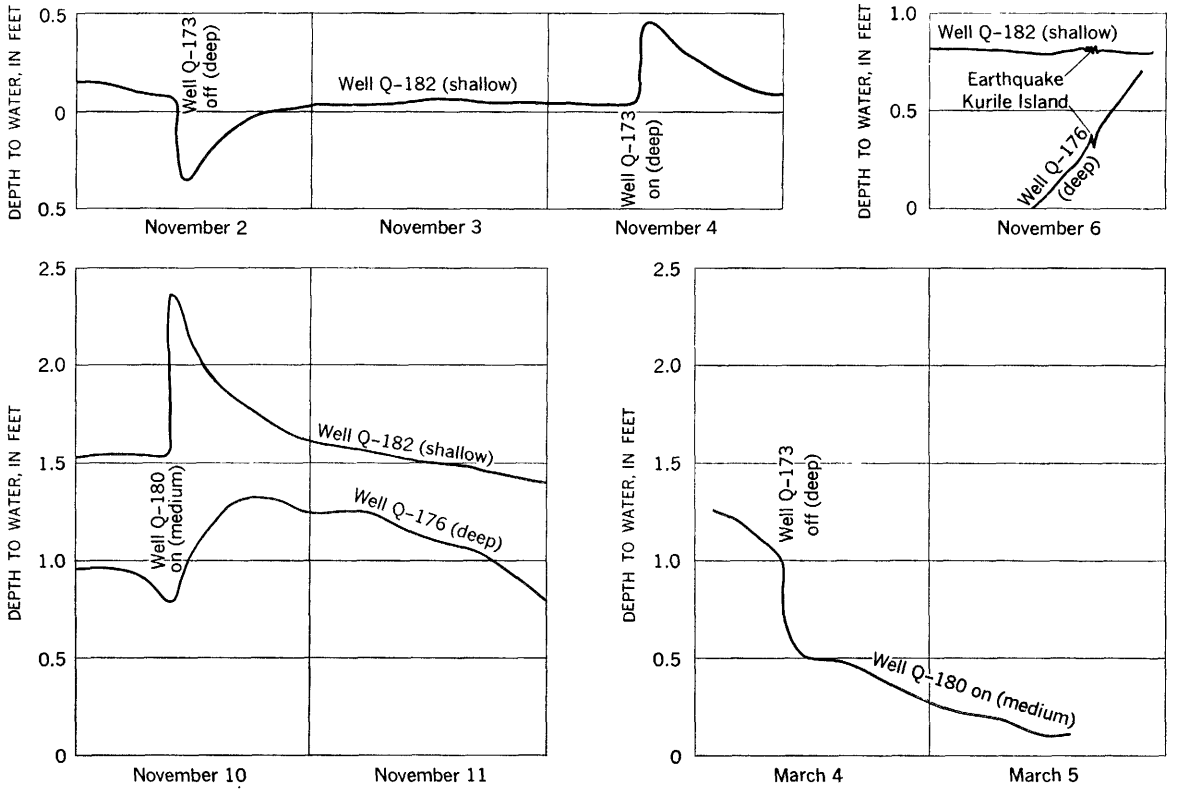

FIGURE 5.—Fluctuations of water levels due to variations in the load on an aquifer in selected wells in the El Paso city well field northwest of Canutillo, Tex., 1958.

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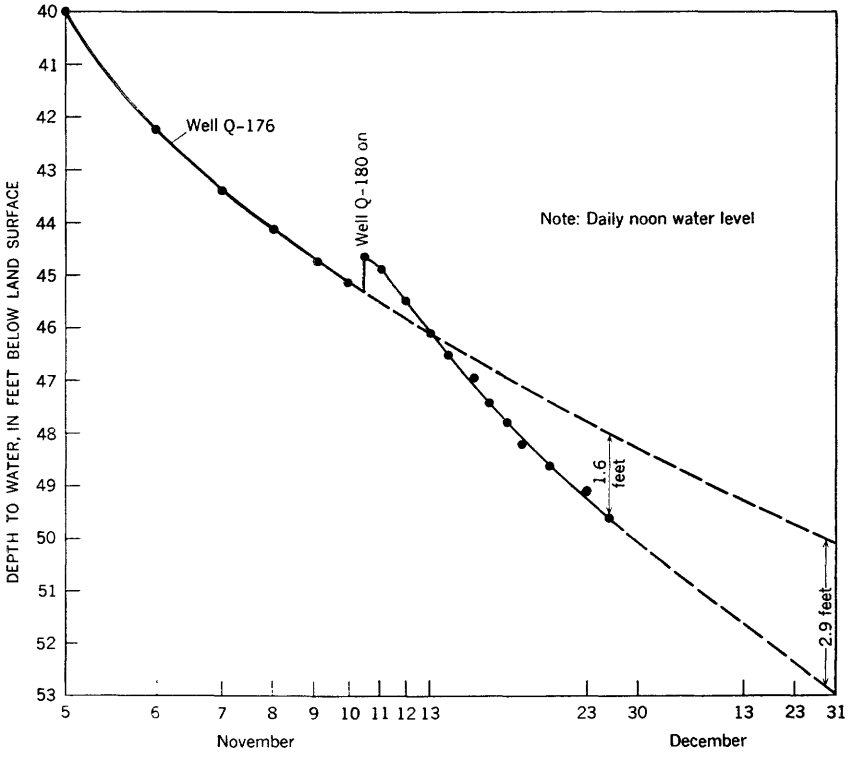

FIGURE 6.—Fluctuations of water level in well Q–176 (deep aquifer) due to pumping of well Q–180 (medium aquifer) in the El Paso city well field northwest of Canutillo, Nov. 10 to Dec. 31, 1958.

Similar fluctuations have been observed in New Jersey (Barksdale and others, 1936), in Long Island, N.Y. (Jacob, 1939), and in Easton, Md., and in Houston, Tex. Thompson (Barksdale and others, 1936, p. 88) explained the phenomenon on the basis of dilatency, which is the property of a compacted granular material to expand in total volume when subjected to lateral pressure. Barksdale, Sundstrom, and Brunstein (1936, p. 90) suggested that the starting of pumping in a well places a sudden load on the foundation of the pump, due primarily to the force required to lift the water to the surface and also for a brief time to the force required to accelerate the water. The effect of the loading would, of course, not be apparent in observation wells tapping the same sand as the pumped well, but it might be observed in wells tapping sands either above or below the sand tapped by the pumped well. The compressive force exerted when a well is turned on or off, although small, results in a compression of the relatively impermeable sediments in the water-bearing sand; as a consequence, the hydrostatic pressure increases instantaneously to the maximum. As pumping con-

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tinues the aquifer adjusts to the load, and the water level approaches asymptotically its initial position. When the pump is shut down, representing an instantaneous removal of the load, the reverse action takes place. Although the load exerted on the pump foundation is small, the instantaneous rate at which the load is applied on the foundation may account for the large rise or fall in the water level in the Canutillo area.

On Long Island, where the fluctuations were due to the passing of heavily loaded trains near the well, the magnitude of the water-level fluctuations, according to Jacob (1939, p. 668), should depend on the weight and the velocity of the train. In the Canutillo area, however, the magnitude of the fluctuations depends on the rate of application of the load and on the distance from the impressed load to the affected well. If the distance is too great, the confined water has sufficient time to escape laterally and the pressure is dissipated. These fluctuations, resulting from variations in the load, indicate that the elasticity of the aquifer is not perfect and that the aquifers are imperfectly connected.

Fluctuations in water levels due to earthquakes have been observed in several wells equipped with recording gages. For example, figure 5 shows a maximum displacement of water level of less than 0.02 foot in well Q–182 in the shallow aquifer caused by the earthquake of November 6, 1959, which had its epicenter in the Kurile Islands in the North Pacific. The water level in well Q–176 in the deep aquifer had a maximum displacement of about 0.07 foot. These data indicate that the magnitude of the change varies with different aquifers in the same locality according to the depth of the aquifer and the degree of confinement.

Large fluctuations of water levels usually result from withdrawals of ground water, the magnitude of the fluctuations diminishing with distance from the point of withdrawal. The fluctuations of water levels in 10 observation wells measured monthly by the U.S. Bureau of Reclamation are shown in plate 5. The approximate change of the water table in the lower Mesilla Valley from 1953 to 1959 is shown in plate 6.

The hydrographs of 10 observation wells (pl. 5), which are scattered throughout the valley, show a general agreement but differ in the magnitude of fluctuations. In most wells the water levels generally were relatively stable through 1950 except for seasonal variations, although in several wells a downward trend started in 1948 and 1949. The uniformity in the water levels suggests that the supply of surface water for irrigation was adequate. The water level in each well indicates a yearly cycle, the highest levels occurring during the growing season because of recharge from infiltration of surface water applied to the

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land and the lowest levels occurring during the winter in response to the discharge of ground water into the drains and the river. In any well the minimum level, which is controlled largely by the elevation of the bottom of a nearby drain or the river, occurs just before irrigation begins in the spring. The net changes in the water levels, therefore, are based on the measurements made in January and February before irrigation begins.

In 1950 when it was apparent that the supply of surface water in Elephant Butte Reservoir would be insufficient to allot a full water supply to lands in the lower Mesilla Valley, many wells were drilled to obtain a supplemental supply of water for irrigation. Figure 7 shows that the annual discharge of the Rio Grande below Caballo Dam averaged about 700 cfs from 1951 to 1953, as compared to an average annual discharge of 1,000 cfs from 1946 to 1950. Coincident with the reduction in diversion of surface water for irrigation and the accompanying increase in the use of ground water as a supplemental supply, the water levels in 10 observation wells declined an average of 0.6 foot from January 1951 to January 1954. The area of greatest decline was in the northern part of the valley.

As the supply of surface water for irrigation continued to decrease through 1956, ground-water withdrawals increased and were accompanied by a marked decline in the water table in the alluvium. Records of the U.S. Bureau of Reclamation show that the discharge of the Rio Grande below Caballo Dam from 1954 to 1956 decreased to an annual average of about 320 cfs; consequently, the diversions from the river decreased from 1.9 acre-feet per acre in 1953 to 0.39 acre-foot per acre in 1956. As a result, the decline of water levels in 10 wells ranged from 0.5 foot to 7.3 feet, averaging 3.5 feet from 1954 through 1956 (pl. 5). Plate 5 shows also that owing to the large withdrawals of ground water for irrigation, the water levels generally were highest just before irrigation began in the spring and lowest during the growing season. Most water levels rose in 1957 and 1958 owing to the above-normal precipitation and the accompanying increase in the surface-water allotment for irrigation and the substantial decrease in the withdrawal of ground water. According to the Bureau of Reclamation, the surface-water allotment was 1.3 acre-feet per acre in 1957 and 4.0 acre-feet in 1958. As a result, the withdrawals of ground water for irrigation decreased from 47,000 acre-feet in 1956, the highest of record, to 33,000 acre-feet in 1957 and to 4,100 acre-feet in 1958. From 1957 through 1958 the rise in the water levels in 10 wells ranged from 0.5 foot to 8.4 feet and averaged 4.3 feet (pl. 5).

The water levels in 92 wells measured during the period January 1957 through January 1959 showed an average rise of 5.5 feet, of which

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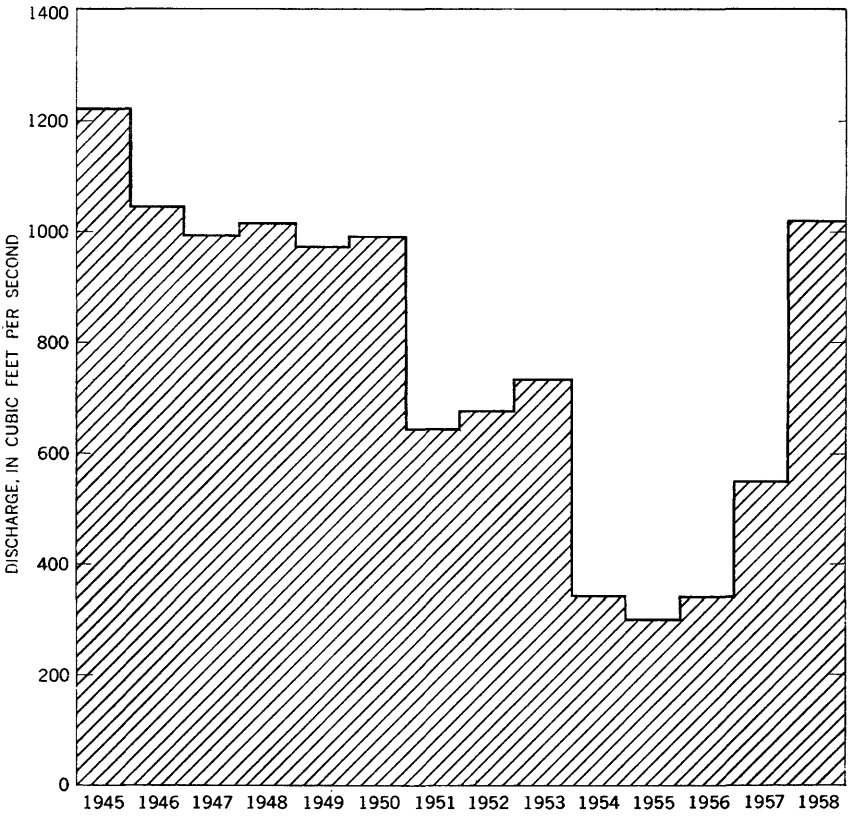

FIGURE 7.—Mean annual discharge of the Rio Grande below Caballo Dam, N. Mex., 1945–58.

3.8 feet was in 1958. The maximum rise, 16.6 feet, was in the vicinity of the shallow well field northwest of Canutillo. In the south end of the valley, the water table rose a maximum of 6.0 feet. In a small area northeast of the shallow well field and east of U.S. Highway 80, where surface-water rights are not available and irrigation was from ground water only, the water declined a maximum of 6.4 feet.

In summary, between 1946 and 1956, water levels in 10 wells declined an average of 0.6 foot. These data show that large quantities of ground water can be pumped from the alluvium over a considerable period of drought without seriously depleting the ground-water supply, owing to substantial recharge when surface-water allotments are adequate.

The hydrographs of the daily fluctuations of water levels in five wells in the city of El Paso well field in 1957–58 are shown in plate 7. Wells Q–86 and Q–182 are in the alluvium (shallow aquifer); well Q–180 is in the medium aquifer; and wells Q–176 and Q–181 are in

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the deep aquifer. The similarity of water-level fluctuations in these wells indicates a degree of interconnection of the three aquifers. On February 4, 1958, when wells Q–172 and Q–174 were shut down, water levels rose in Q–180 and Q–86. On November 1, 1958, when pumping began in wells Q–173 and Q–174, water levels declined in well Q–180 in the medium aquifer and well Q–182 in the shallow aquifer. The fact that decline was more pronounced in Q–180 than in Q–182 is due to the more direct hydraulic connection between the medium and deep aquifers. The withdrawal of water from the deep aquifer results in a reduction of pressure; consequently, water moves from the medium aquifer into the deep in response to the change in pressure. Moreover, this pressure change is reflected in the shallow aquifer, and water moves vertically into the medium aquifer but at a considerably lower rate. The water levels in Q–180 and Q–182 declined when Q–173 and Q–174 were pumped and rose when Q–172 was started. The decline in Q–180 and Q–182 was due to the distance of the wells that imposed the load on the aquifer from the observation wells.

Plate 8 shows the fluctuations of the water levels in four wells in 1958 and part of 1959, three of which (Q–172, Q–173, and Q–176) are in the deep aquifer and one (Q–180) in the medium aquifer. The data show that water levels in the wells become relatively stable soon after pumping begins. This evidence indicates that interformational leakage is substantial and that the movement of water in the three aquifers has been altered in the vicinity of the wells. Prior to the start of pumping from the medium and deep aquifers, the hydraulic pressure gradient was upward—that is, water moved from the deep to the medium aquifer and, in turn, moved upward into the shallow aquifer replacing water that was discharged naturally or artificially. Pumping from the deep aquifer reverses this direction of movement. Water then moves from the shallow into the medium and thence into the deep aquifer. When pumping began from the medium aquifer, however, the pressure head in the deep aquifer as well as the shallow was greater, thus causing water to move from the shallow and deep aquifer into the medium.

CHARACTERISTICS OF WELLS

Data concerning the yields and specific capacities are available for 75 wells, 61 of which obtain water from the shallow aquifer; 6 from the medium and deep aquifers of the Santa Fe group, and 8 from the Santa Fe and consolidated sediments underlying the uplands.

The yields of the 61 wells in the shallow aquifer, either measured or reported, ranged from 25 to 3,015 gpm. Most of the wells used for irrigation and for which records are available had yields greater than 1,000 gpm. In the south end of the valley, the yields of 13 wells

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(grid U) in the alluvium ranged from 35 to 1,025 gpm. In the upland area east of the flooded plain, the yields of 8 wells ranged from 40 to 660 gpm. Three of these wells obtain water from the Santa Fe and their average yield is about 500 gpm. The yields of the remaining five wells, which tap the consolidated sediments, are considerably smaller, averaging about 75 gpm. In the well field northwest of Canutillo, the yields of four wells in the deep aquifer of the Santa Fe ranged from 2,025 to more than 3,000 gpm. The yield of one well in the medium aquifer was 2,205 gpm.

The specific capacity of a well generally is expressed as the ratio of the yield, in gallons per minute, to the drawdown, in feet. The term might imply that the ratio of yield to drawdown is constant, but the specific capacity of a well is only an approximation because of the effects imposed by the rate of withdrawal and the element of time. Moreover, a comparison of the specific capacities as an indication of aquifer productivity is subject to considerable error unless the methods of well construction and the degree of development are taken into account. The use of a gravel envelope and of screens increases the effective diameter of the well by offering a larger open area for the passage of water than is provided by slotted casing. This results in reduced entrance velocities, thereby decreasing the drawdown and increasing the specific capacity. The specific capacities of properly developed wells having gravel envelopes and screens probably best represent the capacity of the aquifer to transmit water.

The specific capacities of wells in the alluvium vary widely. The specific capacities of 13 irrigation wells ranged from 5.4 to 108, averaging 46 gpm per foot of drawdown. In the south end of the valley (grid-U), the specific capacities of 15 wells used for public and industrial supplies ranged from 3.0 to 22 gpm per foot of drawdown. These data indicate that the permeability of the alluvium decreases southward.

In the shallow well field northwest of Canutillo, the specific capacities of six wells equipped with gravel envelope and mill-slotted casing ranged from 13 to 61 gpm per foot of drawdown. It is probable that the low specific capacities in three of the wells is due to incomplete development of the wells. Five wells in the deep aquifer equipped with gravel envelope and mill-slotted casing had specific capacities ranging from 19.7 to 30.7 and averaging 25.3 gpm per foot of drawdown. The specific capacity of well Q–180 in the medium aquifer was 14.0 gpm per foot of drawdown. The low specific capacity of well Q–180, as compared to the average for wells in the shallow and deep aquifers, probably is due to the character of the sand in the medium aquifer. Electric and sample logs show that the sand in the

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medium aquifer is finer than that in the shallow aquifer and that it contains more clay than the sand in the deep aquifer. It is probable that the specific capacities of the wells in the deep aquifer have been reduced because of a decrease in the size of the screen openings necessitated by the fine sand. Records show that well Q–172 had a specific capacity of 27.4, but, because of the quantity of sand pumped during operation of the well, a screen with smaller openings was used in newer wells drilled in the deep sand. The specific capacities of the four wells drilled after well Q–172 averaged 23.2 gpm per foot of drawdown.

Wells capable of yielding large volumes of water may be drilled in almost every part of the flood plain in the lower Mesilla Valley. In the southern part of the valley, however, the yields of most wells may be expected to be small. Wells drilled in the uplands probably will produce only small to moderate quantities of water because of a lesser saturated thickness of the aquifer.

HYDROLOGIC CHARACTERISTICS OF WATER-BEARING MATERIALS

Aquifer tests were made at the sites of eight municipal wells in the shallow aquifer, six wells in the deep aquifer, and one well in the medium aquifer to determine the coefficients of transmissibility and storage, which govern the ability of an aquifer to transmit and to yield water. The results of the tests are shown in the following table.

Well	Aquifer	Coefficient of transmissibility (gpd per ft)	Coefficient of storage
Q–82	Alluvium	158, 000	
83	do	145, 000	
84	do	110, 000	
86	do	155, 000	0. 001
90	do	140, 000	
91	do	150, 000	
165	do	121, 000	
166	do	104, 000	
180	Santa Fe (medium)	34, 000	
172	Santa Fe (deep)	60, 000	. 0007
173	do	59, 000	
174	do	73, 500	
175	do	49, 500	
176	do	60, 000	. 0007
178	do	57, 000	

The coefficient of transmissibility (T) may be defined as the rate of flow of water in gallons per day at the prevailing water temperature through a vertical strip of the aquifer 1 foot wide extending the full height of the aquifer under a unit hydraulic gradient. The volume of water that will flow each day through each foot of the aquifer

TX_MSJ_006010

is the product of the coefficient of transmissibility and the hydraulic gradient. The smaller the coefficient of transmissibility, the greater the hydraulic gradient must be for water to move through the aquifer at a given rate.

The coefficient of storage (S) is the volume of water released from or taken into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface. Under artesian conditions, the volume of water released from or taken into storage is determined by the compressibility of the aquifer and expansion of the water. Under water-table conditions, the coefficient of storage is practically equal to the specific yield, which is defined as the volume of water released from or taken into storage in response to a change in head attributed partly to the gravity drainage or refilling and partly to compressibility of the water and aquifer material in the saturated zone.

The coefficient of storage (S) is the volume of water released from the results of the pumping tests by means of a formula developed by Theis (1935, p. 519–524). A discussion of the formula, the assumptions upon which it is based, and its application is given by Wenzel (1942).

Recovery tests in eight wells in the shadow well field show that the coefficients of transmissibility ranged from 104,000 to 158,000 gpd per ft and averaged 135,000. These coefficients probably are representative of the alluvium, although some water is obtained from the underlying Santa Fe. Aquifer tests of the alluvium failed to show conclusively the connection between the Rio Grande and the ground-water reservoir. Analyses of the test data showed that the water levels in the observation wells were higher than the theoretical water levels. Although the Rio Grande is a contributing stream when the water table is below the streambed, it is probable that slow drainage of excess irrigation water applied to the land has retarded the expansion of the cone of depression. The relation between ground and surface water, however, is clearly shown by the absence of flow in the river between Vinton Bridge and Canutillo Bridge during periods of heavy ground-water withdrawals from the shallow well field. The large withdrawals of ground water from the shallow aquifer reduces the drain flow; in some places, the entire drain flow has been intercepted. The river, as well as the drains, performs as a line source of recharge, and the effect of a pumping well upon the flow of a drain or the river may be computed on the basis of the formula developed by Theis (1941, p. 736). Conover (1954, p. 119) showed diagrammatically that the flow of a drain would be reduced by 63 percent of the pumping rate after 3 months of continuous pumping of a well 0.25

695-880—63——3

TX_MSJ_006011

mile from the drain, by 73 percent after 6 months, and 81 percent after 1 year. The effect of the pumping of a well upon the flow of the drain or the river decreases with distance from the line source.

Aquifer tests at the Federal Correctional Institution at Anthony reported by Sundstrom (1952, p. 6) indicated that the coefficient of transmissibility ranged from 30,000 to 60,000 gpd per ft. In the southern part of the valley, the coefficient of transmissibility determined at the site of well U–38 was about 63,000 gpd per ft. These tests indicate that the wells are screened principally in the Santa Fe.

Aquifer tests at the sites of six wells screened in the deep aquifer showed that the coefficients of transmissibility ranged from 49,500 to 73,500 gpd per ft and averaged about 60,000 gpd per ft. The relatively wide range in transmissibility is due to the varied thicknesses of the contributing sections of the aquifer. The small range in coefficients of permeability, from 146 to 150 gpd per sq ft, in five of the tests indicates that throughout most of the well field the Santa Fe group is composed of relatively homogeneous sediments. The coefficient of permeability is defined as the rate of flow of water in gallons per day through a cross section of 1 square foot under a unit hydraulic gradient, or through a section 1 foot high and 1 mile wide under a gradient of 1 foot per mile.

In September 1957 an aquifer test was made at the site of well Q–180 in the medium aquifer. The coefficients of transmissibility and of permeability determined from the test were 34,000 gpd per ft and 128 gpd per sq ft, respectively.

Under water-table conditions the specific yield is difficult to determine from short-term aquifer tests, because it depends on the time involved in dewatering the part of the aquifer within the cone of depression. Although most of the cone may be dewatered in a relatively short period of time, dewatering may continue at a decreasing rate for years. Thus, specific yields obtained from aquifer tests of short duration generally are too low. The specific yield of the shallow aquifer, as determined from the tests, ranged from 0.0006 to 0.001. A specific yield of 0.0006 may be low for alluvium, but it is probable that the water-bearing material contained clay layers that were fairly well distributed and widespread. Fine-grained sediments retain a considerable part of the water against the pull of gravity and hence have a low specific yield. Sundstrom (1952, p. 4) reported a specific yield of about 5 percent in tests made at the Correctional Institution. As the duration of pumping increases, however, the specific yield should increase to 10 or 15 percent. Conover (1954, p. 103) estimated that the specific yield of the valley fill in the Rincon and Mesilla Valleys was about 25 percent.

TX_MSJ_006012

The coefficient of storage obtained from tests at the sites of wells Q–172 and Q–176 in the deep aquifer averaged 0.0007. The data from well Q–176 showed that after pumping the well for 24 hours the drawdown was less than the predicted drawdown. This evidence indicates that recharge to the aquifer occurred. The coefficient of storage for the deep and medium aquifers ultimately may reach 0.1 percent, the specific yield estimated for the shallow aquifer.

If geologic and hydrologic conditions are favorable, the coefficient of transmissibility and specific yield may be used to predict the performance of the well field.

The curve in figure 8 show the theoretical drawdown in water levels

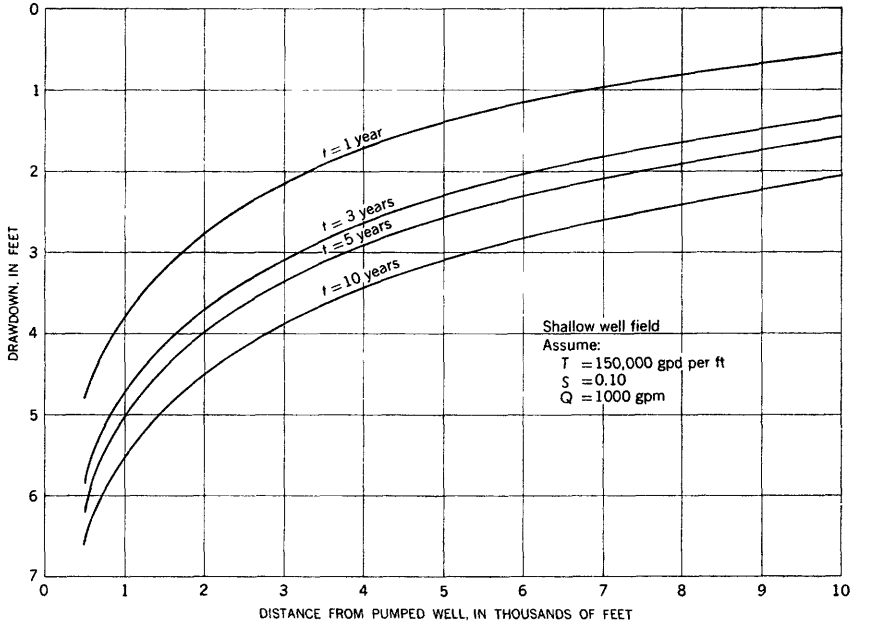

FIGURE 8.—Theoretical drawdown in an infinite aquifer (alluvium) due to pumping.

in the alluvium at the end of various periods of time (t), 1, 3, 5, and 10 years, at various distances from a well pumping 1,000 gpm. The decline at any point is directly proportional to the rate of pumping (Q). The curve is based on a probably conservative specific yield of 10 percent and on the assumption of no recharge to the aquifer; consequently, drawdowns should be less than those indicated on the graph.

The results of aquifer tests of the deep aquifer and the absence of a confining bed as shown by the electric logs indicate that considerable quantities of water may leak from water-bearing sediments through varied thicknesses of clay and into the deep aquifer. Although the clay

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beds are relatively impermeable, water may pass through or around them in response to a change in pressure. As the head in the deep aquifer is lowered by pumping, the pressure differential may be sufficient to change the direction of movement of water. Before pumping began in June 1957, water moved upward from the deep aquifer to the shallow aquifer. A change in pressure in the deep aquifer may reduce or reverse the movement, if the change is sufficiently large. This effect was considered in preparing figure 9. The curves show the effect

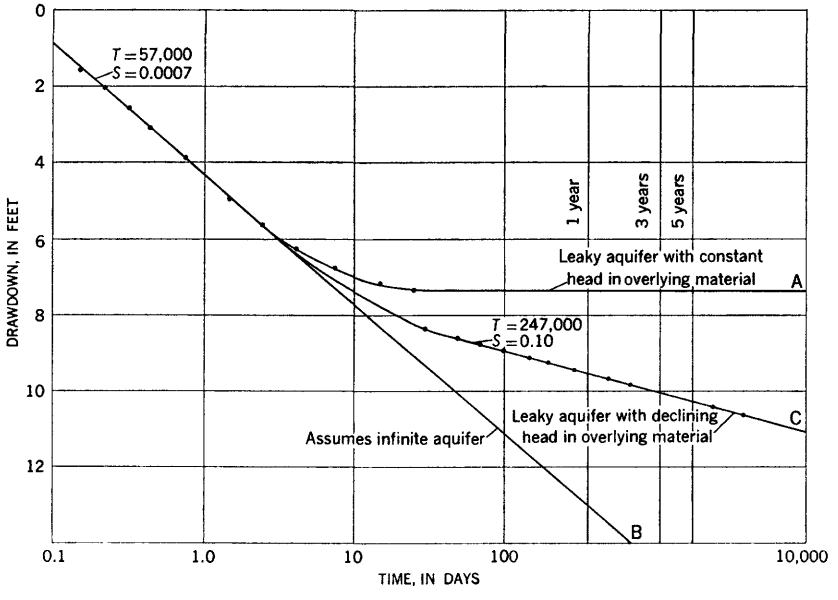

FIGURE 9.—Theoretical drawdown 1,600 feet from a well pumping 1,000 gpm.

on the water levels with respect to time 1,600 feet from a well pumping 1,000 gpm for varying hydraulic conditions.

Curve *A* assumes that water is leaking into the deep aquifer while the head in the overlying aquifer remains constant. Curve *B* assumes that all water comes from artesian storage in the deep aquifer, which is assumed to be infinite in areal extent. Curve *C* assumes leakage between aquifers accompanied by a declining head in the overlying aquifers based on a leakance factor determined from the test at the site of well Q–172 in the deep aquifer. Curve *C* represents more fully the conditions in the deep well field. After 24 hours of pumping, the curve is based on the studies made by Hantush and Jacob (1955, p. 95) on nonsteady flow in leaky systems. Figure 10 shows the theoretical drawdown at various distances and time of a well pumping 1,000 gpm. When the well is pumped, the rate of decline of water level is rapid at

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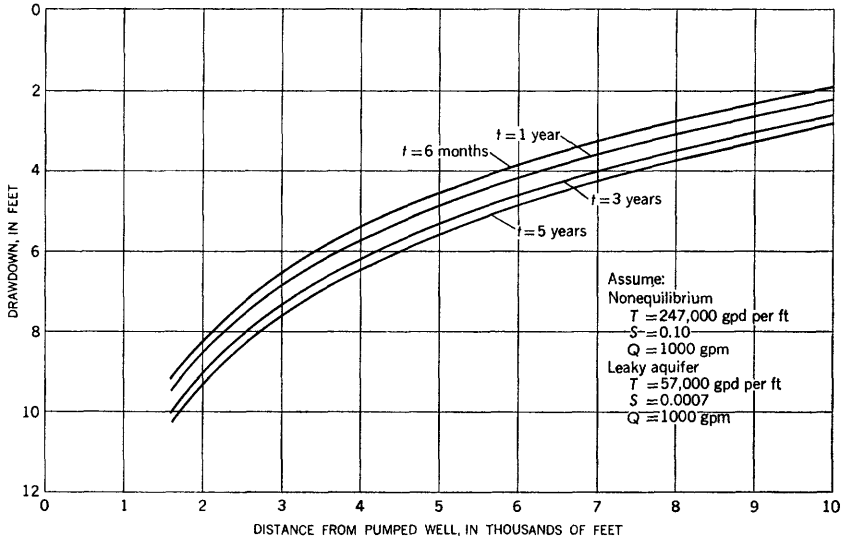

FIGURE 10.—Theoretical drawdown in an infinite aquifer (Santa Fe group) due to pumping. Computed according to the formulas for nonequilibrium and leaky-aquifer conditions.

first. As pumping continues, leakage from the overlying sediments is sufficient to reduce the rate of decline; thus, equilibrium in the cone of depression is approached. If pumping continues for a long period of time, water from the shallow aquifer will replace water pumped from the medium or deep aquifers.

A comparison of the theoretical and the actual drawdown of the water level in the observation well Q–176 from February 1957 through December 1958 due to pumping from the deep and medium aquifers is shown in the following table. The distance from well Q–176 is given in feet.

Well pumped	Aquifer	Discharge (gpm)	Time of pumping (days)	Distance from well Q–176 (feet)	Drawdown in well Q–176 (feet)
Q–172	Deep	2,075	531	1,600	19.9
173	do	2,075	354	1,600	19.6
174	do	2,075	318	4,350	10.2
180	Medium	2,180	51	1,600	2.9
Theoretical					52.6
Measured					51.9

The difference of 0.7 foot between the theoretical and the measured drawdown may be attributed to a substantial rise of the water table in the shallow aquifer during 1958.

TX_MSJ_006015

GROUND WATER IN STORAGE

According to available data, at least 45 million acre-feet of saturated sediments underlies the lower Mesilla Valley. Chemical analyses of samples of water from 127 wells show that about 65 percent of the ground water in the Santa Fe group and alluvium in the valley is too high in mineral content for use as municipal supplies. In this report, fresh water is defined as water that contains less than 250 ppm (parts per million) of chloride. Water that contains more than 250 ppm of chloride is considered to be highly mineralized and, according to standards of the U.S. Public Health Service, is not suitable for municipal supplies. In several small areas, ground water is considered fresh, although the sulfate and dissolved-solids content is somewhat in excess of the limits recommended by the Public Health Service of 250 and 1,000 ppm, respectively.

Analyses of samples of water from wells and test wells indicate that the greatest volume of fresh ground water is in the area northwest of Canutillo and that fresh water-bearing sand thins toward the south and east. The volume of fresh water in storage in the alluvium and Santa Fe in the Texas part of the valley is at least 560,000 acre-feet, and in the New Mexico part the volume of fresh water is at least 980,000 acre-feet. More than 1,540,000 acre-feet of fresh water is in storage in the lower Mesilla Valley; about 150,000 acre-feet is in the alluvium in the Texas part of the valley.

The estimate of the volume of fresh water in storage in the lower Mesilla Valley probably is conservative. The specific yield of 10 percent used in the estimate probably is low; the area of the Santa Fe group used for computation extends only to the west edge of the irrigated area. The estimate of the volume of saturated material is based on known thicknesses of materials; it does not include water-bearing sediments that may lie at great depth in the northwestern part. If the specific yield of the saturated material is as much as 25 percent, as estimated by Conover (1954, p. 103), the volume of fresh water would total at least 3,850,000 acre-feet, of which 1,400,000 acre-feet is in Texas.

All the fresh water in storage cannot be withdrawn by wells. In those parts of the aquifer where fresh water is underlain by highly mineralized water, perhaps less than half the fresh water can be recovered before the remainder becomes unsatisfactory for municipal supply.

Sufficient data are not available to determine the volume of water in storage that is suitable for irrigation or industrial use. A substantial part of the water that is unsuitable for public supply might be used for irrigation, particularly if the chloride content is not excessive

TX_MSJ_006016

and if large quantities of water can be applied for leaching of salts from the soils. Some industries may be able to use part of the water.

QUALITY OF WATER

The results of the chemical analyses of water samples from 127 wells in the lower Mesilla Valley are shown in a report by Leggat, Lowry, and Hood (1962, p. 174–191).

Except for hardness and percent sodium, the analyses are given in parts per million, an expression of the concentration by weight of each constituent in a million unit weights of water. Hardness is expressed as equivalent calcium carbonate ($CaCO_3$). Generally, water having a hardness of less than 60 ppm is classified as soft; from 61 to 120 ppm as moderately hard; and more than 120 ppm as hard. Specific conductance, which is the electrical conductivity of the water, and pH are expressed in appropriate units for the property measured.

GROUND WATER

It is not possible to define exact limits of mineral content beyond which ground water cannot be used for specific purposes. Water for municipal and domestic supplies, however, should conform as nearly as possible to the standards established by the U.S. Public Health Service (1946) for use on interstate carriers. The concentrations of chemical substances preferably should not exceed the indicated limits:

Constituent	*Parts per million (ppm)*
Iron (Fe) and Manganese (Mn) together	0.3
Magnesium (Mg)	125
Sulfate (SO_4)	250
Chloride (Cl)	250
Fluoride (F)	1.5
Nitrate (NO_3)	45
Dissolved solids	[1] 500

[1] 1,000 permitted.

Fluoride content of water in domestic supplies should not exceed 1.5 ppm. Water that contains fluoride in excess of this amount may cause mottling of tooth enamel if the water is used continuously (Dean and others, 1935). Data collected by various agencies have demonstrated that fluoride in drinking water in quantities less than 1.5 ppm reduces the incidence of tooth decay (Dean and others, 1942). The Texas State Department of Health recommends as desirable a fluoride content of 1–1.5 ppm.

The more important factors that affect the quality of ground water for irrigation are dissolved-solids content, percent sodium, residual sodium carbonate (equivalents per million of carbonate and bicarbonate in excess of calcium and magnesium), and boron content. An

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equivalent per million (epm) is the expression of the concentration in terms of chemical equivalents rather than by weight. Water having a percent sodium of more than 80 (Wilcox, 1948, p. 27), a residual sodium carbonate of more than 2.5 epm, or a boron content greater than 1.25 ppm for sensitive crops and 3.75 ppm for tolerant crops is generally considered unsuitable for irrigation (U.S. Salinity Laboratory Staff, 1954, p. 81). Other factors, such as climate, soil type, crop, and quantity of water used may be equally significant and under optimum conditions may permit the satisfactory use of water with a high percent sodium or a high boron content.

In the lower Mesilla Valley, the quality of ground water varies both areally and with depth. Samples of water collected from wells near the south end of the valley and from wells along the east boundary were high in dissolved-solids content. It was not possible to ascertain if certain samples from the shallow aquifer were from the alluvium or from the Santa Fe group. Water from many shallow wells obtain water from both sources.

SANTA FE GROUP

Fresh water in the Santa Fe group extends to a depth of at least 1,200 feet in well Q–178. Electric logs and drill-stem tests indicate that the base of fresh water is progressively shallower toward the south and east. Plate 2 shows the progressive thinning southward of the fresh water-bearing sands in the Santa Fe.

In the city of El Paso deep-well field, water from below 200 feet is satisfactory for municipal use. Analyses of water from well Q–172 show that the water is soft and low in dissolved-solids content. Drill-stem samples from depths between 200 and 500 feet in the deep wells and a sample of water from well Q–180 in the medium aquifer contained more dissolved solids than the deep aquifer.

Fresh water from the Santa Fe probably could be used for irrigation. Analyses of samples of water from the deep-well fields suggest that the water may be used for irrigation. Although the percent sodium generally exceeds 80, the residual sodium-carbonate and the boron content of the samples from Q–172 are lower than the recommended limits. Chemical analyses of more water samples will be necessary in order to determine the suitability of fresh water for irrigation from the Santa Fe.

The south edge of the body of fresh water in the deep aquifer extends to a line through Canutillo. South of Canutillo, the water from the Santa Fe increases in mineral content until it becomes unfit for most uses. Sayre and Livingston (1945, p. 7) reported that two test wells in the lower Mesilla Valley drilled in 1922 yielded salt water.

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The El Paso Electric Co. reported that water from well U–65, depth 600 feet, contained 1,750 ppm of sulfate, 790 ppm of chloride, and 4,080 ppm of dissolved solids.

The southward increase in mineral content of the water in the Santa Fe may be partly due to incomplete flushing from the Santa Fe and partly to the concentration of the ground water in the alluvium by evapotranspiration. Playa lakes probably occupied the Rio Grande depression. Owing to the Rio Grande cutting through the gorge and into the Mesilla Valley and owing to damming by intrusive andesite, salt water in the ancient lake sediments probably was not flushed out at the south end of the valley. According to Slichter (1905, fig. 3), "The rapid rate of increase in the dissolved solids at a depth of about 40 feet [in the gorge near El Paso] indicates that the water below such depth is stagnant or without appreciable movement."

The flow through the gorge was estimated by Slichter as not exceeding 11,200 cubic feet per day, or about 50 gpm. The largest part of the natural discharge of ground water from the valley is by evapotranspiration, resulting in concentration of the mineral content of the ground water. On La Mesa, well P–6, depth 950 feet, yielded water that was suitable for municipal and domestic supply. On the upland east of the flood plain, water from the Santa Fe ranges from fresh to brackish. In the area between Canutillo and Vinton Bridge, water in most wells is satisfactory for domestic use, although the chloride or sulfate content may slightly exceed the recommended limits. South and north of this area the water is high in chloride and dissolved-solids content.

ALLUVIUM

Most wells in the flood plain range in depth from 80 to 200 feet. Therefore, many of these wells yield a mixture of waters from the Santa Fe group and the alluvium. North of Canutillo and west of the Rio Grande in the area of the city well field, water from the alluvium is relatively fresh but contains more dissolved solids than the water in the Santa Fe. The quality of the water in the shallow well field varies laterally and also at different periods of time. The marked change in the quality of water in the shallow well field from 1952 to 1957 was partly due to the infiltration of water from the Rio Grande and to the infiltration of surface water applied to the land. Figure 11 shows the chloride content of water from six wells in the shallow well field and of water from the Rio Grande. The greatest increase in the chloride content was in wells Q–82 and Q–90, which are in the center of heavily irrigated areas. The chloride content in wells Q–83 and Q–84 increased at a rate similar to the increase in the chloride content of the river.

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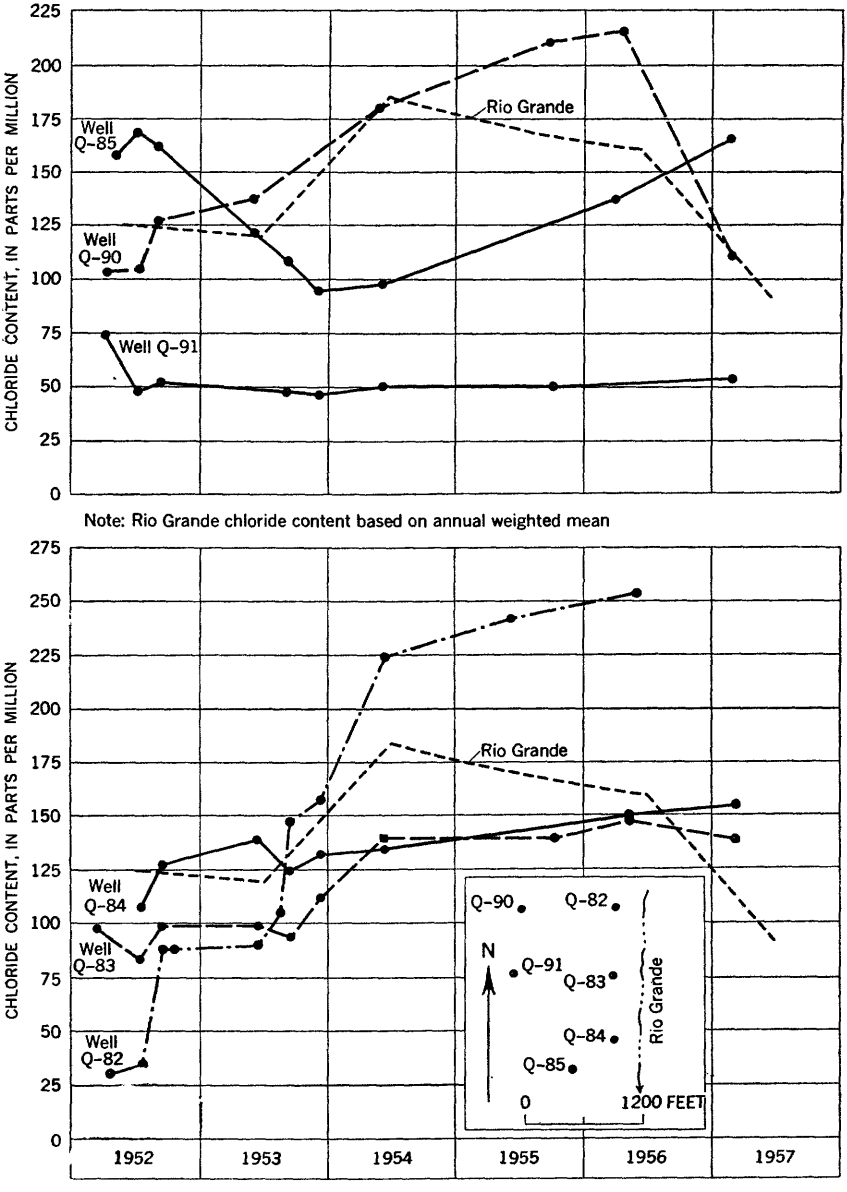

FIGURE 11.—Chloride content of water from wells in the alluvium and from the Rio Grande, 1952–57.

During periods of large flow, the river water may be more dilute in mineral content than ground water in the shallow-well field. For example, in 1957 the weighted average of chloride content of the water in the Rio Grande was less than 100 ppm (the lowest from 1952 to

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1957). Because of the decrease in the quantity of ground water pumped for irrigation and the application of large quantities of surface water of low chloride content, the water in well Q–90 decreased in chloride content. No records are available to show the change in the quality of the water in well Q–82 in 1957. In the area east of the Rio Grande between Vinton Bridge and Anthony, water in the alluvium is more highly mineralized than that in the alluvium northwest of Canutillo. Records show that water at a depth less than 200 feet ranges in chloride content from 190 ppm in well Q–27 to 6,240 ppm in well Q–178. In most of the wells, the chloride content exceeded 300 ppm. The area between Vinton Bridge and Anthony is drained by the East Drain, which, according to Conover (1954, p. 87)

> * * * apparently has water of higher concentrations than found in the irrigation water * * *. [In explaining the poor quality of the water in the East Drain, he proposed that] water east of the valley toward the Franklin Mountains also has a high concentration of dissolved solids and enters the drain, or that similar water occurs in the valley in this area and has not been completely flushed by excess irrigation water applied to the lands.

Because of the shallow water table in the area, mineralization of the ground water probably was increased further by evapotranspiration.

South of Canutillo, the alluvium contains water that is rather high in dissolved-solids content but that is generally of better quality than the water in the underlying Santa Fe group. In the south end of the valley, the El Paso Electric Co. and the American Smelting and Refining Co. obtained water from the alluvium. The water in four wells had a chloride and sulfate content of less than 250 ppm. Fresh water in this area is attributed to recharge from precipitation on the surficial sandy deposits overlying the alluvium. Until November 1955, the White Water Works supplied water to the community of White Spur and nearby residential areas. Analyses of water from five wells, U–1, U–2, U–4, U–6, and U–7, had a chloride content exceeding 340 ppm, except well U–4, which had a chloride content of 92 ppm but a sulfate content of 288 ppm.

CONSOLIDATED ROCKS

Several wells on the uplands bordering the Franklin Mountains and at the south end of the valley yield water from consolidated rocks. Well Q–76 obtained hard water for stock use from a black rock, probably of Pennsylvanian age. Chemical analysis of a sample of the water showed more than 300 ppm of chloride and 1,000 ppm of dissolved solids. At the south end of the valley, well U–59 yielded water high in dissolved-solids, chloride, and sulfate content. Water that is unsuitable for domestic or municipal uses but satisfactory for some industrial uses is obtained from sand and limestone of Early Cretaceous

age. On the west slope of the Franklin Mountains, well U–12 yielded water high in calcium, magnesium, and iron content from a limestone of undetermined age between 1,600 and 1,690 feet deep. The well was abandoned and plugged in 1953 because of the high fluoride content (5.6) in the water.

SURFACE WATER

Records of chemical data from the International Boundary and Water Commission's files show that the water of the Rio Grande increases in dissolved-solids content between Leasburg, N. Mex., and El Paso, Tex. (See fig. 12.) During the period 1930–57, the dissolved-solids content increased from an average of 0.77 ton per acre-foot at Leasburg Dam to 1.10 tons per acre-foot at El Paso, an increase of nearly 45 percent in 50 miles. A ton per acre-foot is equivalent to 735.5 ppm of dissolved solids. Most of the increase in sodium salts of sulfate and chloride is attributed to the accretion of drain water. The following table shows that the chloride content of water in the Rio Grande at El Paso is highest during the nongrowing season and is lowest from March to September, when surface water is released for irrigation. During the winter, the water in the Rio Grande consists largely of return flow from the drains.

Month	1952	1953	1954	1955	1956	1957	1958
January	288	281	377	490	705	710	830
February	309	312	318	570	805	815	870
March	246	88	230	259	169	375	83
April	198	93	169	172	126	227	78
May	142	124	171	234	262	490	69
June	92	92	175	185	142	126	69
July	80	96	167	124	137	57	74
August	76	110	124	153	172	45	76
September	112	128	286	131	176	65	87
October	246	259	190	274	775	375	175
November	260	293	525	507	770	1,090	268
December	268	330	505	700	742	920	------
Weighted mean	125	119	184	170	160	90	------

The water in the drains in the lower Mesilla Valley varies widely in quality, but is usually higher in dissolved-solids content than the river water at El Paso. During part of 1955 and 1956, however, the water in the river at El Paso was higher in dissolved solids than the water in Montoya Drain owing to the low flow of the river and to the discharge into the river of concentrated effluent from the El Paso electric plant. Figures 13 and 14 show that the quality of the water, as specific conductance (micromhos), in Montoya and Anthony Drains varies more or less inversely with the quantity of drain flow. The specific conductance is a measure of the ability of the water to carry an electric current and is therefore an indication, within rather wide

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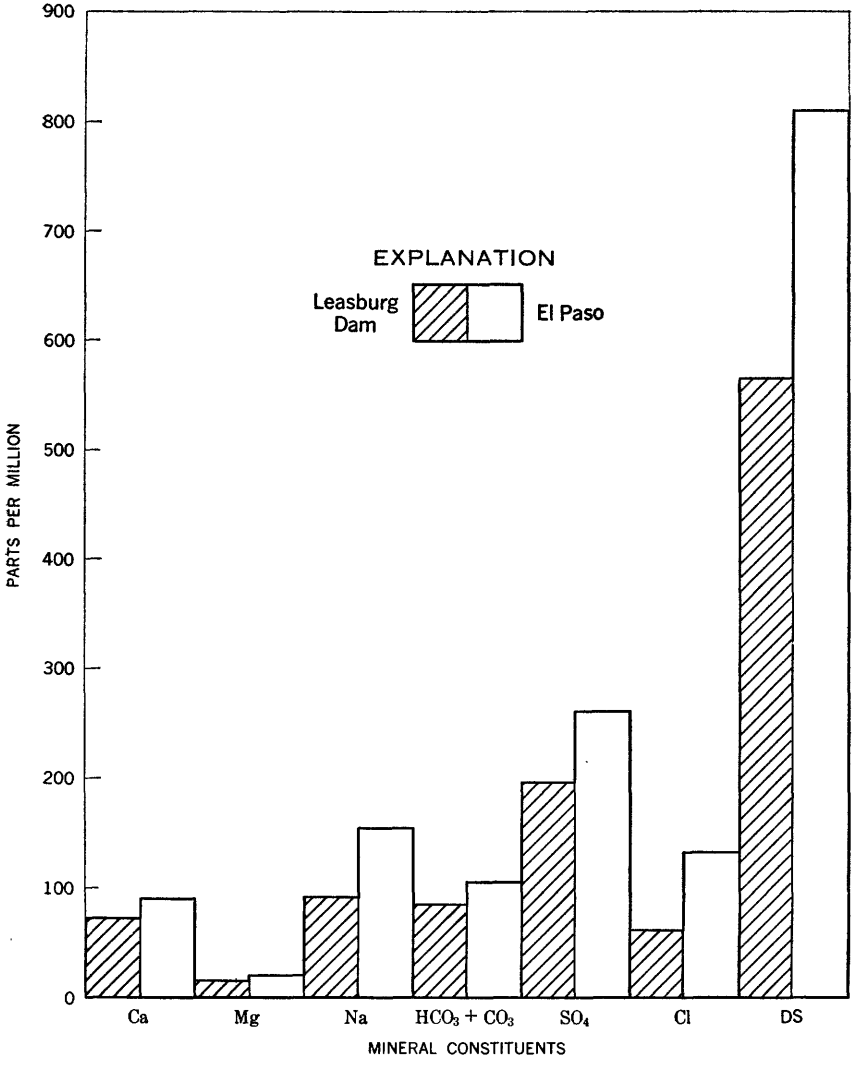

FIGURE 12.—Average chemical quality of water from the Rio Grande at Leasburg Dam, N. Mex., and at El Paso, Tex.

limits, of the ionic strength of the water. These data show that water in Anthony Drain is higher in mineral content that that in Montoya Drain.

In general, the drain water increases in dissolved-solids content from the upper to the lower end of the West Drain (fig. 15). The increase is due principally to the accretion of ground water in mineralization, which increases toward the lower end of the valley, and also to the concentration of the dissolved salts in the drain water by evapotranspiration.

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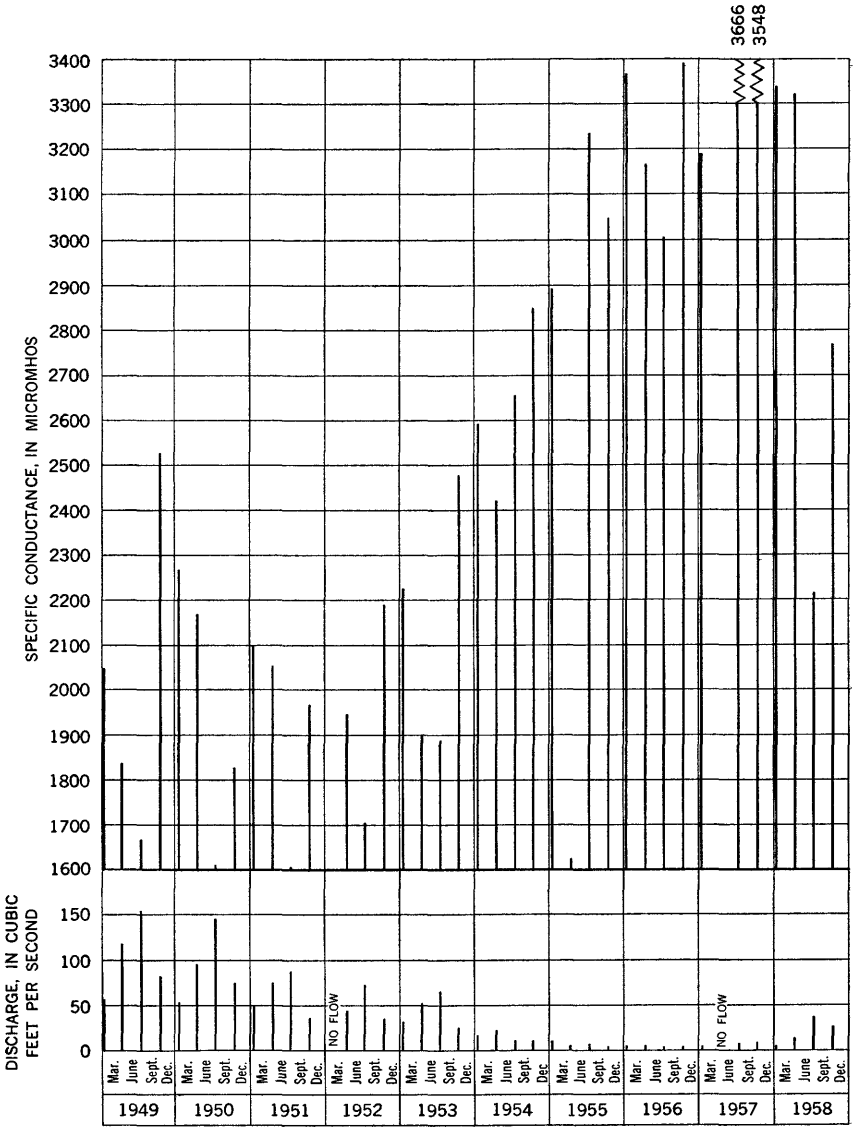

FIGURE 13.—Quality and discharge of water in Montoya Drain, 1949–58.

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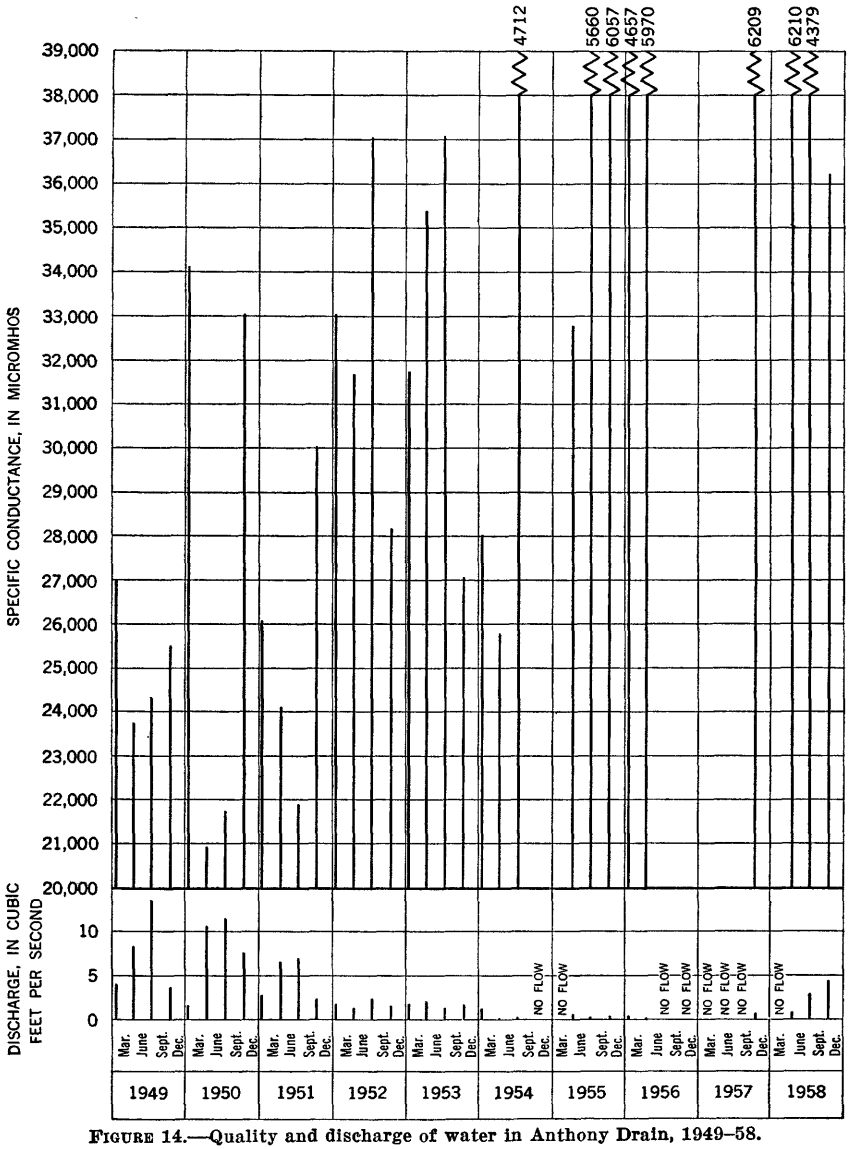

FIGURE 14.—Quality and discharge of water in Anthony Drain, 1949–58.

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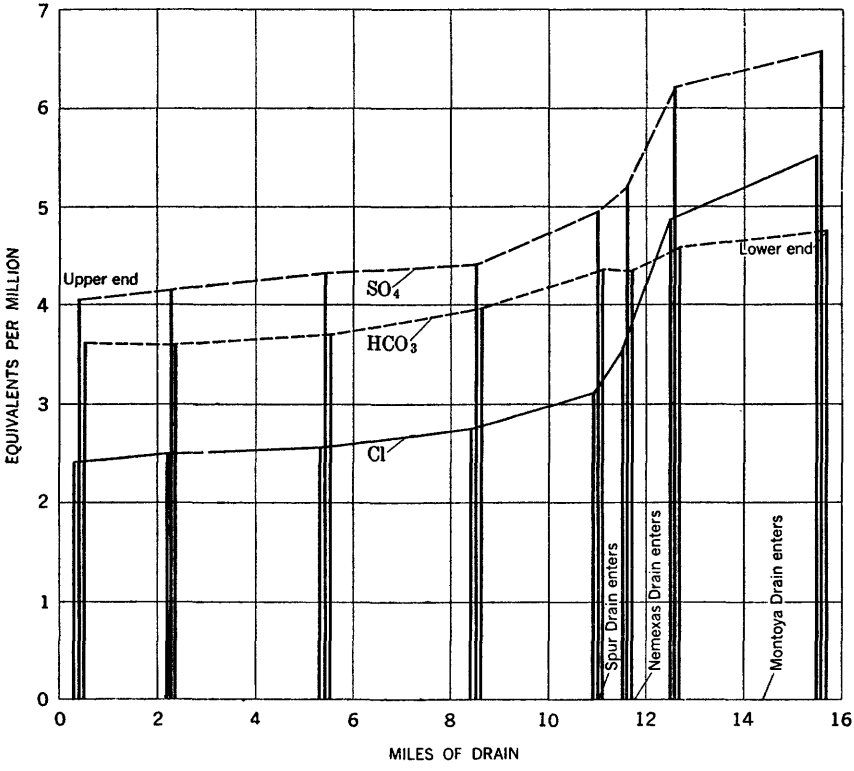

FIGURE 15.—Increase in mineralization of water from the upper to the lower end of West Drain.

FUTURE DEVELOPMENT

The quantity of ground water discharged as drain flow from the lower Mesilla Valley indicates that additional supplies can be developed from wells tapping the shallow, medium, and deep aquifers, with little permanent loss of ground-water storage. Unmeasured, but substantial, amounts of reclaimable ground water are discharged by seepage into the Rio Grande and by evapotranspiration. If the water table is lowered below river level, seepage from the Rio Grande will add to recharge of the ground-water reservoir.

The future development of ground water in the lower Mesilla Valley is affected in several ways: (1) the demand for ground water for irrigation is extremely variable because it depends upon the availability of surface water; (2) the quality of most of the water in the shallow aquifer is unsuitable for public supplies and for some industrial uses; (3) the quality of water in the medium and deep aquifers may deteriorate as a result of leakage of water of poor quality from the shallow aquifer and from encroachment of salt water from under-

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lying and adjoining beds, if withdrawals from the deep aquifer are excessive; (4) the surface-water supply will be reduced if ground-water withdrawals in the valley are increased; and (5) the salt content of the water in the shallow aquifer will increase if the drain flow is reduced substantially.

Drain flow is directly related to the allotment of surface water for irrigation and to the withdrawals of ground water from any of the three aquifers. If surface-water supplies are inadequate, ground-water withdrawals may become so large that drain flow will cease, and the water in the shallow aquifer will increase in dissolved solids content. Thus, if the shallow aquifer is to remain a source of supplemental supply for irrigation, withdrawals of water must not be so great that the drain flow is stopped or is reduced to a point that would result in an unfavorable salt balance in the irrigated area.

The rated capacity of wells drilled in the shallow aquifer during the period 1951–56 probably is adequate to meet the demands for supplemental irrigation water even during prolonged periods of severe shortage of surface water. The demand for irrigation water reached a maximum in 1958 when nearly all the land was being irrigated in this area. About 5 percent of the land, or about 1,000 acres, uses ground water exclusively for irrigation; 95 percent uses surface water supplemented by ground water when allotments are inadequate. The crops require about 3 feet of water annually; thus the demand for ground water ranges from about 3,000 acre-feet per year, when surface-water supplies are adequate (as in 1958), to as much as 50,000 acre-feet per year during extended periods of surface-water shortages.

Development of additional water supplies from the shallow aquifer for uses other than irrigation appears feasible. Withdrawals of water for public supply from the shallow aquifer, however, should not exceed the capacity of the present El Paso shallow well field, about 17,000 acre-feet per year, or 15 mgd. The field includes nearly all the area underlain by water suitable in quality for public supply. Additional development from the shallow aquifer should be limited to water of poor quality which can be used by industries.

The flow from Montoya Drain represents a large part of the water that could be pumped from wells without seriously depleting the amount of water in storage. The records of flow for the period 1946–50 show that about 70,000 acre-feet per year of ground water could be pumped when surface-water allotments are adequate. Surface water was in short supply every year from 1951 to 1957; an increase in pumpage and a decrease in the recharge rate to the ground-water reservoir reduced the average drain flow for the period to 17,000 acre-feet per year, a loss of 53,000 acre-feet per year from the rate of

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the period 1946–50. The average pumping rate from 1951 to 1957 was 36,000 acre-feet per year. About one-third of the water pumped was returned to the aquifer as seepage. Ground water used for irrigation and municipal supplies accounted for about half of the drain-flow loss, or about 26,000 acre-feet per year; the other half was caused by a decrease in the recharge rate caused by the application of less surface water to the land. The average decrease in the recharge rate was greater than 26,000 acre-feet per year, because part of the water pumped was withdrawn from storage. In 1958, when surface water was adequate, the drain flow did not increase as much as expected, because ground water in storage was replenished.

The greatest potential source of water for municipal and industrial supplies is the medium and deep aquifers. In 1958 the city of El Paso pumped an average of 6.8 mgd from the medium and deep aquifers. The rated capacities of the pumps is 19 mgd, or about 6 mgd greater than recharge to the aquifers. Pumping at capacity rates might result ultimately in the encroachment of salt water, which overlies, underlies, or adjoins the fresh water. Encroachment may be kept to a minimum (1) if withdrawals of ground water do not exceed the rate of recharge, (2) if withdrawals are as remote as possible from salt-water bodies, and (3) if withdrawals are chiefly from the deep aquifer. Large withdrawals of ground water from the medium aquifer might accelerate the contamination of the fresh-water body by increasing the rate of downward movement from the shallow aquifer.

As a conservative estimate, at least 200,000 acre-feet of fresh water can be recovered from storage in the Texas part of the valley. This estimate does not include ground water in the New Mexico part of the valley, which would replace the water withdrawn from the Texas part of the valley. The rate at which fresh water in the medium and deep aquifers is depleted will depend upon the withdrawal rate.

On the basis of past records, it appears that from all three aquifers development of ground-water supplies in addition to irrigation supplies could total about 30,000 acre-feet per year, 16,000 acre-feet of which may be safely obtained from the medium and deep aquifers.

SUMMARY AND CONCLUSIONS

The middle and deep aquifers of the Santa Fe group are the most important sources of ground water in the lower Mesilla Valley for the municipal supply of El Paso. The shallow aquifer, which consists of Recent alluvium and a part of the Santa Fe, is used extensively as a supplemental supply for irrigation and to a small extent as a source for municipal and industrial supplies.

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Recharge to the Santa Fe, estimated to be 13 mgd, is derived from precipitation on the bordering uplands and from the valley in New Mexico north of Anthony. The amount of recharge to the Recent alluvium from infiltration of irrigation water varies in accordance with the amount of water applied to the land. During periods when the surface-water supply is normal, the potential annual accretion to the alluvium is at least 36,000 acre-feet. When the water table is high and the drains are flowing, most of the 36,000 acre-feet of recharge will be returned to the river as drain flow.

Aquifer tests indicate that the three aquifers (deep, medium, and shallow) in the city of El Paso well field near Canutillo are hydraulically connected; pumpage from one affects the water level in the others. The tests showed substantial leakage between the aquifers. Therefore, water higher in dissolved-solids content will percolate from the shallow aquifer into the medium and subsequently into the deep aquifer to replace the water of better quality that has been withdrawn.

Fresh water occurs in the Santo Fe from at least the New Mexico-Texas State line southward to a line approximately through Canutillo. South of this line, the dissolved-solids content of the water in the Santa Fe increases until it becomes unfit for most uses. The quality of water in the Recent alluvium varies widely. North of Canutillo and west of U.S. Highway 80, the water in the alluvium is of good quality, but its dissolved-solids content is greater than that of the water in the underlying Santa Fe. Because most of the recharge to the alluvium is from infiltration of water applied to the land and from seepage from drains, canals, and the river the quality of the ground water varies according to the quantity and quality of the surface water available for irrigation. South of Canutillo, the water in the Recent alluvium is high in mineral content but generally is of better quality than the water in the underlying Santa Fe.

The use of ground water for irrigation in the lower Mesilla Valley is inversely related to the supply of surface water. During periods when surface-water storage in Elephant Butte Reservoir is normal, pumpage for irrigation is negligible. Since 1957, pumpage of ground water for the municipal supply of El Paso has increased each year, and in 1958 water usage for minicipal supply exceeded the pumpage of ground water for irrigation. In 1958 the city of El Paso pumped an average of 6.8 mgd from the medium and deep acquifers of the Santa Fe, or about 50 percent of the estimated recharge to the Santa Fe.

It is estimated that 560,000 acre-feet of fresh water is stored in the alluvium and the Santa Fe in the Texas part of the valley and an additional 980,000 acre-feet in the part of the valley in New Mexico. About 150,000 acre-feet is in the alluvium in Texas. In the areas where the

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fresh-water beds are overlain or underlain by salt water, probably less than half of the fresh water can be recovered.

The large amount of ground water discharged as drain flow from the lower Mesilla Valley indicates that additional supplies can be obtained from wells tapping the shallow, medium, and deep aquifers. In addition to irrigation supplies, the three acquifers can furnish long-term sustained supplies totaling about 30,000 acre-feet per year, 16,000 acre-feet of which may be safely developed from the medium and deep aquifers.

Results of the investigation indicate that the ground-water resources of the lower Mesilla Valley are insufficient to furnish a large sustained supply of ground water for the increasing needs of the city of El Paso. Detailed planning and proper development will be necessary to obtain maximum recovery without serious contamination of the water supply. Such planning should include (1) the collection of records of well construction, (2) well performance, (3) periodic water-level measurements, (4) pumpage records, and (5) chemical analyses of water samples.

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DEPARTMENT OF THE INTERIOR

INFORMATION SERVICE

GEOLOGICAL SURVEY

For Release OCTOBER 30, 1950.

GROUND-WATER PUMPING TO TEMPER EFFECTS OF DROUGHTS IN ELEPHANT BUTTE DISTRICT, N. MEX.

Ground water in the subsurface reservoirs of the Rincon and Mesilla Valleys, N. Mex., can be pumped from wells to supplement surface-water supply during drought years in the Elephant Butte District of the Rio Grande Project, according to a Geological Survey report released today by Secretary of the Interior Oscar L. Chapman.

The report, by C. S. Conover, entitled "Ground-water conditions in the Rincon and Mesilla Valleys and adjacent areas in New Mexico," is based on studies made in cooperation with the Elephant Butte Irrigation District in New Mexico.

Local interest in the possibilities of developing ground water to supplement the Rio Grande surface supply stems from an extended period of deficient stream flow during the period 1942 to 1946. The investigation was made to determine the water-bearing characteristics of the sand and gravel deposits of the river valley, and to determine the feasibility of pumping ground water as a supplemental water supply for irrigation during anticipated periods of shortage of surface water from Elephant Butte Reservoir on the Rio Grande.

Mr. Conover states, "The ground-water and surface-water supplies are interdependent, and ground water pumped in the Rincon and Mesilla Valleys does not represent an additional supply or new source of water but rather a change in method, time, and place of diversion of the supplies already utilized." He points out that some adjustments ultimately may be necessary, under the State water laws, in cases where farmers use water from the ground and still receive a full share of water from the District.

For a hypothetical year when the supply of surface water was assumed to be less, by 1 acre-foot per acre of irrigated land, than the amount needed, it was determined that pumping of 2.42 acre-feet of ground water per acre irrigated would be needed to make up the deficiency. This is partly because part of the water would be lost by seepage from the canals before reaching the fields, and partly because the pumping would cut down the flow of some of the drains used for irrigation, and that deficiency would have to be made up. Also, because of the effect upon the ground-water storage, pumping of ground water for five such hypothetical dry years would require at least three additional years of partial pumping and efficient water use after a return to a normal supply of surface water.

Included in the report is a map showing the depth to water in Dona Ana County and the location of wells on which information was obtained.

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The typewritten report, consisting of 316 pages of text and tables, 11 plates, and 12 figures, may be consulted by interested persons in the offices of the Geological Survey, 2209 General Services Bldg., Washington, D. C., and 318 Rosenwald Bldg., Albuquerque, N. Mex., of the Elephant Butte Irrigation District in Las Cruces, N. Mex., and of the State Engineer in Santa Fe, N. Mex. The report may be published later by the State.

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Interior--Duplicating Section, Washington, D. C.

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Copied from materials in the Archives & Special Collections Department, Rio Grande Historical Collections, New Mexico State University Library

June 3, 1953

STATEMENT FROM ELEPHANT BUTTE IRRIGATION DISTRICT REGARDING THE WATER SITUATION

It is now evident that regular spring runoff from melted snow will be extremely small this year.

About all of the water that we can definitely count on is what is in the reservoirs at the present time. Rainfall is too uncertain and too infrequent to be relied upon to change the situation.

Reservoir conditions permit an increase in the allotment of one half acre foot per acre, making a total allotment of one and one half acre feet per acre. This is all that is in sight at the present time.

This situation makes it evident that it will again be necessary to make extensive use of irrigation wells in this District in 1953.

Well owners are urgently requested to make available for transfer as much allotted water as they can spare. As was the case in 1951 and 1952, this is the only certain way of avoiding serious crop loss in this District in 1953.

Insofar as we are able to estimate it at the present time, the excess water rate will be around $5.00 per acre foot. This figure cannot, of course, be finally determined until a budget for 1954 has been approved and the amount of excess water used this year is known.

Well owners who have allotted water available for transfer and who wish to list this water for sale with the District are urged to do so promptly. Call phone #1 in Las Cruces collect if you wish to list allotted water for sale.

People who will need to buy allotted water in 1953 are requested to attempt to make arrangements to obtain this water in their own communities first. Transfer blanks can be obtained from ditchriders or from the District office in Las Cruces.

ELEPHANT BUTTE IRRIGATION DISTRICT

IX.MSJ.006034
EBID000475

ELEPHANT BUTTE IRRIGATION DISTRICT
Las Cruces, New Mexico

March 4, 1954

STATEMENT REGARDING THE CURRENT WATER SITUATION

As announced by the Bureau of Reclamation on March 1, 1954 the starting allotment for the 1954 irrigation season is five inches per acre of water right land.

The first release from Caballo Dam will be made on March 20, 1954.

Project storage in Elephant Butte and Caballo reservoirs, as of March 1, 1954 was 185,200 acre feet. Storage on this date in 1953 was 470,600 acre feet. The 39 year average storage for March 1 is 1,061,000 acre feet. Present storage is only 17½ percent of the 39 year average.

Prospects for 1954 runoff are not encouraging. The February 1, 1954 snow report indicated that conditions on the watershed were below normal. There is no indication that the situation has improved and below normal runoff for 1954 is anticipated.

The current water situation, together with prospects for runoff during the next few months, make conservative use of available water absolutely necessary.

The transfer of water among farms will again be necessary if small farms that do not have wells are to make a crop in 1954. Well owners are urged to make available for transfer as much allotted water as they feel that they can spare. The District will act as transfer agent if requested by those who wish to buy and sell allotted water.

* * * * * * * * * SPECIAL NOTICE TO WELL OWNERS * * * * * * * * * * * * *

(All well owners are requested to read this statement carefully)

The statutes of New Mexico provide that failure to use allotted water for four consecutive years amounts to an abandonment of water right.

All well owners who have not made full use of their allotted water, either by application on their lands or by transfer to other landowners, for any one of the past three years, are advised to make such full use during the 1954 irrigation season.

Transfer of allotted water to another tract is considered to be use of water and would prevent abandonment of water right.

Further information regarding this matter can be obtained from the Elephant Butte Irrigation District if desired.

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TX MSJ 006035
EBID000477

MEMORANDUM
OFFICE OF THE STATE ENGINEER
DISTRICT 4

May 15, 2003

File: LRG-1776

To: John R. D'Antonio Jr., State Engineer
Paul Saavedra, Water Rights Division Chief
John Romero, WRAP Director

Through: Calvin Chavez, District Supervisor

From: Erek H. Fuchs, Lower Rio Grande Basin Supervisor

Re: **Emergency Application for Permit for Supplemental Wells**

Local impairment analysis and issues for consideration

Applicant: Elephant Butte Irrigation District

Summary

The Elephant Butte Irrigation District (EBID) filed emergency Application on April 1, 2003 for Permit for Supplemental Wells by making use of existing wells owned by EBID constituents throughout the EBID to supplement surface water rights of the Rio Grande Project in the amount of up to 271,920 acre-feet[1] of groundwater from the Lower Rio Grande Underground Water Basin for a period not to exceed one year for the irrigation of up to 90,640 acres of land within the EBID in Doña Ana and Sierra Counties. The application identifies ten existing wells owned by EBID constituents, including wells owned by EBID Board President Gary Arnold and also EBID General Manager Gary Esslinger, to serve as supplemental to surface water rights by pumping into EBID conveyances (laterals and canals) at strategic locations for carriage, sale and delivery elsewhere to EBID farmers in need of additional water. Continuing drought conditions affecting the Rio Grande Project are such that EBID constituents can currently expect only about 22% (8 acre-inches per acre) of a typical full surface water allocation (3.0 acre-feet per acre). Half (4 acre-inches) of the current total allocation available for release from the Elephant Butte and Caballo Reservoirs this year reflects waters that otherwise would not be available to Rio Grande Project beneficiaries, but are now planned to be released as a result of recent agreements between Texas and New Mexico to relinquish 122,500 acre-feet of credit water as per the Rio Grande Compact.

[1] The application suggests a diversion amount of up to 3.0 acre-feet per acre of groundwater for the irrigation of 90,640 acres, however the actual quantity necessary to deliver this amount, which could be considerably more, is not identified or addressed in the application as filed.

The original five wells that are the basis for the groundwater right intended to serve the application as recorded under declaration LRG-1776 et. al. are presently unequipped and apparently are not desired for use. Personal communication on May 14, 2003 with Gary Esslinger, General Manager for the EBID, confirmed that in fact the original five wells declared under LRG-1776 et. al. are not planned to be used. However, the application indicates that additional supplemental wells owned by other EBID members beyond the ten initially selected will be identified in the future to be included under the application as filed. Presently, it is unknown when or how many other wells may be identified.

The initial ten wells proposed for supplemental use, associated file numbers, their locations and respective owners are listed herein and an impairment analysis of the predicted effects of these first ten wells on neighboring wells of other ownership is included as required by NMSA 1978 §72-12-24. In summary, the analysis shows that even under very conservative assumptions, all potentially affected neighboring wells of other ownership should not suffer impairment or as a minimum should have sufficient remaining water columns to regain capacity if need be, at least for the first year. Although the EBID's emergency application seeks a temporary permit for a period not to exceed one year, most indications are that drought conditions and the subsequent shortage of surface water available to the Rio Grande Project will persist through next year and for years to come. Therefore, much of the discussion herein considers the possibility of efforts to eventually achieve a full irrigation allotment (3.0 acre-feet per acre) through groundwater pumping alone, which is consistent with the presumed intent of declaration LRG-1776 et. al. and the application as filed. Given the interrelated nature of the surface and groundwater system in question, groundwater diversions of the magnitude potentially necessary to serve the application or that may occur for years to come despite the application as discussed herein are such that much of the available or remaining mainstem flows of the Rio Grande below Caballo Reservoir, beginning with drain flows within the EBID, could be negatively and substantially affected almost immediately, although it is uncertain how severe these effects might be. Should drought conditions persist on a multi-year, continuous basis and the supplemental pumping in question continues at or near full capacity, the manner in which the State of Texas will receive a proportional share of Rio Grande Project water and the quality associated with such in future years remains largely uncertain. In the absence of a clear plan of replacement and/or state line delivery strategy and working agreement with the EBID under these circumstances, it must be assumed that the State of New Mexico could eventually be met with a challenge under the Rio Grande Compact. However, because most of the EBID (~ 90%) already has on-farm access to private wells for supplemental purposes and will in all likelihood continue to use them at or near full capacity, the potential for such a challenge may exist regardless of the action taken on the application. In fact, groundwater pumping very similar to that described in the EBID's emergency application has been initiated and is expected to continue to develop. Most material efforts of this office and possibly those at the state level to discontinue this activity in the field under the current drought conditions will very likely result in mayhem, significant media attention and much political posturing. In the event that EBID's groundwater pumping program is endorsed or some sort of cooperative agreement is reached, some extraordinary data collection and technical sharing opportunities (i.e. metering, monitoring and measurement, model calibration and refinement) may be available to the Office of the State Engineer, including

information necessary for the development of a state line delivery strategy. This data could prove to be very useful, particularly if and when New Mexico finds itself engaged in litigation with Texas, but will probably only be shared in the event that an agreement can be reached on the application in question. If so chosen, potential may exist such that the mere act of sanction and/or endorsement alone regarding the EBID pumping program as it is proposed may strain already tenuous relations with Texas and others and could result in many problems, including the increased potential for a challenge under the Rio Grande Compact due to the uncertain extent of effects of this large scale pumping on the quantity and quality of the mainstem flows of the Rio Grande below Caballo Reservoir. Although no clear conclusion is at present offered herein as the basis for recommending an action on the application (approval or otherwise), several aspects of the application and important considerations concerning the basis for the groundwater right intended to serve the application are reviewed.

Discussion

The supplemental groundwater pumping proposed in the application would be used to irrigate any or all lands that are assessed surface rights via the Rio Grande Project throughout the EBID, potentially with groundwater alone, irrespective of whether or not specific tracts of land have actually received groundwater prior to the State Engineer's jurisdiction in the Lower Rio Grande as recorded and on file or otherwise, or if surface rights of which groundwaters have traditionally been considered supplemental to and in most instances inseparable[2] have been leased or transferred for use elsewhere within the EBID, or such tracts have been permitted recognizing specific wells and associated rights with specific permit conditions or perhaps have been adjudicated. The initial consideration concerning the use of groundwater on lands that have never before been irrigated with groundwater could be particularly problematic in lieu of policy memorandum dated October 22, 2002 from Water Rights Division Chief Paul Saavedra in which it appears that staff are directed to no longer accept applications for supplemental wells to serve as alternate points of diversion to irrigate tracts of land of which groundwater rights are not appurtenant. Memorandum dated January 9, 2002 from Lower Rio Grande Basin Supervisor Erek Fuchs concerning file LRG-11558 also elaborates on this issue. It is worth considering that in lieu of continuing drought conditions, if this policy is revoked or interpreted very differently it is quite possible that a deluge of applications from individuals seeking supplemental wells to serve as surrogates to surface water might occur. This activity would in all likelihood not be limited to the Lower Rio Grande and the EBID, but would probably be very popular in the Middle Rio Grande Conservancy District and elsewhere. Unfortunately, there could be as much as 12,000 acres[3] throughout the EBID of which surface rights are assessed but groundwater rights are not appurtenant. Other considerations regarding existing permits and associated conditions of approval and more significantly matters of adjudication as per *New Mexico ex rel. Office of the State Engineer v. Elephant Butte Irrigation District, et al*., Case No. CV 96-888 (1996) also pose significant problems in entertaining the EBID's application as filed. For example, informal

[2] Groundwater rights for irrigation purposes in the Lower Rio Grande where the land in question is also irrigated with surface water have traditionally been considered supplemental and most often junior to surface water. The administrative result in the Lower Rio Grande has been that if all or part of the surface right is transferred or abandoned, the groundwater right for that part is likewise severed.

[3] Hydrographic Survey of the Lower Rio Grande (2000). Approximate total of those lands found to be "Surface Only" is about 12,711 acres.

internal estimates are that roughly one-third (~ 6000 acres) of the Rincon Valley within the EBID has been adjudicated. Some of these lands have been adjudicated recognizing only surface water rights, while other tracts of which the historic supplemental use of groundwater has been proven are recognized by court order to be served only from specific wells. Another complexity that warrants concern is the fact that some of the tracts that benefit from Rio Grande Project water in the southern-most reaches of the EBID are split to varying degrees between the States of New Mexico and Texas. Of course, these farms are logically managed and irrigated contiguously; therefore there is no practical way to prevent the flow and use of groundwater originating in New Mexico as it is proposed in the EBID's emergency application from being exported in part for use in Texas. This activity may require that the provisions of NMSA 1978 §72-12B-1 concerning exportation of waters outside the state be observed. Additionally, it is worth noting that if the application is to receive the benefit of full consideration, it must be advertised as required by NMSA 1978 §72-12-3(D). Upon advertisement, substantial public attention and numerous protests can be expected, including objections from several Texas entities. Because additional wells in as yet undisclosed numbers and locations are proposed to be added at some later date or dates, multiple advertisements at various times in the future will probably be necessary to include these wells, thus increasing exposure and attracting more protests.

The use of groundwater as it is proposed by the EBID is of course motivated by current drought conditions and the resultant shortage of Rio Grande Project surface water, but apparently is also motivated by the institutional interests of the EBID Board of Directors. This is in contrast to the more traditional private landowner basis for groundwater development for irrigation and other purposes as it has formally evolved through statutory direction, water rights administration and regulation observing and protecting individual property rights in the Lower Rio Grande and elsewhere. Arguably, the EBID's proposed groundwater pumping program is somewhat of a stretch beyond the EBID's more familiar and statutorily sanctioned role regarding the surface waters of the Rio Grande Project, although this is certainly not the first time that drought conditions have plagued the Rio Grande Project, and actually it is not the first time that the EBID has attempted to establish a groundwater pumping program to supplement surface water. However, the last time (mid-late 1970's) the EBID made such an attempt, a flurry of litigation ensued as described in *Mestas v. Elephant Butte Irrigation District*, District Court of New Mexico, Cause No. 79-1689 (1979). This legal contest regarding impairment concerns and other issues of authority following EBID's efforts to pump a large amount of groundwater to mitigate drought effects over twenty years ago became so severe that the membership of the EBID Board of Directors completely changed in the early 1980's, although judgment of the case as it was ultimately reviewed on appeal by the US Tenth Circuit Court of Appeals in 1981 remains somewhat inconclusive. Apparently, the EBID was not happy with parts of the original decision, including a 1.5 mile radius limitation on transportation of pumped groundwater from each source well and also the required distribution of all groundwater pumped from the wells on a pro rata basis to each landowner assessed within the EBID. The Tenth Circuit remanded the case back to the US District Court in Albuquerque, NM where it had been originally heard to consider the fact that the State Engineer had since formally declared the Lower Rio Grande Underground Water Basin in 1980. The Tenth Circuit also urged that the District Court consider whether federal subject matter was warranted. No further judgment has since been rendered, although it is

obvious that the federal courts were of the opinion that as of 1980, the State Engineer had lawful jurisdiction in the matter. Therefore, although the EBID is no stranger to droughts and apparently has experimented with a groundwater pumping program in years past, the emergency application in question is essentially the first time that the EBID has sought formal approval from and to some extent cooperation with the State Engineer in carrying out conjunctive management and administration of the collective ground/surface water resource of the Lower Rio Grande. The significance and complexity of this notion, particularly in a time of severe drought, needs little acknowledgement since the historical merits, institutional differences, local municipal and industrial interests, the Rio Grande Compact and concerns regarding potential litigation with the State of Texas tend to speak for themselves.

The basis for the groundwater right intended to serve the application is described under declaration LRG-1776 et. al. This controversial claim was filed by the EBID on June 1, 1981 asserting a pre-basin intent beginning sometime in 1973 to make use of at least five wells, numbered LRG-1776 through LRG-1776-S-4, drilled on behalf of the EBID by R.L. Guffey between 1973 and 1975 on lands owned by the US Bureau of Reclamation to supplement surface water in the amount of up to 3.0 acre-feet per acre for farm irrigation and related purposes on a pro rata basis on 90,600 acres of land[4]. Information included in the application (page 3, part 9 of affidavit from EBID Board President Gary Arnold) and documented in *Mestas v. Elephant Butte Irrigation District* (1979) indicates that surface water shortage conditions in the late 1970's hastened an approximate maximum total of 13,000 acre-feet of groundwater pumped from wells LRG-1776 through LRG-1776-S-4 during the 1977 irrigation season. This groundwater may well have been offered to EBID constituents on a pro rata basis, but the locations of the wells and other conveyance logistics were and are such that only a select few EBID members in the south-central area of the EBID, roughly between San Pablo and Santo Tomas, could possibly have made use of this groundwater. In fact, this concern was part of the motivation leading to litigation as described in *Mestas v. Elephant Butte Irrigation District* (1979). The pro rata, or equitable apportionment of Rio Grande Project waters, be they of surface or ground origin (if it is so determined) is actually quite an important point because obvious injustices leading to significant legal problems will very likely (and apparently did in 1979) ensue if the waters of this major federal reclamation project were or are made available only to those of convenient location to wells within the EBID. To some extent, a concern to this effect is discussed in a letter included in the application (Tab 8) dated September 9, 1996 from EBID Board Member and Vice President Rudy Provencio.

A return to a full allocation of surface water in 1979, coupled with litigation resulting from the *Mestas* (1979) case as discussed above, prompted use of wells LRG-1776 through LRG-1776-S-4 to be discontinued. Wells LRG-1776 through LRG-1776-S-4 have not been in operation since, are presently unequipped, and a full allocation of Rio Grande Project surface water has been available consistently for the last 23 years until the present shortage. Although wells LRG-1776 through LRG-1776-S-4 were drilled to appreciable depths (~ 400-600 feet) and completed in flood plain alluvium, in near proximity to the Rio Grande (~ 1.0 mile) and were each fitted with

[4] The application as filed identifies 90,640 acres of land; however, declaration LRG-1776 et. al. only identifies 90,600 acres of land.

16-inch casings with thus relatively high potential peak capacities (~ up to 3000 gallons per minute per well (Driscoll, 1986), depending on pump equipment), the potential combined maximum yield from all five wells (~ 13,920 acre-feet assuming 7-months[5], March – September, constant pumping at peak capacity and 100% well efficiency) would not be nearly sufficient to irrigate 90,600 acres of land on a pro rata basis. The declaration itself does not indicate intent or plans to drill additional wells, however information included in the application as filed (Tab 6 of the application, part 5 of a letter dated March 1978 from then EBID Board President L.E. Archer; page 3, part 9 of affidavit from current EBID Board President Gary Arnold) suggests that at least another five wells and perhaps as many as a total of 36 wells may have been planned. Even if 36 high capacity wells were drilled, assuming each well capable of 3000 gallons per minute for 7-months (~ 100,227 acre-feet), this still would not be nearly sufficient to irrigate 90,600 acres of land on a pro rata basis (would equate to about 1.1 acre-feet per acre, or about 37% of a full allotment). Assuming each well would need to be capable of 3000 gallons per minute for 7-months, about 98 or more such wells would actually be needed to divert an amount equivalent to 3.0 acre-feet per acre on 90,600 acres of land.

It is important to consider that the discussion above assumes direct, on-farm application of water from the well or wells, which under the circumstances is not the case since the groundwater in question was and is to be pumped into EBID canals and laterals for conveyance elsewhere throughout the EBID. According to Wilson (1998), when the source of irrigation water does not originate on the farm, an additional quantity of water must be diverted from the ultimate source of supply to make up for conveyance losses between the farm headgate and source of water. Estimated off-farm conveyance losses are added to the farm delivery requirement or actual on-farm application of water to arrive at the total diversion requirement, however this additional amount could be fairly small if not negligible, or could be quite significant depending on conveyance distances. Because the application does not specify a maximum conveyance distance, it must be assumed that the distances could be quite far (i.e. several miles). Wilson (1998) reports that the off-farm conveyance efficiency in the EBID is normally 60-65%, although this figure is generally more applicable to transportation of surface water in the EBID conveyance system. If the diversion amount were strictly limited to 3.0 acre-feet per acre as may be inferred from the application as filed, the actual pro rata delivery would be about 1.8 acre-feet per acre assuming 60% off-farm conveyance efficiency. If a parallel is made with the surface waters of the Rio Grande Project as may also be inferred from the application as filed (page 2, part 6 of affidavit from EBID Board President Gary Arnold), then the practical intent of declaration LRG-1776 et. al. and also the application is in all likelihood to actually deliver up to 3.0 acre-feet per acre, which would be consistent with the traditional operation of the Rio Grande Project regarding surface water. As a somewhat broad but perhaps reasonable generalization, in the absence of surface water the EBID may have to actually pump about 450,000 acre-feet in order to deliver up to 3.0 acre-feet per acre of groundwater, again assuming 60% off-farm conveyance efficiency, though it is worth considering that both on and off-farm irrigation efficiency will necessarily suffer if well capacity, efficiency and/or rate of delivery restrictions prolong irrigation, particularly under flood application techniques. This is because a higher

[5] For the purposes of this discussion, 7 months (210 days), March through September, is taken as a generalized seasonal time frame to represent the primary irrigation season in the Lower Rio Grande on average.

percentage of water originating from the well, transported some distance (with conveyance losses) and ultimately applied to the field may infiltrate and drain below the effective root zone long before the field is uniformly and effectively covered. Reduced on-farm irrigation efficiency necessarily results in greater off-farm demands and a higher farm delivery requirement, which in turn requires additional water (well operated longer) to eventually cover the field and distribute the consumptive water needs of the crop (deliver the consumptive irrigation requirement). This observation is the rationale behind increased irrigation efficiency widely reported with high-flow turnouts using surface water in which water is applied to a field much faster (and hence covers the field faster) than is possible with standard turnouts, provided of course sufficient head is available and can be timely conveyed in the surface water system. The same might be achieved by use of groundwater provided that enough wells of sufficient capacity can be operated simultaneously in reference to a defined and/or limited segment of the conveyance system, but to do so would in most instances require extensive planning and coordination. Under the above assumptions of well capacities, off-farm conveyance efficiency and pumping duration, theoretically about 160 or more large wells would probably be needed to deliver up to 3.0 acre-feet per acre of groundwater on 90,600 acres of land. It could be construed from this estimation that given issues of practicality, efficiency and thus conservation of water and certainly the very substantial and costly well requirements in question, the EBID's intent as a Board of Directors may not have ever actually nor could have reasonably been to achieve a full irrigation allotment through groundwater pumping alone, however the intent identified in declarations LRG-1776 et. al. and also described in the emergency application tends to suggest otherwise and thus should be considered accordingly.

Capacity and/or perhaps feasibility questions aside, it is clear that the EBID did initiate a groundwater-pumping program to supplement Rio Grande Project surface water to some extent well before the State Engineer's formal jurisdiction in the Lower Rio Grande on September 11, 1980 and it is also obvious that the program, for numerous reasons, did not reach fruition. Consequently, the basis for the groundwater right intended to serve the application as it is described under declaration LRG-1776 et. al. may be taken as an inchoate, or *Mendenhall*[6] claim. Typical administrative considerations in evaluating *Mendenhall* claims include, among other things, physical proof that the claim was in fact lawfully initiated prior to the State Engineer's jurisdiction, the reasonableness of the claim and the extent to which diligence has been or is being shown in carrying out the intent of the claim. The first of these basic considerations concerning initiation of the claim is without doubt, however the later two issues regarding reasonableness and to a lesser extent diligence do warrant discussion. Of course, along with these basic considerations are primary statutory requirements regarding impairment, conservation of water and public welfare as set forth in NMSA 1978 §72-12-3(E).

[6] Briefly, the significance of this historic decision as it is generally interpreted for administrative purposes is that so long as the right in question, the works and use associated with which having been lawfully initiated prior to formal declaration of the basin in question, is exercised in concert with the intent declared and done so with due diligence and in harmony with all applicable administrative conditions and/or statutory considerations (i.e., no willful waste, etc.), the opportunity to continue to develop the right within a reasonable period of time and associated priority are generally preserved. *State of New Mexico* v. *Mendenhall*, 68 N.M. 467, 362 P.2d 998 (1961).

The reasonableness of pumping groundwater to supplement an often uncertain surface water supply for irrigation needs, particularly in times of drought, is quite consistent with most forms of logic in an inherently arid environment and in fact has occurred throughout much of the EBID historically and almost exclusively by way of private landowners and farmers drilling wells to irrigate specific tracts of land on a largely private basis prior to the State Engineer's jurisdiction in the Lower Rio Grande. Much, but by no means all of this activity is documented and on file with this office as it has occurred historically in the form of declarations and in many instances permits as many wells drilled in the 1950's and other times have been replaced in recent years under appropriate authorization. It is realized that some irrigators may lack the financial ability to have ever drilled wells or perhaps repair or replace existing older wells as is noted in the application (page 2, part 7 of affidavit from EBID Board President Gary Arnold), but as it has been held for quite some while by the New Mexico Supreme Court (i.e. *Rio Puerco Irrigation Company v. Jastro*, 19 NM 149, 154, 141 P. 874, 879 (1914)), poor financial conditions resulting in inability to put water to beneficial use is not an excuse for nonuse. It is also realized that many EBID farmers, particularly during the drought of the 1950's, did coordinate quite successfully and shared groundwater from individual, privately owned wells with less fortunate growers such that a relatively small amount of otherwise irrigable acreage was left fallow. This point is also noted in the application (page 2, part 7 of affidavit from EBID Board President Gary Arnold). Barring arguments for abandonment and/or forfeiture, when and where this activity has occurred as it has been or may be documented with this office is well within the confines of existing law, regulation and administrative protocol. The central point or perhaps question then concerning the issue of reasonableness may be why, if indeed EBID farmers have coordinated so successfully in years past (i.e. 1950's) is it now necessary for the EBID to come forth in an institutional posture to do or help do or perhaps replace in part what private individuals and farming businesses have been and can continue doing themselves? In part, depending on philosophy and perspective, an answer to this may be found from within the EBID's own constituency as expressed over twenty years ago and documented in *Mestas v. Elephant Butte Irrigation District* (1979), whereby one of the chief contentions of the group of EBID members having brought suit against the EBID was that the EBID had no authority to pump and sell underground water and even if such authority did exist, to do so would be wasteful because sufficient private wells were already available to achieve cooperation and sharing among farmers to meet all water needs in times of drought and otherwise. Of course, the cooperation and sharing of wells contended by the EBID members would have in all likelihood included some measure of monetary exchange as such sharing occurred in the field. Thus, it is possible that private fiscal affairs may have motivated the *Mestas* case to some extent. A potential benefit to the possibility of EBID's institutional oversight of supplemental groundwater pumping could be the expanded role of regulation and policing within the commercial irrigation community, however it is unlikely that the average EBID constituent will demonstrate significantly more interest in cooperation with EBID ditch-riders and other personnel as opposed to staff of the Office of the State Engineer. If a benefit does exist, it is probably to be found in the fact that the EBID has many more ditch-riders at their discretion than the State Engineer has formally educated, trained and available technical staff at the local level. A more specific question of reasonableness concerns whether the EBID as an institution (as opposed to a collection of private individuals and respective farming operations) could have or can now drill or contract use of

somewhere around 160 high capacity wells throughout the EBID to reasonably assure practical availability and delivery of up to 3.0 acre-feet per acre of groundwater to every EBID farm-rate member on a pro rata basis scattered throughout and across over 200 square miles of land? Perhaps most fortunately, the full opportunity or need to prove this was cut short in the late 1970's given a return to full surface water availability, thus the answer may be as uncertain as, or perhaps proven in how and for what duration drought conditions continue to affect the Rio Grande Project. In the event that EBID's groundwater pumping program should proceed much as proposed and does experience significant development in the field, there may be some extraordinary data collection opportunities (i.e. metering, monitoring and measurement, model calibration and refinement) available to the Office of the State Engineer, in addition to some shared responsibility of policing and other regulatory burdens. The later, however, could very well result in questions of jurisdiction and much added confusion.

The question of diligence concerning development of the EBID claim is somewhat moot because immediately following the discontinuance of wells LRG-1776 through LRG-1776-S-4 in the late 1970's, drought conditions lessened and a full allocation of Rio Grande Project surface water was and has been available consistently for the last 23 years until the present shortage. Although arguments concerning prudent planning and the inevitability of returning drought and surface water shortage conditions can be made, it stands to reason that the wells apparently were not maintained nor were additional wells drilled given the availability of much less expensive surface water. This observation may tend to counter arguments for abandonment. Page 4, part 11 of affidavit included in the application from EBID Board President Gary Arnold identifies several steps the EBID has taken to maintain the rights claimed under LRG-1776 et. al. since the wells were initially declared in 1981. All of the activities discussed appear to have stemmed from a renewed interest and concern originating in or about 1996 regarding the potential for drought conditions to affect the Rio Grande Project. Indeed, according to numerous data sources[7] available through the US Bureau of Reclamation, more recent drought conditions in the Rio Grande Basin and records of well below average runoff and recharge to the Elephant Butte Reservoir are well documented as beginning in or about 1996. Therefore, it appears that EBID's interest in an institutionally managed groundwater pumping program to supplement surface water is largely if not strictly limited to drought contingency measures. In this sense, diligence is derived and thus driven by drought conditions and cannot be effectively measured or predicted, other than perhaps by the activity demonstrated in the late 1970's concerning LRG-1776 et. al. If this activity is taken as the measure and limit of the *Mendenhall* claim, then the groundwater right in question could be limited to the maximum diverted and placed to beneficial use historically. This amount is about 13,000 acre-feet as documented in the application (page 3, part 9 of affidavit from EBID Board President Gary Arnold) and discussed in *Mestas* (1979), however such an amount, if apportioned equally on a pro rata basis across the EBID's 90,640 acres of irrigable lands, would only result in approximately 1.72 inches of additional water per acre and could be as little as 1.02 inches per acre if 60% off-farm efficiency is assumed. Such an amount is clearly insufficient for any practical irrigation activity and an attempt to actually deliver such a deficient quantity on a pro rata basis could be argued as contrary to conservation of water. For that matter, the current surface water allotment of 8 inches per acre as it is expected

[7] i.e., US Bureau of Reclamation, DataWeb: http://www.usbr.gov/dataweb/html/riogrande.html

could also be argued to be pointless, however it is worth noting that this relatively small quantity of water could effectively serve as a wetting front throughout the EBID's system of canals and laterals to more efficiently convey groundwater that is/will be pumped into the system. Actual operations, however, are concerned with a block-release type of strategy to deliver a relatively few but reasonably efficient and effective number of irrigations throughout the irrigation season with the limited water that is available in storage. The only viable alternative or possibility to efficiently make use of the 13,000 acre-feet discussed above, if in fact the EBID's groundwater claim is limited to this amount, might be to make this quantity available on a pro rata basis from the EBID's "conservation pool". Traditionally, the EBID's conservation pool reflects surface rights of the Rio Grande Project otherwise appurtenant to lands within the EBID that have been caused to be fallow due to assessment delinquency and/or other reasons, or may reflect surface rights owned by individual EBID farm-rate members (owners of tracts greater than two acres) that have voluntarily fallowed their lands and made the rights available to the EBID for lease to other EBID farm-rate members. If the 13,000 acre-feet of groundwater were administered this way and pumped from wells located on-farm or nearly so, and a pro rata surface water allotment of 8 inches is assumed as currently expected, then approximately 5,600 acres could be irrigated at a full allotment of 3.0 acre-feet per acre. However, this is not the intent or request proposed in the EBID's emergency application and to evaluate it as such would be arguably inappropriate.

In closing, it should be noted that although the EBID's emergency application seeks a temporary permit for a period not to exceed one year, all indications are that drought conditions and the subsequent shortage of surface water available to the Rio Grande Project will persist through next year and for years to come. Because the availability of credit waters via the Rio Grande Compact are indeed limited and may not last for more than another one or two years depending on negotiations between Texas and New Mexico, it is highly probable that the groundwater pumping program currently proposed by the EBID will be sought again next year and for perhaps years to come and could eventually lead to efforts to achieve a full irrigation allotment through groundwater pumping alone. The amount of groundwater diversions potentially necessary to achieve a full allotment of 3.0 acre-feet per acre for the entire EBID in the absence of surface water could be up to 450,000 acre-feet or more as discussed previously and is really only part of the amount actually needed to meet crop requirements. Most EBID constituents consider average annual crop requirements in the Lower Rio Grande to be about 4.0 or 5.0 acre-feet per acre and many farmers, particularly those engaged in the production of alfalfa and/or pecans, believe as much as 6.0 acre-feet per acre is needed. Though much opportunity for debate exists over whether such quantities are actually needed for full production, the reality is that most growers here have and will continue to strive to apply these amounts as long as they consider it economically viable to do so. Traditionally, this additional quantity has been pumped by individually owned private wells for on-farm irrigation needs in furtherance of individually owned groundwater rights, or may in a limited number of other cases be acquired in part through the EBID's conservation pool if surface waters are available. This additional amount could be roughly 150,000 acre-feet or more annually assuming (conservatively) up to an additional 2.0 acre-feet per acre is needed to meet average crop requirements and about 90% of the EBID has on-farm access to private wells and only about 10% of the EBID is fallowed on average each year as suggested by Wilson (1998). However, considerably more land could be fallowed and thus a

lesser quantity pumped in response to drought conditions should the expense of production (well operations) infringe upon profit margins beyond some economic threshold. Potential may also exist to encourage voluntary fallowing beyond what agricultural markets in the area might typically influence in the event that appropriate incentives are made available, and it should also be noted that while many EBID farmers have already voluntarily and at personal expense fallowed some lands and have engaged in water-conserving strategies where possible such as laser-leveling fields and choosing low water-consuming crops (i.e. cotton), there is probably much more remaining opportunity for water conservation. Pecan growers, however, despite the controversy over the benefits and argued "savings" with drip irrigation systems, have really very few options. It is theoretically possible that in the absence of surface water, total groundwater diversions from the Lower Rio Grande for irrigation needs within the EBID could be approximately 600,000 acre-feet or more annually if the entire irrigable area is placed into production. However, since at least 10% of the EBID can be expected to be fallowed in any given year, total groundwater diversions for irrigation needs would probably approach no more than about 540,000 acre-feet annually. The application as filed does not contemplate the possibility or perhaps reality of some percentage of fallowing now or in the future, but rather identifies all lands encompassed within the EBID with the presumed intent to be irrigated, potentially with groundwater alone. Because most of the EBID already has on or near-farm access to private wells for supplemental purposes, an amount somewhat close to this could potentially be pumped regardless of whether the EBID pumping program is endorsed and ultimately developed in a form similar to that currently proposed. To this end, certainly some and perhaps many EBID constituents are currently and have in the past engaged in the practice of pumping groundwater into EBID system conveyances for use by other EBID farmers, similar to that proposed in the application, irrespective of historic use of groundwater in the Lower Rio Grande as it may or may not be documented and on file or in need of permit. Groundwater pumping very similar to the program proposed in the EBID's emergency application has in fact been initiated and will in all likelihood continue to develop. Most material efforts of this office and possibly those at the state level to discontinue this activity in the field under the current drought conditions will very likely result in mayhem, significant media attention and much political posturing. Physical efforts to discontinue this activity in the field could be met with violence in some cases. Conversely though unfortunately, potential does exist such that if so chosen, the mere act of sanction and/or endorsement alone regarding the EBID pumping program as it is proposed may strain already tenuous relations with the State of Texas and others and could result in similar problems, including the increased potential for a challenge under the Rio Grande Compact due to the uncertain extent of negative effects of this large scale pumping on the quantity and quality of the mainstem flows of the Rio Grande below Caballo Reservoir. Although formal comments from the OSE Hydrology Bureau, Dr. Barrol in particular, should be sought for a more thorough analysis of possible river effects in response to the EBID's extensive groundwater pumping, a few relatively safe generalizations can be made. Similar to and in some respects worse[8] than the effects documented during the drought of the 1950's, groundwater

[8] Though specific numbers are not available, there are considerably more irrigation wells in the Lower Rio Grande that have been drilled and equipped on average with better, higher capacity pumps more recently than existed in the 1950's, in addition to the substantial competing demands from municipal, industrial and subdivision needs that have grown exponentially in the last fifty years.

diversions of the magnitude suggested above would rapidly create a large, negative hydraulic gradient throughout the Rincon and Mesilla Valley's such that virtually all surface water drains within the EBID would soon go dry. In turn, much of the available or remaining mainstem flows of the Rio Grande below Caballo Reservoir, if there are any for all practical purposes, would be negatively and substantially affected almost immediately, however it is uncertain how severe these effects might be and for how long even after drought conditions eventually subside. Many shallow wells (~ 100 feet) for domestic and other needs will likely experience problems early on, though most of the deeper (~ 300-400 + feet) domestic wells, large municipal wells in the area and the newer, deep irrigation wells will probably have sufficient capacity for many years to come given the generally robust status of the primary aquifer in the region. Even in full surface water supply years this office has received complaints from owners of small, shallow domestic wells in proximity to larger scale irrigation pumping in the vicinity of Anthony, NM, although it quite possible that the effects of the well-field expansion and associated increased pumping occurring in neighboring Canutillo, TX may also be responsible for effects in this area. This problem is expected to get worse and may prove to be difficult in many instances upon seeking to isolate specific sources of impairment since much of the effects may be due to collective regional pumping rather than individual wells. Also, many of the shallow domestic wells expected to experience problems may simply have never been constructed properly or drilled deep enough to reasonably make use of the groundwater resource, however the owners of such wells will no doubt demand some sort of compensation from somebody or as a minimum require a thorough investigation from this office. Following the onslaught of supplemental irrigation pumping discussed above, significant salt accumulations can be expected and in some cases other water quality problems may become evident as poorer quality shallow groundwaters are drawn down to commingle with generally better quality groundwaters at depth. Given the increasingly environmentally conscious nature of much of the populace in the region, environmental litigation may be quite possible, including federal action under the Clean Water Act, or perhaps worse, the Endangered Species Act. The duration and extent of river effects and degradation will of course be influenced by numerous hydrologic factors and variables, some known and some unknown, but will tend to be governed chiefly by the nature and magnitude of pumping and persistence of drought conditions. While the above assumptions may be more representative of a worst-case scenario, it seems prudent to plan for the possibility of extended drought conditions. Despite the popular belief that New Mexico's obligations to Texas under the Rio Grande Compact essentially end at the Elephant Butte Reservoir, should drought conditions persist on a multi-year, continuous basis, the manner in which Texas will receive a proportional share of Rio Grande Project water and the quality associated with such in future years under the above conditions remains largely uncertain. In the absence of a clear plan of replacement and/or state line delivery strategy and working agreement with the EBID under these circumstances, it must be assumed that New Mexico could eventually be challenged under the Rio Grande Compact. Because most of the EBID already has on-farm access to private wells for supplemental purposes as noted previously and will in all likelihood continue to use them at or near full capacity, the potential for such a challenge and a subsequent, very expensive tour of the US Supreme Court may exist regardless of the action taken on the EBID's emergency application.

The extent to which if any the EBID's groundwater claim under LRG-1776 et. al. can be formally recognized and defensively endorsed for administrative permitting purposes to serve the emergency application as filed is a judgment call probably best left to the State Engineer himself. It is important to keep in mind that whatever the judgment may be, the decision will probably carry some negative consequences either way and will have a profound bearing on managerial and administrative operations in the Lower Rio Grande for years to come, perhaps indefinitely. It is also important to note that inaction in this matter, should this be considered a choice, may be among the worst of available options because the appearance of uncontrolled pumping, illegality and/or the equivalent of water anarchy in the Lower Rio Grande will surely erode the credibility of the Office of the State Engineer and may beckon numerous lawsuits. If nothing else, it is recommended that a clear plan of replacement and/or state line delivery strategy be coordinated with the EBID very soon with particular emphasis on more long-term drought planning. It is clearly important to assure that Texas receives a proportional share of Rio Grande Project water, but it is also very important to safeguard New Mexico's interests within the EBID and the Lower Rio Grande. While institutional differences and questions of jurisdiction are inevitable and will likely continue between the Office of the State Engineer and the EBID, it is further recommended that serious efforts be undertaken to clearly define and communicate the managerial and administrative roles between the two entities to better address the conjunctive reality of the Lower Rio Grande surface and groundwater system.

Local impairment

Section C.6 at page 8 of Turney (1999) states that in the determination of whether local drawdowns are excessive, available water columns, impacts from existing and proposed uses, and the ability to deepen wells to sustain the freshwater supply will be considered as deemed necessary. The criterion also states that drawdown calculations may be performed using the superposition model or the Theis equation, whichever method results in the greatest impact or is more realistic for the situation. Barroll (1999) reports that the model does not accurately estimate drawdowns near a simulated pumping well if distances are closer than about a mile from the pumping well, therefore the Theis equation was chosen for the purposes of this analysis.

Briefly, the Theis analytical nonequilibrium well equation was developed in 1935 and was the first to take in to account the effects of pumping time on well yield (Driscoll, 1986). Its derivation was a major advance in groundwater hydraulics. In its simplest form, the Theis equation is:

$$s = \frac{114.6\, Q\, W(u)}{T}$$

where

s = drawdown, in feet, at any point in the vicinity of a well discharging at a constant rate
Q = pumping rate, in gallons per minute
T = coefficient of transmissivity of the aquifer, in gallons per day per foot
$W(u)$ = "well function of u" and represents an exponential integral such that

$$u = \frac{r^2 S}{4 T t}$$

where

r = distance from the pumping well
S = storage coefficient
T = transmissivity
t = time

The original derivation of the Theis equation is based on the following broad assumptions:

1. The water bearing formation is uniform in character and the hydraulic conductivity is the same in all directions.
2. The formation is uniform in thickness and infinite in areal extent.
3. The formation receives no recharge from any source.
4. The pumped well penetrates, and receives water from, the full thickness of the water-bearing formation.
5. The water removed from storage is discharged instantaneously when the head is lowered.
6. The pumping well is 100% efficient.
7. All water removed from the well comes from aquifer storage.
8. Laminar flow exists throughout the well and aquifer.
9. The water table or potentiometric surface has no slope.

A set of Theis computer programs were written by M. Spinks of the OSE in the 1980's and revised by P. Barroll of the OSE in 1992 and 1994. The program calculates the drawdowns at specified observation points that are caused by pumping at specified wells. The locations of wells LRG-1776 through LRG-1776-S-4 are documented on file and described in the application, however because these wells are not equipped and will not be used in the groundwater pumping program as it has been proposed, no analysis of the predicted effects of these wells is included. According to Subfile no. LRS-280030018 of the Hydrographic Survey of the Lower Rio Grande (see attached), wells LRG-1776-S and LRG-1776-S-4 could not be located. This is not surprising, as inspection of photographs of these well sites available on file taken July 20, 1981 reveal that these wells have long since been abandoned and have apparently been plugged/capped and buried. Though not equipped, wells LRG-1776, LRG-1776-S-2 and LRG-1776-S-3 apparently do exist and are shown on the attached section maps taken from the Hydrographic Survey of the Lower Rio Grande. Should these wells be equipped and made useable, two of them, LRG-1776 and LRG-1776-S-2, are situated close enough to domestic wells in the area that an impairment analysis should be considered.

The initial ten wells proposed to supplement the surface waters of the Rio Grande Project through exercise of the EBID's groundwater claim are described below and shown on the attached section maps taken from the Hydrographic Survey of the Lower Rio Grande. Construction specifications are included only for those wells of which neighboring wells of other ownership were found to be close enough (~ 800-1000 feet) to warrant consideration of possible drawdown impairment. An asterisk next to the OSE file number also marks these wells.

OSE #	Owner	Location	Depth	Casing	Capacity[9]
LRG-7123	Ramon G. Alvarez	SENWSE, S. 21, T. 26S, R. 3E	No neighboring wells close enough		
LRG-6745	James E. Jones	SWNWSW, S. 36, T. 24 S, R. 2E	No neighboring wells close enough		
LRG-5267	Mary M. Prescott	NWNWNE, S. 9, T. 25S, R. 2E	105 ft	16 in	3000 gpm
LRG-5157-S	Thomas J. Chavez	NESWSW, S. 31, T. 21S, R. 1E	No neighboring wells close enough		
LRG-4275*	Armando Angel	SWNESE, S. 26, T. 23S, R. 1E	320 ft	16 in	3000 gpm
LRG-1297	Gary L. Esslinger	SESWNW, S. 14, T. 25S, R. 2E	No neighboring wells close enough		
LRG-1297-S	Gary L. Esslinger	SESENE, S. 15, T. 25S, R. 2E	No neighboring wells close enough		
LRG-832*	Leroy Pritchett	NENWNE, S. 2, T. 25S, R. 2E	320 ft	26 in	6000 + gpm
LRG-688	Robert O. Cosimati	SWSENW, S. 29, T. 26S, R. 3E	No neighboring wells close enough		
LRG-78*	Gary V. Arnold	NWSENW, S. 4, T. 23S, R. 1E	149 ft	16 in	3000 gpm

Upon comparison with the attached Hydrographic Survey section maps, wells LRG-4275, LRG-832 and LRG-78 as marked and described above were found to be the only wells with which neighboring wells of other ownership are situated close enough to warrant consideration of possible drawdown impairment. All analysis conservatively assumed no contribution from the Rio Grande and seven months (210 days) of constant pumping at the peak capacity from each well to simulate potential maximum effects during the irrigation season. Other hydrologic variables (i.e. transmissivity, storativity) were taken from model information specific to the area as documented in Frenzel and Kaehler (1992). All results with associated maps and specific hydrologic assumptions are attached.

Well LRG-4275, owned by Armando Angel, is about 320 feet deep and is situated about 200 feet north of an undeclared domestic well owned by Darrel S. Wiley. Depth to water is about 18 feet in this area. Mr. Wiley's domestic well is labeled as 120268 B as shown on Map LRN 12D of the Hydrographic Survey and is the closest neighboring well to LRG-4275. A telephone conversation with Mr. Wiley on April 16, 2003 revealed that his well is approximately 180 feet deep and is equipped with a marginal centrifugal pump with 1.5-inch plumbing set at an unknown depth. Mr. Wiley indicated that he has considered for some while replacing the equipment on his well with a submersible pump set at a greater depth, but will most likely eventually replace the entire well altogether by drilling to at least 400 feet. Theis analysis does not predict that the minor demands from this domestic well will be impaired as a result of pumping well LRG-4275 at peak capacity (~ 3000 gallons per minute) for seven months, however if it is found to be desirable or necessary to regain capacity, plenty of remaining water column should be available. If an argument for impairment were to be made, it would most likely concern increased pumping lift and the associated potential for increased energy costs.

Well LRG-832, owned by Leroy Pritchett, is 320 feet deep as described by well log received October 7, 2002 and is situated about 500 feet southeast of an undeclared domestic well reported by the Hydrographic Survey to be owned by Antonio Gonzalez. This domestic well is labeled as 50112 C-2 as shown on Map LRS 5D of the Survey, however current Dona Ana County ownership records indicate that the land this domestic well is located on is owned by Sharon Duttle. Depth to water is only about 8 feet in this area. Well LRG-832 is quite large (26-inch casing) and thus is capable of producing a tremendous amount of water from this location (~

[9] Estimates based on casing size as described by Driscoll (1986), Table 13.1, Page 415.

6000 gallons per minute peak capacity), due in part to near (~ 0.5 mile) proximity to the Rio Grande in the area. When combined with very conservative assumptions, Theis analysis suggests that well LRG-832 could potentially lower the water column otherwise available to the domestic well described above by as much as 40 feet. When combined with more realistic assumptions (i.e. contribution of river), drawdown is predicted to be no more than about 25 feet. Although several unsuccessful attempts to reach either Mr. Gonzalez or Mrs. Duttle to gather more specific information about the domestic well in question (i.e. depth) were made, a review of all other domestic wells throughout the area (section) as recorded and on file with this office revealed that all the domestic wells on file in the area were completed to an average depth of just over 200 feet. It is highly probable that the domestic well owned by either Mr. Gonzalez or Mrs. Duttle is of a comparable depth, though as a minimum can be safely assumed to be deeper than 40 feet. Therefore, impairment is unlikely, though if it is found to be necessary to regain the minor capacity needs of this domestic well, plenty of remaining water column should be available.

Well LRG-78, owned by EBID Board President Gary Arnold, is approximately 149 feet deep and is situated about 400 feet south of domestic well LRG-5013 owned by Jose G. Gallegos. Depth to water is about 14 feet in this area. Records on file indicate that well LRG-5013 was drilled August, 6, 1984 to a depth of 84 feet. Theis analysis does not predict that the minor demands from this domestic well will be impaired as a result of pumping well LRG-78 at peak capacity (~ 3000 gallons per minute) for seven months, however if it is found to be desirable or necessary to regain capacity, plenty of remaining water column should be available.

References cited:

Barroll, P. 1999. Draft documentation for the OSE superposition version of the Lower Rio Grande Model OSELRG. State Engineer Office Memorandum. December, 1999.

Driscoll, F.G., 1986, Groundwater and wells, second edition, Johnson Filtration Systems, St. Paul, Minnesota, 1089 p.

Frenzel, P.F. and Kaehler, C.A., 1992, Geohydrology and simulation of ground-water flow in the Mesilla Basin, Dona Ana County, New Mexico, and El Paso County, Texas: U.S. Geological Survey Professional Paper 1407-C, 105 p.

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Wilson, B.C., 1998, Lower Rio Grande River Basin in Dona Ana and Sierra Counties, New Mexico, quantification of irrigation water requirements: New Mexico State Engineer Draft Technical Report, April 8, 1998, 13 p.

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CB-F-137-34

JOHN BLISS ESTIMATE OF PROJECT REQUIREMENTS AT ELEPHANT BUTTE

1.	Use above El Paso - 1917 to 1936 Elephant Butte minus Courchesne.	228,000
2.	Mexican Treaty	60,000
3.	Losses below Courchesne	40,000
4.	Unavoidable Project Waste below River Heading	50,000
5.	Undivertable Winter Flow at Courchesne - 1924-1935	25,000
6.	Hudspeth District (14,000 ac. at 5 a.f.)	70,000
7.	Net Project Diversions below El Paso - 1915-1936	258,000
8.	Salt Balance and Service Equivalents (640,000 Tons/yr. at 2.67 T/a.f. in Drain)	19,000
		750,000

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THE UNIVERSITY OF TEXAS AT AUSTIN

TX_MS_L_006053

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER

IN THE MATTER OF THE CREATION OF	)
THE LOWER RIO GRANDE WATER	)
MASTER DISTRICT FOR THE	)
ADMINISTRATION OF RIGHTS TO	)
THE USE OF GROUND WATER FROM	)
THE LOWER RIO GRANDE GROUNDWATER	)
BASIN OF NEW MEXICO	)

The State Engineer for the State of New Mexico ("State Engineer") is authorized by statute to divide the State into water districts in conformity with the drainage areas for the purpose of performing the essential governmental function of distributing water among water right owners under the laws of the State of New Mexico. The State Engineer may appoint a water master who will have immediate charge of such apportionment of waters.

STATUTORY AUTHORITIES

1. New Mexico law declares that all natural water flowing in streams and watercourses, whether such be perennial, or torrential, within the limits of the State of New Mexico, belong to the public and are subject to appropriation for beneficial use. NMSA 1978, § 72-1-1.
2. The State Engineer has a statutory responsibility to supervise, measure, appropriate, and distribute the waters of the State. NMSA 1978, § 72-2-1, including surface waters , NMSA 1978, §§ 72-5-1 through 37, and groundwaters, NMSA 1978, §§ 72-12-1 through 28, in accordance with the prior appropriation doctrine, as established by New Mexico law, NM Const. art. XVI; NMSA 1978, § 72-1-2.
3. The State Engineer is authorized, if it is in the best interest of the State and the owners of water rights, to establish water districts upon any stream system within the State of New Mexico as necessary for the economical and satisfactory apportionment of said waters. NMSA 1978, § 72-3-1.
4. The State Engineer is authorized, if it is in the interest of public safety and the best interest of water users, to appoint a water master who shall appropriate, regulate and control the waters of such water districts so as to prevent waste. NMSA 1978, § 72-3-2.

FINDINGS OF FACT

1. In order to properly apportion the waters of the Lower Rio Grande stream system in Sierra and Doña Ana Counties, New Mexico, the establishment of the Lower Rio Grande Water Master District ("District") and the appointment of a Water Master in and for the District are necessary.

2. The amount of water in the District is finite and varies from year to year based on annual spring run-off, which is dependent on annual precipitation, and on the amount of groundwater being pumped in the District.
3. The Elephant Butte Irrigation District ("EBID"), and the majority of its constituents, the City of Las Cruces, a number of mutual domestic water users associations, and a number of commercial/industrial users, are all water users in the District.
4. Adjudication of water rights in the Lower Rio Grande stream system and Underground Water Basin has begun, but has not been completed.
5. The recent drought in the State of New Mexico has created a water shortage crisis in the Lower Rio Grande Stream System.
6. The shortage of water in the Lower Rio Grande Stream System is a problem affecting the citizens of Sierra and Doña Ana Counties.
7. Creation of the District is necessary to ensure the economical and satisfactory apportionment of water in the District.
8. Appointment of a Water Master is necessary to ensure the public safety of water users in the District and to ensure protection of existing water rights in the District from impairment.

CONCLUSIONS OF LAW

Creation of Water Master District and Appointment of Water Master

1. The State Engineer concludes that, for the economical and satisfactory apportionment of water in the District, it is in the interest of public safety and in the interest of the water users that the LOWER RIO GRANDE WATER MASTER DISTRICT ("District") should be formed and a Water Master appointed on a permanent basis, so as to administer the groundwaters of the District in accordance with New Mexico law.
2. The District Water Master shall have immediate charge of the apportionment of waters in the District under the general supervision of the State Engineer, and shall appropriate, regulate and control the waters of the District so as to prevent impairment of senior water right owners and to prevent waste.
3. This Order applies to all groundwater rights in the Lower Rio Grande Water Master District, located in Sierra and Doña Ana Counties, State of New Mexico.

Administration of Affected Water Rights

4. The State Engineer concludes that the immediate administration of groundwater rights in the District is necessary for the protection of the public, the protection of prior surface water and groundwater rights, and the prevention of waste.
5. The State Engineer concludes that the Water Master of the District created by this Order shall apportion the waters of the District in accordance with the Active Water Resource Administration regulations for the Lower Rio Grande Water Master District; other existing or future regulations; the Water Master Manual; and any guidelines, directions and supervision provided by the State Engineer.

6. The State Engineer concludes that the Water Master of the District created by this Order shall perform the following specific duties:
   a. Curtail illegal diversions (i.e. any diversion without a water right, or in excess of the elements or conditions of a water right);
   b. Measure and report water usage in the District;
   c. Curtail out-of-priority diversions determined by the State Engineer to be causing injury to senior priority water rights;
   d. Administer water usage according to any agreements entered into by the water right owners of the District; and
   e. Coordinate, where indicated, with the United States Bureau of Reclamation and with the Elephant Butte Irrigation District Ditch Rider(s) so as to ensure appropriate regulation and control of groundwater withdrawals.
7. Additional instructions to the Water Master for the administration of groundwater rights in the District will be based upon available water rights data, hydrologic models, and the State Engineer's best professional judgment.
8. The State Engineer concludes that the District created by this Order shall include the following organizational features:
   a. The appointment of a single Water Master for the District.
   b. The State Engineer may declare sub-districts and appoint sub-district water masters if he deems it necessary.
   c. The Water Master will be a direct employee of the Office of the State Engineer and shall receive compensation in an amount to be determined by the State Engineer. The Water Master shall also be compensated for all actual and necessary expenses incurred in performing the duties of Water Master.
   d. The salary and expenses of the Water Master will be paid monthly by the water right owners through the boards of county commissioners of Sierra and Doña Ana Counties, New Mexico, in accordance with the requirements of NMSA 1978, § 72-3-4. The amount to be paid by each water right owner will be based on the amount of water used by each water right owner, or as otherwise provided for by future legislative acts.
   e. The boundaries of the District may be changed from time to time, as may be necessary in the opinion of the State Engineer, for the economical and satisfactory apportionment of water in the District.

ORDER

IT IS ORDERED that:

1. The LOWER RIO GRANDE WATER MASTER DISTRICT is hereby created to include all groundwater rights within the drainage of the Lower Rio Grande Stream System, within the area depicted on the map attached hereto as Attachment A and incorporated herein by reference.

2. The State Engineer hereby authorizes the appointment of a Water Master for the District for the purpose of administration and apportionment of the groundwaters thereof.

DATED this 3rd day of December, 2004.

JOHN R. D'ANTONIO JR., P.E.
State Engineer

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JAN 8 1938
OFFICE STATE ENGINEER
SANTA FE, N. M.

MIDDLE RIO GRANDE CONSERVANCY DISTRICT
COURTHOUSE
ALBUQUERQUE, N. M.

January 7th, 1938.

Mr. John H. Bliss,
State Engineer's Office,
Santa Fe, New Mexico.

Re: Report of Committee of Engineers to Rio Grande Compact Commissioners, December 27, 1937.

Dear John:

Enclosed is a copy of memorandum relative to the Engineering Committee Report of December 27, 1937. We have gone over this and tried to be fair, and feel that possibly there are other items which might be carefully considered. You will note that we believe the matter of the schedules of delivery at San Marcial or Elephant Butte should be considered further if and when we can get the data used in preparing the schedules.

Stanley and I tried to draw up the curve on the basis of usable supply at Elephant Butte, using the information in T-25, the exhibit of Texas in the case, wherein the water in the reservoir was adjusted for silt. This was worked up for the years 1915 - 1929 inclusive. About the best we could get is one of thosepatterns referred to by Mr. Hill as a shot gun pattern. This makes me feel more strongly than ever that we should have the figures upon which the curves were based for the record. I suggest that you write to Mr. Hill in order to get them.

My plans now are such that I may not be back here until the latter part of this month or early February. However, if there is anything of real importance on this matter I will be glad to come back. My address will be 302 East 18th St., Tulsa, Oklahoma. Drop me a line there as to any developments.

Sincerely yours,

HCN-MCM

H.C. Nutter
Consulting Engineer.

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LEWIS

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
309 Federal Building
Albuquerque, New Mexico
October 23, 1947

Mr. John L. Gregg, Manager
Elephant Butte Irrigation District
Las Cruces, New Mexico

Dear Mr. Gregg:

Herewith is a copy of the preliminary memorandum on ground-water supplies for Elephant Butte Irrigation District by Mr. Conover. This has been reviewed in Washington and officially approved for release to you and to the State Engineer.

Very truly yours,

Chas. V. Theis
District Geologist

cc/Chief Hydraulic Engineer, Washington, D. C.

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Preliminary memorandum on ground-water supplies for Elephant Butte Irrigation District, New Mexico

By Clyde S. Conover
U. S. Geological Survey
September 1947

Reasons for investigation

A study of the ground-water supply of the Elephant Butte Irrigation District in the New Mexico portion of the Rincon and Mesilla Valleys of the Rio Grande was begun in 1946 by the U. S. Geological Survey in cooperation with the Elephant Butte Irrigation District, in response to a request from that District. The study was brought about by continued drought and indications that the Rio Grande Project of the Bureau of Reclamation, of which the Elephant Butte Irrigation District forms the New Mexico portion, would be seriously short of surface-water supplies. The amount of storage available to the Project had dropped to about 465,000 acre-feet by the second week of August 1947. Storage in Elephant Butte Reservoir on August 12, 1947, was 317,000 acre feet, the lowest on record for the 32 years of operation of the dam. The capacity of Elephant Butte Reservoir is 2,219,000 acre-feet and that of Caballo Reservoir 345,870 acre-feet. With another month of irrigation in 1947, the prospect of having the allowable supply of irrigation water in 1948 is poor if the drought conditions continue. The annual supply of water allowable to the Project under the terms of the Rio Grande Compact is 790,000 acre-feet, including 60,000 acre-feet that must be delivered to Mexico.

The U. S. Geological Survey was asked to make a study of the possibilities of pumping ground water for irrigation, mainly from the standpoint of productiveness of wells and the effect of pumping upon the surface-water supply in the rivers and drains. Because of the imminence of some action regarding pumping, this preliminary memorandum is issued at this time.

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All data concerning irrigated acreage, annual diversions, canal wastage, canal seepage losses, water delivered to farms, and flow of the drains were furnished by the U. S. Bureau of Reclamation.

General features of Rio Grande Project

The Rio Grande Project of the Bureau of Reclamation includes the valley lands of the Rio Grande in both New Mexico and Texas from Caballo Dam southward below El Paso, a distance of about 130 miles. From Caballo Dam to Selden Canyon, a distance of about 30 miles, the Rio Grande flows in the Rincon Valley, which has a maximum width of about 2 miles. Below Selden Canyon the valley floor widens into the Mesilla Valley, which extends about 55 miles south to "The Pass", 4 miles above El Paso. The Mesilla Valley is one of the larger subvalleys and has a width of about 6 miles near Las Cruces, 45 miles north of El Paso. The El Paso Valley extends about 90 miles southward from El Paso and ranges in width from 4 to 6 miles, but only the upper 40 miles is included in the Rio Grande Project.

The water for the Rio Grande Project is stored in Elephant Butte Reservoir and in Caballo Reservoir, about 22.5 miles below Elephant Butte Dam. Water released from Caballo Reservoir is diverted from the Rio Grande to the canals in the Rincon Valley by the Percha Dam, about 1.5 miles below Caballo Dam; in the Mesilla Valley by the Leasbury Dam at the head of the valley and by the Mesilla Dam about 5½ miles southwest of Las Cruces; and in the El Paso Valley by the American Dam about 2 miles above the International Dam. Water for the Mexican side of the El Paso Valley, generally referred to as the Juarez Valley, is diverted at the International Dam.

An extensive system of drains has been constructed, covering practically the whole area of the project. Drain water from 42 miles of drains in the

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Rincon Valley is discharged into the river above the Leasbury Dam, and drain water from 218 miles of drains in the Mesilla Valley, except for two drains, is discharged into the river below Mesilla Dam to be diverted for re-use in the El Paso Valley portion of the project and Mexico.

The total land irrigated in the Rio Grande Project in 1945 was 154,775 acres, of which 16,272 acres was in the Rincon Valley, 83,271 acres in the Mesilla Valley, and 55,232 acres in the El Paso Valley. Of the irrigated lands in the Mesilla Valley, 10,834 acres is in Texas. The division of irrigated lands in 1945 by states is 88,709 acres in New Mexico and 66,066 acres in Texas.

Land that is subject to construction charges of the project is referred to as SCC land and carries a full water right. The remainder of the area of land within the limits of irrigation from the canals is referred to as suspended land, which is classified into nine catagories dependent upon the conditions of the individual tracts. The total SCC land in the Rincon and Mesilla Valleys is 90,623 acres and the total suspended land 11,532 acres. The area of SCC land in the New Mexico portion of the project is 88,000 acres.

For the purpose of collection of charges, the lands in New Mexico are under the Elephant Butte Irrigation District and those in Texas under the El Paso County Water Improvement District.

Present use of surface water in the Rio Grande Project

In order to discuss the effects caused by pumping in the Rincon and Mesilla Valleys of the Rio Grande Valley, it will be necessary to consider first the quantities involved in the present irrigation with surface water exclusively. In general these quantities can be estimated only approximately, as many are not measured accurately in the operation of the project.

The average annual diversion to the Rio Grande Project in the period 1930-1945 was 982,300 acre-feet. The average annual diversion for the Rincon and Mesilla Valleys was 584,800 acre-feet and the average annual drain flow returned from the Rincon and Mesilla Valleys and diverted again in the Project was 247,600 acre-feet, or 42 percent of the diversions in these valleys.

The total diversion for the Project minus the drain-flow return from the Rincon and Mesilla Valleys indicates an annual average release from the reservoirs of 734,700 acre-feet, not including allowable diversions of 60,000 acre-feet per year to Mexico and losses due to evaporation from the river bed. The average annual river depletion by the Rincon and Mesilla Valleys was therefore about 337,200 acre feet or 46 percent of the reservoir releases, although the diversions were 80 percent of the reservoir releases.

The average annual diversion of water from the river to the canals in the Mesilla and Rincon Valleys from 1930 to 1945 was about 6.5 acre-feet per acre. Of this total diversion a part is wasted directly back to the river or to the drains. This wastage is estimated at the canal wasteways and is not included in the figures for drainage return used herein, the practice being to not measure the drain flow when it contains waste water as evidenced by a change in color of the drainage water. The minimum figure reported for canal waste in these years was 11 percent of the diversions and the maximum was 35 percent, lower percentages in general being reported in the later years. The reported average wastage is about 20 percent of the diversions, which is assumed to be about correct. The lowest percentage of canal seepage losses reported was 26 percent. As canal seepage losses are taken to be the remainder of the diversion after estimation of canal wastes and deliveries to the farms, it is probable that the actual seepage losses are lower than any reported. Therefore, in a normal year it is estimated that the canal seepage losses would average

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about 20 percent. The remainder, 60 percent of the diversions, is presumably delivered to the lands and amounts to 3.9 acre-feet per acre. In contrast, the reported average delivery of water to the land in the period 1930-1945 was only 2.74 acre-feet per acre, about 42 percent of the water diverted from the river, but it is believed that the reported deliveries are somewhat less than actual as they are mainly estimated quantities on which payment for water is based and are generally estimated conservatively. The maximum reported percentages of the diversions delivered to the farms in any one year was 58 percent. In general, larger percentages have been reported as delivered to the farms in the later years.

The unit consumptive use for crops is subject to a large variation both in actual use and computed use. The unit consumptive use for cotton for the 17-year period from 1919 to 1935 in the Rincon and Mesilla Valleys was taken as 2.5 acre-feet per acre in the report of the Rio Grande Joint Investigation, with an estimated minimum of about 2.00 feet and a maximum of about 3.00 feet. The unit consumptive use of alfalfa for the same period was taken as 4.5 acre-feet per acre with an estimated range from 4 feet to 5 feet. The consumptive use for other crops ranged from a minimum of 1.5 feet for grains to a maximum of 3.0 feet for forage, with an average of about 2.00 feet. _/ The acreage of

_/ Regional Planning, Part VI, The Rio Grande Joint Investigation in the Upper Rio Grande Basin in Colorado, New Mexico, and Texas: National Resources Committee, Volume I, pp. 382-383, 1938.

cotton in 1945 in the Rincon and Mesilla Valleys was 66,624, that of alfalfa 21,864, and that of other crops 11,060 acres. Using the above unit figures, the total consumptive use in 1945 was about 288,000 acre-feet, giving an average unit consumptive use for the total irrigated acreage in the Rincon and Mesilla Valleys of 2.9 acre-feet per acre. Precipitation probably furnishes about 0.4 acre-feet per acre, leaving about 2.5 acre-feet per acre to be supplied by irrigation.

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Assuming that in the period 1930-1945 the average consumptive use of the irrigated lands supplied by irrigation was the same as in 1945, 2.50 acre-feet per acre, the excess water delivered to the lands was 1.4 feet or 21 percent of the total diversions. The return seepage from the irrigated lands plus that from the canals is about 41 percent of the diversions and is to be compared with the measured drain-flow of 42 percent of the diversions.

During years of plentiful water supply the average amount of water believed to be delivered to the lands was 3.9 feet. The amount of water applied to the lands in past years is doubtless more than actually necessary, even though irrigation of crops requires an excess of water applied. It is assumed that an excess of about one-third of the consumptive use, giving a total of 3.3 feet of irrigation water, would be sufficient to grow a normal crop in the Rincon and Mesilla Valleys if the water supply was short.

In a dry year with a shortage of water it is expected that wastage could be cut to 5 percent. Also in a dry year the canal seepage losses would probably be relatively higher than in an average year, probably about 25 percent of the diversions. The delivery of water to the lands would therefore be about 70 percent of the surface-water diversions. In a year having 3.25 feet, or 50 percent of an average supply, of surface water available, 70 percent or 2.28 feet of water could be delivered to the farms or about 70 percent of the 3.3 feet believed necessary to raise a normal crop. Thus in a year of 50-percent average surface supply, with judicious use of water about 70 percent of the land could probably be irrigated without pumping; or, as about two-thirds of the total acreage is planted to cotton, sufficient water would be available to water all the cotton, the main staple crop of the District, if every care in the distribution of the water was exerted by the farmers and ditch riders.

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In order to irrigate all the land in a year having about 50 percent of an average surface supply of water, it would be necessary to pump some ground water.

Ground-water conditions

General character of ground-water flow.— The direction of flow of ground water in the Mesilla Valley, as indicated by maps prepared in 1919 by the U.S. Bureau of Reclamation from water levels measured in auger holes in the summer of 1919, indicates that the general movement is southward down the valley with a gradient of 4 to 8 feet per mile. At the time the map was made only the lower portions of a number of the drains had been constructed. In some parts of the valley the ground water was indicated as moving toward the river and in others away from the river. In places where the constructed drains were near the river a large ground-water flow was indicated from the river to the drain.

The direction of flow of ground water under the mesa lands bordering the Mesilla Valley has been determined from a preliminary map of the water table prepared from elevations obtained by aneroid, aided by topographic maps. Under the mesa to the east of the river the direction of ground-water flow is generally southwest, from the Organ Mountains to the valley. Under the mesa to the west of the valley movement of the ground water near the upper portion of the valley is in general southeast to the valley. However, farther south the direction of flow of the ground water under the west mesa gradually changes to south, with some indication of a small flow from the valley into Mexico.

In the Caballos Mountains, which parallel the Rincon Valley on the east, the strata dip to the east. Thus the amount of ground-water accretion to the Rincon Valley from the east is probably small. On the west the Rincon Valley is flanked by mesas underlain by marls and sands of the Santa Fe formation,

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that are dissected by numerous large arroyos which empty into the valley. The elevations of the water levels in wells located in the arroyos west of the valley are above the level of the Rio Grande and thus indicate some underground flow from the west to the valley, particularly in the arroyos.

Under present conditions in the Rincon and Mesilla Valleys the surface and ground waters maintain an approximate state of balance. Surface water released from Caballo Dam is diverted to the canals and irrigated lands mainly from April through August of each year. The part that is not lost by transportation and evaporation seeps underground from the canals and irrigated lands to return to the river as drain flow which is re-used in lower divisions of the Project. A large part of the drain water is return seepage from the surface-water supply, mainly from the canals and irrigated lands but in part directly from the river. A small portion of the drain flow is ground water from the higher mesa lands that border the valleys. Because of the drains, the amount of ground water in storage each year at the beginning of the irrigation season is approximately constant, small variations from year to year occurring as a result of the varying amounts and time of application of irrigation water to the lands in the preceding year and to the condition of the drains. The low flow of the drains occurs approximately a month later than the minimum diversions, and the maximum flow of the drains usually occurs in the same month as the maximum diversions.

Performance of existing wells.--The discharge of a well, other things being equal, is dependent upon the size and condition of the pump and the speed of the pump, which in turn is dependent upon the amount of power available. A pump discharging only a few gallons per minute does not in itself indicate whether the well is a poor well or a good well. In order to make a comparison

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between wells the specific capacity of a well is usually given, expressed in gallons per minute per foot of drawdown. For a particular well this value is generally regarded as nearly constant for reasonable values of drawdown. For cased wells the specific capacity depends to some extent upon the perforations in the casing, which if plugged or insufficient in total area will indicate a low specific capacity even though the aquifer is highly permeable.

A few irrigation wells have been drilled in the Rincon and Mesilla Valleys. In the Rincon Valley 10 irrigation wells have been drilled in the valley floor, seven of which have been equipped with pumps. Reliable information is lacking on the discharge of some of the wells, particularly those not at present equipped with pumps. The discharges of those either measured or reported range from a minimum of 250 to a maximum of 1,000 g.p.m. The specific capacities of six of the wells range from a minimum of 47 to a maximum of 74, indicating good irrigation wells.

In addition to the irrigation wells in the valley floor in the Rincon Valley, about 13 wells have been drilled on the alluvial fans of the arroyos to the west of the valley, 11 of which have been equipped with pumps. The discharges of the 11 wells, either reported or measured, ranged from a minimum of 125 to a maximum of 800 g.p.m., and the specific capacities for nine of the wells ranged from a minimum of 11 to a maximum of 100.

Very few irrigation wells are in operation at present in the Mesilla Valley, A number of irrigation wells were in operation in the early 1900's but were abandoned after a water supply was assured by Elephant Butte Dam. A few irrigation wells are being drilled or have been drilled in the last few months as a result of the contemplated shortage of surface water in 1948. None of these have pumps installed at present.

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The New Mexico College of Agriculture and Mechanical Arts has two irrigation wells equipped with pumps located on the valley floor and one well intended for use for irrigation, but not at present equipped with a pump, located at the school on the east side of the valley above the valley floor. One of the irrigation wells of the College, located about half a mile west of the College, was drilled to 50 feet in 1935 and produced 1,625 g.p.m. with a drawdown of 18 feet, after being developed for 2 weeks. At present the well, equipped with an electric motor and a pump, discharges 1,270 g.p.m. with a drawdown of 13 feet as measured in November 1946, thus indicating a specific capacity of about 100 g.p.m. per foot of drawdown.

The other irrigation well of the College, located on the horticulture farm, was drilled to 71 feet in 1935 and at that time produced about 1,100 g.p.m. This well at present is sanded up and is equipped with an electric pump and motor that discharges about 250 g.p.m.

Available information indicates that good irrigation wells can be developed on the alluvial floor of the valley, with probable exceptions in the Selden Canyon area of the Rincon Valley and in the southern end of the Mesilla Valley. The upper 60 or 80 feet of the alluvium in the Rincon Valley seems to be quite permeable but clay apparently predominates at greater depth. There seem to be no definite extensive clay layers in the Mesilla Valley. In both valleys considerable trouble is caused by loose sand that runs into the wells and at times causes caving of the ground surface around the well casing. It is possible that gravel packing would eliminate this trouble.

In the southern part of the Rincon Valley, south of the vicinity of Tonuco, the river has eroded through the mountain masses of the Sierra de las Uvas to form the Selden Canyon. The valley floor which in the Rincon Valley, is from 1 to more than 2 miles wide, narrows in the canyon area to less than half a mile,

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and in one place to not much more than 200 feet. There is some seeped (water-logged) land in the canyon area that might be reclaimed by a lowering of the water table. However, as the aquifer is narrow and undoubtedly thin any irrigation wells located there would probably soon draw down excessively, particularly in the part of the valley south of secs. 1 and 2, T. 19 S., R. 2 W.

Reports of well drillers seem to indicate that in the lower part of the Mesilla Valley, south of the vicinity of La Union, about 18 miles north of El Paso, the alluvial sediments are too fine-grained to yield quantities of water to wells sufficient for irrigation.

Successful irrigation wells, many of which would be of small capacity, can probably be developed in places in the alluvial-fan deposits of the arroyos and on the lower terraces above the valley floor.

Hydrologic characteristics of the aquifer

In order to evaluate properly the amount of flow of underground water and the long-term effects of pumping, two hydrologic characteristics of the aquifer, the coefficient of transmissibility and the storage coefficient, the latter approximately equal to the specific yield under water-table conditions, must be known.

The ease with which water flows through an aquifer depends upon the interconnection and size of the pore spaces. The coefficient of transmissibility, which expresses the rate of flow, is defined as the quantity of water in gallons a day that will percolate through a vertical strip of the aquifer 1 foot wide, oriented perpendicular to the direction of flow of the water, under a unit hydraulic gradient.

The specific yield of an aquifer is a measure of the ability of the aquifer to release water to wells under the action of gravity. The specific yield is defined as the ratio, expressed as a percentage, between (1) the volume of water

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that an aquifer saturated with water would yield by gravity and (2) its own volume.

The coefficient of transmissibility of the aquifer in the Rincon and Mesilla Valleys was determined from pumping tests on wells, and from the correlation of slopes of the water table to various drains with the flow of the drains. The value of the coefficient of transmissibility as determined from pumping tests on four wells in the valley floor ranged from a minimum of 91,000 to a maximum of 167,000. The value of the coefficient of transmissibility computed from well-profile cross-sections obtained from the U. S. Bureau of Reclamation across various lengths of six drains ranged from a minimum of 47,000 to a maximum of 135,000. Computations from data obtained from two lines of auger wells established across the Park Drain gave values for the coefficient of transmissibility ranging from a minimum of 53,000 to a maximum of 116,000.

It seems probable that the average coefficient of transmissibility for the aquifer as a whole can be taken as about 75,000, The values of the coefficient of transmissibility for other localities in New Mexico in which irrigation pumping has been successful have ranged from about 50,000 to more than 100,000.

The specific yield of an aquifer is difficult to determine accurately, either in the field or the laboratory. Determinations of the specific yield in other localities of unconsolidated alluvial fill indicate that the average for the Rincon and Mesilla Valleys is probably about 25 percent.

Effects of pumping wells.--Pumping ground water results in a lowering of the water table, at first in the vicinity of the well but as time goes on at greater and greater distances from the well. The area affected by pumping continually expands until an area of rejected recharge or an area of ground-water discharge is reached. In many localities, areas of rejected recharge and ground-water discharge either do not exist or are at such great distances

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that the water pumped must be taken from storage for years to come with a continual lowering of the water table. All water pumped from wells is balanced by a loss of water from somewhere else in the ground-water system, either from the amount stored underground, from the amount seeping out of the aquifer, or, less commonly in arid countries, from the amount of surface water that the system is unable to absorb (rejects) because the aquifer is overfull under non-pumping conditions. Places of ground-water discharge in the Rincon and Mesilla Valleys are the drainage ditches, where lowering of the water table would result in a decrease in the pickup of the drains, and the relatively small areas of waterlogged land where a lowering of the water table would decrease the evaporation and transpiration now taking place. Areas of rejected recharge are sections of the river where the water level in the river is above and in direct contact with the ground water. A lowering of the water table in such areas induces a larger amount of water to seep away from the river.

The increased seepage from the river to the aquifer and the decreased drain-flow resulting from the effects of pumping would not make more water available to the Project as a whole but instead would divert to the pumps water that would otherwise be available as surface supply lower down the valley. However, any water saved by pumping that is now lost by evapo-transpiration in the waterlogged areas would result in an actual increase in water supply for beneficial use in the project. Unfortunately, because the waterlogged area of the Rincon and Mesilla Valleys is very small, only 5,135 acres being classified as seeped, and a portion of this is farmed, the amount of water saved would be small.

The effect of a pumping well upon the flow of a drain or of a river that is in direct connection with the water table can be evaluated theoretically with the aid of a formula developed by Theis. By using the average coefficients

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of transmissibility of 75,000 and specific yield of 25 percent determined for the Rincon and Mesilla Valleys, it is indicated that if a well in one of these valleys were located a quarter of a mile from a drain the flow of the drain would be reduced after 3 months of pumping by 63 percent of the pumping rate, after 6 months by 73 percent of the pumping rate, and after 1 year by 81 percent of the pumping rate. After 6 months of pumping the flow of a drain would be reduced by 88 percent of the pumping rate for a well located an eighth of a mile from the drain, by 73 percent for a well located a quarter of a mile from the drain, 50 percent by a well located half a mile from a drain, and 18 percent by a well located 1 mile from a drain. Fifty percent of the water pumped would be diverted from a drain in about 12 days by a well located an eighth of a mile from the drain but it would take about 2 years for a well located 1 mile from a drain to have the same effect.

The effect of the pumping upon the flow of the drain would initially be a reduction of the pickup of ground water by the drain in the area affected by the pumping. With continued pumping the gradient of the water table would be reversed and the drain would lose water in the section affected and finally, if the pumping rate were great enough, the drain would be dried in that section.

The average drain-flow accretion under the present conditions of an average surface supply of water is from 0.6 to 0.8 second-foot per mile in the late winter months, increasing to a little over 2 second-feet per mile of drain in the late summer. The pumping effect per mile of drain must be at least equal to the pickup of the drain per mile in order to dry the drain. Wells pumping continuously at the rate of 3 second-feet each and places every mile along a drain and a quarter of a mile from it would theoretically dry a drain in the summer under the present conditions of drain-flow at the end of about 4 months of pumping.

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The theoretical effect of the pumping of a well upon the flow of a drain is possibly somewhat greater than would actually occur at any particular time because of clay layers that extend under the drains, which might introduce a lag in the effects of pumping. If a well were located between drains or between a drain and the river, the total effect of pumping upon the drains at any particular time would be greater than upon one drain. Because of the numerous drains in the Rincon and particularly the Mesilla Valley this condition would occur and this accelerated effect of the pumping would probably offset the possible lag caused by the stratification of the aquifer.

Moreover, in a year of about 50-percent average surface supply of water, the flow of the drains would be reduced and the amount of pumping required to dry the drains would not be as large as noted.

Amount of pumped water necessary in a drought period.—The economy of a supplemental pumping project in the Elephant Butte District depends upon the quantity of water that must be pumped. This in turn depends upon how the gravity water in the Rio Grande Project is distributed to the various valleys, what economies could be effected in the distribution of the gravity supply, and what salvage of water would occur by reason of the lowered water table in a dry year. The basis of distribution might be in proportion to the average diversions, or in proportion to the average river depletions. It might be assumed that pumping would also be done in the El Paso District, and thus would save some of the water which would otherwise drain from the land, thus saving more water for the Project; or the reverse might be assumed, in which case the Elephant Butte District may be regarded as having an obligation not to interfere with the deliveries of water to the lower district. Some water would be saved from evaporation by drying up the drains and some saved from evaporation by lowering the water table in waterlogged areas. All these factors cannot be

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evaluated in this preliminary memorandum.

For the purpose of this memorandum, it will be assumed that direct canal waste would be largely eliminated throughout the Project and that the Elephant Butte District has no obligation to the lower District to continue this direct loss. It will be assumed also that an obligation does exist to continue to deliver the average proportionate drain-flow, which will be taken to be 40 percent of the diversions.

As stated on page 6, in a year in which the surface supply of water was only half the average, it is believed that 2.28 feet of water could be delivered to the farms, or about 1 foot of water less than that needed for successful irrigation of the crops. If the additional foot of water were supplied by pumping ground water into the canals, some loss of the pumped water would occur, due to waste and to seepage from the canals. Owing to closer control of the pumps and to the shorter distance that the pumped water would travel in the canals as compared with surface water, a wastage of 3 percent and a seepage loss of 17 percent of the pumped water may be assumed. The combined loss would amount to about 20 percent, compared with a probable minimum of 30 percent for gravity water. Every additional acre-foot of pumped water delivered to the farms would therefore necessitate pumping about 1.25 acre-feet.

However, pumping of wells would diminish the drain-flow. The decrease in drain-flow resulting from the effect of pumping would presumably necessitate a corresponding decrease in the allowable diversions for the Elephant Butte Irrigation District.

The narrowness of the valleys and the large number of drains precludes locating pumps very far from either the drains or the river. If a large number

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of pumps were installed, as would be necessary for a District pumping system, the average distance would be about a quarter of a mile and it is expected that the drains would be dried during the first summer of pumping if only a small gravity water supply was available. The amount of the drain-flow in an average year is about 42 percent of the diversions. In a dry year, with less excess water applied to the lands, the drain-flow is expected to be less, probably about 40 percent of the diversions. If in the assumed dry year only gravity water were available, 3.25 acre-feet per acre would be diverted in the Rincon and Mesilla Valleys, of which 40 percent would be returned to the system as drain-flow, leaving a total diversion used within these valleys of 1.95 feet. If a pumping system were installed and the drains were dried up, presumably 1.95 feet would be the justifiable diversion to these valleys. It has been assumed that, in a dry year, 3.3 acre-feet of water per acre is needed for a full crop, that 30 percent of the surface water diverted would be lost largely by seepage from the canals, and that about 20 percent of the pumped water would be lost by seepage and waste from the canals. Therefore,

$$3.3 = 1.95 \times 0.7 + \text{pumped water} \times 0.8$$

and pumped water = 2.42 acre-feet per acre.

Thus in order to make up the deficiency of 1 acre-foot per acre which would result from gravity irrigation alone in the assumed dry year it would be necessary to pump about 2.4 acre-feet per acre. This is the minimum amount with judicious use of water. If canal wastage were higher and the water were inefficiently used on the land this amount would not be sufficient.

As about 88,000 acres of land has water rights in the New Mexico portion of the project, the total pumpage of water would be about 213,000 acre-feet and the total surface water diverted about 172,000 acre-feet.

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The amount of water pumped from storage in the ground would be the difference between the amount of water actually used by the crops, assumed to be 2.5 acre-feet per acre, and the amount diverted from the river, 1.95 acre-feet per acre, plus canal evaporation and waste. The latter has been taken as 3 percent of the pumped water or .07 foot and 5 percent of the gravity water or 0.10 foot, making the water pumped from storage 0.72 acre-feet per acre per year.

Looked at in another way, the amount of water pumped from storage would equal the difference between the total water pumped and that part of the pumped and surface water that would return to the water table. This amount from storage, all quantities being given in acre-feet per acre, would be (1) the total amount pumped, 2.42; less (2) the pumped water lost by seepage from the canals, 17 percent (see p. 16) of that pumped or 0.41; less (3) the gravity water lost by seepage from the canals, 25 percent (see p. 6) of that diverted, 0.49; less (4) the difference between the water applied to the land, 3.3, and the consumptive use 2.5, or 0.8. The amount of water pumped from storage in 1 year would therefore be 0.72 acre-feet per acre irrigated, or 63,360 acre-feet for the 88,000 acres in the Elephant Butte Irrigation District. The amount of water returned underground by seepage from the canals and from the irrigated lands would be 1.70 acre-feet per acre or 39 percent of the total diversions and pumpage of about 4.4 acre-feet per acre.

The period of drought during which supplemental pumped water might be needed is, of course, a matter of conjecture. The longer the period the less would be the cost per acre-foot of water pumped. As the flow of the Rio Grande at San Marcial at the head of the Rio Grande Project averaged only 697 second-feet in the 5-year period 1898-1902, inclusive, against a 50-year average of 1,560 second-feet, it appears that an assumption is justified of a 5-year drought period in which only half the normal supply of water is available.

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If pumping was done for 5 such dry years the total pumpage from storage would be about 316,800 acre-feet. This amount of ground water would have to be replaced before the flow of the drains would return to normal.

It would appear to be equitable that because the drains would have been dried by the pumping, the diversions to the District in a year of average surface-water supply following a period of 5 years of pumping would be reduced by the amount that the drains would normally flow, or 42 percent of the diversions. The actual diversion would then be 6.5 - (.42 x 6.5) = 3.77 feet. This amount would make 2.64 feet available for delivery to the farms, thus necessitating additional pumping of ground water to make up the difference to 3.3 feet believed necessary for delivery to the farms. The amount of ground water necessary to be pumped would be:

$$3.30 = 3.77 \times .7 + \text{pumped water} \times .8$$

$$\text{pumped water} = .83 \text{ acre-feet per acre}$$

The amount of water that would seep to the water table in this year would equal the seepage losses of pumped and surface water from the canals plus the seepage return of excess water above the consumptive use delivered to the farms, and would be:

$$(.83 \times .17) + (3.77 \times .25) + (3.30 - 2.50) = 1.88 \text{ acre-feet per acre}$$

The payment or reduction of the ground-water debt would be the return seepage in excess of the pumpage, or 1.05 feet. The number of years required while pumping 0.83 acre-feet per acre to pay off the debt would be $\frac{5 \times 0.72}{1.05} = 3.4$ years. The available surface-water diversions without pumping in the fourth year of average surface supply following the assumed five years of pumping would be less than the average by the amount of water that would have to be by-passed to Texas to make up for the reduction in average drain-flow resulting from the remaining effects of the pumping. The amount of by-passed water, x, plus the actual drain-flow, y, must be equal to the average drain return flow of 2.73 feet (.42 x 6.5).

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in a year of average diversions. The actual drain return flow would be equal to 42 percent of the actual diversions reduced by the remaining ground-water debt of 0.45 foot (5 x .72 - 3 x 1.05).

Therefore:

$$x + y = 2.73$$

and $(6.50 - x)\ .42 - 0.45 = y$

therefore: $x = 0.78$

and the actual diversion would be:

$$6.50 - 0.78 = 5.72 \text{ feet.}$$

The water schedule for the 5 years of about 50 percent average surface supply followed by 4 years of average surface-water supply is given in the following table:

Comparison, in acre-feet per acre, of irrigation water available as diversions to the canals of the Elephant Butte Irrigation District, for 5 years of 50 percent average surface supply followed by a period of average surface supply, when a supplemental pumping system is used and when a surface supply only is used.

	With supplemental pumping		Without supplemental pumping
	Pumped water	Surface water	Surface water
1st year	2.42	1.95	3.25
2nd "	2.42	1.95	3.25
3rd "	2.42	1.95	3.25
4th "	2.42	1.95	3.25
5th "	2.42	1.95	3.25
6th "	0.83	3.77	6.50
7th "	0.83	3.77	6.50
8th "	0.83	3.77	6.50
9th "	0.00	5.72	6.50
10th "	0.00	6.50	6.50
Totals	14.59	33.28	48.75

Little net water can be gained to the Rio Grande Project as a whole by pumping ground water in the Elephant Butte District and the total amount of water received by the Elephant Butte District under a pumping system is practically no more than would have been obtained from surface supplies, if the

customary interest of the El Paso District is preserved. The reason for this is, of course, that the drain water is used again in the Project and the District would be physically responsible for any decrease of the flow of the drains resulting from pumping.

The ground-water debt can be repaid by efficient use of water in 4 years of average water supply. If waste of water is not avoided, it would not be possible to repay the ground-water debt and pumping would probably have to be continued for years.

or CIR increase

As indicated previously (p. 4), Rincon and Mesilla Valleys customarily use about 46 percent of the total reservoir releases in a year of average surface supply. In the assumed drought period of 5 years the surface water available for diversions was considered as 50 percent of the average. The average diversion to the El Paso division has been 397,480 acre-feet, and therefore in such a dry year 199,000 acre-feet should be available for diversions to the El Paso Valley. The reservoir releases in a year should be equal to the sum of all diversions minus the return drain flow. As the return drain flow from the Rincon and Mesilla Valleys would be zero if extensive pumping was done the reservoir releases would be 88,000 x 1.95 + 199,000 = 371,000 acre-feet. The depletion of reservoir releases by the Elephant Butte Irrigation District for any of the first 5 years of pumping is then 46 percent, which is the same reservoir depletion as in an average year. In the sixth, seventh, and eighth years, the drains still being dry, the percentage depletion of reservoir releases would be about 45 percent. This shows that the Rincon and Mesilla Valleys would be getting their customary share of the reservoir releases.

In the analysis it was assumed that the drains would be dry during all of the first year, whereas the drains would not be dry until the end of the first

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pumping season and might flow a small amount during the first winter. Therefore, during the first summer it is probable that a smaller amount of water need be pumped. Also, it has been assumed that the water taken from storage was from lowering of the water table under only the irrigated area of the valley. Actually, the effects of pumping would be somewhat smaller in the valley area, as the cone of depression would extend away from the valley, under the mesas. As the irrigation water is applied to lands near the drains, it is possible that the drains would begin to flow in the eighth year even though all of the ground-water debt had not been repaid. The District would benefit by this lag, which would spread the repayment of the ground-water debt over a longer period of time than was assumed.

The minimum number of pumps required to deliver the 213,000 acre-feet of water believed necessary is estimated to be about 148, on the assumption that each pump would discharge 1,800 gallons per minute continuously for 6 months. Allowances should be made for periods of high demand, breakdown of pumping equipment, and a lower average discharge per well, perhaps about 1,500 gallons per minute. The probable number of pumps may therefore be estimated as about 220.

The cost of installation per well, pump, and motor is estimated to be about $6,000. Fuel and lubrication costs for a Diesel motor of appropriate size per pump per year of 6 months of pumping is estimated to be about $1,080. Fixed charges are estimated as $1,452 per pump per year on the basis of 6 percent interest on average investment, total depreciation in 5 years, and taxes at 2 percent on 130 percent initial cost. Labor and transportation charges are estimated at $356 per pump per year. The total charges per pump per year are therefore about $2,900 and the total for 220 pumps would be $638,000 or $3,190,000 for the 5-year period. However, as some of the pumps would be used for an additional three years, the taxes on all of the pumps, plus the charges for fuel,

lubrication, labor, and transportation for the number of pumps required during the additional three years, should be included in the total charges. The number of pumps necessary to deliver the required 73,000 acre-feet per year for the sixth, seventh, and eighth years would be about 75 on the basis of 220 pumps being necessary to pump 213,000 acre-feet per year. The fuel and lubrication costs and labor and transportation charges for the 75 pumps for three years would amount to $323,100. Taxes on 220 pumps for three years would be $23,760 making a total of $346,860 for the three years and $3,536,900 for the eight years of operation. The estimated unit cost for the first five years on the basis of the total pumpage necessary per year would be about $3.00 per acre-foot which includes allowances for breakdowns, peak demands, etc.

As the pumping of irrigation water resulted in saving all the crops on at least 30 percent of the acreage, the pumping costs should be justified by that acreage. The average gross return per acre in 1945 for the Rio Grande Project was about $140. The gross savings then in five years would be $18,500,000. The total cost of pumping and pumping equipment is thus less than one-fifth of the savings in gross crop returns and probably less than the normal net profit. The average cost per acre for 88,000 acres would be about $7 per year.

The favorable factor of cost is offset somewhat by the unfavorable factors of little gain of net water and the problem of installation and operation. Installation of 220 wells, pumps, and motors would consume untold time as drillers are scarce and casing, pumps, and motors would be hard to obtain. The shortage of surface water might well be over by the time installation could be completed.

Operation would present problems, one of which would be the distribution of the pumped water to the New Mexico lands only. About 10,000 acres of land in the Mesilla Valley is in Texas and is served by the same canal system.

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Pumping of ground water in the valley by individual farmers would of course have the same effect upon the flow of the drains as would pumping by the Elephant Butte Irrigation District. Any water pumped on the land that does not return to the ground-water body would be water lost to the Project, even though a gain of water might accrue to an individual farm. It is probable that in a dry year enough farmers would install wells and pumps so that the flow of the drains would be reduced markedly or even in some sections be stopped entirely. If such a reduction of normal drain flow occurred as a result of individual pumps, then diversions to the Elephant Butte Irrigation District would have to be reduced by a like amount, if the El Paso Division received its accustomed share of the reservoir water. Any such reduction in diversions would work a hardship on the farmers who had not installed pumps, providing the available surface water was distributed equally. If it were desired to maintain the delivery of the same amount of water to the farms not having a pump as they would have received had there been no pumping, then it would be necessary to reduce the delivery of water to the farms having pumps.

Intermittent operation and the probable smaller capacity of a pump on an individual farm would result in a somewhat higher unit cost of pumping than that given for continuous operation of large capacity pumps of a District pumping system.

Effects of irrigation of new land.--In addition to pumping water for the 88,000 acres of land in the New Mexico portion having water rights there are suspended lands and lands at elevations above that of the canal system within the boundaries of the Elephant Butte Irrigation District, and additional undeveloped lands outside the boundaries, for which a water supply from wells might be developed.

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The number of tracts of suspended land of all classifications in 1946 of 20 acres or more per tract was 135, with a total area of 5,822 acres in the Mesilla and Rincon Valleys. Only a part of this could be irrigated, probably not more than 3,000 acres.

The area of undeveloped land not served by canals and inside the boundaries of the District that might be developed and watered by pumping is about 900 acres in the Rincon Valley and 2,000 acres in the Mesilla Valley. Undeveloped lands outside the boundaries of the District that might be developed and watered by pumping total about 4,700 acres in the Rincon Valley and 5,600 in the Mesilla Valley. These areas are maximum figures and would be reduced by land needed for roads and other improvements, land not suitable for farming, and areas in which successful wells could not be obtained.

It seems probable that about 15,000 acres of suspended and new land might eventually be irrigated from ground water, provided that the conditions remain favorable for such development. If such a development occurred the minimum amount of water consumed annually on these lands would be about 38,000 acre-feet, on the basis of 2.5 acre-feet per acre. As a large portion of these lands is on the higher ground along the edges of the valley, only a part of this water would be diverted from the drains or the river at the outset. However, as all the ground water in the valleys and mesas is connected and contributes to the drains, any pumping must eventually mean a decrease in the drain flow, in the long run equal to the amount that had been pumped, less any small amount saved by reduction of evapo-transpiration losses.

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Conclusions

1. Successful irrigation wells can be obtained over the major part of the valley floors of the Rincon and Mesilla Valleys, with the probable exceptions of the Selden Canyon area and the southern end of the Mesilla Valley. Running sand will cause trouble in many of the wells and special well construction may be necessary to eliminate it.
2. Irrigation wells, generally of small capacity, can be obtained on the arroyos and on the low bench lands. Many wells in these areas will not obtain sufficient quantities for irrigation.
3. Pumping of ground water would divert water from the drains and the river. The drains would be dried the first summer if enough pumps were installed to furnish an adequate water supply for all lands in a dry year.
4. On a long-term basis all water removed from storage must be replaced before the drain system returns to normal.
5. If water diverted from the drains were made up to the lower district by additional releases from the dams, a corresponding reduction in the diversions to the Elephant Butte Irrigation District would be necessary.
6. As there is no unused ground-water recharge, and very little unused ground-water discharge, only a small amount of water can be salvaged to the Rio Grande Project as a whole over a period of years by pumping in the Elephant Butte District
7. Assuming that the El Paso Division continues to get diversions in the same proportion to reservoir releases as in the past, pumping of ground water will not result in any additional water for the District on a year-to-year basis unless the amount of pumping exceeds the amount of the diverted drain flow, thus pumping from storage.

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8. With a gravity water supply of 50 percent of average, about 70 percent of the land could probably be irrigated with careful use and control of gravity water alone.

9. To furnish an additional 88,000 acre-feet of water per year to the farms in order to have a bare minimum for all the irrigated land would require pumping of 213,000 acre-feet per year, assuming again that the El Paso Division receives its accustomed share of the reservoir water.

10. On the basis of the gross crop return of $140 per acre per year (1945 prices) on about 30 percent of the acreage, the gross saving for a 5-year period is estimated at $18,500,000.

11. The total number of pumps required is estimated as about 220 and the total cost about $3,190,000 on the basis of a 5-year period and $3,536,900 for the eight years, including all charges, or less than one-fifth of the gross dollar benefits from crops grown.

12. Total cost per acre-foot of water pumped would be about $3.00, equal to about $7.00 per irrigated acre per year for the District.

13. Pumping of ground water on individual farms would ultimately reduce the water supply of the Rio Grande Project. If such a reduction were borne by the Elephant Butte Irrigation District, deliveries of surface water to farms with pumps might be reduced in order to maintain the expected deliveries to farms without pumps.

14. About 15,000 acres of presently undeveloped land and suspended land could be irrigated by ground water. Water pumped on these lands will, in a few years, reduce the water available to the existing irrigated lands by nearly a like amount.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO-TEXAS

RIVER LOSS
CABALLO DAM TO EL PASO
AND
IRRIGATION WELLS

EL PASO, TEXAS

JULY 1, 1952

TX_MSJ_006087

NM 00138510

CONTENTS

	Page
Summary, Part I - River Loss	A
Summary, Part II - Irrigation Wells	B
Part I	
River Loss	1
Drain Return Flow	4
Subsurface Water Table - Mesilla Valley	7
Inflow-Outflow Study	8
Precipitation	9
Evaporation	9
Ground-water	10
Inflow and Outflow	10
Consumptive Use	11
Water Pumped	12
River Seepage Investigation	13
Seepage Loss, Canutillo to El Paso	13
Seepage Loss, American Dam to Island Station	15
Part II	
Irrigation Wells	21
Inventory of Irrigation Wells	21
Effect of Irrigation Wells on River and Drains	22
Percent of Pumped Water Diverted from River or Drain	26
Rate of Pumping or Water Distribution	27
Water Diverted from River or Drains Due to Pumping During 1951	31
Forecast River Diversions by Pumping During 1952	32
Comparison of Coefficient of Transmissibility	34
Appendix, Part I	**Drawings**
Daily Graph of River Flow and Losses for 1946-51 and for Daballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso	23-503-5416 to 23-503-5427
Test Well Readings for 38 Wells in Mesilla Valley	23-503-5452
	Tables
Daily Records River Flow, Diversions, Flood Inflow, Return Flow, and River Losses, for 1946-50 and Between Caballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso	1 to 144
Monthly and Annual Records of River Flow, Diversions, Flood Inflow, Return Flow, and River Losses for 1946-50 and Between Caballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso	145 to 156

TX_MSJ_006088
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CONTENTS

Appendix, Part I	Tables
Summary of Estimated River Losses Caballo Dam to Leasburg Dam, 1946-51	157
Summary of Estimated River Losses Leasburg Dam to El Paso, 1946-51	158
Summary of Estimated River Losses Caballo Dam to El Paso, 1946-51	159
Summary of River Loss or Gain, Caballo Dam to El Paso, 1946-51	160
Summary River Flow, Diversions, Waste, Return Flow, Flood Inflow, and Seepage Loss for Rincon and Mesilla Valleys for 1938-51	161
Flood Periods and Discharges - Rio Grande Below Leasburg Dam for 1946-51	162 to 166
River Flow and Depletion for 1946-51, and for Rincon, Mesilla, and Total Rincon and Mesilla Valleys	167
Diversions, Waste, Charged to Farms, Losses, and Drain Discharge for 1946-51, and for Rincon and Mesilla Valleys	168
Depth to Ground-water - Mesilla Valley for 1946-51	169 to 174
Test Well Lines in Mesilla and Rincon Valleys	175
Climatological Data - Precipitation and Evaporation for 1946-51 by Months	176 to 181
Inflow-Outflow Study by Months for 1946-51 and for Rincon and Mesilla Valleys	182 to 193
Summary of Estimated Consumptive Use and Source of Water by Years for 1946-51, and for Rincon and Mesilla Valleys	194
Annual Consumptive Use and Water Charged to Farms - Rincon Valley for 1946-51	195
Annual Consumptive Use and Water Charged to Farms - Mesilla Valley for 1946-51	196

TX_MSJ_006089
NM_00138512

CONTENTS

Appendix, Part I	Tables
Seepage Investigation - January 1952 - American Dam to Juarez Station	197
Seepage Investigation - January 1952 - Juarez Station to Riverside Heading	198
Seepage Investigation - January 1952 - Riverside Heading to Island Station	199
Seepage Investigation - January 1952 - American Dam to Island Station	200
Seepage Investigation - January & February 1942 - Juarez Station to Riverside Heading	201
	Drawings
Location of Test Well Lines No. 8 to No. 11 - Rincon Valley	23-503-5103
Location of 40 Test Wells and Test Well Lines No. 1 to No. 7 - Mesilla Valley	23-503-5314
Valley Cross-sections & Test Wells Mesilla & Rincon Valleys (5 sheets)	23-503-5454
Appendix, Part II	**Tables**
Percent of Pumped Water Diverted from River or Drain - 1 to 4 Months After Pumping Began and for All Wells to River, Wells between River & First Drain, and for All Wells to River or Drain, Whichever is the Least Distance	A
Monthly Distribution of Water Charged to Farms for 1946-51 and for Months January Through April	B
Amount Water Diverted from River or Drain by Pumping at Average Farm Delivery Rate for Rincon, Leasburg, and Mesilla Units	C
Acre-Feet Water Diverted from River or Drain by Pumping Various Number Wells and at Several Different Distances	D

TX_MSJ_006090

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CONTENTS

Appendix, Part II	Tables
Acre-Feet of Pumped Water Diverted from River for Various Pumping Periods and for 1/4, 1/2, 3/4 and 1.00 Acre-Feet Pumped by Units	E to G
Acre-Feet per Acre Charged to Farms by Months for 1946-50, and for Rincon Valley	H
Acre-Feet per Acre Charged to Farms by Months for 1946-50, and for Leasburg & Mesilla Units	I
Acre-Feet Pumped Water Diverted from River for Several Size Farms with 1/2 Foot Farm Delivery for Average Distance of All Wells to River	J
Acre-Feet Pumped Water Diverted from River for Several Size Farms with 1/2 Foot Farm Delivery for Average Distance of All Wells to River Between River and First Drain	K
Acre-Feet Pumped Water Diverted from River for Several Size Farms with 1/2 Foot Farm Delivery for Average Distance of All Wells to River or Drain, Whichever is the Least Distance	L
Percent Pumped Water Diverted from River or Drain by Pumping in 1951	M
Acre-Feet Diverted from River or Drain by Pumping in 1951	N
Acre-Feet Pumped Water Diverted from River in 1952	O
Second-Foot Loss per Mile of River Channel Resulting from Pumping	P
Percent Water Diverted from River by Pumping for Three Different Values of Coefficient Transmissibility and at 500 to 5,280 Feet from Well to River Edge	Q to R
	Plates
Percent Pumped Water Diverted from River for Various Pumping Periods and Distances of Well to River	1

TX_MSJ_006091

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CONTENTS

Appendix, Part II	Plates
Acre-Feet Diverted from River or Drain by Pumping at Pumping Rates of 1/4, 1/2, 3/4, and 1.00 Acre-Feet for 90, 60, and 30 Days	2 to 13
	Drawings
Graph of Percent of Pumped Water Diverted from River for Any Condition (Theis-Conover, USGS)	23-0A - 59
Location Irrigation Wells in Rincon Valley	23-503-5103
Location Irrigation Wells in Mesilla Valley	23-503-5396
Location Irrigation Wells in El Paso Valley	23-503-5389

TX_MSJ_006092

SUMMARY

Part I

River Loss

1. The review of available records and data for the six year period 1946-51 indicates an increase in loss from the river between Caballo Dam and El Paso for 1951 compared to the previous five years. These losses were 71,418 acre-feet during 1951 and an average of 26,757 acre-feet for 1946-50. The loss during 1951 is equivalent to an average of about 1 second-foot per day per mile; this is about twice the average for the period 1946-50.

2. Drain flows as compared to releases reflect a small decrease in 1951 over the previous five years; also, the same is true of drain flow as compared to canal headgate diversions. Drain return in part during 1951 may have been prevented from showing a larger decrease by appreciable interception of seepage from the river. This, coupled with the fact seepage loss from the distribution system continued high and to possibility that pumping may have temporarily created a suspended water table, may account for drain return maintaining a ratio to releases and diversions nearly the same in 1951 as the previous five years.

3. The indicated increase in river loss during 1951 over the period 1946-50 probably reflects the effects of (a) increased irrigation pumping; (b) increase in evaporation in river channel, due to unusually high summer temperatures and below average precipitation during 1951; (c) reduced accretion to river in those segments where in the past the river may have been effluent or gaining; (d) decreasing ground-water elevation during 1951, which was 1.2 feet lower than the previous five years' average. The rate of decline of the ground-water per year for 1950-51 was over seven times that for any two years during 1946-50, as evidenced by readings from 38 test wells in the Mesilla Valley. The major factor is undoubtedly the increased irrigation pumping resulting from the shortage in the water supply of the Project.

4. A further increase in loss may occur from the river in 1952, since 53 new irrigation wells were installed up to May 1, 1952. Pumping from all wells will commence at an earlier date, since all wells installed during 1951 were put down throughout the year, and not available at start of irrigation season. Also a decrease in drain discharge would be expected under the foregoing conditions.

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5. While the river loss as indicated in this study has not been a complete net loss due to partial recovery in the drains near the river, yet under the conditions of a continually dropping water table with resulting decrease in drain flows, the losses from the river instead of being recovered in part by the drains will be principally recharge to the subsurface water table.

6. At such time as drain flows would cease, with no consequent recovery of river seepage for return to the river, a major problem of water distribution on the Project will exist. The present trend of increasing loss from the river, if continued, will require a change in water distribution policy in order that all divisions of the Project receive their proportionate share of storage water.

7. In arriving at the conclusions of the studies the necessity of using a great many estimated wasteway records, the accuracy of which is questionable, should not be overlooked. The most that can be expected in accuracy is that the trends of increase or decrease are reliable; certainly the fact that waste records are estimates would preclude the acceptance of accuracy in any individual conclusions; but as the wasteway estimates have been made by the same people over a period of years, a pattern has been established in this estimating; and accordingly on the average, this pattern will be the same from year to year for the several individuals engaged in estimating the wasteway flows. Figures used in the tabular material may differ somewhat from previously reported ones due to the method of computing. At the same time all records having current meter basis of determination are subject to error; such records are subject to average errors of 5 percent; and should the error be in opposite directions at any two successive stations, it can readily be seen how appreciable error could be present. Consequently as previously stated, the trends are probably more reliable than any individual conclusion.

8. Further proof of increased river loss is the actual river operation; more storage release was required in 1951 to obtain required flows at the diversion points than was necessary during the normal period 1946-50.

Part II

Irrigation Wells

1. A total of 893 wells have been drilled on the Project to December 31, 1951; this includes valley wells, mesa wells, City of Las Cruces wells, and El Paso Electric and American Smelter Company wells. There are 188 in the El Paso Valley, 535 in

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO-TEXAS

RIVER LOSS
CABALLO DAM TO EL PASO
AND
IRRIGATION WELLS

EL PASO, TEXAS

JULY 1, 1952

TX_MSJ_006095

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CONTENTS

	Page
Summary, Part I - River Loss	A
Summary, Part II - Irrigation Wells	B
Part I	
River Loss	1
Drain Return Flow	4
Subsurface Water Table - Mesilla Valley	7
Inflow-Outflow Study	8
Precipitation	9
Evaporation	9
Ground-water	10
Inflow and Outflow	10
Consumptive Use	11
Water Pumped	12
River Seepage Investigation	13
Seepage Loss, Canutillo to El Paso	13
Seepage Loss, American Dam to Island Station	15
Part II	
Irrigation Wells	21
Inventory of Irrigation Wells	21
Effect of Irrigation Wells on River and Drains	22
Percent of Pumped Water Diverted from River or Drain	26
Rate of Pumping or Water Distribution	27
Water Diverted from River or Drains Due to Pumping During 1951	31
Forecast River Diversions by Pumping During 1952	32
Comparison of Coefficient of Transmissibility	34
Appendix, Part I	**Drawings**
Daily Graph of River Flow and Losses for 1946-51 and for Daballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso	23-503-5416 to 23-503-5427
Test Well Readings for 38 Wells in Mesilla Valley	23-503-5452
	Tables
Daily Records River Flow, Diversions, Flood Inflow, Return Flow, and River Losses, for 1946-50 and Between Caballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso	1 to 144
Monthly and Annual Records of River Flow, Diversions, Flood Inflow, Return Flow, and River Losses for 1946-50 and Between Caballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso	145 to 156

TX_MSJ_006096
NM_00138511

CONTENTS

Appendix, Part I	Tables
Summary of Estimated River Losses Caballo Dam to Leasburg Dam, 1946-51	157
Summary of Estimated River Losses Leasburg Dam to El Paso, 1946-51	158
Summary of Estimated River Losses Caballo Dam to El Paso, 1946-51	159
Summary of River Loss or Gain, Caballo Dam to El Paso, 1946-51	160
Summary River Flow, Diversions, Waste, Return Flow, Flood Inflow, and Seepage Loss for Rincon and Mesilla Valleys for 1938-51	161
Flood Periods and Discharges - Rio Grande Below Leasburg Dam for 1946-51	162 to 166
River Flow and Depletion for 1946-51, and for Rincon, Mesilla, and Total Rincon and Mesilla Valleys	167
Diversions, Waste, Charged to Farms, Losses, and Drain Discharge for 1946-51, and for Rincon and Mesilla Valleys	168
Depth to Ground-water - Mesilla Valley for 1946-51	169 to 174
Test Well Lines in Mesilla and Rincon Valleys	175
Climatological Data - Precipitation and Evaporation for 1946-51 by Months	176 to 181
Inflow-Outflow Study by Months for 1946-51 and for Rincon and Mesilla Valleys	182 to 193
Summary of Estimated Consumptive Use and Source of Water by Years for 1946-51, and for Rincon and Mesilla Valleys	194
Annual Consumptive Use and Water Charged to Farms - Rincon Valley for 1946-51	195
Annual Consumptive Use and Water Charged to Farms - Mesilla Valley for 1946-51	196

TX_MSJ_006097
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CONTENTS

Appendix, Part I	Tables
Seepage Investigation - January 1952 - American Dam to Juarez Station	197
Seepage Investigation - January 1952 - Juarez Station to Riverside Heading	198
Seepage Investigation - January 1952 - Riverside Heading to Island Station	199
Seepage Investigation - January 1952 - American Dam to Island Station	200
Seepage Investigation - January & February 1942 - Juarez Station to Riverside Heading	201
	Drawings
Location of Test Well Lines No. 8 to No. 11 - Rincon Valley	23-503-5103
Location of 40 Test Wells and Test Well Lines No. 1 to No. 7 - Mesilla Valley	23-503-5314
Valley Cross-sections & Test Wells Mesilla & Rincon Valleys (5 sheets)	23-503-5454
Appendix, Part II	**Tables**
Percent of Pumped Water Diverted from River or Drain - 1 to 4 Months After Pumping Began and for All Wells to River, Wells between River & First Drain, and for All Wells to River or Drain, Whichever is the Least Distance	A
Monthly Distribution of Water Charged to Farms for 1946-51 and for Months January Through April	B
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Acre-Feet Water Diverted from River or Drain by Pumping Various Number Wells and at Several Different Distances	D

TX_MSJ_006098

NM 00138513

CONTENTS

Appendix, Part II	Tables
Acre-Feet of Pumped Water Diverted from River for Various Pumping Periods and for 1/4, 1/2, 3/4 and 1.00 Acre-Feet Pumped by Units	E to G
Acre-Feet per Acre Charged to Farms by Months for 1946-50, and for Rincon Valley	H
Acre-Feet per Acre Charged to Farms by Months for 1946-50, and for Leasburg & Mesilla Units	I
Acre-Feet Pumped Water Diverted from River for Several Size Farms with 1/2 Foot Farm Delivery for Average Distance of All Wells to River	J
Acre-Feet Pumped Water Diverted from River for Several Size Farms with 1/2 Foot Farm Delivery for Average Distance of All Wells to River Between River and First Drain	K
Acre-Feet Pumped Water Diverted from River for Several Size Farms with 1/2 Foot Farm Delivery for Average Distance of All Wells to River or Drain, Whichever is the Least Distance	L
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Second-Foot Loss per Mile of River Channel Resulting from Pumping	P
Percent Water Diverted from River by Pumping for Three Different Values of Coefficient Transmissibility and at 500 to 5,280 Feet from Well to River Edge	Q to R
	Plates
Percent Pumped Water Diverted from River for Various Pumping Periods and Distances of Well to River	1

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5. While the river loss as indicated in this study has not been a complete net loss due to partial recovery in the drains near the river, yet under the conditions of a continually dropping water table with resulting decrease in drain flows, the losses from the river instead of being recovered in part by the drains will be principally recharge to the subsurface water table.

6. At such time as drain flows would cease, with no consequent recovery of river seepage for return to the river, a major problem of water distribution on the Project will exist. The present trend of increasing loss from the river, if continued, will require a change in water distribution policy in order that all divisions of the Project receive their proportionate share of storage water.

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Part II

Irrigation Wells

1. A total of 893 wells have been drilled on the Project to December 31, 1951; this includes valley wells, mesa wells, City of Las Cruces wells, and El Paso Electric and American Smelter Company wells. There are 188 in the El Paso Valley, 535 in

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Mesilla Valley, and 170 in the Rincon Valley. Of these, 79 wells are on the adjoining mesa.

2. It is estimated that 33,275 acre-feet of water was pumped during 1951 in the El Paso Valley, 77,580 acre-feet in the Mesilla Valley, and 17,810 acre-feet in the Rincon Valley.

3. Formulas used to determine the percent of pumped water diverted from river or drain show that if the percent diverted remains the same, the time varies as the square of the distance of the well from the river or drain. In other words, if two wells pumping the same amount and diverting the same amount from the river, and one well is 1,000 feet from the river and the other is 2,000 feet, it will take 4 times as long for the well 2,000 feet from the river to divert the same amount.

4. Data regarding well depth, discharge, and location with regard to river and drains was determined from field surveys, and average conditions were assumed for the Rincon Valley and in the Mesilla Valley to determine the effect of pumping during 1951 on the river. Due to pumping in 1951, it has been determined that about 29,650 acre-feet of water was diverted directly from the river between April 1, 1951, and December 31, 1951, between Caballo Dam and El Paso. This is 31 percent of the estimated total water pumped from wells. In addition, this pumping further diverted water from the drains; and assuming none of these dried up, the river and drains were effected by at least 76,630 acre-feet diverted from them during the same period and for the same river reach. This is about 80 percent of all estimated pumped water from wells. During this period this loss would equal 140 second-feet and for the reach from Percha Dam to El Paso (105 miles) would amount to 1.34 second-feet per day per mile. This compares to river losses for the same period and reach of .94 second-feet per day per mile. The above does not represent the total water diverted by pumping in 1951, since there is a lag in subsurface water flow that will be reflected during part of 1952.

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RIVER LOSS - CABALLO DAM TO EL PASO
AND
IRRIGATION WELL INVENTORY

Part I

River Loss

Losses in the Rio Grande from Caballo Dam to El Paso, Texas, are considered herein for the years 1946-51. The study involves a review of available stream flow records to determine if withdrawal of subsurface water by pumping during 1951 may have effected river losses above El Paso.

The reach of the Rio Grande from Caballo Dam to El Paso is about 106 river miles. Generally, except for local segments, during times when releases are being made at Caballo, the river is believed to be influent or a losing stream; and for a short period after releases are discontinued in the fall, the river is generally effluent, or a gaining stream as bank storage is returned. An extensive gravity drainage system throughout most of the valley through which the river flows provides means for intercepting river losses, thus making possible a portion of the seepage loss being recovered for later use. This interchange of loss and gain of flow in the river, and how it may have been effected by withdrawal of subsurface water during 1951, is the intent of the review of records and other data presented.

It is based on available records of flow of the river, of waste records, drainage return records, and of diversions from the river. These records were modified to reflect records of tributary inflow in the Rincon Valley at Leasburg Dam. Points at which observations are made, and the status of each station on the river are as follows:

River Observation Stations

Station	Location: Miles Below Caballo Dam	Automatic Recorder: Type	Automatic Recorder: Frequency Checked	Frequency Flow Metered*	Remarks
Caballo	0.8	Stevens Continuous	Daily	2 per week	
Leasburg	45.6	do	5 per week	3 per week	1.6 mile below Leasburg Dam
El Paso	105.6	"	Daily	1 per week	

* During periods of flood flows, additional meterings are made as needed.

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RIVER LOSS - CABALLO DAM TO EL PASO
AND
IRRIGATION WELL INVENTORY

Part I

River Loss

Losses in the Rio Grande from Caballo Dam to El Paso, Texas, are considered herein for the years 1946-51. The study involves a review of available stream flow records to determine if withdrawal of subsurface water by pumping during 1951 may have effected river losses above El Paso.

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It is based on available records of flow of the river, of waste records, drainage return records, and of diversions from the river. These records were modified to reflect records of tributary inflow in the Rincon Valley at Leasburg Dam. Points at which observations are made, and the status of each station on the river are as follows:

River Observation Stations

Station	Location: Miles Below Caballo Dam	Automatic Recorder: Type	Automatic Recorder: Frequency Checked	Frequency Flow Metered*	Remarks
Caballo	0.8	Stevens Continuous	Daily	2 per week	
Leasburg	45.6	do	5 per week	3 per week	1.6 mile below Leasburg Dam
El Paso	105.6	"	Daily	1 per week	

* During periods of flood flows, additional meterings are made as needed.

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Return flow to the river comprises that from drains and wasteways, which discharge to the river at various places throughout its length. The drain flow is metered weekly, but there are a few exceptions when bi-weekly measurements have been made. Wasteway flow, which is water from canals and laterals, is estimated by the various ditchriders as an average daily flow for each wasteway. Wasteway records are questionable insofar as accuracy is concerned; however, as the same ditchriders have made the estimates used, it may be that errors are compensatory, and the trends indicated are consequently a fair indication of actual conditions.

Diversions from the river into the four main canals are metered five times per week, and estimates made for the other two days from staff gages. Three small laterals diverting from the river at various times are estimated on a daily basis by ditchriders.

Tributary inflows resulting in flood water at Leasburg Dam are determined from records of time and duration of inflow by ditchriders and other project personnel by observation of rising and falling stages at Leasburg Dam, and frequent metering of flow. From these data the flood flow at Leasburg is determined from the recorder charts, and records modified to reflect this inflow.

The study, using the data of the above-described records, covers the period from January, 1946, through December, 1951. They are tabulated in second-feet by days for the six years, and for the river reaches from Caballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso. The tables give the flow at the upper end of each reach; diversions, flood inflow, and return flow within the reach; theoretical and actual at the end of the reach; and the difference between theoretical and actual flow, as a loss or gain in flow, which is also summarized by 10-day moving averages. Detail tabulations are shown in Tables 1 to 144 in Appendix, Part I; also, in graphical form on Drawings No. 23-503-5416 through 23-503-5427 in Appendix, Part I. Also, these data, except for the 10-day moving average, are summarized in acre-feet by months for the six year period in Tables 145 through 156 in Appendix, Part I.

A summary of river loss in acre-feet by months for the six year period is shown in Tables 157 through 159 in Appendix, Part I, for the two reaches, and in addition for the overall reach from Caballo Dam to El Paso. These are summarized by years as follows:

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Mesilla Valley, and 170 in the Rincon Valley. Of these, 79 wells are on the adjoining mesa.

2. It is estimated that 33,275 acre-feet of water was pumped during 1951 in the El Paso Valley, 77,580 acre-feet in the Mesilla Valley, and 17,810 acre-feet in the Rincon Valley.

3. Formulas used to determine the percent of pumped water diverted from river or drain show that if the percent diverted remains the same, the time varies as the square of the distance of the well from the river or drain. In other words, if two wells pumping the same amount and diverting the same amount from the river, and one well is 1,000 feet from the river and the other is 2,000 feet, it will take 4 times as long for the well 2,000 feet from the river to divert the same amount.

4. Data regarding well depth, discharge, and location with regard to river and drains was determined from field surveys, and average conditions were assumed for the Rincon Valley and in the Mesilla Valley to determine the effect of pumping during 1951 on the river. Due to pumping in 1951, it has been determined that about 29,650 acre-feet of water was diverted directly from the river between April 1, 1951, and December 31, 1951, between Caballo Dam and El Paso. This is 31 percent of the estimated total water pumped from wells. In addition, this pumping further diverted water from the drains; and assuming none of these dried up, the river and drains were effected by at least 76,630 acre-feet diverted from them during the same period and for the same river reach. This is about 80 percent of all estimated pumped water from wells. During this period this loss would equal 140 second-feet and for the reach from Percha Dam to El Paso (105 miles) would amount to 1.34 second-feet per day per mile. This compares to river losses for the same period and reach of .94 second-feet per day per mile. The above does not represent the total water diverted by pumping in 1951, since there is a lag in subsurface water flow that will be reflected during part of 1952.

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RIVER LOSS - CABALLO DAM TO EL PASO
AND
IRRIGATION WELL INVENTORY

Part I

River Loss

Losses in the Rio Grande from Caballo Dam to El Paso, Texas, are considered herein for the years 1946-51. The study involves a review of available stream flow records to determine if withdrawal of subsurface water by pumping during 1951 may have effected river losses above El Paso.

The reach of the Rio Grande from Caballo Dam to El Paso is about 106 river miles. Generally, except for local segments, during times when releases are being made at Caballo, the river is believed to be influent or a losing stream; and for a short period after releases are discontinued in the fall, the river is generally effluent, or a gaining stream as bank storage is returned. An extensive gravity drainage system throughout most of the valley through which the river flows provides means for intercepting river losses, thus making possible a portion of the seepage loss being recovered for later use. This interchange of loss and gain of flow in the river, and how it may have been effected by withdrawal of subsurface water during 1951, is the intent of the review of records and other data presented.

It is based on available records of flow of the river, of waste records, drainage return records, and of diversions from the river. These records were modified to reflect records of tributary inflow in the Rincon Valley at Leasburg Dam. Points at which observations are made, and the status of each station on the river are as follows:

River Observation Stations

Station	Location: Miles Below Caballo Dam	Automatic Recorder: Type	Automatic Recorder: Frequency Checked	Frequency Flow Metered*	Remarks
Caballo	0.8	Stevens Continuous	Daily	2 per week	
Leasburg	45.6	do	5 per week	3 per week	1.6 mile below Leasburg Dam
El Paso	105.6	"	Daily	1 per week	

* During periods of flood flows, additional meterings are made as needed.

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RIVER LOSS - CABALLO DAM TO EL PASO
AND
IRRIGATION WELL INVENTORY

Part I

River Loss

Losses in the Rio Grande from Caballo Dam to El Paso, Texas, are considered herein for the years 1946-51. The study involves a review of available stream flow records to determine if withdrawal of subsurface water by pumping during 1951 may have effected river losses above El Paso.

The reach of the Rio Grande from Caballo Dam to El Paso is about 106 river miles. Generally, except for local segments, during times when releases are being made at Caballo, the river is believed to be influent or a losing stream; and for a short period after releases are discontinued in the fall, the river is generally effluent, or a gaining stream as bank storage is returned. An extensive gravity drainage system throughout most of the valley through which the river flows provides means for intercepting river losses, thus making possible a portion of the seepage loss being recovered for later use. This interchange of loss and gain of flow in the river, and how it may have been effected by withdrawal of subsurface water during 1951, is the intent of the review of records and other data presented.

It is based on available records of flow of the river, of waste records, drainage return records, and of diversions from the river. These records were modified to reflect records of tributary inflow in the Rincon Valley at Leasburg Dam. Points at which observations are made, and the status of each station on the river are as follows:

River Observation Stations

Station	Location: Miles Below Caballo Dam	Automatic Recorder: Type	Automatic Recorder: Frequency Checked	Frequency Flow Metered*	Remarks
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El Paso	105.6	"	Daily	1 per week	

* During periods of flood flows, additional meterings are made as needed.

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Return flow to the river comprises that from drains and wasteways, which discharge to the river at various places throughout its length. The drain flow is metered weekly, but there are a few exceptions when bi-weekly measurements have been made. Wasteway flow, which is water from canals and laterals, is estimated by the various ditchriders as an average daily flow for each wasteway. Wasteway records are questionable insofar as accuracy is concerned; however, as the same ditchriders have made the estimates used, it may be that errors are compensatory, and the trends indicated are consequently a fair indication of actual conditions.

Diversions from the river into the four main canals are metered five times per week, and estimates made for the other two days from staff gages. Three small laterals diverting from the river at various times are estimated on a daily basis by ditchriders.

Tributary inflows resulting in flood water at Leasburg Dam are determined from records of time and duration of inflow by ditchriders and other project personnel by observation of rising and falling stages at Leasburg Dam, and frequent metering of flow. From these data the flood flow at Leasburg is determined from the recorder charts, and records modified to reflect this inflow.

The study, using the data of the above-described records, covers the period from January, 1946, through December, 1951. They are tabulated in second-feet by days for the six years, and for the river reaches from Caballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso. The tables give the flow at the upper end of each reach; diversions, flood inflow, and return flow within the reach; theoretical and actual at the end of the reach; and the difference between theoretical and actual flow, as a loss or gain in flow, which is also summarized by 10-day moving averages. Detail tabulations are shown in Tables 1 to 144 in Appendix, Part I; also, in graphical form on Drawings No. 23-503-5416 through 23-503-5427 in Appendix, Part I. Also, these data, except for the 10-day moving average, are summarized in acre-feet by months for the six year period in Tables 145 through 156 in Appendix, Part I.

A summary of river loss in acre-feet by months for the six year period is shown in Tables 157 through 159 in Appendix, Part I, for the two reaches, and in addition for the overall reach from Caballo Dam to El Paso. These are summarized by years as follows:

TX_MSJ_006108

ANNUAL ESTIMATED RIVER LOSSES 1/
(Acre Feet)

Year	Reach: Caballo Dam to Leasburg Dam	Reach: Leasburg Dam to El Paso	Reach: Caballo Dam to El Paso
1946	18,485	-19,958	-1,473
1947	-708	-12,447	-13,155
1948	-14,270	-46,290	-60,560
1949	8,557	-34,790	-26,233
1950	14,532	-46,878	-32,346
1951	-10,253	-61,165	-71,418

1/ Minus denotes loss and plus gain in flow.

It will be noted that the river loss for 1951 is greater than for any other of the five years with the exception of 1948 for the reach Caballo Dam to Leasburg Dam, and then it is exceeded by only 4,000 acre-feet. It would seem reasonable that with a greater annual release from caballo, that the losses would be greater since wetted perimeter and water areas are increased, but for 1951 the Caballo reservoir release was about 40 percent less than any of the previous five years, and yet the losses greater. This increased trend may be an indication of increased losses due to partial depletion of the subsurface water by pumping. The average loss in second-feet per mile per day corresponding to acre-feet in Tables 157 through 159 is tabulated in Table 160 in Appendix, Part I. The loss per mile per day during 1951 is about twice that for the average 1946-51 period, and is greater in 1951 than any of the previous five years. During the irrigation months, March to October, the loss per mile per day during 1951 is from 10 to 35 percent more than for the whole year for the three reaches considered. This is to be expected, since losses are greater during periods of release.

There is presented in detail in Table 161, in Appendix, Part I, the foregoing data. Also, for comparison purposes, the annual averages for 1938-41 and 1942-45 are presented. However, river losses prior to 1946 are not comparable to the period 1946-50, as canalization of the river was not effective in the earlier years.

The estimates of waste, are questionable as to accuracy; however, as previously pointed out, these are likely to be compensated for when several months' or several years' records are totaled. The arroyo runs, or flood inflow to the river during the summer, probably also influences conclusions due to lag, bank storage, and observational errors.

Flood inflows between Caballo and Leasburg occurred a minimum of 4 days during 1948 and a maximum of 26 days during

TX_MSJ_006109

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO-TEXAS

RIVER LOSS
CABALLO DAM TO EL PASO
AND
IRRIGATION WELLS

EL PASO, TEXAS

JULY 1, 1952

TX_MSJ_006110

NM_00138510

CONTENTS

	Page
Summary, Part I - River Loss	A
Summary, Part II - Irrigation Wells	B
Part I	
River Loss	1
Drain Return Flow	4
Subsurface Water Table - Mesilla Valley	7
Inflow-Outflow Study	8
Precipitation	9
Evaporation	9
Ground-water	10
Inflow and Outflow	10
Consumptive Use	11
Water Pumped	12
River Seepage Investigation	13
Seepage Loss, Canutillo to El Paso	13
Seepage Loss, American Dam to Island Station	15
Part II	
Irrigation Wells	21
Inventory of Irrigation Wells	21
Effect of Irrigation Wells on River and Drains	22
Percent of Pumped Water Diverted from River or Drain	26
Rate of Pumping or Water Distribution	27
Water Diverted from River or Drains Due to Pumping During 1951	31
Forecast River Diversions by Pumping During 1952	32
Comparison of Coefficient of Transmissibility	34
Appendix, Part I	**Drawings**
Daily Graph of River Flow and Losses for 1946-51 and for Daballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso	23-503-5416 to 23-503-5427
Test Well Readings for 38 Wells in Mesilla Valley	23-503-5452
	Tables
Daily Records River Flow, Diversions, Flood Inflow, Return Flow, and River Losses, for 1946-50 and Between Caballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso	1 to 144
Monthly and Annual Records of River Flow, Diversions, Flood Inflow, Return Flow, and River Losses for 1946-50 and Between Caballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso	145 to 156

TX_MSJ_006111
NM_00138511

CONTENTS

Appendix, Part I	Tables
Summary of Estimated River Losses Caballo Dam to Leasburg Dam, 1946-51	157
Summary of Estimated River Losses Leasburg Dam to El Paso, 1946-51	158
Summary of Estimated River Losses Caballo Dam to El Paso, 1946-51	159
Summary of River Loss or Gain, Caballo Dam to El Paso, 1946-51	160
Summary River Flow, Diversions, Waste, Return Flow, Flood Inflow, and Seepage Loss for Rincon and Mesilla Valleys for 1938-51	161
Flood Periods and Discharges - Rio Grande Below Leasburg Dam for 1946-51	162 to 166
River Flow and Depletion for 1946-51, and for Rincon, Mesilla, and Total Rincon and Mesilla Valleys	167
Diversions, Waste, Charged to Farms, Losses, and Drain Discharge for 1946-51, and for Rincon and Mesilla Valleys	168
Depth to Ground-water - Mesilla Valley for 1946-51	169 to 174
Test Well Lines in Mesilla and Rincon Valleys	175
Climatological Data - Precipitation and Evaporation for 1946-51 by Months	176 to 181
Inflow-Outflow Study by Months for 1946-51 and for Rincon and Mesilla Valleys	182 to 193
Summary of Estimated Consumptive Use and Source of Water by Years for 1946-51, and for Rincon and Mesilla Valleys	194
Annual Consumptive Use and Water Charged to Farms - Rincon Valley for 1946-51	195
Annual Consumptive Use and Water Charged to Farms - Mesilla Valley for 1946-51	196

TX_MSJ_006112
NM_00138512

CONTENTS

Appendix, Part I	Tables
Seepage Investigation - January 1952 - American Dam to Juarez Station	197
Seepage Investigation - January 1952 - Juarez Station to Riverside Heading	198
Seepage Investigation - January 1952 - Riverside Heading to Island Station	199
Seepage Investigation - January 1952 - American Dam to Island Station	200
Seepage Investigation - January & February 1942 - Juarez Station to Riverside Heading	201
	Drawings
Location of Test Well Lines No. 8 to No. 11 - Rincon Valley	23-503-5103
Location of 40 Test Wells and Test Well Lines No. 1 to No. 7 - Mesilla Valley	23-503-5314
Valley Cross-sections & Test Wells Mesilla & Rincon Valleys (5 sheets)	23-503-5454
Appendix, Part II	**Tables**
Percent of Pumped Water Diverted from River or Drain - 1 to 4 Months After Pumping Began and for All Wells to River, Wells between River & First Drain, and for All Wells to River or Drain, Whichever is the Least Distance	A
Monthly Distribution of Water Charged to Farms for 1946-51 and for Months January Through April	B
Amount Water Diverted from River or Drain by Pumping at Average Farm Delivery Rate for Rincon, Leasburg, and Mesilla Units	C
Acre-Feet Water Diverted from River or Drain by Pumping Various Number Wells and at Several Different Distances	D

TX_MSJ_006113

NM_00138513

CONTENTS

Appendix, Part II	Tables
Acre-Feet of Pumped Water Diverted from River for Various Pumping Periods and for 1/4, 1/2, 3/4 and 1.00 Acre-Feet Pumped by Units	E to G
Acre-Feet per Acre Charged to Farms by Months for 1946-50, and for Rincon Valley	H
Acre-Feet per Acre Charged to Farms by Months for 1946-50, and for Leasburg & Mesilla Units	I
Acre-Feet Pumped Water Diverted from River for Several Size Farms with 1/2 Foot Farm Delivery for Average Distance of All Wells to River	J
Acre-Feet Pumped Water Diverted from River for Several Size Farms with 1/2 Foot Farm Delivery for Average Distance of All Wells to River Between River and First Drain	K
Acre-Feet Pumped Water Diverted from River for Several Size Farms with 1/2 Foot Farm Delivery for Average Distance of All Wells to River or Drain, Whichever is the Least Distance	L
Percent Pumped Water Diverted from River or Drain by Pumping in 1951	M
Acre-Feet Diverted from River or Drain by Pumping in 1951	N
Acre-Feet Pumped Water Diverted from River in 1952	O
Second-Foot Loss per Mile of River Channel Resulting from Pumping	P
Percent Water Diverted from River by Pumping for Three Different Values of Coefficient Transmissibility and at 500 to 5,280 Feet from Well to River Edge	Q to R
	Plates
Percent Pumped Water Diverted from River for Various Pumping Periods and Distances of Well to River	1

TX_MSJ_006114

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CONTENTS

Appendix, Part II	Plates
Acre-Feet Diverted from River or Drain by Pumping at Pumping Rates of 1/4, 1/2, 3/4, and 1.00 Acre-Feet for 90, 60, and 30 Days	2 to 13
	Drawings
Graph of Percent of Pumped Water Diverted from River for Any Condition (Theis-Conover, USGS)	23-0A - 59
Location Irrigation Wells in Rincon Valley	23-503-5103
Location Irrigation Wells in Mesilla Valley	23-503-5396
Location Irrigation Wells in El Paso Valley	23-503-5389

TX_MSJ_006115

SUMMARY

Part I

River Loss

1. The review of available records and data for the six year period 1946-51 indicates an increase in loss from the river between Caballo Dam and El Paso for 1951 compared to the previous five years. These losses were 71,418 acre-feet during 1951 and an average of 26,757 acre-feet for 1946-50. The loss during 1951 is equivalent to an average of about 1 second-foot per day per mile; this is about twice the average for the period 1946-50.

2. Drain flows as compared to releases reflect a small decrease in 1951 over the previous five years; also, the same is true of drain flow as compared to canal headgate diversions. Drain return in part during 1951 may have been prevented from showing a larger decrease by appreciable interception of seepage from the river. This, coupled with the fact seepage loss from the distribution system continued high and to possibility that pumping may have temporarily created a suspended water table, may account for drain return maintaining a ratio to releases and diversions nearly the same in 1951 as the previous five years.

3. The indicated increase in river loss during 1951 over the period 1946-50 probably reflects the effects of (a) increased irrigation pumping; (b) increase in evaporation in river channel, due to unusually high summer temperatures and below average precipitation during 1951; (c) reduced accretion to river in those segments where in the past the river may have been effluent or gaining; (d) decreasing ground-water elevation during 1951, which was 1.2 feet lower than the previous five years' average. The rate of decline of the ground-water per year for 1950-51 was over seven times that for any two years during 1946-50, as evidenced by readings from 38 test wells in the Mesilla Valley. The major factor is undoubtedly the increased irrigation pumping resulting from the shortage in the water supply of the Project.

4. A further increase in loss may occur from the river in 1952, since 53 new irrigation wells were installed up to May 1, 1952. Pumping from all wells will commence at an earlier date, since all wells installed during 1951 were put down throughout the year, and not available at start of irrigation season. Also a decrease in drain discharge would be expected under the foregoing conditions.

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5. While the river loss as indicated in this study has not been a complete net loss due to partial recovery in the drains near the river, yet under the conditions of a continually dropping water table with resulting decrease in drain flows, the losses from the river instead of being recovered in part by the drains will be principally recharge to the subsurface water table.

6. At such time as drain flows would cease, with no consequent recovery of river seepage for return to the river, a major problem of water distribution on the Project will exist. The present trend of increasing loss from the river, if continued, will require a change in water distribution policy in order that all divisions of the Project receive their proportionate share of storage water.

7. In arriving at the conclusions of the studies the necessity of using a great many estimated wasteway records, the accuracy of which is questionable, should not be overlooked. The most that can be expected in accuracy is that the trends of increase or decrease are reliable; certainly the fact that waste records are estimates would preclude the acceptance of accuracy in any individual conclusions; but as the wasteway estimates have been made by the same people over a period of years, a pattern has been established in this estimating; and accordingly on the average, this pattern will be the same from year to year for the several individuals engaged in estimating the wasteway flows. Figures used in the tabular material may differ somewhat from previously reported ones due to the method of computing. At the same time all records having current meter basis of determination are subject to error; such records are subject to average errors of 5 percent; and should the error be in opposite directions at any two successive stations, it can readily be seen how appreciable error could be present. Consequently as previously stated, the trends are probably more reliable than any individual conclusion.

8. Further proof of increased river loss is the actual river operation; more storage release was required in 1951 to obtain required flows at the diversion points than was necessary during the normal period 1946-50.

Part II

Irrigation Wells

1. A total of 893 wells have been drilled on the Project to December 31, 1951; this includes valley wells, mesa wells, City of Las Cruces wells, and El Paso Electric and American Smelter Company wells. There are 188 in the El Paso Valley, 535 in

TX_MSJ_006117
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UNITED STATES
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BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO-TEXAS

RIVER LOSS
CABALLO DAM TO EL PASO
AND
IRRIGATION WELLS

EL PASO, TEXAS

JULY 1, 1952

TX_MSJ_006118

NM_00138510

CONTENTS

	Page
Summary, Part I - River Loss	A
Summary, Part II - Irrigation Wells	B
Part I	
River Loss	1
Drain Return Flow	4
Subsurface Water Table - Mesilla Valley	7
Inflow-Outflow Study	8
Precipitation	9
Evaporation	9
Ground-water	10
Inflow and Outflow	10
Consumptive Use	11
Water Pumped	12
River Seepage Investigation	13
Seepage Loss, Canutillo to El Paso	13
Seepage Loss, American Dam to Island Station	15
Part II	
Irrigation Wells	21
Inventory of Irrigation Wells	21
Effect of Irrigation Wells on River and Drains	22
Percent of Pumped Water Diverted from River or Drain	26
Rate of Pumping or Water Distribution	27
Water Diverted from River or Drains Due to Pumping During 1951	31
Forecast River Diversions by Pumping During 1952	32
Comparison of Coefficient of Transmissibility	34

Appendix, Part I	Drawings
Daily Graph of River Flow and Losses for 1946-51 and for Caballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso	23-503-5416 to 23-503-5427
Test Well Readings for 38 Wells in Mesilla Valley	23-503-5452

	Tables
Daily Records River Flow, Diversions, Flood Inflow, Return Flow, and River Losses, for 1946-50 and Between Caballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso	1 to 144
Monthly and Annual Records of River Flow, Diversions, Flood Inflow, Return Flow, and River Losses for 1946-50 and Between Caballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso	145 to 156

TX_MSJ_006119
NM_00138511

CONTENTS

Appendix, Part I	Tables
Summary of Estimated River Losses Caballo Dam to Leasburg Dam, 1946-51	157
Summary of Estimated River Losses Leasburg Dam to El Paso, 1946-51	158
Summary of Estimated River Losses Caballo Dam to El Paso, 1946-51	159
Summary of River Loss or Gain, Caballo Dam to El Paso, 1946-51	160
Summary River Flow, Diversions, Waste, Return Flow, Flood Inflow, and Seepage Loss for Rincon and Mesilla Valleys for 1938-51	161
Flood Periods and Discharges - Rio Grande Below Leasburg Dam for 1946-51	162 to 166
River Flow and Depletion for 1946-51, and for Rincon, Mesilla, and Total Rincon and Mesilla Valleys	167
Diversions, Waste, Charged to Farms, Losses, and Drain Discharge for 1946-51, and for Rincon and Mesilla Valleys	168
Depth to Ground-water - Mesilla Valley for 1946-51	169 to 174
Test Well Lines in Mesilla and Rincon Valleys	175
Climatological Data - Precipitation and Evaporation for 1946-51 by Months	176 to 181
Inflow-Outflow Study by Months for 1946-51 and for Rincon and Mesilla Valleys	182 to 193
Summary of Estimated Consumptive Use and Source of Water by Years for 1946-51, and for Rincon and Mesilla Valleys	194
Annual Consumptive Use and Water Charged to Farms - Rincon Valley for 1946-51	195
Annual Consumptive Use and Water Charged to Farms - Mesilla Valley for 1946-51	196

TX_MSJ_006120
NM_00138512

CONTENTS

Appendix, Part I	Tables
Seepage Investigation - January 1952 - American Dam to Juarez Station	197
Seepage Investigation - January 1952 - Juarez Station to Riverside Heading	198
Seepage Investigation - January 1952 - Riverside Heading to Island Station	199
Seepage Investigation - January 1952 - American Dam to Island Station	200
Seepage Investigation - January & February 1942 - Juarez Station to Riverside Heading	201
	Drawings
Location of Test Well Lines No. 8 to No. 11 - Rincon Valley	23-503-5103
Location of 40 Test Wells and Test Well Lines No. 1 to No. 7 - Mesilla Valley	23-503-5314
Valley Cross-sections & Test Wells Mesilla & Rincon Valleys (5 sheets)	23-503-5454
Appendix, Part II	**Tables**
Percent of Pumped Water Diverted from River or Drain - 1 to 4 Months After Pumping Began and for All Wells to River, Wells between River & First Drain, and for All Wells to River or Drain, Whichever is the Least Distance	A
Monthly Distribution of Water Charged to Farms for 1946-51 and for Months January Through April	B
Amount Water Diverted from River or Drain by Pumping at Average Farm Delivery Rate for Rincon, Leasburg, and Mesilla Units	C
Acre-Feet Water Diverted from River or Drain by Pumping Various Number Wells and at Several Different Distances	D

TX_MSJ_006121

NM 00138513

CONTENTS

Appendix, Part II	Tables
Acre-Feet of Pumped Water Diverted from River for Various Pumping Periods and for 1/4, 1/2, 3/4 and 1.00 Acre-Feet Pumped by Units	E to G
Acre-Feet per Acre Charged to Farms by Months for 1946-50, and for Rincon Valley	H
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Acre-Feet Pumped Water Diverted from River for Several Size Farms with 1/2 Foot Farm Delivery for Average Distance of All Wells to River or Drain, Whichever is the Least Distance	L
Percent Pumped Water Diverted from River or Drain by Pumping in 1951	M
Acre-Feet Diverted from River or Drain by Pumping in 1951	N
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Second-Foot Loss per Mile of River Channel Resulting from Pumping	P
Percent Water Diverted from River by Pumping for Three Different Values of Coefficient Transmissibility and at 500 to 5,280 Feet from Well to River Edge	Q to R
	Plates
Percent Pumped Water Diverted from River for Various Pumping Periods and Distances of Well to River	1

TX_MSJ_006122

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5. While the river loss as indicated in this study has not been a complete net loss due to partial recovery in the drains near the river, yet under the conditions of a continually dropping water table with resulting decrease in drain flows, the losses from the river instead of being recovered in part by the drains will be principally recharge to the subsurface water table.

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Part II

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Mesilla Valley, and 170 in the Rincon Valley. Of these, 79 wells are on the adjoining mesa.

2. It is estimated that 33,275 acre-feet of water was pumped during 1951 in the El Paso Valley, 77,580 acre-feet in the Mesilla Valley, and 17,810 acre-feet in the Rincon Valley.

3. Formulas used to determine the percent of pumped water diverted from river or drain show that if the percent diverted remains the same, the time varies as the square of the distance of the well from the river or drain. In other words, if two wells pumping the same amount and diverting the same amount from the river, and one well is 1,000 feet from the river and the other is 2,000 feet, it will take 4 times as long for the well 2,000 feet from the river to divert the same amount.

4. Data regarding well depth, discharge, and location with regard to river and drains was determined from field surveys, and average conditions were assumed for the Rincon Valley and in the Mesilla Valley to determine the effect of pumping during 1951 on the river. Due to pumping in 1951, it has been determined that about 29,650 acre-feet of water was diverted directly from the river between April 1, 1951, and December 31, 1951, between Caballo Dam and El Paso. This is 31 percent of the estimated total water pumped from wells. In addition, this pumping further diverted water from the drains; and assuming none of these dried up, the river and drains were effected by at least 76,630 acre-feet diverted from them during the same period and for the same river reach. This is about 80 percent of all estimated pumped water from wells. During this period this loss would equal 140 second-feet and for the reach from Percha Dam to El Paso (105 miles) would amount to 1.34 second-feet per day per mile. This compares to river losses for the same period and reach of .94 second-feet per day per mile. The above does not represent the total water diverted by pumping in 1951, since there is a lag in subsurface water flow that will be reflected during part of 1952.

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RIVER LOSS - CABALLO DAM TO EL PASO
AND
IRRIGATION WELL INVENTORY

Part I

River Loss

Losses in the Rio Grande from Caballo Dam to El Paso, Texas, are considered herein for the years 1946-51. The study involves a review of available stream flow records to determine if withdrawal of subsurface water by pumping during 1951 may have effected river losses above El Paso.

The reach of the Rio Grande from Caballo Dam to El Paso is about 106 river miles. Generally, except for local segments, during times when releases are being made at Caballo, the river is believed to be influent or a losing stream; and for a short period after releases are discontinued in the fall, the river is generally effluent, or a gaining stream as bank storage is returned. An extensive gravity drainage system throughout most of the valley through which the river flows provides means for intercepting river losses, thus making possible a portion of the seepage loss being recovered for later use. This interchange of loss and gain of flow in the river, and how it may have been effected by withdrawal of subsurface water during 1951, is the intent of the review of records and other data presented.

It is based on available records of flow of the river, of waste records, drainage return records, and of diversions from the river. These records were modified to reflect records of tributary inflow in the Rincon Valley at Leasburg Dam. Points at which observations are made, and the status of each station on the river are as follows:

River Observation Stations

Station	Location: Miles Below Caballo Dam	Automatic Recorder: Type	Automatic Recorder: Frequency Checked	Frequency Flow Metered*	Remarks
Caballo	0.8	Stevens Continuous	Daily	2 per week	
Leasburg	45.6	do	5 per week	3 per week	1.6 mile below Leasburg Dam
El Paso	105.6	"	Daily	1 per week	

* During periods of flood flows, additional meterings are made as needed.

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RIVER LOSS - CABALLO DAM TO EL PASO
AND
IRRIGATION WELL INVENTORY

Part I

River Loss

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The reach of the Rio Grande from Caballo Dam to El Paso is about 106 river miles. Generally, except for local segments, during times when releases are being made at Caballo, the river is believed to be influent or a losing stream; and for a short period after releases are discontinued in the fall, the river is generally effluent, or a gaining stream as bank storage is returned. An extensive gravity drainage system throughout most of the valley through which the river flows provides means for intercepting river losses, thus making possible a portion of the seepage loss being recovered for later use. This interchange of loss and gain of flow in the river, and how it may have been effected by withdrawal of subsurface water during 1951, is the intent of the review of records and other data presented.

It is based on available records of flow of the river, of waste records, drainage return records, and of diversions from the river. These records were modified to reflect records of tributary inflow in the Rincon Valley at Leasburg Dam. Points at which observations are made, and the status of each station on the river are as follows:

River Observation Stations

Station	Location: Miles Below Caballo Dam	Automatic Recorder: Type	Automatic Recorder: Frequency Checked	Frequency Flow Metered*	Remarks
Caballo	0.8	Stevens Continuous	Daily	2 per week	
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El Paso	105.6	"	Daily	1 per week	

* During periods of flood flows, additional meterings are made as needed.

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Return flow to the river comprises that from drains and wasteways, which discharge to the river at various places throughout its length. The drain flow is metered weekly, but there are a few exceptions when bi-weekly measurements have been made. Wasteway flow, which is water from canals and laterals, is estimated by the various ditchriders as an average daily flow for each wasteway. Wasteway records are questionable insofar as accuracy is concerned; however, as the same ditchriders have made the estimates used, it may be that errors are compensatory, and the trends indicated are consequently a fair indication of actual conditions.

Diversions from the river into the four main canals are metered five times per week, and estimates made for the other two days from staff gages. Three small laterals diverting from the river at various times are estimated on a daily basis by ditchriders.

Tributary inflows resulting in flood water at Leasburg Dam are determined from records of time and duration of inflow by ditchriders and other project personnel by observation of rising and falling stages at Leasburg Dam, and frequent metering of flow. From these data the flood flow at Leasburg is determined from the recorder charts, and records modified to reflect this inflow.

The study, using the data of the above-described records, covers the period from January, 1946, through December, 1951. They are tabulated in second-feet by days for the six years, and for the river reaches from Caballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso. The tables give the flow at the upper end of each reach; diversions, flood inflow, and return flow within the reach; theoretical and actual at the end of the reach; and the difference between theoretical and actual flow, as a loss or gain in flow, which is also summarized by 10-day moving averages. Detail tabulations are shown in Tables 1 to 144 in Appendix, Part I; also, in graphical form on Drawings No. 23-503-5416 through 23-503-5427 in Appendix, Part I. Also, these data, except for the 10-day moving average, are summarized in acre-feet by months for the six year period in Tables 145 through 156 in Appendix, Part I.

A summary of river loss in acre-feet by months for the six year period is shown in Tables 157 through 159 in Appendix, Part I, for the two reaches, and in addition for the overall reach from Caballo Dam to El Paso. These are summarized by years as follows:

TX_MSJ_006127

Mesilla Valley, and 170 in the Rincon Valley. Of these, 79 wells are on the adjoining mesa.

2. It is estimated that 33,275 acre-feet of water was pumped during 1951 in the El Paso Valley, 77,580 acre-feet in the Mesilla Valley, and 17,810 acre-feet in the Rincon Valley.

3. Formulas used to determine the percent of pumped water diverted from river or drain show that if the percent diverted remains the same, the time varies as the square of the distance of the well from the river or drain. In other words, if two wells pumping the same amount and diverting the same amount from the river, and one well is 1,000 feet from the river and the other is 2,000 feet, it will take 4 times as long for the well 2,000 feet from the river to divert the same amount.

4. Data regarding well depth, discharge, and location with regard to river and drains was determined from field surveys, and average conditions were assumed for the Rincon Valley and in the Mesilla Valley to determine the effect of pumping during 1951 on the river. Due to pumping in 1951, it has been determined that about 29,650 acre-feet of water was diverted directly from the river between April 1, 1951, and December 31, 1951, between Caballo Dam and El Paso. This is 31 percent of the estimated total water pumped from wells. In addition, this pumping further diverted water from the drains; and assuming none of these dried up, the river and drains were effected by at least 76,630 acre-feet diverted from them during the same period and for the same river reach. This is about 80 percent of all estimated pumped water from wells. During this period this loss would equal 140 second-feet and for the reach from Percha Dam to El Paso (105 miles) would amount to 1.34 second-feet per day per mile. This compares to river losses for the same period and reach of .94 second-feet per day per mile. The above does not represent the total water diverted by pumping in 1951, since there is a lag in subsurface water flow that will be reflected during part of 1952.

TX_MSJ_006128

RIVER LOSS - CABALLO DAM TO EL PASO
AND
IRRIGATION WELL INVENTORY

Part I

River Loss

Losses in the Rio Grande from Caballo Dam to El Paso, Texas, are considered herein for the years 1946-51. The study involves a review of available stream flow records to determine if withdrawal of subsurface water by pumping during 1951 may have effected river losses above El Paso.

The reach of the Rio Grande from Caballo Dam to El Paso is about 106 river miles. Generally, except for local segments, during times when releases are being made at Caballo, the river is believed to be influent or a losing stream; and for a short period after releases are discontinued in the fall, the river is generally effluent, or a gaining stream as bank storage is returned. An extensive gravity drainage system throughout most of the valley through which the river flows provides means for intercepting river losses, thus making possible a portion of the seepage loss being recovered for later use. This interchange of loss and gain of flow in the river, and how it may have been effected by withdrawal of subsurface water during 1951, is the intent of the review of records and other data presented.

It is based on available records of flow of the river, of waste records, drainage return records, and of diversions from the river. These records were modified to reflect records of tributary inflow in the Rincon Valley at Leasburg Dam. Points at which observations are made, and the status of each station on the river are as follows:

River Observation Stations

Station	Location Miles Below Caballo Dam	Automatic Recorder Type	Automatic Recorder Frequency Checked	Frequency Flow Metered*	Remarks
Caballo	0.8	Stevens Continuous	Daily	2 per week	
Leasburg	45.6	do	5 per week	3 per week	1.6 mile below Leasburg Dam
El Paso	105.6	"	Daily	1 per week	

* During periods of flood flows, additional meterings are made as needed.

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RIVER LOSS - CABALLO DAM TO EL PASO
AND
IRRIGATION WELL INVENTORY

Part I

River Loss

Losses in the Rio Grande from Caballo Dam to El Paso, Texas, are considered herein for the years 1946-51. The study involves a review of available stream flow records to determine if withdrawal of subsurface water by pumping during 1951 may have effected river losses above El Paso.

The reach of the Rio Grande from Caballo Dam to El Paso is about 106 river miles. Generally, except for local segments, during times when releases are being made at Caballo, the river is believed to be influent or a losing stream; and for a short period after releases are discontinued in the fall, the river is generally effluent, or a gaining stream as bank storage is returned. An extensive gravity drainage system throughout most of the valley through which the river flows provides means for intercepting river losses, thus making possible a portion of the seepage loss being recovered for later use. This interchange of loss and gain of flow in the river, and how it may have been effected by withdrawal of subsurface water during 1951, is the intent of the review of records and other data presented.

It is based on available records of flow of the river, of waste records, drainage return records, and of diversions from the river. These records were modified to reflect records of tributary inflow in the Rincon Valley at Leasburg Dam. Points at which observations are made, and the status of each station on the river are as follows:

River Observation Stations

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Caballo	0.8	Stevens Continuous	Daily	2 per week	
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El Paso	105.6	"	Daily	1 per week	

* During periods of flood flows, additional meterings are made as needed.

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Return flow to the river comprises that from drains and wasteways, which discharge to the river at various places throughout its length. The drain flow is metered weekly, but there are a few exceptions when bi-weekly measurements have been made. Wasteway flow, which is water from canals and laterals, is estimated by the various ditchriders as an average daily flow for each wasteway. Wasteway records are questionable insofar as accuracy is concerned; however, as the same ditchriders have made the estimates used, it may be that errors are compensatory, and the trends indicated are consequently a fair indication of actual conditions.

Diversions from the river into the four main canals are metered five times per week, and estimates made for the other two days from staff gages. Three small laterals diverting from the river at various times are estimated on a daily basis by ditchriders.

Tributary inflows resulting in flood water at Leasburg Dam are determined from records of time and duration of inflow by ditchriders and other project personnel by observation of rising and falling stages at Leasburg Dam, and frequent metering of flow. From these data the flood flow at Leasburg is determined from the recorder charts, and records modified to reflect this inflow.

The study, using the data of the above-described records, covers the period from January, 1946, through December, 1951. They are tabulated in second-feet by days for the six years, and for the river reaches from Caballo Dam to Leasburg Dam, and from Leasburg Dam to El Paso. The tables give the flow at the upper end of each reach; diversions, flood inflow, and return flow within the reach; theoretical and actual at the end of the reach; and the difference between theoretical and actual flow, as a loss or gain in flow, which is also summarized by 10-day moving averages. Detail tabulations are shown in Tables 1 to 144 in Appendix, Part I; also, in graphical form on Drawings No. 23-503-5416 through 23-503-5427 in Appendix, Part I. Also, these data, except for the 10-day moving average, are summarized in acre-feet by months for the six year period in Tables 145 through 156 in Appendix, Part I.

A summary of river loss in acre-feet by months for the six year period is shown in Tables 157 through 159 in Appendix, Part I, for the two reaches, and in addition for the overall reach from Caballo Dam to El Paso. These are summarized by years as follows:

TX_MSJ_006131

ANNUAL ESTIMATED RIVER LOSSES 1/
(Acre Feet)

Year	Reach: Caballo Dam to Leasburg Dam	Reach: Leasburg Dam to El Paso	Reach: Caballo Dam to El Paso
1946	18,485	-19,958	-1,473
1947	-708	-12,447	-13,155
1948	-14,270	-46,290	-60,560
1949	8,557	-34,790	-26,233
1950	14,532	-46,878	-32,346
1951	-10,253	-61,165	-71,418

1/ Minus denotes loss and plus gain in flow.

It will be noted that the river loss for 1951 is greater than for any other of the five years with the exception of 1948 for the reach Caballo Dam to Leasburg Dam, and then it is exceeded by only 4,000 acre-feet. It would seem reasonable that with a greater annual release from caballo, that the losses would be greater since wetted perimeter and water areas are increased, but for 1951 the Caballo reservoir release was about 40 percent less than any of the previous five years, and yet the losses greater. This increased trend may be an indication of increased losses due to partial depletion of the subsurface water by pumping. The average loss in second-feet per mile per day corresponding to acre-feet in Tables 157 through 159 is tabulated in Table 160 in Appendix, Part I. The loss per mile per day during 1951 is about twice that for the average 1946-51 period, and is greater in 1951 than any of the previous five years. During the irrigation months, March to October, the loss per mile per day during 1951 is from 10 to 35 percent more than for the whole year for the three reaches considered. This is to be expected, since losses are greater during periods of release.

There is presented in detail in Table 161, in Appendix, Part I, the foregoing data. Also, for comparison purposes, the annual averages for 1938-41 and 1942-45 are presented. However, river losses prior to 1946 are not comparable to the period 1946-50, as canalization of the river was not effective in the earlier years.

The estimates of waste, are questionable as to accuracy; however, as previously pointed out, these are likely to be compensated for when several months' or several years' records are totaled. The arroyo runs, or flood inflow to the river during the summer, probably also influences conclusions due to lag, bank storage, and observational errors.

Flood inflows between Caballo and Leasburg occurred a minimum of 4 days during 1948 and a maximum of 26 days during

TX_MSJ_006132

1950, for which the volume of flood flow was a minimum in 1948 and a maximum in 1950. Days for which adjustments were made at Leasburg Dam to compensate for flood inflow is shown together with other flood data in Tables 162 through 166, in Appendix, Part I, for the years 1946-51. In summary the flood inflow additions range in minimum from 1,152 acre-feet to a maximum of 17,172 acre-feet.

There are other factors that effect river losses such as precipitation, evaporation, consumptive use, and slope of the sub-surface water table which in turn is influenced by pumping. However, these factors do not create large differences from year to year. These factors are considered in inflow-outflow studies in this report.

A comparison of flows at several river stations, and the depletion between them is shown in Table 167, in Appendix, Part I. This depletion should not be confused with river losses, as no consideration is given to inflow and outflow within the reach. It shows the percent of flow of the downstream station to the upstream station for the three reaches and that it is about the same for the years 1946-50, and that there is a decrease in 1951. Also, the percent of depletion to the flow at either the beginning or end of the reach has the same trend, but increasing. This may indicate that there is either more diversions, less return flow (increased consumptive use), excessive seepage, or a combination of any or all of these conditions in 1951.

Drain Return Flow

Drain return flow by days, months, and years is tabulated in Tables 1 through 156, and summarized as follows:

	Acre-Feet Per Year		
Year	Caballo to Leasburg	Leasburg to El Paso	Caballo to El Paso
1946	33,483	250,355	283,838
1947	29,143	216,916	246,059
1948	28,981	216,320	245,301
1949	33,742	237,088	270,830
1950	33,639	230,122	263,761
(Avg. 1946-50)	31,798	230,160	261,958
1951	16,671	131,946	148,617
(% 1951 of Avg.)	52	57	57

It will be noted that the drain return flow for 1951 was more than 40 percent less than the average of the preceding five years for the three reaches. Also, it is about the same percent

TX_MSJ_006133

less than for the lowest of any of the five years. For comparison of releases to drain return flow the following is shown:

RIVER DISCHARGE COMPARED TO DRAIN RETURN FLOW
(Acre-feet per year)

	Caballo to Leasburg			Leasburg to El Paso			Caballo to El Paso		
Year	Caballo Release	Drain Flow Caballo to Leasburg	% Drain of Caballo	Flow Above Leasburg	Drain Flow Leasburg to El Paso	% Drain of Leasburg	Caballo Release	Drain Flow Caballo to El Paso	% Drain of Caballo
1946	763,759	33,483	4.4	734,821	250,355	34	763,759	283,838	37
1947	724,932	29,143	4.0	686,132	216,916	32	724,932	246,059	34
1948	741,189	28,981	3.9	686,650	216,320	32	741,189	245,301	33
1949	712,247	33,742	4.7	689,974	237,088	34	712,247	270,830	38
1950	719,347	33,639	4.7	709,016	230,122	32	719,347	263,761	37
1951	469,716	16,671	3.5	432,044	131,946	31	469,716	148,617	32

The percent of drain return to flow at the beginning of each reach is less in 1951 than for any of the previous five years, and is 11 percent less than the average of the preceding five years for the reach Caballo to El Paso, 19 percent less for the Caballo to Leasburg reach, and from Leasburg to El Paso is 5 percent less.

It would be expected that extensive pumping and smaller canal diversion from the river would result in (a) lower drain discharge, (b) almost immediate increased seepage loss from river to wells lying within 2,000 feet or less of the river or drain, (c) reduction in ground-water elevation.

Condition (a) would also follow from decrease in canal diversions and resulting decrease in delivery to farms and reduced seepage from canals and laterals, as well as reduction in flow at drains due to pumping. Condition (b) would be expected to result from the increased seepage opportunity from the river due to the increased gradient following initiation of pumping operations. Condition (c) would follow in course as a direct result of the two foregoing conditions.

Determining in part the result of lower diversions and drain discharge is summarized in Table 168, in Appendix, Part I.

The data for the Rincon Valley shows that diversions in 1951 was 61 percent of the average for the five previous years, and drain flow was 52 percent; this shows that the drain flows in 1951 were less in proportion to diversions for that year than for the previous five years. Examining the percentage for the period in 1951, it is noted

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drain flow was 30 percent of net diversions and averaged 34 percent for the previous five years. The difference is small, but may reflect the effect of increased pumping, or increased consumptive use.

In the Mesilla Valley the diversions during 1951 were 58 percent of the average of five previous years while drain discharge was 57 percent. Thus, in the Mesilla Valley, the inference is there was no material percentage reduction in drain flow due to pumping, but it is probable other factors, such as greater direct seepage from the river, enter that affect the apparent maintenance of balance between diversions and drain flows. The drain flow from the Mesilla Valley in 1951 was 47 percent of the net diversion and averaged 48 percent for the previous five years.

The diversions in 1951 were about 40 percent less than the five previous years, and seepage losses from canal and laterals about 35 percent less; consequently, it is possible that drain return continued on about a normal ratio, but seepage loss as compared with diversions was a much higher ratio. If this is tenable, then there was an effect of pumping that was actually in part absorbed by the high seepage from the canals and laterals and seepage from the river. In other words, had no pumps been operating with the same amount of diversions being made in 1951, the seepage loss could have been much less.

Another hypothesis explanation of the drain-diversion ratio being as high as it was in 1951, is that pumping during the first half of 1951 caused a temporary lag in reduction in drain flow by, in effect, holding water in a transition state. If this is the case, then it may be expected that at some time in the future a rather abrupt change in drain flows will occur, with a corresponding change in subsurface water table.

There was less drain return flow at El Paso in 1951 than any of the previous five years, which should have resulted in a better quality of water below El Paso, since drain water contains more dissolved solids than river water. However, as has been noted in years in which storage was low, the river water contained more dissolved solids at Caballo. It will be noted in the following tabulation that the quality of water at Caballo and El Paso contained more salt in 1951 than for any preceding year, but the difference between these two stations is less than for any of the five previous years, which indicates less percent return flow with regard to release.

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Year	Tons Salt per Acre-Foot Discharge: El Paso	Below Caballo	Difference
1946	1.11	.64	.47
1947	1.12	.74	.38
1948	1.13	.76	.37
1949	1.02	.60	.42
1950	1.05	.62	.43
1951	1.23	.96	.27

Subsurface Water Table - Mesilla Valley

There are about 40 test wells in the Mesilla Valley that have been read monthly since about 1918. Only 38 of these have been continued since 1946. The records for these are shown in Tables 169 through 174, in Appendix, Part I, and location of each is shown on Drawing No. 25-503-5314, "Location of 40-Test Wells - Mesilla Valley" in Appendix, Part I. In addition, Drawing No. 23-503-5452, in Appendix, Part I, shows in graphical form the monthly and annual average depth to water for 38 test wells for the years 1946-51. Since 1946 the water table has been declining, but there is an abrupt change since April of 1951, when the water table declined rapidly. The annual average depth to water for 38 test wells together with annual difference follows:

TEST WELLS MESILLA VALLEY

Year	Feet: Annual Average Depth to Water For 38 Test Wells	Annual Difference
1946	6.91	
		.16
1947	7.07	
		.13
1948	7.20	
		.05
1949	7.25	
		.19
1950	7.44	
		.96
1951	8.40	

The annual difference in decline of water table for 1950-51 is over seven times greater than for the average differ-

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ence for the years 1946-50. It may be deducted from this rapid decline in subsurface water table that irrigation pumps have effected it, for the approximate date of lowering coincides with pumping. Actually, the amount of water pumped is much greater than indicated by lowering of the water table, since recharge was taking place during pumping, but at a reduced rate in 1951 as compared to the previous five years. Records of the 38 test wells from 1940-45 show that the subsurface water table in 1940 was about the same as 1948 and was rising from 1940 to 1942, and that it has been gradually declining every since. The reservoir spilled in 1942 and there was more water in the river than in previous years, which accounts for the high water table that year.

Eleven test well lines were established during August, 1951, which ran normal to the river to the first drain intercepted. Their location is shown on Drawings No. 23-503-5103, "Location of Test Well Lines No. 8 to No. 11 - Rincon Valley," and 23-503-5314, "Location of 40 Test Wells and Test Well Lines No. 1 to No. 7 - Mesilla Valley", both in Appendix, Part I. These lines were installed for use in observing subsurface water table for continued below-normal storage operations, and for data needed for river operations. These data are detailed in Table No. 175, in Appendix, Part I, and shown on profile Drawing No. 23-503-5454, consisting of five sheets in Appendix, Part I, which also shows logs of test wells. Water surface in the river and test wells was taken during the last half of October, 1951, while there was release flow in the river and again during February, 1952, when no releases were being made. There is a definite slope of the subsurface water table from the river for the 1951 readings, except for two instances: one is on the West side of the river at Line 2 and is likely influenced by a main canal between the river and the drain; the other is on the East side of the river at Line 9, which may have been influenced by local irrigations. The drop in subsurface water table between October and the February readings is normal, since there is very little water in the river during the winter months to recharge the ground-water. The ground-water slope was from the river in most cases even in February; however, the slope was less in most instances than in October. This shows that the rate of loss from the river has some relationship to amount of flow, and increases with greater river discharge.

- INFLOW - OUTFLOW STUDY -

The preceding records of this report are sufficient to make an inflow-outflow study. While such a study is not required in connection with river losses it is desirable, as the

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criteria used in the loss studies can be used in inflow-outflow use studies to proceed with the determination of use by the inflow-outflow method.

Inflow and outflow consists of determining all inflow which includes river flow, flood inflow, precipitation, and decrease in ground-water storage. Outflow consists of river flow at lower end of reach, evaporation from river water surface, and increase in ground-water storage.

River flows are available in preceding tables for years, months, and days for the years 1946-51. Precipitation and evaporation records by months for the same period are listed in Tables 176 through 181, in Appendix, Part I. Valley areas within the irrigable limits were planimetered, as well as river channel areas. It was necessary to apply some adjustments and criteria to the records presented and these are discussed.

Precipitation

Precipitation records from the Rincon Valley were taken as the average of the Caballo and Hatch Stations, and in the Mesilla Valley the average of Leasburg Dam, Las Cruces, Agricultural College, Mesilla Dam, Chamberino, La Tuna, and La Union Stations. Yearly averages are presented below:

AVERAGE ANNUAL PRECIPITATION
(Inches)

	Period						
Valley	1946	1947	1948	1949	1950	Average 1946-50	1951
Rincon	7.07	4.92	7.25	9.85	7.35	7.29	5.31
Mesilla	7.10	6.19	5.44	9.02	6.22	6.79	4.55

The 1951 precipitation is about 70 percent of the previous five year average, which would result in less inflow of about 4,400 acre-feet for the Rincon Valley and about 20,100 acre-feet for the Mesilla Valley during 1951. Valley and river channel acreage was determined to be 26,840 acres in the Rincon Valley and 107,951 acres in the Mesilla Valley. Not all rainfall is effective in satisfying consumptive use, but it is so considered here. Part may evaporate, some will run off, and some will be deep percolation.

Evaporation

Evaporation for both valleys was taken as the average for the Caballo Dam and Agricultural College Stations by months for the period 1946-51. Records are recorded for pan evaporation and these

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adjusted to actual by multiplying by 0.7. It was assumed that during days when there were no river releases the evaporation surface is 70 percent of river channel area, and for days releases are being made, the total channel area was used. The river channel in the Rincon Valley comprises 1,719 acres, and 1,847 acres in the Mesilla Valley. Annual summary of evaporation follows:

TOTAL ANNUAL EVAPORATION
(Inches)

	Period						
Valley	1946	1947	1948	1949	1950	Average 1946-50	1951
Rincon & Mesilla	105.8	107.3	111.7	101.1a/	114.1b/	108.0	112.9a/

a/ Record for Caballo Dam Station not complete.
b/ Record for Agricultural College Station Not complete.

Evaporation for 1951 is slightly greater than the average of the previous five years, which would indicate a decrease in outflow for 1951.

Ground-water

Previous data regarding the 38 test wells in the Mesilla Valley is the only information available regarding fluctuations in subsurface water table. The average monthly differences in water table for these wells were used for both the Rincon and Mesilla Valleys. Test wells have been installed in the Rincon Valley, and at some later date a correlation might be made between the two valleys. Area of ground-water storage is considered to be the valley area less the river channel. Acreage for the Rincon Valley is 25,121 and 106,104 for the Mesilla Valley. The coefficient of yield is considered as 15 percent.

Inflow and Outflow

Computations using available records to determine inflow and outflow by months for the years 1946-51 and for both the Rincon and Mesilla Valleys are shown in Tables 182 through 193, in Appendix, Part I, and are detailed by years in Table 194, in Appendix, Part I, together with source of consumptive use. The difference in inflow and outflow represents the gross valley area consumptive use. The percent source of consumptive use from the river for 1951 is about the same as the previous five years; the percent source of consumptive use from precipitation for 1951 is about the same as the lowest of any of the previous five years, but much lower than the average for this period; but the percent source of consumptive use from ground-water is much more in 1951

TX_MSJ_006139
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than for any of the previous five years, or the average of same. Thus, it might be reasoned that since the subsurface water in 1951 supplied a greater percentage of the total consumptive use than for any of the previous five years, that irrigation wells were instrumental in this increase. This is further confirmed, since there was not an increase in percent inflow from the river, or rainfall.

Consumptive Use

While not pertinent to a study of river loss, it is so closely related as to data used that it is given here in order to develop the probable influences on increased seepage from the river resulting from pumpage.

Annual consumptive use requirements as determined by the inflow-outflow method are compared with the amount of water charged to farms. However, it should be understood that water charged to farms is actual amount delivered from the main distribution system and includes farm ditch loss, deep percolation, and often waste from fields and farm ditches into drains. Therefore, the water charged to farms should be much more than Valley consumptive use requirements determined by the inflow-outflow method. Valley consumptive use represents plant transpiration and evaporation, or only the actual amount of water used in plant growth and evaporation from the entire area. Annual consumptive use and water charged to farms are shown for the period 1946-51 in Tables 195 and 196, in Appendix Part I, and summarized as follows:

EFFECTIVE CONSUMPTIVE USE IRRIGATION WATER
(Feet Per Year)

Valley	By Inflow-Outflow Method		By Water Charged To Farms	
	Avg. 1946-50	1951	Avg. 1946-50	1951
Rincon	1.14	1.36	2.34	1.40
Mesilla	2.17	1.89	2.76	1.55

It will be noted that the previously described criteria is satisfied for the average of the period 1946-50. That is, the consumptive use amounts are less than actual charges to farm. Also, that as suspected, the inflow-outflow results for consumptive use in the Rincon Valley differ greatly from those in the Mesilla Valley, and it can be assumed that consumptive use by the inflow-outflow method in the Rincon Valley is misleading under the conditions assumed. This may be due to the fact that ground-water conditions differ in the two valleys and not the same as assumed. Also, other factors could contribute to this difference, such as: (a) Flood inflow corrections made for the Rincon Valley may not take into

TX_MSJ_006140

account total flood inflow due to lag in surface flow and bank return flow; (b) there is 10 percent less valley area irrigated in the Rincon Valley; (c) seepage or ground-water recharge from adjoining mesa lands to the valley may be different; (d) seepage from Caballo Dam to the ground-water table may be sufficient to account for a difference; (e) and farm waste and deep percolation may be different.

The inflow-outflow method and water charged to farms for 1951 do not agree with the above criteria. In fact, the reverse is the case. That is, water charged to farms is less than consumptive use requirements in the Mesilla Valley. This is perhaps due to the operation of the irrigation wells in pumping from the underground supply.

Water Pumped

During 1951, there were drilled and installed in the Rincon and Mesilla Valleys some 626 irrigation wells. The Project through its Watermasters, Ditchriders, and Patrolmen kept records of all water pumped insofar as it could be obtained. There were many instances where such was not available from the water user and had to be estimated. These amounts follow:

Source Data	Amount Water Pumped, 1951	
	Rincon Valley	Mesilla Valley
Actual by records and estimates (Acre-feet)	17,810	77,580
Actual by records and estimates (Feet)	1.06	0.92

If the above records and estimates of water pumped are added to the water charged to farms, it should give an amount that would compare to water charged to farms if 1951 had been a normal year, this since crops were about normal that year. These follow together with averages for 1946-50 period:

Valley	Feet for 1951			Average 1946-50 Water Chg. to Farms
	Water Charged to Farms	Estimated Pumped Water	Total of Pumped & Charged to Farms	
Rincon	1.47	1.06	2.53	2.60
Mesilla	1.63	.92	2.55	3.07

The above shows that about the same amount of water was used in both Valleys for irrigation in 1951, and that this amount would about satisfy the average requirements for irrigated land during a water short year. This further confirms the foregoing data and state-

TX_MSJ_006141

ments pointing to depletion of subsurface water by irrigation well pumping, and acknowledgment of same gives reason to believe that such was the cause of increased river losses in 1951.

Based on records and estimates of water withdrawn by irrigation wells, the decrease in ground-water storage for 1951 would be about as follows:

Valley	Record & Estimated Water Pumped (A.F)	Recharge to Ground-water: Approximates: River Loss (A.F.)	Decrease In Ground-water Difference Column 1 & 2 (A.F.)	Decrease in Ground-water Specific yield 15 percent (feet)
Rincon	17,810	10,250	7,560	2.00
Mesilla	77,580	60,980	16,600	1.04

The above value of 1.04 feet for the Mesilla Valley agrees closely with that observed in 38 test wells in this valley of 0.96 feet. The decrease for the Rincon Valley is about twice that for the Mesilla Valley and this accounts for the inflow-outflow method in the Rincon Valley being low, since only about half the ground-water decrease as shown above was assumed.

- RIVER SEEPAGE INVESTIGATION -

Two detailed river seepage investigations have been made: one during June, 1951, for a nine mile section of the Rio Grande within the reach between Canutillo and El Paso; the other during January and February, 1952, for that section of the Rio Grande between the American Dam and Island Station, a distance of about 27 miles.

Seepage Loss, Canutillo to El Paso

The field investigation was made on June 6 to 14, inclusive, and at a time when river discharge was low. Automatic recorders were used at the beginning and end of the reach with daily current meter measurements being made. Very careful measurements were made at frequent intervals to determine river water surface areas; also, to determine kind and quantity of vegetation in the flood-plain. A summary of the river area and vegetation surveys follows:

RIVER SECTION BETWEEN CANUTILLO-EL PASO

Length of Reach (Miles)	River Channel Areas - (Acres)		
	River Water Surface	Sandbars	Flood-Way
9.09	183	37	300

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RIVER SECTION BETWEEN CANUTILLO - EL PASO
VEGETATION SURVEY
(Acres)

Length of Reach (Miles)	Salt Cedar	Salt Grass	Mesquite	Tules	Willows	Woods	Cotton-woods	Bare Land
9.09	53	186	5	3	15	34	3	1

Consumptive use for the various types of vegetation for the year 1936 is available (1/) and these have been used and adjusted for the difference in consumptive use requirements for 1936 of 2.76 feet and 2.81 feet for 1951, and the percentage of June consumptive use to annual for 1936 of 13.25 percent used to determine that for June, 1951. These data follow:

CONSUMPTIVE USE IN FEET

Item	Annual C.U. 1936	Annual C.U. 1951	June, 1951 (13¼% of Annual)	For June 6-14 (9 days)
Valley	2.76	2.81	.37	.11
Trees (Cottonwood & Willows)	4.8	4.9	.65	.20
Brush (Mesquite)	2.8	2.8	.37	.11
Tules	7.8	7.9	1.05	.31
Grass (Weeds)	2.5	2.5	.33	.10
Salt Grass	4.2	4.3	.57	.17
Salt Cedar 2/	7.9	8.0	1.06	.32
Bare Land	0.7	0.7	.09	.03

1/ Regional Planning, Part VI - The Rio Grande Joint Investigation in the Upper Rio Grande Basin in Colorado, New Mexico, and Texas; 1936-37; p. 424.
2/ Use of Water by River Bottom Vegetation in Lower Safford Valley, Arizona; by J. S. Gatewood, et. al. (Average of 1933-34).

From the above consumptive use requirements and acreage of various vegetation, the total loss in the reach is computed and follows:

CONSUMPTIVE USE IN REACH FOR JUNE 6 THROUGH 14, 1951
(Acre-Feet)

Length of Reach (Miles)	Salt Cedar	Salt Grass	Mesquite	Tules	Willows	Woods	Cotton-woods	Bare Land	Total
9.09	17.0	31.6	0.6	0.9	3.0	3.4	0.6	0.0	57.1

Evaporation is taken as the average for the Agricultural College, New Mexico, and Ysleta, Texas, Stations for June of 1.3 feet. For the 9 days in June, 6-14, this would amount to 0.39 feet pan evaporation or 0.27 feet actual evaporation. Evaporation from sandbars is considered to

TX_MSJ_006143
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be the same as for free water surface. Total evaporation in reach is therefore (0.27 x 220), 59.4 acre-feet.

Data for and computation of river loss follows:

RIO GRANDE SEEPAGE INVESTIGATION - JUNE 6-14
(Acre-feet)

Total Discharge Beginning Reach	Total Discharge End Reach	Depletion in Reach	River Evaporation	Consumptive Use	River Loss	Second Foot Per Day Per Mile
6,583	5,732	851	59.4	57.1	735	4.53

The loss per day per mile of 4.53 compares to the average for 1951 for the reach Leasburg Dam to El Paso of 1.41 second feet per day per mile. Also the losses per day per mile for the river in Mesilla Valley for June were greater than any other month. River Loss for June follows:

RIVER LOSS MESILLA VALLEY - JUNE 1951 - ACRE-FEET

Total Loss Mesilla Valley	River Evaporation	Consumptive Use 1/	River Loss	Second Feet Per Day Per Mile
12,140	1,861	1,260	9,019	5.05

1/ Based on same rate per mile per month, as for the reach Canutillo to El Paso.

During the period June 6 to 14, the river was fluctuating slightly in flow with consequent gains and losses (See Drawing No. 23-503-5427, in Appendix, Part I.) Starting about one month prior to June 6 reservoir releases were very small and consequently losses were small. After June 14 river releases were increased and river flow increased, and was greater for the balance of the month than prior to June 14. Consequently, losses were greater with a larger flow in the river and this partly explains the difference in loss per mile for the Mesilla Valley in June and that portion between Canutillo and El Paso from June 6-14. Precipitation was zero during June and had no effect on this study.

Seepage Loss, American Dam to Island Station

A report of this investigation was prepared and is presented in its entirety, together with Table 197 through 201, in Appendix, Part I, and follows:

RIVER LOSS EL PASO - ISLAND STATION

During January and February, 1952, a seepage investigation

TX_MSJ_006144

was undertaken on a reach of the Rio Grande between "Below American Dam" Station and "Island Station." This section of the Rio Grande extends from just above El Paso, Texas, for a distance of about twenty-seven miles downstream. The river, throughout this entire course, is bounded on the north by El Paso County, Texas, and on the south by the Republic of Mexico.

The investigation was divided into two separate parts. The first portion was a detailed and comprehensive investigation of the entire reach of the river under study and was conducted over a period of six days. The second phase of the investigation lasted an entire month, but a smaller section of the river reach was investigated.

The flow of the Rio Grande, during the period of the investigation, was drainage return flows from that portion of the Mesilla Valley lying below Leasburg Dam, New Mexico. The discharge of the Rio Grande at the Below American Dam Station was fairly uniform from day-to-day with a slow downward trend throughout the entire period of the investigation.

Climatic conditions that prevailed during the period of the investigation were generally favorable. There were no unusual climatic conditions during the first phase of the investigation that would preclude accuracy of determinations or measurements. There was some precipitation and fairly high wind during the second phase of the investigation, but it is felt that there was little or no resultant effect upon accuracy of determinations.

A general description of all river stations where observations were made are as follows:

(a) Below American Dam Station - This station lies 3,200 feet downstream from the American Dam. An automatic water stage recorder, river gage, and cable-car measurement facilities are maintained by the United States Section of the International Boundary and Water Commission. This station is the inflow station for the purpose of this investigation.

(b) Juarez Station - The Juarez Station is approximately 7.0 river miles downstream from the American Dam. An automatic water stage recorder, river gage, and cable-car measurement facilities are maintained by the Mexican Section of the International Boundary and Water Commission.

(c) Intermediate Station - The Intermediate Station is a temporary station placed approximately half-way between the Juarez Station and the Riverside Heading. It is approximately 12.9 river miles below the American Dam. There was no water stage recorder at this station, the only installation being a river gage.

(d) Riverside Heading Station - This station was located 1,000 ft. upstream from the Riverside Heading and is approximately 16.5 river miles below the American Dam. For the purpose of this

TX_MSJ_006145

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investigation a water stage recorder and river gage were installed. For the second part of the investigation the flow past this station was computed using the discharge of the Riverside Canal at Heading and the Rio Grande immediately below the Riverside Heading.

(e) Island Station - The Island Station is 27.1 river miles downstream from the American Dam. An automatic water stage recorder, river gage, and cable-car measurement facilities are maintained by the United States Section of the International Boundary and Water Commission.

Determinations were also made on quantities of water pumped into or from the Rio Grande between the Below American Dam Station and the Island Station. A list of all outfalls and intakes to or from the river is as follows:

(a) City of El Paso Water Treatment Plant. The City of El Paso Water Treatment Plant lies approximately 3.2 miles below or downstream from the American Dam. All water pumped either from or into the Rio Grande is measured through meters and accurate determinations may be made as to quantities.

(b) El Paso Electric Company Santa Fe Street Plant Outfall. This outfall enters the river 3.3 river miles below the American Dam. No flow was observed at any time from this outfall.

(c) Peyton Packing Company Outfall. This outfall enters the river 5.7 miles below the American Dam. Current meter observations were taken at this point and estimates as to discharges were based upon these measurements and information received from Payton's plant engineer.

(d) El Paso Sewage Outfall. This outfall enters the river 6.6 river miles below the American Dam. Current meter observations were taken in the outfall. Discharges were computed upon Parshall meter readings furnished by the Department of Water and Sewerage - City of El Paso.

(e) El Paso County Water Control and Improvement District No. 1 Sewage Outfall Nos. 1 & 2. These two outfalls, although being several miles apart, enter the river between Juarez Station and Riverside Heading. The separate daily discharges were furnished by the District Manager. It was impossible to make any type of current meter observation at either plant.

The first phase of the investigation was conducted from January 24th through January 29th, 1952. All river stations, El Paso Sewer Outfall, and Peyton Packing Plant Outfall were measured, by means of current meters, twice each day for the 24th, 25th, 28th, and 29th of January. These measurements were made by two separate

TX_MSJ_006146

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parties, one party measuring each station once per day. Rating curves were made, on the basis of the current meter measurements, for the Below American Dam, Juarez, Riverside Heading, and Island Stations. Mean daily discharges were computed for the above four stations from water stage recorder charts. Quantities of water pumped either to or from the river between stations, were balanced and the remaining net quantity added to river discharges. In most cases, withdrawals from the river were exceeded by waters pumped into the river. Table No. 197 gives a complete summary of discharges of outfalls and intakes, actual losses or gains, and indicated losses or gains.

Table No. 197 indicates that withdrawals from the river between Below American Dam Station and Juarez Station were roughly balanced by the amounts of water pumped into the river. Indicated seepage losses (Column 11) were 4.8 percent of Indicated Total Inflow (Column 9). With discharge relationships held fairly stable throughout this particular reach, seepage losses should not be excessive. Losses from all sources were found to be 0.53 c.f.s. per river mile within this reach.

Table No. 198 indicates the discharge relationships between the Juarez Station and the Riverside Heading. Total losses between these two stations were considerably higher than losses between Below American Dam Station and Juarez Station. It is felt that the "Dren De Interseptacion," which parallels the Rio Grande on the Mexican side from just upstream from the Juarez Station to below the Island Station, and the Playa Intercepting Drain, which parallels the Rio Grande on the United States side from just above the Juarez Station to just above the Riverside Heading, was a large contributing factor in the increased seepage losses between Juarez Station and Riverside Heading. Losses from all sources between these two stations averaged 1.74 c.f.s. per mile or 28.1 percent of total flow past the Juarez Station.

Table No. 199 gives the discharge relationships between the Riverside Heading and the Island Station. There was neither side inflow to nor pumpage or diversion from the river between these two stations. The river is paralleled on the Mexican side by the "Dren De Interseptacion" throughout the entire reach. On the United States side the river is paralleled by the Riverside Intercepting Drain throughout the entire reach to Island Station. However, approximately 2.4 miles downstream from the Riverside Heading, the Riverside Canal approaches the river and runs parallel to it past Island Station. At the point where the Riverside Canal parallels the Rio Grande, the Riverside Intercepting Drain crosses under the Riverside Canal and runs parallel to the canal past Island Station. Losses from all sources were found to average 1.42 c.f.s. per mile. This is a reduction of 0.32 c.f.s. per mile from the river reach between Juarez Station and Riverside

TX_MSJ_006147
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Heading. Total losses from all sources were 35.2 percent of total flow past Riverside Heading and 55.7 percent of total inflow to river.

Table No. 200 is a summary of Tables No. 197, 198, and 199 and gives the discharge relationship of all river stations from Below American Dam Station through Island Station. It will be noted that 55.7 percent of the total waters were lost between the upper and lower stations. Of this total loss of 413.97 A.F. out of 742.83 A.F., evaporation losses were 7.26 A.F. Transpiration losses were considered to be of infinitesimal quantity and were not calculated separately, but are included in seepage loss figures.

In conclusion, the results of Phase 1 of this investigation seem to indicate that: (1) The sector where the largest loss per mile occurs is between Juarez Station and Riverside Heading, where the loss is shown to be 1.74 c.f.s. per mile of river. (2) The loss per mile of river between the American Dam and the Juarez Station was 0.53 c.f.s.

The second phase of the investigation was conducted between the Juarez Station and Riverside Heading from January 30, 1952, through February 29, 1952.

Inflow quantities at Juarez Station were computed from a print of the water stage recorder chart furnished by the International Boundary and Water Commission. Weekly current meter observations were made at this station.

Pumpage to the river from the El Paso County Water Control and Improvement District No. 1 Sewage Plants Number 1 and 2 was estimated on the basis of figures furnished by the District Manager.

Discharge at the Riverside Heading was computed using the water stage recorder record from the temporary recorder installation, used for part one of the investigation, until 10:00 a.m., February 1st. At that time the river gates were closed and the water was diverted into the Riverside Canal. The discharge was then computed from the Riverside Canal water stage recorder record and daily current meter observations on the amount of leakage to the river through and under the river gates at the heading. (The Riverside Canal, just below the heading, has a gage and an automatic water stage recorder, which is in continuous operation.) Daily current meter observations were also taken on the Riverside Canal.

Evaporation losses were computed from daily evaporation observations taken at the U.S.B.R. yards in Ysleta, Texas. Transpiration losses were not figured separately, but are included in

TX_MSJ_006148

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the seepage loss determinations.

Table No. 201 gives the discharge relationship between the Juarez Station and the Riverside Heading for the period January 30 - February 29, 1952. Total losses amounted to 25.5 percent of total indicated inflow. This compares with a 28.1 percent loss between the two stations during the 6 day period of the first part of the investigation. Loss per mile was found to average 1.40 c.f.s./mile. This is compared with 1.74 c.f.s./mile for the first part of the investigation.

The results of Part 2 of the investigation substantiate the results of Part 1. The loss per mile figures are somewhat different, but this determination will tend to vary with the amount of discharge or the wetted perimeter of the section. The actual discharges at Juarez Station for Part 1 of the investigation averaged 58.2 c.f.s., and 52.4 c.f.s. for Part 2. However, total losses were found to be somewhat lower than indicated by Part 1 of the investigation. In any event, a loss of between 25 - 28 percent of total inflow is quite serious in such a short river reach. At higher flows the loss percentage would likely decrease somewhat and at lower flows the percentage would tend to increase.

The investigation (Part 1 and Part 2) clearly indicates that the losses from Juarez Station downstream to Island Station are excessively high. This condition is quite serious, as a large quantity of Project irrigation waters are transported in the river from the American Dam to Riverside Heading.

The reach from Juarez Station to Riverside Heading and from this heading to Island Station may be comparable to parts of the Mesilla Valley. Also the reach from American Dam Station to Juarez Station may be comparable to at least a portion of the Rincon Valley. For these reasons, the river loss per mile, as are available, are compared below:

		Second-feet Per Day		Per Mile		
Valley	Reach	1951	Jan. 24-29, 1952	Jan.30-Feb.29 1952	June 1951	June 6-14 1951
Rincon	Caballo to Leasburg	0.32				
El Paso	American Dam to Juarez Station		0.53			
Mesilla	Leasburg Dam to El Paso	1.41			5.05	
El Paso	Juarez to Riverside		1.74	1.40		
El Paso	Riverside to Island		1.42			
Mesilla	Canutillo to El Paso					4.53

TX_MSJ_006149

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Part II.

Irrigation Wells

Inventory of Irrigation Wells

Irrigation wells in large numbers have not been necessary on the Rio Grande Project since storage began in 1915 until the threatened shortage at the close of 1947. During the fall-winter of 1947-48 a total of 70 wells were drilled above El Paso for irrigation purposes; fortunately the run-off in 1948, together with the 1947 carry-over, permitted almost normal irrigation. Irrigation well development has been taking place on the benches and mesas on both sides of the river between Caballo Dam and El Paso since about 1946. As of December 31, 1951, there were about 79 of these wells. It is not improbable that this bench and mesa development may be intercepting underground water previously reaching the river.

The critical water shortage that developed in 1951, and the necessary allotment of irrigation water on the Project which drastically reduced the normal usage from 3.1 acre-feet per acre to 1.75 acre-feet per acre, was the cause of extensive well drilling during the season. This drilling program began almost overnight, and continued at a rapid pace throughout the irrigation season. As of December 31, 1951, there were 893 irrigation wells on the Project and located as follows:

IRRIGATION WELLS RIO GRANDE PROJECT
(December 31, 1951)

Valley	Within Valley	Benches & Mesa	Total
Rincon	149	21	170
Mesilla, N.M.	431	52	483
Mesilla, Texas	46	6	52
Mesilla	(477)	(58)	(535)
El Paso	188	0	188
Totals	814	79	893

Drawings No. 23-503-5103, 23-503-5396, and 23-503-5389, in Appendix, Part II, for the Rincon, Mesilla, and El Paso Valleys, respectively, show the location of all wells to May 1, 1952. Number of wells installed between January 1, and May 1, 1952, follow.

TX_MSJ_006150

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IRRIGATION WELLS RIO GRANDE PROJECT
(Installed Between Jan. 1, and May 1, 1952)

Valley	Within Valley	Benches & Mesa	Total
Rincon	9	0	9
Mesilla, N.M.	37	0	37
Mesilla, Texas	7	0	7
El Paso	32	1	33
Totals	85	1	86

As of May 1, 1952, there were 979 wells on the Project.

Statistical data regarding the wells installed up to January 1, 1951, are a part of this report, together with the effects of irrigation well pumping on river and drain flow.

Effect of Irrigation Wells on River And Drains

Irrigation wells in the Rincon and Mesilla Valleys derive their flow from the water in the aquifer below the valley floor. The water in this aquifer is recharged partly by storage water released into the river, canals, laterals, and to a minor extent in certain sections, from the mesa and hill areas bounding the valley. Release of storage water and its use in a major manner recharges this aquifer and is evident by the annual rise and fall of the water table, and the discharge of the drains. Similarly by pumping from this aquifer the subsurface water table is lowered if the pumping exceeds the recharge, and is made evident by a greater depth to the static water table, and decreased drain flow. Since pumping from the aquifer lowers the subsurface water table, it naturally increases the recharge from all sources as the slope of the hydraulic gradient is greater in the direction of the pumping wells. On the other hand, if opportunity for recharge is ample, such as from the river or drains, lowering of the water table may not be excessive for one or more reasons.

That portion of recharge of the aquifer that comes from the river or drain is the primary object of the discussions that follow. They show by means of formulas the portion of pumped water diverted from the river or drain. The formulas have resulted from many underground water investigations with particular determinations of permeability, transmissibility, and specific yield.

Two formulas for the determinations made herein are used. One by C. V. Theis, Groundwater Division of the Geological Survey,

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and one by R. E. Glover, a Research Engineer of the Bureau of Reclamation. Both assume the following conditions:

A river runs in a channel through a valley which is filled with sediments to a certain depth. The floor of the valley is farm land below which there exists a water table continuous with and approximately at the elevation of the water surface in the river. Below the water table the sediments have a depth D, a permeability K, and possess a porosity which will permit them to give up V cubic feet of water for each cubic foot of the sediments drained. Suppose now that a well is put down at a distance X_1 from the near bank of the river and water is pumped out of it continuously at the rate F. This well will, at first, draw water from storage in the sediments adjacent to it. This causes a local lowering of the water table and initiates the formation of the "cone of depression." As pumping continues, the cone of depression deepens and widens until the disturbance of the original water table levels reaches the river. From this time on, a part of the flow which is pumped from the well is supplied by the river. A large part of the flow still comes from storage, however, and the cone of depression, therefore, continues to deepen. This deepening of the cone of depression, in turn, builds up gradients which take water from the river and divert it to well. These transient conditions terminate when the cone of depression becomes deep enough to draw all of the well flow from the river.

Theis' formula is fully explained by C. S. Conover, Groundwater Division, Geological Survey, in his unpublished report on "Ground-Water Conditions in the Rincon and Mesilla Valleys and Adjacent Areas." For the purpose of this study a curve by Theis - Conover is used to estimate the percent of pumped water taken from a river or drain and is included.

Glover's formula which applies to the above explained condition is:

$$\frac{q}{F} = 1 - E\left(\frac{X_1}{\sqrt{4h^2 t}}\right)$$

where

F = Flow pumped from well (ft^3/sec)

q = The part of the well flow which comes from the river (ft^3/sec)

X_1 = Distance of the well from the near bank of the river (feet)

t = Time after pumping begins (seconds)

$h_2 = \frac{KD}{V}$

TX_MSJ_006152

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where

K = Permeability (ft/sec)

D = Depth of sediments below the original water table level

V = Volume of water which sediments will give up when drained (ratio of voids in sediments to total volume)

and

$E\left(\frac{X_1}{\sqrt{4h^2t}}\right)$ = Represents the probability integral

In solving these formulas the following assumptions are made:

(a) The Rincon Valley is considered separately from the Mesilla Valley; and the latter is also subdivided into the area above Mesilla Dam, called the Leasburg Unit, and the area below, called the Mesilla Unit.

(b) Theis coefficient of transmissibility "T" taken at 50,000 gallons per day per foot. Conover in his study of Rincon and Mesilla Valleys determined a number of coefficients and adopted an average of 75,000. Since the river bed is partly silted and might offer some resistance to the movement of ground-water, the coefficient selected is considered on the conservative side. The result of Conover's recovery tests on irrigation wells is summarized and follows:

Valley	Location: Twp.	Rang.	Sec.	Hours Pumped	Coefficient of Transmissibility: (g.p.d./ft)	
Rincon	17S	4W	31	9	167,000	
Rincon	19S	3W	4	96	136,000	
Rincon	17S	5W	14 a/	7	13,000	
Rincon	17S	5W	26 a/	10	298,000	
Average Rincon Valley						153,500
Mesilla	23S	1E	13	15	91,000	
Mesilla	23S	2E	29	24	116,000	
Mesilla	23S	2E	8 a/	84	73,000	
Average Mesilla Valley						93,300
Average Rincon and Mesilla Valleys						127,714

a/ Above valley floor

To make Theis Recovery Method test in even fairly permeable sediments the well should be pumped for at least seventy-two hours in order to unwater materials within the cone of depression; otherwise, the coefficient of transmissibility may be too high. Only two tests of

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Conover's fall in this category and the average coefficient of transmissibility for those is 104,500. In 1951 the Bureau of Reclamation ran a recovery test on a well located in T27S, R3E, Sec. 21. The pumping period was 34 hours with a coefficient of transmissibility of 102,400.

Conover also made tests to determine the coefficient of transmissibility for drains by correlation of the water table slope to the drain flow. These results are summarized as follows:

Valley	Name Drain	Coefficient of Transmissibility (g.p.d./ft.)
Rincon	Rincon	96,000
Mesilla	Picacho	77,000
Mesilla	West	135,000
Mesilla	Del Rio	60,000
Mesilla	Mesquite	47,000
Mesilla	Anthony	54,000
Average		78,000

(c) The volume of water "V", or the specific yield, which the sediments or aquifer will give up is assumed at 0.15. Conover used 0.25 for his value for the same areas, consequently the 0.15 adopted for this study is on the conservative side.

(d) Meinzer's coefficient "P_f" is equal to T divided by the depth of sediments (depth taken as distance from static water table to bottom of well.) Since this average depth varies for the valley areas considered, the coefficient differs for these areas as follows:

Item	Rincon Unit	Leasburg Unit	Mesilla Unit	Total Mesilla
Average depth well (feet)	70	105	110	110
P_f = Meinzer's coef. (g.p.d.)	714	476	455	455
K = Glover* (ft/sec)	.0011	.00074	.0007	.0007

*Glover's coefficient of permeability "K" is equal to Meinzer unit times 48.8 which gives K in feet per year.

(e) $h^2 = \frac{KD}{V} = .515$

(f) An inventory of all wells was made and location of each is shown on the accompanying maps of the Rincon and Mesilla Valley, Drawing No. 23-503-5103, "Elephant Butte Irrigation District - Rincon Valley Unit," and Drawing No. 23-503-5399, "Elephant Butte Irrigation District - Mesilla Valley Unit," both in Appendix, Part II. This report includes all wells up to December 31, 1951;

TX_MSJ_006154

NM 00138543

however, the maps include all wells up to May 1, 1952. From January 1, through May 1, 1952, there were 9 wells in the Rincon Unit and 44 wells in the Mesilla Units installed. Distances "X_1" of wells to river's edge and drains was determined and included in the following summary:

Item	Percha Dam to El Paso			
	Rincon Unit	Leasburg Unit	Mesilla Unit	Total Mesilla Valley
Total No. Valley wells	149	167	310	477
Avg. distance to river edge	2,540	6,375	5,540	5,830
All wells between river and first drain	76	33	81	114
Avg. distance to river edge	1,700	1,800	1,500	1,670
Total No. valley wells	149	167	310	477
Avg. distance to river edge or drain whichever is least	1,080	1,460	1,205	1,295

The various relationships with regard to distance of wells to river or drain are considered as shown above, for the purpose of comparison.

Percent of pumped water diverted from river or drain.

It is desirable at this time to determine in advance of the release of storage water the possible effects of pumping upon the river and drains for normal operational purposes. The period through April is considered for the year 1952.

Glover's formula is computed below for insertion of various distances to be used and for pumping periods February through April, and January through April.

TX_MSJ_006155

NM 00138544

Date	Months After Pumping Began	Time x 10^6 Seconds	$\frac{X_1}{12.06t}$
Feb. 1 a/	0	0	00
Feb. 29	1	2.5056	$\frac{X_1}{2270}$
Mar. 31	2	5.1840	$\frac{X_1}{3380}$
Apr.30	3	7.7760	$\frac{X_1}{4010}$
Jan. 1	0	0	
Jan. 31	1	2.6784	$\frac{X_1}{2350}$
Feb. 29	2	5.1840	$\frac{X_1}{3380}$
Mar. 31	3	7.8624	$\frac{X_1}{4030}$
Apr. 30	4	10.4544	$\frac{X_1}{4650}$

a/ January omitted since there were no farm deliveries for that month during 1946-50.

A comparison of Glover's formula to the Theis - Conover graph (Drawing No. 23-0A-59, in Appendix, Part II) for determining the percent of pumped water diverted from river or drains is shown in Table 4, in Appendix, Part II, for the various distances selected, and for several valley areas. It will be noted that the two formulas give the same percentage under the same assumptions as to transmissibility and specific yield.

Rate of pumping or water distribution.

Average pumping rates for irrigation wells were determined by actual measurements and from rated capacity; this for about 60 percent of total wells in the Rincon Valley, and for about 50 percent of total wells in the Mesilla Valley. Slight reductions in average rates were made for use in this report, as rated capacities are generally higher than actual delivery rates. The average pumping rate together with quantities that could be pumped follow:

TX_MSJ_006156

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Item	Rincon Unit	Leasburg Unit	Mesilla Unit	Total Mesilla Valley
Total No. wells	149	167	310	477
Avg.well discharge (g.p.m.)	1,000	1,600	1,600	1,600
A.F./Day/Well	4.42	7.06	7.06	7.06
A.F./Day for all wells	657	1,180	2,190	3,370
A.F./Mo. for all wells	19,710	35,400	65,700	101,100

A comparison can be made of the theoretical quantities above to actual farm delivery for the first four months of the period 1946-50 in Table B, in Appendix, Part II. Also, the average rate of delivery in second-feet is shown for those quantities. It will be noted that the theoretical values greatly exceed the past actual deliveries, which would indicate that a full water supply could be furnished by pumping existing wells, if this water could be distributed to all irrigable lands with not excessive losses.

The rate of pumping can be taken from Table B if all wells are considered. Since comparisons are made to wells between the river and first drain the rate for these wells is taken as a percent of the rate for all wells based on the ratio of number of wells, and follows:

	Acre-Feet			
Wells Considered	Rincon Unit	Leasburg Unit	Mesilla Unit	Total Mesilla Valley
Between river and 1st drain	5,020	3,930	9,775	13,690

The amount of water diverted from the river or drains based on the preceding pumping rates and percentages diverted is shown in Table C, in Appendix, Part II. It will be noted that all the wells between the river and first drain divert more water from the river than when all the wells are considered from the river. This is because, as distance from the river increases, percentage of water diverted therefrom decreases fast. Also all wells divert more water from the drain or river, whichever is the least distant, than all the wells from the river, for the same reason. If drains are flowing at the time pumping is being made, then the draft upon them should be considered as depleting drain and river flow. Since there are sufficient wells between the river and first drain to have a greater effect on diverting water from the river than when considering all wells, this quantity should be considered in preference to the diverted quantity for all wells for the short periods of time used.

In order to show further the effects of pumping on diverting river or drain water several examples are made assuming various

TX_MSJ_006157

quantities pumped during a three month period, and these are tabulated below.

Assumed Acre-Feet pumped	Acre-Feet Pumped For Period February Through April for No. Pumps Shown				
	1	50	100	500	700 (No. pumps)
1/4	.25	12.5	25.	125.	175.
1/2	.50	25.0	50.	250.	350.
3/4	.75	37.5	75.	375.	525.
1	1.00	50.0	100.	500.	700.

The assumption is for continuous pumping, but if the pumping period of three months or ninety days is a fair average of the time a pump would have to operate during the entire season, the diversion from the stream in a continuous period could be proportioned during an entire season.

The percent of water diverted from river or drain by pumping for various pumping periods and at several different distances of well to river or drain are shown below, and in graphical form on Plate 1, in Appendix, Part II. These are useful for other discussions throughout this report.

PERCENT OF WATER DIVERTED FROM RIVER OR DRAIN

Days Pumped	Percent Diverted Distance Well to River or Drain								
	500	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000
10	60	30	3	0					
15	66	39	9	1					
20	70	46	15	2	0				
25	73	50	20	4	1				
30	76	54	24	7	1	0			
45	80	61	33	14	5	1	0		
60	83	66	40	20	8	3	1	0	
90	86	71	49	29	16	8	3	1	0
120	87	76	54	35	22	12	7	3	1

The acre-feet diverted from the river or drain by pumping 1/4, 1/2, 3/4, and 1 acre-foot for a three month period is shown in Table D, in Appendix, Part II, for various distances of wells to river or drain. Also, this is presented graphically on Plates 2 to 13, in Appendix, Part II, as well as the same data for pumping periods of 60 and 30 days.

In order to show the acre-feet diverted from the river or drain in comparison to the acre-feet pumped per acre for various pumping periods, Tables E through G, in Appendix, Part II, are included. They show the acre-feet diverted for the Rincon, Leasburg ,

TX_MSJ_006158
NM 00138547

and Mesilla Units, for all wells to the river, for all wells to the river between the river and first drain, and for all wells to the river or drain whichever is the least distance. This is shown for 1/4, 1/2, 3/4, and 1 acre-foot pumped. From these tables the amount of water diverted from river or drain can be approximately determined for the average acre-foot per acre farm delivery. Actual per-acre farm charges for the years 1946-50 are shown in Tables H and I, in Appendix, Part II, by months. The monthly averages follow:

	Average A.F. Charge 1946-50		
	Unit		
Month	Rincon	Leasburg	Mesilla
Jan.	.00	.00	.00
Feb.	.01	.01	.01
Mar.	.16	.17	.19
Apr.	.46	.54	.59
May	.23	.29	.27
June	.35	.38	.35
July	.46	.65	.61
Aug.	.60	.67	.62
Sept.	.29	.37	.37
Oct.	.01	.02	.03
Nov.	.01	.01	.02
Dec.	.01	.01	.00
Totals	2.59	3.12	3.06

From the foregoing tables and comparisons, several samples of effects of pumping upon diverting water from river or drains are presented for clarity. Tables J through L, in Appendix, Part II, show the acre-feet diverted for several size farms pumping 1/2 acre-foot per acre and using average pumping rates of existing wells. Also included is the water diverted from the river by pumping after pumping has ceased, or the residual effect of pumping. For this purpose twice the pumping period since pumping started has been selected. Both Glover and Theis formulas give the water diverted up to time pumping stops, but since river or drain losses continue until the storage deficiency is satisfied or the cone of depression resulting from the pumping is erased, this lag should be considered in determining total diverted river loss after any pumping period. The lag or residual effect is computed as the difference in percent diverted at the end of any period after actual pumping stops at time an imaginary recharge pumping well stops by assuming that recharge pumping continues at same rate after pumping stops.

In summary, as an example, it may be stated that for the

TX_MSJ_006159

NM 00138548

average irrigation well between the river and first drain pumping water sufficient to deliver 0.5 acre-feet to 200 acres would divert the following amounts from the river for the three units considered at the end of the pumping period, and at the end of twice the pumping period.

Unit	Distance to River 1/	Days Required to Pump	A.F. Diverted From River At End Pumping Period	A.F. Diverted From River Total At End Twice Pumping Period
Rincon	1,700	25	25.44	42.10
Leasburg	1,800	15	11.98	27.12
Mesilla	1,500	15	19.47	35.94

1/ Average distance of wells between river and first drain.

Should the well be located between the river and a flowing drain there would also be diversions from the drain as well as the river, but at this time dual draft conditions are not considered.

Water Diverted From River or Drains Due to Pumping During 1951

The records and estimates of water pumped during 1951 do not reflect what might have been pumped in a similar water-short year had all the irrigation wells been in at the beginning of the season. As it happened, almost all the 626 wells on the valley floor were drilled and put into operation throughout the year. Owners and operators of all these wells were contacted at various intervals to determine the amount of water pumped. This information was freely given up until about September. For the balance of the year only about 50 percent was contributed, and watermasters and ditchriders made estimates in all cases where the data could not be had. The records and estimates of pumped irrigation water follow:

Valley	Acre-Feet Pumped Jan. 1 to Sept. 15	Sept. 16 to Dec. 31	Year Total
Rincon	17,760	50	17,810
Mesilla	75,030	2,550	77,580
Above Mesilla Dam	(26,890)	(510)	(27,400)
Below Mesilla Dam	(48,140)	(2,040)	(50,180)
Totals	92,790	2,600	95,390

The amount of the above pumped water diverted from the river or drains for the year are determined from April 1, since very little pumping preceded that date. These determinations, showing the

TX_MSJ_006160
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percent diverted for distances considered, are shown in Table M, in Appendix, Part II.

By using the above percentages of pumped water diverted during 1951, the loss in acre-feet to river and drains for various periods is shown in Table N, in Appendix, Part II. It will be noted that the water diverted from the river for a year's period is greater for all wells than for those between the river and first drain; whereas for only two or three months' periods as previously used in examples, the water diverted by wells between the river and first drain was greater by far than for all wells. This is explained since for any given percent diverted, the time varies as the square of the distance as shown below:

Distance	Time Months	Percent Diverted
1000	1	55
2000	4	55
3000	9	55
4000	16	55
5000	25	55

Due to pumping in 1951 there was about 35,500 acre-feet of water diverted from April 1, 1951, to March 31, 1952, directly from the river below Caballo Dam and El Paso. This is 37 percent of the water pumped. Also, this pumping further diverted water from the drains; and assuming none of these dried up, the river and drains were effected by at least 79,000 acre-feet diverted from them. This is about 83 percent of all pumped water. During a year this loss would equal 109 second-feet and for the reach from Percha Diversion Dam to El Paso (105 miles) would amount to over 1 second-foot per mile.

Forecast River Diversions by Pumping During 1952

In order to make any kind of forecast as to the amount of water that will be diverted from the river by pumping, certain criteria or assumptions will have to be made. These are listed together with values selected for the forecast.

1. Storage water will be short at planting time, and allotment of water will be necessary. This allotment during period April through June will be one-half average farm delivery for 1946-50, and follows:

	1/2 Average Farm Delivery 1946-50 (Ft./Ac.)		
Month	Rincon Unit	Leasburg Unit	Mesilla Unit
April	.23	.27	.30
May	.12	.14	.18
June	.18	.19	.18

TX_MSJ_006161
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percent diverted for distances considered, are shown in Table M, in Appendix, Part II.

By using the above percentages of pumped water diverted during 1951, the loss in acre-feet to river and drains for various periods is shown in Table N, in Appendix, Part II. It will be noted that the water diverted from the river for a year's period is greater for all wells than for those between the river and first drain; whereas for only two or three months' periods as previously used in examples, the water diverted by wells between the river and first drain was greater by far than for all wells. This is explained since for any given percent diverted, the time varies as the square of the distance as shown below:

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	1/2 Average Farm Delivery 1946-50 (Ft./Ac.)		
Month	Rincon Unit	Leasburg Unit	Mesilla Unit
April	.23	.27	.30
May	.12	.14	.18
June	.18	.19	.18

TX_MSJ_006162

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2. Pumps will supply one-half of average farm delivery which will be equal to amounts listed above.

3. Area irrigated will be the same as for 1951 which was a water-short year, and follows:

Valley	Approx. Acres Irrigated
Rincon	16,000
Mesilla:	85,000
Leasburg Unit	(31,400)
Mesilla Unit	(53,600)
Total	101,000

4. Coefficient transmissibility of 50,000 and coefficient of yield of 15 percent. Average data pertaining to wells the same as previously given in this report.

Based upon the above selected values the amount of water pumped for areas considered is shown below and the amount of this water diverted from the river is shown in Table O, in Appendix, Part II.

Date	A. F. Water Pumped		
	Rincon Unit	Leasburg Unit	Mesilla Unit
April 1	0	0	0
April 30	3,680	8,480	16,080
May 31	1,920	4,400	9,650
2 Mo. Avg.	2,800	6,440	12,860
June 30	2,880	5,970	9,650
3 Mo. Avg.	2,830	6,280	11,790

A comparison of water diverted by pumping to total water requirements follows:

	For Area Percha Dam to El Paso					
	Total A.F. Required	Diverted By All Wells From River		Diverted By All Wells Between River and 1st Drain From River		Diverted By All Wells From River or Drain Whichever is Closest To Well
Date	Avg. 1946-50,a/ For 1951 Irrig. Ac.	A.F.	% or Total	A.F.	% of Total	A.F.	% of Total
April 1							
April 10	18,830	10	0	230	1.2	1,730	9.2
April 20	37,650	140	0	1,130	3.0	6,600	17.6
April 30	56,480	460	.8	2,520	4.5	12,460	22.1
May 31	31,940	1,070	3.4	3,000	9.4	12,930	40.5
June 30	37,000	1,800	4.9	3,300	8.9	13,720	37.1

a/ Farm Delivery.

TX_MSJ_006163
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The second-foot loss per mile of river channel resulting from pumping for various periods is shown in Table P, in Appendix, Part II, for the several reaches considered. It will be noted that these losses do not reach their maximum until about 30 days after pumping began, or about the time cotton planting would be completed.

Comparison of Coefficient of Transmissibility

For comparison purposes the percent of pumped water diverted from the river by pumping for coefficients of transmissibility of 25,000, 50,000, and 75,000 are shown in Tables Q and R, in Appendix, Part II. They are made for various pumping periods at several different distances of well to river. It will be noted that the percent diverted does not differ so greatly for the three different values of transmissibility when wells are close to the river and pumping for a 90-day period, but as the distance increases up to around 3,000 feet the difference becomes greater. Beyond 3,000 feet the percent diverted for a 90-day period does not amount to much anyway.

It is believed that the coefficient of transmissibility of 50,000 used throughout this report is conservative. In support of the coefficients previously determined in the Mesilla and Rincon Valleys, several Theis recovery tests were made for wells in the El Paso Valley. It would seem reasonable to believe that values in the El Paso Valley might be lower than for those in the upper valleys, this for the reason that sediments laid down in the valley by the river moved over a longer distance, and consequently should be of smaller size due to erosion.

Values of coefficient of transmissibility determined in the El Paso Valley follow:

Name	Hours Pumped	Coefficient Transmissibility
Ralph Gonzales	220	174,913
Vince Segulia	44	(93,234)
Vince Segulia	120	91,700
Jack Stallings	122	131,500
Francis Warnock	77	91,300
Average		122,700

This average value is about the same as for the average value of 128,000 made for seven wells in the Rincon and Mesilla Valleys by Conover. Also, it raises the question as to whether the coefficient of transmissibility in the El Paso Valley is not about the same as the upper valley.

TX_MSJ_006164
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RIVER LOSS STUDY IN ACRE FEET TABLE No. 161

RINCON VALLEY

	1938-1941	1942-1945	1946	1947	1948	1949	1950	1951
	a)	a)	b)	b)	b)	b)	b)	b)
Flow Below Caballo Dam	751,360	1,114,240	763,759	724,932	741,189	712,247	719,347	469,716
Diversions - Rincon Valley	79,280	104,270	100,265	87,544	86,529	92,706	90,270	55,531
Waste	17,210	20,930	14,259	13,231	16,220	16,115	14,560	9,772
Return ~~Drain~~ Drain Flow	33,380	39,735	33,483	29,143	28,989	33,742	33,639	16,671
Flood Inflow			5,086	7,037	1,152	12,022	17,172	1,639
Flow Above Leasburg Dam	714,970	1,060,080	734,801	686,691	686,693	689,977	708,980	432,014
Seepage Loss	-7,700	-10,550	+18,485	-708	-14,270	+8,557	+14,552	-10,253

MESILLA VALLEY

Flow Above Leasburg Dam	714,970	1,060,080	724,821	686,132	686,650	689,974	709,016	432,044
Diversions - Mesilla Valley	434,940	529,510	509,045	470,615	469,145	480,618	469,213	277,969
Waste	59,160	80,710	41,723	38,692	44,252	51,844	49,618	26,226
Return Drain Flow	211,070	245,080	250,355	216,916	216,320	237,088	230,122	131,946
Flow at El Paso	507,960	784,270	497,896	458,678	433,787	463,498	472,665	251,082
Seepage Loss	-42,300	-72,090	-19,958	-12,447	-46,290	-34,790	-46,878	-61,165

a) Yearly Average
b) Lower Station of both reaches lagged one day

Minus denotes loss and plus gain in Flow

TX_MSJ_006165

TABLE # 167

River Flow and Depletions
(Acre feet per year)

Caballo Dam To Leasburg Dam (Rincon Valley)

Year	Flow (acre feet) Caballo	Flow (acre feet) Leasburg [1]	Percent Leasburg of Caballo	Depletion in Reach [2]	Depletion as % of Flow at Caballo	Depletion as % of Flow at Leasburg
1946	763,759	734,801	96	28,958	3.8	3.9
1947	724,932	686,091	95	38,841	5.4	5.7
1948	741,189	686,693	93	54,505	7.4	7.9
1949	712,247	689,977	97	22,270	3.1	3.2
1950	719,347	708,980	99	10,367	1.4	1.5
1951	469,716	432,014	92	37,703	8.0	8.7

Leasburg Dam to El Paso (Mesilla Valley)

~~1946~~ Year ~~1947~~ ~~1948~~ ~~1949~~	Flow Below Leasburg	Flow El Paso [1]	Percent El Paso of Leasburg	Depletion in Reach [2]	Depletion as % of Flow at Leasburg	Depletion as % of Flow at El Paso
1946	734,821	497,896	68	236,925	32.2	47.5
1947	686,132	458,678	67	227,454	33.1	49.5
1948	686,650	431,787	63	254,863	37.1	59.1
1949	689,974	463,498	67	226,476	32.8	48.8
1950	709,016	472,665	67	236,351	33.3	50.0
1951	432,044	251,082	58	180,962	44.2	76.0

Caballo Dam to El Paso (Rincon and Mesilla Valleys)

Year	Flow Acre feet Caballo	Flow Acre feet El Paso [1]	Percent Caballo of El Paso	Depletion in Reach [2]	Depletion as % of Flow at Caballo	Depletion as % of Flow at El Paso
1946	763,759	497,896	65	265,863	34.8	53.3
1947	724,932	458,678	63	266,254	36.8	58.0
1948	741,189	431,787	58	309,402	41.7	71.8
1949	712,247	463,498	65	248,749	35.0	53.7
1950	719,347	472,665	66	246,682	34.3	52.2
1951	469,716	251,082	53	218,634	46.5	87.2

[1] Daily flows lagged one day

[2] Depletion is arithmetical difference between stations
Diversions and returns that in between not accounted for.

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Table # 168

Diversions, Waste, Charged to Farms, Losses, and Drain Discharge

acre feet per year

Item	1946	% of Div	1947	% of Div	1948	% of Div	1949	% of Div	1950	% of Div	1951	% of Div	% 19[illegible] average for 194[illegible]
Rincon Valley													
Diversions	100,265	100	87,544	100	86,579	100	92,706	100	90,270	100	55,531	100	6[illegible]
Waste	14,253	14	13,231	15	16,220	19	16,115	17	14,560	16	9,772	18	6[illegible]
Charged to Farms	47,500	47	43,490	50	40,960	47	44,960	49	48,038	53	24,702	44	5[illegible]
Losses	38,512	38	30,823	35	29,399	34	31,631	34	27,672	31	21,057	38	6[illegible]
Drain Discharge	33,483	33	29,143	33	28,981	33	33,742	36	33,639	37	16,671	30	5[illegible]
Irrigated Acres	17,000	17	17,323	20	16,656	19	17,711	19	17,651	20	16,855	30	9[illegible]
Mesilla Valley													
Diversions	509,045	100	470,615	100	469,145	100	480,618	100	469,213	100	277,969	100	58
Waste	41,723	8	38,692	8	44,252	9	51,844	11	49,618	11	26,226	9	58
Charged to Farms	270,450	53	253,040	54	251,170	53	258,590	54	258,981	55	137,209	49	53
Losses	196,872	39	178,883	38	173,723	38	180,184	35	160,614	34	114,534	41	65
Drain Discharge	250,355	49	216,916	46	216,320	46	237,088	49	230,122	49	131,946	47	57
Irrigated Acres	83,911	16	84,401	18	83,197	18	84,686	18	84,567	18	84,210	30	100

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Table No. 194

Summary of Estimated Consumptive Use Rincon and Mesilla Valley

Valley	Year	Consumptive Use Acre Feet	Source of Water (Percent) River 2/	Precipitation	Ground Water
Rincon 1/	1946	41,446	58	37	3.6
	1947	34,656	67	32	1.3
	1948	61,009	75	27	- 1.1
	1949	47,946	52	46	2.0
	1950	34,224	50	48	2.3
	Avg 1946 - 1950	43,856	61	37	1.4
	1957	45,162	65	26	9.1
Mesilla	1946	296,256	76	22	2.1
	1947	274,288	79	20	0.7
	1948	290,223	85	17	- 0.9
	1949	301,502	72	25	1.2
	1950	283,358	79	19	1.2
	avg 1946-1950	289,125	78	21	0.9
	1957	240,355	76	17	- 7.2

1/ Includes Selden Canyon

2/ Upper station and flood inflow less evaporation and lower station.

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Table 195

Annual Consumptive Use and Water Charged to Farms
Rincon Valley

Feet Per Year

Item	1946	1947	1948	1949	1950	Average 1946-50	1951
— Inflow - Outflow Method — 1/							
Total Consumptive Use	1.65	1.38	2.43	1.91	1.36	1.75	1.18
Precipitation	0.59	0.41	0.60	0.82	0.61	0.61	0.45
Effective Cons. Use of Irrigation Water	1.06	0.97	1.83	1.09	0.75	1.14	1.13
— Water Charged to Farms —							
Water Charged to Farms 2/	2.79	2.51	2.46	2.54	2.72	2.60	1.47
Farm Deliveries 3/	0.28	0.25	0.25	0.25	0.27	0.26	0.07
Effective Cons. Use of Irrig. Water	2.51	2.26	2.21	2.29	2.45	2.34	1.40

1/ Based on equivalent valley area (25,121 acres)

2/ From Table 16-8

3/ Deep percolation and Farm Waste, assumed as 10 percent of farm deliveries for 1946-50 and 5 percent for 1951

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Table No. 196

Annual Consumptive Use and Water Charged to Farms
Meadow Valley

Item	Feet Per Year 1946	1947	1948	1949	1950	Average (1946-1950)	1951
— Taylor-Griffith Method 1/ —							
Total Consumptive Use	2.77	2.59	2.74	2.84	2.67	2.73	2.27
Precipitation	0.57	0.62	0.45	0.75	0.51	0.56	0.38
Effective Consumptive Use of Irrigation Water	2.20	2.07	2.29	2.09	2.16	2.17	1.89
— Water Charged to Farms —							
Water Charged To Farms 2/	3.22	2.99	3.02	3.05	3.06	3.07	1.63
Farm Delivery Losses 3/	0.32	0.30	0.30	0.30	0.31	0.31	0.08
Effect Consumptive Use of Irrigation Water	2.90	2.69	2.72	2.75	2.75	2.76	1.55
— Stream Flow Depletion —							
Per Acre Irrigated	2.8	2.7	3.1	2.7	2.8	2.8	2.2
Precipitation	0.6	0.5	0.4	0.7	0.5	0.6	0.4
Effective Consumptive Use of Irrigation Water	2.2	2.2	2.7	2.0	2.3	2.2	1.8

1/ Based on equivalent valley area (106,104 acres)

2/ From Table 168

3/ Deep percolation and farm waste assumed as 10 percent of farm delivery for 1946-50 and 5 percent for 1951

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H. C. Neuffer,
January 6, 1938.

MEMORANDUM

Subject: Report of Committee of Engineers to
Rio Grande Compact Commissioners,
December 27, 1937.

A study of this report indicates that in general it is an approach to the matter of agreement between the States of Colorado, New Mexico and Texas for a division of the waters of the Rio Grande. However, there are certain items and paragraphs of this report with which the writer cannot agree, part of which may be due to lack of the availability of the data used by the engineers in making the report, and also it cannot be agreed that some of the findings are correct.

As to the matter of the schedules of delivery of water at Lobatos, Colo., there seems to be no disagreement as a preliminary check of the schedules shown in the report indicate that they are reasonable and should work out satisfactorily. However, further study should be made before final acceptance.

As to the schedule of delivereies to Elephant Butte Reservoir, beginning on page 5 of the report, there is no serious objection to the proposition of eliminating the months of July, August and September from consideration in drawing the curves, except that a study of the basic data indicates that since the construction work began on the Middle Rio Grande Conservancy Project a comparison of the flow at Otowi and San Marcial during the months of July, August and September shows a greatet proportionate flow at San Marcial for the years 1931 - 1936 than occurred for these three months prior to that time, and also a greater proportionate flow at San Marcial than occurred during the other nine months for the sameperiod.

At this time there is no satisfactory explanation why the schedule of deliveries was not based on the delivery at San Marcial rather than the so-

called "Usable" supply at Elephant Butte. It is noted on page 6 that the station at San Marcial was not deemed satisfactory for the purpose of future consideration. However, the information is that the data at that station was taken as a basis for drawing up the curves from which the schedules were prepared. Therefore, the schedules based on this record would seem to be in as much error in the future as the San Marcial Record.

Exception is taken to the consideration of the last sentence of the paragraph ending at the top of page 7, quoted as follows: "This curve was then shifted arbitrarily to compensate for increased salinity of the Elephant Butte supply". It is understood that the arbitrary shifting amounted to 12,000 acre feet. The data upon which the schedule on page 7 was prepared is not available and it is felt that no acceptance of this schedule should be made until the complete figures used in preparing this schedule are made available, and a careful check is made.

The paragraph headed (6), at the top of page 8, is not clear, but by changing the last line to read: "minus any decrease in the amount of stored water over the same period", we might arrive at the original intention, or at least know what is meant, although the entire paragraph might be rewritten for the sake of clarity.

Paragraph (e), page 9, does not appear to be acceptable for the reason that normal release at Elephant Butte Reservoir need not be in excess of 700,000 acre feet per annum. A study of the release from Elephant Butte Dam for the years 1927 to 1936 shows a mean release of 781,000 acre feet per annum. This includes release of excessive quantitites of water delivered to Mexico, avoidable project wastes, and savings which can be made after the channel rectification is completed. The report of the Rio Grande Joint Investigation, Vol. I, page 287, shows an average annual diversion by Mexico above Tornillo Bridge of 131,000

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acre feet, or 71,000 acre feet more than the treaty allowance. While it is not expected that it will be possible to confine Mexico to 60,000 acre feet except at points of direct diversion from the river, it is believed that a total of 90,000 acre feet would be more than ample, thus making it possible to save 41,000 acre feet from this source. Also, as shown by the operation of the Rio Grande Project during the past three years, it is possible to reduce the waste and likewise of water passing the Tornillo Bridge. For the years 1927 to 1936 this quantity of water has averaged 171,000 acre feet annually, and for the years 1934 to 1936 has averaged 98,000 acre feet. By making an allowance of an additional 22,000 acre feet, or a total of 120,000 acre feet, there could be a saving of 51,000 acre feet annually from that source. Another item which should be considered is the work now being done by the International Boundary Commission, which will eliminate the necessity of diluting the drain water with additional reservoir water, as a result of which 25,000 acre feet more can reasonably be expected to be saved each year. Deducting these items from the total of 781,000 acre feet, the net required release from the Elephant Butte Reservoir is 664,000 acre feet per annum.

The quantity of water to be released from Elephant Butte Reservoir can be arrived at in another way, as shown by the following tabulation which it will be noted results in 686,000 acre feet per annum:

Project use above El Paso (1925-36 av.)	273,000
Mexico Treaty Requirements plus river loss to riverside drain in Mexico	90,000
Unavoidable project wastes below Riverside heading	50,000
Winter discharge of Project drains in New Mexico not re-divertable	25,000
Net project diversions below El Paso	248,000
Total Elephant Butte Reservoir demand:	686,000

It is therefore concluded that a normal release from Elephant Butte Reservoir of 700,000 acre feet per annum would be a liberal allowance.

Exception is also taken to that part of the first sentence of paragraph (e), on page 9, reading as follows:

"adjusted for any gain or loss in suable water resulting from the operation of any reservoir below Elephant Butte."

This apparently has reference to the operation of the Caballo Reservoir which is understood to have a capacity of 300,000 acre feet, of which it is understood 125,000 acre feet have been reserved for flood storage by State Department through the Boundary Commission, and 175,000 acre feet may be used by the Rio Grande Project for storage purposes.

It would appear to be reasonable that any water delivered to the Caballo Reservoir in excess of the 175,000 acre feet would be at the project's own risk and therfore, the Project should take responsibility for any loss of "usable supply" for that reason. Also, it is understood that the Caballo Reservoir is to be used as a regulating reservoir for the development of power at the Elephant Butte Dam and in as much as this power delopment is for the benefit of the Project, then the Project should take responsibility for loss of water as the result of this operation. Of course, it is understood that the operation of the Caballo Dam and Reservoir will be handled by the U. S. Reclamation Service and perhaps technically Texas or the water users do hot have control. However, as a practical matter the water users do control the operations, except for the flood control capacity of 125,000 acre feet, and therefore should take the responsibility for any loss incurred for the irrigation and power development operation. It is certain that Colorado and the Middle Valley have no control over the matter and it seems absurd to assume responsibility or suffer loss of water on account of any loss of water due to the Rio Grande Project operations. These matters should also be considered when considering the second paragraph of the Recommendations on page 13.

As to the least sentence of paragraph (e), there is a question as to who would determine this loss to Mexico from 1927 to 1937. Also, in the previous sentence the lowest point of diversion should be changed to the Riverside heading as in the future that will probably be the lowest point of diversion for the

Project. This will make a considerable difference in the quantity of water allowed to Texas, and, if the matter stands as written, would supply sufficient water to permit Mexico to take as much or more water as in the past, particularly if release from Elephant Butte remains as 800,000 acre feet.

Paragraph (f), page 9, provides for a maximum storage for the Rio Grande Project of 2,638,860 acre feet. This is assumed to be the capacity of the Elephant Butte Reservoir at the time of completion of construction. Surveys indicate that by 1935 this capacity had been reducted to approximately 2,273,700 acre feet or an average loss of storage capacity of approximately 18,000 acre feet per year, so that now the capacity would be approximately 2,255,000 acre feet to which the allowable storage capacity of Caballo Dam, of 175,000 acre feet, might be added, resulting in a total present storage capacity of 2,430,000 acre feet.

It is possible that Texas desires to maintain the figure of 2,638,760 for the purpose of providing other storage as the present reservoirs fill with silt. However, the figure becomes important when considering the last part of the paragraph entitled "Limitation on Debits" near the top of page 11. If the "total capacity of Project Storage" is the actual available capacity of Elephant Butte Reservoir plus the actual capacity of Caballo Reservoir, less 125,000 acre feet, plus any actual future storage up to a total of 2,638,860 then there would be no objection. It appears that a more specific definition is needed.

On page 10 it is suggested that the 6th line be changed to read as follows: "from Elephant Butte Reservoir from time to time of previous unused spill".

On page 11, in the paragraph beginning with the 6th line from the top, it is believed that the last clause of that sentence, beginning with the word "excepting should be stricken out so that the paragraph will read as follows:

> "If in any year there is unusable spill from Elephant Butte Reservoir, all accrued debits of Colorado and New Mexico shall be cancelled, and no debits shall be considered in that year."

If the last clause in the report remains, then "storage debits" could be carried over even though Elephant Butte and Caballo spilled any quantity of water, no matter how much.

In the paragraph headed "limitation on Credits, page 11, the word "larger" in lines 3 and 9 should be eliminated, and the words "of any amount" should be inserted after the word "accruals" in both lines, so that the paragraphs should read as follows:

> "In the case of Colorado, accrued credits in excess of 100,000 acre feet at any time shall be considered, provided that accruals of any amount may be applied to offset debits caused by storage in reservoirs. In computing accrued credits or debits, annual credits in excess of 150,000 acre feet shall be taken as equal to that amount."
>
> In the case of New Mexico, accrued credits in excess of 200,000 acre feet at any time shall not be considered, provided that accruals of any amount may be applied to offset debits caused by storage in resevoirs. In computing accrued credits or debits, annual credits in excess of 150,000 acre feet shall be taken as equal to that amount."

On page 12, in the paragraph headed "Other Limitations", it is believed that that part of the first paragraph after the words "Rio Grande Project" is unnecessaryand should be eliminated; aso, that the "400,000 acre feet" in line 3 of said paragraph should be changed to "300,000 acre feet". This latter figure might be considered open for further discussion. This paragraph would then read as follows:

> "Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs constructed since 1929 whenever there is less than 300,000 acre feet of water in storage available for use in the Rio Grande Project."

However, the paragraph might be left as originally drawn if the following were added at the end: "until the total water stored in Elephant Butte and other Project reservoirs has reached 400,000 acre feet."

Under "Recommendations", page 13, second paragraph and second line, the figure "800,000" should be changed to read "700,000". It is possible, in a matter of negotiation and agreement, that this might possibly be raised to 750,000 as the very maximum figure without injury to New Mexico or the Middle Valley.

ANALYSIS OF TERMS OF THE COMPACT

The Rio Grande Compact represents a complete agreement by the Compact Commission on the division of the waters of the Rio Grande stream system above Fort Quitman, Texas It is their unanimous opinion that it provides an eminently fair and equitable solution of a very troublesome problem and sets up the machinery through which the fullest beneficial use of the available water supply may be made

The terms of the Compact accomplish two major purposes First, they protect all present uses of water in the stream basin by schedules of delivery of water at the Colorado-New Mexico State Line and at San Marcial at the head of Elephant Butte Reservoir, Second, they provide that the three major basins may make the best use of their available supplies by the conservation and use of waters now being non-beneficially consumed and particularly by the construction of additional reservoirs to make use of waters which would otherwise spill from Rio Grande Project storage and be lost to the entire area

The Colorado schedule of water deliveries is based upon the relation found to exist between the annual inflow into, and the outflow from, the San Luis Valley for the years 1928 to 1937, both inclusive The schedule is divided into two parts, one applying to the Conejos stream system and one to the Rio Grande proper The sum of the deliveries required by the two relationships equals the total discharge at the Lobatos gaging station, based upon conditions of the past ten years, and, when reduced annually by ten thousand acre feet, represents the obligation of Colorado to deliver water at the State Line

The New Mexico schedule of water deliveries is based upon the relationship between the inflow to the Middle Valley at Otowi gaging station and the outflow therefrom at San Marcial gaging station for the years of record prior to 1930 The period 1930 to 1937 could not be included because of the changed conditions of discharge at San Marcial due to the works of the Middle Rio Grande Conservancy District The subdivision of the basin at San Marcial rather than at the New Mexico-Texas State Line is necessary because the Rio Grande Project of the Bureau of Reclamation must be oper-

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ated as a unit The figures used in computing the Middle Valley schedule were the annual discharges at Otowi and at San Marcial reduced by the discharges during the months of July, August and September The inclusion of these three months seemed to be impracticable because of the extremely variable tributary inflows between the two stations during these periods and the difficulty of arriving at the amounts thereof It was the feeling of the Commissioners that any changes in consumption during the periods excluded from the schedule would be small in amount Should appreciable deviations toward either higher or lower consumptions become evident in the future, it will probably become necessary that a supplementary schedule be adopted to compensate for such changes

In the application of the Colorado and Middle Valley schedules appropriate adjustments are to be made for any new or increased depletions above the respective inflow stations and for any importations of new waters into the drainage basin

The Compact provides no schedule of releases from Rio Grande Project storage, normal project release, however, is considered to be an average of 790,000 acre feet per annum, when and if available, and proper adjustments of the amounts in project storage are to be made whenever average releases have exceeded this normal The 790,000 acre feet normal release includes the 60,000 acre feet fixed by treaty to be delivered annually to Mexico Maximum Project storage is fixed at 2,638,860 acre feet, the original capacity of Elephant Butte reservoir

Annual deliveries of water in exact accordance with the schedules are not required The Compact provides for a system of accounting whereby deviations from the required deliveries are set up as debits or credits to the State making the deliveries These deviations may result from two causes, one of which is natural and the other, man-made No restrictions have been placed upon the amount of credit water which may be accrued by Colorado or New Mexico, excepting certain natural restrictions (evaporation) mentioned in Article VI The total debit, however, which may be accrued by either State has necessarily been limited to prevent additional and continuing depletions in one State to the detriment of downstream users

The operation of the Compact in Colorado will not injure

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users in New Mexico but should be a distinct benefit to them Analysis of Middle Valley operation under complete irrigation development, with present day conditions of depletion in Colorado and with no major reservoirs constructed in that State, indicates that, with a water supply similar to that of 1895-1938, there would have been ample water to meet fully the irrigation requirements of the valley in every year but seven The shortage in three of the years would have been minor, with appreciable deficiencies in the other four These shortages are the natural result of unusually deficient run-off, and their occurrence was recognized in the Official Plan of the Conservancy District Had major reservoirs in Colorado, as contemplated by the Compact, been in operation during the period, the water supply for the Middle Valley would have improved during the late summer months when it is most needed, due to additional return flow from upstream reservoir releases As a result, the Middle Valley would have experienced but four years of deficient supply during the above period and even in these years the shortages would have been less than those which would have occurred under non-storage conditions

In the case of New Mexico (Middle Valley), the Compact provides that the accrued debit due to natural variations shall not exceed 200,000 acre feet and no annual debit shall be considered to exceed 150,000 acre feet When applied to actual river flows in past years, natural departures from the Otowi-San Marcial schedule indicate that the debit limit would never have been exceeded Accrued debits are, of course, reduced by deliveries in excess of those required by the schedule and, at times of spill from Project storage, are entirely eliminated

New Mexico deliveries may allowably fall far below schedule deliveries when such deficiency is caused by the withholding of water by storage in reservoirs above Elephant Butte constructed after 1929 Since the amount so stored is water which formerly would have been available for storage in Elephant Butte, the Compact provides that storage debits may accumulate in any amount so long as an equivalent amount of water is held in storage

Annual and accumulated credits may be accrued to either or both of the two upper States by deliveries in excess of those required by the schedules Credit water may result from a better use of the available supply by drainage or other conservation measures, or it may come from importations of new supplies to the drainage basin Another and very important

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source is water held in upstream reservoirs which would otherwise be spilled from Rio Grande Project storage and be lost to the entire basin The amount saved by this means may be considerable since stream flow records of the past fifty years indicate that there would have been spill from Project storage in about half of those years

In effect, the Compact provides for the storage of Rio Grande Project water (debit water) in upstream reservoirs and for the storage of upstream reservoir water (credit water) in Project storage, to the mutual benefit of all three States Debit water in upstream reservoirs becomes restriction-free in the amount by which it would actually spill were it being held in Project storage Similarly, credit water in Project storage, which must be considered as floating on top of actual Project storage, is lost to the upper States in the amount that Project storage is physically incapable of holding it

During the years prior to 1929 when plans for the reclamation of the Middle Rio Grande Valley were being considered, investigations of the problem were made from time to time by several of the country's ablest irrigation engineers They found that considerable areas of the valley were overflowed, seeped and swampy, resulting in large non-beneficial uses of water Their independent conclusions were that drainage and reclamation of the area should conserve so much of the water supply formerly wasted that there should be no increase in water consumption, even under complete irrigation and agricultural development of the valley, and that it was probable that, thereafter, substantial quantities of water might be conserved annually Based upon these findings the Middle Rio Grande Conservancy District was formed and her reclamation program carried to completion Analysis of the data since 1930 indicates that substantial savings have resulted from the works of the District The record is too short and too variable to estimate the amount of such credits which would have accrued under the terms of the Compact but the indications are that savings may average in the neighborhood of 50,000 acre feet annually Because of these credits it is probable that the operation of El Vado reservoir will not be restricted more than three or four times during a fifty year period, and in these years, which must necessarily be unusually dry ones, it is probable that the available water supply will be so limited that very little use could be made of the reservoir At all other times the Conservancy District should be able to develop and operate her system in accordance with her Official Plan without restriction or hindrance

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The Rio Grande Project will also be substantially benefitted by the provisions of the Compact The water users will be fully protected against encroachments upon their water supply by upstream developments, a vital consideration to any consumer at the lower end of a stream system They will receive all the water which they were accustomed to receive in past years whenever required for their needs The "normal" release of 790,000 acre feet annually is ample for normal Project uses and may be supplemented from time to time by additional amounts, whenever spill from Project storage is imminent, for leaching or other purposes Further, the right is specifically reserved to any signatory State to seek redress through the Supreme Court of the United States should the character or quality of her water be changed injuriously by another signatory State

The following brief comments on each article of the Compact are intended for a clearer conception of the terms and provisions thereof

Article I is a description of the compacting agencies and defines certain terms used in the Compact

Article II provides for the establishment and maintenance of standard stream gaging stations at critical points upon the Rio Grande and its tributaries for the collection of hydrographic data necessary for the proper administration of the provisions of the Compact

Article III sets up the schedules of relationships between index inflow into and outflow from the San Luis Valley and defines Colorado's obligation to deliver water at the Colorado-New Mexico State Line Colorado shall receive full credit for any new water delivered to the river by draining of the Closed Basin in San Luis Valley, provided the quantity and quality of dissolved salts therein do not exceed certain minimums

Article IV sets up the New Mexico schedule above Elephant Butte and defines her obligation to deliver water at San Marcial, subject to certain provisions and adjustments

Article V provides for any necessary abandonment or change in location of Compact gaging stations

Article VI, which has been partially explained in preceding paragraphs, sets up the conditions under which departures from the schedules may be made, and establishes certain necessary limitations upon the debits and credits so acquired

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It provides for the adjustments of credits or debits or both whenever water is about to be lost to the basin by spill from Project storage It also provides that neither Colorado nor New Mexico may accumulate credits in Elephant Butte reservoir in excess of 150,000 acre feet of water annually This provision is designed to limit the accumulation of extraordinary credits which, of course, are not dependable and which might lead to unsound agricultural expansion

Paragraph 3 of Article VI provides that, by unanimous action, the Commission may set aside certain limitations on debits during periods of need and authorize the release of debit-restricted water from post-1929 reservoirs, provided that such water is replaced in storage at the first opportunity thereafter Paragraph 6 provides that the Commissioners of the upper States, which have accrued credits in Project storage, may authorize the release of any part of such credits for Project use if, in their judgment, failure to authorize such releases would result at a later date in actual spill This provision allows for a more extended use of the "spill" water for leaching and other Project purposes which otherwise might spill from Project storage at a dangerous rate and pass down the river largely unused It should be noted here that the authorization of sush releases is optional and would not be made unless spill from Project storage was reasonably certain

Article VII prohibits the increase in storage in reservoirs in Colorado and New Mexico constructed after 1929 whenever there is less than 400,000 acre feet of usable water in storage in Project reservoirs, the amount in storage to be adjusted, in case of over-releases, to a release at the "normal" rate of 790,000 acre feet annualy, provided that, should either Colorado or New Mexico or both own credit water in Elephant Butte, they may, with the consent of Texas, relinquish their claim to such credit water and store in their own reservoirs an amount equal to that so released As such a condition could not occur excepting during a cycle of very deficient runoff, it was felt that during such an emergency neither upper State, whatever her credits, should, by current storage, enjoy a near-normal supply at the expense of the Rio Grande Project whose only water, over and above the very deficient supply in storage at the time, must come down the river through the upper valleys In effect, this provision sets the Compact aside during such a period and allows each State to make the best use she may of direct stream flows, plus, of

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course, any water she may have in storage at the beginning of such period

Article VIII provides that should Project storage at the beginning of an irrigation season become deficient because of Elephant Butte water (debit water) stored in upstream reservoirs, the Commissioners for New Mexico or Texas may demand the release of sufficient quantities of such debit water to bring the amount of usable water in Project storage to 600,000 acre feet by March first and to maintain this quantity in storage until April thirtieth New Mexico and Colorado are required to release such water only to the extent of the debits of each Releases will be made at such times and at such rates of discharge as will protect structures and property along the river and will not encroach upon the stream channel capacity to the detriment of appropriators along the channel

Article IX is a recognition of the right of the Federal government or of New Mexico to make importations of San Juan River water from Colorado to the Rio Grande Basin in New Mexico, provided that present and prospective uses in the San Juan basin are fully protected

Article X assures that, in the application of the schedules, the State or States having the right to the use of water imported to the basin shall be given the proper credit

Article XI states that upon the ratification of the Compact all controversies between the States of New Mexico and Texas are composed and settled However, it specifically reserves the right of any signatory State in the future to seek redress through the Supreme Court should the character or quality of the water be changed by another signatory State to her injury

Article XII sets up the machinery for the administration of the provisions of the Compact It was deemed by the Commissioners and their advisers that the joint Commission for the administration of the Compact should interfere as little as possible with the control now exercised by the duly accredited State and local authorities While it was recognized that the provisions of the Compact are not self-executing and hence require some administration aside from the collection and tabulation of hydrographic data, etc , it will be noted that any action taken by the Commission must be unanimous This is designed to protect the rights of any one State against concerted action by a mere majority of the members of the Commission

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Article XIII provides for minor modifications of the provisions of the Compact which later years may show to be desirable All changes must be unanimous, must be ratified by the legislatures of the three States and approved by Congress, and must not alter the fundamental provisions of the Compact

Article XIV provides that the schedules of delivery shall not be changed by reason of any change in the delivery or loss of water to Mexico Should any savings be effected in present Mexican consumption the benefits will accrue to the water users in the Rio Grande Project

Article XV is a declaration that the Rio Grande Compact is based solely upon conditions peculiar to that basin, and that the provisions therein contained do not establish any general principle or precedent applicable to other interstate streams

Article XVI is a recognition of the rights and obligations of the United States to the Indian tribes and to Mexico

Article XVII provides that the Compact shall become effective when ratified by the legislatures of the signatory States and consented to by the Congress of the United States

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SUMMARY

In brief, the Rio Grande Compact accomplishes the following purposes

1 It protects all present uses of water in the stream basin In the Middle Valley it permits the Conservancy District to complete its development to 123,000 acres of cultivated lands in accordance with the Official Plan under which the works of the District were constructed

2 It permits each State to make the best possible use of her available supply and, by means of storage, to conserve considerable flood waters which must otherwise spill from Project storage and be lost to the basin

3 By reservoir construction, Colorado will be enabled to improve her use of water by storing during periods of high river discharge and releasing from storage during periods of low flow This operation should improve the low summer flows in the Middle Valley without interfering with its usable supply in periods of high water Colorado may further improve and extend her beneficial uses by transmountain diversion, by drainage of the Closed Basin and by other conservation measures

4 The State Line schedule, together with certain other restrictions placed upon Colorado operations, guarantees to the Middle Valley and the Rio Grande Project all the water they were accustomed to receive in the past, whenever it is needed for their uses

5 New Mexico will receive credit for all the water which has been saved by the works of the Conservancy District It seems probable that, upon the completion of agricultural development of the District, credits may still be accumulated If this proves to be the case, the development of some additional new lands may be desirable

6 Application of the Middle Valley schedule during the first four years of El Vado reservoir operation indicates that the average credit accruing to the District has been over 50,000 acre feet annually Substantial credits accumulated in the Middle Valley will permit practically restriction-free operation of El Vado, or any other reservoir which may be constructed in New Mexico in the future

7 The Rio Grande Project is guaranteed all the usable water which she has enjoyed in the past She may make an-

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nual releases averaging 790,000 acre feet whenever her available supply is sufficient to do so and, if her supply becomes deficient because of debit water stored in upstream reservoirs, she may require the release of sufficient debit water to supply her needs

8 The Compact settles all present controversies between New Mexico and Texas, thereby relieving both States of an expensive and burdensome suit

9 It permits transmountain diversion of San Juan River water to the Rio Grande basin in either Colorado or New Mexico, provided present and future uses in the San Juan basin are fully protected

10 It provides for a Commission, together with necessary legal and engineering aid, to administer its provisions, and sets up the machinery by means of which future questions or controversies may be arbitrated

11 Provision is made that, at the end of every five year period, the Commission may, by unanimous consent, review any provisions which are not substantive in character and which do not effect the basic principles upon which the Compact is founded

The Rio Grande Compact was executed in quadruplicate originals and signed by the Commissioners for the States of Colorado, New Mexico and Texas, and approved by a representative of the United States Government, on March 18, 1938

At a meeting of the New Mexico Interstate Stream Commission on April 11, 1938, the terms of the Compact were explained and discussed and the action of the Compact Commission was fully approved

THOMAS M McCLURE,
State Engineer

ANALYSIS OF COMPACT

BY

M C HINDERLIDER

The terms of the Rio Grande Compact accomplish two major purposes First, they protect the present use of water in the various sections of the basin by setting up schedules of delivery of water at the Colorado-New Mexico stateline and at Sun Marcial, which is at the head of the Elephant Butte Reservoir, and by fixing the average annual releases from Elephant Butte Reservoir Second the terms of the Compact permit the construction and operation of additional reservoirs above Elephant Butte Reservoir to regulate the water that is being used at the present time, and to capture and make usable, for beneficial use in the Upper Rio Grande basin water which otherwise would spill from Elephant Butte Reservoir and be lost

The schedules of water deliveries are based upon the relation found to exist between the annual inflow into, and the outflow from the San Luis Valley in Colorado for the years 1928 to 1937, both inclusive, and the relation between the flow at Otowi Bridge in northern New Mexico and the flow at Sun Marcial for all years of record prior to 1930 (pre Middle Rio Grande Conservancy period)

The Colorado-New Mexico stateline schedule is divided into two parts one applying to the Conejos stream system and the other to the Rio Grande proper Required deliveries by the State of Colorado are taken as the sum of the required delivery by the Conejos system and by the Rio Grande proper, less ten thousand acre feet The separation of the stateline schedule into the two parts will permit the fixing of responsibility for any depletion or the proper allocation of credits resulting from increased deliveries of water through future drainage developments

Since the stateline schedules are based upon the relation between the inflow and outflow for the period 1928 to 1937, present uses of water in the San Luis Valley plus ten thousand acre feet per year are recognized by the Compact The use of water in some of the years of this period was the maximum in the history of irrigation in the Valley Deliveries in exact accordance with schedules are not required on an annual basis The Compact provides for a system of accounting whereby deviations from the deliveries required by the schedules are set up as debits or credits to the state making the deliveries In other words, if more water flows across the Colorado New Mexico stateline in any year than is required by the schedules, Colorado is credited with the surplus If less water is delivered than required by the schedules, Colorado is debited with the deficiency The credits and debits are allowed to accumulate subject to certain conditions

Variations between the actual deliveries of water and the

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scheduled deliveries may result from two causes, or a combination of the two, the first of which is natural and the second of which may be caused by man Natural variations may be due to variations in precipitation on the valley floor, unduly high or low runoff from the foothills area in relation to the flow of the Rio Grande and the Conejos, or to a year of high runoff following one of extremely low runoff, which will tend to cause a high consumption in the Valley in that year

In the case of Colorado, yearly or accumulated debit departures of as much as 100,000 acre feet from the schedules of required deliveries due to such natural causes, are allowable The maximum annual and cumulative debit departure between the actual river flow in the past at the stateline, and the required deliveries under the schedules, has been less than 50,000 acre feet The allowable 100 000 acre feet departure, therefore, is sufficient to protect Colorado against shortages, due to vagaries of nature in meeting the required deliveries of water at the stateline Deliveries of water in excess of those required by the schedules through a bookkeeping system may be applied to reduce debits and in the absence of debits are allowed to accumulate as credits Such credits may be reduced either by unusable spill from Elephant Butte Reservoir, or by departures on the debit side from deliveries as required by the schedules

Man induced departures between the actual flow of water at the stateline, and the flow required under the schedules may be due to the withholding of water in reservoirs constructed after 1937, as a result of which debits will result, or they may be due to an increased flow brought about by additional drainage development or the release of water held over in reservoirs constructed after 1937 or both in which case credits to the state will result If debits are caused by the withholding of water from the stream in future reservoirs, such water is that which otherwise would have been stored in Elephant Butte Reservoir unless Elephant Butte Reservoir were at such a stage that the water would have spilled had it not been stored in new upstream reservoirs

The terms of the Compact therefore provide that debits may accumulate in any amount so long as an equivalent amount of water is held in storage in future reservoirs, provided, however, that any portion of the water so stored which otherwise would have spilled from Elephant Butte Reservoir, becomes the property of the owners of such reservoir or reservoirs

Since Elephant Butte Reservoir will spill frequently during those periods when water will be available for storage in future reservoirs above Elephant Butte, and since such spills will eliminate all debits against Colorado and upper New Mexico, future reservoirs can operate freely under the terms of the Compact

Conversely, deliveries of water in excess of the requirements under the schedules are credited to those areas making the same,

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so long as such excess deliveries remain in storage in Elephant Butte Reservoir. Such excess deliveries or credits are considered as floating on the top of Elephant Butte Reservoir, and if the stage of project water in storage in Elephant Butte Reservoir rises, causing a spill, the water which is then in the reservoir to the credit of the upper area, is reduced by the amount of any spill which cannot be beneficially used below Elephant Butte Reservoir.

In order that the area above the latter reservoir shall have practically exclusive right to the consumption of the water which would otherwise spill from Elephant Butte Reservoir, the average annual release from that reservoir is fixed at 790,000 acre-feet, which includes 60,000 acre-feet required to be delivered to Mexico by the existing treaty. For the same reason the storage capacity of Elephant Butte Reservoir is fixed at 2,638,860 acre-feet, the original capacity of this reservoir.

The following brief comments on each article of the Compact are intended for a clearer conception of the terms and provisions thereof.

Article I is descriptive of the compacting agencies and major terms as used in the Compact.

Article II provides for the establishment and maintenance of standard gaging stations at predetermined points along the river, for collecting hydrographic data needful for a proper administration of the provisions of the Compact.

Article III sets up the schedules of relationship between the total water supply furnished by the Conejos and its tributaries and the outflow to the Rio Grande, and also the relationship between the total water supply furnished by the Rio Grande at Del Norte and outflow at the stateline, less contributions from the Conejos River basin, as determined by conditions of inflow and outflow since 1928 (the former temporary compact provided that the conditions on the river should remain as of 1929), and makes provisions for correcting this relationship between inflow and outflow resulting from new depletions of inflow, or increase of inflow resulting from importation of water from the Colorado River basin.

While the obligation to meet the schedule of stateline deliveries rests upon the San Luis Valley as a whole, it is believed that a division of the obligation as between the Conejos and Rio Grande will better enable the water users to apportion among themselves their relative responsibilities in meeting the total obligations of Colorado.

The obligation of Colorado to deliver water, as set up by the Compact, is 10,000 acre-feet per annum less than the amount of water indicated by the tables of relationship between inflow and outflow.

This Article also permits Colorado to increase its consumptive uses of water out of the Rio Grande and Conejos Rivers to the extent that water may later be delivered at the stateline from

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the Closed Basin, and to the extent that the quality of water recovered from the Closed Basin is suitable for irrigation uses.

Article IV sets up the schedules of relationship between the total water supply furnished by the Rio Grande at Otowi, New Mexico, which is located 78 miles south of the Colorado-New Mexico stateline, and that furnished at San Marcial near the upper end of Elephant Butte Reservoir, and the obligation of New Mexico to make deliveries of water annually to the Elephant Butte Reservoir in accordance with such schedules, subject to certain provisions and adjustments resulting from changes in location of gaging stations, depletion of streamflow at Otowi after 1929, depletion of runoff during July, August and September from tributaries between Otowi and San Marcial by works constructed after 1937, and by virtue of transmountain diversions into the Rio Grande between the Colorado-New Mexico stateline and San Marcial.

Article V provides for the abandonment or changes in the location of gaging stations by the unanimous decision of the Rio Grande Compact Commission.

Article VI provides for certain allowable departures from the schedules of required deliveries of water by Colorado and New Mexico in any calendar year. Such variation in any year by Colorado may amount to as much as 100,000 acre-feet together with larger debits resulting from holdover storage without violating Colorado's obligation to meet its schedule of deliveries at the stateline. This provision is necessary to permit future diversions in Colorado in any year by presently decreed appropriations in the San Luis Valley in substantially the same manner in which the diversions and uses have been made in past years. Colorado, however, must always retain in storage reservoirs sufficient water to repay any debits due from failure to meet the required schedule of stateline deliveries. It should be noted that this obligation applies only to reservoirs constructed after 1937, and in no way affects the rights of present reservoirs in Colorado to store water within the limits of their present decrees.

This Article also provides that Colorado or New Mexico may not accumulate annual credits in Elephant Butte reservoir in excess of 150,000 acre-feet of water. This limitation is designed to prevent unsound expansion of development which otherwise might result from accumulations of large annual credits and which also might reduce the available capacity of that reservoir to regulate the portion of the river flow to which the lands under the Elephant Butte project are rightfully entitled.

Paragraph six of Article VI provides that the Commissioners of the upper states which have accrued credits in Elephant Butte Reservoir, may authorize any part of such credits to be used under the Elephant Butte project if in their judgment failure to release such credits would result in "actual spill" from the Elephant Butte Reservoir. This would permit at times, a greater use of water under that project for reduction of salinity in the lands which if not used would pass over the

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spillway and be wasted down the river. It should be noted, however, that such releases of credit water belonging to an upper state is entirely optional with the Commissioner of the state holding such credits and would not be agreed to unless in his judgment, the stage of storage in Elephant Butte Reservoir at that time or the prospect for an abnormally large runoff from the basin above would definitely indicate that such credits would later be floated out over the spillway or through the flood release valves of Elephant Butte Reservoir of which no beneficial use could be made.

This Article also provides for reduction in the amount of credit water held in Elephant Butte storage and debit water held in reservoirs in upper New Mexico and Colorado constructed after 1929 to compensate for losses due to evaporation.

Article VII prohibits increase in storage of water in reservoirs in Colorado and New Mexico constructed after 1929, whenever there is less than 400,000 acre feet of usable water in storage in Elephant Butte Reservoir provided however that if the total releases of usable water from that reservoir since the effective date of the Compact, or the last actual spill from the reservoir, have aggregated more than an average of 790,000 acre feet per year, including required deliveries to Mexico the time and amount of minimum storage in Elephant Butte Reservoir shall be adjusted for the excess deliveries.

Article VIII provides for the releases of water from storage reservoirs in Colorado and New Mexico constructed after 1929, to the extent of accrued debits against those states at "the greatest rate practicable under the conditions then prevailing", sufficient to bring the quantity of usable water in Elephant Butte storage to 600,000 acre-feet, and to insure a release from that reservoir of 790,000 acre feet in such year.

This provision is to prevent shortage under the Elephant Butte Reservoir due to the withholding of water which would otherwise have been in storage in that reservoir. The terms of the provisions are such that the release of the water can be made at a rate to protect structures and property along the Conejos and Rio Grande against high stages of flow, and to insure that the releases of reservoir water may be made in such manner as not to encroach upon the stream channel capacity to the detriment of the use of such capacity by Colorado appropriators.

Article IX is a recognition of the right of the U. S. Government or New Mexico to make importations of water into the Upper Rio Grande Basin under conditions that will insure the protection of vested rights present and future uses of water and full development in the San Juan Basin in Colorado.

Article X assures to the state or governmental agency which makes an importation of water from the San Juan basin into the Upper Rio Grande Basin the proper credit for such importation. This provision should be read in connection with subparagraph (c) of Article III.

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Article XI is a most important declaration of principle with respect to the responsibility of an upper state, or citizen thereof, for the quality or character of the water flowing from an upper state into another state, and is designed for the protection of the interests of the upper state and its water users It will be noted that there is now no question concerning the quality or character of the waters of the Upper Rio Grande Basin, but any state may at a later time raise this question in an action before the Supreme Court of the United States, should it decide that a change in quality or character of the waters in later years justifies such action

Article XII sets up the machinery for the administration of the provisions of the Compact The conception of the Commissioners and their advisers was that there should be as little interference as possible with the control by the duly accredited state authorities, and the present uses of water in each state, by the Joint Commission for the administration of the Compact While it was recognized that the provisions of the Compact are not self executing, and hence require some administration aside from the collection of hydrographic data, et cetera, it will be noted that any action taken by the Commission must be unanimous This is designed to protect the rights of any one state against concerted action by a mere majority of the members of the Commission

Article XIII makes provision for minor modifications of the provisions of the Compact which later years may show to be desirable Such changes however, cannot affect the fundamental provisions of the Compact, nor their operation and may be made only by unanimous consent of the members of the Commission, and then are operative only when such unanimous action has been ratified by the Legislatures of the signatory states and consented to by the Congress of the United States

Article XIV is designed to protect Colorado and New Mexico against any increases in future uses of water by Mexico over and above the 60 000 acre-feet recognized by treaty By the provisions of this Article, any decrease in uses of water by Mexico would be to the benefit of the water users under the Elephant Butte Reservoir

Article XV is a declaration that the Compact is based solely upon the conditions peculiar to the Rio Grande Basin and that any provisions therein contained do not establish any general principle or precedent applicable to other interstate streams

Article XVI is a recognition on the part of the signatory states of the rights of Indian tribes and of the obligations of the United States to such tribes, and to the Republic of Mexico under existing treaties

Article XVII provides that the Compact shall become effective when ratified by the Legislatures of the signatory states and consented to by the Congress of the United States

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WHEREAS, On March 18, 1938, an interstate compact equitably apportioning the waters of the Rio Grande above Fort Quitman, Texas, was executed by commissioners for the States of Colorado, New Mexico and Texas and approved by a representative of the United States government, and,

WHEREAS, it appears from the terms of said compact that the rights of the people of Colorado in the country drained by the Rio Grande to use the waters thereof for the development of the San Luis Valley have been established and assured,

NOW, THEREFORE, BE IT RESOLVED by The Colorado Water Conservation Board in regular session assembled at Denver, Colorado, this 28th day of October, A D 1938, that the General Assembly of Colorado at its next regular session be requested and urged to ratify such compact and to urge the Congress of the United States that similar action be taken to the end that such compact may be fully validated, approved and confirmed

Passed, adopted and approved this 28th day of October, A D 1938

TELLER AMMONS,
Chairman

Attest

VENA POINTER
Secretary

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CENTRAL CLASSIFIED FILE
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DEPARTMENT OF THE INTERIOR

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File No. 8 3
(Part 2)

- RECLAMATION BUREAU -

-O-

- RIO GRANDE

-O-

- DISTRIBUTION OF WATERS -

-O-

- COMPACT -

-O-

IMPORTANT

This file constitutes a part of the official records of the Department and should not be separated or papers withdrawn without express authority of the Secretary.

All files should be returned promptly to the File Room.

Officials and employees will be held responsible for failure to observe these rules, which are necessary to protect the integrity of official records.

Ray Lyman Wilbur
Secretary.

August 18. 1930.
to
Feby 25, 1936

U. S. GOVERNMENT PRINTING OFFICE: 1929 6—7385

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ADDRESS ALL COMMUNICATIONS TO
THE CHIEF ENGINEER

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CUSTOMHOUSE
DENVER, COLORADO

OFFICE OF THE CHIEF ENGINEER

December 14, 1934.

The Honorable
The Secretary of the Interior,
Washington, D. C.

(Through the Commissioner
of Reclamation.)

My Dear Mr. Secretary:

Upon receipt of your telegram of December 8, reading as follows,

"BY DIRECTION OF PRESIDENT YOU ARE DIRECTED TO ATTEND MEETING SANTA FE DECEMBER TEN AS HIS REPRESENTATIVE TO PRESIDE AT MEETING OF COMMISSIONERS REPRESENTING COLORADO NEW MEXICO AND TEXAS TO CONFER FOR PURPOSE OF NEGOTIATING A NEW INTERSTATE COMPACT REGARDING WATERS OF THE RIO GRANDE TO REPLACE TEMPORARY COMPACT TO WHICH THE UNITED STATES IS A PARTY STOP PLEASE CONFIRM,"

I replied by telegram of the same date, which is quoted for convenient reference:

"IN ACCORDANCE WITH YOUR TELEGRAPHIC INSTRUCTIONS THIS DATE I WILL PROCEED TO SANTA FE TO PRESIDE AT MEETING DECEMBER TEN OF COMMISSIONERS REPRESENTING COLORADO NEW MEXICO AND TEXAS STOP MEETING CALLED FOR TWO PM AND GOVERNORS OF THREE STATES SO ADVISED."

I immediately communicated with the Governor of Colorado and ascertained that he had previously made tentative arrangements with the Governors of New Mexico and Texas for convening a meeting of the commissioners of the three states at Santa Fe, New Mexico, on December 10. Upon receipt of information that the undersigned had been appointed as the representative of the Federal Government it was agreed with the Governor that the meeting would be called for 2:00 p.m. on December 10, and he thereupon telegraphed the Governors of New Mexico and Texas accordingly.

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On my arrival at Santa Fe at noon on December 10, it was ascertained that the commissioner and other representatives of the State of Texas would not arrive until late that day and after informal conference with the commissioners representing Colorado and New Mexico, it was decided to call a preliminary meeting for the purpose of organization at 8:00 p.m. on December 10, and to defer the formal meeting until the next day.

The preliminary meeting, at which were present the four commissioners and one legal or engineering advisor for each, was held in the La Fonda Hotel. The meeting was called to order by the representative of the Government, who after briefly stating the purpose of the meeting, requested each commissioner to submit his credentials and furnish the names of his legal and engineering advisors who would participate in the formal conference the next day. The first action was to elect the representative of the Government as permanent chairman of the meeting. The following names were submitted by the respective commissioners as the official representatives of the Federal Government and the three States:

United States

S. O. Harper, Asst. Chief Engineer, Bureau of Reclamation,
Representative of President.
E. B. Debler, Hydr. Engineer, Bureau of Reclamation,
Engineering Advisor.

Colorado

M. C. Hinderlider, State Engineer, Commissioner.
Schrader P. Howell, Asst. Attorney General, Legal Advisor.
Geo. M. Corlett, Legal Advisor.
Ralph Carr, Legal Advisor.
Royce J. Tipton, Engineering Advisor.

New Mexico

Thomas M. McClure, State Engineer, Commissioner.
Frank H. Patton, Asst. Attorney General, Legal Advisor.
Pearce C. Rodey, Legal Advisor.
Edwin Mechem, Legal Advisor.
John Bliss, Engineering Advisor.
C. H. Howell, Engineering Advisor.

Texas

T. H. McGregor, State Engineer, Commissioner.
Major Richard F. Burgess, Legal Advisor.

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It was agreed that at the formal meeting the next day each State would be called upon in alphabetical order to submit, through its commissioner or other authorized representative, a general statement outlining the position of that State, to be followed by such further presentations of detailed matters as each commissioner might desire to submit.

The formal meeting was called to order by the chairman at 10:00 o'clock a.m., on December 11, in the Supreme Court Chambers of the State Capitol at Santa Fe. There were present, in addition to the above listed official representatives, about forty persons, including officials of various irrigation projects in the San Luis Valley of Colorado and of the Middle Rio Grande and Rio Grande projects in New Mexico and Texas.

The chairman in his opening statement briefly outlined the history of the previous conference held in February, 1929, resulting in the execution of the compact of February 12, 1929, which was later ratified by the legislatures of the three states and approved by Act of Congress of June 17, 1930. The purpose of the present meeting and the reason for calling it at this time were explained by reference to Article 7 of the compact of February 12, 1929, which is herewith quoted:

> "(a) On or before the completion of the closed basin drain and the State line reservoir, and in any event not later than June 1, 1935, a commission of three members shall be constituted to which the Governor of each of the signatory States shall appoint a commissioner for the purpose of concluding a Compact among the signatory States and providing for the equitable apportionment of the use of the waters of the Rio Grande among said States. The Governors of said states shall request the President of the United States to name a representative to sit with said Commission."

The action taken at the informal meeting the evening before was explained and the names of the commissioners and their authorized advisors were read. The chairman stated that in presiding over the meetings of the Commission he would have no vote, but would act, insofar as possible, as an impartial umpire of the proceedings, his duties as representative of the President being to assist the States in reaching an agreement, and to see that the obligations of the Government under the Treaty of 1906 with Mexico, and its investment in the Rio Grande Project were protected. He stated that

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Hydraulic Engineer E. B. Debler would be available for consultation by the representatives of the States on water supply and engineering matters. The chairman then called on the commissioner from Colorado to open the discussion.

Commissioner Hinderlider, after a brief opening statement, introduced Geo. M. Corlett, former lieutenant governor of Colorado, to present Colorado's case. Mr. Corlett spoke for about an hour, reciting the history of irrigation in the San Luis Valley of Colorado, with figures showing the past, present and prospective irrigation development, the use of water, and the effect of the so-called embargo placed upon construction of reservoirs in the Rio Grande watershed. Mr. Corlett summed up his position by stating that all Colorado asked for was "parity" with the other two States in the use of the waters of the Rio Grande. Upon questioning by the commissioner from Texas as to what Mr. Corlett meant by "parity" there ensued a discussion participated in by several of the representatives of Colorado and Texas, in which the fact was developed that Mr. Corlett in the use of the word "parity" had in mind that the waters of the Rio Grande in Colorado should be regulated by additional storage reservoirs to place Colorado on an equality as regards dependability of water supply with the lands under the Elephant Butte Reservoir in New Mexico and Texas.

After conclusion of Colorado's presentation, the chairman called upon the commissioner from New Mexico to make the opening statement for his State. Commissioner McClure introduced Frank H. Patton, legal advisor, who requested that a recess be called to permit the New Mexico and Texas representatives to confer. The meeting was thereupon adjourned until 2:00 p.m.

Upon reconvening at 2:00 p.m., Mr. Patton resumed his presentation on behalf of New Mexico and stated that after conferring with the Texas commissioner and his advisors, the two States had reached the conclusion that no further progress could be made until two questions were propounded and replies thereto made by Colorado. These questions were:

(1) Does the State of Colorado intend to build the sump drain to drain the closed basin area in the San Luis Valley and utilize the money allotted by the Federal Public Works Administration for this purpose?

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(2) Does Colorado favor the continuation of the present compact?

After a conference among the Colorado representatives, Commissioner Hinderlider announced that Ralph Carr, legal advisor, would answer the questions of the representative of New Mexico. Mr. Carr devoted considerable time to a discussion of the two questions and the issues affecting them, but did not give a clear-cut answer. Regarding the first question, he conveyed the impression that Colorado would be glad to see the closed drain constructed but was not prepared to assume certain obligations which had been attached to the $900,000 allotment made by the Public Works Administration. He stated that the requirement that a district be organized to contract with the Government to agree to furnish the necessary right of way and to assume the obligation of maintaining the drain, was objectionable to Colorado. He also intimated that in addition to the construction of the drain, storage facilities should be provided to place Colorado on a "parity" with the other two states.

Replying to the second question, Mr. Carr stated that the present temporary compact contemplates that the States shall enter into a permanent compact by June 1, 1935, and intimated that Colorado would not look with favor on the continuance of the present compact.

There ensued an argumentative discussion participated in by Commissioner McGregor and Major Burgess of Texas, and Attorneys Corlett and Carr of Colorado. Major Burgess contended that as far as a permanent compact was concerned, the situation was practically the same as it was in 1929, and that no progress had been made, since the date the present compact was entered into; that neither the closed basin drain nor the State Line Reservoir had been constructed; that until the drain had been completed, the quantity of additional water to be developed could not be determined, and that facts were therefore not available upon which a permanent compact could be based. He expressed the view that the present compact should be continued until the closed basin drain had been completed and information on the yield of this drain made available. The Colorado representatives on the other hand contended that they were anxious and willing to enter into a permanent compact at this time, contending that as the present compact concedes to Colorado an additional amount of water equivalent to that developed by the drain, it was not necessary to know, prior to the consummation of the permanent compact, how much water the drain would yield.

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As the discussion proceeded, it became evident that it would be impossible to reach an agreement at this time and as the representatives of each of the States had now become informed as to the attitude of the other States, and as all of the commissioners desired additional time to study the questions which had been raised and to discuss them with other officials of their States, it was the unanimous opinion of the Commission that the meeting should adjourn to a later date. A motion was therefore adopted that the meeting adjourn, to be reconvened at Santa Fe on January 28, 1935, or such other date about that time as may suit the convenience of all of the commissioners.

Although the discussions between certain representatives of the States were at times heated, and although it is recognized by everyone familiar with the situation on the Rio Grande that agreement on a permanent compact is certain to be difficult for the reason that the available water supply is inadequate for the irrigation of all of the lands in the irrigated valleys, and it will therefore be necessary for each of the States to make substantial sacrifices, the meeting closed with a feeling of optimism and with the hope that at the next meeting a permanent agreement may be reached.

Copies of a full record of the proceedings made by the official reporter, will be available for the use of the commissioners and other interested parties in the near future.

Respectfully,

S. O. Harper,
Chairman,
Rio Grande Compact Commission.

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(Correspondence) re: Texas vs New Mexico
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State of Texas v. State of New Mexico,

No. 12 Original, 1936 Term.

Statement by Special Master.

On May 25, 1936, I was appointed Special Master in this case.

On August 4, 1936, I held a conference in Washington with counsel to agree on dates for hearings and method of procedure.

From November 6, 1936 to January 16, 1937, I was engaged in travel to New Mexico and Texas, and in holding 34 hearings at El Paso, Texas, and at Albuquerque, New Mexico, and I made a personal inspection of the whole drainage and irrigation systems, dams, diversion dams, etc., involving motoring upwards of 600 miles up and 600 miles down the Rio Grande River. Much testimony by engineers, chemists, and other experts has been introduced, as well as several hundred documentary exhibits, maps, charts, etc. Hearings are to be resumed by me at El Paso on March 15, 1937, and it is expected that New Mexico will then close its case and Texas its rebuttal, prior to March 25. The progress of the suit has developed new situations which were not apparent when the motion to dismiss was argued March 3, 1936.

The suit arises out of the following circumstances.

In 1915-1916, the United States completed the Elephant Butte Dam and Reservoir in New Mexico, to store waters which it had appropriated in 1906 and 1908, allegedly under the Federal Reclamation Act and under the laws of New Mexico; such water was to be used for two purposes, first to supply the Republic of Mexico with water under the Treaty of 1906; and, second, to provide irrigation for lands in New Mexico and Texas, south of the Elephant Butte Dam.

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In 1929, the States of Colorado, New Mexico, and Texas, entered into the Rio Grande Compact (a temporary measure which expires in June, 1937) to regulate the use of waters of the Rio Grande. This Compact contained, amongst other provisions, an article which provided that New Mexico "will not cause or suffer the water supply of the Elephant Butte Reservoir to be impaired by new or increased diversion or storage within the limits of New Mexico unless and until such depletion is offset by increase of drainage return."

Under the laws of New Mexico of 1923 and 1927, the Middle Rio Grande Conservancy District (a municipal corporation of New Mexico) was constituted for the purpose of drainage, irrigation, and flood protection of lands north of Elephant Butte Reservoir extending for about 170 miles up the Rio Grande Valley, with a net irrigable area of about 124,000 acres.

Construction of the irrigation and drainage system began in April, 1930; and later construction of a new dam and reservoir -- the El Vado Dam -- was begun in connection with the project.

On October 28, 1935, the State of Texas brought this suit against the State of New Mexico, and the Middle Rio Grande Conservancy District, basing its suit, as it contends, on two grounds -- first, that New Mexico had violated the Compact by impairing the water supply in the Elephant Butte Reservoir through excessive diversions and through injurious increase of the salt contents of the water; and second, that such excessive diversions and increase of salt contents were in violation of the rights of Texas water users, under the general doctrines of water law in the southwest.

During the hearings, the following complications and new angles have arisen:

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First. New Mexico contends that the decrease of water supply alleged by Texas is not due to unlawful diversion by New Mexico, but is in part due to unlawful diversion by the Republic of Mexico, in that Mexico has violated its Treaty of 1906 and has taken two to three times the amount of water to which she is entitled. This contention by New Mexico, if sustained by the facts, will require a ruling by the Master and by the Court on the question whether the Republic of Mexico has violated a treaty. It seems desirable to avoid such a ruling if possible. There is a conflict of evidence as to the amount of water being taken by Mexico, and as to its effect on Texas. The fact that the present International Dam at El Paso is half in Mexico and half in the United States makes any accurate measurement of water diversions impossible. This situation will be changed during the next year, owing to the fact that a new dam is already under construction, north of El Paso, which will be entirely in United States territory and at which it will be possible, probably by the end of the year 1937, to measure more accurately the water diversions.

Second. New Mexico also contends that the depletion of water supply alleged by Texas is due to improvident or wasteful methods of operation of the Elephant Butte System by the United States Government; and it also contends that the appropriation of water by the United States in 1906 was not made in compliance with the laws of New Mexico, as required by the Federal Reclamation Act.

These contentions directly involve the interests of the United States; but the United States is not a party to the suit.

The United States has a further interest in this suit, as the Reconstruction Finance Corporation has loaned to the Conservancy District about $6,000,000 on bonds of the District; and though not a

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party to the suit, counsel and engineers of the Reconstruction Finance Corporation are acting as assistant counsel for the District, though I have not recognized them as counsel of record, since their appearance has not been filed with the Clerk of the Court as yet).

Third. Texas contends that the operation of the Conservancy District had depleted the water supply in the Elephant Butte Reservoir by excessive diversions of water, to the injury of the State of Texas, and of present and future Texas water users.

The District drainage and irrigation system, however, was not completely constructed until the year 1933-1934, and the effect on the water storage in the Elephant Butte Reservoir could not be properly ascertained until 1934. Such limited statistics for less than three years are unsatisfactory.

Fourth. Texas contends that the operation of the drainage portion of the Conservancy District has increased the salt contents of the water. Prior to the year 1933-1934, the drainage system had not been completed, and the effect upon the salt contents of the water in the Elephant Butte Reservoir would probably not become fully apparent until the year 1935. No actual salt tests of the waters in the drains themselves were made until the year 1936. Such limited amount of evidence as to salt contents is unsatisfactory.

Fifth. Texas contends that the construction and operation of the El Vado Dam by the District has still further depleted the waters of the Elephant Butte Reservoir. This El Vado Dam, however, was not completed until the year 1935, and water was not released for irrigation purposes until July, 1935. Hence, there is evidence as to its actual effect for only one and one half years.

Sixth. Since December, 1935, the National Resources Committee

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on Public Works Planning, appointed by the President and headed by Frederic A. Delano as Vice Chairman, through a Water Resources Committee (largely of engineers) has been investigating the whole problem of water supply and distribution in the Upper Rio Grande region, from below El Paso, Texas, up to and including the San Luis Basin in southern Colorado.

This Committee in conjunction with the United States Geological Survey, the Bureau of Agricultural Engineering, the Bureau of Reclamation, the Bureau of Indian Affairs and other Federal agencies, together with engineers of New Mexico, Texas, and Colorado, has been investigating and preparing a report, all through the year 1936. This report, it is understood, will probably be submitted in April, 1937. It is certain that this report will contain facts and suggestions of great value as bearing on the issues in this case.

Seventh. Though this Court has held, on motion to dismiss, that the State of Colorado is not a necessary party to this suit, it is evident that if the contentions of the State of Texas should be upheld in this suit, it would be very difficult to frame a decree for equitable distribution of the waters of the Rio Grande, without taking cognizance of the rights of Colorado, or at least of the actual facts relating to the Rio Grande in Colorado, and of the present and future diversions of water in that State. While, at this time, it is not appropriate for me to arrive at any conclusions of law, it is probable that at the termination of the case, the decree, if in favor of Texas, will be based on the doctrine of equitable distribution laid down in recent cases, rather than on the strict prior-appropriation doctrine of Wyoming v. Colorado, owing to the fact that while the law of New

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Mexico is that of prior-appropriation, the law of Texas seems to be a combination of the old riparian-right law with a prior-appropriation feature added.

Though Colorado is not a party to the suit, counsel from that State (though I am not informed whether they are actually acting as counsel for the State) have been present and taking notes at all the hearings.

In view of the foregoing, I am of opinion that findings of fact by me based on the evidence in its present shape would be unsatisfactory, and even if I should find in favor of Texas, would not equitably adjust the situation. It is apparent that postponement of findings by me for a year (a) might result in the practical elimination of the Republic of Mexico complication; (b) might give all parites opportunity to consider carefully, and possibly act on, the forthcoming report of the National Water Resources Committee; (c) might enable further figures to be obtained as to the consumptive use of water by the Conservancy District and also further tests to be made of the salt contents of the drains of the Conservancy District during the coming irrigation season of 1937; (d) might furnish further evidence of the practical effect of the operation of the El Vado Dam; (e) might afford opportunity for the United States or the State of Colorado (either or both) to seek to intervene in this suit, if it should see fit so to protect its interests. I also have a feeling that a postponement might tend to result in a settlement of the suit, for the respective factual rights of the States are such that they ought to be settled by agreement of the engineers, rather than by lawsuits.

At the suggestion of the Chief Justice, I am submitting this statement, to this Honorable Court, so that, if possible, I may be

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advised informally, whether under the order appointing me as Special Master, I have any authority to postpone further hearings in this suit after March 26, until the end of 1937; or whether I have the power to file with the Court an interim Report setting forth the foregoing facts and suggesting postponement.

Respectfully submitted,

Special Master.

March 5, 1937.

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RG 115

FY 13

Bureau of Reclamation
Project Correspondence File
1930 - 1945

Rio Grande Pro.

223.02

Box 920

Entry 7

TX_MSJ_006211

223.02 Rio Grande - Leases, Sales & Rentals of Water
El Paso, City of thru Dec 1941

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

223.02-
RIO GRANDE

JUL 25 1940

HJSD:NH

Mr. W. E. Robertson, Chairman,
Water Development Commission of the City of El Paso,
P. O. Box 65,
El Paso, Texas.

Dear Mr. Robertson:

As promised in Commissioner Page's letter of June 17, your letter of June 8 addressed to him has been receiving the further consideration of the Bureau of Reclamation in relation to the problems of municipal water supply for the city of El Paso.

As you are perhaps aware, the water supply of the Rio Grande project has for some time been fully committed to the purpose of development of hydroelectric energy at Elephant Butte dam and to the furnishing of an irrigation supply for project lands within the Elephant Butte Irrigation District and the El Paso County Water Improvement District Number One, both of which districts have heretofore contracted with the United States pursuant to the Reclamation Laws for the repayment of certain costs in connection with the project.

The supply of water available for storage in the Elephant Butte Reservoir is also subject to the provisions of the Rio Grande Compact signed at Santa Fe on March 18, 1938, among the states of Colorado, New Mexico and Texas, and approved by the Act of May 31, 1939 (53 Stat. 785).

As suggested in your letter, there would therefore probably be involved in the first instance the retirement from a water right status of lands within the project to an extent that would relieve the irrigation demand upon the water supply to the extent of a quantity of water comparable to that sought to be acquired for municipal uses by the city of El Paso. This, I believe, would be a matter for arrangement with owners of such lands, possibly in collaboration with representatives of the district within which such lands may be situated.

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

There would then be for consideration the provisions of the Reclamation Laws of possible application to the matter of acquisition of a portion of the project water supply to serve municipal purposes.

In this connection your attention is invited to the Act of February 25, 1920 (41 Stat. 451), which provides as follows:

> "That the Secretary of the Interior, in connection with the operations under the reclamation law, is hereby authorized to enter into contract to supply water from any project irrigation system for other purposes than irrigation, upon such conditions of delivery, use, and payment as he may deem proper: Provided, That the approval of such contract by the water users' association or associations shall have been first obtained: Provided, That no such contract shall be entered into except upon a showing that there is no other practicable source of water supply for the purpose: Provided further, That no water shall be furnished for the uses aforesaid if the delivery of such water shall be detrimental to the water service for such irrigation project, nor to the rights of any prior appropriator: Provided further, That the moneys derived from such contracts shall be covered into the reclamation fund and be placed to the credit of the project from which such water is supplied."

In view of the quoted provision relating to the approval of the project water users' organizations, I believe that the greatest progress could be made toward attainment of the city's objectives, with reference to the desired water supply, if the Water Development Commission of the city of El Paso should first collaborate with representatives of the Elephant Butte Irrigation District and the El Paso County Water Improvement District in reaching a preliminary understanding as to what arrangement, if later embraced in a contract with the city of El Paso, might receive favorable consideration and ultimate approval by those Districts, after which it might be possible to work out the precise details of form of such contract as might then appear to be desirable.

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You may be sure that the Bureau of Reclamation will cooperate fully with the city of El Paso, its Water Development Commission and the project Districts in the matter.

Very truly yours,

Acting Commissioner.

CC-Hon. R. E. Thomason
Roland Harwell, Mgr., El Paso County Water Develpt. Dist. No. 1
N. B. Phillips, Mgr., Elephant Butte Irrigation Dist.,
Chief Engineer, Denver
Supt., El Paso
D. C., El Paso

Dennis Sanford Attorney

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RG 115

FY 13

Bureau of Reclamation
Project Correspondence File
1930 - 1945

Rio Grande Pro.

223.02

Box 920

Entry 7

TX_MSJ_006216

223.02 Rio Grande - Leases, Sales & Rentals of Water
El Paso, City of thru Dec 1941

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

223.02-
RIO GRANDE

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WASHINGTON

January 17, 1941.

OFFICE OF THE COMMISSIONER

Memorandum for Mr. Stinson.
(Harrell)

Subject: Rio Grande Project - Sale of water to City of El Paso for supplemental supply for Municipal purposes.

It appears that there is no surplus of water available from the Rio Grande Project which might be sold by the United States to the City of El Paso for a supplemental water supply for municipal purposes.

Although the several repayment contracts between the United States and the El Paso and the Elephant Butte Districts are not as explicit as they might be, the contracts taken together provide that the United States will construct project works for the distribution and delivery of water for irrigation to the irrigable lands of the districts, and that the districts will repay the United States the entire construction cost of the project works upon the basis of their relative irrigable acreages.

Pursuant to authority in the Interior Department Appropriation Act, fiscal year 1938 (50 Stat. 564,592), contracts between the United States and the districts dated November 10, 1937, and November 9, 1937, allocated the entire cost of Elephant Butte Reservoir storage to power, and reduced the total repayment obligation of the two districts by $4,246,408.39. Although by said contracts the districts conveyed to the United States all interest in the project works and in the project water supply, for the development of power, they did not convey or release their interests in the project works for the storage and delivery of water for irrigation, or their interests in the project water supply for irrigation. Under said Act and said contracts, the use of project works and water supply for power generation is secondary to use for irrigation purposes.

The project water supply is covered by water filings made by the United States pursuant to the law of the Territory of New Mexico on January 23, 1906, and pursuant to the laws of the State of New Mexico April 11, 1908.

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Archival Operations

RG No. 115

The project irrigable area is considered to be 155,000 acres, 88,000 acres in the Elephant Butte District, and 67,000 acres in the El Paso District. The interdistrict agreement of February 16, 1938, approved by the Assistant Secretary on April 11, 1938, adds a 3% increase to these acreages, as the acreages against which the Districts may levy their assessments.

The project water supply is restricted by the Rio Grande Compact, which establishes the average permissible release from Elephant Butte Reservoir at 790,000 acre feet per year. The letter from the Acting Chief Engineer to the Commissioner dated June 17, 1940, in reference to the 790,000 acre feet covered by the Compact states that studies placed the project water supply at 787,000 acre feet annually for a project irrigated area of 155,000 acres, and that until the project can demonstrate its ability to irrigate more than 155,000 acres with such a fixed water supply, no increase in irrigated area should be contemplated. If it be determined that this fixed water supply is in excess of that required for 155,000 acres, other project lands will have first call for such water. The Superintendent in his letter of November 19, 1940, to the Commissioner (paragraph 3) states that the total area which is susceptible of irrigation on the project is approximately 175,000 acres. Although in any given year there may be a surplus of water available for disposal by the United States, that is an excess in that year over the amount necessary for the acreage under irrigation that year, a contract covering such surplus would not assure any certain water supply.

Since there is no surplus available, a contract for the furnishing of the City of El Paso with a supplemental water supply from releases from project storage will require the consent of the two districts, the El Paso County Water Improvement District No. 1, and the Elephant Butte District, without regard to the Act of Congress pursuant to which the contract is executed.

There are three acts under which contracts furnish municipalities with water from a reclamation project can be authorized. The authority set out in Section 9 of the Reclamation Project Act of 1939 (53 Stat. 1187) contemplates the furnishing of a permanent water right to a city municipality for water from a reclamation project, with the payment by the municipality of its proportionate share of the construction costs for the storage and delivery of such water. The present proposed contract with the City of El Paso does not propose to give the city such a permanent water right.

Section 4 of the Act of April 16, 1906, (34 Stat 116) reading as follows:

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

"That the Secretary of the Interior shall, in accordance with the provisions of the reclamation act, provide for water rights in amount he may deem necessary for the towns established as herein provided, and may enter into contract with the proper authorities of such towns, and other towns or cities on or in the immediate vicinity of irrigation projects, which shall have a water right from the same source as that of said project for the delivery of such water supply to some convenient point, and for the payment into the reclamation fund of charges for the same to be paid by such towns or cities, which charges shall not be less nor upon terms more favorable than those fixed by the Secretary of the Interior for the irrigation project from which the water is taken."

also appears to contemplate the acquisition of a permanent water right.

The proposed contract to supply water to the City of El Paso more clearly falls within the authority of the Act of February 25, 1920, (41 Stat. 451), reading as follows:

"That the Secretary of the Interior, in connection with the operations under the reclamation law, is hereby authorized to enter into contract to supply water from any project irrigation system for other purposes than irrigation, upon such conditions of delivery, use, and payment as he may deem proper: Provided, That the approval of such contract by the water users' association or associations shall be entered into except upon a showing that there is no other practicable source of water supply for the purpose: Provided further, That no water shall be furnished for the uses aforesaid if the delivery of such water shall be detrimental to the water service for such irrigation project, nor to the rights of any prior appropriator: Provided further, That the moneys derived from such contracts shall be covered into the reclamation fund and be placed to the credit of the project from which such water is supplied."

Under the proposed contract, the City will pay each year the same aggregate charge that the lands acquired by the City would have been subject to, under all charges levied by the El Paso District during the year, if the lands had been owned by qualified private owners and had received the amount of water received by the City under the contract. The District is protecting the water supply available for other lands in the District by requiring the City to buy District lands, and limiting the water to be received by the City to the amount that these lands would have received. The District, therefore, requires that the District receive the full credit of the payments made by the City to the United States, which are the ones that would have been paid to the District if the lands acquired by the City had remained in the hands of private owners and had received such water.

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

It appears that there is nothing in the Act of February 25, 1920, or in other acts of Congress which would prevent the United States from requiring that the City pay an additional charge under the contract which could be credited by the United States to Elephant Butte Reservoir storage, since such credit would be a credit to the project within the proviso of the act. The question of the advisability of imposing this additional charge is, however, a question of policy.

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RG 115 FY 13

Records of the Bureau of Reclamation
Washington, D.C.

PROJECT ADMINISTRATIVE
AND PROJECT RECORDS

1919-1945
PROJECT FILES, 1919-1929
RIO GRANDE 223.02

Box 907 **Entry 7**

TX_MSJ_006222

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

223.02 Rio Grande Water Hudspeth County Conservation & Reclamation District

Thru 1929

Transfer Case

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Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Return to files of
Bureau of Reclamation

RIO GRANDE
223.02-
Separate Folder

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CONTRACT

HUDSPETH COUNTY CONSERVATION & RECLAMATION DISTRICT

December 1, 1924

TX_MSJ_006224

Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Separate Folder 223

3

Form 7-523t (Revised Feb., 1923)

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE

LEGAL
RIO GRANDE
TRANSFER CAS

Rio Grande Project El Paso, Texas (Place.) December 27th (Date.) 1924

Superintendent ~~Project Manager~~ to Commissioner ~~Chief Engineer~~ through Director of Finance ~~District Counsel~~ Asst. to the Com'r

Subject: Forwarding contract dated December 1, 1924 for execution approval ~~xxxxxx~~ 1/2 Accounting

With Hudspeth County Conservation and Reclamation District No. 1 deed ~~xxxx~~

Estimated amount involved, $ 35,000.00 Annually Authority No. 13A-1 ~~xx Clearing Acctx~~

Accompanied by bond and 2 copies (No bond)
(Insert "Yes" or "No" bond.)

Purpose: Sale of surplus and recovered waters

Advise Superintendent ~~Project Manager~~ at El Paso, Texas (Post office address.)

District Counsel at El Paso, Texas (Post office address.)

and Denver Office

of the approval of the above, using extra copy hereof.

NOTE.—Before submitting contract or deed, see that the instructions on reverse hereof have been FULLY complied with. See also par. 16, page 205, Vol. I of Manual.

Inclosures from project office:
Original and 3 copies of this form letter.
Original and 4 copies of contract.

S. G. 11/21/31

L. M. Lawson,
(Signature.)

Denver, Colo., , 192

Contract, and bond if any, approved

by , Chief Engineer, on , 192

Denver, Colo., Dec. 31, 1924 , 192

~~Chief Engineer to Director~~:
Acting Director of Finance to Commissioner:

It is recommended that the above-described contract be executed ~~approved~~ ~~xxxxxx~~ ~~xxxxx~~

~~and bond if any approved~~.

Inclosures listed on reverse hereof.

Armand Offutt.
(Signature.)

Washington, D. C., JAN 12 1925 , 192

Contract, and bond, if any, executed ~~approved~~ by ~~accepted~~

Deed

on JAN 7 - 1925 , 192

Elwood Mead, Commissioner,
Bureau of Reclamation

JAN-5 '25 79862

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

nclosures from Denver office:
Original and 3 copies of this form letter.
Original and 2 copies of contract.
deed

Executed under Special Authority
dated Nov 19 1924

Remarks:

he organization of the contracting district is being confirmed in a roceeding now pending in court, and the district is planning to approve the ithin contract by a vote of the electorate in the near future. After the ontract shall have been so approved the Secretary of the Interior should all upon the district for confirmation of the contract under Section 61, apter 87; General Laws, Texas, 1917. In view of the fact that the nited States is making no expenditure under the contract, and the further act that the contract, without a vote of the electorate, would be good or a year, it would seem appropriate for the Government to execute it ow. In Article 7, line 8, the words "per acre" were inadvertently omitted rom the form approved by the Secretary.

Ottamar Hamele

Special Attorney.

(Inserted by Denver Office)

Wrong statute reference in line 4 of preamble. For approved draft of contract see Commissioner's letter to Secretary of November 19, 1924.

INSTRUCTIONS

1. This form is devised to render unnecessary the writing of various routine letters in reference to contracts and deeds. If e contract submitted is not of the class for approval in Denver (see C. L. 969 as amended by C. L's. 980, 1002, 1029, and 1071), e chief engineer will forward with his recommendation to Washington for appropriate action.

2. This form shall be used only in the case of contracts to be executed or approved at Washington or Denver (see C. L. 969 amended) and for deeds and easements which are accepted only at Washington.

3. The office in which the contract or deed originates will transmit *three* (3) *copies* of this form *in excess* of the number of ices to be advised of approval, execution, or acceptance, one copy to be held by the district counsel pending approval, execu- n, or acceptance. For example, in the usual case where the project manager and the district counsel are to be advised, five copies and one (1) original (6 in all) should be sent to the district counsel, who will forward to Denver four copies and one ginal (5 in all).

4. With every contract or deed submitted involving an expenditure, the authority number (G. O. 278) or clearing account which charges will be made must be given in the space provided on this form letter. (See par. 41, p. 214a, Vol. I of Manual.) e amount of probable expenditure or collection must also be shown. (See par. 11, p. 204, Vol. I of Manual.) Any other special tter or information relative to the contract or deed too long to write on this form should be set out in a statement or certificate d submitted with the contract or deed.

5. Reference should be made to previous correspondence of importance, especially if form of contract or deed was approved advance, *giving dates*, stating whether a telegram or letter, and from and to whom.

6. The office in which the contract or deed originates should list all inclosures in the space on the face of this form. If the ace is not sufficient, list on separate sheet.

7. All quitclaim or donation deeds and easements (see par. 47, p. 265, and par. 10, p. 290, Vol. I of Manual) shall be trans-

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Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT.

ORIGINAL TO
Held for records and return
General Accounting Office

1/17/25

1/17/25

CONTRACT BETWEEN THE UNITED STATES AND HUDSPETH COUNTY CONSERVATION AND RECLAMATION DISTRICT NO. 1, PROVIDING FOR RENTAL OF WATER TO THE DISTRICT.

ENTERED
Contract Record

THIS CONTRACT, made this first day of December 1924, in pursuance of the act of June 17, 1902 (32 Stat., 388), and acts amendatory thereof or supplementary thereto, particularly the Warren act of February 21, 1911 (36 Stat., 925), all herein styled the Reclamation Law, by and between THE UNITED STATES OF AMERICA, herein styled the United States, acting in this behalf by the officer executing this contract, and the HUDSPETH COUNTY CONSERVATION AND RECLAMATION DISTRICT NO. 1, herein styled the District, an irrigation district duly organized and existing under and by virtue of the laws of the State of Texas, witnesseth:

Explanatory Recitals.

2. WHEREAS, the District contains an irrigable area of 20,014 acres, located in Texas just below the Rio Grande Federal Irrigation Project; and,

3. WHEREAS, the terminus of the Tornillo Main Canal of said

TX_MSJ_006227

Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations

RG No. 115

project may be feasibly connected with a district canal to serve water to lands of the District; and,

4. WHEREAS, the United States will have available for disposal at the terminus of said Tornillo Main Canal, certain water developed from the Rio Grande project, which water may be used for the irrigation of lands within the district;

5. NOW THEREFORE, for and in consideration of the mutual and dependent stipulations herein set forth, it is hereby agreed as follows:

Rental of Water to District.

6. The United States will deliver to the District at the terminus of the Tornillo Main canal, during the irrigation season of 1925 and thereafter during each irrigation season as established on the Rio Grande project, such water from the project as may be available at said terminus without the use of storage from Elephant Butte reservoir. The Secretary of the Interior shall be at all times the sole judge of the availability of such water. The rental of water hereunder is secondary and inferior to the right to use water for any purpose on the lands of the Rio Grande Federal Irrigation Project. In consideration of such rental the District hereby relinquishes all right, title, interest, and claim to any and all waters of the Rio Grande, except as herein provided.

Payment by District for Water.

7. For the delivery of water during the irrigation season

TX_MSJ_006228

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

of 1925, the District shall pay the United States a charge of one dollar and twenty-five cents ($1.25) per acre-foot, on or before December 1, 1925. For the delivery of water thereafter, the District shall pay to the United States, on each December 1, such a charge per acre-foot, to be fixed annually by the Secretary of the Interior, as shall return to the United States, six per centum on the construction cost per acre of such project works as affect the district water supply hereunder, plus a proper, proportionate share of the cost of operating and maintaining such project works. The decision of the Secretary of the Interior in fixing such charges shall be final and conclusive. All water available at the terminus of the Tornillo Main Canal, which can be put to beneficial use on district lands subject to irrigation at the time the water is available, shall be considered delivered to the district, and the district shall pay therefor, without reference to whether all of such water is in fact actually taken and used on such lands. For the information of the district the Superintendent of the Rio Grande project will render to the district monthly statements showing the quantity of water in acre-feet delivered to the district during the preceding month. All water rental charges due and unpaid the United States from individual water users within the District, for the years 1921, 1922, and 1923, totaling $3,702.50, together with the penalties thereon, shall be paid by the District to the United States on December 31, 1925, and the District agrees to make during the year 1925, a special assessment against the lands on account of which said accruals are unpaid and to pay the

TX_MSJ_006229

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

amount so assessed on December 31, 1925.

Penalty for Delinquency in Payment.

8. To every sum of money required to be paid under this contract which shall remain unpaid after the same shall have become due, there shall be added at once a penalty of one per centum (1%) thereof, and a like penalty of one per centum (1%) on the first of each month thereafter so long as such default shall continue; and the District hereby agrees to pay such penalty. In the event the District fails to pay any amount provided for in this contract when due the United States may refuse to deliver water to the District until such payment is made. The provisions of this article are not exclusive and shall not in any manner hinder the United States from exercising any other remedy to enforce collection of moneys payable hereunder.

Default by Individual Landowners.

9. The District as a whole is obligated to pay to the United States the full amounts herein agreed upon, regardless of any individual default in the payment of any assessment levied by the District, and the District will make extra levies and collect extra assessments whenever necessary to make up for any such default or delinquency, so that in any event and regardless of such default or delinquency, the full amounts agreed to be paid shall be paid the United States by the District.

Measurement of Water.

10. The flow of water provided for in this contract during the irrigation season of 1925 and thereafter will be measured by

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Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

the United States at the heading of the Ft. Hancock Main Canal where the United States will install and operate and maintain a measuring device, the cost of which as found by the United States, shall be borne by the District, and the measurements by the United States shall control for all purposes of this contract. This cost shall be additional to the charge payable under Article 7 hereof and shall be due and payable upon rendition of bills therefor.

Control of Water by District After Delivery.

11. The District, upon receiving the water delivered as herein provided, shall, at its own cost and expense, convey the same to the lands of the District and perform all acts necessary or required by law or custom, in order to maintain its control over such water and in order to secure its beneficial application to the lands of the District. The District assumed full responsibility for the control and handling of said water and for any damage that may result therefrom after its delivery by the United States at the aforesaid point of delivery. All losses or diminution of such water by reason of seepage, evaporation or other causes after delivery by the United States at the aforesaid point of delivery shall be borne by the District.

Use of Water by District.

12. The water supplied under the terms of this contract shall be used solely for the purpose of distribution by the District for irrigation of lands in the District and such water shall be delivered by the District in accordance with and subject to the

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RG No. 115

conditions and limitations of Section 1 of said Warren Act: Provided, that the provisions of this article shall not be construed to the prejudice of the District as to any benefit which otherwise would accrue through the enactment of future Federal legislation.

Shortage in Water Supply.

13. On account of drought, inaccuracy in distribution or by reason of the requirements and use on the lands within the Rio Grande Federal Irrigation Project or by the use of municipalities supplied by the waters thereof, or other causes, there may be at times an insufficiency of water for district lands but in no event shall any liability accrue against the United States or any of its officers, agents or employees for any damage, direct or indirect, arising therefrom, nor shall any charge provided for herein be reduced on account of any such shortage.

Waste and Seepage Water.

14. The District releases the United States, its officers, agents and employees from every claim for damage, direct or indirect, arising by reason of the presence of waste or seepage water on the lands of the District by reason of the water furnished the District as herein provided, or from any other cause.

Officials not to Benefit.

15. No Member of or Delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract or to any benefit that may arise therefrom. Nothing, however, herein contained shall be construed to extend to this contract if made with a corporation for its general benefit.

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Successors and Assigns Obligated.

16. The provisions of this contract shall apply to and bind the successors and assigns of the respective parties.

IN WITNESS WHEREOF, the parties hereto have hereunto subscribed their names the day and year first above written.

THE UNITED STATES OF AMERICA

By Elwood Mead
Commissioner, Bureau of Reclamation

JAN 7 1925

HUDSPETH COUNTY CONSERVATION AND RECLAMATION DISTRICT NO.1.

By (Sgd) W. T. Young
President.

Attest:

(Sgd) C.J.Mapel
Secretary.

(SEAL)

Executed under Special Authority
Dated 11/19/24

-7-

TX_MSJ_006233

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EXTRACT FROM

MINUTES OF A MEETING OF THE BOARD OF DIRECTORS OF HUDSPETH COUNTY CONSERVATION AND RECLAMATION DISTRICT NO. 1, HELD DECEMBER 1, 1924.

The President laid before the Board for consideration the proposed contract between the District and the United States, for water service during the year 1925, and thereafter, and the Board having duly considered the same, the following resolution was unanimously adopted:

BE IT RESOLVED: That the proposed contract between Hudspeth County Conservation and Reclamation District No. 1 and the United States of America for water supply for the District for the year 1925 and thereafter, be and the same is hereby in all things approved, and the President and the Secretary of the Board are hereby authorized and directed to execute the same on behalf of the District, and to take all steps which may be necessary in the premises.

We hereby certify that the above and foregoing is a true and correct copy of the resolution adopted, and of the portion of the minutes of the Board relating thereto, at a meeting of the Board duly and regularly held at the office of the District, on the first day of December, A. D. 1924, at which all of the members of the Board of Directors were present and consenting thereto.

(Sgd) W. T. Young,
President.

ATTEST:

(Sgd) C. J. Mapel
Secretary.

(SEAL)

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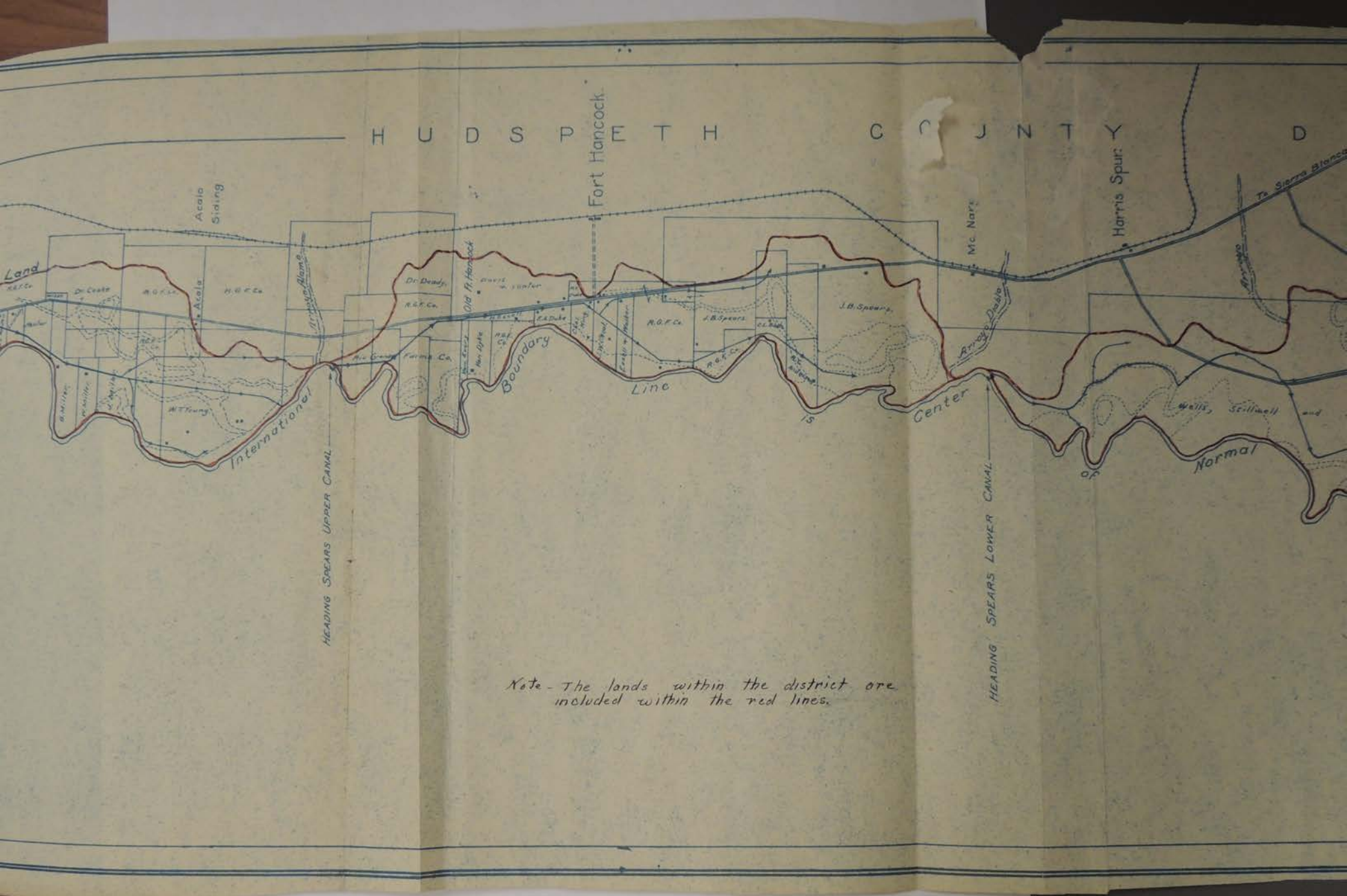

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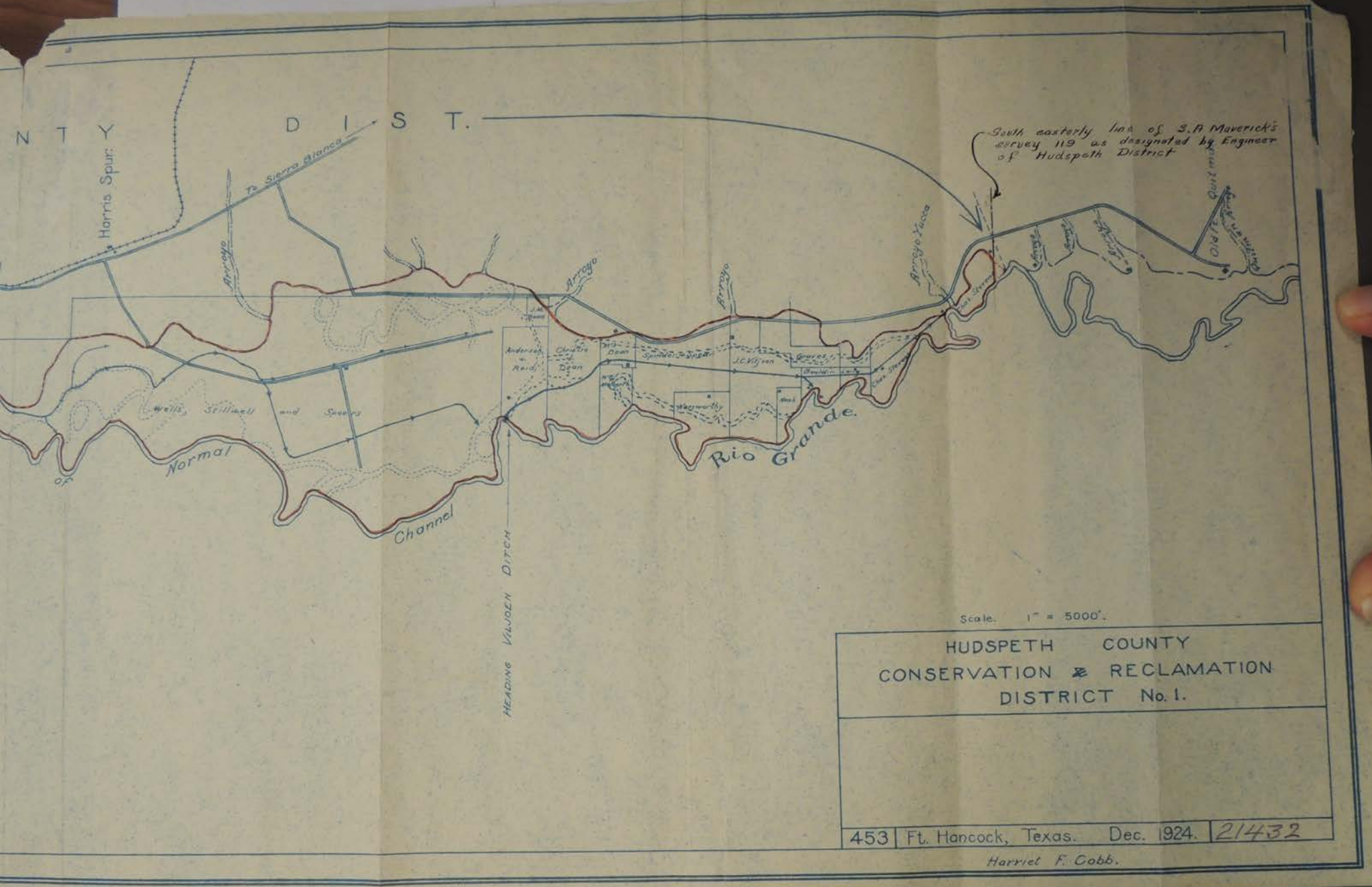

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RG 115 Records of the Bureau
of Reclamation

GENERAL ADMINISTRATIVE AND
PROJECT RECORDS, 1902-1919

Rio Grande 17-46

Box No. 792

Entry 3

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46 RIO GRANDE PROJECT. PENASCO ROCK RESV. SITE-ELEPHANT BUTTE RESV. SITE 46
1903 - 1905

TRANSFER CASE

Box 438

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46
Rio Grande

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

RECLAMATION SERVICE

A DISCUSSION OF PAST AND PRESENT PLANS FOR IRRIGATION OF THE RIO GRANDE VALLEY

By

B. M. Hall
Supervising Engineer
U. S. Reclamation Service

----- : -----

November
1904

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TX_MSJ_006242

A DISCUSSION OF

PAST AND PRESENT PLANS FOR IRRIGATION OF THE RIO GRANDE VALLEY

By

B. M. Hall
Supervising Engineer,
U. S. Reclamation Service.

The Rio Grande rises in the State of Colorado, and flows south through the entire length of the Territory of New Mexico to the north boundary of Texas, near the town of Anthony. From this point to "The Pass", about four miles above El Paso, Texas, it forms the boundary between New Mexico and Texas. At "The Pass" it becomes the boundary line between the United States and Mexico, and continues as such for about 1,300 miles to the Gulf of Mexico.

So far as its history is known it has always been a torrential or storm-water stream, subject at times to great floods, amd at other times to periods of minimum flow when its bed was dry, or carried an insignificant amount of water along certain parts of its course.

Above El Paso it has a length of about 900 miles, and a drainage area of about 38,000 square miles. In this section its ordinary flow, or what is known as its permanent water, comes almost entirely from a comparatively small area in Colorado and upper New Mexico where there is a heavy snow fall in the mountains.

The country through which it flows is very fertile, but the rainfall is so meager, and so erratic that it is an arid

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desert, and no crops can be raised without artificial irrigation.

"Before the middle of the sixteenth century the Spaniards entered the valley of the Rio Grande in New Mexico, and there found the Pueblo Indians living in towns, cultivating the land, and bringing water onto it by irrigating ditches, many of which are still in use to this day". A Spanish colony was established at Chamita, New Mexico, in 1598, and at Santa Fe in 1605. The latter colony existed until 1680, when they were driven out by the Pueblo Indians. Spanish supremacy was again established in 1692. From that time to near the middle of the nineteenth century the Rio Grande Valley in New Mexico was under the dominion of Spain and Mexico, and was settled up by Spaniards and Mexicans, who irrigated and cultivated the lands. In the excellent report made by Mr. W. W. Follett in 1896 to the International Boundary Commission, he says: "While quite a large native population has come into the Rio Grande drainage in New Mexico since the construction of railroads in 1880, it is confined principally to the towns, and today fully 90 per cent of the irrigating in this section is done by Mexicans and Indians" In the same report Mr. Follett says: "The El Paso Valley was occupied by Spaniards over three hundred years ago. In the year 1600 El Paso del Norte (now called Juarez) was an important town, and records are in existence over two hundred and eighty years old which refer to the Acequia Madre of El Paso

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del Norte as being in use. In speaking of his investigations in El Paso Valley, Mr. Follett says: "From all I could learn, I should judge that in former years some 40,000 acres of land were tilled in this valley, more than half of which was on the Mexican side of the river."

During recent yeas there has been a great scarcity of water in the Rio Grande, in New Mexico and in the El Paso Valley of Texas and Mexico. The deficiency of flow at El Paso brought about a complaint from the Republic of Mexico. The question by a protocal, dated May 6, 1896, was referred to the International Boundary Commission for a full investigation and a report upon the following points:

1- The amount of water of the Rio Grande taken by irrigation canals in the United States of America.

2- The average amount of water in said river, year by year, before the construction of said irrigation canals, and since said construction.

3- The best and most feasible mode of so regulating the use of the waters of said river as to secure to each country concerned, and to its inhabitants, their legal and equitable rights and interests in said waters.

On November 25, 1896, this Commission, composed of Col. Anson Mills for the United States, and Senor Don F. Javier Osorno for the Republic of Mexico, having before them the full and complete report of Mr. W. W. Follett, United States

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Engineer for the Commission, reported as follows:

1- The increase in the acreage irrigated from the Rio Grande in the State of Colorado from the year 1880 to the year 1896 was 197,000 acres. The increase of acreage irrigated in New Mexico during the same years was 3,000 acres, making a total of 200,000 acres.

2- The flow of the river at El Paso has been decreased about 200,000 acre-feet of water per annum by the taking of water for irrigation by canals constructed in the United States of America; the great mass of these waters consisting of flood waters utterly unavailable for irrigation without large reservoirs.

3- As "the best and most feasible mode of regulating the use of water, and securing to each country and its inhabitants their legal and equitable rights in said waters", the Commission recommended that the United States Government should buy all necessary land, pay all damages, and construct at its own expense an international dam at "The Pass", about four miles above El Paso; Submerge ~~[illegible]~~ 25,565 acres of good land in the United States with water; extend the Mexican boundary upstream to the dam site, giving Mexico 98 acres additional territory in order that one end of the dam may be on Mexican soil; deed one half of the dam, the reservoir and the water supply to the Republic of Mexico; and in some way prevent the construction of any large reservoirs on the Rio Grande in the Territory of New Mexico.

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The Commission estimated the cost of this project at $2,317,113.36.

As above mentioned, Mr. Follett estimates that about 40,000 acres of land had prior rights under the old canals in El Paso Valley, and was deprived of irrigation by the act of American citizens on the head waters; and that something more than one half of this 40,000 acres lay on the Mexican side of the River. As the restoring of these ancient water rights is the primary object of the proposed expenditure of $2,317,113.36, the cost of the project would be $57.92 per acre. However, it will be shown further along in this paper that the proposed reservoir could be made to irrigate 55,000 acres in El Paso Valley, which would put the cost per acre at $42.12, provided the estimate of the Commission is a correct one. There is every reason for believing this estimate too low, but aside from the monetary cost per acre for the land to be irrigated, there is another item of cost to be considered. The reservoir would cover 25,565 acres of good valley land with mud and water, and would cause marshes to form in the low flat valley at the head of the lake amounting to perhaps 15,000 acres additional, making a total destruction of about 40,000 acres of land in Mesilla Valley, which is just as near to El Paso, and just as valuable as any of the land that would be irrigated.

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While the published report of the Commission and its engineers plainly sets forth the fact that increased irrigation in Colorado caused shortage of water in Mexico, Texas and New Mexico, their recommendations not only leave New Mexico out of all the benefits to be derived from a project inaugurated for the purpose of making up this shortage, but give part of her territory to Mexico; cover up another part of it by the proposed reservoir; and distinctly ask that the Government shall prevent the construction of any other large reservoir on the Rio Grande in the territory of New Mexico. The only reasonable explanation of these extraordinary recommendations lies in the probable fact that the Commission had no alternative plan for consideration, and thought that the plan recommended was the only possible plan that could be adopted for restoring the water to which Mexico laid claim by virtue of ancient prior use. Indeed they were confronted at the time with the prospect of an Elephant Butte dam in New Mexico, not under Government management, but to be constructed, owned and operated by a stock company of private capitalists, whose plans contemplated the construction of a comparatively low dam, without sufficient storage capacity for irrigating a large area above and having a surplus for Mexico. At that time the United States Government had no Reclamation Service. Now that conditions have completely changed, and there is an alternative plan which claims to be able to accomplish just

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as much for Mexico, and a great deal more for the United States, it becomes necessary to compare these two plans, and choose between them.

The alternative plan, suggested by the U. S. Reclamation Service, is to build a storage dam opposite Engle, New Mexico, across the Rio Grande at a point about a quarter of a mile below the site selected by the old Elephant Butte Company, and a third of a mile below the Elephant Butte, which is a conical mountain peak rising abruptly from the river bank to a height of about 500 feet. At this site it is proposed to build a dam that will form a reservoir 175 feet deep at its lower end, and 40 miles long, with a storage capacity of two million acre feet, that will impound enough water to furnish 600,000 acre feet per annum, and irrigate one hundred and eighty thousand acres of land, distributed as follows:

110,000 acres in New Mexico,
20,000 " " Texas above El Paso,
50,000 " " El Paso Valley below El Paso.

With the above brief statement of the U. S. Reclamation Service Projedt, we will proceed to compare it with the International Boundary Commission Project, in a spirit of fairness, and with the object of arriving at the best solution of the question before us.

In considering these projects, or any other plan of water storage on the Rio Grande, it is well to keep in mind the following facts:

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1st- While the floods on the river are enormous, they do not come with any regularity, and the total flow in some years is less than one tenth of the total flow in other years.

2nd- Any reservoir constructed on the river will stop all the silt that comes down the river in suspension. Hence a small reservoir will accumulate as many acre feet of mud per year as a large one until it is filled with mud.

3rd- All of the water that comes down the river is needed for irrigation. We cannot afford to waste any of it.

These three conditions make it imperative that the reservoir should be as large as possible, and as deep as possible; having capacity for carrying a supply of water over from year to year to equalize the yearly inequalities, a surplus capacity for mud accumulations, and a surface for evaporation that is as small as possible in comparison with the quantity of water in storage.

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A STUDY OF FLOOD STORAGE ON THE RIO GRANDE

The following is a study of the service that could have been performed by the proposed "International Dam" at El Paso, Texas, and by the proposed "Elephant Butte Dam" near Engle, New Mexico, from January 1897 to June 1904, inclusive, in the storage of the flood waters of the Rio Grande, and the distribution thereof for irrigation.

This study necessarily requires a knowledge of the following conditions:

1st- The quantity of water flowing in the river during each month of the period specified.

2nd- The percentage of mud, or silt, carried in suspension by the water to be deposited in the reservoir.

3rd- The depth of evaporation from the surface of the reservoir for each month in the year.

4th- The storage capacity and area of water surface of the reservoir at different levels from bottom to top.

From these we may arrive at a fair estimate of the amount of water that will be available for irrigation, the quantity of mud that will accumulate in the reservoir, and the total number of years that the reservoir can be used for the service required without cleaning out the accumulated mud. In this item we have assumed that either reservoir will give good service until the mud in it fills 60 percent of its capacity.

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- Percentage of Silt in Water -

The following silt measurements of Rio Grande water at El Paso, Texas, are from samples taken under the supervision of the U. S. Consulting Engineer of the International Boundary Commission between the United States and Mexico; the percentage of silt contained therein being determined by Professor J. C. Nagle of The Agricultural & Mechanical College of Texas. The percentage of silt by volume for 7 days settlement was obtained by filling a tube with 100 cubic centimetres of muddy water, allowing it to stand for a week, and reading the height of mud in the bottom of the tube. The percentage by weight was obtained by drying and weighing the mud deposit, and comparing its weight with that of the 100 cubic centimetres of water.

The measurements made in September 1900 are published on page 382, Bulletin No.119, Office of Experiment Stations, U. S. Department of Agriculture. Those for 1901 and 1902 are published on page 206, Bulletin No.113 of same Department. Those for 1897, 1898 and 1903 and for June 1900, I have obtained from a letter to Mr. W. W. Follett, U. S. Consulting Engineer, International Boundary Commission, by Prof. J. C. Nagle. The whole data is given here, but only the percentage by weight will be used in our calculation, and this will be converted into percentage by volume by a method hereinafter described.

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MEASUREMENTS OF PERCENTAGE OF SILT IN THE WATERS OF THE RIO GRANDE AT EL PASO, TEXAS.

Date.	Percent of silt by volume after standing 7 days.	Percent of silt by weight, dry.	Discharge of river in second feet when sample was taken.
1897 - May 7.	3.39	----	5,980
" " 11.	5.04	----	7,240
" Sept. 23.	15.94	----	550
1898 - May 21.	2.76	----	1,700
" Nov. 8.	1.52	----	-----
1900.- June 27.	0.74	----	95
" " 29.	0.64	----	45
" Sept. 9.	8.49	3.91	830
" " 9.	22.20	5.52	830
" " 13.	15.74	3.70	1,690
" " 13.	17.67	4.29	1,690
" " 15.	18.40	5.15	740
" " 18.	17.74	4.90	680
" " 20.	33.22	8.66	160
" " 24.	12.81	3.37	45
1901 - Feb. 14.	6.05	1.36	90
" " 15.	5.86	1.47	110
" " 16.	6.02	1.47	180
" May 2.	12.42	3.98	1,020
" " 4.	10.29	2.96	1,520
" " 5.	6.07	1.92	1,880
" " 6.	6.01	2.03	2,380
" " 7.	5.83	1.95	3,050
" " 8.	5.84	1.99	3,100
" " 9.	5.86	1.64	2,340
1902 - Apr. 26.	8.22	1.56	465
" " 28.	13.55	3.61	425
" " 30.	5.45	1.35	145
" May 2.	6.81	2.06	60
" " 7.	0.40	0.06	5
" June 3.	8.23	2.46	135
1903 - Feb. 27.	8.88	1.69	25
" Mch. 11.	16.51	4.04	1,360
" " 24.	2.91	1.82	405
" Apr. 10.	8.04	2.69	1,020
" " 24.	1.53	1.41	660
" May 9.	4.35	1.80	2,452
" " 16.	2.45	0.64	5,060
" " 25.	1.12	0.52	4,430
" " 31.	2.20	0.64	2,340
" June 6.	1.29	0.40	2,590
" " 18.	4.66	0.89	16,000
" " 26.	1.58	0.53	16,660
" " 29.	0.76	0.22	12,430
" July 2.	1.06	0.15	10,030
" " 7.	0.94	0.28	3,540
" " 12.	1.27	0.17	1,740
" " 16.	0.98	0.15	970
" " 24.	1.39	0.70	1,000

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Data for Converting Percentage of Silt by Weight into Percentage of Compacted Mud by Volume.

On June 29, 1904, Mr. Follett and the writer cut a 3-inch cube of wet silt-mud from the bed of the Rio Grande, and had Mr. Arthur W. Houck, Assayer, to dry it at a low temperature, and weigh the dried content. It weighed 5,789 grains, and shows that a cubic foot of silt-mud, dried out, will weigh 53 lbs., which is 85 percent of the weight of a cubic foot of water.

In the following table, Column A shows the percentage of silt in Rio Grande water, by weight in different months and years, as estimated and tabulated by Mr. Follett from the foregoing silt measurements, and from his observed changes in turbidity for different seasons and stages of the river. Column B shows the percentage of silt-mud in a compacted state by volume, based on the dry weight of a cubic foot of such mud, found as above described to be 85% of the weight of a cubic foot of water. The figures of Column B are therefore obtained by dividing the figures of Column A by 0.85, and are the figures used for estimating the mud accumulations by volume from month to month.

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Table No. 1.

By W. W. Follett and B. M. Hall.

Showing percentage "A" by weight, and "B" by compacted volume of the silt in the waters of the Rio Grande for each month from January 1897 to June 1904, inclusive.

1897		
Date.	A	B
Jan.	2.40	2.82
Feb.	2.40	2.82
Mch.	2.40	2.82
Apr.	2.06	2.42
May.	0.81	0.95
June.	0.52	0.61
July.	0.52	0.61
Aug.	4.00	4.71
Sept.	5.45	6.41
Oct.	3.75	4.41
Nov.	2.06	2.42
Dec.	0.90	1.06

1898		
Date.	A	B
Jan.	0.90	1.06
Feb.	0.90	1.06
Mch.	0.90	1.06
Apr.	2.38	2.80
May.	1.00	1.18
June.	1.00	1.18
July.	1.00	1.18
Aug.	1.00	1.18
Sept.	1.00	1.18
Oct.	----	----
Nov.	----	----
Dec.	1.00	1.18

1899		
Date.	A	B
Jan.	0.90	1.06
Feb.	0.90	1.06
Mch.	1.40	1.65
Apr.	2.00	2.35
May.	1.40	1.65
June.	----	----
July.	4.90	5.76
Aug.	0.50	0.59
Sept.	----	----
Oct.	----	----
Nov.	----	----
Dec.	0.90	1.06

1900		
Date.	A	B
Jan.	0.90	1.06
Feb.	0.90	1.06
Mch.	0.50	0.59
Apr.	0.30	0.35
May.	1.62	1.91
June.	1.00	1.18
July.	0.30	0.35
Aug.	----	----
Sept.	4.94	5.81
Oct.	----	----
Nov.	----	----
Dec.	1.00	1.18

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Table No. 1. (Continued)

1901		
Date.	A	B
Jan.	1.00	1.18
Feb.	1.43	1.68
Mch.	1.40	1.65
Apr.	----	----
May.	1.62	1.91
June.	1.00	1.18
July.	4.94	5.81
Aug.	4.94	5.81
Sept.	4.94	5.81
Oct.	4.94	5.81
Nov.	1.43	1.68
Dec.	0.50	0.59

1902		
Date.	A	B
Jan.	0.50	0.59
Feb.	0.50	0.59
Mch.	0.30	0.35
Apr.	2.17	2.55
May.	2.06	2.42
June.	2.46	2.89
July.	----	----
Aug.	4.94	5.81
Sept.	4.94	5.81
Oct.	0.50	0.59
Nov.	0.50	0.59
Dec.	0.50	0.59

1903		
Date.	A	B
Jan.	1.70	2.00
Feb.	1.69	1.99
Mch.	2.38	2.80
Apr.	2.06	2.42
May.	0.90	1.06
June.	0.52	0.61
July.	0.29	0.34
Aug.	1.40	1.65
Sept.	1.40	1.65
Oct.	1.40	1.65
Nov.	0.50	0.59
Dec.	1.00	1.18

1904		
Date.	A	B
Jan.	1.00	1.18
Feb.	0.50	0.59
Mch.	----	----
Apr.	----	----
May.	----	----
June.	----	----

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- Evaporation From Surface of Reservoir -

In the following investigations we use figures for evaporation published in 12th Annual Report, Part 2, U. S. Geological Survey, page 235, and in 13th Annual Report, Part 3, page 411; Evaporation at Fort Bliss, near El Paso, Texas, 1889 and 1890.

Table No. 2.

EVAPORATION.

Month.	In Inches.	Decimals of a Foot.
January.	2.0	0.17
February.	2.0	0.17
March.	7.0	0.58
April.	7.3	0.61
May.	10.8	0.90
June.	11.2	0.94
July.	9.6	0.80
August.	11.4	0.95
September.	9.2	0.77
October.	6.8	0.56
November.	4.6	0.38
December.	2.9	0.24
Annual.	84.8	7.07

In the following discussion it is assumed that Tables No. 1 and No. 2 are applicable alike to the El Paso Reservoir and to the Elephant Butte Reservoir, and they will be used in both cases for finding the volume of mud deposited and the loss of water by evaporation. The other data entering into these calculations will be the "Inflow of water for each month" and the capacity and surface area of the reservoir at all levels of water. It is evident that these items will be different for different reservoirs and localities. We will therefore consider each reservoir separately.

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- Proposed International Reservoir at El Paso -

This proposed dam would be constructed at "The Pass", four miles above El Paso, and would be of a height sufficient to give a depth of 63.5 feet of water just above the dam. When full, the area of water surface would be 25,565 acres. With the water standing 43.5 feet deep just above the dam, its surface would cover only 12,428 acres, and its contents would be only one third of the capacity of the full reservoir. 13,000 acres of land covered by the full reservoir would be covered to a depth of less than 20 feet. The following table of capacities and areas is made by Mr. W. W. Follett, U. S. Consulting Engineer of the International Boundary Commission, from his own surveys and contour maps of the basin.

Table No. 3.

Capacities and Surface Areas of Proposed

El Paso Reservoir at Different Elevations of Water.

By W. W. Follett.

Sea Level Elevation (S.P.Ry.datum.)	Depth of water.	Area of water surface in acres.	Capacity in acre feet.
3710	0	0	0
3715	5	180	0
3716	6	333	256
3717	7	486	666
3718	8	639	1228
3719	9	792	1944
3720	10	946	2813
3721	11	1128	3850
3722	12	1311	5069
3723	13	1494	6472
3724	14	1677	8057
3725	15	1858	9825
3726	16	2032	11770
3727	17	2205	13889

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(Continued)

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Table No. 3. (Continued)

Sea Level Elevation. (S.P.Ry.datum.)	Depth of water.	Area of water surface in acres.	Capacity in acre feet.
3728	18	2378	16180
3729	19	2551	18645
3730	20	2725	21283
3731	21	2968	24129
3732	22	3211	27219
3733	23	3455	30552
3734	24	3699	34129
3735	25	3943	37950
3736	26	4264	42053
3737	27	4585	46478
3738	28	4906	51223
3739	29	5227	56290
3740	30	5548	61677
3741	31	6099	67501
3742	32	6650	73876
3743	33	7201	80801
3744	34	7752	88278
3745	35	8304	96306
3746	36	8794	104855
3747	37	9285	113894
3748	38	9776	123425
3749	39	10267	133446
3750	40	10758	143959
3751	41	11235	154955
3752	42	11712	166429
3753	43	12189	178379
3754	44	12667	190807
3755	45	13145	203713
3756	46	13518	217044
3757	47	13891	230749
3758	48	14265	244827
3759	49	14639	259279
3760	50	15013	274105
3761	51	15675	289449
3762	52	16337	305455
3763	53	16999	322123
3764	54	17661	339453
3765	55	18324	357445
3766	56	19125	376170
3767	57	19926	395695
3768	58	20727	416022
3769	59	21528	437149
3770	60	22328	459077
3771	61	23253	481868
3772	62	24178	505583
3773	63	25103	530224
3773.5	63.5	25565	542891

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Table No. 4.

Monthly Discharge of the Rio Grande at El Paso, Texas.

at the gaging station in charge of

Mr. W. W. Follett, U. S. Consulting Engineer,

International Boundary Commission.

(Discharge in Acre Feet)

Month.	1897	1898	1899	1900	1901	1902	1903	1904
Jan.	3100	30129	12912	8110	278	8291	615	972
Feb.	10080	33655	11330	5680	4503	5772	1289	387
Mch.	9920	20044	7071	460	3669	635	22602	0
Apr.	128400	97944	8807	300	0	7904	49468	0
May.	511101	140192	10330	44810	158102	526	203623	0
June.	362697	111570	0	93100	77038	307	586909	0
July.	81739	196269	19553	70	12576	20	158202	
Aug.	8132	31236	430	0	60655	14499	4334	
Sept.	41950	2262	0	16483	21005	9313	1031	
Oct.	108099	160	123	0	5336	1428	2033	
Nov.	69322	119	119	0	12813	298	298	
Dec.	40205	5718	2828	738	7993	1775	2440	
The Year.	1374745	669298	73503	169751	363968	50768	1032844	

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- Water Used For Irrigation -

We find by our calculations that 180,000 acre feet per year will be the largest amount of irrigation water that can be realized at El Paso, from this reservoir. A proper distribution of this amount of water for this region will be as follows:

Table No. 5.

Water Used For Irrigation In Each Month.

January-----	0	Acre	Feet.
February----	3,600	"	"
March-------	16,200	"	"
April-------	36,000	"	"
May---------	36,000	"	"
June--------	36,000	"	"
July--------	25,200	"	"
August------	12,600	"	"
September---	9,000	"	"
October------	3,600	"	"
November----	1,800	"	"
December----	0	"	"
The Year---	180,000	"	"

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- Service of Reservoir -

Having established our premises in Tables No. 1, 2, 3, 4, and 5, we can form proper conclusions as to the service that can be performed by the proposed reservoir, and estimate the length of time required for it to fill with mud to the point where its capacity will be less than is necessary for storage; unless some means of cleaning out this mud is resorted to, or the mud is prevented from entering the reservoir by means of settling basins above. We will consider such expedients later in this paper, but for the purposes of discussion and comparison of the two reservoirs, it will be assumed that the mud which settles in the reservoir remains there; at least until the reservoir becomes inefficient by reason of its accumulation.

- Method of Calculation Used in the Following Service Tables -

1- The "Inflow" is taken from Table No. 4.

2- The "Silt Deposited in Month" is found by multiplying the "Inflow" by the percentage in Column B of Table No. 1, and pointing off four decimal places.

3- "Water Available" equals the "Inflow" minus the "Silt Deposited", plus the "Water in Reservoir" at end of preceding month.

4- "Silt in Reservoir" is the total accumulation at end of each month.

5- "Loss by Evaporation" is figured by first adding together the "Water Available" and "Silt in Reservoir" to get the total contents of reservoir. Then find this amount in last column of Table

A353958

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No. 3; taking the corresponding water surface in acres, in same table, and multiplying by evaporation in "decimals of a foot" in last column of Table No. 2 for the given month.

6- "Water Used for Irrigation" is from Table No. 5.

7- "Water in Reservoir at end of Month" equals "Water Available" minus "Loss by Evaporation" minus "Use for Irrigation" in month.

8- "Deficiency" is the deficiency in amount necessary for irrigation.

9- To find the "Overflow", subtract "Silt in Reservoir" from total capacity of reservoir. This gives the water capacity of the reservoir at end of given month. If the water left over after subtracting "Evaporation" and "Irrigation" from "Water Available", exceeds this amount, the excess is the "Overflow."

Note:- It is to be remembered:

First; that the "Loss by Evaporation" cannot exceed the "Water Available". (See October and November, 1902.) It is also limited by the surface area of the reservoir during months in which there is an overflow.

Second; that water "Used for Irrigation" is limited by quantity available. This quantity subtracted from the water required for irrigation gives the "Deficiency". (See October and November, 1902, and February 1903.

Third; that the water capacity of reservoir limits the amount of "Water in Reservoir at end of Month". (See months having an "Overflow".

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED INTERNATIONAL RESERVOIR ON THE RIO GRANDE AT EL PASO,

FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 180000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date. 1897	In-flow.	Silt de-posited in month.	Water avail-able.	Silt in re-ser-voir.	Lost by evap-ora-tion.	Used for irri-ga-tion.	Water in re-ser-voir at end of month.	De-fi-cien-cy.	Over-flow.
Jan.	3100	87	3013	87	110	0	2903	0	0
Feb.	10080	284	12699	371	357	3600	8742	0	0
Mch.	9920	280	18382	651	1856	16200	326	0	0
Apr.	128400	3107	125619	3758	6100	36000	83519	0	0
May.	511101	4855	589765	8613	23400	36000	530365	0	0
June.	362697	2212	890850	10825	24440	36000	532066	0	298344
July.	81739	500	613305	11325	20800	25200	531566	0	35739
Aug.	8132	383	539315	11708	24700	12600	502015	0	0
Sept.	41950	2689	541276	14397	20020	9000	512256	0	0
Oct.	108099	4767	615588	19164	14560	3600	523727	0	73701
Nov.	69322	1678	591371	20842	9880	1800	522049	0	57642
Dec.	40205	426	561828	21268	6240	0	521623	0	33965
Total for Year.	1374745	21268			152463	180000			499391

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED INTERNATIONAL RESERVOIR ON THE RIO GRANDE AT EL PASO,

FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 180000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date. 1898	In-flow.	Silt de-posited in month.	Water avail-able.	Silt in re-ser-voir.	Lost by evap-ora-tion.	Used for irri-ga-tion.	Water in re-ser-voir at end of month.	De-fi-cien-cy.	Over-flow.
Jan.	30129	319	551433	21587	4420	0	521304	0	25709
Feb.	33655	357	554602	21944	4420	3600	520947	0	25635
Mch.	20044	212	540779	22156	15080	16200	509499	0	0
Apr.	97944	274	607169	22430	15860	36000	520461	0	34848
May.	140192	1654	658999	24084	23400	36000	518807	0	80792
June.	111570	1317	629060	25401	24440	36000	517490	0	51130
July.	196269	2316	711443	27717	20800	25200	515174	0	150269
Aug.	31236	369	546041	28086	24700	12600	508741	0	0
Sept.	2262	27	510976	28113	19558	9000	482418	0	0
Oct.	160	0	482578	28113	13664	3600	465314	0	0
Nov.	119	0	465433	28113	9206	1800	454427	0	0
Dec.	5718	67	460078	28180	5640	0	454438	0	0
Total for Year.	669298	6912			181188	180000			368383

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED INTERNATIONAL RESERVOIR ON THE RIO GRANDE AT EL PASO,

FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 180000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date. 1899	In-flow.	Silt de-posited in month.	Water avail-able.	Silt in re-ser-voir.	Lost by evap-ora-tion.	Used for irri-ga-tion.	Water in re-ser-voir at end of month.	De-fi-cien-cy.	Over-flow.
Jan.	12912	137	467213	28317	4046	0	463167	0	0
Feb.	11330	120	474377	28437	4097	3600	466680	0	0
Mch.	7071	117	473634	28554	13920	16200	443514	0	0
Apr.	8807	207	452114	28761	14152	36000	401962	0	0
May.	10330	170	412122	28931	19530	36000	356592	0	0
June.	0	0	356592	28931	18330	36000	302262	0	0
July.	19553	1126	320689	30057	14400	25200	281089	0	0
Aug.	430	3	281516	30060	15675	12600	253241	0	0
Sept.	0	0	253241	30060	11858	9000	232383	0	0
Oct.	123	0	232506	30060	8232	3600	220674	0	0
Nov.	119	0	220793	30060	5472	1800	213521	0	0
Dec.	2828	30	216319	30090	3432	0	212887	0	0
Total for Year.	73503	1910			133144	180000		0	0

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED INTERNATIONAL RESERVOIR ON THE RIO GRANDE AT EL PASO,

FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 180000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date. 1900	Inflow.	Silt deposited in month.	Water available.	Silt in reservoir.	Lost by evaporation.	Used for irrigation.	Water in reservoir at end of month.	Deficiency.	Overflow.
Jan.	8110	86	220911	30176	2465	0	218446	0	0
Feb.	5680	60	224066	30236	2473	3600	217993	0	0
Mch.	460	3	218450	30239	8323	16200	193927	0	0
Apr.	300	1	194226	30240	8357	36000	149869	0	0
May.	44810	856	193823	31096	12330	36000	145493	0	0
June.	93100	1099	237494	32195	14006	36000	187488	0	0
July.	70	0	187558	32195	10880	25200	151478	0	0
Aug.	0	0	151478	32195	11685	12600	127193	0	0
Sept.	16483	958	142718	33153	9240	9000	124478	0	0
Oct.	0	0	124478	33153	6356	3600	114522	0	0
Nov.	0	0	114522	33153	4142	1800	108580	0	0
Dec.	738	9	109309	33162	2568	0	106741	0	0
Total for Year.	169751	3072			92825	180000		0	0

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED INTERNATIONAL RESERVOIR ON THE RIO GRANDE AT EL PASO,

FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 180000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date.-- 1901	In-flow.	Silt de-posited in month.	Water avail-able.	Silt in re-ser-voir.	Lost by evap-ora-tion.	Used for irri-ga-tion.	Water in re-ser-voir at end of month.	De-fi-cien-cy.	Over-flow.
Jan.	278	3	107016	33165	1802	0	105214	0	0
Feb.	4503	76	109641	33241	1819	3600	104222	0	0
Mch.	3669	60	107831	33301	6177	16200	85454	0	0
Apr.	0	0	85454	33301	5795	36000	43659	0	0
May.	158102	3020	198741	36321	12600	36000	150141	0	0
June.	77038	909	226270	37230	13818	36000	176452	0	0
July.	12576	731	188297	37961	10960	25200	152137	0	0
Aug.	60655	3524	209268	41485	13680	12600	182988	0	0
Sept.	21005	1220	202773	42705	11011	9000	182762	0	0
Oct.	5336	310	187788	43015	7784	3600	176404	0	0
Nov.	12813	215	189002	43230	5301	1800	181901	0	0
Dec.	7993	47	189847	43277	3348	0	186499	0	0
Total for Year.	363968	10115			94095	180000		0	0

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED INTERNATIONAL RESERVOIR ON THE RIO GRANDE AT EL PASO,

FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 180000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date. 1902	In-flow.	Silt de-posited in month.	Water avail-able.	Silt in re-ser-voir.	Lost by evap-ora-tion.	Used for irri-ga-tion.	Water in re-ser-voir at end of month.	De-fi-cien-cy.	Over-flow.
Jan.	8291	49	194741	43326	2397	0	192344	0	0
Feb.	5772	34	198082	43360	2414	3600	192068	0	0
Mch.	635	2	192701	43362	8149	16200	168352	0	0
Apr.	7904	202	176054	43564	8296	36000	131758	0	0
May.	526	13	132271	43577	10890	36000	85381	0	0
June.	307	9	85679	43586	9400	36000	40279	0	0
July.	20	0	40299	43586	5920	25200	9179	0	0
Aug.	14499	842	22836	44428	5785	12600	4451	0	0
Sept.	9313	541	13223	44969	4158	9000	65	0	0
Oct.	1428	8	1485	44977	0	1485	0	2115 *	0
Nov.	298	2	296	44979	0	296	0	1504 *	0
Dec.	1775	10	1765	44989	1104	0	661	0	0
Total for Year.	50768	1712			58513	176381		3619	0

* Deficiency equals amount required for irrigation less amount used for irrigation.

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED INTERNATIONAL RESERVOIR ON THE RIO GRANDE AT EL PASO,

FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 180000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being acre feet)

Date. 1903	In-flow.	Silt de-posited in month.	Water avail-able.	Silt in re-ser-voir.	Lost by evap-ora-tion.	Used for irri-ga-tion.	Water in re-ser-voir at end of month.	De-fi-cien-cy.	Over-flow.
Jan.	615	12	1264	45001	777	0	487	0	0
Feb.	1289	26	1750	45027	0	1750	0	1850 *	0
Mch.	22602	633	21969	45660	3550	16200	2219	0	0
Apr.	49468	1197	50490	46857	5100	36000	9390	0	0
May.	203623	2158	210855	49015	13185	36000	161670	0	0
June.	586909	3580	744999	52595	24440	36000	490296	0	194263
July.	158202	538	647960	53133	20800	25200	489758	0	112202
Aug.	4334	72	494020	53205	24700	12600	456720	0	0
Sept.	1031	17	457734	53222	18788	9000	429946	0	0
Oct.	2033	34	431945	53256	13104	3600	415241	0	0
Nov.	298	2	415537	53258	8722	1800	405015	0	0
Dec.	2440	29	407426	53287	5369	0	402057	0	0
Total for Year.	1032844	8298			138535	178150		1850	306465

* Deficiency equals amount required for irrigation less amount used for irrigation.

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED INTERNATIONAL RESERVOIR ON THE RIO GRANDE AT EL PASO,

FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 180000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date. 1904	Inflow.	Silt deposited in month.	Water available.	Silt in reservoir.	Lost by evaporation.	Used for irrigation.	Water in reservoir at end of month.	Deficiency.	Overflow.
Jan.	972	11	403018	53298	3774	0	399244	0	0
Feb.	387	2	399629	53300	3740	3600	392289	0	0
Mch.	0	0	392289	53300	12644	16200	363445	0	0
Apr.	0	0	363445	53300	12657	36000	314788	0	0
May.	0	0	314788	53300	16920	36000	261868	0	0
June.	0	0	261868	53300	15698	36000	210170	0	0

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YEARLY SUMMARY OF SERVICE THAT COULD HAVE BEEN PERFORMED
BY THE PROPOSED INTERNATIONAL RESERVOIR ON RIO GRANDE AT EL PASO,
FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE, 7 1/2 YEARS.
(All quantities being in acre feet)

Year.	Inflow from river.	Silt deposited.	Lost by evaporation.	Used for irrigation.	Lost by overflow.	Water in reservoir. at end of year.	Remarks.
1897.	1374745	21268	152463	180000	499391	521623	
1898.	669298	6912	181188	180000	368383	454438	
1899.	73503	1910	133144	180000		212887	
1900.	169751	3073	93825	180000		106741	
1901.	363968	10115	94095	180000		186499	
1902.	50768	1712	58513	176381		661	Empty in Oct.& Nov.
1903.	1032844	8298	138535	178150	306465	402057	Empty in February.
1904. Half year.	1359	13	65433	127800		210170	June 1904.
Total for 7 1/2 years.	3736236	53300	917196	1382331	1174239		
Average per Year.	498165	7107	122293	180000	156565		
Percentage of Inflow.		1.43%	24.55%	37.00%	32%	5.02%	End of 7½ years.

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The above table for proposed El Paso Reservoir shows:

1st:- That the accumulated mud in the reservoir at the end of seven and a half years would be 53,300 acre feet, which is at the rate of 7,107 acre feet per year. At the end of 46 years this would amount to 325,735 acre feet, or 60 per cent of the entire capacity of the reservoir; leaving only 217,000 acre feet water capacity in the reservoir, inless some means of getting rid of this mud is devised. The mud in the reservoir would have a maximum depth of 46 feet, and its surface would cover an area of valley land about 3 miles wide, and 13 1/3 miles long. The entire water space above this mud would have a maximum depth of 17 1/2 feet, covering an area of 25,000 acres.

2nd:- The tabulated statement shows that a very large amount of water is wasted through the overflow, because the dam cannot be made high enough to hold it. Even if the material of the hills on either side is of such a nature that a safe dam can be built with a spillway 63.5 feet above the river bed, the height of these hills is such that the spillway cannot reasonably be at a greater elevation.

3rd:- We have estimated on a supply of 180,000 acre feet per year for irrigation, but although it is shown that only 176,381 acre feet will be available in 1902, and 178,150 acre feet in 1903, the waste by overflow amounts to 36 per cent of the inflow in 1897; 55 per cent of the inflow in 1899; and nearly 30 per cent of the inflow in 1903.

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During the seven and a half years the water that flows into the reservoir isdisposed of as follows:

Loss by sediment----------	1.43	per cent.
Loss by evaporation----------	24.55	" "
Loss by overflow----------	32.00	" "
Total loss--	57.98	" "
Water used for irrigation----------	37.00	" "
Water in reservoir at end of 7 1/2 years-	5.02	" "
	100.00	" "

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- PROPOSED ELEPHANT BUTTE RESERVOIR NEAR ENGLE, NEW MEXICO -

This dam would be constructed in a narrow gorge of the river, below the site that was proposed for the dam of the old Elaphant Butte Company. According to surveys of the Reclamation Service, it is projected to give a depth of 160 feet just above the dam, and a storage capacity of 1,500,000 acre feet. Recent additional surveys made by Mr. J. L. Rhead, under the direction of the writer, show that it will be practicable to build a dam at this point 230 feet high above the river bed, but there is a natural gap in the hill to the west, several miles above the dam, that has an elevation of only 4383 feet above sea level. A spillway can be made at this po int at elevation 4385, limiting the water depth to 175 feet. If the water is 175 feet deep, we estimate a storage capacity of 2,000,000 acre feet, as shown in the following table, No. 6. This table of areas and contents is based on topographic surveys of the Reclamation Service up to a water depth of 160 feet, (Elevation 4370). Areas andcapacities from 160 to 175 feet of depth are calculated by percentage of increase. This reservoir will be deep and narrow, and sediment could be cleaned out of it more easily than if it were wide and shallow. The methods of calculation for service in this reservoir are the same as those for the El Paso Reservoir, Tables 6, 7, and 8 being used instead of 3, 4 and 5, respectively. Tables 1 and 2 are used alike for both reservoirs.

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Table No.6.

Area of surface and capacity of Elephant Butte Reservoir at different water elevations.

(U. S. Reclamation Service)

Sea Level elevation. (Santa Fe Ry.datum)	Depth of water in feet.	Surface of water in acres.	Capacity to contour in acre feet.	
4210	0	00.0	0	
4215	5	41.5	110	
4220	10	130.5	415	
4225	15	219.5	1290	
4230	20	365.0	2610	
4235	25	511	4825	
4240	30	843	7720	
4245	35	1175	12765	
4250	40	1781	19470	
4255	45	2388	29890	
4260	50	3145	43350	
4265	55	3908	58470	
4270	60	4664	82375	
4275	65	5426	107600	
4280	70	6175	136635	
4285	75	6924	169385	
4290	80	7630	205880	
4295	85	8335	245795	
4300	90	8977	289235	
4305	95	9620	335730	
4310	100	10550	385435	
4315	105	11480	440510	
4320	110	12553	500240	
4325	115	13626	565685	
4330	120	14811	636500	
4335	125	15996	713515	
4340	130	17618	796465	
4345	135	19241	888615	
4350	140	21370	988875	
4355	145	23499	1101045	
4360	150	25516	1223065	
4365	155	27534	1355690	
4370	160	29553	1500000	
4375	165	30447	1650000	Estimated
4380	170	35600	1815000	"
4385	175	38400	2000000	"

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Table No. 7.

Monthly Discharge of Rio Grande in Acre Feet
at San Marcial (above Elephant Butte) from Records of
U. S. Geological Survey
and
U. S. International Boundary Commission

Month.	1897	1898	1899	1900	1901	1902	1903	1904
Jan.	19553	57675	27854	40582	20967	22731	17197	8490
Feb.	24325	59425	24603	35099	25468	17435	21927	9530
Moh.	40767	62164	27546	33203	15114	7954	46790	3055
Apr.	212548	271458	54089	6248	23683	40106	100007	0
May.	755196	165832	35048	123590	256126	26787	318367	0
June.	366426	126268	952	159888	96178	6407	660476	0
July.	65977	167062	28407	0	59286	0	77841	
Aug.	6149	13835	6395	0	65534	49210	3064	
Sept.	114188	4641	2916	73190	37607	13349	1438	
Oct.	281677	1230	676	0	17018	823	545	
Nov.	175715	11722	9521	2440	20053	4641	5534	
Dec.	152736	23365	21828	10084	19240	11286	18883	
The Year.	2215257	964677	239835	484324	656274	200729	1272069	

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Table No. 8.

Water Used For Irrigation In Each Month.

January-----	0	Acre Feet.
February----	13,000	" "
March-------	54,000	" "
April-------	119,000	" "
May---------	119,000	" "
June--------	119,000	" "
July--------	83,000	" "
August------	42,000	" "
September---	31,000	" "
October-----	13,000	" "
November----	7,000	" "
December----	0	" "
The Year----	600,000	Acre Feet.

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED ELEPHANT BUTTE RESERVOIR ON THE RIO GRANDE NEAR ENGLE,

NEW MEXICO, FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 600,000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date. 1897	Inflow.	Silt deposited in month.	Water available.	Silt in reservoir.	Lost by evaporation.	Used for irrigation.	Water in reservoir at end of month.	Deficiency.	Overflow.
Jan.	19553	551	19002	551	304	0	18698	0	0
Feb.	24325	686	42337	1237	537	13000	28800	0	0
Mch.	40767	1150	68417	2387	2320	54000	12097	0	0
Apr.	212548	5144	219501	7531	4820	119000	95681	0	0
May.	755196	7174	843703	14705	16650	119000	708053	0	0
June.	366426	2235	1072244	16940	21800	119000	931444	0	0
July.	65977	402	997017	17342	17360	83000	896659	0	0
Aug.	6149	290	902518	17632	18800	42000	841718	0	0
Sept.	114188	7319	948587	24951	15700	31000	901887	0	0
Oct.	281677	12422	1171142	37373	14164	13000	1143978	0	0
Nov.	175715	4252	1315481	41625	10487	7000	1297954	0	0
Dec.	152736	1619	1449071	43244	7080	0	1441991	0	0
Total for Year.	2215257	43244			130022	600000		0	0

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED ELEPHANT BUTTE RESERVOIR ON THE RIO GRANDE NEAR ENGLE,

NEW MEXICO, FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 600,000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date.	In-flow.	Silt de-posited in month.	Water avail-able.	Silt in re-ser-voir.	Lost by evap-ora-tion.	Used for irri-ga-tion.	Water in re-ser-voir at end of month.	De-fi-cien-cy.	Over-flow.
1898									
Jan.	57675	611	1499055	43855	5065	0	1493990	00	00
Feb.	59425	630	1552785	44485	5100	13000	1534685	0	0
Mch.	62164	659	1596190	45144	17285	54000	1524905	0	0
Apr.	271458	7601	1788762	52745	21960	119000	1647802	0	0
May.	165832	1957	1811677	54702	32760	119000	1659917	0	0
June.	126268	1490	1784695	56192	33840	119000	1631855	0	0
July.	167062	1971	1796946	58163	28920	83000	1685026	0	0
Aug.	13835	163	1698698	58326	31490	42000	1625208	0	0
Sept.	4641	55	1629794	58381	24100	31000	1574694	0	0
Oct.	1230	0	1575924	58381	16970	13000	1545954	0	0
Nov.	11722	0	1557676	58381	11470	7000	1539206	0	0
Dec.	23365	276	1562295	58657	7250	0	1555045	0M	0
Total for Year.	964677	15413			236210	600000		0	0

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED ELEPHANT BUTTE RESERVOIR ON THE RIO GRANDE NEAR ENGLE,

NEW MEXICO, FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 600,000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date. 1899	Inflow.	Silt deposited in month.	Water available.	Silt in reservoir.	Lost by evaporation.	Used for irrigation.	Water in reservoir at end of month.	Deficiency.	Overflow.
Jan.	27854	295	1582604	58952	5168	0	1577436	0	0
Feb.	24603	261	1601778	59213	5233	13000	1583545	0	0
Mch.	27546	455	1610636	59668	18021	54000	1538615	0	0
Apr.	54089	1271	1591433	60939	18611	119000	1453822	0	0
May.	35048	578	1488292	61517	26865	119000	1342427	0	0
June.	952	0	1343379	61517	26517	119000	1197862	0	0
July.	28407	1636	1224633	63153	21096	83000	1120537	0	0
Aug.	6395	38	1126894	63191	23731	42000	1061163	0	0
Sept.	2916	0	1064079	63191	18428	31000	1014651	0	0
Oct.	676	0	1015327	63191	12914	13000	989413	0	0
Nov.	9521	0	998934	63191	8645	7000	983289	0	0
Dec.	21828	231	1004886	63422	5486	0	999400	0	0
Total for Year.	239835	4765			190715	600000		0	0

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED
BY THE PROPOSED ELEPHANT BUTTE RESERVOIR ON THE RIO GRANDE NEAR ENGLE,
NEW MEXICO, FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.
- USING 600,000 ACRE FEET PER YEAR FOR IRRIGATION -
(All quantities being in acre feet)

Date. 1900	Inflow.	Silt deposited in month.	Water available.	Silt in reservoir.	Lost by evaporation.	Used for irrigation.	Water in reservoir at end of month.	Deficiency.	Overflow.
Jan.	40582	430	1039552	63852	4002	0	1035550	0	0
Feb.	35099	372	1070277	64224	4090	13000	1053187	0	0
Mch.	33203	196	1086194	64420	14106	54000	1018088	0	0
Apr.	6248	22	1024314	64442	14182	119000	891132	0	0
May.	123590	2261	1012461	66703	20763	119000	872698	0	0
June.	159888	1887	1030699	68590	22043	119000	889656	0	0
July.	0	0	889656	68590	16576	83000	790080	0	0
Aug.	0	0	790080	68590	17774	42000	730306	0	0
Sept.	73190	4252	799244	72842	14707	31000	753537	0	0
Oct.	0	0	753537	72842	10158	13000	730379	0	0
Nov.	2440	0	732819	72842	6768	7000	719051	0	0
Dec.	10084	119	729016	72961	4250	0	724766	0	0
Total for Year.	484324	9539			149419	600000		0	0

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED ELEPHANT BUTTE RESERVOIR ON THE RIO GRANDE NEAR ENGLE,

NEW MEXICO, FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 600,000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date. 1901	In-flow.	Silt de-posited in month.	Water avail-able.	Silt in re-ser-voir.	Lost by evap-ora-tion.	Used for irri-ga-tion.	Water in re-ser-voir at end of month.	De-fi-cien-cy.	Over-flow.
Jan.	20967	247	745486	73208	3062	0	742424	0	0
Feb.	25468	424	767468	73632	3128	13000	751340	0	0
Mch.	15114	249	766205	73881	10660	54000	701545	0	0
Apr.	23683	0	725228	73881	10773	119000	595455	0	0
May.	256126	4892	846689	78773	18018	119000	709671	0	0
June.	96178	1135	804714	79908	18010	119000	667704	0	0
July.	59286	3445	723545	83353	14240	83000	626305	0	0
Aug.	65534	3808	688031	87161	16340	42000	629691	0	0
Sept.	37607	2185	665113	89346	12936	31000	621177	0	0
Oct.	17018	989	637206	90335	9111	13000	615095	0	0
Nov.	20053	337	634811	90672	6167	7000	621644	0	0
Dec.	19240	114	640770	90786	3924	0	636846	0	0
Total for Year.	656274	17825			126369	600000		0	0

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED ELEPHANT BUTTE RESERVOIR ON THE RIO GRANDE NEAR ENGLE,

NEW MEXICO, FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 600,000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date. 1902	Inflow.	Silt deposited in month.	Water available.	Silt in reservoir.	Lost by evaporation.	Used for irrigation.	Water in reservoir at end of month.	Deficiency.	Overflow.
Jan.	22731	134	659443	90920	2842	0	656601	0	0
Feb.	17435	103	673933	91023	2890	13000	658043	0	0
Mch.	7954	28	665969	91051	9773	54000	602196	0	0
Apr.	40106	1023	641279	92074	9992	119000	512287	0	0
May.	26787	648	538426	92722	13248	119000	406178	0	0
June.	6407	185	412400	92907	11882	119000	281518	0	0
July.	0	0	281518	92907	8280	83000	190238	0	0
Aug.	49210	2859	236589	95766	9101	42000	185488	0	0
Sept.	13349	776	198061	96542	6968	31000	160093	0	0
Oct.	823	5	160911	96547	4766	13000	143145	0	0
Nov.	4641	27	147759	96574	3154	7000	137605	0	0
Dec.	11286	67	148824	96641	2000	0	146824	0	0
Total for Year.	200729	5855			84896	600000		0	0

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED ELEPHANT BUTTE RESERVOIR ON THE RIO GRANDE NEAR ENGLE,

NEW MEXICO, FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 600,000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date. 1903	Inflow.	Silt deposited in month.	Water available.	Silt in reservoir.	Lost by evaporation.	Used for irrigation.	Water in reservoir at end of month.	Deficiency.	Overflow.
Jan.	17197	344	163677	96985	1453	0	162224	0	0
Feb.	21927	436	183715	97421	1504	13000	169211	0	0
Mch.	46790	1310	214691	98731	5400	54000	155291	0	0
Apr.	100007	2420	252878	101151	6076	119000	127802	0	0
May.	318367	3375	442794	104526	11988	119000	311806	0	0
June.	660476	4029	968253	108555	21648	119000	827605	0	0
July.	77841	265	905181	108820	17472	83000	804709	0	0
Aug.	3064	51	807722	108871	18848	42000	746874	0	0
Sept.	1438	24	748288	108895	14384	31000	702904	0	0
Oct.	545	9	703440	108904	10024	13000	680416	0	0
Nov.	5534	33	685917	108937	6688	7000	672229	0	0
Dec.	18883	223	690889	109160	4243	0	686646	0	0
Total for Year.	1272069	12519			119728	600000		0	0

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ESTIMATE OF SERVICE THAT COULD HAVE BEEN PERFORMED

BY THE PROPOSED ELEPHANT BUTTE RESERVOIR ON THE RIO GRANDE NEAR ENGLE,

NEW MEXICO, FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE.

- USING 600,000 ACRE FEET PER YEAR FOR IRRIGATION -

(All quantities being in acre feet)

Date. 1904	Inflow.	Silt deposited in month.	Water available.	Silt in reservoir.	Lost by evaporation.	Used for irrigation.	Water in reservoir at end of month.	Deficiency.	Overflow.
Jan.	8490	100	695036	109260	3017	0	692019	0	0
Feb.	9530	56	701493	109316	3038	13000	685455	0	0
Mch.	3055	18	688492	109334	10231	54000	624261	0	0
Apr.	0	0	624261	109334	10004	119000	495257	0	0
May.	0	0	495257	109334	12843	119000	363414	0	0
June.	0	0	363414	109334	11327	119000	233087	0	0

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YEARLY SUMMARY OF SERVICE THAT COULD HAVE BEEN PERFORMED BY THE PROPOSED ELEPHANT BUTTE RESERVOIR ON THE RIO GRANDE NEAR ENGLE, NEW MEXICO, FROM JANUARY 1897 TO JUNE 1904, INCLUSIVE, 7 1/2 YEARS.

(All quantities being in acre feet)

Year.	Inflow from river.	Silt deposited.	Lost by evaporation.	Used for irrigation.	Lost by overflow.	Water in reservoir at end of year.
1897.	2215257	43244	130022	600000	0	1441991
1898.	964677	15413	236210	600000	0	1555045
1899.	239835	4765	190715	600000	0	999400
1900.	484324	9539	149419	600000	0	724766
1901.	656274	17825	126369	600000	0	636846
1902.	200729	5855	84896	600000	0	146824
1903.	1272069	12519	119728	600000	0	686646
1904. Half Year.	21075	174	50460	424000	0	233087 {End of half year.
Total for 7 1/2 years.	6054240	109334	1087819	4624000	0	
Average per Year.	807232	14578	145043	600000	0	
Percentage of Inflow.		1.8%	18.0%	76.2%	0	4.0% {End of 7½ years

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Putting the last line of the summary in a different form, we find that during this seven and a half years the water that flowed into the reservoir would have been disposed of as follows;

Loss by sediment----------	1.8	per cent.
Loss by evaporation----------	18.0	" "
Loss by overflow----------	0.0	" "
Total loss-------	19.8	" "
Water used for irrigation----------	76.2	" "
Water in reservoir at end of 7 1/2 years-	4.0	" "
	100.0	

The foregoing tables for the proposed Elephant Butte Reservoir near Engle, New Mexico, show:

1st- That the accumulation of mud in the reservoir at the end of seven and a half years would be 109,334 acre feet, which is at the rate of 14,580 acre feet per year. It will therefore require 82 years to accumulate 1,200,000 acre feet of mud, and fill up 60 per cent of the reservoir capacity, leaving a water capacity at that time of only 800,000 acre feet, unless some means of getting rid of the mud is devised. This mud in the reservoir would have a depth of 150 feet, and its surface, as estimated from Table No. 6, would cover 25,516 acres, its surface dimensions being approximately one and one third miles in width, and thirty miles in length. The entire water space above this mud would have a maximum depth of 25 feet, and its surface when full would cover 38,000 acres.

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2nd- The tabulated statement shows that the reservoir will furnish continuously 600,000 acre feet for irrigation, without any deficiency, and without any overflow.

3rd- The largest amount of water in the reservoir at any time was in July 1898, when there was 1,685,026 acre feet of water; 168 feet being the maximum depth of water, including the mud. Hence, no water would have been lost by overflow with a 170-foot dam, or rather with a dam having a spillway for 170 feet depth of water, which spillway would be at elevation 4380, or 3 feet below the level of the lowest point of the gap selected for a spillway.

4th- The lowest quantity of water in the reservoir was 127,802 acre feet, which was at the end of April 1903; and the depth in reservoir at the time was 83 feet. The amount of water in the reservoir June 1904, at end of estimate, is 233,087 acre feet.

- COMPARISON OF THE TWO PROPOSED RESERVOIRS -

1- Storage Capacity:-

El Paso-------- 542,891 Acre feet.

Elephant Butte- 2,000,000 " "

2- Yearly Supply for Irrigation, (Ordinary Years)

El Paso--------- 180,000 Acre feet.

Elephant Butte-- 600,000 " "

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3- Supply for Irrigation in Dryest Year.

El Paso-------- 176,881 Acre feet.

Elephant Butte- 600,000 " "

4- Average Annual Loss by Overflow.

El Paso-------- 156,565 Acre feet.

Elephant Butte- No Overflow.

5- Average Annual Loss by Evaporation.

El Paso-------- 122,293 Acre feet.

Elephant Butte- 145,043 " "

6- Agiven quantity of water stored in El Paso Reservoir will have nearly twice the evaporation surface as the same quantity stored in Elephant Butte Reservoir.

7- Combined Annual Loss from Evaporation and Overflow.

El Paso loses 278,858 acre feet in supplying 180,000 acre feet and less for irrigation.

Elephant Butte loses 145,043 acre feet in supplying 600,000 acre feet for irrigation.

8- Time Required to Fill 60 Per Cent of Capacity With Silt.

El Paso-------- 46 years.

Elephant Butte- 82 years.

9- Remaining Storage Capacity after Filling 60 Per Cent With Silt.

El Paso after 46 years-------- 217,000 Acre feet.

Elephant Butte after 82 years- 800,000 " "

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10- The efficiency of the two reservoirs can be seen at a glance, from the following table, showing the percentage in each of the water supply that is lost by evaporation and overflow, and the percentage that is made available for irrigation:

Record for 7 1/2 Years.	Percentage of Inflow	
	El Paso Reservoir	Elephant Butte Reservoir
Loss by Sediment----------	1.43%	1.8%
Loss by Evaporation---------	24.55%	18.0%
Loss by Overflow----------	32.00%	0.0%
Total Loss--	57.98%	19.8%
Water used for irrigation---	37.00%	76.2%
Water in reservoir at end of 7 1/2 Years----------	5.02%	4.0%
	100.00%	100.0%

11- Effect of Sluicing Out Part of the Mud.

We will now consider the possibilities of sluicing out part of the mud that accumulates, and the corresponding effect upon each of the reservoirs in question:

In order to be able to sluice mud from a reservoir the reservoir must be empty, and the sluice water must come from some source other than the reservoir itself. Hence, advantage must be taken of a natural flood in the river, or there must be an

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auxiliary storage dam above on the river or one of its tributaries for supplying sluice water. Without going into the question of the quantity of water necessary for this work, we will assume that it can be done by the method of ground sluicing used in hydraulic mining; a large tunnel being constructed at the bottom of the dam to provide the necessary outlet. A high level canal along the hillside above the reservoir, and a number of hydraulic giants under-cutting the banks would materially increase the work that can be done by a given quantity of water, but we will consider for the present the chance of ground-sluicing with a large flow of water without resorting to pressure nozzles for under cutting the banks, and we will assume for the purpose of comparison that a single channel can thus be maintained through the mud from the upper end to the lower end of the reservoir, having a width of fifty feet at the bottom and having side slopes of four horizontal to one vertical (4 to 1). Referring to the foregoing statement, the El Paso reservoir will accumulate sufficient mud in 46 years to fill 60% of its entire capacity, and the mud will have a depth of 46 feet in the river channel just above the dam, and will extend upstream with a decreasing depth for a distance of about 13 1/3 miles. Sluicing a channel through this mud along the center of the valley, with a width of 50 feet at the bottom, and with side slopes 4 to 1, will remove 280,000,000 cubic feet of mud which amounts to 6,428 acre feet. But the rate of mud accumulation in this reservoir is 7,107 acre feet per year. Hence, the proposed sluicing would take out less than one year's accumulations.

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It has also been shown that the Elephant Butte Reservoir will accumulate sufficient mud in 82 years to fill 60% of its entire capacity, and that the mud depth just above the dam will be 150 feet, and will extend upstream with a decreasing depth for a distance of at least 30 miles. Sluicing through this deposit a channel with a bottom width of 50 feet and side slopes 4 to 1 will remove 5,353,920,000 cubic feet of mud, which is equivalent to 120,613 acre feet. As the mud depcsit in this reservoir is at the rate of 14,580 acre feet per year, the proposed sluicing would remove the accumulations of eight and a fourth years. This mud-sluicing discussion is not given to show the practical limits to which cleaning out by sluicing can be carried, nor is it here claimed that even the supposed channel can be maintained by sluicing; but the disoussion applies the same hypothetical conditions to both reservoirs, and shows that the same process applied to both will produce very different results. It takes out less than one year's accumulations of mud from the El Paso Reservoir, while it removes more than eight years accumulations from the Elephant Butte Reservoir. This difference is due to the fact that the mud in the former is a wide shallow deposit, and in the latter is a deep narrow deposit. The same advantage will hold good for the latter, no matter what process of sluicing may be applied, or what the difficulties of sluicing the material may be, provided the material is the same in both reservoirs. The same process will take out

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nine tenths of a year's accumulations in the El Paso Reservoir, and eight and one fourth years' accumulations in the Elephant Butte Reservoir. Sluicing is therefore nine times as efficient in the latter as the former. As the depth of mud in the latter is practically three times as great as in the former, the efficiency of sluicing appears to vary directly as the squares of the depths. This conforms to general principles, and is a natural result of the investigations.

- CONCLUSION -

The foregoing study has been confined to a comparison of the service that can be performed by the two proposed reservoirs. We have not gone into the question of cost. This will be done later, but it is safe to say that the El Paso Reservoir would cost a great deal more in proportion to its efficiency than the Elephant Butte Reservoir. The high dam of the latter would be largely offset by the following conditions in the former:

1st: The greater depth of bed-rock, and the same being a broken limestone formation dipping downstream.

2nd: The many thousand acres of rich, high-priced, Mesilla Valley lands to be covered by water and mud by the reservoir, or converted into marsh lands above the head of the reservoir.

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3rd: The railroad tracks occupying the land to be flooded and to be removed at great expense.

4th: The quarrying and manufacturing plants in the basin to be paid for and removed.

The El Paso Reservoir would waste more water by evaporation and overflow each year than it would furnish for irrigation. It would produce in the immediate vicinity of El Paso many thousands of acres of mud flats and marshes on land that would otherwise be exceedingly valuable for agriculture and other purposes. It would furnish no water for irrigating the great Mesilla Valley in New Mexico, a region that is as truly tributary to El Paso as El Paso Valley itself; although it would waste enough water by evaporation and overflow to irrigate 83,000 acres.

On the other hand, the Elephant Butte Reservoir will waste no water by overflow, and a minimum amount by evaporation; and at the same time will furnish enough water for irrigation to supply the Mesilla Valley, give a flow to the old Mexican canal equal to that which was used from it years ago for irrigation, and have enough left over to allow Texas to participate in the benefits.

The Elephant Butte Dam has the final advantage of being in New Mexico, and subject to the operations of the U. S. Reclamation Service. The project can be so planned that legislation by Congress can allow Mexico and Texas to participate. But the

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extent and manner of this participation is a matter that must be arranged and decided on by Congress and the Department of State. All that the Reclamation Service can do at present is to make plans and estimates for work in the Territory of New Mexico that will not conflict with any action that may be taken by Congress and by the Secretary of State for restoring water to which the El Paso Valley in Texas and Mexico has laid claim by virtue of ancient prior appropriation and continuous use.

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- RIO GRANDE PROJECT OF THE U. S. RECLAMATION SERVICE -

The foregoing discussions have brought out certain facts concerning the Rio Grande that cannot be neglected in making a general plan for storing its flood waters and irrigating its rich valleys. We have found:

That the Rio Grande is essentially a torrential or storm-water stream, subject to great floods so irregular in their occurrence that the total flow in some years is less than one tenth of the total flow in other years, and that the whole of this water is badly needed for irrigation. A reservoir that will waste any large amount of it by overflow, or unnecessarily expose it to evaporation is not to be considered. So far as the required capacity for water storage is concerned it might be secured by a series of reservoirs along the river, having a combined capacity sufficient for impounding all the flood water, but the cost per acre of land irrigated would be too great. The depth from the present river bed down to le d rock is from 65 to 90 feet at nearly all of the available reservoir sites. As all the dams,whether large or small, must be founded on bed rock, it requires no argument to prove that a series of small dams will cost more than one large dam forming a reservoir with a storage capacity equal to that of all the others. But aside from the increased cost of storage by means of a number of small reservoirs, there is another condition that absolutely prohibits

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their use. The Rio Grande is a very muddy river. It carries a large percentage of silt in suspension that varies in its amount from year to year, and from month to month, sufficient to have made a mud deposit in the last seven and a half years equivalent to 1.8 per cent of the total volume of water that has come down the river.

Any reservoir constructed on the river will stop all the silt that comes down the river in suspension. A small reservoir will accumulate as many acre feet of mud per year as a large one until it is filled with mud. With a series of small reservoirs the upper one would fill with mud in a short time, and any mud that might be sluiced out of it would simply be transferred to the next one below, and so on. We have also shown that any process of mud sluicing that can be resorted to is much more efficient in a large deep reservoir than in a smaller shallow one.

It therefore appears that the best solution for the mud question, as well as the storage question, is the construction of one big reservoir, of great depth, with capacity to store all the water and equalize the irregular flow over a number of years, and with surplus capacity for mud storage, until posterity can take advantage of its great depth to sluice it out economically.

So far as the writer knows, the only site for such a dam and reservoir on the river is the site selected by the U. S. Reclamation [redacted] Engineers at Elephant Butte, near Engle, New

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Mexico. If the plans are carried out successfully at this site, the reservoir, will not only meet all of the demands for irrigation below it, but will protect the valley below from the disastrous floods to which it is now subject.

The following is a statement of the irrigable lands of the Rio Grande Valley in the United States lying immediately below the proposed dam:

IRRIGABLE LANDS SURVEYED IN NEW MEXICO AND TEXAS

BELOW THE PROPOSED ELEPHANT BUTTE DAM

	Acres
Below Elephant Butte Dam to U. S. Dam site #39	
East side of river, survey by U. S. R. S.....	2949
West side of river, survey by U. S. R. S.....	6913
Below Dam site #39 to Rincon-	
East side of river, Land Office maps.....	6400
West side of river, Land Office maps.....	15240
Below Rincon to Penasco Rock...	
East side of river, Land Office map.....	5230
West side of river, Land Office map.....	3560
Below Penasco Rock to Texas State Line-	
East side of river, U. S. R. S.....	52879
West side of river, U. S. R. S.....	25152
Below Texas State Line to El Paso in Texas-	
But in Mesilla Valley, U. S. R. S.....	22227
Below El Paso, Texas, on east side of Rio Grande to town of Rio Grande.....	71800
	208400

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The Elephant Butte Dam, as projected by this Survey, will be arched upstream, and on a six degree (6°) curve, the upstream edge of crest, having a radius of 955 feet. The dimensions are as follows:

Height from bed-rock foundation to top of parapet walls on crest, 255 feet.

Height from river bed (sand) to top of parapet walls on crest, 185 feet.

Thickness at bottom, 180 feet.

Thickness at crest from outside to outside of parapet walls, 20 feet.

Length of crest, 1,150 feet .

From upstream edge parapet wall of crest a triangular section gives upstream batter 1 inch to the foot; downstream batter 7 1/2 inches to the foot.

Downstream edge of crest 3' 6" vertical, and curved to meet the downstream batter with a 100-foot radius.

Roadway 5 feet below crest between parapet walls on each side, and 14 feet wide.

The height of spillway, 10 feet below roadway of crest, and 15 feet below top of parapet wall.

Depth of water from river bed to spillway, 175 feet.

Strains calculated for possible high water at crest 255 feet above foundation, with weight of masonry 141 lbs. per cubic foot, or a specific gravity of 2.25.

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Spillway to be at a gap on west side of valley several miles above the dam. This spillway will be 175 feet above the level of the present river bed at dam site, and will have a length of 800 feet.

The reservoir will be about 40 miles in length, and will have a storage capacity of 2,000,000 acre-feet to level of spillway. It will furnish about 600,000 acre-feet per annum for irrigation, and will irrigate 180,000 acres of land.

If no means of keeping the mud cleared out is provided, it is estimated that the silt deposits in the reservoir will fill up 60 per cent of its capacity in 82 years, but a proper sluice tunnel and gates will make it possible to take advantage of conditions and opportunities for getting rid of mud by sluicing. The necessary conditions are an empty reservoir, and a flow of water through the reservoir bed, either from a natural flood in the river, or from an auxiliary reservoir above, provided for the purpose.

All that is necessary at present is to construct an ample opening at the river level with gates that can be operated when the reservoir is empty. The mud sluicing can be safely left to the ingenuity of posterity.

The openings for every-day use will consist of a sufficient number of cast iron pipes with proper gates on them.

Some of the large cast iron service pipes will have their inlets in the vicinity of the large sluice gate, so that this large gate will not be covered with mud.

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Another set of pipes will come through the rock bluff at the opposite end of the dam, and will lead to water wheels, if it is found to be profitable to produce power in this way.

As bed-rock is about 65 feet below the present river bed, it will be necessary to excavate about 65 feet of sand and gravel to get the dam on bed-rock.

Al though the river was practically dry for ~~four~~ three months in 1900, and for five months in 1904, it willbe necessary to provide a flume or other water-way that will carry the whole river, and keep it out of this excavation; also strong coffer-dams and a large pumping plant. The sand must be excavated either by pumping, or by an elevator dredge, or by cable-way excavators. By a system of driven wells allaround the inside of the coffer-dam it is probable that the sides of the excavation can be kept dry enough to maintain a slope of 3 to 1, in an open cut, but in this estimate a slope of 4 to 1 is assumed.

ESTIMATE OF COST FOR DAM

44,400 cu.yds.soft rock and earth excavation along hill slopes @ 50¢	$ 22,200.
335,000 cu.yds.sand excavation @ 85¢	284,750.
Coffer-dams above and below, 400 ft. each	30,000.
Flume or water-way for river, 800 ft. long	40,000.
5,000 cu.yds.bed-rock excavation for dam anchorages @ $2,00 per cu.yd.	10,000.
Amount forwarded	$ 386,950.

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Amount brought forward	$ 386,950.
114,000 cu.yds. of Cyclopean Concrete below river bed, including pumping, @ $9.50	1,083,000.
296,000 cu.yds.Cyclopean Concrete above river bed @ $9.00	2,664,000.
Tunnel and sluice gates and outlets	250,000.
Paving for spillway	17,000.
Earth excavation for spillway 120,000 cu.yds.@ 15¢	18,000.
Foundation for spillway	5,000.
Soft rock excavation for spillway	6,000.
Concrete masonry for spillway 2,000 cu.yds.@ $9.00	18,000.
	$ 4,447,950.
15% for engineering and contingencies	667,192.
	$ 5,115,142.

DIVERSION DAM AND CANAL

We have made detailed plans and specifications for a diversion dam at Penasco Rock, near Selden Station on the Santa Fe Railroad about 18 miles above Las Cruces, New Mexico; and for seven miles of canal from that point to the head of the present Las Cruces canal, this work being intended as a part of a general project, known as the Rio Grande Project, for irrigating the Rio Grande Valley by the proposed Elephant Butte Storage Dam, and by diversion dams and canals below. The most important system of this project will consist of head works near the upper end of Me-

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silla Valley, and a large canal about 50 miles in length for irrigating the Mesilla Valley, and conveying water for use at El Paso and below.

It has been generally considered that Penasco Rock, near Selden, is the proper point for this diversion dam, as the large solid rock protruding from the left bank and extending some 50 feet into the river offers a safe abutment for a dam, and anchorage for canal gates. Notwithstanding the fact that borings in the river-bed opposite this point of rock show a depth of 70 feet to bed-rock, the site is still a desirable one. But the Survey plans and estimates above referred to, show that its advantages are more than counterbalanced by its unfavorable location. Some of the unfavorable conditions are as follows:

1st: The Santa Fe Raulroad occupies the only ground that would be available for a canal in the first 2,600 feet below the rock. It will therefore be necessary either to move the railroad farther back into the hill at a great expense, or to build the canal in the river-bed, by constructing a high embankment, and protecting the embankment against the scour of the river. The estimates are made on the latter plan.

2nd: The elevation gained by starting the canal at Penasco Rock cannot be maintained except at great expense; and if it could be kept up at a regular grade the water would be on a higher level than is necessary to cover the agricultural lands.

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3rd: The high soft river bluff for a half a mile above the mouth of Las Cruces Canal is undermining and encroaching on the railroad to such an extent that there is not room for a canal between the river and the railroad, and the ground is entirely too high for a canal above the railroad. It will therefore be necessary to drop nearly to the river level, and use the present river-bed for a canal at this point. In order to do this the river can be turned across the big bend by a cut-off along the west side of the valley. This will put the river channel at least a mile west of its present location, and get it out of the way.

The above practical considerations have developed the fact that Penasco Rock is four or five miles farther up the river than is necessary to go for a diversion, and that aside from the extra four or five miles of canal, it will be cheaper to make a diversion dam lower down the river where there is no rock bluff, as the difficulties encountered in building the first 2,600 feet of canal more than counterbalance the advantages of the rock abutment.

NEW DIVERSION POINT

The above considerations have led to the selection of a new diversion point on the river opposite the residence of Mr. Summerford, which is at Leasburg Station on the Santa Fe Railroad about 5 miles below Penasco Rock. At this new site the river is on the west side of the valley against the foot-hills, as

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shown on map herewith. The site is about two miles above the proposed cut-off across the big bend. The cut-off will cause the river channel to lower at least five feet at the site, and will make the banks comparatively high.

Here a diversion dam can be constructed similar in every way to the proposed Penasco Rock Diversion Dam, except that a concrete pier will take the place of the natural rock. The canal will also have a similar head wier and head gates. From the Leasburg Diversion Dam (as this site will be called for distinction) two miles of canal will reach the point where it is proposed to use half a mile of thepresent narrow river bed above the mouth of the Las Cruces Canal.

Referring to estimates of Penasco Diversion for details, the following is an estimate of cost for the Leasburg Diversion Dam, sluice gates, canal inlet and two and a half (2 1/2) miles of canal leading to head of Las Cruces Canal:

COST OF LEASBURG DIVERSION AND CONDUIT TO LAS CRUCES CANAL

500-ft. concrete wier dam, with pier, embankment and sluice gates	$ 35,000.
Pier at left bank	3,000.
Inlet to canal	4,350.
Head gates in canal	3,175.
Concrete in head gates, wing walls and floor	7,000.
Two miles of full size canal 146,000 cu.yds. of earth excavation @ 12 1/2¢	18,250.
Amount forwarded	$ 70,775.

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Amount brought forward----	$ 70,775.
River cut-off at Big Bend, 24,000 cu.yds. earth excavation @ 12 1/2¢----------	3,000.
Embankment across river above cut-off, 10,000 cu.yds. @ 12 1/2¢----------	1,250.
Wire fencing for river control----------	775.
Right of way----------	2,500.
Sluice gates in embankment above mouth of Las Cruces Canal----------	2,600.
Arroyo control, drop, lower embankment, etc.----	11,000.
Watchman's house----------	1,100.
	$ 93,000.
15% for engineering and contingencies----------	14,000.
Total------	$ 107,000.
Maintainance and operation for 10 years---------	43,000.
	$ 150,000.

The above estimate includes a canal large enough for 1,000 second feet. If the canal is made at present only large enough for 500 second feet, this will effect a saving of $7,000, and make the total cost for diversion project $100,000. The capacity of 500 second feet will be sufficient for furnishing water from the river to existing canals in the valley while the Ele-Butte Storage Dam is in construction.

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COMPLETION OF RIO GRANDE PROJECT

After building the storage dam, the diversion dam, and 2 miles of canal as above set forth, all that will be necessary in order to irrigate the lands below will be to extend the main canal along the valley on the east side of the river and to take out such lateral canals as may be necessary. Water may be taken across the river in pipes to the west side, or electric power generated by drops in the canal can be used to run pumps to irrigate the west side; or a separate canal can convey the water for irrigating the west side. Estimates will be made on the last mentioned plan. The east side canal will be built with capacity to convey water for 50,000 acres in New Mexico; 20,000 acres in Texas above El Paso; and 50,000 acres below El Paso.

This will require:

20 miles of canal with 1,000 second feet capacity:

20 miles of canal with 700 second feet capacity:

10 miles of canal with 500 second feet capacity:

The west side canal will be constructed with capacity to convey water for 20,000 acres in New Mexico.

This will require:

20 miles of canal with capacity for 200 second feet, and

10 miles of canal with capacity for 50 second feet.

As most of the land has been under cultivation, existing laterals can be used in many cases for distribution, but an allowance for laterals will be made in the estimates. These canals will also require arroyo crossings, drops in water level, outlets, etc.

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ESTIMATE OF COST FOR EAST SIDE CANALS

20	miles of 1,000 sec.ft.capacity canal	@ $7,700--	$ 154,000.
20	arroyo crossings	@ $450 each----------	9,000.
20	" "	@ $600 " ----------	12,000.
4	" "	@ $800 " ----------	3,2000.
3	" "	@ $10000"" ----------	3,000.
3	" "	@ $1600 " ----------	4,800.
5	4-foot drops	@ $900----------	4,500.
5	outlet gates	@ $200----------	1,000.
20	miles of 700 sec.ft.capacity canal	@ $6,000----	120,000.
20	arroyo crossings	@ $400----------	8,000.
20	" "	@ $540----------	10,800.
4	" "	@ $700----------	2,800.
3	" "	@ $900----------	2,700.
3	" "	@ $1400----------	4,200.
4	4-foot drops	@ $750----------	3,000.
5	outlet gates	@ $200----------	1,000.
10	miles of 500 sec.ft.capacity canal	@ $4,000----	40,000.
10	arroyo crossings	@ $350----------	3,500.
10	" "	@ $470----------	4,700.
2	"" "	@ $600----------	1,200.
3	" "	@ $730----------	2,190.
1	" "	@ $1240----------	1,240.
2	outlet gates	@ $200----------	400.
Lateral canals on east side----------			140,000.
			$ 537,230.
15% for engineering and contingencies A354002--			80,770.
			$ 618,000.

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ESTIMATE OF COST FOR WEST SIDE CANALS

Diversion dam near head of San Miguel Ditch----------	$ 50,000.
20 miles of 200 sec.ft.capacity canal @ $1,200--------	24,000.
20 arroyo crossings @ $100----------	2,000.
20 " " @ $200----------	4,000.
10 " " @ $400----------	4,000.
10 miles of 50 sec.ft.capacity canal @ $600----------	6,000.
10 arroyo crossings @ $ 50----------	500.
10 " " @ $100----------	1,000.
5 " " @ $300----------	1,500.
Lateral canals on west side----------	40,000.
	$ 133,000.
15% for engineering and contingencies----------	20,000.
	$ 153,000.

- SUMMARY -

Elephant Butte Storage Dam and Spillway----------	$ 5,115,000.
Leasburg Diversion Dam, head gates and canal complete to head of Las Cruces Ditch----------	107,000.
East Side Canal and Laterals----------	618,000.
West Side Canal and Laterals----------	153,000.
	$ 5,993,000.
Diversions and Canals for 40,000 acres above Penasco Rock	300,000.
Maintainance for 10 years----------	750,000.
Right of way----------	175,000.
Total cost----------	$ 7,218,000.

Land irrigated, 180,000 acres; cost per acre, $40.

The above is the writer's estimate of cost for the Rio Grande Project as revised by A. P. Davis, W. H. Sanders and B. M. Hall, the Board of Engineers appointed by the Chief Engineer to inspect and report upon the same in October 1904. The following is their report to the Chief Engineer; which is given as an appendix to this paper:

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Las Vegas, N. M. Oct. 22, 1904.

Mr. F. H. Newell,

Chief Engineer,

U. S. Reclamation Service.

Sir:-

The undersigned Board of Engineers have visited the locality of the proposed International and Elephant Butte dams on the Rio Grande, and the proposed diversion works at the head of the Mesilla Valley, and have studied the designs and estimates prepared under the direction of Mr. B. M. Hall, Supervising Engineer.

The considerations which prompted the investigations for a high dam near Elephant Butte as superior to the International Dam project have been signally justified by the results, which may be summarized as follows:

1- The proposed Elephant Butte reservoir has a capacity of two million acre feet, as against about five hundred and forty thousand acre feet that can be provided by the proposed International reservoir at El Paso.

2- The former will furnish for irrigation six hundred thousand acre feet of water per annum, while the latter will furnish only one hundred eighty thousand acre feet.

3- The former will lose no water by overflow, while the latter will waste a very large percentage by overflow.

4- With a given amount of water the Elephant Butte reservoir will present only one half the surface for evaporation that will be presented by the International reservoir.

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5- We estimate that it will require eighty two years to fill sixty per cent of the former reservoir with mud, while the latter reservoir will be filled to sixty per cent of its capacity with mud in forty six years.

6- The Elephant Butte Reservoir is deep and narrow, while the International Reservoir is wide and shallow, and in consequance it is found that any process of sluicing out mud will be nine times as efficient in the former as in the latter.

7- The Elephant Butte Reservoir will store the entire flow of the river without waste and with a minimum evaporation, and will prevent disastrous floods along the valley occupied by the Santa Fe Railroad, and by several important towns, while the International Reservoir will waste the water by overflow, present conditions producing a maximum of evaporation, regulate no floods above El Paso, cover twenty five thousand acres of good land near El Paso and make marsh land of probably 15,000 more acres above it and produce unsanitary conditions at El Paso.

8- The International dam proposes to destroy about 40,000 acres of good land immediately north of El Paso, in order to irrigate about 55,000 acres below El Paso; while the Elephant Butte Reservoir proposes to irrigate the forty thousand acres of land that the other would destroy, also to irrigate 50,000 acres below El Paso, and in addition to irrigate 90,000 acres above in New Mexico, a total of 180,000 acres, all of which is tributary to El Paso.

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A study of the water supply of the Rio Grande as measured at San Marcial, regulated by the proposed dam below Elephant Butte, shows that 600,000 acre feet of water could have been drawn from the reservoir each year without ever emptying the reservoir, and we consider this a basis for estimating the future duty.

At the rate of three and one third feet in depth for irrigation, the water would serve 180,000 acres; the surveys show irrigable land about as follows:

Above Penasco Rock------- 40,000 acres.
Penasco Rock to Texas line-70,000 "
In Texas above El Paso--- 20,000 "
In Texas below El Paso--- 50,000 "

According to the above figures the Elephant Butte dam would furnish water to 110,000 acres of land in New Mexico, and 20,000 acres in Texas, or a total of 130,000 acres of land above El Paso, and a surplus of water sufficient for 50,000 acres which could be emptied into the river for use below El Paso.

The cost of the project, including the reservoir and all diversion works and canals above El Paso, is estimated at $7,200,000, or $40 per acre on 180,000 acres. This is below the value of irrigated land in this valley, and those best informed pronounce the project desirable at this price. The main item of cost is the dam, and this will require about 300,000 barrels of cement, a large amount of machinery, gates, etc; entailing a very heavy outlay for freight. The irrigable land is

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all tributary to the Santa Fe Railroad system, and the reservoir, by regulating the floods of the Rio Grande, will greatly cheapen the maintainance of the railway between Rincon and El Paso. In view of these facts, and the very high cost of the dam, we recommend that the Santa Fe Railway Company be requested to grant half traffic rates on the material used in the project, as was done by the Denver & Rio Grande Railroad for the Uncompahgre project.

In making our estimates we have assumed that reasonable concessions of this nature can be secured.

We have informed the people in a public meeting in Las Cruces of the result of our investigations, and at the same meeting a resolution was unanimously adopted, declaring in favor of the project, and requesting this Board to recommend legislation by Congress to enable lands in Texas to benefit by the reservoir and contribute to its cost.

The land to be irrigated is nearly all private land.

We are assured by prominent citizens of the valley that there is little doubt that practically all the owners of land in the valley will readily comply with the provisions of the law by which they may receive the benefits of the Reclamation Act, and we concur in this opinion. We have recommended an organization to take in hand the subject of securing pledges of land to the cost of the project, and it is not feasible to begin construction until these are secured, but the prospects are suf-

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ficiently good so that we feel justified in recommending that legislation be asked that will authorize the irrigation of lands in Texas, in connection with the project.

We also recommend that the surveys and preparation of plans be continued under the direction of Mr. B. M. Hall.

(Signed) A. P. Davis.
W. H. Sanders.
B. M. Hall.
Board of Engineers.

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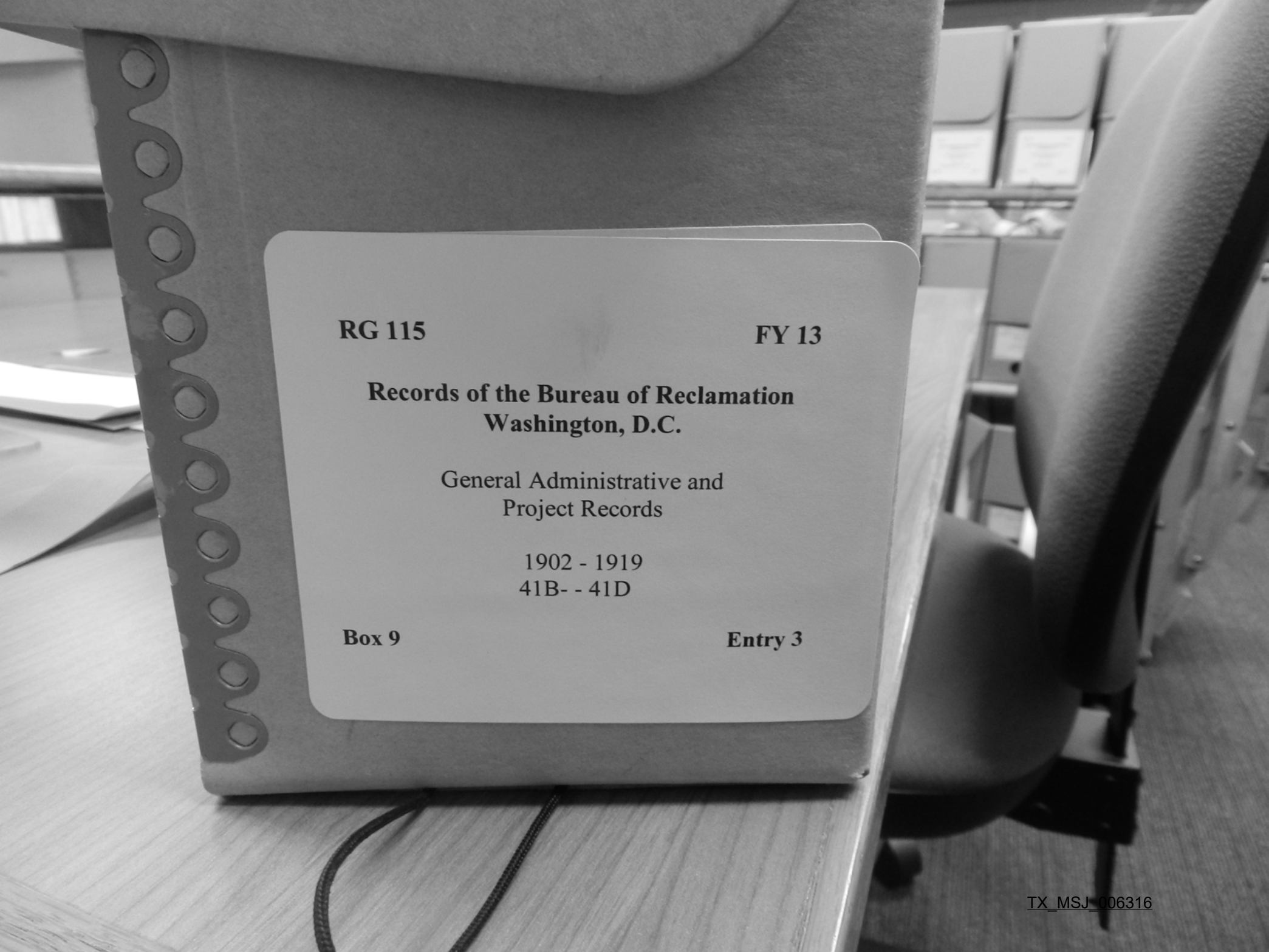

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41-D NEW MEXICO. W ater Appropr iations. RIO GRANDE PROJECT THRU 1910. 41-D

TRANSFER CASE

TRANSFER CASE

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SUBJECT: Supplemental notice of the intention of the United States to use the waters of the Rio Grande for irrigation purposes on the Rio Grande Project.

DEPARTMENT OF THE INTERIOR

UNITED STATES RECLAMATION SERVICE

April 14, 1908.

Mr. Vernon L. Sullivan,
Territorial Engineer,
Santa Fe, New Mexico.

Dear Sir:-

Claiming and reserving all rights under our former notice of January 25, 1906, addressed to David L. White, Territorial Irrigation Engineer of New Mexico, which said notice advised him of the intention of the United States to use the waters of the Rio Grande for the purpose of irrigation, and is now filed in your office, I do now hereby give you the following notice in addition to said former notice and supplemental thereto.

The United States acting under authority of an Act of Congress known as the Reclamation Act, approved June 17, 1902, (32 Stat 388), proposes to construct within the Territory of New Mexico certain irrigation works in connection with the so called Rio Grande Project. The operation of the works in question contemplates the diversion of the water of the Rio Grande River.

Section 40 of Chapter 49 of the laws enacted in 1907 by the 37th Legislative Assembly of the Territory of New Mexico, an Act entitled, "An Act to conserve and regulate the use and distribution of the waters of New Mexico; to create the office of Territorial

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Engineer; to create a Board of Water Commissioners, and for other purposes", approved March 19, 1907, reads as follows:

"Whenever the proper officers of the United States authorized by law to construct works for the utilization of waters within the Territory, shall notify the Territorial Engineer that the United States intends to utilize certain specified waters, the waters so described, and unappropriated, and not covered by applications or affidavits duly filed or permits as required by law, at the date of such notice, shall not be subject to a further appropriation under the laws of the Territory for a period of three years from the date of said notice, within which time the proper officers of the United States shall file plans for the proposed work in the office of the Territorial Engineer for his information, and no adverse claim to the use of water required in connection with such plans, initiated subsequent to the date of such notice, shall be recognized under the laws of the Territory, except as to such amount of water described in such notice as may be formally released in writing by an officer of the United States, thereunto duly authorized: Provided, That in case of failure to file plans of the proposed work within three years, as herein required, the waters specified in the notice given by the United States to the Territorial Engineer shall become public waters, subject to general appropriations."

In pursuance of the above statute of the Territory you are hereby notified that the United States intends to utilize the following described waters, to wit:

All the unappropriated water of the Rio Grande and its tributaries, said water to be diverted or stored from the Rio Grande River at a point described as follows:

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- No. 3 - Notice of use of waters of Rio Grande.

Storage dam about nine miles west of Engle, New Mexico, with capacity for (2,000,000) two million acre feet, and diversion dams below in Palomas, Rincon, Mesilla and El Paso Valleys in New Mexico and Texas.

It is therefore requested that the waters above described be withheld from further appropriation and that the rights and interests of the United States in the premises be otherwise protected as contemplated by the statute above cited.

Very truly yours,

Supervising Engineer.

B

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DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY

CENTRAL CLASSIFIED FILE
1907-1936

8-3, Rio Grande, R
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1-094a

DEPARTMENT OF THE INTERIOR

OFFICE OF THE SECRETARY

File No. 8 3
(Part 7)

- RECLAMATION BUREAU -

-0-

- RIO GRANDE PROJECT -

-0-

- RIO GRANDE RIVER - DISTRIBUTION OF WATERS -

- GENERAL

IMPORTANT

This file constitutes a part of the official records of the Department and should not be separated or papers withdrawn without express authority of the Secretary.

All files should be returned promptly to the File Room.

Officials and employees will be held responsible for failure to observe these rules, which are necessary to protect the integrity of official records.

Ray Lyman Wilbur
Secretary.

Feb. 6, 1933 to
Dec. 12, 1936

U. S. GOVERNMENT PRINTING OFFICE: 1929 6—7385

TOTAL PAGES

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8-3
Rio Grande
Dist. & Water
General

THE WHITE HOUSE
WASHINGTON

September 23, 1935.

To Federal agencies concerned with projects or allotments for water use in the Upper Rio Grande Valley above El Paso:

From information secured by the National Resources Committee, it appears that in view of the practically complete present appropriation of reliable water supply in the basin of the Rio Grande above El Paso, Federal investments in this region which promote increased use of water tend to impair the security of extensive prior investments of Federal funds, to violate the terms of an Interstate Compact to which the Federal Government is a party, and to promote social insecurity in the region.

Please instruct appropriate officials of your agency in Colorado and New Mexico, as well as in Washington or in other supervisory offices, not to approve any application for a project involving the use of Rio Grande waters without securing from the National Resources Committee a prompt opinion on it from all relevant point of view.

Franklin D. Roosevelt

Photostat copy filed in 1-12 - PRESIDENT

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PRELIMINARY DRAFT

of

REPORT OF COMMITTEE

to

RIO GRANDE COMPACT COMMISSIONERS

December 22, 1937

December 22, 1937.

The Rio Grande Compact Commission,
Mr. S.O. Harper, Chairman,
Mr. M.C. Hinderlider, Member for Colorado,
Mr. T.H. McClure, Member for New Mexico,
Mr. F.B. Clayton, Member for Texas.

Gentlemen:

The Engineering Advisers of your Commission have held two meetings, the first in Santa Fe from November 22 to 24, and the other in Los Angeles from December 15 to 24. The first meeting was largely devoted to consideration of the general factors affecting the discharge of Rio Grande at the Colorado-New Mexico State Line and the delivery of water into Elephant Butte Reservoir. At the second meeting more detailed consideration was given to these matters, and definite schedules of deliveries were developed.

We avoided discussion of the relative rights of water users in the three states and were guided throughout our work by the general policy - expressed at the meeting of the Compact Commission in October - of maintenance in the future of the same conditions of flow at the State Line and into Elephant Butte Reservoir as those which prevailed in recent years. We were further governed by the generally accepted fact that the Rio Grande is utilized to the maximum extent possible with present irrigation works, and that further development in any upstream section will require adequate safeguards to prevent injury to existing projects downstream.

(A)

The Rio Grande above Fort Quitman, which constitutes the part of the drainage basin in which the Commission has primary

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interest, is divided naturally into three sections:

(a) The San Luis Valley, comprising the drainage area above the Lobatos gaging station on the Rio Grande near the Colorado-New Mexico State Line;

(b) The Middle Rio Grande section from Lobatos to Elephant Butte Reservoir and streams tributary to the river in this section;

(c) The balance of the Rio Grande Basin, ~~including the Rio Grande Project, lands in Hudspeth County, Texas, and the~~ between Elephant Butte and Fort Quitman, including the Juarez Valley in Mexico.

It must be recognized that precise determination of past conditions and close estimates of future changes are not possible. Accordingly, in submitting the following for your favorable consideration and inclusion in a permanent Compact to govern the future administration of the Rio Grande above Fort Quitman, we suggest that provision be made for review of these matters after first 5 years and for adjustments within the intent of the Compact.

SCHEDULED DELIVERIES AT LOBATOS

A close relationship has long been noted between the combined inflow of the major streams to San Luis Valley and the outflow of the Rio Grande at Lobatos. This relationship, however, may be disturbed in the future due to construction of storage reservoirs, and we have therefore prepared separate schedules applicable to ~~both of the principal~~ the Conejos and Rio Grande stream systems. This is a departure from previous plans but has no practical disadvantage and has certain definite advantages; variations in discharge of the ~~different~~ contributing streams will auto-

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matically be taken into account, particularly if storage reservoirs are constructed; and it will also enable the San Luis Valley water users to apportion among themselves their relative responsibility for meeting the obligation of Colorado.

The flow of Conejos River at its mouths, near Los Sauces, was found to bear a close relation to the combined discharge of Conejos River near and its principal tributaries below Mogote. The following values are from a smooth curve expressing that relationship for the past ten years, and it is recommended that these be used as a schedule of future deliveries.

SCHEDULE OF DELIVERIES FROM CONEJOS RIVER

Quantities in thousands of acre feet

Conejos Index Supply (1)	Conejos River at Mouths (2)
100	0
150	20
200	46
250	76
300	111
350	150
400	191
450	235
500	280
550	328
600	375
650	424
700	480

Intermediate quantities shall be computed by proportional parts.

(1) Conejos Index Supply is the natural flow of Conejos River at the U.S.G.S. gaging station near Mogote for the calendar year, plus the natural flow of Los Pinos River at the U.S.G.S. gaging station near Ortiz and the natural flow of San Antonio River at the U.S.G.S. gaging station near Ortiz, both for the months of April to October, inclusive.

(2) Conejos River at its mouths is the combined discharge

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The USGS 2a

of branches of this river at gaging stations near ~~San~~ S (Los Sauces) Sauces during the calendar year.

When from the total discharge of Rio Grande at Lobatos there is subtracted the contribution from Conejos River, a close relationship is also found to exist between that residual quantity and the discharge of Rio Grande near Del Norte. The following values are from a smooth curve expressing the relationship for the past ten years, and it is recommended that this be the schedule of deliveries for the future.

SCHEDULES OF DELIVERIES FROM RIO GRANDE ABOVE DEL NORTE

Quantities in thousands of acre feet

Rio Grande at Del Norte (3)	Rio Grande at Lobatos less Conejos at Mouths (4)
200	60
250	65
300	75
350	87
400	100
450	114
500	130
550	147
600	165
650	185
700	207
750	235
800	270
850	305
900	345
950	390
1 000	440
1 100	540
1 200	640
1 300	740
1 400	840

Intermediate quantities shall be computed by proportional parts.

(3) The ~~natural~~ recorded flow of Rio Grande at the U.S.G.S. gaging station ~~west of~~ near Del Norte during the calendar year. (measured above all principal points of diversion to San Luis valley).

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The U.S.G.S. gaging station near

(4) The total flow of Rio Grande at Lobatos, less the discharge of Conejos River at its mouths, during the calendar year.

The obligation of Colorado to deliver water in the Rio Grande at the Colorado-New Mexico State Line would be the sum of the quantities set forth in the above tabulations, except for such departures from normal deliveries as are provided for below. In the application of either schedule, appropriate adjustments must be made for any change in location in gaging stations and for any new or increased depletion of the natural ~~diversions or storage above the stations~~

SCHEDULED DELIVERIES INTO ~~THEIR~~ ELEPHANT BUTTE RESERVOIR

The relation between the amount of water in the Rio Grande above the principal agricultural areas in New Mexico and inflow to Elephant Butte Reservoir is quite erratic, due primarily to wide variations in the discharge of tributary streams. Your committee tried many devices to eliminate the influence of such tributary inflow. Finally, it was found that there was a reasonable relationship between the discharge of Rio Grande at Otowi Bridge and the inflow to Elephant Butte Reservoir when the discharge at Otowi and the inflow to the reservoir during the months of July, August, and September were excluded. Such a relationship does not reflect possible changes in consumptive use during the summer months between these points, and tributary flow in other months still results in considerable variation, but it is our opinion that no more precise relationship can be developed from present information, and that its use as a schedule will be practicable.

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In order that all available data might be used in determining the proper schedule, the flow of the Rio Grande at Otowi, exclusive of July, August, and September, was first compared to the flow of the Rio Grande at San Marcial, excluding the same months, and a curve was drawn which expressed most closely the relationship which existed in the past. However, the gaging station at San Marcial is expensive to operate, and physical conditions make it difficult to obtain accurate records, while water released from Elephant Butte reservoir can be measured with considerable precision. The second step was to determine the normal net loss from the river below San Marcial and from the reservoir, and it was found that for more than ten years these losses have borne a very close and consistent relation to the discharge of the river at San Marcial. The third step was then the subtraction of the normal losses so found from the curve of relationship between the flow at Otowi and that at San Marcial. The net result was to give a curve which expresses the relation between the flow of the Rio Grande at Otowi and the usable supply of water at Elephant Butte, both exclusive of July, August, and September.

The final relationship which we recommend be used as the schedule of deliveries is as follows:

DELIVERIES INTO ELEPHANT BUTTE RESERVOIR
EXCLUSIVE OF JULY, AUGUST, AND SEPTEMBER

Quantities in thousands of acre feet

Otowi Index Supply (5)	Elephant Butte Index Supply (6)
100	0
200	45 ~~47~~ 47
300	101 ~~103~~

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400	161	~~157~~	64
500	225	~~227~~	68
600	293	~~296~~	73
700	366	~~368~~	77
800	443	~~445~~	85
900	528	~~530~~	88 90
1000	618	618	97 95
1100	713	~~715~~	100
1200	813	~~815~~	110
1300	923	925	117
1400	1040	~~1042~~	123
1500	1163	~~1265~~ 1165	130
1600	1293	~~1295~~	135
1700	1428	~~1430~~	143
1800	1571	~~1473~~ 1573	154
1900	1725	1727	158
2000	1883	1885	168
2100	2040	2043	167
2200	2210	2210	175
2300	2380	2385	

Intermediate quantities shall be computed by proportional parts.

(5) Natural flow of Rio Grande at the USGS gaging station at near San Ildefonso Otowi Bridge (formerly station near Buckman) during the calendar year, exclusive of the flow during the months of July, August, and September.

(6) Usable supply at Elephant Butte during the calendar year, exclusive of the months of July, August, and September, such usable supply being equal to the release from Elephant Butte Reservoir, plus any gain in the amount of water stored in the reservoir and minus any draft on storage over the same period of time.

The obligation of New Mexico to deliver water into Elephant Butte Reservoir in accordance with the foregoing schedule would be subject to the provisions set forth below, and in the application of this schedule proper allowance must be made for any change in points of measurement and for any ~~diversions or storage~~ increased depletion in New Mexico above Otowi Bridge of the natural runoff at this station.

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ALLOWABLE DEPARTURES

There will be natural variations in the relationships between the discharge at the control stations in the future, as in the past, and reasonable departures should be permitted. Furthermore, departures which are caused by storage of water in reservoirs at time of flood should be permitted, subject to proper safeguards.

Definitions

The following terms will be used repeatedly and are here defined:

(a) Annual Debits - are the amounts by which deliveries in any calendar year fall below scheduled deliveries.

(b) Annual Credits - are the amounts in any calendar year by which actual deliveries exceed scheduled deliveries.

(c) Accrued Debits - are the amounts by which the sum of all credits and debits falls below the sum of all scheduled deliveries over any common period of time.

(d) Accrued Credits - are the amounts by which the sum of all credits and debits exceeds the sum of all scheduled deliveries over any common period of time.

(e) Normal Release from Elephant Butte - is an average of 800,000 acre feet per annum drawn out of Elephant Butte Reservoir, adjusted for any gain or loss in usable water resulting from the operation of any reservoir below Elephant Butte; provided that this amount shall be adjusted by two-thirds of any change in aggregate diversions and loss to Mexico between Courchesne gaging station and the lowest point of diversion to lands of Rio Grande Project.

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In determining the amount of such change, the average annual diversion and loss to Mexico from 1928 to 1937, inclusive, shall be used as a basis.

(f) Project storage - is the combined capacity of Elephant Butte Reservoir and all other reservoirs available for storage of usable water between Elephant Butte and Courchesne, but not more than a total of 2,638,860 acre feet.

(g) Usable water - is all water in Project storage which is available for release in accordance with irrigation demands.

(h) Unusable Spill - is the amount of water which is actually spilled from Elephant Butte Reservoir or released for flood control in excess of the current demand for irrigation of Rio Grande Project lands and which is not stored in another reservoir for subsequent use; provided that, if the actual release from Elephant Butte Reservoir from the time of previous spill has averaged more than the normal release, the time of occurrence and amount of spill shall be adjusted by the difference between the total actual release and the accrued normal release.

Limitation on Debits

In the case of Colorado, no annual debit nor accrued debit shall exceed 100,000 acre feet, except as either or both may be caused by storage of water in reservoirs constructed in Colorado after 1937. Accrued debits which are caused by storage of water in reservoirs not now constructed shall not be greater at any time than the amount of water then in storage in such reservoirs.

In the case of New Mexico, the accrued debit shall not exceed 200,000 acre feet at any time, except as such debit

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may be caused by storage of water in reservoirs in New Mexico. Accrued debits caused by storage of water in reservoirs shall not be greater at any time than the amount of water then in storage in such reservoirs. In computing the magnitude of accrued credits or debits, annual debits greater than 150,000 acre feet shall be taken as equal to that amount.

Whenever the aggregate accrued debits of Colorado and New Mexico exceed the difference between 2,638,860 acre feet and the amount of Elephant Butte water then in storage, such debits shall be reduced proportionally to an aggregate amount equal to such unfilled capacity.

Whenever there is unusable spill from Elephant Butte Reservoir, all accrued debits of Colorado and New Mexico shall be cancelled, and no debits shall thereafter accrue until the end of such spill.

Limitation on Credits

In the case of Colorado, the accrued credit shall not exceed 100,000 acre feet at any time, provided that larger accruals may be applied to offset debits caused by storage in reservoirs. In computing the amount of accrued credits or debits, any annual credits in excess of 150,000 acre feet shall be taken as equal to that amount.

In the case of New Mexico, accrued credits shall not exceed ~~150~~ 200,000 acre feet at any time, provided that larger accruals may be applied to offset debits caused by storage in reservoirs. In computing accrued credits or debits, annual

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credits in excess of 150,000 acre feet shall be taken as equal to that amount.

At the time of actual or potential spill from Elephant Butte Reservoir, the aggregate credits of Colorado and New Mexico shall be reduced by the amount of unusable spill at Elephant Butte in proportion to their respective credits at the time of such spill.

Other Limitations

Neither Colorado nor New Mexico shall increase the amount of water in storage in reservoirs whenever there is less than 400,000 acre feet of Elephant Butte water in storage available for use in the Rio Grande Project, and if this minimum stage is reached between January first and March first, Colorado and New Mexico shall each release on demand, at the greatest rate practicable, water from reservoirs in an amount equal to the total debit of each which was caused by storage of water in reservoirs.

Accrued credits of Colorado and New Mexico shall be reduced, but not below zero, by an amount equal to one acre foot for each three tons of salts in excess of 500,000 tons in the normal annual release from Elephant Butte Reservoir, and the allocation of such reductions shall be determined by the departure of the quality of water at Lobatos from that which has been customary.

IMPORTATIONS

Material expansion of irrigation use within Rio Grande Basin above Fort Quitman will depend upon importations from watersheds which do not now contribute to the flow of the Rio Grande.

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It is our opinion that each of the States should support projects for importation of water, but that no State should thereby be obligated to bear any costs of construction of such works. It is our further opinion that each State should derive full benefit from the construction of any works paid for directly by citizens of that State, except as such works adversely affect the water supply of another of the States, but that all benefits from works constructed at the cost of the United States should be shared equally by the three States.

Importations from the Closed Basin in the San Luis Valley should be credited to Colorado on its obligation to deliver water at Lobatos, provided that the water delivered into the Rio Grande is of at least as good quality as the weighted average quality of the Rio Grande at Otowi.

In the event of an importation into the Rio Grande Basin from the Colorado River Basin above Lobatos, Colorado should be credited with the same proportion of the total water that its contribution to the cost bears to the total cost, and the three States should share equally in the balance. In event of an importation from the Colorado River Basin below Lobatos, which is paid for in part by Colorado, that State should derive benefit as if such diversion were made to the Rio Grande Basin above Lobatos. Similarly, if New Mexico shall pay directly for a part of the cost of importation of water from Colorado River Basin, it should have credit for that part of the total supply plus one-third of the portion

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developed with Federal funds.

While not in the category of importations, any reductions in the aggregate diversions and loss to Mexico between Courchesne and the lowest point of diversion to the Rio Grande Project should be shared equally by the three States to the extent that such saving results from works constructed at the expense of the United States.

SUMMARY

We recommend that the obligation of Colorado to deliver water in the Rio Grande at the Colorado-New Mexico State Line be that set forth in the above described schedules of deliveries from the Rio Grande and from the Conejos subject to proper limitations on departures.

We recommend that deliveries by New Mexico into Elephant Butte Reservoir be in accordance with the foregoing schedule which sets forth the relation between the flow at Otowi and the usable supply at Elephant Butte be subject also to proper departures.

It is our opinion that these schedules and provisions will permit the maximum practicable use of the waters of the Rio Grande and will greatly reduce the amount of unusable spill at Elephant Butte. Your favorable consideration for inclusion of these in a permanent Compact is recommended.

Respectfully submitted,

COMMITTEE ON ENGINEERING ADVISORS

JOHN H. BLISS for New Mexico E. B. DEBLER for the United States

RAYMOND A. HILL for Texas ROYCE J. TIPTON for Colorado

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opriations,
rande Project.

BMH--MBM.

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY
Reclamation Service

"Exhibit A"

Carlsbad, New Mex. Jan. 23, 1906.

Mr. David L. White,
Territorial Irrigation Engineer,
Santa Fe, New Mexico.

Dear Sir:-

The United States Reclamation Service, acting under authority of an act of Congress known as the Reclamation Act, approved June 17, 1902 (32 Stat., 388), proposes to construct within the Territory of New Mexico certain irrigation works in connection with the so-called Rio Grande project. The operation of the works in question contemplates the diversion of the water from the Rio Grande River.

Section 22 of Chapter 102 of the laws enacted in 1905 by the 36th Legislative Assembly of the Territory of New Mexico an act entitled, "An Act Creating the Office of Territorial Irrigation Engineer, to promote Irrigation Development and Conserve the Waters of New Mexico for the Irrigation of Lands and for other Purposes", approved March 16, 1905 reads as follows:

> "Whenever the proper officers of the United States authorized by law to construct irrigation works, shall notify the territorial irrigation engineer that the United States intends to utilize certain specified waters, the waters so described, and unappropriated at the date of such notice, shall not be subject to further appropriations under the laws of New Mexico, and no adverse claims to the use of such waters, initiated subsequent to the date of such notice, shall be recognized under the laws of the territory, except as to such amount of the water described in such notice as may be formally released in writing by an officer of the United States thereunto duly authorized."

In pursuance of the above statute of the Territory you are hereby notified that the United States intends to utilize the following described waters, to-wit:-

A volume of water equivalent to 730,000 acre feet per year requiring a maximum diversion or storage of 2,000,000 miner's inches, said water to be diverted or stored from the Rio Grande River at a point described as follows:

B006515

Storage dam about nine miles west of Engle, New Mexico.

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.city for 2,000,000 acre feet, and diversion dams below .omas, Rincon, Mesilla and El Paso Valleys in New Mexico Texas.

It is, therefore, requested that the waters above described be withheld from further appropriation and that the rights and interests of the U$_n$ited States in the premises be otherwise protected as contemplated by the statute above cited.

Very truly yours,

(Signed) B. M. Hall

Supervising Engineer.

B006516

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Engineering and Research Center

PROJECT REPORTS, 1910-55

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Contracts
with
Water Users

249-H

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DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

NEW MEXICO - TEXAS

- - - -

CONTRACTS

WITH WATER USER'S ORGANIZATIONS

(Copies)

- - - -

Compiled November 1, 1929.

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DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE IRRIGATION PROJECT
NEW MEXICO - TEXAS

- - - - -

Section I. Water Users Associations.

Section II. Elephant Butte Irrigation District.

Section III. El Paso County Water Improvement District No. 1.

Section IV. Joint Contracts between United States and the Elephant Butte Irrigation District and El Paso County Water Improvement District No. 1.

Section V. Hudspeth County Conservation & Reclamation District No. 1.

(See Index next Page)

TX_MSJ_006346

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE IRRIGATION PROJECT
NEW MEXICO - TEXAS

INDEX

Date	Contract with	Sec., page
June 27, 1906 ✓	Elephant Butte Water Users Association & El Paso Valley Water Users Association	I, 2
Aug. 19, 1916 ✓	El Paso Valley Water Users Association	I, 11
Oct. 13, 1917 ✓	El Paso Valley Water Users Association	I, 15
	- - -	
June 15, 1918 ✓	Elephant Butte Irrigation District	II, 2
Oct. 25, 1919 ✓	Elephant Butte Irrigation District	II, 13
Feb'r 21, 1924 ✓	Elephant Butte Irrigation District	II, 17
July 16, 1928 ✓	Elephant Butte Irrigation District	II, 22
Aug. 20, 1928 ✓	Elephant Butte Irrigation District	II, 27
_____ ✓	(Proposed contract with Elephant Butte Irri. Dist. - Increase of total construction Liability)	II, 34
(Dec. 29, 1917 with Elp Co W I ~~[illegible]~~ No. 1 + Elp V W U Assn not included)		
Jan. 17, 1920	El Paso County Water Imp. District No.1. and Elpaso Valley W. U. Assn	III, 2
Oct. 12, 1922	El Paso County Water Imp. District No.1.	III, 15
Aug. 2, 1926 ✓	El Paso County Water Imp. District No.1.	III, 23
July 16, 1928 ✓	El Paso County Water Imp. District No.1.	III, 29
Aug. 4, 1928 ✓	El Paso County Water Imp. District No.1.	III, 34
Sept. 3, 1929 ✓	El Paso County Water Improvement Dist.No 1.	III, 41
Sept. 3, 1929 ✓	El Paso County Water Imp. District No. 1.	III, 48
	- - -	
May 10, 1928 ✓	Joint - Elephant Butte Irri. Dist. & El Paso County Water Imp. Dist.No. 1.	IV, 2.

TX_MSJ_006347

Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Date	Contract with	Sec. Page
Dec. 1, 1924 ✓	Hudspeth County Conservation & Reclamation District No. 1.	V. 2.

TX_MSJ_006348

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT.

NEW MEXICO - TEXAS.

- - - - -

Section I.

Contracts with Water Users Associations.

Joint Contract

between

THE UNITED STATES OF AMERICA

and

THE ELEPHANT BUTTE WATER USERS' ASSOCIATION

and

THE EL PASO COUNTY WATER USERS' ASSOCIATION

- - - - - -

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DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

C O N T R A C T

Dated June 27, 1906

between

THE UNITED STATES OF AMERICA

and

THE ELEPHANT BUTTE WATER USERS' ASSOCIATION

and

THE EL PASO VALLEY WATER USERS' ASSOCIATION

For Repayment

of

Construction & Operation & Maintenance Charges

TX_MSJ_006350

Records in the National Archives & Records
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Archival Operations

RG No. 115

THESE ARTICLES OF AGREEMENT, made and entered into this 27th day of June, 1906, by and between the United States of America, acting in this behalf by Jesse E. Wilson, Acting Secretary of the Interior, party of the first part, and the Elephant Butte Water Users' Association of New Mexico, a corporation duly organized and existing under the laws of the Territory of New Mexico, and the El Paso Valley Water Users' Association, a corporation duly organized and existing under the laws of the Territory of Arizona, parties of the second part, their successors and assigns,

WITNESSETH, That whereas the Elephant Butte Water Users' Association of New Mexico is a corporation organized and existing under the laws of the Territory of New Mexico, and the El Paso Valley Water Users' Association is a corporation organized and existing under the laws of the Territory of Arizona for the purposes mentioned in their articles of incorporation and by-laws, copies of which are appended to this agreement and are, for every purpose of the interpretation, construction and consideration of this agreement and of the rights of the parties hereunder, to be deemed, held, read and considered as if fully written out or printed herein, and deemed a part hereof; and

WHEREAS, the lands embraced within the area proposed to be irrigated, as described in said articles of incorporation or by-laws, are naturally desert and arid and incapable of proper cultivation without irrigation, and will to a greater or less extent remain unclaimed, unfit for habitation, and uncultivated, in which condition they, or a great part thereof, now

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Archival Operations

RG No. 115

are, unless the waters of the Rio Grande in New Mexico, and its tributaries, be impounded and the flow thereof otherwise regulated and controlled, and,

Whereas, the said Secretary of the Interior contemplates the construction of certain irrigation works under the provisions of an Act of Congress entitled "An Act appropriating the receipts from the sale and disposal of public lands in certain States and Territories to the construction of irrigation works for the reclamation of arid lands, "approved June 17, 1902, for the irrigation and reclamation of the lands described in the said articles or by-laws; and

Whereas, the incorporators and shareholders of said Elephant Butte Water Users' Association of New Mexico, and El Paso Valley Water Users' Association are, and under the provisions of their articles of incorporation must be, owners and occupants of lands in said area, and in some cases are appropriators of water for the irrigation thereof, and in addition thereto such incorporators and shareholders and their successors or assigns must initiate rights to the use of water from the said proposed irrigation works, to be constructed by the said Secretary of the Interior as soon as such rights may be initiated, and thereafter complete the acquisition thereof in the manner and upon the terms and conditions to be prescribed therefor by the Secretary of the Interior, which rights shall be, and thereafter continue to be, forever appurtenant to designated lands owned by such shareholders; and,

Whereas, neither the relative priority nor the extent of

TX_MSJ_006352

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

the individual appropriations of such water heretofore made by said incorporators and shareholders for the lands described in said articles or by-laws, and which are now vested rights, have been ascertained or determined, but said incorporators and shareholders have agreed, among themselves, by the terms and provisions of said articles of incorporation and by-laws, upon the rules and principles by and upon which the relative priority and the extent of their several appropriations and vested rights to the use of such waters shall be determined;

Now, Therefore, it is agreed and understood by and between the parties hereto,

1. That if the said Secretary of the Interior shall authorize and cause the construction of said irrigation works, the said associations will take prompt action to secure the determination by the courts of the relative rights of their shareholders to the use of water for said lands, and that in the determination of such rights and of their respective rights to the use of water acquired under said Act of Congress, the rules and principles set out in said articles of incorporation and by-laws, for such determination, shall be deemed the established rules and principles for that purpose.

2. That only those who are or who may become members of said association, under the provisions of their articles of incorporation and by-laws, shall be accepted as applicants for rights to the use of water available by means of said proposed irrigation works.

TX_MSJ_006353

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

3. That the aggregate amount of such rights to be issued shall, in no event, exceed the number of acres of land capable of irrigation by the total amount of water available for the purpose, being (1) the amount now appropriated by the shareholders of said associations, and (2) the amount to be delivered from all sources in excess of the water now appropriated; and that the Secretary of the Interior shall determine the number of acres so capable of such irrigation as aforesaid, his determination to be made upon due and expert consideration of all available data, and to be based upon and measured and limited by the beneficial use of water.

4. That the payments for the water rights to be issued to the shareholders of said associations under the provisions of said Act of Congress, shall be divided into not less than ten equal annual payments, the first of which shall be payable when the water is first delivered from said works, or within a reasonable time thereafter, and after due notice thereof by the Secretary of the Interior to the Associations, and that the cost of said proposed irrigation works shall be apportioned equally per acre among those acquiring such rights.

Provided, that the charges apportioned under the integral part of the said irrigation works, known as the Leasburg Diversion Dam and Canal, the construction of which is now proposed, shall be paid in ten equal annual instalments, upon the terms herein specified.

Provided further, that in the assessment of the charges under the main Rio Grande project, when constructed, the Secre-

TX_MSJ_006354

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

tary of the Interior shall apportion equitably the charges therefor against the land irrigated under the Leasburg Diversion Dam and Canal, due allowance being made for the charges already paid under this agreement.

5. That the said Water Users' Associations hereby guarantee the payments for that part of the cost of the irrigation works which shall be apportioned by the Secretary of the Interior to their shareholders, and will promptly levy calls or assessments therefor and for the cost of maintenance and operation, as may be assessed from year to year by the Secretary of the Interior, and collect or require prompt payment thereof in such manner as the Secretary of the Interior may direct; that they will promptly pay the sums collected by them to the receivers of the local land offices for the districts in which said lands are situated; that they will promptly employ the means provided and authorized by the said articles of incorporation and by-lawsfor the enforcement of such collections, and will not change, alter or amend their articles of incorporation, or by-laws in any manner whereby such means of collection, or the lien given to them by the shareholders to secure the payment thereof, or of any assessments contemplated or authorized thereby, shall be impaired, diminished or rendered less effective, without the consent of the Secretary of the Interior.

6. That the United States shall in no manner be responsible for the sums collected by said associations until they have been paid into the hands of the receiver of the local land office, as provided by the law, and in accordance with such regulations as may be prescribed by the Secretary of the Interior.

TX_MSJ_006355

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

7. That for the purpose of enforcing said collections the associations will adopt and enforce proper by-laws, subject to the approval of the Secretary of the Interior, and not change them so as to in anywise impair their efficiency for said purpose, and will otherwise do any and all things they are authorized and empowered to do in the premises.

8. That the associations will adopt and enforce such rules and regulations as they are authorized by their articles of incorporation and by-laws to adopt and enforce, concerning the use of water by their shareholders and concerning the administration of the affairs of the associations to effectually carry out and promote the purposes of their organization, within the provisions of said articles of incorporation and by-laws, which rules and regulations shall be subject to the approval of the Secretary of the Interior, and that if the associations fail to make and adopt such rules and regulations, then the Secretary of the Interior may prescribe them;; but in such event the Secretary of the Interior shall impose no rule or regulation interfering with any vested right of the shareholders of the associations, as defined or modified by said articles of incorporation and by-laws.

9. That persons who are not now members of the associations, but who may be the owners or occupants of land to be irrigated, as described in their articles of incorporation or by-laws, or of added lands as therein provided for and to whom rights to the use of water from the proposed irrigation works may be issued by the United States, may, at the designation of

TX_MSJ_006356

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

the Secretary of the Interior, become members of the associations upon subscribing to the stock thereof and upon compliance with the other conditions prescribed for such membership.

10. That in all the relations between the United States and these associations and the members of the associations, the rights of the members of the associations to the use of water where the same have vested, are to be defined, determined and enjoyed in accordance with the provisions of the said act of Congress and of other acts of Congress on the subject of the acquisition and enjoument of the rights to use water; and also by the laws of New Mexico and Texas, where not inconsistent therewith modified if modified at all, by the provisions of the articles of incorporation and by-laws of said associations.

11. That nothing contained in this agreement, or to be implied from the fact of its execution, shall be construed, held or deemed to be an approval by the Secretary of the Interior, nor an adoption by him of the articles of incorporation or by-laws of said associations in all their details as the form of organization of water users, contemplated and authorized by section 6 of the said Act of Congress of June 17, 1902; but such approval and adoption is expressly reserved until the conditions prescribed in said Act, authorizing such approval and adoption shall have arisen; and that when the Secretary of the Interior shall make, approve and promulgate rules and regulations for the administration of the water to be supplied from said proposed irrigation works, such rules and regulations and such modifications thereof as the Secretary may, from time to time, approve and promulgate, shall be deemed

TX_MSJ_006357

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

and held to be obligatory upon these associations as fully and completely, and to every intent and purpose as if they were now made, approved, promulgated, and written out in full in this agreement, and the same are to be so read and construed.

12. It is further understood and agreed that the charges apportioned by the Secretary of the Interior for the construction of the Leasburg Diversion Dam and Canal against the lands irrigated thereunder, shall be upon the basis of the water available from the natural flow of the Rio Grande at said dam.

IN WITNESS WHEREOF, the undersigned have hereunto subscribed their names and affixed their seals the day and year first herein written.

JESSE E. WILSON.

Acting Secretary of the Interior.

For and on behalf of the United States of America.
PARTY OF THE FIRST PART.

ELEPHANT BUTTE WATER USERS' ASSOCIATION OF NEW MEXICO.

Attest:

N. C. Frenger,
Secretary,

By H. B. HOLT. President.

Attest:

F. Martine:
Secretary.

TX_MSJ_006358

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

C O N T R A C T

Dated August 19, 1916

between

THE UNITED STATES OF AMERICA

and

THE EL PASO VALLEY WATER USERS' ASSOCIATION

for

Drainage Construction

TX_MSJ_006359

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Form 7-523

DEPARTMENT OF THE INTERIOR

UNITED STATES RECLAMATION SERVICE.

RIO GRANDE PROJECT NEW MEXICO - TEXAS

THIS AGREEMENT, made the Nineteenth day of August Nineteen hundred and sixteen, in pursuance of the act of June 17, 1902 (32 Stat. 388), between THE UNITED STATES OF AMERICA, hereinafter styled the United States, by Oro McDermith, Acting Project Manager United States Reclamation Service, thereunto duly authorized, and subject to the approval of the Comptroller or Director of the United States Reclamation Service, and THE EL PASO VALLEY WATER USERS' ASSOCIATION, a corporation organized and existing under the laws of the State of Arizona hereinafter styled Contractor, its successors, and assigns,

W I T N E S S E T H:

WHEREAS, the contractor is desirous of obtaining the construction of drainage canals for the purpose of lowering the rising water-table under the lands of its shareholders, and the contractor has been requested by the agents of the United States to form an irrigation district embracing the lands of the shareholders and others as a prerequisite to the ordering of two dragline excavators to perform the drainage canal construction work aforesaid; and,

WHEREAS, the contractor is desirous of having said excavators ordered by the United States immediately and in advance of the formation of the irrigation district as aforesaid:

Article 1: The United States agrees to purchase as soon as practicable two dragline excavators at a total cost not to exceed

TX_MSJ_006360

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

twenty thousand dollars ($20,000) delivered on the work, of design suitable for use for the drainage canal construction within the Rio Grande project, and to expedite the purchase, delivery and use of the same, within the lands of the proposed irrigation district and as rapidly as possible.

Article II. If, however, a sufficient number of signatures is not obtained to the petition for the organization of the irrigation district as aforesaid within three months from the approval hereof, or if the electors, within the proposed irrigation district boundaries, fail to vote in favor of organization, or if for any reason whatsoever the irrigation district fail of organization on or before March 1, 1917, or if, on or before October 1, 1917, the district declines to enter into a contract for cooperation with the United States upon the terms acceptable to the United States then and in any such event the contractor will pay to the United States the cost of the excavators delivered at the work within sixty days after demand therefor by the Secretary of the Interior. Upon payment as aforesaid the said execavators shall become the property of the contractor.

Article III: No interest in this agreement shall be transferred to any other party, and any such transfer shall cause annulment of the contract so far as the United States is concerned; all rights of action, however, for breach of this contract are reserved to the United States, as provided by section 3737, Revised Statutes of the United States.

Article IV. It is further stipulated and agreed that in the performance of this contract no persons shall be employed who are undergoing sentences of imprisonment at hard labor which have been imposed

12

TX_MSJ_006361

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

by courts of the several States or Territories or municipalities having criminal jurisdiction.

Article V. No Member of or Delegate to Congress, or Resident Commissioner, after his election or appointment or either before or after he has qualified and during his continuance in office, and no officer agent, or employee of the Government, shall be admitted to any share or part of this contract or agreement, or to any benefit to arise thereupon. Nothing, however, herein contained shall be construed to extend to any incorporated company, where such contract or agreement is made for the general benefit of such incorporation or company, as provided in section 116 of the act of Congress approved March 4, 1909 (35 Stat. L., 1109).

IN WITNESS WHEREOF the parties have hereto signed their names the day and year first above written.

THE UNITED STATES OF AMERICA

BY ORO MCDERMITH
Acting Project Manager,

EL PASO VALLEY WATER USER'S ASS'N

By J. A. SMITH, president.

Attest:

Beruobe Flores,

Acting Secretary,

(Seal)

TX_MSJ_006362

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

C O N T R A C T

Dated October 13, 1917,

between

THE UNITED STATES OF AMERICA

and

THE EL PASO VALLEY WATER USERS' ASSOCIATION

For Repayment of Construction Charges

TX_MSJ_006363

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Form 7-523

DEPARTMENT OF THE INTERIOR

UNITED STATES RECLAMATION SERVICE

RIO GRANDE PROJECT - TEXAS

THIS AGREEMENT, made this 13th day of October, Nineteen hundred and Seventeen, in pursuance of the acts of June 17, 1902 (32 Stat., 388), and acts amendatory thereof and supplementary thereto, between THE UNITED STATES OF AMERICA, hereinafter styled the United States, by L. M. Lawson, Project Manager, United States Reclamation Service, thereunto duly authorized, and subject to the approval of the Comptroller or Director of the United States Reclamation Service and the El Paso Valley Water Users' Association, a corporation duly organized and existing under the laws of the State of Arizona, its successors and assigns,

WITNESSETH:

WHEREAS, The Contractor desires to obtain the construction of a drainage system for the purpose of relieving the water-logged condition of the lands of its shareholders lying within the El Paso Valley, Texas, and within the boundaries of the El Paso County Water Improvement District No. 1; and,

WHEREAS, The sundry Civil Appropriation Act approved June 12 1917, provides funds for construction work upon the Rio Grande project in Texas to be used for drainage purposes only in irrigation districts formed under State laws and upon execution of agreements for the repayment to the United States of all project investments; and,

WHEREAS, Pending the making of contract, pursuant to said

TX_MSJ_006364

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Sundry Civil Act or pursuant to said act as proposed to be amended, the Contractor desires that drainage work be prosecuted with diligence at least equal to that exercised by the United States under appropriations for the fiscal year of 1917.

NOW, THEREFORE, In consideration of the premises it is agreed as follows:

ARTICLE 1. The Contractor will provide and deliver funds to the Project Manager of the United States Reclamation Service for the continuation of drainage work, in accordance with plans heretofore formulated, until such time as the said Water Improvement District shall make appropriate contract with the United States, as required by law, for such portion of the Rio Grande project as may be incorporated within the district boundaries. Said funds shall be provided and delivered in accordance with the needs of the work as may be most convenient to the Contractor, provided that funds at all times shall be in the hands of the agents of the United States for not less than one week's work in advance, until contract be made and approved with said District, whereupon drainage work will thereafter be financed by the United States under the said Sundry Civil Appropriation Act, and pursuant to contract with the District so to be executed.

ARTICLE 2. Within a reasonable time after the execution of contract an aforesaid with such Water Improvement District, the United States will reimburse the Contractor without interest for sums advanced by him pursuant to Article 1 hereof; provided that in the event such contract be not entered into and approved before May 1, 1918, or before such later date as may be provided by an extension of this contract, no obligation shall rest upon the United States

TX_MSJ_006365

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

to make such reimbursement.

ARTICLE 3. The drainage operations herein referred to relate to a continuation by the Contractor of the drainage work now being done by the United States, as a matter of convenience by means of the Government organization, pending the execution of said contract.

Upon reimbursement of the moneys advanced by the Contractor, pursuant to Article 1, the Contractor hereby agrees to assign to the United States all its interest in drainage works constructed during the period beginning July 1, 1917, and terminating with the execution of the contract on the part of the Water Improvement District as aforesaid, and reasonable time thereafter for making the necessary arrangements.

ARTICLE 4. No interest in this agreement shall be transferred to any other party, and any such transfer shall cause annulment of the contract so far as the United States is concerned; all rights of action, however, for breach of this contract are reserved to the United States, as provided by section 3737, Revised Statutes of the United States.

ARTICLE 5. It is further stipulated and agreed that in the performance of this contract nopersons shall be employed who are undergoing sentences of imprisonment at hard labor which have been imposed by courts of the several States or Territories or municipalities having criminal jurisdiction.

ARTICLE 6. No Member of or Delegate to Congress, or Resident Commissioner, after his election or appointment or either before or after he has qualified and during his continuance in office, and no officer, agent or employee of the Government, shall be admitted to any share

TX_MSJ_006366

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

or part of this contract or agreement, or to any benefit to arise thereupon. Nothing, however herein contained shall be construed to extend to any incorporated company, where such contract or agreement is made for the general benefit of such incorporation or company, as provided in section 116 of the act of Congress approved March 4, 1909 (35 Stat. l., 1109).

IN WITNESS WHEREOF the parties have hereto signed their names the day and year first above written.

THE UNITED STATES OF AMERICA,

By L. M. Lawson,
Project Manager

El Paso Valley Water Users' Ass'n.

By J. A. Smith, President,
El Paso, Texas.

Attest:

Bernabe Flores,
Secretary,

(corporate seal)

TX_MSJ_006367

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

NEW MEXICO - TEXAS.

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Section II.

Contracts with

THE ELEPHANT BUTTE IRRIGATION DISTRICT.

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TX_MSJ_006368

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE PROJECT - NEW MEXICO - TEXAS

C O N T R A C T

Dated June 15, 1918 -

between

THE UNITED STATES OF AMERICA

and

THE ELEPHANT BUTTE IRRIGATION DISTRICT

For Repayment of Construction

and

Operation and Maintenance Charges.

Note

See Sperry v. Elephant Butte Irrigation District Supreme Court of New Mexico, 270 Pac. 889, in which decision the above named contract is considered by the court.

TX_MSJ_006369

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Symbol No. Ilr-349

THIS AGREEMENT, made this the 15th day of June, 1918, by and between the UNITED STATES OF AMERICA, by Alexander T. Vogelsang, Acting Secretary of the Interior, under the provisons of the Act of Congress approved June 17, 1902 (32 Stat., 388) and acts amendatory thereof and supplementary thereto, all known and referred to as the Reclamation law; the ELEPHANT BUTTE IRRIGATION DISTRICT, a public corporation, duly formed under the laws of the State of New Mexico, having its principal place of business at Las Cruces, Dona Ana County, New Mexico, hereinafter styled the "District," and the ELEPHANT BUTTE WATER USERS' ASSOCIATION, of New Mexico, a private corporation, hereinafter styled the "Association";

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WITNESSETH: That

WHEREAS, the Association executed contract with the United States dated the 27th day of June , 1926, whereby the Association agreed to pay for that part of the cost of the irrigation works of the Rio Grande Project which should be apportioned by the Secretary of the Interior, hereinafter styled the "Secretary", to the shareholders of the Association, and it is now the desire of the said shareholders that the Association be dissolved and that appropriate arrangements be made between the said District and the United States; and

NOW, THEREFORE, in consideration of the covenants herein contained it is agreed between the parties as follows:

ARTICLE 1. The United States will expend, in addition to the sum of $63,616.00 heretofore expended, the sum of one million four hundred thousand dollars ($1,400,000.00).

TX_MSJ_006370

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

(which includes the sum of $100,000.00 for flood protection,) or such part thereof as may be necessary, in the construction of drainage works for the lands of the District, subject always, however, to appropriation being made therefor by Congress. It is understood to be the desire of the District that in the expenditure of the moneys for drainage purposes the agents of the United States shall avail themselves of all the information as to subsurface formation and conditions to be obtained as the work shall progress, to the end that the drainage system may be built in an efficient manner; and that therefore it is not to the interest of the landowners of the District that the approximate dimensions or alignment of drainage canals and ditches be prescribed in advance of the progress actual construction work. When the sum herein stated has been expended the United States shall be under no further obligation to make expenditures for the purposes specified in this article.

ARTICLE 2. The United States will, in addition to the sum agreed to be expended under Article 1, and in addition to the sums heretofore expended, expend the sum of one million, eight hundred and four thousand dollars ($1,804,000.00), or such part thereof as may be necessary, in the modification and extension of the system for the distribution and delivery of water for the irrigation of the irrigable lands of the District, subject, always, however, to appropriation therefor being made by Congress and contingent moreover upon the acquisition of the necessary property and rights therefor. When the sum herein stated has been expended

TX_MSJ_006371

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

the United States shall be under no further obligation to make expenditures for the purposes specified in this article.

For reimbursing the United States for any work done on the lateral system, the District may collect right either from the lands of the District as a whole, or it may, in the discretion of the Directors of said District, and in so far as authorized by law, collect the necessary funds from the unit of the project, or the tract or tracts of land within said District for the benefit of which said works are constructed. The lateral system as here defined is understood to comprise the whole of the distribution system for the District, except the Mesialla Diversion Dam, the West Side Canal, the East Side Canal, the Leasburg Canal and Diversion Dam, the Percha Dam, the Arrey Canal, the Garfield Canal, the Hatch Canal, the Rincon Canal, the Picacho Canal, and all siphons, flumes and other necessary works and facilities connected with and used as a part of said diversion dams and canals; and any and all other main canals of similar character and purpose which may be hereafter constructed within said District, PROVIDED, that nothing herein contained shall be construed as in any wise releasing said District as a whole from its liability for repayment to the United States for any and all work done under the terms of this article.

ARTICLE 3. All work done under this contract shall be in accordance with plans and specifications to be approved by the Chief Engineer of the U. S. Reclamation Service.

ARTICLE 4. The Secretary of the Interior hereby signi-

TX_MSJ_006372

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

fies his approval of the plans of the District in compliance with the provisions of the Act of Congress approved August 11, 1916 entitled "An Act to Promote Reclamation of Arid Lands," and hereby designates all public lands situated within the District as subject to the provisions of this said Act of Congress.

ARTICLE 5. The United States will continue the operation and maintenance of the project including said irrigation and drainage systems until otherwise provided by contract after vote by the electorate of the District, or until the payments required by the reclamation law are made for the major portion of the lands irrigated from the project works, subject, however, to appropriation for such maintenance and operation work being made by Congress.

ARTICLE 6. The United States will divert and carry through the canals and distribution system of the Rio Grande Project in New Mexico water for the irrigation of District lands, and maintain the project works at an annual rental charge equal to the cost of operation and maintenance of the irrigation and drainage systems, plus 10%. The District will also pay an aggregate annual storage water rental charge equal in amount to fifty cents (50¢) per acre for the total area within the District actually irrigated whether or not stored water is used. Such rental charges shall be payable annually to the United States on such date as may be fixed by the Secretary of the Interior. The water shall be diverted and distributed in such manner as may be hereafter arranged

TX_MSJ_006373

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

between the Board of Directors of said District and the United States. The aforesaid rental charges shall be payable annually for the lands of the District until the time specified by the Secretary in pursuance of Article seven, for beginning the payment of the construction charge and thereafter the said rental charges shall apply only to the lands not designated by the Secretary in pursuance of Article seven. The District hereby assumes liability for all charges for rental of water due from land within the district to the United States for irrigation seasons prior to 1918 and will pay to the United States the sums so delinquent.

Any excess of moneys heretofore or hereafter collected and paid for the purposes of this Article remaining after meeting the actual cost of operation and maintenance and said delinquent water rental charges shall be applied as a credit on the construction cost.

ARTICLE 7. From time to time as the Secretary of the Interior may determine that specified areas of irrigable district lands, not necessarily contiguous, should commence payment of the construction charge for said irrigation works, he shall render a statement to such effect to the District, designating the areas of said district lands, and shall state the amount of the construction charge payable for such designated areas, and the

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

District will pay the construction charge for said works in installments of the same percentages and subject to the penalties of the same amounts and terms as specified in Sections 2 and 3 of the Reclamation Extension Act approved August 13, 1914. Such installments shall be due on such annual date as may be specified in said statement conformable to the state laws. The instalments, may, however, be divided and become payable semi-annually by contract between the Secretary and the District.

ARTICLE 8. The irrigable lands in New Mexico and in Texas under the Rio Grande Project shall contribute by way of reimbursement to the United States for the cost of construction, other than drainage and lateral system as defined in Article 2 hereof, in amounts based upon the same rate per irrigable acre, and the total thus paid shall equal the entire cost of the works as determined by the Secretary.

In addition to any and all other remedies available to the United States to secure payment of any amount due, the United States shall have the right to shut off water from and refuse to deliver water to the district or any of the lands within the District, until all instalments due and unpaid, together with accrued penalties, are fully paid.

ARTICLE 9. That upon the expenditure for drainage of said sum provided in Article one, or such part thereof as may be found necessary by the Secretary, he shall, when he deems it advisable, render to the District a statement of the total sum which has been expended in the construction of drainage works for

TX_MSJ_006375

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

district lands, and thereupon said sum shall become due to the United States and payment shall be made in the manner designated by the Secretary in pursuance of the provisions of Article seven and eight hereof; and assessments and levies to meet the said drainage payments shall be made by the District in proportion to drainage benefits as required by the laws of New Mexico.

ARTICLE 10. The District hereby assumes the liability for the reimbursement to the United States of that part of the aggregate cost of the irrigation and drainage works heretofore constructed and which may be hereafter constructed, which shall be apportioned by the Secretary to the irrigable lands of the District in the manner outlined in Article eight hereof; and the District agrees to pay the same and each installment thereof. The total liability of the District hereunder, however, for irrigation and drainage construction pruposes, exclusive of rentals, operation and maintenance charges and penalties, shall in no case exceed the aggregate sum of six million, five hundred and thirty thousand dollars ($6,530,000.00).

ARTICLE 11. After rendering any statement under Article seven hereof, the Secretary will, from time to time, announce the rates for operation and maintenance due from the District for water for lands designated by said statement, which rates shall be established in the same manner as provided in Sections five and six of the aforesaid Reclamation Extension Act; and the District agrees to pay the United States the amounts due for said areas in the same manner as provided by said Sections five and six.

TX_MSJ_006376

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

ARTICLE 12. Until all amounts payable to the United States for the construction of the works of the Irrigation and drainage of district lands have been fully paid and discharged, there is reserved to the Secretary, the right to make reasonable rules and regulations and to modify the same in his discretion, not however, contrary to this contract, but to the end that the true intent of the law and of this contract shall be carried into effect and the District agrees to use its powers for the purpose of carrying out such rules and regulations and the purposes of this contract. The proper officials of the District shall have full and free access to the project books and official records of the United States Reclamation Service relative to the costs of the construction and operation and maintenance of the works constructed by the United States with the right at any time during office hours to make copies of and from the same. The representatives of the United States shall have the same right in respect to the like books and records of the District.

ARTICLE 13. The Secretary, in his discretion, if he deem lands within the District temporarily incapable of successful cultivation on account of seepage, alkaline or other conditions, may notify the District that it will be relieved from payment of the amounts payable or a part thereof, on account of such lands for a specified period or until further notice, whereupon the District shall exempt from assessment and levy the lands as speficied during the period named. Nothing in this article, however, shall be deemed to relieve the District or individual landowners from any reasonable responsibility for improving drainage

TX_MSJ_006377

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

conditions and for using reasonable economy in the use of water. If the Secretary of the Interior shall deem any lands of the project permanently insusceptible of reclamation on account of seepage or other conditions, he may in his discretion contract with the District for the severance of the water rights from such lands and for their becoming appurtenant to other lands within or without the District or to lands which by appropriate proceedings are brought within the District. Nothing in this article contained, however, shall be deemed to release the district from its liability for the reimbursement of the reclamation fund for the cost of the project works, but if transfers of water right be made to lands without the district, as in this article provided, and the United States shall thereby be satisfactorily secured for proportionate reimbursement the obligation of the district shall be reduced to the same extent.

ARTICLE 14. The Association and the United States agree that as soon as the affairs of the Association will permit they will execute the necessary instruemtns of release of all the lands in Dona Ana and Sierra Counties, New Mexico, from the liens existing under subscriptions to stock to said association, and upon the execution and filing of said instruments of release the United States will assent to the dissolution of said Association.

ARTICLE 15. The District agrees to assume the liabilities of the Association upon obtaining an assignment of the latter's assets.

ARTICLE 16. THE District shall as early as practicable commence and prosecute to decree proceedings in confirmation of the

TX_MSJ_006378

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

authorization of this contract and in the event that this contract be not confirmed by court of competent jurisidction within a year from its date, or within such further period as may be named by the Secretary, the same shall not be binding upon the parties hereto.

ARTICLE 17. No member of or delegate to Congress, or Resident Commissioner, after his election or appointment or either before or after he has qualified and during his continuance in office, shall be admitted to any share or part of this contract or agreement, or to any benefit to arise thereupon. Nothing, however, herein contained shall be construed to extend to any incorporated company, where such contract or agreement is made for the general benefit of such incorporation or company, as provided in Section 116 of the Acts of Congress approved March 4, 1909 (33 Stat., 1109).

IN WITNESS WHEREOF, this contract has been executed on behalf of the parties hereto and certified copies of resolutions of the boards of directors of the District and the Association hereto attached and the respective seals of the said corporation hereto affixed.

THE UNITED STATES OF AMERICA

By Alexander T. Vogelsang
Acting Secretary of the Interior.

THE ELEPHANT BUTTE WATER USERS' ASS'N

By Albert T. Eyler
President.

(SEAL)

ATTEST:

S. G. Kilgore
Secretary

THE ELEPHANT BUTTE IRRIGATION DISTRICT

By Albert T. Eyler, President.

TX_MSJ_006379

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

C O N T R A C T

Dated October 25, 1919

between

THE UNITED STATES OF AMERICA

and

THE ELEPHANT BUTTE IRRIGATION DISTRICT

for

Advancing Funds for Drainage Operations

TX_MSJ_006380

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Form 7-523,

DEPARTMENT OF THE INTERIOR

United States Reclamation Service.

Rio Grande project New Mexico-Texas.

This Agreement, made this 25th day of October nineteen hundred and Nineteen, in pursuance of the act of June 17, 1902 (32 Stat., 388), and acts amendatory thereof and supplementary thereto, between THE UNITED STATES OF AMERICA, hereinafter styled the United States, by L. M. Lawson Project Manager United States Reclamation Service, thereunto duly authorized, and subject to the approval of the Director of the United States Reclamation Service, and Elephant Butte Irrigation District, a Corporation duly organized and existing under the laws of the State of New Mexico hereinafter styled Contractor, its successors, and assigns.

WITNESSETH: XX

1. WHEREAS, there are not available sufficient funds for financing the drainage operations on the Rio Grande Project in New Mexico, during the Fiscal Year 1920; and

2. WHEREAS, because of the crying need for drainage by reason of the seeped condition of the lands of said project in New Mexico, the Contractor desires that the drainage work shall proceed in accordance with the program heretofore laid out and with the full utilization of the equipment now available on the project for said work, so far as this may be done.

3. NOW THEREFORE, in consideration of the premises it is agreed as follows:

The Contractor will provide and advance to the Project Manager of said project, funds to the extent of Sixty Thousand Dollars ($60,000) to be utilized in drainage work for the benefit of lands within the boundaries of said district, in accordance with the plans heretofore formulated. Said funds shall be provided and delivered in accordance with the needs of the work, as may be most convenient to the Contractor; provided, that funds shall at all times be in the hands of the agents of the United States sufficient in amount to finance operations for not less than thirty days in advance, until the sum hereinbefore mentioned shall have been delivered.

4. If Congress should by proper legislation provide sufficient funds for conducting operations on said project for the fiscal year 1920, in accordance with the plans heretofore formulated, the amount so provided and advanced by the Contractor hereunder shall be

TX_MSJ_006381

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

reimbursed, without interest, by the United States within a reasonable time after the passage of such legislation and the date when the funds become available for such reimbursement to the contractor. Should Congress at any time hereafter provide funds for the reimbursement of the amount so advanced by the Contractor appropriate refund, without interest, shall be made within a reasonable time after the funds shall become available for that purpose.

5. In case Congress, before the sum hereinbefore stipulated shall have been provided and delivered by the Contractor, provide sufficient funds for financing operations in accordance with plans heretofore formulated, no further amount shall be thereafter advanced and appropriate refund shall be made of the sum already advanced as herein provided.

6. Upon reimbursement of the moneys advanced as in this contract provided, the Contractor agrees to assign to the United States all right, title and interest in and to the drainage works constructed during the period the funds so advanced have been employed, and to release the United States from any and all claims in any wise connected with, or growing out of the advance of said funds.

7. All of the moneys refunded to the contractor by the United States, as herein provided, shall become part of the indebtedness of the contractor assumed by agreement between the United States the Elephant Butte Irrigation District and the Elephant Butte Water Users' Association dated June 15, 1918, and reimbursement of the said sums shall be made to the United States in accordance therewith.

8 (Agency clause.)

9. No interest in this agreement shall be transferred by the contractor to any other party, and any such transfer shall cause annulment of the contract so far as the United States is concerned; all rights of action, however, for breach of this contract are reserved to the United States, as provided by Section 3737, Revised Statutes of the United States.

10. It is further stipulated and agreed that in the performance of this contract no persons shall be employed who are undergoing sentences of imprisonment at hard labor which have been imposed by courts of the several States or territories or municipalities having criminal jurisdiction.

11. No member of or Delegate to Congress, or Resident Commissioner, after his election or appointment or either before or after he has qualified and during his continuance in office, and no officer, agent or employee of the Government, shall be admitted to any share or part of this contract or agreement, or to any benefit to arise thereupon. Nothing, however, herein contained shall be construed to extend to any incorporated company, where such contract or agreement is made for the general benefit of such incorporation or company,

TX_MSJ_006382

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

as provided in Section 116 of the act of Congress approved March 4, 1909 (35 Stat. L., 1109).

IN WITNESS WHEREOF the parties have hereto signed their names the day and year first above written.

THE UNITED STATES OF AMERICA

BY L. M. Lawson
Project Manager

ELEPHANT BUTTE IRRIGATION DISTRICT

By Albert S. Eyler

President,

Las Cruces, N. M.

Attest:

J. H. Evans
Secretary

(Seal)

TX_MSJ_006383

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

C O N T R A C T

Dated February 21, 1924

between

THE UNITED STATES OF AMERICA

and

THE ELEPHANT BUTTE IRRIGATION DISTRICT

for

Additional Construction Work

TX_MSJ_006384

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Symbol No. IIr-349

DEPARTMENT OF THE INTERIOR

BUREUA OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT.

CONTRACT BETWEEN THE UNITED STATES AND ELEPHANT BUTTE IRRIGATION DISTRICT, PROVIDING FOR ADDITIONAL CONSTRUCTION WORK, SUPPLEMENTARY TO CONTRACT OF JUNE 15, 1918.

THIS CONTRACT, made this 21st day of February 1924, by and between the United States of America, herein styled the United States acting for this purpose through _____ the Secretary of the Interior, herein styled the Secretary, under the provisions of the Act of June 17, 1902 (32 Stat. 388), and acts amendatory thereof or supplementary thereto, herein styled the reclamation law, and the Elephant Butte Irrigation District, herein styled the District, an irrigation district duly organized and existing under the laws of the State of New Mexico, having its principal place of business at Las Cruces, New Mexico, witnesseth:

EXPLANATORY RECITALS

2. WHEREAS, the District executed a contract with the United States dated June 15, 1918, prividing for the payment by the District to the United States of the maximum sum of Six Million Five Hundred and Thirty Thousand Dollars ($6,530,000.00), on account of the District's proportionate part of the cost of the irrigation system of the Rio Grande Federal Irrigation project; and

3. WHEREAS, the District now desires the construction of

TX_MSJ_006385

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

additional work not provided for in said contract for the benefit of irrigable lands of the District as now constituted;

4. NOW, THEREFORE, in consideration of the covenants herein contained, it is mutually agreed as follows:

Construction of Project Works by the United States.

5. The United States will expend, in addition to the amounts heretofore provided for in said contract of June 15, 1918, the sum of Nine Hundred and Forty Thousand Dollars ($940,000.00), or so much thereof as may be appropriate and necessary in the opinion of the Secretary, for addition to existing storage works, the improvement and extension of the present distribution system, flood protection, drainage works, purchase of supplies, machinery, equipment and plants, and for general and miscellaneous project features.

Payment of Construction Charges.

6. The District shall pay the United States the said sum of Nine Hundred and Forty Thousand Dollars ($940,000.00), under the same terms and conditions as set forth in Article 7 of said contract of June 15, 1918, which amount is added to and consolidated with the amount provided for in said contract of June 15, 1918, namely Six Million Five Hundred and Thirty Thousand Dollars ($6,530,000.00), making an aggregate cost of Seven Million Four Hundred and Seventy Thousand Dollars ($7, 470,000.00), which the District agrees to pay.

XX

Computation of Cost.

7. The Cost of the work provided for by this contract, which the District obligates itself to pay, shall embrace all expense of whatsoever kind in connection with, growing out of, or resulting from,

18

TX_MSJ_006386

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

the work described including the cost of labor, material, equipment, engineering, legal work, superintendence, administration, overhead, rights of way, property, and damage of all kinds; and in determining the total amount of such cost the project books of the Bureau of Reclamation shall be accepted as conclusive.

Contract Subject to Appropriation by Congress.

8. This contract is subject to appropriations being made by Congress, from year to year, of moneys sufficient to do the work provided for herein. No liability shall accrue against the United States by reason of such moneys not being appropriated. Should only a portion of the moneys necessary to complete the work be so provided and expended, then the amount to be repaid by the District to the United States for such work shall be reduced to an amount equal to the sum actually expended.

This Contract Supplementary to Contract of June 15, 1918.

9. This contract is supplementary to said contract of June 15, 1918, and is subject to all of the terms and conditions thereof so far as the same are applicable and not modified herein.

Officials not to benefit.

10. No Member of or Delegate to Congress or Resident Commissioner shall be admitted to any share or part of this contract or any benefit to arise therefrom. Nothing, however, herein contained shall be construed to extend to any incorporated company, if the contract be for the general benefit of such corporation or company.

TX_MSJ_006387

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Successors and Assigns Obligated.

11. The provisions of this contract shall apply to and bind the successors in interest and assigns of the respective parties.

IN WITNESS WHEREOF the parties have hereto signed their names the day and year first above written.

THE UNITED STATES OF AMERICA

BY Hubert Work
Secretary of the Interior

ELEPHANT BUTTE IRRIGATION DISTRICT

BY J. W. Taylor
President

ATTEST:

F. J. Rigney Jr.

Secretary.

TX_MSJ_006388

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

C O N T R A C T

between

THE UNITED STATES OF AMERICA

and

THE ELEPHANT BUTTE IRRIGATION DISTRICT

for

Amendments to Existing Contracts for Construction Repayment.

Dated July 16, 1928.

TX_MSJ_006389

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Symbol #Ilr-349

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT NEW MEXICO -

TEXAS

CONTRACT BETWEEN THE UNITED STATES AND THE ELEPHANT BUTTE IRRIGATION DISTRICT, PROVIDING FOR CERTAIN AMENDMENTS OF EXISTING CONTRACTS

- - -

THIS AGREEMENT, made this 16th day of July 1928, by and between the United States of America, acting for this purpose by E. C. Finney, First Assistant, Secretary of the Interior, hereinafter called the Secretary, under the provisions of the Act of June 17, 1902 (32 Stat. 388) and acts amendatory thereof or supplementary thereto, and specifically pursuant to the provisions of the Act of May 28, 1928, Public No. 556, 70th Congress, and the Elephant Butte Irrigation District, a corporation duly organized and existing under the laws of the State of New Mexico, hereinafter called the District,

WITNESSETH THAT:

Explanatory Recitals

2. WHEREAS the United States has constructed and is operating and maintaining the Rio Grande project in New Mexico and Texas, and the Elephant Butte Irrigation District has by contract with the United States dated June 15, 1918, as supplemented by contract dated February 21, 1924, assumed the liability for repayment

TX_MSJ_006390

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

to the United States of the aggregate sum represented by the cost of the irrigation and drainage works constructed by the United States in whole or in part for the use and benefit of the District, and

3. WHEREAS by act of Congress approved May 28, 1928, being Public No. 556- 70th Congress, the Secretary is authorized and directed to enter into an amended contract with the District whereby after the payment of the first four annual installments upon the construction charge of the said project, as now provided for in the aforesaid existing contracts, the remaining unpaid construction charge per irrigable acre shall be payable annually in installments of three and 60/100 dollars ($3.60) until the total charge against the district is paid, and

4. WHEREAS the provision for the basis of repayment by the District of the obligations created by existing contracts with the United States is contained in Article 7 of the said contract of June 15, 1918, and in Article 6 of the said contract dated February 21, 1924, between the United States and the District,

NOW THEREFORE in consideration of the premises, it is hereby agreed as follows:

Amendment of Existing Contracts

5. That Article 7, of the contract of Jun3 15, 1918, between the United States and the Elephant Butte Irrigation District be and it is hereby amended to read as follows:

TX_MSJ_006391

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

"Article 7. From time to time as the Secretary of the Interior may determine that specified areas of irrigable district lands, not necessarily contiguous, should commence payment of the construction charge for said irrigation works, he shall render a statement to such effect to the District, designating the areas of said district lands, and shall state the amount of the construction charge payable for such designated areas, and the District will pay the construction charge for said works in annual installments, the first four of which shall each be two per centum of the total construction charge, or the portion of the construction charge unpaid at the beginning of such installments, and the remainder of said annual installments shall be at the rate of Three Dollars and Sixty Cents ($3.60) per irrigable acre of District lands comprising such designated areas, and shall continue until the total construction charge against the District is paid, subject to the penalties provided for by the reclamation law. Such installments shall be due on such annual date as may be specified in said statement conformable to the State Laws. The installments may, however, be divided and become payable semi-annually by agreement between the Secretary and the District."

6. That Article 6 of the contract of February 21, 1924, between the United States and the Elephant Butte Irrigation District be and it hereby is amended to read as follows:

"Article 6. The District shall pay the United States the said sum of Nine Hundred and Forty Thousand Dollars ($940,000.00), under the same terms and conditions as set forth in Article 7 of said contract of Jun3 15, 1918, as amended by supplementary contract made pursuant to the Act of May 26, 1928, Public No. 556- 70th Congress, which amount is added to and consolidated with the amount provided for in said contract of June 15, 1918; namely, Six Million Five Hundred and Thirty Thousand Dollars ($6,530,000.) making an aggregate cost of Seven Million Four Hundred and Seventy Thousand Dollars ($7,470,000.00), which the District agrees to pay."

Existing Contracts to Remain Otherwise Unaltered.

7. That the existing contracts between the United States and the District shall remain unaltered except as herein expressly

TX_MSJ_006392

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

provided.

Officials not to Benefit

8. No Member of, or Delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract, or to any benefits to arise therefrom. Nothing, however, herein contained shall be construed to extend to any incorporated company if the contract be for the general benefit of such corporation or company.

IN TESTIMONY WHEREOF, the parties hereto have hereunto affixed their names as of the day and year first above written.

UNITED STATES OF AMERICA

By E. F. Finney,

First Assistant Secretary of the Interior

ELEPHANT BUTTE IRRIGATION DISTRICT

By A. S. Robertson

President.

Attest:

L. E. Kuhnley

TX_MSJ_006393

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

C O N T R A C T

Dated August 20, 1928

between

THE UNITED STATES OF AMERICA

and

THE ELEPHANT BUTTE IRRIGATION DISTRICT

for

Advancing funds for Drainage Operations

TX_MSJ_006394

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Symbol No. I16r-241

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

CONTRACT BETWEEN THE UNITED STATES AND THE ELEPHANT BUTTE IRRIGATION DISTRICT REGARDING CLEANING AND MAINTENANCE OF DRAINS.

THIS AGREEMENT made this 20th day of August 1928 under the provisions of the Act of June 17, 1902 (32 Stat. 388) and acts amendatory thereof and supplementary thereto and especially the Act of March 4, 1921 (41 Stat. 1367, 1404) together known as the Reclamation Law, by and between the United States of America, hereinafter styled the United States, represented by the officer executing this contract, and the Elephant Butte Irrigation District, a corporation duly organized and existing under the laws of the State of New Mexico, hereinafter styled the District,

WITNESSETH THAT:

Explanatory Recitals.

2. WHEREAS, the United States has constructed and is operating and maintaining the Rio Grande project in New Mexico and Texas pursuant to the Reclamation Law and existing contracts with the Dis-

TX_MSJ_006395

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

trict.

3. WHEREAS incident to the construction and operation of the said project the United States has acquired and now has available equipment useful and necessary for operation and maintenance of drains,

4. WHEREAS, in order to supply irrigation demands and to provide adequate drainage for District lands under the said project it is essential that the distribution system and drains be maintained in a high state of efficiency, and

5. WHEREAS it now appears that the funds appropriated from the Reclamation fund and available for such purpose during the remainder of the calendar year 1928 will not be sufficient to carry out a complete and continuous program for the adequate maintenance of certain project works, particularly the drainage system, during said period, and

6. WHEREAS the District, realizing the importance of maintainin-g the works to a high degree of efficiency and desiring to secure the maximum results economically obtainable is willing to provide additional funds for such maintenance over the said period in the manner hereinafter set forth:

NOW THEREFORE, in consideration of the premises, and the mutual covenants herein contained it is hereby agreed as follows:

28

TX_MSJ_006396

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Work to be done by the United States.

7. Upon the execution of this contract and initial deposit of funds by the District as hereinafter provided, the United States during the life of this contract to such extent as funds may be found to be available therefor, will continue the cleaning and maintenance of the drainage system serving District lands and in so doing will carry out a program of drain cleaning which contemplates the continuing of work on the drains in the Leasburg Division, the beginning of drain cleaning at the upper end of the West side thence down the West side and across to the lower East side, and, also, cleaning the lower and of the Hatch Drains. In carrying out this program the United States will do all things incident to such work as shall in the opinion of the project Superintendent, be conducive of efficient operation and maintenance of said drainage system, using, in addition to funds otherwise available for such work, funds to be advanced by the District as hereinafter provided, or so much thereof as in his opinion may be deemed necessary for the efficient maintenance of the drainage systems serving District lands, The program hereinbefore described will be followed as near as may be, but should it hereafter, by reason of unforeseen emergency or other necessity, be deemed desirable to vary such program in any major respect, this may be done by the mutual consent of the parties hereto.

29

TX_MSJ_006397

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Payment by the District to the United States.

8. The District shall, in advance, provide funds not to exceed twenty thousand dollars ($20,000.00) in the amount of the actual cost of such maintenance work as may be done pursuant to this agreement, and for which funds are not otherwise available, which cost and expense shall embrance all expenses of whatsoever kind in connection with, growing out of, or resulting from said work, including the cost of materials and supplies, labor, repairs, renewals, equipment, and the usual overhead cost. The books of the Bureau of Reclamation shall be final and conclusive evidence of such cost and expense.

Method of Advancing Funds.

9. Prior to the commencement by the United States of operations hereunder, the Project Superintendent shall estimate the amount of money necessary to be advanced by the District to cover the cost and expense of such operations for the period from the date of the execution of this contract to the 10th day of September, 1928, and the District shall deposit with the Special Fiscal Agent, Bureau of Reclamation at El Paso, Texas the amount of such estimate. On or before the 1st day of September and each month thereafter during the life of this contract the Superintendent shall make similar estimates for monthly periods extending rom the 10th of each month to the 10th of the succeeding month except that the last period shall extend from

TX_MSJ_006398

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

December 10th to Decmeber 31, 1928, and the District, prior to the commencement of the period for which such estimate is made, shall make a deposit with the said Fiscal Agent of the amount of such estimate, provided, however, that no liability to the United States or any third party shall attach to the District by reason of its failure from any cause whatsoever to deposit the sum of sums of any such estimate and provided that no liability shall attach to the United States by reason of its failure from any cause whatsoever, to perform any of the work provided for by this agreement. Upon completion of the work or at the expiration of the period covered by this contract any unexpended balance remaining from such deposite in the hands of the said fiscal agent shall be refunded to the District. Upon the sums so deposited by the District being exhausted, no funds then being otherwise available, which availability shall be determined by the Project Superintendent, the work provided for herein shall be discontinued unless and until the District shall deposit additional funds.

Duration of Contract.

10. This contract shall be in force from the date of its execution until and including the 31st day of December, 1928.

Existing Contracts not Affected.

11. Existing contracts between the United States and the District

TX_MSJ_006399

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

shall remain in full force and effect and unaltered by the provisions of this agreement.

Officials not to Benefit.

12. No Member of or Delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract or to any benefit that may arise therefrom. Nothing, however, herein contained shall be construed to extend to this contract if made with a corporation for its general benefit.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first above written.

THE UNITED STATES OF AMERICA

BY L. R. Flock
Acting Superintendent

ELEPHANT BUTTE IRRIGATION DISTRICT,

Attest:

L. E. Kuhnley

By A. S. Robertson
President.

32

TX_MSJ_006400

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT.

- - - - -

C O N T R A C T

between

THE UNITED STATES OF AMERICA

and

THE ELEPHANT BUTTE IRRIGATION DISTRICT

providing

For Credits for Drainage Rights of way
And increasing the Total Construction Work.

(Note: October, 1929)
Contract given advance approval as to form by Commissioner's letter to the Chief Engineer of June 8, 1929 and was authorized by a vote of the electors of the Elephant Butte Irrigation District on August 27, 1929. It now awaits confirmation by court proceedings before its final submission to the Secretary of the Interior for execution.

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

- - - - - -

CONTRACT BETWEEN THE UNITED STATES AND THE ELEPHANT BUTTE IRRIGATION DISTRICT PROVIDING FOR CREDITS FOR DRAINAGE RIGHTS OF WAY AND INCREASING THE TOTAL CONSTRUCTION COST.

- - - - - -

This agreement made this ____ day of _____, 1929, by and between the United States of America, acting for this purpose by and through _____, Secretary of the Interior, under the provisions of the Act of Congress approved June 17, 1902, (32 Stat. 388), and acts amendatory thereof or supplementary thereto, hereinafter styled the United States, and the Elephant Butte Irrigation District, hereinafter styled the District, an irrigation District duly organized and existing under the laws of the State of New Mexico, having its principal place of business at Las Cruces, New Mexico.

WITNESSETH:

Explanatory Recitals.

1. WHEREAS, the District executed a contract with the United States dated June 15, 1918, providing for the payment by the district to the United States of the maximum sum of Six Million Five Hundred and Thirty Thousand Dollars ($6,530,000.00) on account of the District's proportionate part of the cost of the irrigation system of the Rio Grande Federal Irrigation project; and

TX_MSJ_006402

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

2. WHEREAS, thereafter the District executed a supplemental contract with the United States dated February 21, 1924, providing for the payment by the District to the United States of an additional maximum sum of Nine Hundred Forty Thousand Dollars ($940,000.00) in addition to the said amount provided in the said contract dated June 15, 1918, as amended by contract dated July 16, 1928, and for the purpose therein set forth; and

3. WHEREAS, the District now desires the construction of additional works, not provided for in said contracts for the benefit of irrigable lands of the District as now constituted to the end, among other things, that irrigation and drainage works may be provided for an additional area within said district for which such works are not completed, and

4. WHEREAS, it has been necessary to utilize certain rights-of-way for drainage ditches across privately owned lands within said district and the district now desires to credit upon assessments, due and to become due from district lands, amounts equivalent to credits to individual landowners on account of the rights-of-way for drainage works which have been taken across lands within the district and to have the aggregate of such credits applied as a credit as between the United States and the District upon payments due or hereafter to become due from the district to the United States pursuant to the said contracts above mentioned and to have such amounts added to the total construction charges to be repaid by the District to the United States; and

5. WHEREAS, it is estimated that an expense of about thirty thousand dollars ($30,000.00) will be incurred in the preparation by the

TX_MSJ_006403

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

United States of rights-of-way maps and other material necessary and useful to the district in ascertaining the proper amounts of individual credits on assessments to be made by the district and for recording the quit claim deeds hereinafter provided for; and that the individual credits accruing on account of rights-of-way may amount to an additional sum of Two Hundred Thirty Thousand Dollars ($230,000.00) so that the total construction charge payable by the District may be, on this account, increased by not to exceed the aggregate sum of Two hundred Sixty Thousand Dollars ($260,000.00) of which there may be credited on future installments becoming due thereon, not to exceed the aggregate sum of two hundred thirty thousand dollars ($230,000.00).

Provisions of Agreement.

6. NOW THEREFORE, in consideration of the covenants herein contained it is mutually agreed as follows:

Additional Expenditures
For Drainage, Etc.

7. The United States, in addition to such amounts as may be expended pursuant to said existing contracts, will expend the sum of not to exceed One Hundred Ninety Thousand Dollars ($190,000), or so much thereof as may be necessary in the opinion of the Secretary of the Interior, for the improvement and extension of the district's irrigation distribution system, drainage works, purchases of supplies, machinery, equipment and plants and for general and miscellaneous project features or for one or more of such purposes, the amount so expended to be added to and consolidated with the total construction charge payable by the district.

United States to Prepare Data.

8. The United States will prepare rights-of-way maps and such

TX_MSJ_006404

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

other data as it may deem necessary and useful to the district in ascertaining the amounts of credit to be extended by the district to the respective lands over which the drainage ditch rights-of-way have been utilized and the cost of such work and material, together with the cost of recording the quit-claim deeds hereinafter provided for, not to exceed the sum of Thirty Thousand Dollars ($30,000), together with not to exceed the sum of Two Hundred Thirty Thousand Dollars ($230,000) being aggregate credits as provided in article 10, or an aggregate total of not to exceed Two Hundred Sixty Thousand Dollars ($260,000), on account of the work and credits provided for in this article, shall be added to and consolidated with the total construction charge payable by the district. Upon completion of the work provided for in this article the Bureau of Reclamation will present the district with a statement of the cost thereof and the books of the Bureau shall be conclusive evidence of such cost.

District to Extend Individual Credits.

9. The District will proceed to ascertain and fix the amounts of credits to be extended to the respective landowners and in all cases possible will cause to be conveyed to the United States by good and sufficient quit claim deeds from the respective owners thereof, title to the lands occupied by drainage ditches constructed by the United States, and to which it does not already have title, such conveyance to be of a strip of land in each case measuring not less than one hundred twenty (120) feet in width and in length co-extensive with such drainage ditches respectively. In all cases where it is not possible to obtain quit claim deeds from the owners of any such drainage rights-

TX_MSJ_006405

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

of-way, the District will institute proper proceedings to have credits due to such owners confirmed by a court of competent jurisdiction and will convey to the United States the title obtained by the District in such court proceedings. Thereafter the District will apply such credits as payment of the then current assessments on account of construction charges against the respective landowners entitled thereto as rapidly as such assessments shall become due until the entire amount of total credit to which such landowners may be respectively entitled, have been absorbed, no individual credit at any time, however, to exceed the amount then due from such individual for the then current assessment of construction charges. The lands referred to above, deeds to which are to be procured and for which credits shall be allowed, shall be deemed not to include tracts of land over which a right-of-way has been reserved to the government by Act of August 30, 1890 (26 Stat. 371) provided, however, that credits in lieu of compensation may be applied for improvements damaged or taken on rights-of-way reserved in said Act of August 30, 1890, in accordance with decisions and regulations of the Secretary of the Interior.

Credits Extended by United States on Showing by District.

10. After the extension of credits by the District as hereinabove set forth and as a condition precedent to allowance by the United States of credits to the district, the district shall deliver to the Superintendent of the Rio Grande project good and sufficient quit claim deeds, each of which said deeds shall be accompanied by a certificate executed by the President and attested by the Secretary of the District substantially in

TX_MSJ_006406

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

the form set forth on a separate sheet attached hereto, made a part hereof, and marked Exhibit "A", or in cases where quit claim deeds cannot be obtained from landowners a certified copy of decree of a state court of competent jurisdiction confirming the action of the district in fixing the respective amounts of credits in favor of such landowners, together with a list of names and such amounts as have been actually credited by the District as payment upon individual assessments due or to become due from such individuals respectively before the next payment of construction charges to the United States falls due. The United States shall in turn, credit the district with a sum equivalent to the total of such amounts as have been thus actually credited to individuals by the district as aforesadd, and for which amounts credit has not theretofore been received by the district, to be applied on the next installment of construction charge maturing and becoming due thereafter from the district under the said contracts dated June 15, 1918, February 21, 1924, and July 16, 1928, and should such credits exceed the total construction installment next maturing thereunder the additional sum will be similarly applied on the succeeding installment or installments until the entire amount of credits thus accruing in favor of the District have been absorbed, and thereupon payments will be resumed in strict accordance with the schedule of payments and provisions contained in the said contracts of June 15, 1918, February 21, 1924, and July 16, 1928, provided however, that the district will at all times continue to cause annual assessments to be made in the same manner and to the same extent as if no credits were to be given. Should the amount of credit accrued in favor of the

TX_MSJ_006407

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

district in the aforesaid manner, when any installment of construction charges regularly becomes due from the district to the United States be less than the amount of such maturing installment the district will pay the difference between such credit and the amount of such installment due as provided by the said contracts of June 15, 1918, February 21, 1924, and July 15, 1928, augmented by the additional amount to be paid as provided in Article Il hereof.

Total Credits and addition to Construction Charge.

11. The total amount of credits upon installments hereafter to become due, to be so allowed the district, shall not in any event exceed the sum of Two Hundred Thirty Thousand Dollars ($230,000) and the total amount to be added to the construction charge payable by the district by virtue of this agreement shall in no event exceed the sum of Four Hundred Fifty Thousand Dollars ($450,000) making an aggregate amount which the district obligates itself to repay as construction charges under existing contracts and this contract, of Seven Million Nine Hundred Twenty Thousand Dollars ($7,920,000). Said total construction charges shall be repaid by the district in the manner provided for in the above-mentioned contracts of June 15, 1918, February 21, 1924, July 16, 1928, and this agreement.

Total Cost to be Repaid.

12. The cost of the work provided for by this contract, which the district obligates itself to pay, shall embrace all expense of whatsoever kind in connection with, growing out of, or resulting from the work described including the cost of labor, material, equipment, engineering,

TX_MSJ_006408

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

legal work, superintendence, administration and overhead of all kinds; and in determining the total amount of such cost project books of the Bureau of Reclamation shall be accepted as conclusive.

Appropriation Clause.

13. This contract is subject to appropriations being made by congress, from year to year, of moneys sufficient to do the work provided for herein. No liability shall accrue against the United States by reason of such moneys not being appropriated. Should only a portion of the moneys necessary to complete the work be so provided and expended, then the amount to be repaid by the District to the United States for such work shall be reduced to an amount equal to the sum actually expended.

This Contract Supplementary to Prior Contract.

14. This contract is supplementary to said contract of June 15, 1918, February 21, 1924 and July 16, 1928, and is subject to all of the terms and conditions thereof so far as the same are applicable and not modified herein.

Officials not to benefit.

15. No member of or Delegate to Congress or Resident Commissioner shall be admitted to any share or part of this contract or any benefit to arise therefrom. Nothing, however, herein contained shall be construed to extend to any incorporated company, if the contract be for the general benefit of such corporation or company.

To Bind Successors or Assigns.

16. The provisions of this contract shall apply to and bind the successors in interest and assigns of the respective parties.

TX_MSJ_006409

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

To be Authorized by Electors and Judicially confirmed.

17. The execution of this contract shall be authorized by the qualified electors of the District by an election for that purpose. The District, thereafter, without delay, shall prosecute to decree proceedings in court for a judicial confirmation of the authorization of this contract. This contract shall not be binding upon the United States until a confirmatory final judgment on such proceedings shall have been rendered, including final decision on any appeal prosecuted therefrom. The District shall furnish the United States for its files certified copies of all proceedings relating to the election upon the contract, and confirmatory proceedings.

IN WITNESS WHEREOF the parties have hereto signed their names the day and year first above written.

THE UNITED STATES OF AMERICA,

By _____
Secretary of the Interior

ELEPHANT BUTTE IRRIGATION DISTRICT,

By _____

ATTEST:

_____

_____

TX_MSJ_006410

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

NEW MEXICO - TEXAS.

- - - - -

Section III.

Contracts with

EL PASO COUNTY WATER IMPROVEMENT DISTRICT No.1,

- - - - - -

TX_MSJ_006411

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE PROJECT - NEW MEXICO - TEXAS

C O N T R A C T

Dated January 17, 1920

between

THE UNITED STATES OF AMERICA

and

THE EL PASO COUNTY WATER IMPROVEMENT DISTRICT No. 1,

For Repayment of Construction

and

Operation and Maintenance Charges.

Note

See Parker v. El Paso County Water Improvement district No. 1, Supreme Court of Texas, 297 S.W. 737 affirming 260 S.W. 667 in which decisions this contract is mentioned.

TX_MSJ_006412

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Symbol No. Ilr-348

1. THIS AGREEMENT made this the 17th day of January 1920, by and between the UNITED STATES OF AMERICA, acting for this purpose by John Barton Payne, the Secretary of the Interior, hereinafter styled the "Secretary," under the provisions of the Act of Congress approved June 17, 1902, (32 Stat., 388) and acts amendatory thereof and supplemental thereto, hereinafter styled the "Reclamation Law"; the EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1, a public corporation duly formed under the laws of the State of Texas, with irrigation and drainage powers, having its principal place of business at El Paso, El Paso County, Texas, hereinafter styled the "District;" and the EL PASO VALLEY WATER USERS' ASSOCIATION, a private corporation organized under the laws of the State of Arizona and having its principal place of business in the City of El Paso, Texas, hereinafter styled the "Association";

WITNESSETH: THAT -

2. "WHEREAS, the association executed contract with the United States dated June 27, 1906, whereby that corporation agreed to pay for that part of the cost of the irrigation works of the Rio Grande project which should be apportioned by the Secretary to the shareholders of the association, and it is now the desire of the said shareholders that the liens in favor of the association primarily for the purpose of securing reimbursement to the United States, be relaased and that the association be dissolved; and,

TX_MSJ_006413

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

3. WHEREAS, the District desires to cooperate with the United States as authorized by law and particularly for the construction of drainage works and for the construction of works for the distribution and delivery of water for irrigation purposes to the irrigable lands of the District;

4. NOW, THEREFORE, in consideration of the covenants herein contained, it is agreed between the parties as follows:

5. The United States will expend, in addition to the amount heretofore expended, the sum of One Million Six Hundred Twenty-four Thousand ($1,624,000) Dollars, or so much thereof as may be necessary, for the improvement, construction and extension of the irrigation system for the storage, distribution and delivery of water to the irrigable district lands and for the construction of drainage works for the restoration and maintenance of the irrigability of district lands, subject always, however, to appropriation therefor being made by Congress. In the improvement and extension of the distribution system, the United States shall use such portions of the systems already in existence as may be utilized to advantage to the extent that the titles to said systems and control thereover may be acquired from the owners thereof for use by the United States. The tentative plan prepared by the United States in connection with this work is as follows:

DISTRIBUTION DISTRICTS

The enlargement and extension of the following named lateral systems, or districts to provide for the irrigation of the areas shown, respectively:

TX_MSJ_006414

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Name of System	Approximate Area to be Irrigated.
Upper Franklin	5300 Acres
Juan d'Herrera	3760 "
Jornado	2720 "
Ysla	4450 "
Socorro	1510 "
San Elizario	6270 "
Salatral	3700 "
Clint	2420 "
Island	9400 "
Lower Franklin	6070 "
Montoya in Texas	2600 "
La Union District in Texas	5600 "
Three Saints District in Texas	1000 "

The cost of the La Union and Three Saints Districts will include a part of the cost of the Mesilla Diversion Dam, and East and West Side Canal Systems in Mesilla Valley, prorated according to the area irrigated from this source. The work as tentatively laid out is shown on map entitled "El Paso Improvement District No. 1, Proposed Lateral System, dated July, 1919," on file in the office of the Project Manager, Rio Grande project.

It is understood to be the desire of the District that in the expenditure of the moneys for drainage purposes, the agents of the United States shall avail themselves of all information as to sub-surface formation and other conditions, to be obtained as the work shall progress, to the end that the drainage system may be built in an efficient manner, and that therefore it is not to the interest of the landowners of the district that exact dimensions, alignment of extent of drainage canals and ditches be prescribed in advance of the progress of actual construction work.

TX_MSJ_006415

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

There have been prepared by the United States plans and schedules of drainage works which it is planned to construct approximately according to the sub-joined table:

Primary Drains

Drain	Length Miles	Excavation Cu. Yards.
Mesa	23.0	1,100,000
Middle	13.9	655,000
Franklin	12.7	584,000
River	7.0	350,000
San Elizario	8.0	400,000
Island	8.0	320,000
Fabens	6.3	240.000
Total primary	78.9	3,649,000

Secondary Drains

Drain	Length Miles	Excavation Cu. Yards.
Clint Spur	1.1	30,000
Socorro	2.0	80,000
Valley Gate	3.5	140,000
Val Verde	2.5	100,000
Border	5.0	200,000
Fabens	4.5	180,000
Total Secondary	18.6	730,000

Mesilla Valley Drains in Texas.

Montoya	12.6	404,000
Nemexas	6.8	336, 143
Vinton	3.6	143,378
Lower West	4.6	240,000
Total In Mesilla	27.6	1, 123,521

Total for District 125.1 Miles - - - 4,773,251 Cubic Yards.

The bottom width of drains will vary from 24 feet to 10 feet, average approximately 12 feet, with side slopes 1½,1, and average out 10 feet.

TX_MSJ_006416

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Structures will be required approximately as follows:

100 Timber Highway Bridges
200 Timber Farm Bridges
200 Metal Flumes
50 Drain Inlets
50 Special Structures for Canal, Highway and Railroad Crossings.

6. It is understood that the plans for the drainage work and the construction of the distribution system hereinbefore described in Paragraph 5, are necessarily dependent upon conditions variable and uncertain. Such plans are, therefore, tentative merely, and to the end that said works may be constructed, operated and maintained so as to attain the best results, it is understood that the United States reserves the right to change any and all of said plans as conditions developing from time to time may justify and render necessary or advisable. No change, however, shall be made which will defeat the general purpose sought to be accomplished, or subvert the general tenor of this contract, but all work done under this contract shall be in accordance with plans and specifications approved by the Chief Engineer of the United States Reclamation Service.

7. The United States will continue the operation and maintenance of the irrigation and drainage system until otherwise provided by contract after a vote by the electorate of the District, or until the payments required by the Reclamation Law are made for the major portion of the irrigable lands of the district, subject, however, to appropriations for such maintenance and operation work being made by

TX_MSJ_006417

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Congress, and provided always that such operation and maintenance shall be performed only in case the Secretary shall receive satisfactory assurance that lawful assessments and levies are being made or tolls and charges are being imposed, sufficient to meet the expense thereof, and provided further, that full repayment of the cost of the operation and maintenance for previous years shall have been made to the United States. There shall be considered as a part of the operation expense a storage cost of fifty cents per acre for the operation expense of the district actually irrigated, whether or not stored water is used. The water shall be diverted and distributed in such manner as may be hereafter arranged between the Board of directors of said District and the United States. The United States will so continue to operate and maintain said project works until the issuance by the Secretary of public notice as provided in Section 4 of Reclamation Act approved June 17, 1902 (32 Stat., 388), whereupon the United States will continue the operation and maintenance of the said project in Texas under the reclamation law and public notice issued thereunder.

8. The District hereby assumes the liability for the reimbursement to the United States of the aggregate sum represented by the cost of the irrigation and drainage works heretofore constructed or hereafter to be constructed for the use and benefit of District lands, and agrees to pay the same and each installment thereof. Such aggregate sum shall include the District's pro-

TX_MSJ_006418

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

portionate share of the cost for construction of the Elephant Butte Reservoir. The total liability assumed by the District for irrigation and drainage construction purposes, exclusive of penalties, shall in no case exceed the aggregate sum of Four Million Nine Hundred Forty-one Thousand ($4,941,000.00) Dollars.

9. The charge for construction of the Elephant Butte reservoir assumed by the District hereunder and included in the amount estimated and set forth in the preceding paragraph, is based upon the irrigable area of the project in the states of New Mexico and Texas and included within the boundaries of the Elephant Butte Irrigation District and the El Paso County Water Improvement District No. 1, as such districts are now constituted. Should a contract or contracts be hereafter made between the United States and the El Paso County Conservation and Reclamation District No. 2, or any other similar district or organization, comprising land in the States of Texas and New Mexico, or either of them, by which the payment of any part of the storage charge for the construction of the Elephant Butte Reservoir is assumed, the amount payable by the District under this contract shall be reduced in such sum as will equitably adjust and apportion the charge to be paid for the construction of said reservoir by the District hereunder with the amount to be paid on account of other lands in Texas and New Mexico which shall receive stored water from said reservoir.

TX_MSJ_006419

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

10. Should the boundary line between the States of New Mexico and Texas be changed as a result of the suit now pending in the Supreme court of the United States entitled State of New Mexico vs. State of Texas, in such manner that the boundaries of the District and the irrigable area of lands included therein are modified, the obligations under this contract shall be reduced in proportion to the acreage which may be eliminated from said district.

11. From time to time as the Secretary may determine that specified areas of irrigable district lands, not necessarily continguous, should commence payment for the drainage and irrigation works herein provided for, he shall render a statement to such effect to the District, designating the areas of said District lands, and shall state the amount payable for such designated areas on account of the work herein provided for; and the District will pay such amount in installments of the same percentages and subject to the penalties of the same amounts and terms as specified in Sections 2 and 3 of the Reclamation Extension Act approved August 13, 1914, Such installments shall be due on such annual date as may be specified in said statement conformable to the state laws. The installments may, however, be divided and become payable semi-annually by contract between the Secretary and the District.

12. Until all amounts payable to the United States for the construction of the works herein provided for have been

TX_MSJ_006420

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

fully paid and discharged, there is reserved to the Secretary the right to make reasonable rulse and regulations and to modify the same in his discretion, not, however, contrary to this contract, but to the end that the true intent of the law and of this contract shall be carried into effect, and the District agrees to use its powers for the purpose of carrying out such rules and regulations and the purposes of this contract. The proper officials of the District shall have full and free access to the project books and official records of the United States Reclamation Service relative to the costs of the work herein provided for and the operation and maintenance thereof, with the right at any time during office hours to make copies of and from the same. The representatives of the United States shall have the same rights in respect to the books and records of the District.

13. The Secretary, in his discretion, if he deems lands within the District temporarily incapable of successful cultivation on account of seepage, alkaline or other conditions, may notify the District that it will be relieved from payment of the amounts payable, or a part thereof, on account of such lands for a specified period or until further notice, whereupon the District shall exempt from assessment and levy the lands as specified during the period named. Nothing in this paragraph, however, shall be deemed to relieve the District or individual land-

TX_MSJ_006421

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

owners from any reasonable responsibility for improving drainage conditions and for using reasonable economy in the use of water. If the Secretary of the Interior shall deem any lands of the project permanently insusceptible of reclamation on account of seepage or other conditions, he may, in his discretion, contract with the District for the severance of the water rights from such lands and for their becoming appurtenant to the other lands within or without the District or to lands which by appropriate proceedings are brought within the District. Nothing in this paragraph contained, however, shall be deemed to relaase the District from its liability for the reimbursement of the Reclamation fund for the cost of the said works, but if transfers of water right be made to lands without the District, as in this paragraph provided and the United States shall thereby be satisfactorily secured for proportionate reimbursement the obligation of the District shall be reduced to the same extent.

14. It is agreed that as soon as the affairs of the Association will permit, there shall be executed the necessary instruments of release of all the lands in El Paso County, Texas, included within the boundaries of the District, from the liens existing under subscriptions to stock in and trust agreements with said Association to the end that said lands shall be clear of encumbrances for the carrying out of the Reclamation Law. except such as shall be created by annual assessments by the District.

TX_MSJ_006422

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

No such relaase, however, shall be made until decree in confirmation of the proceedings for the authorization of the contract indebtedness herein undertaken and in confirmation of the validity of this contract shall have been rendered by a district court of Texas having jurisdiction or decision rendered by any appellate court to which appeal shall be taken.

No copy of this contract here but there is a copy in B.O. file No. 249 B1

15. The indebtedness herein assumed by the district is understood not to be cumulative with that of one million dollars for construction pruposes undertaken in favor of the United States by the district by contract of December 29, 1917, between the parties hereto, but that the maximum amount of indebtedness to the United States for construction purposes set forth in Paragraph 8 hereof includes such pre-existing obligation to the United States.

16. No member of or delegate to Congress, or resident commissioner, after his election or appointment, or either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of the Government shall be admitted to any share or part of this contract or agreement, or to any benefit to arise thereupon. Nothing, however, herein contained shall be construed to extend to any incorporation or company, as provided in Section 116 of the Act of Congress approved March 4, 1919 (35 Stat., L., 1109).

TX_MSJ_006423

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

IN WITNESS WHEREOF, this contract has been executed on behalf of the parties hereto and certified copies of ~~resolutions~~ resolutions of the boards of Directors of the District and the Association hereto attached and the respective seals of the said corporations hereto affixed.

THE UNITED STATES OF AMERICA

By John Barton Payne
Secretary of the Interior

EL PASO COUNTY WATER IMPROVEMENT
DISTRICT NO. 1

ATTEST:

O. D. Porchea

Secretary El Paso County Water
Improvement District No. 1.

By J. A. Smith
President

B. Flores
Secretary El Paso Valley Water
Users' Association.

EL PASO VALLEY WATER USERS' ASS'N

By J. A. Smith
President.

Note: The officials who executed this contract on behalf of El Paso County Water Improvement District No. 1 were the officials thereof on the date they signed the same, January 17, 1920, but were not such officials on the date the Secretary of the Interior signed it, June 24, 1920. The date has been changed to show the true date, January 17, 1920, has been stamped opposite his name. For authority to make this correction, see letter of August 18, 1920, from the Acting Director.

(Signed) P. W. DENT, Dist Counsel
U S R S El Paso Texas
Aug. 23, 1920.

13

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

C O N T R A C T

Dated October 12, 1922

between

THE UNITED STATES OF AMERICA

and

EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1.

for

Additional Construction Work

TX_MSJ_006425

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Archival Operations

RG No. 115

Symbol No. Ilr-348

DEPARTMENT OF THE INTERIOR

UNITED STATES RECLAMATION SERVICE

RIO GRANDE IRRIGATION PROJECT

- - -

CONTRACT BETWEEN THE UNITED STATES AND EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1, SUPPLEMENTARY TO CONTRACT OF JANUARY 17, 1920.

- - -

THIS AGREEMENT, made this 12th day of October, 1922, by and between the UNITED STATES OF AMERICA, herein styled the United States, acting for this purpose by E. C. Finney, First Asst., Secretary of the Interior, herein styled the Secretary, under the provisions of the act of June 17, 1902 (32 Stat., 388) and acts amendatory thereof or supplementary thereto, herein styled the reclamation law, and the EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO.1, herein styled the District, a public corporation duly formed under the laws of the State of Texas, having its principal place of business at El Paso, El Paso County, Texas, witnesseth;

Explanatory Recitals.

2. WHEREAS, contract between the District and the United States dated January 17, 1920, provides that the District shall pay to the United States the maximum sum of Four Million Nine Hundred Forty-one Thousand Dollars ($4,941,000) on account of the cost of the irrigation system of the Rio Grande Federal irrigation project; and,

TX_MSJ_006426

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

3. WHEREAS, under an election held on September 25, 1920, the boundaries of the District were extended by the Inclusion of approximately 8,000 acres of lands known as the Tornillo Tract, heretofore included in El Paso County Conservation and Reclamation District No. 2; and,

4. WHEREAS, The District now desires the construction of additional works for the benefit of irrigable lands of the District as now constituted:

5. NOW, THEREFORE, in consideration of the mutual covenants herein contained, it is agreed:

Construction of Project Works by the United States

6. The United States will expend, in addition to the amounts heretofore covered by said contract of January 17, 1920, the sum of One Million One Hundred Sixty-five Thousand Dollars ($1,165,000) or so much thereof as may be appropriate and necessary, in the opinion of the Secretary, for additions to existing storage works, for the improvement and extension of the present distribution system, for flood protection, for drainage works, and for general project features. Such portion of said distribution system as may be utilized to advantage shall be used. The contemplated work shall include the construction or reconstruction of approximately 110 miles of canals and laterals as tentatively laid out and shown on a map, dated March 4, 1922, entitled "El Paso County Water Improvement District No. 1, proposed Distribution and Drainage System," on file in the office of the Project Manager of the

TX_MSJ_006427

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Rio Grande project. Also in addition to the drainage works heretofore provided for, the contemplated work shall include about 39 miles of main drainage canals, the tentative locations of which are shown on the said map. The Secretary shall have the right to make such changes in the works shown on said map as he may deem appropriate.

Payment by District for Project Works.

7. The District shall pay to the United States as a part of the construction cost of the project, the aggregate cost of all works constructed under Article 6 hereof, according to the terms of payment named in Article 10 hereof; Provided; That such aggregate cost, exclusive of the amount stated in Article 8 hereof, shall in no event exceed the sum of One Million One Hundred Sixty-five Thousand Dollars ($1,165,000.00).

Payment by District for Supplies and Equipment.

8. Upon completion of the work provided for by Article 6 hereof, the District shall take over from the United States, (a) such materials and supplies purchased for work in the district as shall remain on hand, and (b) the machinery,

TX_MSJ_006428

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

equipment, and plant procured for district work and not required elsewhere by the United States. The District shall pay to the United Statea as a part of the construction cost of the project, according to the terms of payment named in Article 10 hereof, the value of said materials and supplies and of said machinery, equipment and plant: Provided, That such value shall not exceed the sum of One Hundred Fifty Thousand Dollars ($150,000.00). In determining the value of the property to be taken over by the District under this Article, said materials and supplies shall be valued at their cost to the United States, and said machinery, equipment, and plant shall be valued at their cost to the United States less any portion thereof theretofore charged to project work as depreciation. The obligation described in this Article is additional to the obligation described in Article 7 hereof.

Computation of Cost.

9. The cost of the work provided for by this contract, which the District obligates itself to pay, shall embrace all expense of whatsoever kind in connection with, growing out of, or resulting from the work described, including the cost of labor, material, equipment, engineering, legal work, superintendence, administration, overhaad, rights of way, property, and dsmage of all kinds; and in determining the total amount of such cost the project books of the United States Reclamation Service shall be accepted as conclusive.

18

TX_MSJ_006429

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Time and Manner of Payment by District.

10. From time to time as the Secretary of the Interior may determine that specific areas of irrigable District lands, not necessarily contiguous, should commence payment for the construction cost of the project works under this contract and said contract of January 17, 1920, he shall render a statement to the District, designating the areas of said lands, and shall state the amount of such construction cost payable for such designated areas. The District shall pay to the United States such amount in instalments of the same percentages and subject to the same penalties as specified in Sections 2 and 3 of the Reclamation Extension Act of August 13, 1914 (38 Stat., 686). Such instalments shall be due on such annual or semi-annual dates, conformable to the tax laws of the State of Texas, as shall be specified in said statement.

Contract Subject to Appropriations by Congress.

11. This contract is subject to appropriations being made by Congress, from year to year, of moneys sufficient to do the work provided for herein. No liability shall accrue against the United States by reason of such moneys not being appropriated. Should only a portion of the moneys necessary to complete the work be so provided, then the amount to be repaid by the District to the United States for such work shall be reduced to an amount equal to the sum actually expended.

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

This Contract Supplementary to Contract of January 17, 1920.

12. This contract is supplementary to said contract of January 17, 1920, and shall be subject to all of the terms and conditions of the latter so far as the same are applicable.

Member of Congress clause

13. No member of or Delegate to Congress, or Resident Commissioner, after his election or appointment, or either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of the Government, shall be admitted to any share or part of this contract or agreement, or to any benefit to arise thereupon. Nothing, however, herein contained shall be construed to extend to any incorporated company, where such contract or agreement is made for the general benefit of such incorporation or company, as provided in section 116 of the act of Congress approved March 4, 1909 (35 Stat. 1109)

Successors and Assigns Obligated.

14. It is understood and agreed that the terms of this contract shall inure to the benefit of and be binding upon the successors in interest and assigns of the respective parties.

TX_MSJ_006431

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

IN WITNESS WHEREOF the parties hereto have caused these presents to be duly executed by their respective officers the day and year first above written.

THE UNITED STATES OF AMERICA

By E. C. Finney
First Asst. Secretary of the
Interior

EL PASO COUNTY WATER IMPROVEMENT
DISTRICT NO. 1

By T. D. Porcher
President

ATTEST:

Idus T. Gillett
Secretary.

(SEAL)

TX_MSJ_006432

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

C O N T R A C T

between

THE UNITED STATES OF AMERICA

and

THE EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1.

for

Riverside Canal Construction

Dated August 2, 1926,

TX_MSJ_006433

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Symbol No. Ilr-48

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT - NEW MEXICO -

TEXAS - -

CONTRACT BETWEEN THE UNITED STATES AND THE EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1, REGARDING THE CONSTRUCTION OF ADDITIONAL IRRIGATION WORKS.

- - - - -

This agreement, made this 2nd day of August 1926, by and between the United States, acting for this purpose by E. C. Finney, First Assistant, Secretary of the Interior, hereinafter called the Secretary, under the provisions of the Act of June 17, 1902, (32 Stat., 388) and acts amendatory thereof or supplementary thereto, and the El Paso County Water Improvement District No. 1, a corporation duly organized and existing under the laws of the State of Texas, hereinafter called the District, having its principal place of business at El Paso, Texas,

W I T N E S S E T H: That,

Explanatory Recitals.

2. WHEREAS, the United States has constructed and is operating and maintaining the Rio Grande Irrigation project in New Mexico - Texas, and the El Paso County Water Improvement District No. 1 has by contract with the United States dated January 17, 1920, as supplemented by contract of October

TX_MSJ_006434

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

12, 1922, assumed the liability for repayment to the United States of the aggregate sum reppesented by the cost of the irrigation works constructed for the use and benefit of the District lands, and

3. WHEREAS, certain additional works at an estimated cost of approximately $350,000, which works will be more particularly designated by a Board of Engineers, as provided in Articles 8 and 9 hereof, and hereinafter referred to as proposed works, are necessary to be built as a part of the Rio Grande project for the protection of its water supply encroached upon by diversions made from the Rio Grande for use in Mexico, and

4. WHEREAS, Section 30 (b) Act of May 25, 1926, (Public No. 284, 69th Congress) authorizes the Secretary to credit on the said contracts of January 17, 1920, and October 12, 1922, the sum of $350,000 or such portion thereof as in the opinion of the Secretary may be necessary and is actually expended by the District in the investigation and construction of the said proposed works, and

5. WHEREAS, the District desires the United States to undertake for it the investigation and construction of the proposed works and is willing to advance to the United States the moneys necessary for that purpose.

NOW, THEREFORE, in consideration of the premises, it

TX_MSJ_006435

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

is hereby agreed as follows:

6. The District shall in advance provide funds in the amount of the actual cost of the construction of the proposed works, and other expenses incident to such work and shall, for the calendar month during which the work is begun, deposit with the Local Fiscal agent of the Bureau of Reclamation the estimated amount of the expenditure for such month, and shall from time to time thereafter deposit such additional sums as may be estimated by the United States as necessary in accordance with the needs of the works; Provided that funds shall at all times be in the hands of the agents of the United States sufficient in amount to finance construction operations for not less than thirty days in advance until the proposed works are completely constructed.

7. With the funds so advanced, the United States will construct the proposed works with diligence and in accordance with the plans and procedure described in Articles 8 and 9 of this contract. If the funds advanced are insufficient, the United States will stop work when the funds are exhausted and will not resume work until additional and sufficient funds are supplied by the District. The cost of the proposed works shall embrace all expenses of whatsoever kind in connection with, growing out of or resulting from said works, including the cost of investigation, labor, financing, machinery,

TX_MSJ_006436

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

equipment, engineering, legal work, superintendance, administration, overhead, rights of way, property, and damages of all kinds, and in determining the total amount of such cost, the decision of the Secretary shall be accepted as conclusive.

8. For the purpose of formulating the plans and specifications of the works to be built hereunder, a board of engineers, consisting of three members shall be organized immediately after the execution of this contract. One member of said board shall be selected by the Secretary, another shall be appointed by the District, and these two acting in conjunction with the Project Superintendent as a third member shall be charged with the duty of recomending detailed plans for, and the estimated cost of the works necessary to be built for the protection of the District's water supply, as authorized by section 30 (b) of said act of May 25, 1926.

9. Upon the approval by the Secretary and the District, such plans as may be recommended by the board of engineers shall be considered the plans for and specifications of the work to be done hereunder, and upon notice of such approval given by each party hereto unto the other, work thereon shall commence and shall be diligently carried to completion.

Rights of Way.

10. The proposed works shall become a part of the Rio

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Grande project and title thereto shall vest and remain in the United States until otherwise provided by Congress. So far as is practicable, the United States will utilize, in connection with the proposed construction work, any ditch, canal, or other rights of way possessed by it. In cases where the Government does not have such rights of way, the cost of securing the same and all damage that may result from the work of construction to any improvement on such rights of way shall be included in the total cost of the work and paid for by the District.

11. The District will save harmless the United States, its officers, agents, servants and employees, from any and all claims, suits, judgments, liabilities and obligations on account of the construction of any and all of the proposed works.

12. No Member of, or Delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract, or to any benefits to arise therefrom. Nothing, however, herein contained shall be construed to extend to any incorporated company if the contract be for the general benefit of such corporation or company.

IN TESTIMONY WHEREOF, the parties hereto have hereunto affixed their names the day and year first above written.

UNITED STATES OF AMERICA,

By E. F. Finney
First Asst Secretary of the Interior

EL PASO COUNTY WATER IMPROVEMENT
DISTRICT NO. 1.

Attest:

By T. D. Porcher, President

Idus T. Gillett, Sec'y

97

TX_MSJ_006438

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

C O N T R A C T

Dated July 16, 1928

between

THE UNITED STATES OF AMERICA

and

THE EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1.

for

Amendments to Existing Contracts for Construction Repayment

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RG No. 115

Symbol No. Ilr-348

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT - NEW MEXICO -

TEXAS

CONTRACT BETWEEN THE UNITED STATES AND THE EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1, PROVIDING FOR CERTAIN AMENDMENTS OF EXISTING CONTRACTS

- - -

THIS AGREEMENT, made this 16th day of July 1928, by and between the United States of America, acting for this purpose by E. F. Finney First Assistant Secretary of the Interior, hereinafter called the Secretary, under the provisions of the Act of June 17, 1902 (32 Stat. 388) and acts amendatory thereof or supplementary thereto, and specifically pursuant to the provisions of the Act of May 28, 1928, Public No. 556, 70th Congress, and the El Paso County Water Improvement District No. 1, a corporation duly organized and existing under the laws of the State of Texas, hereinafter called the District,

WITNESSETH THAT:

Explanatory Recitals.

2. WHEREAS the United States has constructed and is operating and maintaining the Rio Grande project in New Mexico and Texas, and the El Paso County Water Improvement District No. 1, by contract with the United States dated January 17, 1920, as supple-

TX_MSJ_006440

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

mented by contract dated October 12, 1922, assumed the liability for repayment to the United States of the aggregate sum represented by the cost of the irrigation and drainage works constructed by the United States in whole or in part for the use and benefit of the District, and

3. WHEREAS by act of Congress approved May ~~26~~ 18, 1928, being Public No. 556- 70th Congress, the Secretary is authorized and directed to enter into an amended contract with the District whereby after the payment of the first four annual installments upon the construction charge of the said project, as now provided for in the aforesaid existing contracts, the remaining unpaid construction charge per irrigable acre shall be payable annually in installments of three and 60/100 dollars ($3.60) until the total charge against the district is paid, and

4. WHEREAS the provision for the basis of repayment by the District of the obligations created by existing contracts with the United States is contained in Article 11 of the said contract dated January 17, 1920, and in Article 10 of the said contract dated October 12, 1922, between the United States and the District.

NOW THEREFORE in consideration of the premises, it is hereby agreed as follows:

Amendment of Existing Contract.

5. That Article 11, of the contract of January 17, 1920

TX_MSJ_006441

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

between the United States and the El Paso County Water Improvement District No. 1, be and it hereby is amended to read as follows:

> "11. From time to time as the Secretary may determine that specified areas of irrigable district lands, not necessarily contiguous, should commence payment for the drainage and irrigation works herein provided for, he shall render a statement to such effect to the District, designating the areas of said District lands, and shall state the amount payable for such designated areas on account of the work herein provided for; and the District will pay such amount in installments, the first four of which said annual installments shall be two per centum of the total construction charge, or the portion of the construction charge unpaid at the beginning of such installments, and the remainder of which said annual installments shall be at the rate of three and 60/100 dollars ($3.60) per irrigable acre of district lands comprising such designated areas, and shall continue until the total construction charge against the District is paid, subject to the penalties of the same amounts and terms as specified in Section 2 and 3 of the Reclamation Extension Act approved August 13, 1914. Such installments shall be due on such annual date as may be specified in said statement conformable to the state laws. The installments may, however, be divided and become payable semi-annually by contract between the Secretary and the District."

6. That Article 10 of the said contract of October 12, 1922 between the United States and the District be and it hereby is amended to read as follows:

> "10. From time to time as the Secretary of the Interior may determine that specific areas of irrigable District lands, not necessarily contiguous, should commence payment for the construction cost of the project works under this contract and said contract of January 17, 1920, he shall render a statement to the District, designating the areas of said lands, and shall state the amount of such construction cost payable for such designated areas. The District shall pay to the United States such amount in installments, the first four of which said annual installments shall be two per centum of the total construction charge, or the portion of the construction charge unpaid at the beginning of such installments, and the remainder of which said annual installments shall be at the rate of

TX_MSJ_006442

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

three and 60/100 dollars ($3.60) per irrigable acre of District lands comprising such designated areas, and shall continue until the total construction charge against the District is paid and subject to the same penalties as specified in Sections 2 and 3 of the Reclamation Extension Act of August 13, 1914 (38 Stat. 686). Such installments shall be due on such annual or semi-annual dates, conformable to the tax laws of the State of Texas, as shall be specified in said statement."

Existing Contracts to remain Otherwise Unaltered.

7. That the existing contracts between the United States and the District shall remain unaltered except as herein expressly provided.

Officials not to Benefit.

8. No Member of, or Delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract, or to any benefits to arise therefrom. Nothing, however, herein contained shall be construed to extend to any incorporated company if the contract be for the general benefit of such corporation or company.

IN TESTIMONY WHEREOF, the parties hereto have hereunto affixed their names as of the day and year first above written.

THE UNITED STATES OF AMERICA

By E. G. Finney
First Ass't Secretary of the Interior

EL PASO COUNTY WATER IMPROVEMENT
DISTRICT NO. 1.

By T. D. Porcher
President.

Attest:

Idus T. Gillett,
Secretary.

TX_MSJ_006443

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Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

C O N T R A C T

between

THE UNITED STATES OF AMERICA

and

THE EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1.

for

Advancing Funds for Drainage Operations,

Dated August 4, 1928

TX_MSJ_006444

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RG No. 115

Symbol No. I16r-239

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

oooooooo

CONTRACT BETWEEN THE UNITED STATES AND THE EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1, REGARDING CLEANING AND MAINTENANCE OF DRAINS.

oooooooooo

THIS AGREEMENT made this fourth day of August 1928 under the provisions of the Act of June 17, 1902 (32 Stat. 388) and acts amendatory thereof and supplementary thereto and especially the Act of March 4, 1921 (41 Stat. 1367, 1404) together known as the Reclamation Law, by and between the United States of America, hereinafter styled the United States, represented by the officer executing this contract, and the El Paso County Water Improvement District No. 1, a corporation duly organized and existing under the laws of the State of Texas, hereinafter styled the District,

WITNESSETH THAT:

Explanatory Recitals.

2. WHEREAS, the United States has constructed and is operating and maintaining the Rio Grande project in New Mexico and Texas pursuant to the Reclamation Law and existing contracts with the District,

3. WHEREAS incident to the construction and operation of the said project the United States has acquired and now has available equipment useful and necessary for operation and maintenance of drains,

TX_MSJ_006445

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

4. WHEREAS in order to supply irrigation demands and to provide adequate drainage for District lands under the said project it is essential that the distribution system and drains be maintained in a high state of efficiency, and

5. WHEREAS it now appears that the funds appropriated from the Reclamation fund and available for such purpose during the remainder of the calendar year 1928 will not be sufficient to carry out a complete and continuous program for the adequate maintenance of certain project works, particularly the drainage system, during said period, and

6. WHEREAS the District, realizing the importance of maintaining the works to a high degree of efficiency and desiring to secure the maximum results economically obtainable is willing to provide additional funds for such maintenance over the said period in the manner set forth hereinafter:

NOW THEREFORE, in consideration of the premises, and the mutual covenants herein contained it is hereby agreed as follows:

Work to be done by the United States.

7. Upon the execution of this contract and initial deposit of funds by the District as hereinafter provided, the United States during the life of this contract to such extent as funds may be found to be available therefor, will continue the cleaning and maintenance of the drainage system serving District lands and in so doing will carry out a program of drain cleaning which contemplates the completion of the cleaning of the Island and Tornillo Drainage system,

TX_MSJ_006446

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

resuming the work where operations have been suspended, and thereafter the cleaning of the main drains of the major division of the District. In carrying out this program the United States will do all things incident to such work as shall in the opinion of the Project Superintendent, be conducive of efficient operation and maintenance of said drainage system, using, in addition to funds otherwise available for such work, funds to be advanced by the District as hereinafter provided, or so much thereof as in his opinion may be deemed necessary for the efficient maintenance of the drainage systems serving District lands. The program hereinabove described will be followed as near as may be, but should it hereafter, by reason of unforeseen emergency or other necessity, be deemed desirable to vary such program in any major respect, this may be done by the mutual consent of the parties hereto.

Payment by the District to the United States.

8. The District shall, in advance, provide funds not to exceed twenty thousand dollars ($20,000.00) in the amount of the actual cost of such maintenance work as may be done pursuant to this agreement, and for which funds are not otherwise available, which cost and expense shall embrace all expenses of whatsoever kind in connection with, growing out of, or resulting from said work, including the cost of materials and supplies, labor, repairs, renewals, equipment, and the usual overhead cost. The books of the Bureau of Re-clamation shall be final and conclusive evidence of such cost and expense.

TX_MSJ_006447

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Archival Operations

RG No. 115

Method of Advancing Funds.

9. Prior to the commencement by the United States of operations hereunder, the Project Superintendent shall estimate the amount of money necessary to be advanced by the District to cover the cost and expense of such operations for the period from the date of the execution of this contract to the 10th day of September, 1928, and the District shall deposit with the Special Fiscal Agent, Bureau of Reclamation at El Paso, Texas the amount of such estimate. On or before the 1st day of September and each month thereafter during the life of this contract the Superintendent shall make similar estimates for monthly periods extending from the 10th of each month to the 10th of the succeeding month except that the last period shall extend from December 10th to December 31, 1928, and the District, prior to the commencement of the period for which such estimate is made, shall make a deposit with the said Fiscal Agent of the amount of such estimate, provided, however, that no liability to the United States or any third party shall attach to the District by reason of its failure from any cause whatsoever to deposit the sum or sums of any such estimate and provided that no liability shall attach to the United States by reason of its failure from any cause whatsoever, to perform any of the work provided for by this agreement. Upon completion of the work or at the expiration of the period covered by this contract any un-

TX_MSJ_006448

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

expended balance remaining from such deposits in the hands of the said fiscal agent shall be refunded to the District. Upon the sums so deposited by the District being exhausted, no funds then being otherwise available, which availability shall be determined by the Project Superintendent, the work provided for herein shall be discontinued unless and until the District shall deposit additional funds.

Duration of Contract.

10. This contract shall be in force from the date of its execution until and including the 31st day of December, 1928.

Existing Contracts not affected.

11. Existing contracts between the United States and the District shall remain in full force and effect and unaltered by the provisions of this agreement.

Officials not to Benefit.

12. No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract or to any benefit that may arise therefrom. Nothing, however, herein contained shall be construed to extend to this contract if made with a corporation for its general benefit.

TX_MSJ_006449

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Archival Operations

RG No. 115

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first above written.

THE UNITED STATES OF AMERICA

BY L. R. Flock

Acting Superintendent

EL PASO COUNTY WATER IMPROVEMENT DISTRICT No.1

By T. D. Porcher
President

Attest:

Idus T. Gillett.

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RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT.

C O N T R A C T

between

THE UNITED STATES OF AMERICA

and

THE EL PASO COUNTY WATER IMPROVEMENT DISTRICT No.1.

for

Construction of Additional Drainage Works -

Dated September 5, 1929.

TX_MSJ_006451

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

NEW MEXICO-TEXAS

Contract between the United States and the El Paso County Water Improvement District No. 1 for construction of additional drainage works with contributed funds and providing for crediting of revenues.

THIS AGREEMENT, made this 3rd day of September, 1929, under the provisions of the Act of June 17, 1902 (32 Stat. 388), and acts amendatory thereof and supplementary thereto, and especially the Act of March 4, 1921 (41 Stat. 1367, 1404) together known as the Reclamation Law, by and between the United States of America, hereinafter styled the United States represented by the officer executing this contract, and the El Paso County Water Improvement District No. 1, a corporation duly organized and existing by virtue of the laws of the State of Texas, hereinafter styled the District,

WITNESSETH THAT:

Explanatory Recitals.

2. WHEREAS, the United States has constructed and is operating and maintaining the Rio Grande project in New Mexico and Texas pursuant to the Reclamation Law and existing contracts with the District; namely, contracts dated January 17, 1920, October 12, 1922, and July 16, 1928.

3. WHEREAS, drainage improvement, hereinafter referred to as the proposed work, is necessary for certain district lands as to which lands the collection of construction charges is now suspended, and

TX_MSJ_006452

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

4. WHEREAS, funds for such drainage improvement are not otherwise available, and

5. WHEREAS, the District is desirous of having such drainage improvement accomplished for the benefit of said district lands and is willing to provide funds therefor, and

6. WHEREAS, incident to the construction and operation of the said project the United States has acquired and now has available facilities and equipment useful and necessary for the accomplishment of such drainage improvement.

7. WHEREAS, certain revenues are received by the United States in connection with the Rio Grande project from sale of water for miscellaneous purposes and rental of water to non-project lands a part of which may be applied as a credit upon operation and maintenance charges to become due from the District under existing contracts,

NOW, THEREFORE, in consideration of the premises and the mutual covenants and agreements herein contained, it is hereby agreed as follows:

Work to be done by the United States.

8. The proposed work which is contemplated by this contract to be done by the United States with and to the extent of funds supplied by the District in the manner hereinafter provided, is for the improvement and betterment of drainage facilities and consists of;

(a) Installation of pumps at the outlet of the Mesa drain near Fabens, Texas, deepening of the Mesa Drain and construction of such supplemental drains as may be feasible and required to improve the drainage conditions in the area northwest of Fabens;

(b) The improvement of drainage conditions along the Franklin Canal in the vicinity of the junction of the Franklin Feeder Canal with the Franklin

TX_MSJ_006453

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Canal, and conducting such investigations and tests as may be necessary to determine the most practical means of accomplishing such improvements or betterments of existing drainage conditions in the vicinity;

(c) The construction of a branch drain to supplement the main drainage system on the eastern edge of El Paso Valley between Clint and Ysleta, sometimes referred to as the Mesa Spur Drain.

Funds to be provided by the District

9. The District shall in advance provide funds not to exceed the sum of $50,000, or so much thereof as may be the actual cost of the proposed work as hereinafter defined, and shall for the calendar month in which the work is commenced, deposit with the Special Fiscal Agent, Bureau of Reclamation, El Paso, Texas, the amount of the anticipated expenditure for such month as estimated by the Project Superintendent, and shall from time to time thereafter deposit the amount of similar estimates for succeeding months; Provided that such funds shall at all times be provided by the District in amount sufficient to finance the proposed work for not less than thirty days in advance.

If the said sum of $50,000 is insufficient to cover the cost of the proposed work, and/or if the funds provided by the District are at any time insufficient, the United States will stop work under this agreement when the funds so provided are exhausted and will not resume work until additional and sufficient funds are provided by the District and in any event the United States shall not be obligated by this agreement beyond the expenditure of the amount actually provided by the District whether the proposed work is completed or not.

The cost of the proposed work shall embraces all expense of whatsoever

TX_MSJ_006454

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

kind in connection with, growing out of or resulting from said works, including the cost of rights of way materials and supplies, labor, repairs, renewals, equipment, and the usual overhead costs.

Upon the completion of the proposed work or upon the termination of this agreement any unexpended balance remaining from such deposits in the hands of the Special Fiscal Agent shall be refunded to the District.

Rights of Way.

10. So far as practicable the United States will utilize any rights of way which it may possess. When the United States does not have such additional rights of way as may be required in the prosecution of the proposed work the cost of securing the same shall be included in the cost of the work and the title thereto shall remain in the United States as a part of the Rio Grande project.

District not obligated to Provide Funds.

11. It is intended by the parties hereto and accordingly agreed that there shall be no obligation upon the district to provide the said sum of $50,000 or any part thereof and there shall be no obligation upon the United States to perform the proposed work but in the event that said sum or a portion thereof is provided by the District and the proposed work or a part thereof is done by the United States the money shall be provided and the work shall be done in the manner set forth in this agreement, provided, however, that if any of the proposed work is undertaken by the United States with funds so provided by the District, the District, irrespective of any of the other provisions herein contained, shall indemnify and save harmless the United States on account of any claims which may be compromised by the United States or judgments rendered against the United States arising out of or in connection with the prosecution of the proposed work under this agree-

TX_MSJ_006455

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

ment.

Crediting of certain revenues to District.

12. The United States will credit the operation and maintenance charges payable by the district under existing contracts with an amount equal to the proportionate part of the construction component of all revenues received by the United States during the year 1929 and thereafter from the sale of water for irrigation and miscellaneous purposes under the acts of February 21, 1921 (36 Stat. 925), and February 25, 1920 (41 Stat. 451), and other revenues and water rentals, properly to be allocated to the Texas division of the Rio Grande project, as and when received; provided, that the aggregate of such credits shall not at any time be in excess of the aggregate sums contributed by the district for the performance by the United States of the additional work contemplated by this contract.

Existing Contracts not Affected.

13. Existing contracts between the United States and the District shall remain in full force and effect and unaltered by the provisions of this agreement.

Officials not to Benefit.

14. No Member of or delegate to congress, or resident Commissioner, shall be admitted to any share or part of this contract ar to any benefit that may arise therefrom. Nothing, however, herein contained shall be construed to extent to this contract if made with a corporation for its general benefit.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first above written.

THE UNITED STATES OF AMERICA,

By Jos. A. Dixon
First Assistant Secretary of the Interior

Attest:

Idus T. Gillett
Secretary.

EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1.,

By T. D. PORCHER - Pres.

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Archival Operations

RG No. 115

EL PASO COUNTY WATER IMPROVEMENT DISTRICT
NO. 1

CERTIFIED COPY OF A PORTION OF THE
MINUTES OF THE BOARD OF DIRECTORS
IN SESSION ON SEPTEMBER 3, 1929.

Next was considered the proposed contract between the United States and the District providing for the expenditure of $50,000.00 for drainage improvement work in vicinity of the outlet of the Mesa drain near Fabens, the improvement of drainage conditions along the Franklin Canal in the vicinity of the junction of the Franklin Feeder Canal with the Franklin Canal, and the construction of a branch drain to supplement the main drainage system on the eastern edge of El Paso valley between Clint and Ysleta. On motion of Mr. Frist, seconded by Mr. Gillett and carried the draft of contract covering these features, as tendered by the Superintendent of the Bureau of Reclamation under date of August 29th, was approved and the President and Secretary were authorized to execute the same.

CERTIFICATE

I hereby certify that the above and foregoing is a true and correct copy of the minutes of the Board of Directors, in session on September 3, 1929, relating to the contract between El Paso County Water Improvement District Number One and the United States, for the expenditure of $50,000,00 for drainage improvement work herein above stated.

Idus T. Gillett
SECRETARY

(S E A L)

TX_MSJ_006457

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

C O N T R A C T

BETWEEN

THE UNITED STATES OF AMERICA

and

THE EL PASO COUNTY WATER IMPROVEMENT DISTRICT No. 1.

for

Cleaning and Maintenance of Drains.

Dated September 3, 1929.

TX_MSJ_006458

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Symbol No. I16r-365

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

CONTRACT BETWEEN THE UNITED STATES AND THE EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1, REGARDING CLEANING AND MAINTENANCE OF DRAINS.

THIS AGREEMENT made this 3rd day of September 1929, under the provisions of the Act of June 17, 1902 (32 Stat. 388) and acts amendatory thereof and supplementary thereto and especially the act of March 4, 1921 (41 Stat. 1367, 1404) together known as the Reclamation Law, by and between the United States of America, hereinafter styled the United States, represented by the officer executing this contract, and the E l Paso County Water Improvement District No. 1, a corporation duly organized and existing under the laws of the State of Texas, hereinafter styled the District.

Explanatory Recitals.

2. WHEREAS, the United States has constructed and is operating and maintaining the Rio Grande project in New Mexico and Texas pursuant to the Reclamation Law and existing contracts with the District,

3. WHEREAS incident to the construction and operation of the said project the United States has acquired and now has available equipment useful and necessary for operation and maintenance of drains,

TX_MSJ_006459

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

4. WHEREAS in order to supply irrigation demands and to provide adequate drainage for District lands under the said project it is essential that the distribution system and drains be maintained in a high state of efficiency, and

5. WHEREAS it now appears that the funds appropriated from the Reclamation fund and available for such purpose during the remainder of the calendar year 1929 will not be sufficient to carry out a complete and continuous program for the adequate maintenance of certain project works, particularly the drainage system, during said period, and

6. WHEREAS the District, realizing the importance of maintaining the works to a high degree of efficiency and desiring to secure the maximum results economically obtainable is willing to provide additional funds for such maintenance over the said period in the manner hereinafter set forth:

NOW THEREFORE, in consideration of the premises, and the mutual covenants herein contained it is hereby agreed as follows:

Work to be done by the United States.

7. Upon the execution of this contract and initial deposit of funds by the District as hereinafter provided, the United States during the life of this contract to such extent as funds may be found to be available therefor, will continue the cleaning and maintenance of the drainage system serving District lands and in so doing will carry out a program of drain cleaning which contemplates the cleaning of the Mesa Drain and Franklin and Playa Intercepting

TX_MSJ_006460

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

drains. In carrying out this program the United States will do all things incident to such work as shall in the opinion of the Project Superintendent, be conducive of efficient operation and maintenance of said drainage system, using, in addition to funds otherwise available for such work, funds to be advanced by the District as hereinafter provided, or so much thereof as in his opinion may be deemed necessary for the efficient maintenance of the drainage systems serving District lands. The program hereinabove described will be followed as near as may be, but should it hereafter, by reason of unforeseen emergency or other necessity, be deemed desirable to vary such program in any major respect, this may be done by the mutual consent of the parties hereto.

Payment by the District to the United States.

8. The District shall, in advance, provide funds not to exceed ten thousand dollars ($10,000.00) in the amount of the actual cost of such maintenance work as may be done pursuant to this agreement, and for which funds are not otherwise available, which cost and expense shall embrace all expenses of whatsoever kind in connection with, growing out of, or resulting from said work, including the cost of materials and supplies, labor, repairs, renewals, equipment, and the usual overhead cost. The books of the Bureau of Reclamation shall be final and conclusive evidence of such cost and expense.

Method of Advancing Funds.

9. Prior to the commencement by the United States of operations

TX_MSJ_006461

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

hereunder, the Project Superintendent shall estimate the amount of money necessary to be advanced by the District to cover the cost and expense of such operations for the period from the date of the execution of this contract to the 10th of September, 1929, and the District shall deposit with the Special Fiscal Agent, Bureau of Reclamation at El Paso, Texas the amount of such estimate. On or before the 1st day of September and each month thereafter during the life of this contract the Superintendent shall make similar estimates for monthly periods extending from the 10th of each month to the 10th of the succeeding month except that the last period shall extend from December 10th to December 31, 1929, and the District, prior to the commencement of the period for which such estimate is made, shall make a deposit with the said Fiscal Agent of the amount of such estimate, provided, however, that no liability to the United States or any third party shall attach to the District by reason of its failure from any cause whatsoever to deposit the sum or sums of any such estimate and provided that no liability shall attach to the United States by reason of its failure from any cause whatsoever, to perform any of the work provided for by this agreement. Upon completion of the work or at the expiration of the period covered by this contract any unexpended balance remaining from such deposits in the hands of the said fiscal agent shall be refunded to the District. Upon the sums so deposited by the District being exhausted, no funds then being otherwise available, which availability shall

TX_MSJ_006462

Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations

RG No. 115

be determined by the Project Superintendent, the work provided for herein shall be discontinued unless and until the District shall deposit additional funds.

Duration of Contract.

10. This contract shall be in force from the date of its execution until and including the 31st day of December, 1929.

Existing Contracts not Affected.

11. Existing contracts between the United States and the District shall remain in full force and effect and unaltered by the provisions of this agreement.

Officials not to Benefit.

12. No member of or Delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract or to any benefit that may arise therefrom. Nothing, however, herein contained shall be construed to extend to this contract if made with a corporation for its general benefit.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first above written.

THE UNITED STATES OF AMERICA,

L. R. Flock, Superintendent

EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO.1

By T. D. Porcher, Pres.

Attest:

Idus T. Gillett

TX_MSJ_006463

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

NEW MEXICO - TEXAS.

- - - - -

Section IV.

Joint Contracts

with

THE ELEPHANT BUTTE IRRIGATION DISTRICT

and

THE EL PASO COUNTY WATER IMPROVEMENT DIST. No. 1.

- - - - -

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

C O N T R A C T

between

THE UNITED STATES OF AMERICA

and

THE ELEPHANT BUTTE IRRIGATION DISTRICT

and

THE EL PASO COUNTY WATER IMPROVEMENT DISTRICT No. 1.

Power Privilege Lease

Dated May 10, 1928.

TX_MSJ_006465

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

THIS AGREEMENT, made this 10th day of May, 1928, in pursuance of the act of Congress approved June 17, 1902 (32 Stat., 388), and acts amendatory thereof or supplementary thereto, between THE UNITED STATES OF AMERICA, hereinafter styled the United States, represented by the officer executing this contract, and the ELEPHANT BUTTE IRRIGATION DISTRICT, a corporation organized and existing under the laws of the State of New Mexico, and EL PASO COUNTY WATER IMPROVEMENT DISTRICT NO. 1, a corporation organized and existing under the laws of the State of Texas, said corporations hereinafter collectively styled the Districts, their successors and assigns, WITNESSETH THAT:

RECITALS

WHEREAS, the districts have heretofore contracted with the United States for the repayment of the costs of construction of the storage and distribution system constituting the Rio Grande Federal Irrigation Project, and

WHEREAS, the districts are noe desirous of constructing, operating and maintaining certain works for the development of hydroelectric power and are desirous of expending such development from time to time to the end that the full potential power resources of the Rio Grande project may be ultimately developed, and

WHEREAS, the construction, operation and maintenance of such works in accordance with such detailed plans as may hereafter be approved by the Secretary of the Interior may be accomplished without impairing the efficiency of the Rio Grande Project, and

TX_MSJ_006466

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

WHEREAS, the districts propose to generate power primarily for consumption for municipal purposes, and

WHEREAS, the Secretary of the Interior is authorized by the Act of February 24, 1911 (36 Stat. 930), to lease the privilege of power development on the Rio Grande Project for a period not to exceed fifty years with the consent and approval of the districts,

NOW, THEREFORE, in consideration of the terms and mutual covenants and agreements hereinafter contained, it is covenanted and agreed by and between the parties hereto as follows:

ARTICLE 1. POWER PRIVILEGE.

Pursuant to the provisions of the Act of Congress approved February 24, 1911, (36 Stat. 930), the districts shall have the privilege of constructing, operating and maintaining a power plant or plants and all necessary works incident thereto for the full development of hydroelectric power, making use of all facilities, title to which may be in the United States as a part of the Rio Grande Project, for that purpose, subject to the provision for examination and approval by the Secretary of the Interior, as hereinafter set forth, of the utilization of energy and plans for development as may be proposed by the districts from time to time hereafter.

ARTICLE 2. RELEASE OF WATER

The amount of water which shall be released from the Elephant Butte reservoir or elsewhere through penstock openings in said dam or otherwise shall be that amount only which results from regulation of said reservoir or other works to fulfill the demands for irrigation or flood control and the obligations arising under treaty with Mexico proclaimed January 16, 1906,

TX_MSJ_006467

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

(34 Stat. 2955). In determining the amount of water available for power purposes the decision of the Secretary of the Interior or his representatives designated by him to act for this purpose shall control and no obligation is hereby created upon the United States to release stored waters in any manner other than that in which stored waters would be released for irrigation purposes independently of such hydroelectric power development.

ARTICLE 3. APPROVAL OF PLANS

All general and detailed plans and specifications for the exercise by the districts of the power privilege hereby conferred, shall be subject to approval by the Secretary of the Interior and all work which may hereafter be done by the districts, its agents, employees, contractors and sub-contractors in construction, operation and maintenance pursuant to such plans, shall be subject to inspection by the United States. The cost of such inspection shall be paid by the districts and in determining the amount thereof the books and records of the Bureau of Reclamation shall be deemed conclusive evidence.

No plans shall be approved that would, in the opinion of the Secretary of the Interior, when put into effect, result in interference with existing works or in impeding or unduly interfering with storage or delivery of water for irrigation purposes in accordance with the Treaty with Mexico hereinabove referred to, and/or pursuant to existing contracts with the districts.

ARTICLE 4. LIENS.

The districts shall have the right to encumber by liens to secure bonds issued and/or other obligations incurred incident to power development,

TX_MSJ_006468

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

all power plants and incidental works which they may hereafter construct for the purpose of hydroelectric development. The districts shall have the right to so encumber any and all rights and privileges conferred by or arising out of this contract insofar as the same may be necessary in financing the power development herein authorized; provided, however, that this provision shall not be construed as authorizing any encumbrance or liens of any character whatsoever upon or against the said Elephant Butte Dam or reservoir or any other property of the United States, it being the intention that such encumbrance or lien may be directed only against and applied to such power plant or plants and necessary facilities connected therewith as may be hereafter constructed or provided by and at the expense of said districts and the power privilege to the extent hereinabove set forth.

ARTICLE 5. TERM.

This agreement shall be effective for a period of 50 years from the date of its execution unless sooner terminated by the parties hereto. Within eighteen months after termination of this agreement the districts shall have the right to remove any and all structures, equipment, machinery and plant which they may have constructed for hydroelectric development pursuant to this agreement, to any extent possible so long as such removal may be made without damage to the Elephant Butte dam and distribution works thereunder, or other property title to which at such time may be vested in the United States. Upon the failure of the districts to make such removal within the time stated, the United States may at its option remove such works and sell the same to pay the cost of removal.

ARTICLE 6. DAMAGES.

The districts hereby waive all claim for damages of any nature

TX_MSJ_006469

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

whatsoever incident to or arising out of the proper repair or operation of the Rio Grande Project works insofar as the same may effect the construction or operation of hydroelectric power development plant or plants and waive all claims of any nature whatsoever incident to the increasing or diminishing the amounts of water released by the United States in the operation of said project.

The districts shall save the United States harmless from any damage resulting to the project works incident to the construction, operation or maintenance of works for hydroelectric power development.

This agreement shall not be construed to constitute the United States a participant in a joint enterprise with said districts for the development of hydroelectric power and the districts shall be solely liable for and save the United States harmless from all damage of any nature whatsoever to persons orproperty, arising out of or incident to the development or transmission of hydroelectric power.

ARTICLE 7. POWER TO BE FURNISHED.

The right is reserved to the United States to continue to operate the power plant now operated by it at Elephant Butte Dam except in the event that it becomes necessary to move or discontinue it in order to render more feasible the power development hereunder by the districts in which event the districts shall furnish to the United States without cost to it, electrical energy for all purposes for which the said plant now supplies energy or for which it was intended to supply energy.

ARTICLE 8. PAYMENT FOR PRIVILEGE

For the power privilege by this agreement created in favor of the

TX_MSJ_006470

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

districts, the said districts shall, on or before each March first, pay to the United States a sum equivalent to the total amount of revenue received from the sale of power for the preceding calendar year less the following deductions:

(1) All amounts necessary to the payment of interest on and the current retirement installment with previous deficits, if any, of the bonded and/or other obligation of the districts relating to power development hereunder.

(2) Any amounts expended during the preceding calendar year in the maintenance and operation of all hydroelectric works constructed by the Districts,

(3) Any deficit incurred incident to the operation of all such hydroelectric works for the preceding calendar year or years,

(4) Such other amount or sums which may, in subserving the ends of good business practice, be designated by the joint action of the districts and approved by the Secretary of the Interior, to be set aside as a reserve for future expenditures incident to the proper preservation, operation, improvement and betterment of the hydroelectric works constructed by the districts,

Provided, however, that after payment has been made by the districts, of all sums due the United States under present or future contracts for the repayment of the cost of construction operation and maintenance of the Rio Grande project, the amount to be paid by said districts during the life of and pursuant to this agreement shall be the sum of ten dollars ($10.00) per annum.

TX_MSJ_006471

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

All money received by the United States hereunder shall be credited annually, first on account of Rio Grande Irrigation project construction charges, second, on account of Rio Grande Irrigation project operation and maintenance charges, and third, as the districts may direct, such credits to be received by each of the districts respectively in the proportion in which its irrigable acreage therein for which water shall be provided bears to the total of such irrigable acreage of the said Rio Grande Irrigation Project for which water shall be provided.

ARTICLE 9. ASSIGNMENT

No interest in this agreement except as herein specifically authorized, shall be assigned by the districts without first having obtained the consent thereto in writing by the Secretary of the Interior. The provisions of this agreement shall be binding upon the assigns and successors in interest of the respective parties hereto.

ARTICLE 10. APPROPRIATION CLUASE

This contract is subject to appropriations being made by Congress, from year to year, of moneys sufficient to do the work provided for herein. No liability shall accrue against the United States by reason of such moneys not being appropriated. Should only a portion of the moneys necessary to complete the work be so provided and expended, then the amount to be repaid by the District to the United States for such work shall be reduced to an amount equal to the sum actually expended.

ARTICLE 11. OFFICIALS NOT TO BENEFIT

No Member of or delegate to Congress or Resident Commissioner shall be admitted to any share or part of this contract or any benefit to

TX_MSJ_006472

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

arise therefrom. Nothing, however, herein contained shall be construed to extend to any incorporated company, if the contract be for the general benefit of such corporation or company.

THE UNITED STATES OF AMERICA,

By L. R. Flock,
Acting Superintendent,

ELEPHANT BUTTE IRRIGATION DISTRICT,

By A. S. Robertson
President.

ATTEST:

(Seal) June 5, 1928
L. E. Kuhnley
Secretary

EL PASO COUNTY WATER IMPROVEMENT DIST. No. 1,

By T. D. Porcher
President.

ATTEST:

(Seal) May 31, 1928

Idus T. Gillett
Secretary.

TX_MSJ_006473

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

EXTRACT OF MINUTES OF A SPECIAL MEETING OF THE BOARD OF DIRECTORS OF THE EL PASO COUNTY WATER IMPROVEMENT DISTRICT NUMBER ONE ON MAY 31, 1928, HELD IN THE GENERAL OFFICES OF THE DISTRICT AT EL PASO, TEXAS.

Meeting called to order at 10. a.m. May 31, 1928.
Directors present, T. D. Porcher W. J. Stahmann, Idus T. Gillett, Joe Campbell, Frank P. Frist,

Directors absent - None.

The board then considered the proposed contract dated May 10, 1928, between the United States of America as the first party and the Elephant Butte Irrigation District and the El Paso County Water Improvement District Number 1, as the second parties, providing for the granting by the United States to the said districts, of the privileges of constructing operating and maintaining a power plant or plants for the development of hydro-electric energy making use of all facilities, title to which may be in the United States, as a part of the Rio Grande project under the conditions set forth in the said proposed contract.

After due consideration by the board it was moved by Director W. J. Stahmann, that the president be authorized to execute the said proposed contract on behalf of the El Paso County Water Improvement District Number 1. Thereupon Director Idus T. Gillett seconded the motion and the same being put to a vote the motion was passed.

C E R T I F I C A T E

I, Idus T. Gillett, hereby certify that the above and foregoing is a full, true and correct copy and transcript of so much of the minutes of a meeting of the Board of Directors of the El Paso County Water Improvement District Number 1, held on May 31, 1928, as relates to the execution of a contract dated May 10, 1928, between the United States of America as the first party and the Elephant Butte Irrigation second parties, providing for the granting to the said districts of the privilege of constructing, operating and maintaining a power plant or plants for the development of hydro-electric energy making use of all facilities title to which may be in the United States as a part of the Rio Grande project.

Witness my hand and the seal of the El Paso County Water Improvement District #1, this 31st day of May 1928.

Idus T. Gillett
Secretary

(Seal)

TX_MSJ_006474

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

EXTRACT OF MINUTES OF SPECIAL MEETING OF THE BOARD OF DIRECTORS OF THE ELEPHANT BUTTE IRRIGATION DISTRICT ON JUNE 4th, 1928, HELD IN THE TEMPLE OF AGRICULTURE AT LAS CRUCES, NEW MEXICO.

Meeting called to order at ten a. m., June 4th, 1928.

Directors Present: Robertson, Hernandez, Benvie, Bennett, Mayfield, Hibler, Bowman, Rigney.

Directors Absent: Kuhnley.

The board then considered the proposed contract dated May 10, 1928, between the United States of America as the first party and the Elephant Butte Irrigation District and the El Paso County Water Improvement District Number 1, as the second parties, providing for the granting by the United States to the said districts, of the privilege of constructing, operating and maintaining a power plant or plants for the development of hydroelectric energy making use of all facilities, title to which may be in the United States, as a part of the Rio Grande project under the conditions set forth in the said proposed contract.

After due consideration by the board, it was moved by Director Rigney that the President and Secretary be authorized to execute the said proposed contract on behalf of the Elephant Butte Irrigation District. Thereupon Director Mayfield seconded the motion and the same being put to a vote the motion was passed.

C E R T I F I C A T E

I, L. E. Kuhnley, hereby certify that the above and foregoing is a full, true and correct copy and transcript of so much of the minutes of a meeting of the Board of Directors of the Elephant Butte Irrigation District, held on June 4th, 1928, as relates to the execution of a contract dated May 10, 1928, between the United States of America as the first party and the Elephant Butte Irrigation District and El Paso County Water Improvement District Number 1, as the second parties, providing for the granting to the said districts of the privilege of constructing, operating and maintaining a power plant or plants for the development of hydroelectric energy making use of all facilities title to which may be in the United States as a part of the Rio Grande project.

Witness my hand and the seal of the Elephant Butte Irrigation District, this 5th day of June, 1928.

L. E. Kuhnley
Secretary.

(Seal)

TX_MSJ_006475

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT

NEW MEXICO - TEXAS.

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Section V.

Contracts with

HUDSPETH COUNTY CONSERVATION AND RECLAMATION DISTRICT NO.1.

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT.

C O N T R A C T

between

THE UNITED STATES OF AMERICA

and

THE HUDSPETH COUNTY CONSERVATION

AND RECLAMATION DISTRICT NO. 1,

Dated December 1, 1924

For water supply under the Warren Act

(Act Feb'y 21, 1911, 36 Stat. 925)

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

RIO GRANDE IRRIGATION PROJECT.

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CONTRACT BETWEEN THE UNITED STATES AND HUDSPETH COUNTY CONSERVATION AND RECLAMATION DISTRICT NO. 1, PROVIDING FOR RENTAL OF WATER TO THE DISTRICT.

- - -

THIS CONTRACT, made this first day of December 1924, in pursuance of the act of June 17, 1902 (32 Stat., 388), and acts amendatory thereof or supplementary thereto, particularly the Warren act of February 21, 1911 (36 Stat., 925), all herein styled the Reclamation Law, by and between THE UNITED STATES OF AMERICA, herein styled the United States, acting in this behalf by the officer executing this contract, and the HUDSPETH COUNTY CONSERVATION AND RECLAMATION DISTRICT NO. 1, herein styled the District, an irrigation district duly organized and existing under and by virtue of the laws of the State of Texas, witnesseth:

Explanatory Recitals.

2. WHEREAS, the District contains an irrigable area of 20,014 acres, located in Texas just below the Rio Grande Federal Irrigation Project; and,

3. WHEREAS, the terminus of the Tornillo Main Canal of said

TX_MSJ_006478

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

project may be feasibly connected with a district canal to serve water to lands of the District; and,

4. WHEREAS, the United States will have available for disposal at the terminus of said Tornillo Main Canal, certain water developed from the Rio Grande project, which water may be used for the irrigation of lands within the district;

5. NOW THEREFORE, for and in consideration of the mutual and dependent stipulations herein set forth, it is hereby agreed as follows:

Rental of Water to District.

6. The United States will deliver to the District at the terminus of the Tornillo Main canal, during the irrigation season of 1925 and thereafter during each irrigation season as established on the Rio Grande project, such water from the project as may be available at said terminus without the use of storage from Elephant Butte reservoir. The Secretary of the Interior shall be at all times the sole judge of the availability of such water. The rental of water hereunder is secondary and inferior to the right to use water for any purpose on the lands of the Rio Grande Federal irrigation project. In consideration of such rental the District hereby relinquishes all right, title, interest, and claim to any and all waters of the Rio Grande, except as herein provided.

Payment by District for Water.

7. For the delivery of water during the irrigation season

TX_MSJ_006479

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

of 1925, the District shall pay the United States a charge of one dollar and twenty-five cents ($1.25) per acre-foot, on or before December 1, 1925. For the delivery of water thereafter, the District shall pay to the United States, on each December 1, such a charge per acre-foot, to be fixed annually by the Secretary of the Interior, as shall return to the United States, six per centum on the construction cost per acre of such project works as affect the district water supply hereunder, plus a proper, proportionate share of the cost of operating and maintaining such project works. The decision of the Secretary of the Interior in fixing such charges shall be final and conclusive. All water available at the terminus of the Tornillo Main Canal, which can be put to beneficial use on district lands subject to irrigation at the time the water is available, shall be considered delivered to the district, and the district shall pay therefor, without reference to whether all of such water is in fact actually taken and used on such lands. For the information of the district the Superintendent of the Rio Grande project will render to the district monthly statements showing the quantity of water in acre-foot delivered to the district during the preceding month. All water rental charges due and unpaid the United States from individual water users within the District, for the years 1921, 1922, and 1923, totaling $3,702.50, together with the penalties thereon, shall be paid by the District to the United States on December 31, 1925, and the District agrees to make during the year 1925, a special assessment against the lands on account of which said accruals are unpaid and to pay the

TX_MSJ_006480

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

amount so assessed on December 31, 1925.

Penalty for Delinquency in Payments.

8. To every sum of money required to be paid under this contract which shall remain unpaid after the same shall have become due, there shall be added at once a penalty of one per centum (1%) thereof, and a like penalty of one per centum (1%) on the first of each month thereafter so long as such default shall continue; and the District hereby agrees to pay such penalty. In the event the District fails to pay any amount provided for in this contract when due the United States may refuse to deliver water to the District until such payment is made. The provisions of this article are not exclusive and shall not in any manner hinder the United States from exercising any other remedy to enforce collection of moneys payable hereunder.

Default by Individual Landowners.

9. The District as a whole is obligated to pay to the United States the full amounts herein agreed upon, regardless of any individual default in the payment of any assessment levied by the District, and the District will make extra levies and collect extra assessments whenever necessary to make upfor any such default or delinquency, so that in any event and regardless of such default or delinquency, the full amounts agreed to be paid shall be paid the United States by the District.

Measurement of Water.

10. The flow of water provided for in this contract during the irrigation season of 1925 and thereafter will be measured by

TX_MSJ_006481

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

the United States at the heading of the Ft. Hancock Main Canal where the United States will install and operate and maintain a measuring device, the cost of which as found by the United States, shall be borne by the District, and the measurements by the United States shall control for all purposes of this contract. This cost shall be additional to the charge payable under Article 7 hereof and shall be due and payable upon rendition of bills therefor.

Control of Water by District After Delivery.

11. The District, upon receiving the water delivered as herein provided, shall, at its own cost and expense, convey the same to the lands of the District and perform all acts necessary or required by law or custom, in order to maintain its control over such water and in order to secure its beneficial application to the lands of the District. The District assumed full responsibility for the control and handling of said water and for any damage that may result therefrom after its delivery by the United States at the aforesaid point of delivery. All losses or diminution of such water by reason of seepage, evaporation or other causes after delivery by the United States at the aforesaid point of delivery shall be borne by the District.

Use of Water by District.

12. The water supplied under the terms of this contract shall be used solely for the purpose of distribution by the District for irrigation of lands in the District and such water shall be delivered by the District in accordance with and subject to the

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conditions and limitations of Section 1 of said Warren Act: Provided that the provisions of this article shall not be construed to the prejudice of the District as to any benefit which otherwise would accrue through the enactment of future Federal legislation.

Shortage in Water Supply.

13. On account of drought, inaccuracy in distribution or by reason of the requirements and use on the lands within the Rio Grande Federal Irrigation Project or by the use of municipalities supplied by the waters thereof, or other causes, there may be at times and insufficiency of water for district lands but in no event shall any liability accrue against the United States or any of its officers, agents or employees for any damage, direct or indirect, arising therefrom, nor shall any charge provided for herein be reduced on account of any such shortage.

Waste and Seepage Water.

14. The District releases the United States, its officers, agents and employees from every claim for damage, direct or indirect, arising by reason of the presence of waste or seepage water on the lands of the District by reason of the water furnished the District as herein provided, or from any other cause.

Officials not to Benefit.

15. No Member of or Delegate to Congress, or Resident Commissioner shall be admitted to any share or part of this contract or to any benefit that may arise therefrom. Nothing, however, herein contained shall be construed to extend to this contract if made with a corporation for its general benefit.

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Successors and Assigns Obligated.

16. The provisions of this contract shall apply to and bind the successors and assigns of the respective parties.

IN WITNESS WHEREOF, the parties hereto have hereunto subscribed their names the day and year first above written.

THE UNITED STATES OF AMERICA,

By _____
Commissioner, Bureau of Reclamation

HUDSPETH COUNTY CONSERVATION AND
RECLAMATION DISTRICT NO. 1,

By (Sgd) W. T. Young
President.

Attest:

(Sgd) C.J.Mapel
Secretary.

(SEAL)

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March 11, 1955

TO ALL IRRIGATION WELL OWNERS:

The Bureau of Reclamation advises that water now in storage is sufficient to justify a starting allotment of only two and one half inches per acre of water right land.

It will again be necessary to ask well owners to transfer as much allotment water as they can spare so that small tracts without wells can start the 1955 crop season.

The Irrigation district will again act as agent for the transfer of allotment water. Water users who are willing to sell allotment water can list it with the District for transfer.

The cooperation of all well owners in connection with this matter is solicited.

Board of Directors
Elephant Butte Irrigation District

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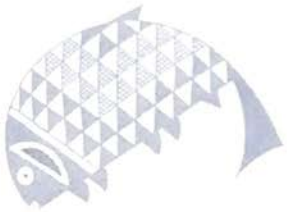

WATER in NEW MEXICO

A History of Its Management and Use

Ira G. Clark

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Contents

Illustrations ix
Preface xi
1 The Ancient Ones and Their Successors 1
2 Spain Sends Its Law to the New World 9
3 New Mexico Changes Hands 24
4 Congressmen—and Others—Discover the Arid Lands 44
5 Remolding Land Law to Arid Conditions 55
6 In Search of a Reclamation Policy 67
7 New Mexico Reacts to Federal Legislation 83
8 New Mexico Expands Its Local Water Institutions 100
9 New Mexico Defines Its Law and Refines Its Practices 115
10 From Reclamation to Conservation 133
11 The New State and Its Water Problems 171
12 From Irrigation Districts to Conservancy Districts 188
13 Dividing the Waters of Interstate Streams 214
14 Groundwater in the Ascendancy 233
15 Depression and War Years 243
16 Trials and Tribulations of Groundwater Administration 296
17 Intrastate Problems and Progress 323
18 Institutional Water Administration 347
19 Cooperative Federalism 375
20 Crises: Environmental and Energy 443
21 Interstate Compacts, Conflicts, and Compromises 500
22 Federal Lands and Installations 551
23 Indian Water Rights 596
24 Retrospect and Prospect 671
Notes xi 697
Selected Bibliography 787
Table of Cases 809
Index 815

TX_MSJ_006488

Illustrations

Acoma women at the reservoir 151
Dowlin's Mill at Ruidoso 152
Old well at Pojoaque 153
Irrigation system near Las Vegas 154
Flume at Picuris Pueblo 155
Water gate on irrigation ditch 156
Aerial view near Anton Chico 157
Placer mining near Silver City 158
Placer mining near Elizabethtown 159
Windmills, reservoir, and drinking tank on B. F. Pankey Ranch 160
Armijo Irrigation Canal west of Las Cruces 161
Corn grown by irrigation in the Pecos Valley 162
Spillway at Avalon Dam 163
Remains of Avalon Dam 164
Spillway at Avalon Dam after it was rebuilt 165
Main canal of the Carlsbad Irrigation Project 166
Effects of the great flood of 1895 in Silver City 167
Artesian well in the Roswell area 168
Bringing in an artesian well near Roswell 169
Laying pipe for carrying water from an artesian well 170
Steam dragline on East Side Canal in the Mesilla Valley 276
Construction of Elephant Butte Dam 277
Elephant Butte Dam and Reservoir 278
County extension agent H. H. Brook campaigning 279
Arroyo Chico tributary of the Rio Puerco 280
Preparing a field in the Mesilla Valley for an onion crop 281
Conchas Dam 282
New Mexico Agricultural Experiment Station well 283
San Marcial during the flood of 1929 284
Riverside drain constructed by Middle Rio Grande Conservancy District 285
Soaking logs at a sawmill in Alamogordo 286

TX_MSJ_006489

Washing facility at coal mine at Madrid 287
Winter view of Santa Cruz irrigation dam 288
Pumps revolutionized the use of ground water 289
Watering with sprinklers 290
Windmill and tanks in the Tularosa Basin 291
Aerial view of Lake McMillan 292
Results of the Percha Creek flood 293
Flow through a pipe, installed as a P.L. 566 project 294
Controlled arroyo floodwaters 295
Aerial view of P.L. 566 floodwater retarding structure 423
Bosque del Apache National Wildlife Refuge 424
Silos at the Seven Springs Hatchery 425
Brood pond at Seven Springs Hatchery 426
Boats moored at Elephant Butte Reservoir 427
Fishing on the upper Pecos River 428
Bringing in catches from Conchas Lake 429
Roswell saline water conversion plant 430
Aerial view of flooding in Albuquerque 431
Flooding in Carlsbad 432
The Mesquite Mutual Domestic Water Consumers' Association 433
Rio Puerco below United Nuclear Corporation's Church Rock Mill 434
Stream gauging station on Red River 435
Deterioration of the Alameda Drain 436
Alameda bridge before rehabilitation of the Middle Rio Grande 437
Check dams built in Fresnal Canyon in the Lincoln National Forest 438
Reseeding following terracing in the Carson National Forest 439
Sprinkler irrigation in the Navajo Indian Irrigation Project 440
Siphon on the main canal of the Navajo Indian Irrigation Project 441
Navajo Dam 442

TX_MSJ_006490

rado which problematically would benefit Colorado enough to offset the harm done to New Mexico by reducing the water available for existing uses in that state.[4]

Although in this one instance equitable apportionment will in time determine the ultimate fate of the waters of the Vermejo, New Mexico has depended on compacts as the most effective method for determining the rights of respective states in the waters of interstate streams. Unfortunately, with the exception of the Canadian River the waters were in every case overappropriated at the time the agreements were entered into, and they were negotiated in an atmosphere of suspicion and animosity. Interpretation of the terms of the compacts has therefore become the basis for extended litigation.

The most serious recent threat of water loss to a neighbor, together with substantial weakening of the state's control over its water resources, involves groundwater rather than a surface stream. In a surprise move, on 5 September 1980, the Public Service Board of El Paso, Texas, filed suit against State Engineer S. E. Reynolds, the state's attorney general, and the Dona Ana County district attorney in the federal district court for New Mexico challenging the constitutionality of New Mexico's statute forbidding the exportation of groundwater as an unreasonable burden on interstate commerce. Subsequently, the Elephant Butte Irrigation District, the city of Las Cruces, and Stahmann Farms were permitted to be joined as defendant-intervenors. Combining its present rate of growth with the industries which it hoped to attract, the city fathers estimated that El Paso would face a critical water shortage by the year 1995, and that the situation would worsen rapidly thereafter. El Paso currently depends primarily on wells drawing water from the portions of the Mesilla and Hueco bolsons located in Texas, but excepting a very small strip the Mesilla bolson lies west of the Rio Grande in New Mexico and the Hueco bolson thrusts north to cross the state line into New Mexico east of the river. The most economical and convenient sources to which El Paso could turn for its future municipal and industrial needs were these two New Mexico basins, but the export ban stood in the way.

Within two weeks after the suit was filed, Reynolds brought both of these subterranean sources under his control by declaring the Lower Rio Grande Underground Water Basin to encompass the Mesilla bolson and the Hueco Underground Water Basin for the Hueco bolson. The Lower Rio Grande basin is a strip about thirty-five miles wide following the river from the Texas state line some fifty-five miles north while the Hueco basin, averaging twelve miles in width, runs north for approximately twenty miles from the state line in the vicinity of Newman and Chaparral. The declarations placed El Paso in the position of having to make applications for permits to drill in the New Mexico basins. The general manager for the El Paso water utilities immediately filed applications for 266 wells in the Lower Rio Grande basin through which collectively the city could appropriate 246,000 acre-feet of water annually, and for sixty wells in the Hueco basin for pumping 50,000 acre-feet per year. The number of New Mexicans protesting these filings ran into the thousands.

The presiding judge, Howard C. Bratton, made it clear that the sole point at issue was the validity of New Mexico's statute prohibiting the exportation of groundwater, and that the initial suit would remain premature until after Reynolds denied the applications, citing that law as the reason for his action. This the state engineer in effect did on 21 April 1981.

The suit was followed with much interest throughout the West because it would necessarily set a precedent in determining the extent to which arid states could forestall raids from outside on their groundwater supplies. Since the export ban was a logical extension of the state's comprehensive groundwater code, designed to assure that the state engineer would maintain continuing supervision as a conservation measure, it was generally agreed that regardless of the holding of the lower tribunal the case eventually would be decided in the Supreme Court of the United States because of its impact on western water law. Local residents, however, were less concerned with points of constitutional law than with the effect the withdrawals would have on the Mesilla Valley. The El Paso wells in the Lower Rio Grande basin were to be located on the mesa near the southern end where

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