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

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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

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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
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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
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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
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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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Bureau of Reclamation

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RIO GRANDE PROJECT
BOARD REPORTS

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VOL. 495.

NEW MEX.- TEXAS

RIO GRANDE

BOARD OF ENGINEERS

REPORTS

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7—618 (April, 1915)

DEPARTMENT OF THE INTERIOR

UNITED STATES RECLAMATION SERVICE

No.

~~DUMMY FOR FILES.~~

, 19

From
To Apr. 7. 1915

Subject Bd. Engrs
Drainage

REFERENCE.

Referred on , 19 , to

6—1368

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DEPARTMENT OF THE INTERIOR

UNITED STATES RECLAMATION SERVICE

El Paso, Texas, April 7, 1915.

From Board of Engineers: E. H. Baldwin, Supervising Engineer; L. C. Hill, Consulting Engineer; D. W. Murphy, Engineer in charge of Drainage and L. M. Lawson, Project Manager.

To Reclamation Commission.

Subject: Report on Drainage - Rio Grande Project.

1. In compliance with authority from the Director and Chief Engineer, the undersigned board met at El Paso April 3rd, 1915 to study and report upon drainage conditions in the Mesilla and the El Paso Valleys. One day was spent in each valley inspecting seepage conditions. As a result of the inspection and the study of the cross-sections and other data prepared by the Project Manager, the board has prepared the following report.

2. Irrigation from the Rio Grande, in the Mesilla and the El Paso Valleys, has been carried on for many years. At the present time there are in the two valleys about 60,000 acres under irrigation, out of a total of 130,000 acres which it is proposed to irrigate. Scattered throughout these valleys are various large areas which are now wet or alkaline to such an extent that they are unfit for cultivation. The alkalinity of the lands is due principally to the high water table, which permits capillary action to the surface and the consequent bringing

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up of alkali as a result of this action. In several places alkaline areas have been formed by the wasting of water from the lower ends of canals, thus temporarily raising the water plane in that vicinity. Generally the water in the Rio Grande is but little below the adjacent lands on either side. This condition permits waters from the river being carried under the irrigable lands through the more or less porous sand strata. This has in some places resulted in water logging lands to an extent that they are unfit for agricultural purposes, until reclaimed by drainage. As the amount of land under cultivation is increased the amount injured by seepage will also increase, and unless drainage works are constructed at an early date large portions of the valley will in a short time be rendered unfit for cultivation.

3. Over the Mesilla Valley the water table at the present time is generally less than 10-ft. below the surface; while over large areas its depth is less than 5-ft. Where this water table is the highest, the land is now in a bogged and alkaline state. The reclamation of the land in these places will require not only the drawing down of the water table but also the careful leaching of the soils. The conditions as described in the Mesilla Valley are typical to a great extent of all of the valleys along the river, so far as is known.

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Concerning the reclamation of these lands, the following is taken from the report of Mr. A. T. Strahorn - "Soil Reconnoissance of the Palomas, Rincon and El Paso Valleys, New Mexico-Texas".

"All of the soils in these valleys can be successfully reclaimed and made productive, and the remedy is in the establishing of thorough drainage facilities, followed by deep cultivation and more or less thorough flooding of the surface. The amount of flooding that may be necessary will depend upon the texture of the soil, and the amount of alkali present; but there is probably no land in any of these valleys that cannot, when provided with adequate drainage and a plentiful supply of irrigation water, be thoroughly reclaimed within one irrigating season.

"Where excessive amounts of alkali occur only in very small areas, surrounded by non-alkali land, a reclamation may generally be effected by the land owner, but in the larger alkali areas shown upon the map, individual reclamation is a difficult task and one at which few will succeed. The reclamation of these areas will only be thoroughly and economically secured either through the formation of drainage districts by the communities, or by rec-

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lamation by the Government."

Similar statements concerning the Mesilla Valley may be found in the report "Soil Survey of Mesilla Valley", by T. W. Nelson and L. C. Holmes.

4. There is required, for successful agricultural operations in these valleys, a comprehensive system of drains, which will be effective in lowering and holding the water table several feet below its present elevation. Any drainage system which is constructed must be planned with a view to taking care of practically the entire area of irrigable lands, since it is not possible to do the work effectively by draining individual small areas. The investigations which have been carried on during the past two years in the El Paso and the Mesilla Valleys have resulted in the preparation of a tentative plan, consisting of a series of drains running generally parallel to the river and extending nearly the entire length of these valleys before emptying into the river. The principal drains in these systems are those projected along the river front for the purpose of intercepting seepage waters from the river. The drains proposed are all of the open type, to be made large enough to discharge the estimated flow and at the same time keep the surface of water in the drains sufficiently below the surface of the ground to fully protect the

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irrigability of the soil.

5. In the El Paso Valley it seems probable that for the main system of outlets, three drains will be required; in the Mesilla Valley two drains will be required on the east side and two on the west side of the river. It is believed, however, that in the construction of these drains that those along the river should be built first, as it appears that this is the greatest source of seepage at the present time; and that the construction of the drains further inland should, in most cases, be delayed until the effects of the river drains are more fully known. The preliminary investigations and plans are sufficient to show, roughly, the required locations and the grades which are available. It is now proposed to continue more detailed investigations and also to make final locations on the ground. (For preliminary locations see accompanying maps of El Paso and Mesilla Valleys.)

6. From the tentative plans which have been worked out for the El Paso Valley and the lower portion of the Mesilla Valley, an estimate of cost has been prepared. The total length of drains required for a main outlet system for the areas above mentioned is estimated at about 175 miles, and the total cost of this is estimated at $1,000,000. The area tributary to these drains is estimated at 100,000 acres, which makes an estimated cost of $10.00 per acre. Investiga-

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tions have not yet been carried on over the upper portion of the Mesilla, the Palomas and the Rincon Valleys. It is believed, however, from the general condition in these valleys, that the above estimate of $10.00 per acre will apply for these lands also. This estimate is intended to cover a system of main outlets.

7. One of the principal things to which the board desires to call attention, is the necessity for early action in constructing drainage works. The large amount of work necessary on the project will require a number of years for its completion; all of the work must be done by means of machinery, the rate of which is limited to the number of machines which can be economically used. For the purpose of comparison, it may be stated that a one yard drag line excavator, working on such drains as it is proposed to construct, will excavate about six miles per year. There are now two drag line excavators on the project which can be made available for drainage work at an early date, and it is especially desirable that these machines be put on this work as soon as the necessary arrangements therefor can be made.

8. Drainage was not originally contemplated as a part of the construction work of the project. The cost of the work is, however, in the opinion of this board, fully covered by the stock subscription and contract, also by resolutions, of

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the board of directors of the El Paso Valley Water Users' Association on October 8, 1908, and the Elephant Butte Water Users' Association on December 11, 1909, in which they agreed to assume the cost of the project whatever it may be.

9. Funds are available for continuing the investigations to the end of the fiscal year, and $50,000 is available for construction during the fiscal year 1916. It is probable that sufficient money can be transferred from other features of the project to provide sufficient funds to do such drainage work as seems advisable during the next fiscal year.

10. It is the judgment of this board, after going over the results of recent investigations, that drainage is absolutely necessary in order to maintain the irrigability of the lands. Without drainage it is believed that the security of the United States, for the moneys invested in the construction of irrigation works, would in a short time become seriously impaired. It is believed, as a matter of policy, that the question should be taken up with the board of governors of the water users' associations, and that they should be asked to approve, by formal resolution or otherwise, the construction of a drainage system.

Recommendation

It is recommended:

(a) That investigations and the preparation

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of plans for a drainage system for the entire project be continued, under the direction of the drainage engineer;

(b) That the project manager be authorized to present this matter to the board of governors of both water users' associations and request their official approval for the expenditure of $10.00 per acre for the construction of a main drainage system;

(c) That, in the event of favorable action by the board of governors of the water users' associations, construction work be authorized as soon as final plans for portions of the work can be prepared and approved, and in so far as funds therefor can be made available.

- - - - -

E. H. Baldwin
Supervising Engineer.

Louis C. Hill
Consulting Engineer.

Encs.

D. W. Murphy
Engineer in charge of
Drainage.

L. M. Lawson.
Project Manager.

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April 19, 1915.

Reclamation Commission

Project Manager, El Paso, Texas.

Report on Drainage - Rio Grande project.

1. The Reclamation Commission has carefully considered the report dated April 7, 1915. The recommendations therein contained are approved.

- - - - - -

A. P. Davis.

Copy to S. E., Elephant Butte, N. M.

Consulting Engr. L.C.Hill, Los Angeles, Cal.

Engr. in Charge of Drainage, Los Angeles, Cal.

TX_MSJ_002668

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Engineering and Research Center

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Report on Mesilla & Rio Paso Valley Drainage Feb 1917

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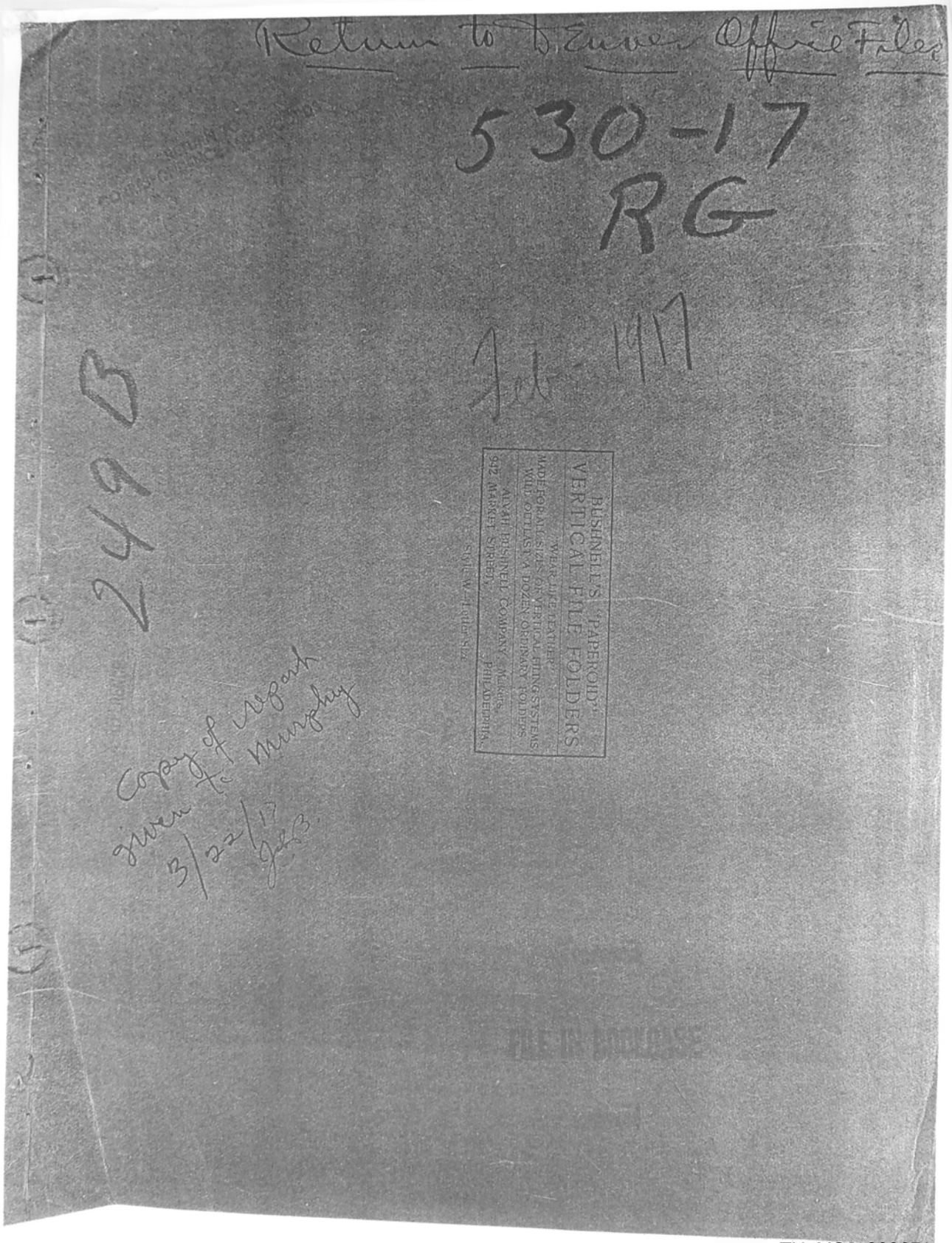

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REPORT

on

MESILLA & EL PASO VALLEY DRAINAGE

RIO GRANDE PROJECT

February , 1917.

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EXHIBITS

A - Map of Mesilla Valley.

B - Fluctuation of Water in Mesilla Valley Wells.

C - Gross Duty from Heads of Community Ditches,
Mesilla & El Paso Valley.

D - Cross-Section Drain.

E - Specification Drain Excavation.

F - Map of El Paso Valley.

G - Fluctuations of Water in El Paso Valley.

- - -

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RG No. 115

Board of Engineers,

Chief of Construction,

Mesilla and El Paso Valley Drainage - Rio Grande Project.

INSTRUCTIONS

1. This board was appointed by you with instructions as contained in your letter of January 30, 1917, to consider the drainage problem of the Mesilla and El Paso Valleys with especial reference to expediting the drainage work and in connection therewith, to consider the feasibility of letting contracts for a portion of the work.

MESILLA VALLEY DRAINAGE

PREVIOUS REPORTS

2. Some of the reports which deal directly or indirectly with Mesilla Valley Drainage are as follows:

I. W.S. Paper #141, 1905.	Ground Waters in Rio Grande Valley - Schlichter.
II. W.S. Paper #188, 1907.	Water Resources of Rio Grande Valley - Lee.
III. Bureau of Soils, 1912.	Soil Survey of Mesilla Valley - Nelson & Holmes.
IV. U.S.R.S. Board of Engineers, Dec.3, 1913.	Irrigation and Lower Development of Mesilla Valley.
V. U.S.R.S. Board of Engineers, Nov.4, 1914.	Designation of Irrigable Lands for Rio Grande Project.
VI. U.S.R.S. Engineer, June, 1905.	Community Ditches in Rio Grande Proper.
VII. U.S.R.S. Board of Engineers, April 7,1915.	Drainage Rio Grande Project.

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IRRIGATION HISTORY

5. Irrigation of part of the Mesilla Valley was commenced in early days by Indians. Modern irrigation development took place in the period 1844 to 1864, during which all the community ditches in the valley were built. The Leasburg Canal was put in use in 1908 and the East and West Side Canals in 1916. Storage in the Elephant Butte reservoir was commenced on Jan. 7, 1915.

4. Various causes have produced a rise of ground water and a concentration of alkali over extensive areas. The water table has risen so as now to be dangerously close to the surface over a large portion of the valley to the serious injury of crops. In addition there are swails and old river channels, where the water stands almost at the surface or in stagnant pools.

UNDERFLOW CONDITIONS.

5. Various studies were made in 1905 and 1907 as to the movement of ground water but these were necessarily based on such few data as could then be collected from water in existing wells and from a few wells which were driven for the purpose.

6. These studies indicated that little water comes into the valley from the side hills, that a movement of

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underground waters exists down the valley, that the river along certain stretches loses water, that only a small portion of the water proceeds under ground through the narrow valley west of El Paso, that the underground flow may continue from the lower end of the valley in a southwesterly direction away from the river under high mesa lands towards Mexico and that more probably the outflow is largely disposed of through evaporation from ponds and wet soil surfaces within the valley itself. (Report II page 50.)

7. Numerous borings were made during the last two years, from which water contours have been platted and the position of the water table has been determined. No study has yet been made of the amounts of losses from or gains to the river along its course through the valley.

8. The results of recent studies are in part shown on Exhibit A, on which are indicated the approximate water contours for November, 1916, and the areas where the water at that time stood within 4 feet from the surface.

9. No borings have been made to determine the character of the deeper strata. Some information is obtained from the record of well borings, pages 40-45 Report II, which show that layers of sand and gravel and sometimes boulders exist below 20 feet from the surface, overlaid by finer sand and soil. The water contours indicate that the water table has a free

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surface of considerable regularity over the whole area, which leads to the conclusion that there is general freedom of subsoil water movement.

CHANGE IN WATER TABLE

10. As regards such changes which may have taken place prior to 1915, no definite knowledge exists except in one locality in the vicinity of Mesilla park where borings were made in 1904 and the water plane was then determined. (Page 24 Report I.) The rise of the water table in that locality has been as follows:

Year	Average depth below surface	Rise of Water Table For period	Average for Year
1904	11.5 ft.		
1915	7.0	4.5 ft.	0.41 ft.
1916	5.7	1.3	1.30

11. The recent drainage investigations permit a fair approximation of the rise of the water table between November 1915 and November, 1916 over most of the valley. This rise in several places exceeded 3.0 feet. The average for the southern three-fourths of the valley, is shown in the following table:

	West Side	East Side
South of Township 27	-0.28 ft.	
Township 27	0.21	-1.40 ft.
" 26	0.80	-0.06
" 25	1.02	-0.03
" 24	0.24	0.94
" 23	not determined	
Average	0.50	0.59
General Average	0.55	

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The rise for some individual wells is shown on Exhibit B.

12. The entire valley has an area of 110,000 A. of which approximately 10,000 A. consists of river bed. During 1916 about 47,000 A. have been irrigated out of an estimated irrigable area of 77,000 A.

13. As the result of the accumulated rise, the ground water stood within 4 feet from the surface on November last over an area colored on Exhibit A of 55,000 A. amounting to over 40% of the gross irrigable area of the portion of the valley for which above determination was made. The seriousness of this condition will be the better realized when it is borne in mind that in November the water table is close to its lowest seasonal elevation and that during the irrigation season it is liable to rise from one to two feet.

14. The deeper roots of old alfalfa have rotted over possibly 60% of the acreage planted to this prop. A considerable portion of this is being plowed up, mostly for the above reason, the bulk of which is located within four miles of Las Cruces, both north and south. There are also large areas on the west side of the river. Other deep rooted crops have suffered similar large damage. Conditions are highly unsatisfactory and the rapid rise during 1916 especially has given cause for serious concern for the future.

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CAUSES OF RISING WATER TABLE

15. The general cause for the rising of the water table is the overtaxing of natural drainage, which fails to dispose fully of the water seeping into the soil from canals and laterals, irrigated lands, low places into which waste water is discharged and from the river as hereinafter explained.

16. As irrigation in this locality is very old there must for a considerable period have existed a fair balance between seepage and natural drainage. The balance has however become disturbed during recent years.

Changes in River.

17. The river channel is very shallow. The land next to the river rises from 2 to 6 feet above the usual river surface but farther back it generally drops again to 2 to 3 feet above river surface and continues practically level to the bordering hills. The plain contains large areas in old river channels over which the surface is close to or even below river level, and in a few locations ponds and lakes occur. Before storage in the Elephant Butte dam commenced, the river flow varied greatly. There were occasional flashy floods followed by reduced flow and by periods of entire cessation of flow. During such times the river would dry up

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completely and the underlying water plane would sink gradually below river bottom.

18. Control of river flow at Elephant Butte dam has greatly changed these conditions. A practically steady flow has been maintained varying from 1,500 to 2,500 s.f. Since the ground water plane in some parts of the valley slopes down from the river, and along certain river stretches losses must occur, the maintenance of such flow tends to increase such losses and to raise the water plane. On the other hand, the avoidance of floods tends to reduce such losses.

19. The storage of water in the Elephant Butte reservoir has the effect of clarifying the water. This prevents the river bed from becoming partially sealed by silt as formerly, during times of low flow and may have resulted in increased river losses.

20. The clarifying of the river water may be expected to have the further effect of gradually cutting down the river channel. (Section 9 Report IV.) Erosion will probably be most marked at first in the long river reach between the upper end of the Mesilla Valley and the dam (60 miles) and its effect might be to deposit material eroded from above in the lower river sections where the grade begins to flatten.

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A temporary rise of the river grade in these sections might cause a similar rise of the adjacent underground water plane.

21. The effect of clear water erosion in the upper river stretch has not yet been determined. River elevations were taken in 1914, 1915 and 1916 at various points in the Mesilla valley, and for almost identical flows from 600 to 800 s.f. These elevations are given in the following table:

Location	Oct. 1914	Oct. 1915	July 1916	Change from 1914 to 1916
0.50 mi.below Picacho Bridge	3875.9	3874.0	3874.5	-1.4 ft.
0.50 " " Mesilla Dam	3821.7	3820.0	3820.1	-1.6
0.50 " above Mesquite Bridge	3796.3	3798.0	3798.0	1.7
3.45 " below Anthony "	3736.3	3736.0	3737.0	0.7
0.40 " " Canutillo "	3716.2	3716.0	3716.7	0.5

22. The changes in river elevation as indicated in above table may well be such as might have taken place under previous shifting river conditions and probably have had no general effect upon the water plane.

Canal Seepage.

23. The construction of government canals may have increased the total canal seepage. These canals are as follows:

Leasburg Canal 6 miles
West Side " 14.4 "
East " " 10.2 "

24. Losses have not been determined for the Leasburg Canal. Those for the East and West Side Canals are yet very uncertain but measurements for one half year give results as per following table:

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	West Side Canal July 1-Dec.31;16	East Side Canal July 1-Dec.31;16.
Inflow	101,400 a.f.	26,400 a.f.
Delivered to heads of community ditch	86,500 "	20,700 "
Seepage losses for period	14,900 "	5,700 "
% losses	14.6%	21%
Estimated losses for entire year	24,800 "	13,200 "
Loss in depth per day during midsummer	1.8 ft.	1.8 ft.

25. The Leasburg canal was operated for seven years prior to the commencement of storage in the Elephant Butte reservoir and has probably had the advantage of considerable silting. The operation of the East and West Side Canals, was from the beginning, however, with water clarified by the reservoir and while large amounts of eroded channel sand have piled into these canals, the original seepage losses have not been materially checked.

26. These losses have been heavy, as shown by the above table and undoubtedly have had a considerable effect upon the immediately adjacent water plane. This is evidenced by water showing on the surface in low places alongside the canals, more particularly as regards the West Side Canal.

Irrigation Losses.

27. The amounts which have entered the heads of community ditches for various years give a gross duty from these points down in depth on the irrigated lands as follows:

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Year	For 17,000 to 19,000 A. supplied from Leasburg Canal.	For 28,000 A. from East & West Side Canals.
1910	5.29 ft.	
11	7.42	
12	6.02	
13	4.94	
14	6.30	
15	6.57	
16	8.52	7.03 ft/

28. The canal losses from the heads of community ditches down are probably light as these ditches have been well silted up. No measurements are at hand. Such losses, however, may be estimated for the purposes of this report at not over 20%.

29. The above shown gross duty also includes water wasted from the canals, of which no measurement was kept. Making allowance for both ditch seepage and waste at the rate of 25% which is exclusive of losses from government canals, the amount placed on the farms may have ranged from 3.7 to 5.6 feet prior to 1916 and may have reached 6.4 feet in 1916.

30. Table 1 Report IV shows an average net duty for various crops as determined by numerous experiments of 2.6 feet in depth on the land. Table 3 of the same report estimates this duty at 2.7 feet and in order to provide a margin it was concluded in section 8 of said report that 3 feet is a reasonable net duty. The quantity of water

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actually supplied has been from 25 to over 100% in excess of this estimate, the bulk of this excess having gone into the ground.

31. The duty as measured at the head of community ditches was much greater in 1916 than in previous years. This may have been due to the fact that irrigators had laid out their head ditches for silty water such as will carry long distances through furrows. Although the waste from irrigation was excessive prior to 1916, it became still more so in 1916, when clear water was furnished from the reservoir and this may be a full explanation of the acceleration during that year in the rate of rise of the water table.

32. For comparison it may be stated that for 15,000 acres irrigated from the Franklin Canal the gross duty at the head of community ditches was 4.45 acre feet per acre in 1915 and 3.85 acre feet per acre in 1916, no damage to crops having resulted from scarcity of water. The seasonal curves of gross duty at the points of discharge of the Leasburg, East and West Side and the Franklin Canals are shown in Exhibit C.

33. In studying the seepage water carried off by underflow under present conditions of excessive water use and in estimating the lowering effect on the water plane by a more careful use of water it is desirable to place before the eye

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concrete figures representing probabilities, even though they must be necessarily based on speculative assumptions.

34. The average gross duty at river intakes of government canals for 1916 may be estimated as follows:

Delivered from Leasburg Canal	167,483 a.f.	
Assumed Leasburg Canal losses 3%		
Diverted by Leasburg Canal		173,000 a.f.
Delivered from East & West Side Canals	193,900 a.f.	
Estimate E & W Side Canal losses 16%		
Diverted by E & W Side Canals		231,000 "
Total Diverted		404,000 "
Total area irrigated		47,092 acres
Gross duty at river head gates		8.59 ft.

35. The amount of water strictly necessary for average crops, if all waste could be avoided, may be assumed for present purposes at 2 acre feet per acre. On the basis of this and other highly uncertain assumptions, the following table was prepared:

Items	Past Conditions 1916		Feasible Future conditions. *1917 & 18		Ultimate	
Irrigated area	47,000 A.		47,000 A.		77,000 A.	
Gross duty at river headgates	8.59 ft.		6.00 ft.		4.00 ft.	
Gross supply	404,000 a.f.		282,000 a.f.		308,000 a.f.	
Consumed by plant growth & evaporated from well cultivated soil, 2 a.f. per acre	94,000 a.f.		94,000 a.f.		154,000 a.f.	
Difference	310,000		188,000		154,000	
Returned to river assumed 10%	15,500	5%	9,400		0	
Balance	294,500		178,600		154,000	
Evaporated account poorly cultivated soil assumed 20%	58,900	10%	17,900		0	
Seepage into ground due to irrigation	235,600		160,700		154,000	

* No increase in irrigated area.

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DISPOSITION OF SEEPAGE WATER

36. Changes in river flow from point to point through the valley, as was stated before, have not yet been measured. The general impression prevails that the river loses rather than gains water from seepage in its course through the valley. The water contours also fail to show any condition of seepage return; on the contrary, they tend to confirm the supposition that water leaks from the river into the ground.

37. The question now presents itself as to what becomes of the large seepage inflow from canals, irrigation and the river itself. This question was considered in Report II and it was deemed probable by its author that evaporation from wet surfaces might offer an explanation.

38. Apparently the seepage inflow from irrigation during 1916 exceeded 200,000 acre feet, equivalent to a steady flow throughout the year of nearly 280 s.f. Such flow, if returning to the river at the lower end of the valley, should be apparent, especially during periods of low river flow. Until measurement is made no definite conclusion is possible. No large return flow is stated to have been observed in the past and assuming that, if it exists at all, it is relatively small, it may be asked whether evaporation of wet surfaces is likely to offer a satisfactory solution.

39. The extent of wet areas is not known. From lakes and pools the evaporation loss annually may be 7 feet and

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higher, while from fully saturated uncultivated surfaces it may be from this amount down. If it be assumed that for uncultivated lands where water stands closer than 3 feet during the summer season the average evaporation is 4 feet, it might require some 50,000 acres of such land including open water surfaces to account for the disappearance of the seepage water. Whether such large areas exist and what may be the evaporation from them is as yet uncertain.

40. If the above should prove upon study to offer a satisfactory explanation of prevailing conditions, the conclusion would be that no material underground outflow to the South acting as a general valley drain exists and further that unless the water table is lowered alkaline areas may be expected to increase rapidly.

REMEDY

41. The remedy of present unsatisfactory drainage conditions must be logically sought first in the removal of its causes so far as this is reasonably feasible. The principal cause, by far, is excessive irrigation.

Reduction of Irrigation Supply.

42. From the table in Section 35 the conclusion may be drawn that seepage inflow can be reduced very largely, possibly 75,000 acre feet each year by a reduction of the gross duty from 8.59 feet to 6.00 feet, assuming that present area

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of irrigation to be maintained. Such reduction is equivalent to enough water to fill the soil over the entire valley 1.70 feet and instead of experiencing a rise of the water table of 0.55 feet a material lowering might be reasonably expected. The ~~reduced~~ improved duty assumed is still very excessive and far above that which was attained in the El Paso Valley.

43. The obstacles at present in the way of bringing about a material reduction in the use of water are the past habits of the people and the fact that no control is exercised by any central authority over the lateral system.

44. As regards the former the injury already done is having a salutory effect in producing a realization of the consequences of over-irrigation, especially now that clear water is furnished. It will be necessary to lay out head ditches at closer distances so as to shorten the runs, to look more closely after the avoidance of waste from the farms and to practice better cultivation of the soil.

45. As regards the latter, water should be furnished under a more systematic rotation of irrigation supply, adjusted so as to fit the crops. The water should be measured to individuals and the charge to individuals should be in accordance with the water furnished at rapidly increasing

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rates for water in excess of a minimum supply. The present method is to charge cost of operation and maintenance not to individuals but to community ditches, which in turn divide the cost evenly per acre among individual users without reference to the amount used by each.

Expediting River Erosion.

46. Another remedy and one which may well be seriously considered is to expedite by river control works the cutting down of the river channel and in connection therewith to hold it within narrow and definite bounds. The effect of this upon the water plane may be expected to be generally beneficial and to follow closely the deepening of the river bed. Considerable river control work may eventually become necessary in any event, as was intimated in Report IV. Work of this kind must for some time be decidedly experimental in character and no plans or estimates can at present be made. It may be considered as certain, however, that unless considerable time is given for gradual erosion, ~~xxxprocceeding~~ as a result of the clarification of river water, the cost will be very high.

47. If injury to the lower sections of the river is to be avoided by too rapid erosion above, it will be necessary to begin such work at the lower end, in this case at a point some 35 miles below El Paso and proceed upstream gradually.

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The work, if commenced, should be planned first in a tentative way, and should include channel straightening by excavation, channel narrowing by jetty work and channel protection at bends. As the work progresses it is probable that the results obtained by various methods of construction will point the way to the most economical and effective manner in which it should be carried out. In the meantime the present clear water flow may be expected to do much of this erosive work and may render unnecessary a large portion of the construction which would be called for if such work be done rapidly and on a large scale.

48. It is believed that so far as the Mesilla Valley is concerned the effect to be hoped from this work if authorized would necessarily be distant and not available for early relief. River control construction below El Paso would take much time and is liable moreover to be hampered by the fact that most of the southern shore of the river below El Paso is on Mexican soil.

Artifdcial Drainage.

49. Artificial drainage is objectionable if it can be avoided, because of its high cost, the permanent destruction of a large area of good land, the bad appearance of high waste banks and the constant burden of maintenance of both the channel and the bridges and flumes crossing it.

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50. The last column of the table in Section 35 indicates that with the entire acreage under cultivation and with a reasonably economical water duty the reduction of seepage inflow may be very large. From this it can, however, not be safely concluded that the water table would be lowered correspondingly.

51. In case the present disposition of seepage water takes place principally through evaporation of wet uncultivated surfaces, the reclamation and irrigation of these lands will withdraw them from such use and in that event the only remaining outlet so far as known will consist of the river itself. To keep the water down permanently under conditions of irrigation expansion, and assuming that no material help may be had from a river lowering, artificial drainage may be essential to permit the early extension of irrigation, even though after a long period of river erosion some of the drainage work built in the meantime may become of reduced value.

52. The design of an economic and efficient drainage system requires certain essential data. These relate partly to underground flow conditions which are not as yet fully understood, and partly to effectiveness of drains in reducing the waterplane, which can only be definitely ascertained by studying the effect of drains as they are gradually being built.

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55. The first set of data refer particularly to a study of the disposition of seepage inflow. This involves in part the measuring of gains to and losses from the river and approximating the extent of the wet areas and ponds and estimating the evaporation therefrom. The water contours fail to show any underground movement of water in a southerly direction away from the river valley. Nevertheless if a large outflow remains unaccounted for a basis for assuming the existence of such movement might then be established.

54. This matter may be of importance in the design of a drainage system for the Mesilla Valley. Assuming that no such outflow exists and considering that in Report I the fact was well established that the underflow in the lower neck of the valley cannot be great, the free river must carry off practically all return flow.

55. If a drainage system be built to meet such condition drains must carry the entire return flow together with water leaking from the river into the drains. Especially where drains approach close to the river such leakage may be a serious element in itself.

56. If on the other hand, an independent outflow exists, drains will only need to handle a part of the return flow and possibly as is often the case, only a small part of this flow.

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57. The second set of data mentioned in Section 54 relates to the amount of flow in the drains as constructed including the Montoya drain now under construction by land owners and their preliminary effect on the surrounding water plane.

58. In a general way it can now be stated that if extensive systems should prove necessary, in regard to which, as indicated above, some doubt exists, a system for the East Side can to advantage be designed on the basis of two outlets to the river, one at the lower end of the valley in Texas just across the New Mexican line to serve the area from this point northwest to the Mesilla Dam, the other some distance below the Mesilla Dam to serve the remainder. On the same basis, it appears at present that the West Side can probably be drained best through a single outlet at the extreme southern end, although for immediate construction purposes a temporary outlet might be provided at a point 6 miles north of the New Mexican line. This is in accordance with preliminary plans outlined in report VII with provisions for an additional outlet for the upper portion of the east side of valley and temporary outlet for west side.

59. Comprehensive systems may consist of a trunk line dividing into two main lines, one following up the valley on the river side and the other along the base of the hills.

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Leakage from the river into the river side drain may, however, be a severe tax on the latter. Studies made in Report I as to underground flow in the vicinity of Mesilla Park indicate that for steep slopes such as may prevail from river to drain at distances averaging 1000 feet with 4 feet difference in water elevation, the inflow in places may be as much as 7 s.f. per mile. The length of such drain on the East Side as far as Mesilla Dam may be over 12 miles and on the West Side 30 miles, showing that on the basis of very insufficient present knowledge this river inflow, until the river erodes down to lower levels and during the long period that such drain would be most beneficial, may become a very serious factor.

60. The system may also consist of a trunk drain on each side of the river half way between river and hillside with herringbone feeders. With such system the inflow from the river may become greatly reduced, and the number of feeders and their location might be left for determination until after the effect of the trunk drain shall have become known. The total length of drains required may, however, under adverse conditions be greater than with the other system.

EARLY CONSTRUCTION

61. Uncertainties regarding extent that drainage will be necessary, proper choice of locations and required capacities should lead to deliberation in proceeding with the work and

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careful avoidance of undue haste. It may, however, be practicable at the present time, without danger of serious error, to lay out drainage work for the current year such as is likely to be necessary in any event.

62. Such drains are shown in approximate cross-section when of 12 feet bottom width on Exhibit "D" and in tentative location until definite location can be made on Exhibit "A". Drain A, called the East River Drain, is planned for the reclamation of the large alkali area between the railroad and the hills to the east, to a point 3 or 4 miles above Mesquite. It probably will require herringbone feeders or a parallel drain for complete effect. It has been started and is now partially finished with a 14 foot bottom for a distance of 5½ miles. Drain B is intended to protect lands above the Mesilla Dam. It may have an early effect upon the lowering of the water plane near Mesilla Park which is now dangerously close to the surface. Drain C starts from the lower end of the valley on the West side. Commencement of work on the upper end of Drain C with temporary river outlet near Chamberino is also advisable to relieve bad conditions above as soon as possible. The location and dimensions of all drains will be the subject of further study.

63. The flow to be accommodated by these drains cannot now be known. This flow may be large and the method of con-

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struction should therefore be to deposit all material on one side of the drain, except that a low levee may be thrown up on the other side to prevent overflow running indiscriminately into the drain. The bottom width for the lower stretch of the drains could to advantage be fixed as wide as can be excavated in one operation, approximately 12 feet, final width to be obtained by a second operation. Large section will be advisable in view of the very flat grades needed to gain as rapidly as possible on the grade of the ground water which is about 4 feet per mile.

64. Canal concreting cannot be done until the end of the present irrigation season during which the extent of desirable work, if any, and its location can be ascertained by careful study. Its cost should be figured on the basis of a reduced section estimated for the present canal grade. The earliest if not the only work of this character which may be advisable is at points along the West Side Canal in the vicinity of Santo Tomas and San Miguel.

METHOD OF DRAIN CONSTRUCTION

65. One steam driven, dragline machine with forty foot boom and one yard bucket is now at work on drain A. This machine is too small for economical construction of large drains. So long as it remains at work the present method of depositing material on both sides should be discontinued so

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as to permit future enlargement, even if the desired section cannot in that manner be obtained in one operation.

66. Two Bucyrus caterpillar distillate burning 1½ yard dragline machines with 50 foot boom will be available to start work next August. The purchase of two additional excavators is advisable as soon as repayment is guaranteed through irrigation district organization and proper contract. Specifications should be prepared and bids should be received at an earlier date in order that time may be saved. The points at which the machines upon arrival should be put to work can best be selected at the time of their arrival.

67. In regard to contracting for drainage work it is believed that definite location for an entire schedule of sufficient magnitude to attract contractors is not feasible at the present time. The work laid out now should be subject to change of location as well as of dimensions and slopes to suit the conditions as they develop and as additional information becomes available. Contracts do not leave the desired freedom of change and are liable in these circumstances to be productive of annoying difficulties, lawsuits and delays. Moreover, it is very doubtful whether irrigation district organization upon which contracts for drains are understood to be contingent, can be accomplished in time to permit any contract to be entered into prior to the end of the present

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fiscal year. For work during the next fiscal year direct construction by the government also seems preferable.

68. In order to comply with your instructions, specifications for contract work are herewith submitted as Exhibit E.

RECOMMENDATIONS.

69. We recommend:

(a) That every effort be made both by the Reclamation Service, local organizations of water users and public spirited men in the valley to remedy the present wasteful use of water.

(b) That during the current year the observation of wells for determination of ground water be continued and that in addition thereto studies be made of canal and lateral seepage, of changes in river water elevations to the Elephant Butte Dam, of disposition of seepage water and of the effect of drainage construction.

(c) That the desirability be determined of concreting parts of Government canals for construction during next fall.

(d) That definite location be made of the lower ends of drains A, B, C and D in advance of the arrival of new machines.

(e) That upon compliance by the water users with such conditions as to irrigation district organization and repayment of cost as may be imposed, two additional machines be

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immediately purchased.

(f) That the general type of drain to be excavated conform as much as practicable to sketch on Exhibit D.

EL PASO VALLEY DRAINAGE

PREVIOUS REPORTS

70. Some of the reports which deal with the El Paso Valley drainage are as follows:

I. Bureau of Soils, Soil Reconnaissance of the Palomas, Rincon and El Paso Valleys - Strahorn.
II. U.S.R.S. Board of Engineers, Nov. 4, 1914 - Designation of Irrigable Lands - Rio Grande Project.
III. U.S.R.S. Engineer, June, 1915 - Community Ditches in Rio Grande Project.
IV. U.S.R.S. Board of Engineers, April 7, 1915 - Drainage Rio Grande Project.

IRRIGATION HISTORY

71. Irrigation of the El Paso Valley (American side) is probably even older than in the upper valleys, and dates back over 300 years. Community ditches were built during the period 1835 and 1856 and again from 1887 to 1890. The Franklin Canal was acquired by the Government in 1912 and the work of enlargement was completed early in 1914.

72. Irrigation conditions have differed somewhat from those in the Mesilla Valley. Statements have been made that some time prior to 1886 the irrigation area was far greater than at present, and may have been twice what it is now. Its

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reduction is generally attributed to a diminution of river flow, caused by increasing diversions above. The water table has probably fluctuated materially according to acreage irrigated, water applied and maintenance of flow in the river. It is possible that abandonment of irrigation may at times have been caused by rise of underground water.

73. As in the Mesilla Valley the ground water has come up during recent years and large areas have become alkaline. Serious injury has also been caused to crops.

UNDERFLOW CONDITIONS

74. The conditions are very much the same as in the Mesilla Valley. Exhibit "F" shows approximate water contours on November 1915 and the areas where the water at that time stood within four feet from the surface.

CHANGE IN WATER TABLE

75. Nothing definite is known regarding the rise and fall of the water plane prior to 1914. Investigations since that time show that for individual wells the rise has been as high as 2 feet per year. (See Exhibit G.) For the entire valley the rise has averaged 0.88 ft. Any rise is serious since the irrigable land lies only from 4 to 8 ft. above the river.

76. The gross area exclusive of San Elizario Island and the Tornco district, which have not been considered in

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this report, is about 47,000 acres, of which possibly 80% is irrigable, and about 17,000 acres is irrigated. The area where water stood within 4 feet of the surface on November last is estimated at about 16,600 acres, or 36% of the gross, with results corresponding to those in the Mesilla Valley.

CAUSES OF RISING WATER TABLE

77. These are generally the same as in the Mesilla Valley, although they probably have not had the same relative effect. The valley under which the ground water may spread includes the Mexican side and is far wider than the Mesilla Valley. The same amount of river losses will therefore produce a lesser relative rise in the ground water. The proportion of recently irrigated land to gross area is 56% for the lower as against 43% for the upper valley.

78. A still larger difference lies in the amount of probable irrigation losses, indicated by the amount of water diverted by community ditches as is well shown by Exhibit "G". The following figures show this to have averaged about 50% more for the upper than for the lower valley:

Amount supplied to Community Ditch in depth on irrigated land

	El Paso Valley	Mesilla Valley
1913	4.32 ft.	4.94 ft.
1914	4.93 "	6.30 "
1915	4.45 "	6.57 "
1916	3.85 "	7.69 "
Average	4.39 "	6.37 "

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79. As to canal seepage, the Franklin Canal has had one year of silty water flow. The losses as indicated by estimates made for 1915 and 1916 have averaged 14,500 acre feet per year, or as near as can be stated, about 60% of the losses from the Government Canals above.

80. All differences above mentioned tend toward a lesser rise of water plane in the lower as compared with the upper valley. Nevertheless, the average rise of the ground water during 1916 has been about 0.3 ft. greater than in the Mesilla Valley. No explanation can at present be offered other than that the river below El Paso may have risen. No measurements have been made but there is some evidence that a rise in river elevation has taken place near the San Elizario Island.

DISPOSITION OF SEEPAGE WATER

81. Topographic and underground conditions render it quite probable that the only disposition of seepage water is the river with its underflow passing out of the valley and evaporation from wet surfaces. No outflow away from the general river valley has ever been suggested.

82. The valley below Fabens continues of considerable width for some 12 miles downstream. Nothing is known as regards return flow to the river above where the valley contracts to a narrow outlet, and as regards the underflow at

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this point, as the valley at Fabens is several miles wide, the underflow past this point may be much greater than the underground inflow above El Paso.

85. The study of this matter is less promising of broad results than in the Mesilla Valley because present conditions do not permit study of the large area lying in Mexico. Even survey work along the American side of the river is at present not safe.

REMEDY

84. Reduction of irrigation supply to the lowest feasible gross duty should be the earnest and constant aim, but as the present duty is already fairly close to the estimated 4 ft., no very large effect can be expected therefrom, upon the lowering of the water plane.

85. Expediting river erosion is in one respect promising, as interests below will not be injured. It is believed that this matter should be taken seriously in hand and that the Senior Engineer should be instructed to make early investigations and surveys with a view to starting this work some distance below Fabens. It is not probable, however, that early general relief can be expected from such measure, as the progressive work would be slow and cannot at present be extended more than six miles above Fabens, where the present channel becomes the boundary line, without an understanding with Mexico.

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86. There remains for present relief no other means than artificial drainage, which by reason of the greater width of valley and low elevation of the land away from the river, may to a large extent be necessary under the best conditions which can be expected in the future.

87. In regard to the design of a drainage system, conditions in the El Paso Valley should be further studied, additional wells should be placed in the lower end of the valley, the reading of wells should continue, and changes in river flow should be measured, but in view of international complication these studies must be confined to the American side and no leading facts to assist in design can be expected therefrom. The most important information which can be gathered is the effect of drains as they are being built and the flow they develop, especially as regards the riverside drain.

88. The shape and conditions of the valley appear to exclude consideration of drains with herringbone feeders and so far as it can now be seen the system suggested by the drainage board in Report IV is probably the best that can be devised. It consists of one drain near the hillside, one central valley drain and one riverside drain, all in a general way parallel to the direction of the valley, with a common outlet near Fabens. The lower ends of these drains

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are approximately marked on Exhibit "F". Riverwork below Fabens, if successful, is likely to be of great benefit in affording a lower drainage outlet.

EARLY CONSTRUCTION

89. A beginning has already been made with a small steam machine which has excavated three miles of 12 ft. bottom drain at the common outlet end. Unavoidable uncertainty as to amount of water to be carried favors the disposition of practically all excavated material on one side to permit of ready future enlargement, and a bottom width as wide as can be excavated in one operation.

90. Concreting of canals is very expensive and as the seepage from the Franklin Canal appears to be less than 0.4 foot per day over the wetted area such work need not be considered in the El Paso Valley.

METHOD OF DRAIN CONSTRUCTION

91. Two new machines similar to those described for the Mesilla Valley have been ordered for work on two drains in the El Paso Valley. It will be economical to discontinue the use of the smaller steam machine now on hand upon the arrival of these large excavators, expected in July of this year.

92. It is believed that work should be prosecuted simultaneously on the three drains suggested and a choice

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should be made between contract or direct Government work for one of these drains. There is less uncertainty as to the probable amount of ultimate drains required in this valley than in the Mesilla Valley, but otherwise all that was said in Section 69 regarding the objections to contract work applies with equal force in this case.

93. In the event contract work should nevertheless be decided on, the specifications submitted in Exhibit "F" may be made applicable. In case direct work by the Government, as preferred by this board, should be approved, the early purchase of a third machine is advisable as soon as payment therefor through district organization and contract or otherwise is guaranteed.

94. The employment of more than three machines does not seem practicable, except possibly for the river drain, as for the other drains no temporary outlets can be made available without serious injury to lands immediately above and for a considerable distance below. A fourth machine could be started at some point part way up the riverside drain with temporary outlet into the river. It is highly desirable that seepage from the river into the riverside drain be first determined from experience with the lower end of the drain so as to govern location farther up and the immediate purchase of a fourth machine is not advised.

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RECOMMENDATIONS

95. We recommend:

(a) That every effort be made both by the Reclamation Service, local organizations of water users and public spirited men in the Valley to reduce as much as possible wasteful use of water.

(b) That during the current year the observation of wells for determination of ground water be continued and extended and that in addition thereto studies be made of canal and lateral seepage, river seepage, changes in river elevations and the effect of drainage construction.

(c) That definite location be made of the lower ends of a hillside, a central and so far as feasible, a riverside drain in advance of the arrival of new machines.

(d) That as soon as feasible after compliance by the water users with such conditions as to district organization and repayment of cost as may be imposed, one additional machine be purchased.

(e) That the general type of drain to be excavated conform as much as practicable to sketch on Exhibit "E".

(f) That the Senior Engineer be instructed to make a study of river deepening in the vicinity of Pabens.

Sgd D. C. Henny

D. W. Murphy.

E. H. Baldwin

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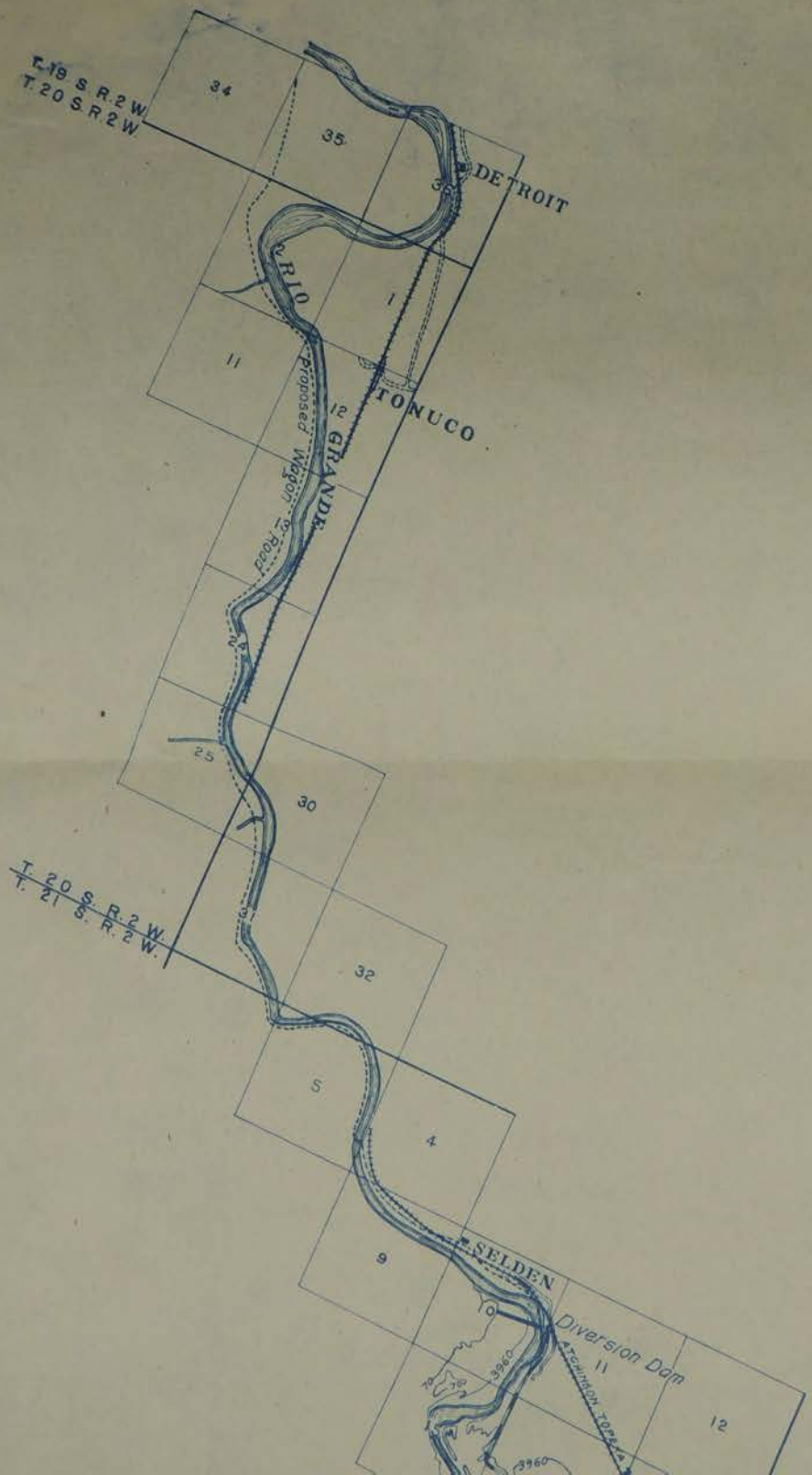

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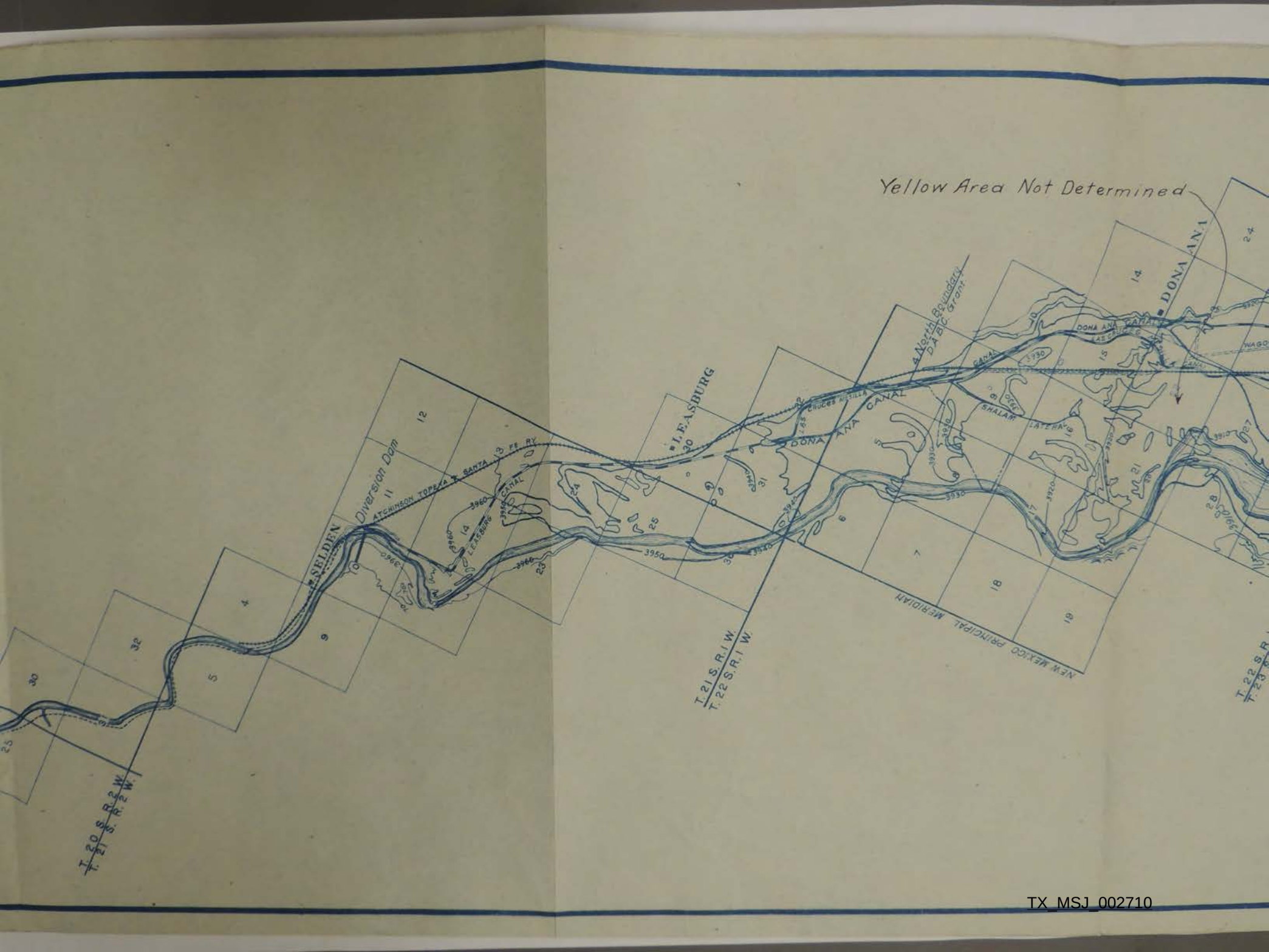

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EXHIBIT "A"

UNITED STATES RECLAMATION SERVICE

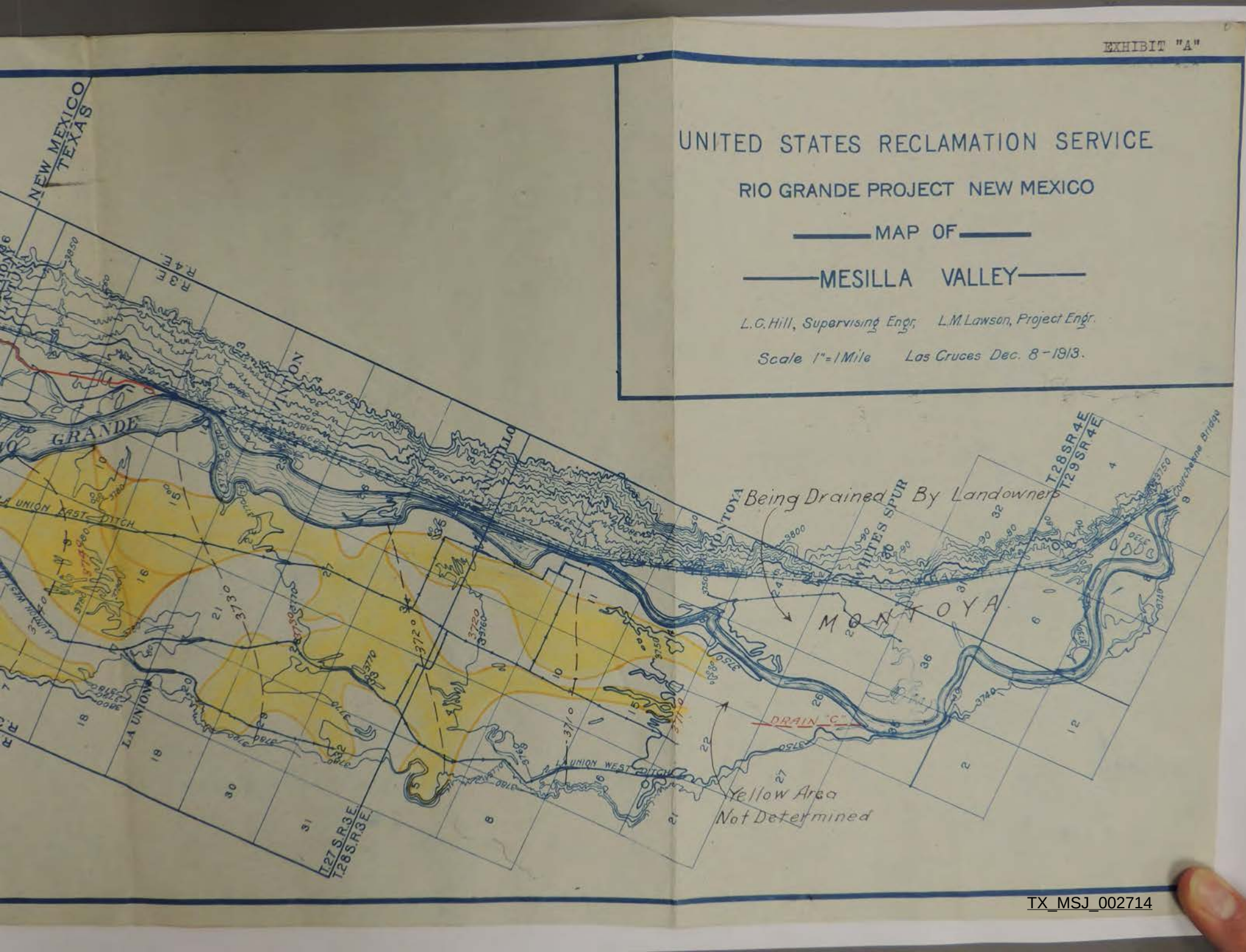
RIO GRANDE PROJECT NEW MEXICO

MAP OF

MESILLA VALLEY

L.C. Hill, Supervising Engr. L.M Lawson, Project Engr.

Scale 1"=1 Mile Las Cruces Dec. 8-1913.



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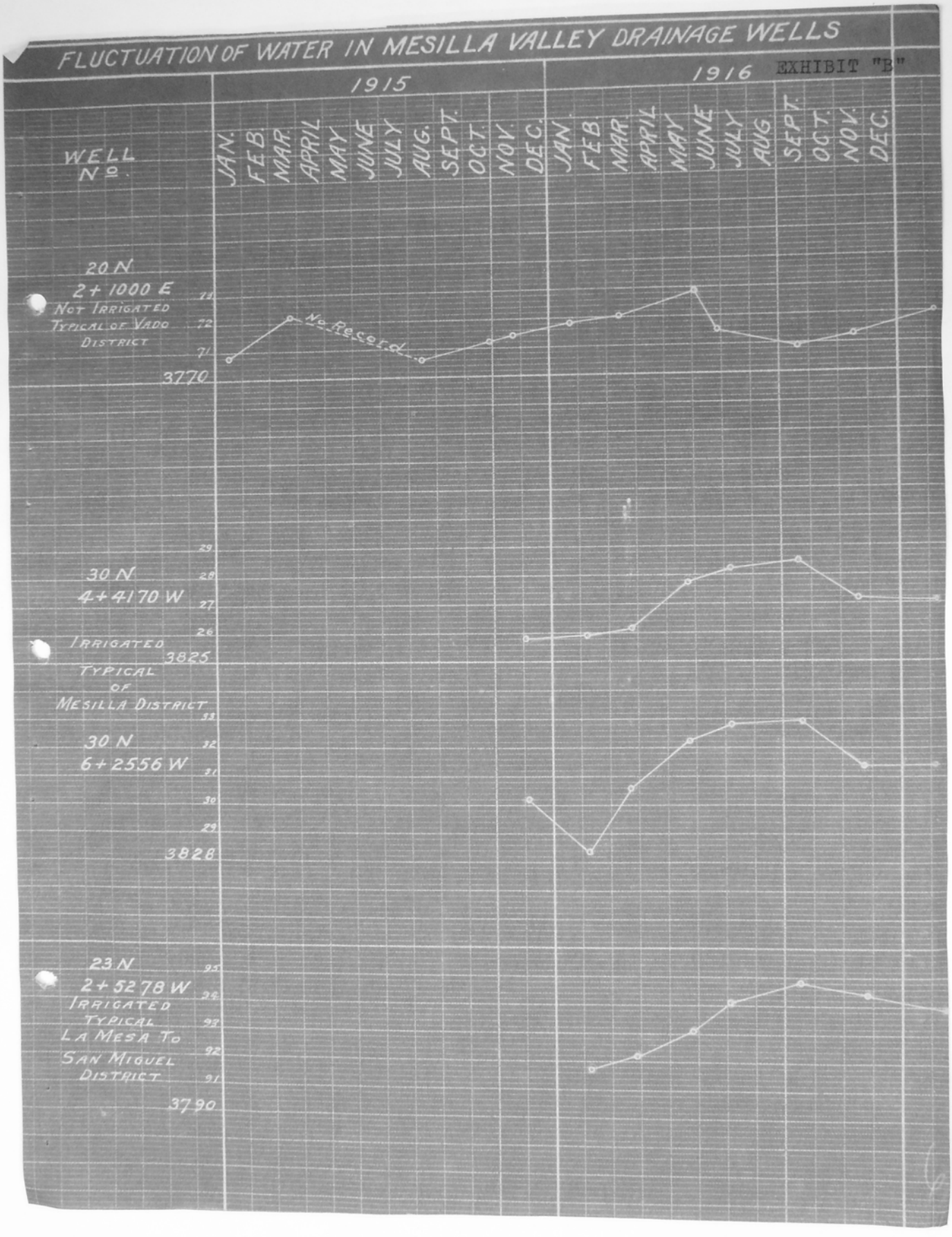
FLUCTUATION OF WATER IN MESILLA VALLEY DRAINAGE WELLS

EXHIBIT "B"



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FLUCTUATION OF WATER IN MESILLA VALLEY DRAINAGE TEST WELLS

EXHIBIT "B"

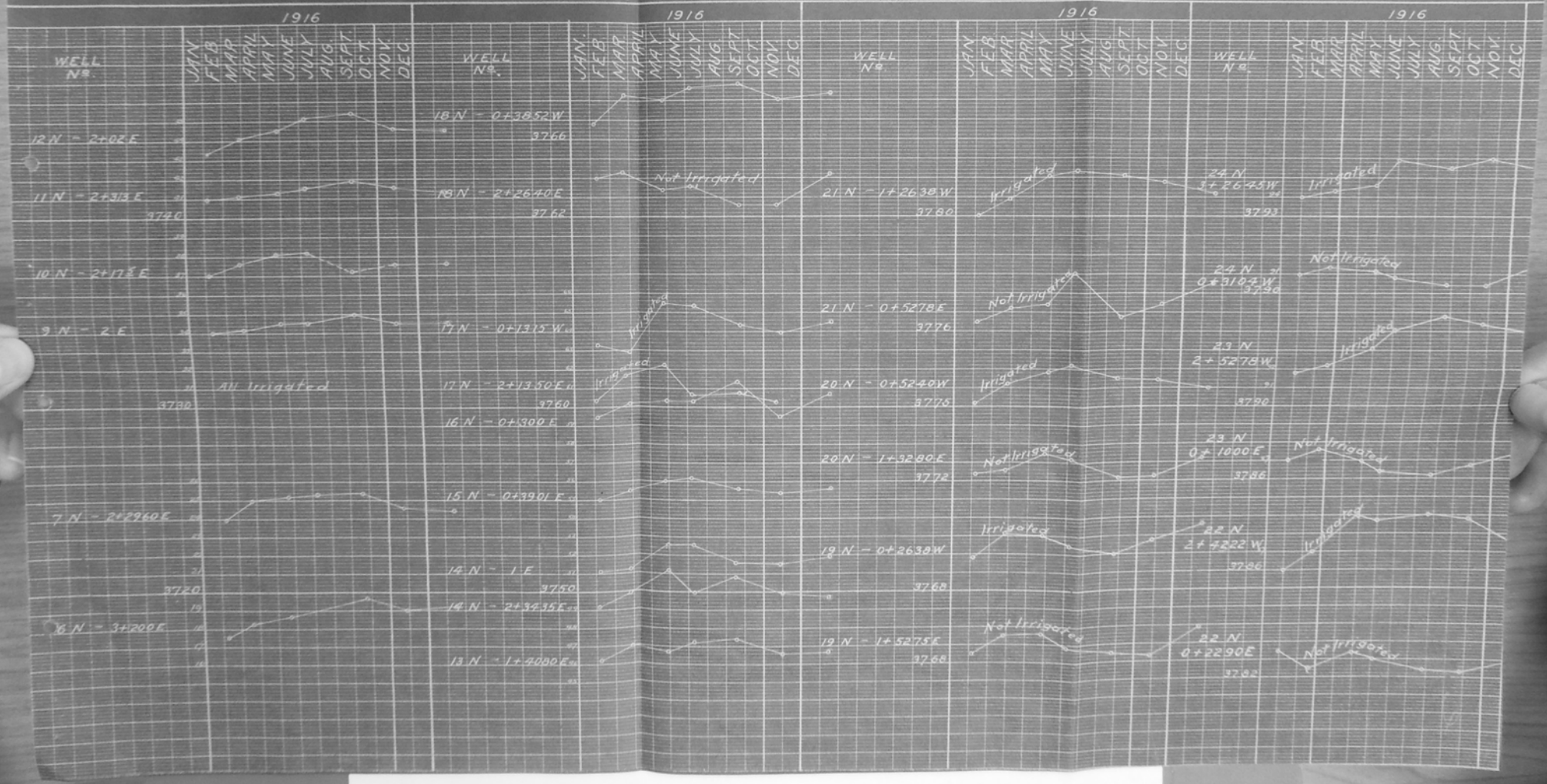

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EXHIBIT C
B'd Report Drainage
Rio Grande Project
Febr 1917

MONTHLY DELIVERIES
from
Government Canals Rio Grande Project
to
Community Ditches
in
1916

		Total
from Leasburg Canal		8.52 A.F.
" East & West Mesilla Valley Canals		7.03
" Franklin Canal		3.85

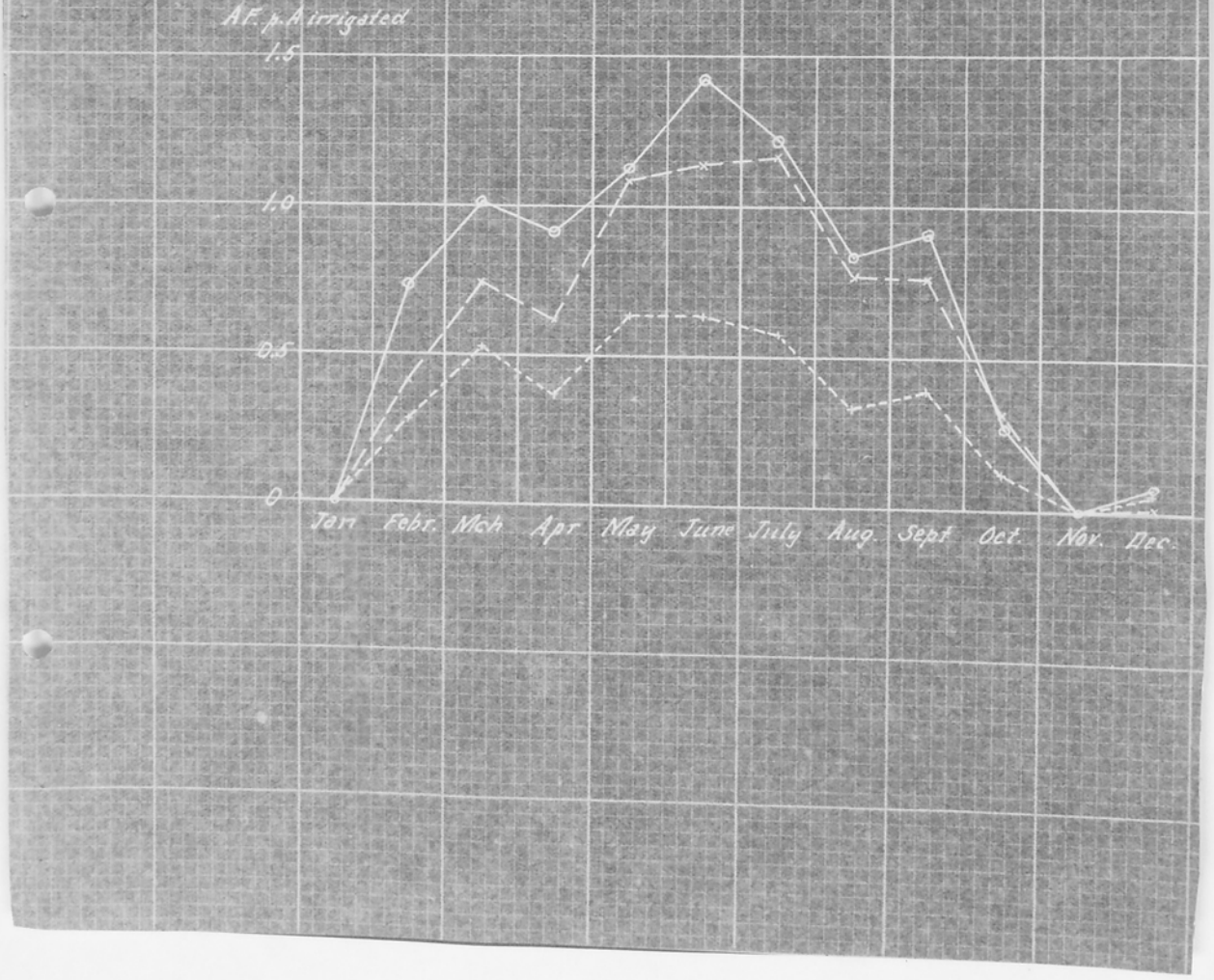

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EXHIBIT "D"

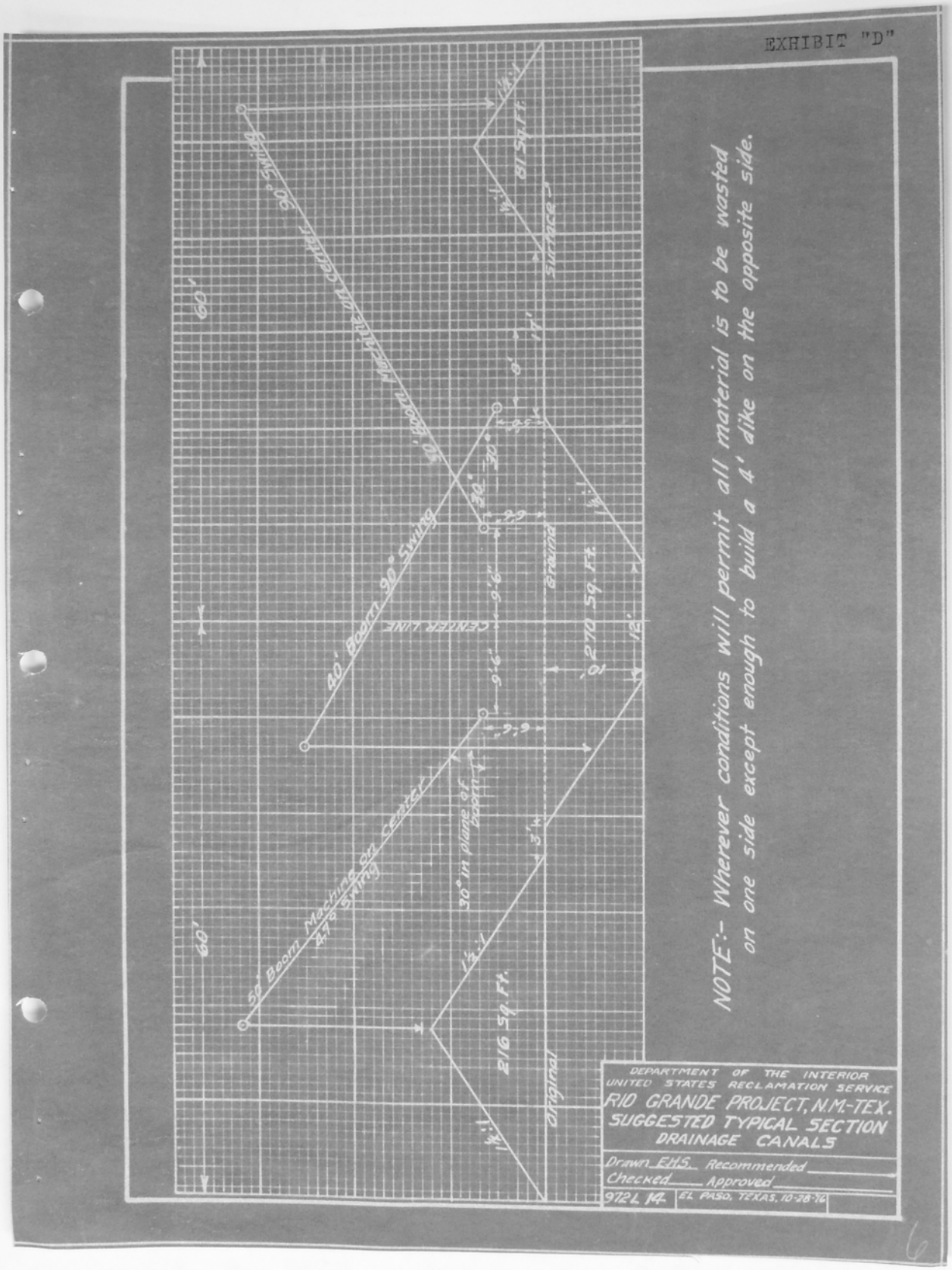

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EXHIBIT "E"

DETAIL SPECIFICATIONS

Special Conditions.

41. The Requirement: It is required that there be constructed and completed in accordance with these specifications and drawings herein below listed, _____ miles of drain involving the excavation of about _____ cubic yards.

42. Drawings: _____

_____

45. Commencement, prosecution and completion of work: Work shall be commenced by the contractor within the number of days stated in the proposal, after the execution of the contract on behalf of the United States, and all work shall be completed within _____ months from the date of commencement of work stated in the proposal. If the United States occupies more than thirty days' time after the opening of the bids in awarding and executing contract, exclusive of the time occupied in transmitting contract and bond to and from the contractor and in the execution of such papers by him, the contractor will be entitled to an extension of time for a period equivalent to the excess time so used by the United States. The contractor shall at all times during the continuance of the contract prosecute the work with such force and equipment as, in the judgment of the engineer, are sufficient to complete it within the specified time.

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44. Failure to complete the work in the time agreed upon: Should the contractor fail to complete the work in the time agreed upon in the contract, or within such extra time as may have been allowed for delays by extensions granted as provided in the contract, a deduction of twenty dollars ($20) per day will be made for each schedule for each day, including Sundays and holidays, that such schedule remains uncompleted after the date required for the completion. The said amounts are hereby agreed upon as liquidated damages for the loss to the United States on account of all expenses due to the employment of engineers, inspectors and other employees after the expiration of the time for completion and on account of the value of the operation of the irrigation works dependent thereon, and will be deducted from any money due the contractor under this contract, and the contractor and his sureties shall be liable for any excess.

45. Progress estimates and payments: At the end of each calendar month the engineer will make an estimate of the amount earned to that date, under the terms of the contract, classified and computed on the basis of the items and unit prices named in the contract. To the estimate made as above set forth will be added the amounts earned for extra work to the date of the progress estimate. From the total thus computed a deduction of ten per cent will be made, and from the remainder, a further deduction will be made of all amounts due to the United States from the contractor for supplies or materials furnished or services rendered and any other amounts that may be due to the

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United States as damages for delays or otherwise under the terms of the contract. From the balance thus determined will be deducted the amount of all previous payments and the remainder will be paid to the contractor upon the approval of the accounts. One-half of the ten per cent deducted as above set forth will become due and payable upon the completion of the work to the satisfaction of the engineer and its acceptance by the United States. The remaining one-half of said ten per cent shall not be paid until release shall have been executed and filed as hereinafter provided. In case of suspension of the contract, the said ten per cent shall be and become the sole and absolute property of the United States to the extent necessary to repay to the United States any excess in the cost of the work above the contract price. When the terms of the contract shall have been fully complied with to the satisfaction of the engineer and a release of all claims against the United States under or by virtue of the contract shall have been executed by the contractor and filed with the engineer, final payment will be made of any balance due, including the percentage withheld as above stated or such portion thereof as may be due to the contractor.

Earthwork

46. Classifications: All materials moved in the excavation of drains will be measured in excavation only, to the neat lines as shown on the drawings or prescribed by the engineer. No classification will be made and all material required to be excavated will be paid for at the unit price bid for excavation.

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47. Section of drains: The sections of drains are shown on the drawings, but the undetermined stability of the material forming the slopes of drains may make it necessary to vary the slopes and dimensions dependent thereon. Increase or decrease of quantities excavated as a result of such changes shall be covered in the estimate and shall not otherwise affect the payments due to the contractor, unless it is found by the engineer that the unit cost is thereby increased, in which case the engineer will estimate and include in the amount due the contractor the amount of such increase. The work is intended to be done by machinery and the excavation shall be as close to the neat lines as is practicable. In general the neat lines indicate the minimum of excavation. Excavation beyond the neat lines shall not exceed one foot. Projections beyond the neat lines of 6 inches will be permitted provided they occur only above the line marked on the sections as water line and provided they do not in the aggregate exceed the over excavation. Payment for excavation will be made to the neat lines only as shown on the drawings or as established by the engineer.

48. Machinery to be used in construction of drains: The construction of drains requires the use of machinery. The contractor shall submit with his proposal a statement of the kind and the amount of machinery and equipment he proposes to use on the work, and of the number of shifts he intends to work with each machine.

49. Disposal of material: Material excavated from the drains shall be disposed of in accordance with plans shown on drawing or as directed by the engineer. The remainder will be placed on the other

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side. The contractor shall use due diligence in dumping excavation in the upper portion of the spoil banks to keep the top as level as possible.

50. Structures: All structures will be built by the United States. It is the intention that where underground crossings are employed, to have them built in advance of excavation, in order to avoid delays to the contractor. In the event of delay caused by the United States, reasonable compensation, to be determined by the engineer, will be allowed to the contractor. At road crossings, excavated material shall be deposited so as to leave an open roadway as directed by the engineer.

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Administration, Rocky Mountain Region
Archival Operations
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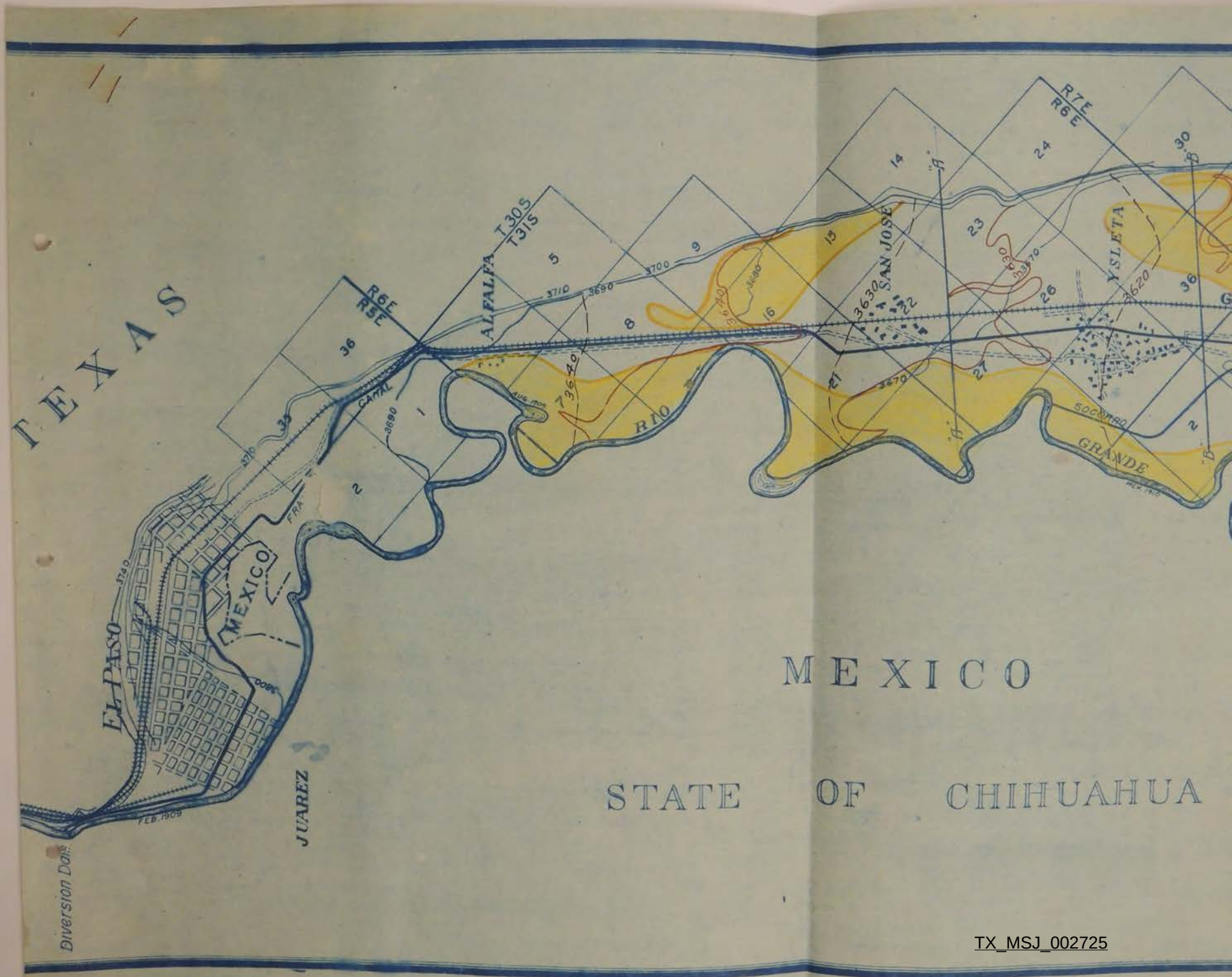

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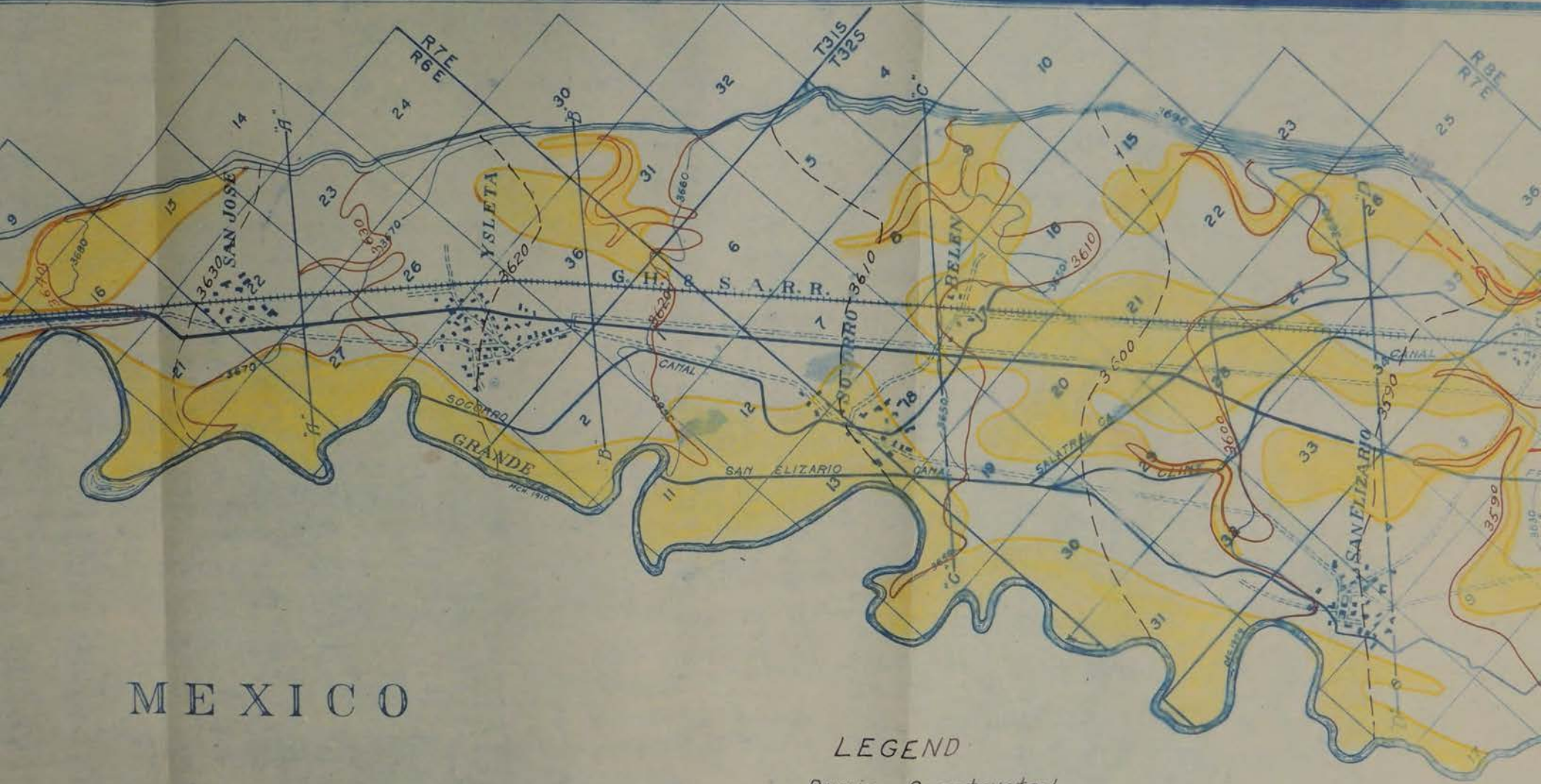

MEXICO

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LEGEND

- Drains Constructed
- Preliminary Location New Drains
- Ground Water Elevation Nov. 1916
- Ground Water within 4 ft. of Surface Nov. 1916
- Surface Contours

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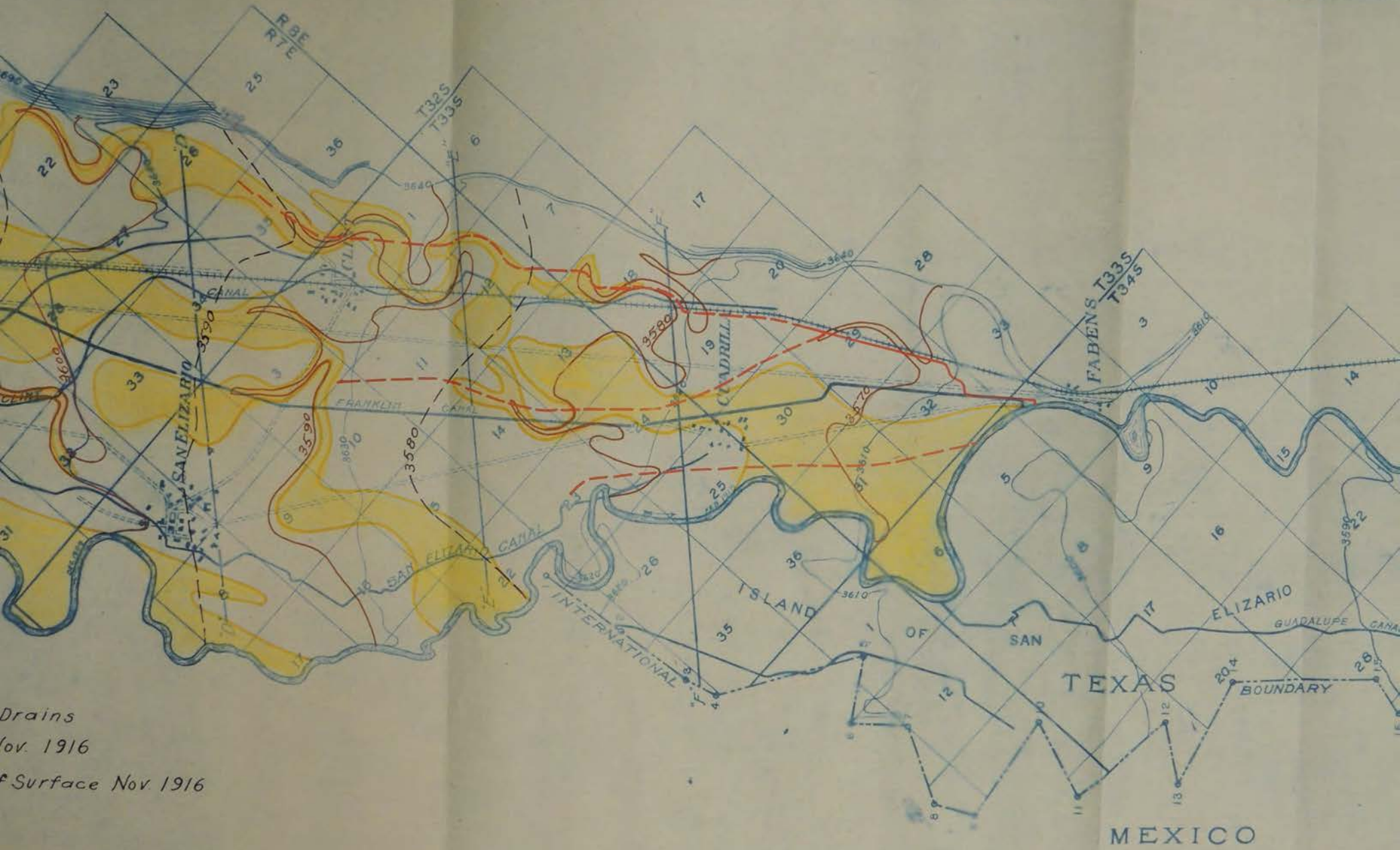

Drains
Nov. 1916
f Surface Nov. 1916

Contour interval 10 Feet
Datum of Elevations is Sea Level

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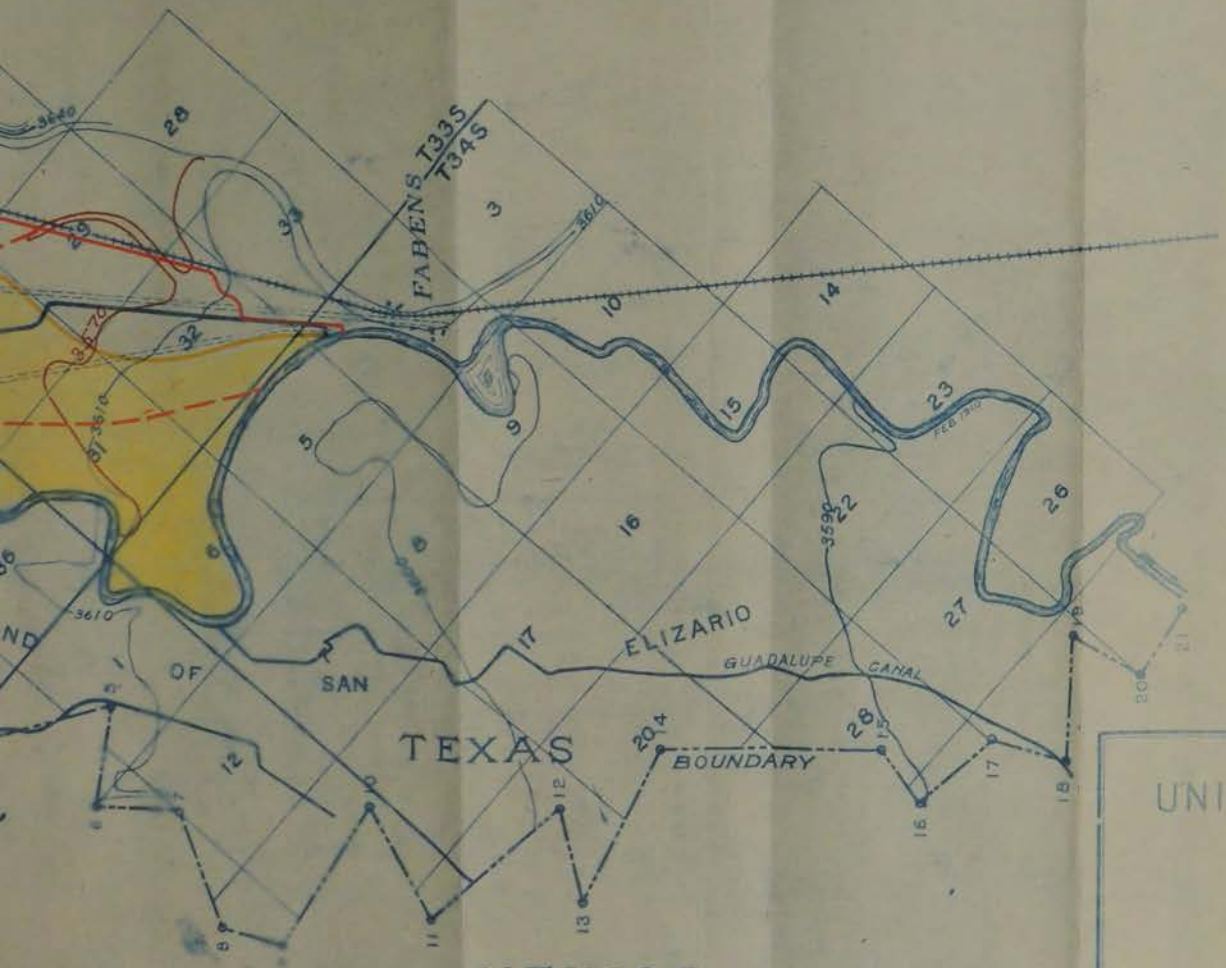
EXHIBIT "F"



Contour interval 10 Feet
Datum of Elevations is Sea Level

UNITED STATES RECLAMATION SERVICE

RIO GRANDE PROJECT

—MAP OF—

EL PASO VALLEY TEXAS

SCALE 1 INCH = 1 MILE

APRIL 21 1913

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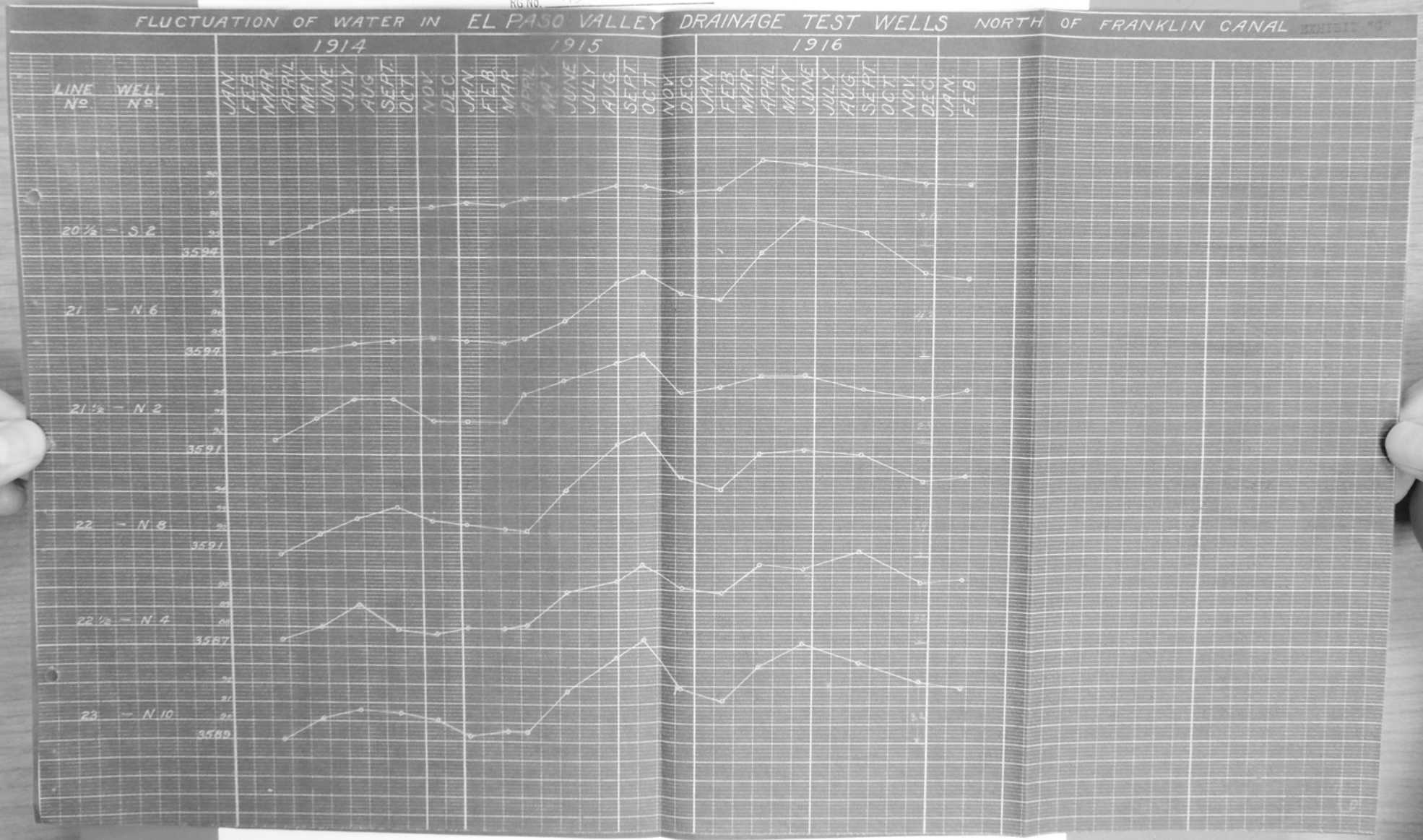

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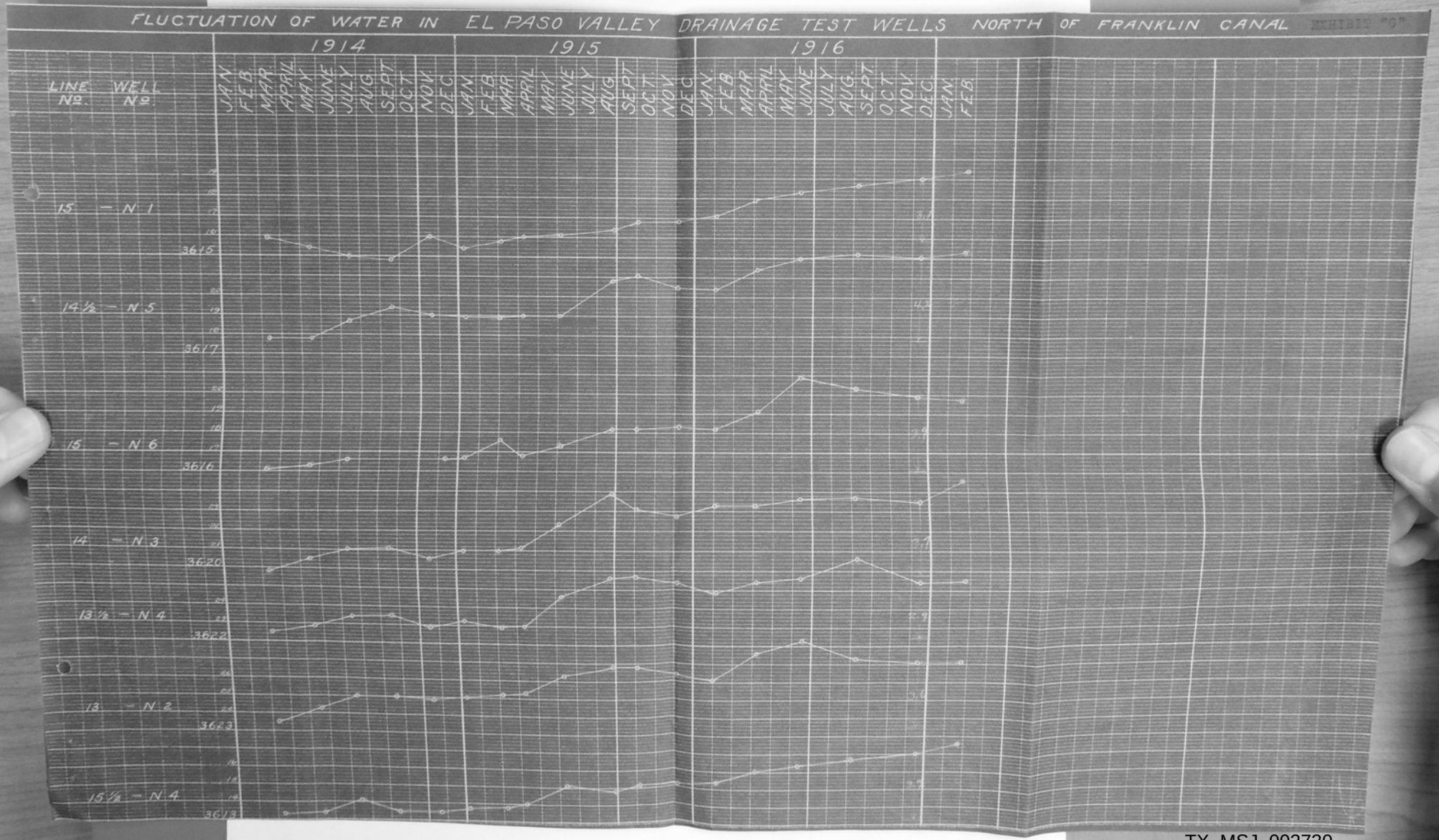

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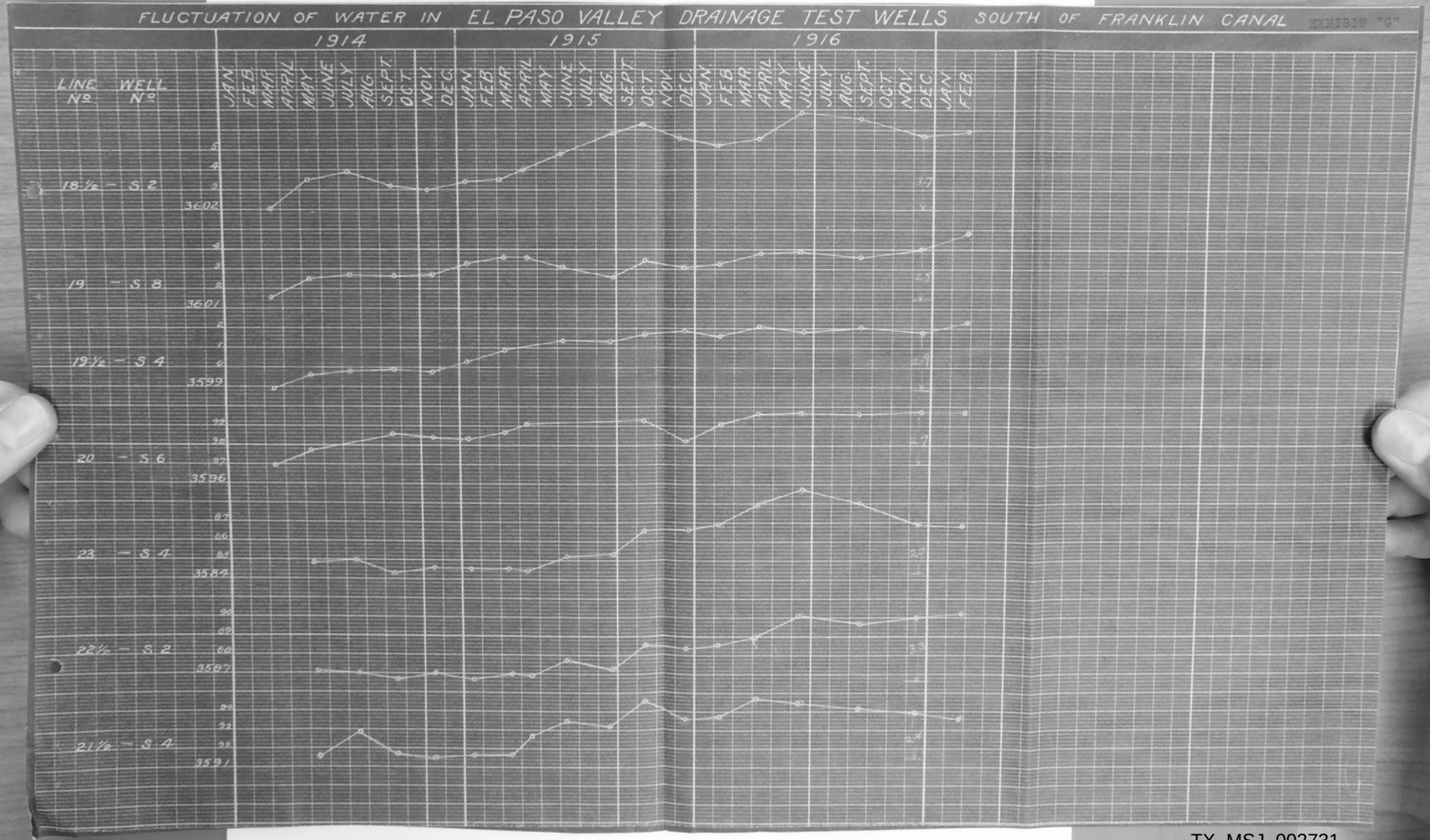

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U. S. Bureau of Reclamation

DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, SECRETARY

SEVENTEENTH ANNUAL REPORT

OF THE

RECLAMATION SERVICE

1917–1918

ARTHUR P. DAVIS
Director and Chief Engineer

WILL R. KING
Chief Counsel

WASHINGTON
GOVERNMENT PRINTING OFFICE
1918

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Reclamation ~~Service~~
Agricultural Settlement
Drainage

ANNUAL REPORTS OF THE RECLAMATION SERVICE.

[Reports may be purchased from Superintendent of Documents, Government Printing Office, at the prices given.]

I. June 17 to Dec. 1, 1902; 317 pages, 46 plates, 65 figures, case of drawings. Out of print.

II. Through the field season of 1903; 550 pages, 49 plates, 56 figures. Cloth, 85 cents.

III. Through the field season of 1904; 653 pages, 59 plates, case of drawings. Cloth, $1.25.

IV. Through the field season of 1905; 374 pages, 63 plates. Paper, 80 cents.

V. Fiscal year 1905–6; 312 pages, 101 plates, 2 figures. Cloth, $1.25.

VI. Fiscal year 1906–7; 287 pages. Paper, 25 cents.

VII. Fiscal year 1907–8; 219 pages. Paper, 25 cents.

VIII. Fiscal year 1908–9; 222 pages. Cloth, 40 cents; paper, 20 cents.

IX. Fiscal year 1909–10; 329 pages. (Includes history of construction to date.) Cloth, 40 cents; paper, 25 cents.

X. Fiscal year 1910–11; 290 pages. (Includes index Vols. I–X.) Cloth 40 cents; paper, 25 cents.

XI. Fiscal year 1911–12; 310 pages, map. Cloth, 40 cents; paper, 25 cents.

XII. Fiscal year 1912–13; 382 pages. Cloth, 40 cents; paper, 25 cents.

XIII. Fiscal year 1913–14; 514 pages. Cloth, 45 cents; paper, 30 cents.

XIV. Fiscal year 1914–15; 521 pages. Cloth, 45 cents; paper, 30 cents.

XV. Fiscal year 1915–16; 808 pages. Cloth, 75 cents; paper, 60 cents.

XVI. Fiscal year 1916–17; 598 pages. Cloth, 65 cents; paper, 50 cents.

XVII. Fiscal year 1917–18; 552 pages. Cloth, 70 cents; paper, 50 cents.

A price list of publications issued by the Reclamation Service can be obtained by application to the Director and Chief Engineer, United States Reclamation Service, Washington, D. C.

The monthly bulletin of the service, the "Reclamation Record," is issued about the first of each month. It contains usually 48 pages of general news and notes of interest about the projects. The subscription price to others than water users is 50 cents per year, payable in advance. The publication is free to water users.

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Forestry

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Principal irrigation projects of the U. S. Reclamation Service.

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LETTERS OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
Washington, December 5, 1918.

SIR: In compliance with the provisions of section 2 of the act approved June 17, 1902, 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," I have the honor to transmit the Seventeenth Annual Report of the Reclamation Service.

Respectfully,

FRANKLIN K. LANE, *Secretary.*

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

DEPARTMENT OF THE INTERIOR,
UNITED STATES RECLAMATION SERVICE,
Washington, D. C., September 19, 1918.

SIR: Transmitted herewith is the Seventeenth Annual Report of the Reclamation Service, covering the work completed and in progress during the fiscal year ended June 30, 1918.

Very respectfully,

A. P. DAVIS,
Director and Chief Engineer.

The SECRETARY OF THE INTERIOR.

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NEW MEXICO-TEXAS, RIO GRANDE PROJECT.

L. M. LAWSON, project manager, El Paso, Tex.

LOCATION.

Counties: Socorro, Sierra, Dona Ana, N. Mex.; El Paso, Tex.
Townships: 8 to 29 S., Rs. 3 E. to 5 W., New Mexico meridian.
Railroads: Atchison, Topeka & Santa Fe, El Paso & Southwestern, Southern Pacific, and Texas & Pacific.
Railroad stations and estimated population, June 30, 1918: Texas—El Paso, 75,000; Ysleta, 500; La Tuna, 325; Fabens, 500; Canutillo, 275; Clint, 500; Vinton, 25; Belen, 20. New Mexico—Las Cruces, 4,500; Mesilla Park, 850; Rincon, 400; Dona Ana, 250; Engle, 120; Bernio, 50; Fort Selden, 25; Hatch, 200; Hill, 50; Leasburg, 25; Mesquite, 50; and Vado, 50.

WATER SUPPLY.

Source of water supply: Rio Grande.
Area of drainage basin: 37,000 square miles.
Annual run-off in acre-feet of Rio Grande: At San Marcial (30,000 square miles), 1895 to 1917, inclusive, maximum, 2,422,000; minimum, 200,700; mean, 1,158,329. At El Paso, Tex. (38,600 square miles), 1889 to 1914, inclusive, maximum, 2,010,000; minimum, 50,700; mean, 925,400. Data since 1914 at El Paso do not include run-off, as most of the surplus water is stored in Elephant Butte Reservoir.

AGRICULTURAL AND CLIMATIC CONDITIONS.

Area for which the service is prepared to supply water, season of 1918: 90,000 acres.
Area under rental contracts, season of 1918: 69,889 acres.
Length of irrigating season: From February 15 to November 15—274 days.
Average elevation of irrigable area: 3,700 feet above sea level.
Rainfall on irrigable area: 32-year average, 10.61 inches; 1917, 6.49 inches.
Range of temperature on irrigable area: −5° to 105° F.
Character of soil of irrigable area: Fertile alluvium and sandy loam.
Principal products: Alfalfa, corn, wheat, melons, fruit, and vegetables.
Principal markets: Towns in Texas, New Mexico, and Louisiana, and eastern cities.

LANDS OPENED FOR IRRIGATION.

No lands have been opened for irrigation by public notice.
All lands in the Mesilla and El Paso Valleys are being irrigated under rental contracts.

CHRONOLOGICAL SUMMARY.

Reconnoissance and preliminary surveys begun in March, 1903.
Construction of Leasburg unit authorized December 2, 1905.
Reclamation act extended to Texas June 12, 1906 (34 Stat., 259).
Treaty with Mexico providing for distribution of waters of the Rio Grande proclaimed January 16, 1907.
Construction of Elephant Butte Dam authorized by Congress and $1,000,000 appropriated March 4, 1907 (34 Stat., 1357).
Leasburg unit completed July, 1908.
First irrigation by Reclamation Service (Leasburg unit), season of 1908.
Construction of Elephant Butte Dam authorized by Secretary May 23, 1910.
Construction plans of Elephant Butte Dam approved by board of engineers June 6, 1910, January 22, 1911, August 12, 1912, January 30, 1913.
Construction plans approved by Secretary October 26, 1910.
Franklin Canal purchased October, 1912.
First 11 miles of Franklin Canal reconstructed March, 1914; second section (8 miles) reconstructed 1915.

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East Side Canal completed September, 1915.
West Side Canal completed November, 1915.
San Elizario feed canal completed April, 1916.
Elephant Butte Dam completed May 13, 1916.
Mesilla diversion dam completed May 31, 1916.
Leasburg extension canal and Picacho branch canal to station 121 completed May 31, 1916.
Percha Dam completed January, 1918.
Arrey Canal completed January, 1918.
Garfield flume completed February, 1918.
Garfield Canal construction begun June, 1917.
Hatch siphon construction begun January, 1918.
Hatch Canal construction begun February, 1918.
San Miguel Canal construction begun October, 1917.
Mesilla Valley, Nemexas drain begun August, 1917.
Mesilla Valley, west drain begun August, 1917.
Montoya headgate completed June, 1918.
Montoya Canal construction begun March, 1918.
Juan d'Herrera lateral district completed May, 1918.
San Elizario headgate completed May, 1918.
San Elizario main canal construction begun January, 1918.
El Paso Valley River and middle drains construction begun July, 1917.
Project, exclusive of Elephant Butte Dam, 40 per cent completed June 30, 1918.
Project, including Elephant Butte Dam, 66.4 per cent completed June 30, 1918.

IRRIGATION PLAN.

The irrigation plan of the Rio Grande project provides for the storage of flood waters of the Rio Grande in a reservoir controlled by Elephant Butte Dam, about 12 miles west of Engle, N. Mex., and the diversion of water from the Rio Grande, about 24 miles below for watering lands in Rincon Valley; about 60 miles below for the irrigation of 28,000 acres in the upper Mesilla Valley under the Leasburg diversion dam; about 80 miles below for the irrigation of 57,000 acres in the lower Mesilla Valley under the Mesilla Dam; and about 120 miles below for supplying water to lands in El Paso Valley and furnishing 60,000 acre-feet per annum for use on land in El Paso Valley on the Mexican side of the Rio Grande. The United States claims all waste, seepage, spring, and percolating water arising within the project and proposes to use such water in connection therewith. All irrigation works required for Las Palomas and Rincon Valleys will be new; those for the Mesilla Valley include a diversion and 10.8 miles of canal now constructed, as well as a diversion dam 5½ miles southwest of Las Cruces and 27 miles of canal leading therefrom which have also been constructed; and those required for El Paso Valley will supplement and improve present canal systems.

The features of the above irrigation plan that have been completed are the Elephant Butte Dam, the Percha diversion dam, the Arrey Canal, the Garfield flume, the main portion of the Hatch main canal, the Leasburg diversion dam and Leasburg main canal, the Mesilla diversion dam and East and West Side Canals in the lower Mesilla Valley, the reconstruction of the major portion of the Franklin Canal and the construction of the San Elizario main canal headworks in the El Paso Valley. In addition, for the Montoya district in the lower east side of the Mesilla Valley, but in the Texas irrigation district, the intake works and main canal were begun and completed in the spring of 1918. The Hatch siphon and Garfield Canal connecting this structure with the Garfield flume were begun in 1918, and on June 30, were over 90 per cent completed. The construction of five main drains is also under way.

SUMMARY OF GENERAL DATA FOR RIO GRANDE PROJECT, TO END OF FISCAL YEAR, 1918.

Areas:		
Irrigable acreage when project is complete		155,000
Public land entered to end of fiscal year	553	
Public land withdrawn at end of fiscal year	4,890	
State land	2,602	
Private land	146,955	
Acreage service could have supplied season of 1917		88,000
Addition in fiscal year 1918		2,000
Estimated addition in fiscal year 1919		8,000
Estimated acreage service can supply July 1, 1919		98,000
Acreage actually irrigated, season of 1917		64,308
Acreage cropped under irrigation, season of 1917		63,626

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Crops:		
Value of irrigated crops, season of 1917		$3,598,424.00
Value of irrigated crops, per acre cropped		56.50
Finances:		
Net construction cost to end of fiscal year		$7,699,391.07
Per cent complete at end of fiscal year		66.4
Appropriated for fiscal year 1919, total		$1,296,000.00
Allotment for construction, fiscal year 1919		$1,346,000.00
Estimated per cent complete, June 30, 1919		77.3
Proposed appropriation, fiscal year, 1920, for construction		$1,161,900.00
Estimated gross construction expenditures to June 30, 1920		$10,658,700.00
Estimated per cent complete, June 30, 1920		90
Total appropriation fiscal year 1918		[1] $1,387,600.00
Expenditures during fiscal year, chargeable to 1918 appropriation:		
Disbursements	$984,534.68	
Transfers	46,675.20	
	$1,031,209.88	
Registered liabilities chargeable to 1918 appropriation	90,668.34	
Contract obligations wholly covered by 1918 appropriation	135,736.16	
Estimated engineering expenses on contract work wholly covered by 1918 appropriation		1,257,614.38
Unencumbered balance, July 1, 1918		129,985.62
Repayments:		
Water-rental charges—		
Accrued to end of fiscal year		420,703.63
Collected to end of fiscal year		375,612.07
Uncollected at end of fiscal year		45,091.56
Power earnings—		
Accrued to end of fiscal year		2,243.33
Collected to end of fiscal year		2,243.33
Drainage:		
Estimated acreage damaged by seepage to end of fiscal year		118,000
Miles of drains built to end of fiscal year: Open		44.8
Estimated acreage protected by drains built to end of fiscal year		20,500
Estimated acreage to be protected by authorized system		145,000
Cost of drainage works to end of fiscal year		$386,119.43

CONSTRUCTION DURING FISCAL YEAR.

The Percha diversion dam, described in the sixteenth annual report, and upon which construction work was begun in July, 1916, was completed for the beginning of the irrigation season in 1918. Early in the fall, the concrete work on this structure was completed, but the earth embankment across the river channel portion was left until the winter months, when water was not required for irrigation. This structure, which is located 27 miles from the nearest railroad point, contains about 4,500 yards of concrete and was built within the estimated cost.

Arrey Canal.—The construction of structures on the Arrey Canal by Government forces, which was begun in July, 1917, was completed in January, 1918, and the Percha Dam and Arrey Canal utilized for the diversion and carriage of water to certain lands in Rincon Valley.

[1] Includes unexpended balance of 1917 appropriation and refunds authorized to be added to 1918 appropriation by sundry civil act of June 12, 1917.

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Garfield Canal.—Contract was awarded for the construction of the Garfield Canal, and actual construction began in June, 1917. In September, the contractors, after performing a small portion of the construction work, relinquished the contract, and readvertisement and award were made. At the end of the fiscal year some work still remained to be performed on this delayed construction, and water deliveries through this canal, which had been expected during the fiscal year, were postponed until the season of 1919.

Garfield flume.—This structure, upon which construction work had begun during the fiscal year 1917, was completed by Government forces in February, 1918. It forms the connecting link between the Garfield Canal and the Hatch Canal. Although completed for the irrigation season of 1918, the contractor's delay on the Garfield Canal work prevented its use.

Hatch siphon.—Construction was begun on the Hatch siphon in January, 1918. This structure is a single barrel concrete siphon, 6 feet inside diameter, which will connect under the Rio Grande the lower end of the Garfield Canal and the Hatch Canal, and form an important connecting link in the main canal system for the Rincon Valley. On June 30, 1918, this structure was 90 per cent completed.

Hatch Canal.—The Hatch Community Canal, a small ditch located through the Hatch Valley, was deeded to the Government in December, 1917, to be utilized as part of the main canal system for the Rincon Valley, and reconstruction work was begun by contract when the irrigation season closed, the contracts being of such size as to enable the local water users to obtain the work. A large portion of this canal was completed before the 1918 irrigation season, and only a small part of the earthwork and structure work remained to be completed at the next opportunity for this work, when irrigation is closed for the winter months.

San Miguel Canal.—In carrying out the policy during the years 1914 and 1915 of constructing main canals in the Mesilla Valley to deliver water to communities, arrangements could not be concluded at that time to afford the La Mesa community a direct connection with the Government main canal. It received its water at this time through the San Miguel Community Ditch, operated by that community, and water deliveries were irregular and limited. Negotiations with the San Miguel community, carried on during the fall of 1917, resulted in this community ditch being turned over to the Reclamation Service to form part of the main canal system for the west side of the Mesilla Valley, and its reconstruction was begun and completed during the winter months without interference with the irrigation of lands.

Montoya headgate.—Water for this district of 3,000 or 4,000 acres, located in the lower portion of the Mesilla Valley, was supplied about June 1, 1918, by the construction of the Montoya headgate and main canal, begun in March, 1918.

San Elizario headworks.—The irrigation water supply for the lower portion of the El Paso Valley and the San Elizario Island tract is diverted from the Rio Grande at an intake structure located approximately 2 miles southeast of the town of Ysleta. This structure was completed in May, 1918, and pending the construction of the main canal, which utilizes a portion of the system already built, it diverted water for irrigation in the lower valley.

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Lateral system.—No lateral construction work was performed in the Mesilla Valley portion of the New Mexico irrigation district during the fiscal year. The water users' association and irrigation district, together with the farm bureau, all adopted resolutions recommending the deeding of community canals to the Government for their reconstruction and operation. In the El Paso Valley, the Juan d'Herrera lateral district was completed in May, 1918, and during the winter season a large amount of reconstruction was performed on the community ditches taken over for rebuilding and operation by the Government. Practically all large community ditches have now been deeded to the Government, and such canals as remain in community ownership are of small size and length. During the latter part of the fiscal year, the Ysla lateral, the distributary for the Ysla community district, was advertised for construction by contract.

Drainage construction.—At the end of the fiscal year, 44.8 miles of open drain had been constructed in the project by Government forces, involving the excavation by machine of 1,830,000 cubic yards. Four new Bucyrus caterpillar drag-line machines were received at the beginning of the fiscal year and operated practically continuously during the period. In addition, one small steam drag line was utilized on this work. On June 30, 1918, drainage construction was 12 per cent completed.

Surveys.—Surveys during the fiscal year included the location of the Rincon siphon and the main canal, those required for the Montoya main canal and laterals, extensions of lateral systems in the El Paso Valley, and investigations accompanied by surveys for the Tornilla and Fort Hancock districts in the lower end of the project. Extensive drainage surveys have been made covering the Rincon Valley, in addition to those required for the Mesilla and El Paso Valleys. The San Elizario Island drain was located during this year and profile of the river from Elephant Butte to Fabens, Tex., including traverse of the river in the El Paso Valley, was completed.

SEEPAGE AND DRAINAGE.

Investigations of ground-water conditions in the Rincon, Mesilla, and El Paso Valleys were continued and extended during the year. Well readings, which are taken at regular intervals, are utilized for location of the large mileage of contemplated drainage canals. The record from these wells, which show a seasonal rise each year and a constant rise from year to year, exhibited a serious seepage condition at the beginning of the fiscal year. At that time approximately 66 per cent of the area in the Mesilla Valley was affected, the underground water elevation being within less than 4 feet of the surface. The same condition in the El Paso Valley covered an area of 69 per cent of the total acreage. Approximately 4½ per cent of the acreage in both valleys had free water on the surface. Since this serious condition could not be quickly relieved by the construction of drains, efforts were made through the associations of the farmers and water users to reduce the amount of water used for irrigating purposes as far as possible. The engineering board, held in January, considered the additional data collected and the plans presented for drainage work on the project.

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Construction.—Early in the fiscal year four Bucyrus drag lines were received on the project, and together with the steam machine previously operating, excavated approximately 33 miles of open drains. Mechanical difficulties in the new machines prevented obtaining the expected output. These features were being corrected during the year and individual machines made record runs of cost and output. Contracts were awarded to the Bucyrus Co. for four additional machines, which are expected for delivery during the summer of 1918. With these machines and others that may be available for transfer, together with the award for the construction of portions of the system by contract, considerable relief from the seepage conditions can be expected in certain areas and the construction of the drainage system pushed with all possible expedition.

Irrigation districts.—The formation of the two irrigation districts necessary in the New Mexico and Texas portions of the project was completed during the year. In the El Paso portion a contract for drainage and lateral work was executed between the Secretary and the district during the winter, and the funds previously advanced by the directors of this district to finance temporary drainage operations pending the approval of the contract were later returned. In the New Mexico portion of the project some delay was experienced in the formation of the district and the execution of the contract between the Secretary and the district for drainage and lateral work. The passage of a congressional relief measure permitting the expenditure of $15,000 on the drainage system, pending the execution of the contract, relieved the district from financing the drainage operations to that extent. Before the end of the year a contract was approved, and the small amount of funds advanced by the association were returned. The contract with both irrigation districts contemplated lateral as well as drainage construction and it is expected also that in both districts the irrigation district formation will succeed the water-users' association.

BOARD MEETINGS.

Date.	Subject.	Personnel.
1918.		
Jan. —	Drainage	D. C. Henny, L. M. Lawson, J. L. Burkholder.
Jan. 29	Water distribution, El Paso Valley	D. C. Henny, L. M. Lawson.
June 12	Inspection of Elephant Butte outlet works	O. H. Ensign, R. F. Walter, James M. Gaylord, L. M. Lawson.

OPERATION AND MAINTENANCE.

The Reclamation Service delivered water in 1917 on a rental basis for the irrigation of 64,308 acres of land. The larger acreage of this amount was in New Mexico, and water was supplied under contract with the Elephant Butte Water Users' Association at the rate of actual cost of operation and maintenance plus 10 per cent. In addition, a charge of 50 cents per acre was made for reservoir service. In the El Paso Valley in Texas water was supplied under contracts with various community ditches and individuals during the latter part of the calendar year 1917. During the winter season practically all the large community ditches were taken over by the Reclamation

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Service for reconstruction and operation. Beginning with the first irrigation in 1918 an individual water-rental contract was inaugurated with charges for water at the rate of 75 cents per acre-foot for the first 3 acre-feet and $1 per acre-foot for any water used in excess of 3 acre-feet per acre. In addition, a charge of 50 cents per acre was made for reservoir service.

The total amount of water diverted throughout the project amounted to 646,075 acre-feet, giving a duty of approximately 7.9 acre-feet per acre. The taking over of community ditches in the El Paso Valley is expected to reduce the water use and eliminate much waste in irrigation. Individual measurements were carried on as far as possible in order that bills rendered would represent the actual amount of water used and to be paid for. In the New Mexico portion of the project the contract provides for billing the association for the total cost plus 10 per cent, and individual measurement is not possible nor attempted on account of the lack of jurisdiction or authority over communities.

On June 30, 1918, the service was prepared to supply water to 90,000 acres.

Historical review, Rio Grande project.

Item.	1912	1913	1914	1915	1916	1917	1918[1]
Acreage for which Service was prepared to supply water	25,000	35,000	40,000	45,000	85,000	88,000	90,000
Acreage irrigated	23,115	27,723	28,442	33,876	62,513	64,308	68,334
Miles canal operated	6	37	37	37	754	86	172
Water diverted (acre-feet)[2]	125,000	149,610	179,964	199,952	420,646	646,075	400,000
Water delivered to land per acre irrigated (acre-feet)[2]	5.40	4.34	5.68	5.90	6.73	7.9	5.5

[1] Estimated. [2] Measured at point of delivery from canals.

SETTLEMENT.

As in previous years, the project lands were seriously affected by the rise of ground water, due to the overirrigation of cultivated lands and the lack of proper drainage works. Although a large number of land sales and transfers were effected on the project, little attempt was made to interest outside settlers because of the condition of the lands.

The construction results are more in the nature of perfecting the water system for the present area than the addition of new tracts. In the Tornilla district, below Fabens, which area is below the limits of the present project, there is considerable activity in clearing lands and cultivating crops. During the latter portion of the fiscal year 1918 results were apparent from the drains as constructed, and this demonstration of the possibilities to relieve the seepage situation gave some impetus to settlement, which will increase as the drainage and lateral work progresses.

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Settlement data, Rio Grande project.

Item.	1913	1914	1915	1916	1917	1918
Total number of farms	1,784	1,536	1,700	1,638	1,700	1,740
Population	6,947	6,642	10,000	10,431	10,500	10,600
Number of irrigated farms	1,784	1,536	1,700	1,638	1,700	1,740
Operated by owners	1,089	932	1,000	1,145	1,170	1,200
Operated by tenants	695	604	700	493	530	540
Number of towns	25	25	25	25	25	25
Population	74,918	78,135	80,000	86,331	86,600	86,950
Total population in towns and on farms	81,865	84,777	90,000	96,762	97,100	97,550
Number of public schools	47	47	52	52	52	52
Number of churches	76	81	85	87	90	99
Number of banks	14	14	19	19	19	27
Total amount of capital stock	$2,580,000	$2,645,000	$3,251,000	$3,251,000	$3,251,000	$4,000,000
Amount of deposits	$10,398,000	$11,653,000	$19,916,380	$29,282,455	$31,000,000	$35,000,000
Number of depositors	40,000	45,784	48,000	50,000	55,000	60,000

PRINCIPAL CROPS.

Alfalfa was still the principal crop on the project, but the acreage was reduced materially in 1917 over the previous year on account of the effect of the high underground water table. The average yield was also less than the previous year, but the increased price per ton resulted in a total value for the yield in excess of the previous year. To meet the demands for war crops the wheat acreage was doubled during the year, and the returns from this crop were considerably in excess of the previous year. Garden truck, potatoes, and vegetables did well during the season, and a particularly abundant and well-paying crop is expected in 1918.

Crop report, Rio Grande project, New Mexico-Texas, year of 1917.

Crop.	Area (acres).	Unit of yield.	Yields.		Values.		
			Total.	Average per acre.	Per unit of yield.	Total.	Per acre.
Alfalfa hay	26,112	Ton	64,569	2.47	$27.00	$1,743,363	$66.75
Alfalfa seed	33	Bushel	139	4.2	12.00	1,668	50.50
Apples	378	Pound	262,960	695	.04	10,518	27.75
Barley	3,610	Bushel	91,679	25.3	1.40	128,350	35.50
Beans	4,011	do	46,058	8.9	4.80	173,078	43.15
Beets, sugar	1,078	Ton	8,420	7.7	5.00	42,100	39.00
Corn, Indian	10,566	Bushel	265,836	25	1.40	372,170	35.20
Corn, sorghum	1,894	do	38,566	20	1.20	46,267	24.40
Corn fodder	2,113	Ton	6,188	2.9	16.00	99,008	46.85
Corn, broom	5	Pound	2,000	400	.07½	150	30.00
Cantaloupes	548	Crate	103,220	188	1.20	123,864	226.00
Fruits, small	115	Pound	193,528	1,681	.03	5,806	50.50
Garden	2,160					162,000	75.00
Hay, except above	440	Ton	677	1.5	20.00	13,540	30.75
Oats	1,145	Bushel	40,294	35	.80	32,235	28.15
Onions	11	do	43	3.9	1.42	61	5.50
Pasture	2,158					64,740	30.00
Peaches	228	Pound	400	1.7	.04	16	.07
Pears	814	do	837,612	1,029	.03	25,128	30.85
Peas	114	Bushel	1,240	10.8	4.20	5,208	45.70
Potatoes, white	7	do	630	90	1.20	787	112.50
Potatoes, sweet	338	do	21,290	63	.60	12,774	37.80
Rye	65	do	1,216	18.6	1.96	2,372	36.50
Tomatoes	148	Pound	638,620	4,315	.01	6,386	43.15
Watermelons	84	Ton	193	2.3	15.00	2,895	34.45
Wheat	11,714	Bushel	261,970	22.3	2.00	523,940	44.70
	69,889						
Less duplicated areas	6,263						
Total cropped	63,626	Total and average				3,598,424	56.50
Irrigated, no crop:							
Nonbearing orchard	1,188						
Crops grown in nonbearing orchard	545						
Young alfalfa	39						
Less duplicated area	1,090						
Total irrigated	64,308						

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FINANCIAL STATEMENT.

Project balance sheet, Rio Grande project, June 30, 1918.

Cash		$292.75
Inventory of stock on hand		195,215.89
Accounts receivable		45,657.36
Construction work contracted		221,691.16
Construction cost	$8,110,942.01	
Less construction revenue earnings	441,576.39	
Add cost adjustments	[1] 30,025.45	
	411,550.94	7,699,391.07
Total		8,162,248.23
Accounts payable		130,242.62
Contingent obligations		275.00
		221,691.16
Capital investment:		
Disbursement, transfer, and joint construction vouchers received	$8,704,469.97	
Collection, transfer, refund, and joint construction vouchers issued	894,430.52	
Net investment		7,810,039.45
Total		8,162,248.23

Feature costs of Rio Grande project, New Mexico–Texas, to June 30, 1918.

Features.	Cost.	
	Fiscal year, 1918.	Total to June 30, 1918.
Examination and surveys:		
Project, general	.....	$76,619.16
High line canal	.....	37,513.78
Silt deposits, Elephant Butte Reservoir	$1,216.68	9,236.12
Hydrographic survey, New Mexico	.....	5,534.43
Hydrographic survey, Colorado	.....	15,409.70
Drainage investigation, San Luis Valley	.....	7,286.53
San Marcial investigations, New Mexico	.....	1,792.34
Topographic surveys, Torrillo and Fort Hancock districts	2,906.69	2,906.69
Rio Grande hydrometry	1,297.31	1,297.31
	5,420.68	157,596.04
Storage system:		
Preliminary and general	.....	396,350.45
Elephant Butte Dam	[1] 88,578.73	4,171,966.75
Embankment	.....	129,946.04
Spillway	.....	124,461.35
	[1] 88,578.73	4,824,724.63
Canal system:		
Palomas system, preliminary	117.25	1,774.73
Rincon system:		
Preliminary surveys and testing (including Arrey Canal surveys)	[1] 1,916.50	19,440.22
Percha Dam	21,846.05	137,849.13
Tonuco cut-off	188.98	188.98
Arrey Canal, excavation and structures	7,373.85	105,165.17
Garfield Canal, excavation and structures	195,478.74	217,680.01
Hatch Canal and siphon (near Salem, N. Mex.) excavation and structures	151,736.67	151,736.67
Rincon Canal, surveys, and culvert	2,955.49	2,955.49
Leasburg system:		
Preliminary	.....	29,438.57
Leasburg diversion dam	1,512.91	94,182.45
Leasburg Canal	5.75	86,501.14
Las Cruces, Mesilla wasteway	14,602.51	14,602.51
Leasburg extension canal	6.17	40,836.80
Picacho branch canal	.....	16,067.65
Mesilla system:		
Mesilla diversion dam	194.66	126,309.31
Mesilla West Side Canal	1,443.56	264,738.02
Widening west side canal	7,430.06	7,430.06
Mesilla east side canal	706.10	122,694.49
San Miguel branch of west side canal	22,456.04	22,456.04
Timber flumes over Las Cruces Mesilla wasteway	1,032.58	1,032.58

[1] Deduct.

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Feature costs of Rio Grande project, New Mexico–Texas, to June 30, 1918—Continued.

Features.	Cost.	
	Fiscal year, 1918.	Total to June 30, 1918.
Canal system—Continued		
El Paso Valley system:		
Preliminary		$145,228.09
Franklin Canal	$114.88	314,157.90
San Elizario feeder canal	131.03	24,096.64
San Elizario canal and minor structures	23,152.63	31,330.72
Franklin canal wasteway	579.94	579.94
San Elizario headgate No. 1	280.14	1,743.20
San Elizario headgate No. 2	12,288.37	12,288.37
Guadalupe headgate	255.74	1,843.13
	463,773.60	1,994,347.91
Lateral system:		
Leasburg system and preliminary		3,959.77
Rincon system:		
Hatch canal lateral construction	2,324.66	2,324.66
Rincon Valley lateral construction	609.83	609.83
Mesilla system:		
Mesilla west side canal, lateral surveys and investigation	672.16	4,727.82
Mesilla east side canal, lateral surveys and investigations	67.84	4,635.87
Montoya district:		
Montoya lateral and its branches	30,193.81	30,193.81
Montoya headgate	4,576.12	4,576.12
El Paso Valley, preliminary surveys and testing	15,941.90	24,678.72
Bovee lateral		1,463.86
Surveys, lateral district No. 2	90,210.27	91,480.07
Surveys, lateral district No. 4	3,554.47	3,554.47
Surveys, lateral district No. 5	4,267.82	4,267.82
Surveys, lateral district No. 6	189.45	189.45
Surveys, lateral district No. 8	991.49	991.49
Surveys, lateral district No. 9	1,005.42	1,005.42
Surveys, lateral district No. 10	24.57	24.57
Juan de Herrera siphon	163.25	7,567.24
	157,566.56	186,250.99
Drainage system:		
Project as a whole, preliminary		164.51
Palomas system, preliminary		20.41
Rincon system, preliminary	2,515.[illegible]	3,102.74
Hatch drain, location surveys	329.45	329.45
Mesilla system:		
Preliminary surveys and testing	10,097.91	25,524.36
East drain extension	9.72	9.72
East drain, excavation and structures	43,303.75	90,803.99
Nemexas drain, excavation and structures	40,416.31	40,416.31
West drain, excavation and minor structures	40,665.72	40,665.72
Tributary drains	305.67	305.67
Leasburg drain, preliminary	96.41	96.41
Anthony drain, preliminary	1,445.32	1,445.32
La Mesa drain	47.61	47.61
Chamberino drain, preliminary	28.89	28.89
Vinton drain, preliminary	26.39	26.39
Park drain, preliminary	27.62	27.62
Montoya district surveys in Texas	150.72	1,301.80
El Paso system:		
Preliminary surveys and testing	9,941.16	24,725.65
Mesa drain, excavation and structures	62,763.43	98,834.92
Middle drain, excavation and structures	40,420.67	40,420.67
River drain excavation and structures	17,763.48	17,763.48
Fabens drain, preliminary	57.79	57.79
	270,413.62	386,119.43
Flood protection:		
Project as a whole, preliminary	1,341.55	3,749.84
Palomas Valley system		33.43
Leasburg system, cut-off in river channel		13,877.59
Mesilla Valley system—		
Levee at east side canal headworks		2,620.03
Levee at west side canal headworks		2,841.17
El Paso Valley system—		
Preliminary		23.12
San Elizario levee No. 1	1,750.14	1,750.14
	3,091.69	24,895.32

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Feature costs of Rio Grande project, New Mexico–Texas, to June 30, 1918—Continued.

Features.	Cost.	
	Fiscal year, 1918.	Total to June 30, 1918.
Power system: Transmission lines		1,294.14
Farm units:		
Subdivision surveys, project as a whole	303.43	2,250.23
Palomas system		3,352.33
Rincon system		20,855.02
Leasburg system		14,530.50
Mesilla system		52,405.21
El Paso system		27,962.01
	303.43	121,355.30
Permanent improvements:		
Leasburg system—		
Buildings		3,053.02
Roads—		
Leasburg canal		10,375.60
Leasburg canal extension		133.29
Picacho canal		186.44
Mesilla system—		
Buildings		1,358.90
Roads—		
West side canal		1,422.28
East side canal		89.14
El Paso system—		
Buildings		1,381.26
Elephant Butte Dam, roads		26,612.37
Rincon system, buildings	1,597.68	3,026.55
	1,597.68	47,638.85
Telephone system:		
Leasburg system		1,400.52
Mesilla system		8,761.24
Rincon system	7.57	7.57
	7.57	10,169.33
Subtotal		7,754,391.93
Operation and maintenance during construction (water-rental basis)	117,904.34	337,624.63
Balance in plant accounts:		
El Paso	38,329.78	126,210.38
Elephant Butte	[1] 23,992.18	[1] 112,819.86
	14,337.60	13,390.52
Clearing accounts (unadjusted)	[1] 1,916.62	5,534.93
Loss on buildings and cottages		39,894.16
Gross construction cost of project to June 30, 1918	943,921.42	8,150,836.17
Less revenues earned during construction period:		
Rental of buildings	998.90	12,606.96
Rental of grazing and farming lands	8.00	8.00
Net power earnings (prior to public notice)		2,243.33
Rentals of irrigation water	140,309.23	420,703.63
Rentals of telephones and tolls	124.82	5,326.87
Other revennes, unclassified	67.41	687.60
Profit on hospital operations	3,507.43	4,928.59
Suspended contract cost, Knowles & Warren contract, No 777	4,940.12	4,940.12
	149,955.91	451,445.10
Net cost to June 30, 1918		7,699,391.07

[1] Deduct.

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Statement of cost by calendar years, Rio Grande project.

Year ending Dec. 31—	Construction.	Operation and maintenance during construction.	Total.
1906	$24,589.24		$24,589.24
1907	141,484.18	$2,398.86	143,883.04
1908	153,567.87	2,400.51	155,968.38
1909	105,421.86	1,890.88	107,312.74
1910	334,599.30	4,435.18	339,034.48
1911	585,991.02	5,303.18	591,294.20
1912	859,515.72	5,587.05	865,102.77
1913	942,232.25	23,864.19	966,096.44
1914	2,099,399.24	30,736.25	2,130,135.49
1915	901,476.03	47,770.61	949,246.64
1916	520,271.53	58,346.46	578,617.99
1917	476,912.70	78,764.78	555,677.48
To June 30, 1918	608,930.99	76,126.68	685,057.67
Plant accounts to June 30, 1918	13,390.52		13,390.52
Clearing accounts to June 30, 1918	5,534.93		5,534.93
Loss on buildings and cottages	39,894.16		39,894.16
Total	7,813,211.54	337,624.63	8,150,836.17

Statement of cost by fiscal years, Rio Grande project.

Year ending June 30—	Construction.	Operation and maintenance during construction.	Total.
1907	$89,757.29		$89,757.29
1908	174,949.01	$2,138.18	177,087.19
1909	113,335.41	1,167.54	114,502.95
1910	259,654.15	6,856.40	266,510.55
1911	303,292.41	5,680.44	308,972.85
1912	777,317.32	5,678.88	782,996.20
1913	947,304.36	7,447.45	954,751.81
1914	1,451,013.42	33,490.27	1,484,503.69
1915	1,500,688.47	47,277.71	1,547,966.18
1916	940,642.06	41,396.66	982,038.72
1917	382,841.93	68,586.76	451,428.69
1918	813,596.10	117,904.34	931,500.44
Plant accounts to June 30, 1918	13,390.52		13,390.52
Clearing accounts to June 30, 1918	5,534.93		5,534.93
Loss on buildings and cottages	39,894.16		39,894.16
Total	7,813,211.54	337,624.63	8,150,836.17

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Estimated cost of contemplated work, Rio Grande project, during fiscal year 1919.

Principal features.	Estimated cost during fiscal year 1919.	
	Subfeature.	Principal feature.
Examination and surveys:		
Elephant Butte silt survey	$500	
Hydrography, project as a whole	1,000	
Drainage investigations	400	
Miscellaneous	100	
		$2,000
Storage: Elephant Butte sluice gates and balanced valves		1,000
Canal system:		
Garfield Canal excavations	4,000	
Hatch siphon across Rio Grande	15,000	
Hatch Canal, excavation and structures	20,000	
Rincon Canal, excavation and structures	90,000	
Rincon siphon, across Rio Grande	54,000	
Leasburg Dam, raising crest	10,000	
Mexican Dam, sluiceway	10,000	
San Elizario Canal, excavation and structures	29,000	
Island Feeder Canal, excavation and structures	25,000	
		257,000
Lateral system:		
Rincon Valley	10,000	
Mesilla Valley	50,000	
El Paso Valley—		
Ysla district	48,000	
Salatral district	39,000	
Lower Franklin district	36,000	
Clint	25,000	
		208,000
Drainage system:		
Mesilla Valley	435,000	
El Paso Valley	290,000	
		725,000
Permanent improvements:		
Hatch district, Rincon Valley	1,500	
Montoya district, El Paso Valley	1,500	
		3,000
Operation and maintenance during construction (water-rental basis)		150,000
Total		1,346,000

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NEW MEXICO-TEXAS, RIO GRANDE PROJECT.

El Paso V lley Water Users' Association v. *W. H. Austin et al.*—In United States district court. Suit filed April 29, 1912, for adjudication of water rights of Rio Grande in Texas. Case pending.

Oscar C. Snow v. *Francisco Abalos et al.*—In district court of New Mexico (third judicial district). Suit filed October 24, 1912, for adjudication of water rights of Rio Grande in New Mexico. Case pending.

United States v. *A., T. & S. F. Ry. Co.*—In United States district court. Suit filed October 29, 1915, for condemnation of land and other property as right of way. Commissioners appointed January 8, 1916. Report filed September 2, 1916. Case pending on exceptions by plaintiff to report of commissioners. Amount involved indeterminate.

Nellie D. Sperry v. *Chamberino Community Ditch Co. et al.*—In district court of New Mexico, third judicial district. Suit filed March 31, 1916, against employees of Reclamation Service and others seeking injunction against the operation of a certain flume across west side canal account alleged defective construction, and asking for $5,000 damages. Injunction denied. Case still pending on claim for damages.

* *United States* v. *W. F. Payne.*—In United States district court. Suit filed October 13, 1917, for condemnation of land as right of way. Amount involved $326. Commissioners appointed October 17, 1917. Case pending.

* *United States* v. *Elmer C. Beezly.*—In United States district court. Suit filed October 13, 1917, for condemnation of land as right of way. Amount involved $60 and certain legal questions not monetary. Commissioners appointed October 17, 1917. Case pending.

* *El Paso Valley Water Users' Association* v. *Mrs. L. L. Bowen and W. H. Bowen.*—In the forty-first judicial district court, El Paso County, Tex. Suit filed February 4, 1918, to restrain defendants from interfering with United States in constructing drainage ditch over defendants' land under right of way granted in stock subscription contract with association. Temporary injunction granted February 7, 1918. Defendants appealed to Court of Civil Appeals, which, on June 27, 1918, dismissed appeal. Writ of error sued out by defendants June 29, 1918, and case pending in Supreme Court of Texas. Amount involved indeterminate.

NORTH DAKOTA, NORTH DAKOTA PUMPING PROJECT.

No litigation.

OREGON, UMATILLA PROJECT.

In re determination of water rights.—Proceedings begun September 11, 1911, before State water board of Oregon to determine relative rights to the waters of the Umatilla River and tributaries Decree rendered September 9, 1916, by circuit court for Umatilla County. On appeal taken by Western Land & Irrigation Co. decree affirmed November 27, 1917. On rehearing, modified April 16, 1918, by requiring water masters to enforce findings of decree; otherwise decree affirmed.

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ENGINEERING DATA FOR PROJECTS ON COMPLETION.

[The following tables of data for projects on completion, covering reservoirs, storage dams, diversion dams, canals, tunnels, and irrigable area, are necessarily subject to some revision as the projects develop and more detailed plans are prepared. In so far as they refer to works yet to be built or areas not yet covered by canal, they are not to be taken as guaranteeing that such work will ever be done. All future work depends on appropriations therefor by Congress.]

Engineering data for projects when completed.

RESERVOIRS.

Projects.	Name.	Area.	Capacity.	Spillways.			
				Length.	Elevation above stream bed.	Capacity.	
						Normal.	Maximum.
		Acres.	*Acre-feet.*	*Feet.*	*Feet.*	*Sec.-ft.*	*Sec.-ft.*
Arizona: Salt River	Roosevelt	16,832	1,365,000	420	225	.....	.....
California: Orland	East Park	1,850	51,000	415	88	8,000	12,000
Colorado: Uncompahgre Valley.	Taylor Park	2,260	106,000	(1)	(1)	(1)	(1)
Idaho:							
Boise	Deer Flat	9,835	177,000	None.	.....	.....	.....
Do	Arrowrock	2,860	280,000	402	247	15,000	40,000
Minidoka	Lake Walcott	11,350	[2] 150,000	2,385	42	40,000	60,000
Do	Jackson Lake	25,530	789,000	160	41	7,500	13,000
Montana:							
Milk River	St. Mary Lakes	6,910	124,000	500	20	[3] 500	20,000
Do	Sherburne Lakes	2,000	78,000	200	70	[3] 200	8,000
Do	Nelson Reservoir	6,020	132,000	(4)	[5] 35	.....	.....
Do	Point of Rocks	180	830	740	8	[3] 0	700
Do	Beaver Creek	5,800	60,000	(1)	39	[5] 100	5,000
Sun River	Willow Creek	2,696	86,000	200	100	725	(1)
Do	Sun River Storage	3,540	209,000	580	321	14,000	46,000
Do	Pishkun Reservoir	1,542	45,700	Under	control.	.....	.....
Do	Muddy Creek	1,828	33,000	.....	80	284	(1)
Do	Benton Lake	9,300	144,000	Under	control.	.....	.....
Nebraska-Wyoming: North Platte.	Pathfinder	22,700	1,070,000	605	184	40,000	.....
Do	Lake Alice	900	11,400	100	18	2,500	.....
Do	Lake Minatare	2,240	67,000	100	55	2,000	.....
Do	Winters Creek Lake	360	3,000	None.	.....	.....	.....
Nevada: Truckee-Carson:	Lake Tahoe	120,000	120,000	85	6	.....	.....
Do	Alkali Flat	8,500	88,000	(1)	(1)	.....	.....
Do	Lahontan	12,000	290,000	500	112	.....	30,000
New Mexico: Carlsbad	Avalon	970	6,200	1,026	21	88,000	.....
Do	McMillan	7,860	51,500	1,750	26.1-24.9	17,000	34,500
New Mexico-Texas: Rio Grande.	Elephant Butte	40,080	2,638,000	275	193	8,000	16,000
Oregon: Umatilla	Cold Springs	1,500	50,000	330	90	6,000	6,000
Oregon-California: Klamath.	Upper Klamath Lake	60,000	264,000	None.	.....	.....	.....
Do	Clear Lake	25,000	462,000	357	24	10,000	30,000
South Dakota: Belle Fourche.	Belle Fourche	8,010	203,000	314	100	2,000	2,000
Do	Nine Mile	150	2,500	20	20	(1)	(1)
Utah: Strawberry Valley.	Strawberry Valley	8,370	250,000	58	61	500	2,000
Washington:							
Okanogan	Salmon Lake	200	3,200	None.	.....	.....	.....
Do	Conconully	460	13,000	180	55	4,500	16,000
Yakima	Bumping Lake	1,350	34,000	235	36	.....	6,000
Do	Lake Clealum	4,680	501,000	420	112	.....	18,000
Do	Lake Kachess	4,800	210,000	250	53	.....	7,200
Do	Tieton (McAllister Meadows).	1,800	185,000	350	183	.....	19,000
Do	Lake Keechelus	2,550	152,000	300	60	.....	10,000
Do	Clear Creek	126	1,700	210	35	.....	.....
Wyoming: Shoshone	Shoshone	6,600	456,600	300	233	11,000	30,000
Do	Ralston	200	2,100	.....	.....	.....	.....
INDIAN PROJECTS.							
Montana:							
Blackfeet	Two Medicine Lake	854	16,000	66	25½	[3] 250	6,000
Do	Spring Lake	1,400	29,000	50	45	[3] 0	900
Do	Four Horns	1,867	60,640	50	57	[3] 0	1,000
Do	Guardipee	1,110	22,600	170	[5] 40	[3] 0	840
Flathead	Big Draw	901	9,330	100	25	200	500
Do	Dog Lake	160	3,200	.....	[6] 30	.....	.....
Do	Dry Fork	250	2,000	250	25	500	1,500

[1] Undetermined.
[2] 53,500 acre-feet only available; above fixed crest of spillway.
[3] Average flow of stream on which reservoir is located.
[4] No spillways; drainage limited; elevation is that of water surface.
[5] Elevation above outlet.

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Engineering data for projects when completed—Continued.

RESERVOIRS—Continued.

Projects.	Name.	Area.	Capacity.	Spillways.			
				Length.	Elevation above stream bed.	Capacity.	
						Normal.	Maximum.
INDIAN PROJECTS—contd.							
Montana—Continued.		*Acres.*	*Acre-feet.*	*Feet.*	*Feet.*	*Sec.-ft.*	*Sec.-ft.*
Flathead	Flathead Lake	107,000	1,800,000	1,000	180	100,000	150,000
Do	Horte	73	260	40	17	140	300
Do	Hubbart	400	15,000	50	120	400	1,200
Do	Kickinghorse	675	6,800	.....	[1] 23	.....	.....
Do	Little Bitter Root Lake	3,000	9,000	.....	[1] 3	.....	.....
Do	Lower Crow Creek	300	9,485	100	82	600	1,500
Do	McConnell	100	2,000	.....	[1] 40	.....	.....
Do	McDonald Lake	220	10,600	200	51	3,000	6,000
Do	Mission	300	8,300	100	74	1,200	3,000
Do	Ninepipe	1,630	15,100	.....	[1] 30	.....	.....
Do	Pablo	2,100	29,600	.....	[1] 36	.....	.....
Do	Polson	70	1,700	.....	[1] 80	.....	.....
Do	Tabor (St. Mary Lake)	300	25,000	50	52	400	1,200
Do	Twin	70	937	.....	[1] 25	.....	.....
Fort Peck	Little Porcupine	390	3,900	.....	.....	.....	.....
Do	Big Porcupine	750	9,400	([2])	.....	.....	.....
Do	Poplar River	3,700	50,000	([2])	.....	.....	.....
Do	Wolf Creek	350	4,550	([2])	.....	.....	.....
Do	Smoke Creek	300	5,300	([2])	.....	.....	.....
Total		580,009	13,175,432	.....	.....	.....	.....

STORAGE DAMS.

Projects.	Name.	Type.	Maximum height.	Crest length.	Volume.
			Feet.	*Feet.*	*Cubic yds.*
Arizona: Salt River	Roosevelt [3]	Rubble masonry arch, gravity.	280	1,125	342,325
California: Orland	East Park [3]	Concrete arch, gravity	139	250	12,200
Colorado: Uncompahgre Valley.	Taylor Park	Undetermined	([4])	([4])	([4])
Idaho:					
Boise	Upper Deer Flat	Earth fill	70	4,000	1,190,275
Do	Lower Deer Flat [5]	do	40	7,200	1,207,606
Do	Deer Flat Forest	do	16	950	22,500
Do	Arrowrock [6]	Rubble concrete arch, gravity.	349	1,100	585,130
Minidoka	Minidoka [3]	Rock fill, concrete core	86	937	242,500
Do	Jackson Lake [6]	Massive concrete gate section and earth fill.	67	4,450	345,400
Montana:					
Milk River	St. Marys Lake	Earth embankment	30	2,000	135,000
Do	Sherburne Lakes [5]	do	78	2,000	215,000
Do	Nelson Reservoir [6]	do	39	20,730	1,016,000
Do	Point of Rocks [3]	do	12.5	2,680	31,000
Do	Beaver Creek	do	49	8,000	500,000
Sun River	Willow Creek [7]	Earth fill	110	1,045	452,000
Do	Sun River Storage	Masonry	329	989	296,050
Do	Pishkun	Earth fill	48	8,600	444,000
Do	Muddy Creek	do	90	800	440,000
Do	Benton Lake	do	40	240	12,000
Nebraska-Wyoming: North Platte.	Pathfinder [3]	Broken range masonry arch.	218	432	60,210
Do	Pathfinder Dike [3]	Earth fill	40	1,650	152,000
Do	Dam No. 1 [3]	do	30	3,100	240,000
Do	Dam No. 1½ [3]	do	23	2,550	119,000
Do	Minatare [5]	do	65	3,700	570,000

[1] No spillways; drainage limited; elevation is that of water surface.
[2] Undetermined.
[3] Completed.
[4] Not designed.
[5] Under construction.
[6] Completed to height of 11 feet, with storage of 25,000 acre-feet.
[7] Completed to height of 70 feet.

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Engineering data for projects when completed—Continued.

STORAGE DAMS—Continued.

Projects.	Name.	Type.	Maximum height.	Crest length.	Volume.
			Feet.	*Feet.*	*Cubic yds.*
Nevada: Truckee-Carson.	Lake Tahoe [1]	Concrete sluiceway regulator.	14	109	425
Do	Alkali Flat	Not designed			
Do	Lahontan [1]	Earth and gravel fill with concrete spillways.	124	1,400	770,000
New Mexico:					
Carlsbad	Avalon [1]	Earth and rock fill, concrete core.	50	1,380	168,773
Do	McMillan [1]	Earth and rock fill	55	2,070	150,744
New Mexico-Texas: Rio Grande.	Elephant Butte [1]	Rubble concrete, gravity, straight structure.	318	[2] 1,674	[3] 605,200
Do	Elephant Butte Dike [1]	Earth fill	42	1,900	184,650
Oregon: Umatilla	Cold Springs [1]	do	98	3,800	789,500
Oregon - California: Klamath.	Clear Lake [1]	Rock fill	33	790	56,600
South Dakota: Belle Fourche.	Belle Fourche [1]	Earth fill	115	6,200	1,600,000
Do	Nine Mile	do	28	1,400	50,800
Utah: Strawberry Valley.	Indian Creek Dike [1]	Earth fill, reinforced concrete	37	1,311	101,107
Do	Strawberry Dam [1]	Earth fill, reinforced concrete core wall.	72	488	108,415
Washington:					
Okanogan	Salmon Lake [1]	Concrete head works			
Do	Conconully [1]	Hydraulic earth fill	64	1,000	336,000
Yakima	Bumping Lake [1]	Earth fill	45	3,425	247,700
Do	Lake Clealum	Earth and gravel fill	125	700	462,000
Do	Lake Kachels [1]	do	63	1,400	193,300
Do	Tieton [4]	Earth and rock fill	220	900	1,785,000
Do	Lake Keechelus [1]	Earth and gravel fill	70	6,500	639,000
Do	Clear Creek [5]	Single concrete arch	84	404	4,100
Wyoming: Shoshone.	Shoshone [1]	Rubble concrete arch	328	200	78,576
Do	Ralston [1]	Earth fill	50	150	24,740
INDIAN PROJECTS.					
Montana:					
Blackfeet	Two Medicine [1]	Earth embankment	36	900	28,600
Do	Spring Lake	do	50	1,500	75,000
Do	Four Horns [6]	do	62	2,225	149,000
Do	Guardipee	do	50	613	45,000
Flathead	Big Draw	Earth	35	3,600	137,000
Do	Dog Lake	Loose rock and earth	35	2,250	67,000
Do	Dry Fork	Earth	33	1,860	130,000
Do	Newell	Concrete	170	850	100,000
Do	Horte [1]	Earth fill	16	930	3,800
Do	Hubbart	Loose rock and earth	118	450	302,000
Do	Kickinghorse	Earth	31	3,700	181,000
Do	Little Bitter Root	do	10	300	4,000
Do	Lower Crow Creek	do	92	860	330,000
Do	McConnell	do	45	1,130	71,000
Do	McDonald Lake	Loose rock and earth	57	1,500	214,000
Do	Mission	do	80	2,500	346,000
Do	Ninepipe [7]	Earth	38	2,180	162,000
Do	Pablo [8]	do	46	14,000	1,028,000
Do	Polson	do	85	1,100	170,000
Do	Tabor	Loose rock and earth	58	2,200	140,000
Do	Twin	Earth	30	1,600	46,000
Fort Peck	Little Porcupine [1]	Earth fill	17	4,200	43,400
Do	Big Porcupine	do	30	1,500	118,000
Do	Poplar River	do	51	5,200	960,000
Do	Wolf Creek	do	36		85,300
Do	Smoke Creek	do	48		76,000
Total					21,978,926

[1] Completed.
[2] Including spillway.
[3] Including spillway, 611,000 cubic yards.
[4] Under construction.
[5] In process of being raised 21 feet.
[6] First development, 16,000; completed for 4,000 acre-feet.
[7] First development, 64,191; completed for 5,000 acre-feet.
[8] First development, 153,750; completed for 5,000 acre-feet when paved; now paved for 3,000 acre-feet.

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Engineering data for projects when completed—Continued.

DIVERSION DAMS.

Projects.	Name.	Type.	Maximum height.	Crest length.	Volume.
			Feet.	*Feet.*	*Cubic yds.*
Arizona: Salt River.	Granite Reef[1]	Rubble concrete weir	38	1,000	40,000
Do	Power Canal[1]	do	12½	400	4,800
Do	Joint Head[1]	Concrete weir	10	600	1,740
Arizona - California: Yuma.	Laguna[1]	Indian weir, concrete and rock fill.[2]	40	4,780	441,732
California: Orland	South Canal[1]	Concrete on piling, with rock fill.	20	900	2,886
Do	North Side[1]	Concrete weir, with removable timber crest.	8	360	270
Do	East Park Feed Canal.[1]	Concrete arch	44	154	1,777
Colorado:					
Grand Valley	Grand River Diversion.[1]	Masonry ogee weir with roller crest 10 to 15 feet high.	24	546	25,682
Uncompahgre Valley.	Gunnison[1]	Crib on rock fill and movable flashboards.	15½	237	3,200
Do	Montrose and Delta[1]	Movable flashboard weir	6.8	684	
Do	Loutsenhizer[1]	Pile and timber weir		100	
Do	Selig[1]	Movable flashboard weir	6	954	
Do	Ironstone[1]	Pile foundation with deck and needle flashboards.	8½	584	
Do	East Canal[1]	Movable flashboard weir	(3)	144	
Do	Garnet[1]	Rock basket and brush dam			
Idaho:					
Boise	Boise River[1]	Rubble concrete weir	45	[4] 246	21,750
Minidoka	Minidoka[1]	Combined diversion and storage dam. (See Storage.)			
Montana:					
Milk River	Swift Current[1]	Earth and timber crib	13	2,800	86,700
Do	St. Mary[1]	Concrete	6.5	198	480
Do	Chinook	Reinforced concrete	20	250	3,400
Do	Dodson[1]	Timber crib, rock filled	25	319	12,000
Do	Vandalia[1]	Reinforced concrete	34	1,500	11,000
Sun River	Sun River[1]	Concrete masonry	132	212	6,200
Do	Deep Creek	Reinforced concrete	12	100	500
Montana-North Dakota: Lower Yellowstone.	Lower Yellowstone[1]	Rock-filled, timber weir	12	700	14,500
Nebraska-Wyoming: North Platte	Whalen[1]	Concrete weir	29	300	80,740
Nevada: Truckee-Carson.	Truckee River[1]	16 concrete sluiceways	22	171	3,322
Do	Carson River[1]	23 concrete sluiceways	21	240	2,707
New Mexico: Carlsbad.	Avalon[1]	Combined storage and diversion. (See Storage.)			
New Mexico-Texas: Rio Grande	Leasburg[1]	Rubble concrete weir	9	600	2,318
Do	Mesilla[1]	do.[5]	16.7	303	2,876
Do	Mexican[7]	Rubble masonry	4.7	320	
Do	Palomas	Not designed			
Do	Percha[1]	Rubble concrete	17	350	4,346
Oregon: Umatilla	Feed Canal (Echo)[1]	Concrete weir on timber crib.	2½	400	296
Do	Maxwell Canal[1]	do	2.3	175	43
Do	Three-Mile Falls[1]	Concrete multiple arch	24	800	4,160
Oregon - California: Klamath.	Lost River[1]	Hollow reinforced concrete	40	290	5,550
South Dakota: Belle Fourche.	Diversion[1]	Concrete weir	23	400	12,149
Utah: Strawberry Valley.	Spanish Fork[1]	do	16	70	1,262
Do	Indian Creek Crossing[1]	Earth	17	1,300	15,183
Do	Horse Creek Crossing[1]	do	6	500	7,376
Do	Diverting dam at Strawberry dam.[1]	do	6	100	1,146
Do	Diverting dam at rating flume.[1]	do	12	150	4,103
Washington:					
Okanagon	Salmon Creek[1]	Concrete weir	4½	50	132
Yakima	Sunnyside[1]	Concrete ogee weir	8½	500	2,291
Do	Tieton Diversion[1]	Concrete and rock-filled crib	3	110	334
Wyoming: Shoshone	Corbett[1]	Reinforced-concrete weir	18	400	4,951

[1] Completed.
[2] Area formed by Laguna diversion dam, 6,400 acres.
[3] Two weirs, one 6 feet by 72 feet, the other 6 feet 10 inches by 72 feet.
[4] Length, including logway.
[5] Completed, except for installation of movable crest.
[6] With 6 foot 3 inch and 4 foot 6 inch tainter gate movable crest.
[7] Constructed by Mexican authorities and used jointly.

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Engineering data for projects when completed—Continued.

DIVERSION DAMS—Continued.

Projects.	Name.	Type.	Maximum height.	Crest length.	Volume.
			Feet.	*Feet.*	*Cubic yds.*
Montana:					
Blackfeet	Two Medicine	Brush and rock	4	165	175
Do	Blacktail [1]	Concrete	14	54	200
Do	Badger Birch and Cut Bank.	Not yet designed			
Flathead	Jocko River	Log crib, rock filled [2]			
Do	Little Bitter Root	....do			
Do	Camas A [1]	Arched masonry	25	125	500
Do	Mud Creek [1]	Concrete	12	18	116
Do	Crow Creek [1]	....do	13	82	330
Do	Post Creek—Kicking-horse. [1]	Log crib, rock filled	7	110	1,500
Do	Post Creek—Pablo Feeder.	....do. [2]			
Do	Mission Creek [1]	Log apron	3	80	
Do	Dry Creek	Log crib, rock filled [2]			
Do	Finley Creek	....do			
Do	Agency Creek	....do			
Do	Big Knife Creek [1]	Concrete	5	6	25
Do	Valley Creek	Log crib, rock filled [2]			
Do	Other small creeks	....do			
Fort Peck	Little Porcupine [1]	Concrete weir on timber crib.	4	150	250
Do	Poplar River [1]	....do	4	300	180
Do	Big Porcupine [1]	....do	6	150	185
Total					837,453

CANALS.

Projects.	Principal canals.			Mileage, with capacity in second-feet.				
	Name.	Maximum capacity.	Length.	Over 800.	300–800.	50–300.	Less than 50.	Total.
		Sec.-ft.	*Miles.*					
Arizona: Salt River	Power [1]	225	19					
Do	Arizona [1]	2,000	22	32	71	78	566	747
Do	South [1]	1,200	2					
Do	Consolidated [1]	1,000	7½					
Arizona-Cal.: Yuma	Main [1]	1,700	12					
Do	West Main	520	23	17	12	100	430	559
Do	East Main	880	24½					
California: Orland	East Park Feed [1]	250	7			7		7
Do	North Main [1]	80	4.5			8	32	40
Do	South Main [1]	225	9.1			23	75	98
Colorado:								
Grand Valley	Main [1]	1,425	62	5	39	21	232	297
Uncompahgre	South [1]	1,300	12	12		1	50	63
Do	West [1]	120	22			14	27	41
Do	Montrose and Delta [1]	450	32		16	37	80	133
Do	Loutsenhizer [1]	125	15			8	22	30
Do	Selig [1]	300	20		4	17	70	91
Do	Ironstone [1]	350	12		5	13	50	68
Do	East [1]	325	11		4	10	50	64
Do	Garnet [1]	50	10			8	4	12
Idaho:								
Boise	Main South [1]	2,500	34					
Do	Mora [1]	915	56	40	57	165	788	1,050
Do	Deer Flat, Low Line [1]	780	37					
Minidoka	North Side [1]	1,500	8	25	30	95	483	633
Do	South Side [1]	1,000	13					
Montana:								
Huntley	Main [1]	500	32		10	22	200	232
Do	Pumping High Line [1]	100	12					
Milk River	St. Mary [1]	850	29	29				29
Do	Dodson South [1]	900	44	44		66	130	240
Do	Dodson North [1]	200	29			23	37	60

[1] Completed. [2] Not yet designed. [3] Under construction.

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Engineering data for projects when completed—Continued.

CANALS—Continued.

Projects.	Principal canals.			Mileage, with capacity in second-feet.				
	Name.	Maximum capacity.	Length.	Over 800.	300–800.	50–300.	Less than 50.	Total.
Montana—Continued.		*Sec.-ft.*	*Miles.*					
Milk River	Vandalia South [1]	300	48	.....	.....	44	41	85
Do	Nelson Reservoir North.	250	45	.....	.....	40	30	70
Do	Nelson Reservoir South. [2]	260	27	.....	.....	26	59	85
Do	Chinook	350	80	.....	30	50	90	170
Sun River	Fort Shaw [1]	175	12	.....	.....	18	103	121
Do	Pishkun [3]	2,500	12	12	.....	.....	.....	12
Do	Sun River Slope [4]	1,000	25.4	25.4	.....	74	286	404.3
Do	Greenfields	850	18.9	10.9	8			
Do	Other units	.....	.....	.....	50	54	210	314
Montana-North Dakota: Lower Yellowstone.	Main [1]	830	66	.....	49	19	190	258
Nebraska-Wyoming: North Platte.	Interstate [1]	1,400	95	90	20	92	603	805
Do	Fort Laramie	1,430	127	62	42	44	[4] 600	748
Nevada: Truckee-Carson	Truckee [1]	1,500	31					
Do	V Line [1]	1,500	8					
Do	L Line [1]	1,210	14.5					
Do	S Line [1]	1,210	18.7	12	62	80	511	695
Do	D Line [1]	440	7					
Do	AA Line [1]	400	13.4					
Do	T Line [1]	400	9					
New Mexico:								
Carlsbad	Main [1]	450	[5] 3	.....	13	12	120	145
Texas, Rio Grande	Palomas	100	12					
Do	Arrey [1]	350	30					
Do	Garfield [3]	330	9.3					
Do	Hatch [3]	200	8.0					
Do	Rincon	100	7.0					
Do	Leasburg [1]	485	10.8					
Do	Picacho Branch [1]	90	3.7					
Do	East Side [1]	240	10.3					
Do	West Side [1]	493	14.4					
Do	Chamberino Feed	70	2.2	.....	67.8	126.1	27	220.9
Do	Franklin [3]	450	31.4					
Do	San Elizario Feeder [1]	220	3.2					
Do	San Elizario main canal. [3]	270	3.5					
Do	Salatral [3]	177	1.6					
Do	Montoya [1]	54	3.1					
Do	Juan d'Herrera [3]	170	0.8					
Do	Island Feeder	125	2.1					
North Dakota: North Dakota Pumping.	Buford Trenton [1]	60	6	.....	.....	6	39	45
Do	Williston [1]	90	3	.....	.....	3	57	60
Oregon: Umatilla	Feed [1]	350	25					
Do	West extension main	375	26.7	.....	33	52	90	175
Do	Maxwell	140	8					
Oregon-California: Klamath.	Main [1]	1,400	9					
Do	Keno [1]	635	1					
Do	Lost River Diversion Channel.	250	8	9	9	42	250	310
Do	East Branch [1]	260	4.5					
Do	South Branch [1]	205	13.2					
Do	Adams [1]	205	12					
Do	Griffith Lateral [1]	190	9					
South Dakota: Belle Fourche.	Inlet [1]	1,600	6½					
Do	North Side [1]	700	45	7	55	105	146	627
Do	South Side [1]	300	40					

[1] Completed.
[2] Under construction.
[3] Completed to first development capacity of 1,000 second-feet.
[4] Completed to first development capacity of 500 second-feet.
[5] Estimated.
[6] Main and southern canals, 31 miles.
[7] 2.3 miles constructed.
[8] Old canal purchased by U. S. Reclamation Service and reconstructed.
[9] Old canal purchased by U. S. Reclamation Service. Reconstruction under way.

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Engineering data for projects when completed—Continued.

CANALS—Continued.

Projects.	Principal canals.			Mileage, with capacity in second-feet.				
	Name.	Maximum capacity.	Length.	Over 800.	300–800.	50–300.	Less than 50.	Total.
Utah:		*Sec.-ft.*	*Miles.*					
Strawberry Valley	Power [1]	500	3.3	.....	3.3	.....	.....	3.3
Do	Trail Hollow [1]	125	4	.....	.....	4	.....	4
Do	Indian Creek [1]	750	2	.....	2	.....	.....	2
Do	High Line [1]	300	17.5	.....	.....	17.5	.....	17.5
Do	Mapleton	100	6.75	.....	.....	6.75	.....	6.7
Do	Lateral 3 [1]	30	2.2	.....	.....	.....	2.2	2.2
Do	Lateral 20 [1]	55	6.1	.....	.....	1.1	5	6.1
Do	Lateral 30 [1]	66	8.5	.....	.....	3.5	5	8.5
Do	Lateral 31 [1]	10	.....	.....	.....	.....	.....	.....
Do	Lateral 32 [1]	50	2.9	.....	.....	0.8	2.1	2.9
Do	Lateral 33	150	2.2	.....	.....	2.2	.....	2.2
Do	Lateral 34 [1]	55	11.1	.....	.....	1.3	9.8	11.1
Do	Miscellaneous laterals and sublaterals.	12	31.4	.....	.....	.....	31.4	31.4
Washington:								
Okanogan	Main [1]	110	2	.....	.....	10	69	79
Yakima	Sunnyside Main [1]	1,200	60	31	19	15	342	407
Do	Snipes Mountain [1]	160	13	.....	.....	10	42	52
Do	Rocky Ford [1]	100	13	.....	.....	1	29	30
Do	Manton [1]	110	14	.....	.....	8	44	52
Do	Benton Extension [1]	80	16	.....	.....	9	13	22
Do	Tieton [1]	300	12	.....	12	32	291	335
Wyoming: Shoshone	Garland [1]	1,000	18	10.6	23.3	66.3	281	381.2
INDIAN PROJECTS.								
Montana:								
Blackfeet	Two Medicine	530	25					
Do	Fisher	500	30					
Do	Birch	45	6					
Do	Cutbank North	250	30	.....	55	144	600	799
Do	Cutbank South	300	20					
Do	Four Horns Supply	275	12					
Flathead	Tabor Feeder	300	11					
Do	Pablo Feeder	300	44					
Do	Kickinghorse Feeder [1]	400	4					
Do	Ninepipe Feeder	250	2	.....	14	82	800	896
Do	Pablo Lateral A [1]	400	17					
Do	Camas A	150	10					
Fort Peck	Little Porcupine [1]	250	1	.....	.....	1	13	14
Do	Poplar River B [1]	100	29	.....	.....	11	22	33
Do	Poplar River C [1]	100		.....	.....	18	48	66
Do	Big Porcupine [1]	100	7	.....	.....	7	25	32
Do	Missouri Gravity	625	100	.....	10	30	60	100
Total		.....	.....	503.9	825.4	2,077.8	9,826.5	13,233.6

TUNNELS.

Projects.	Name.	Length.	Capacity.
Arizona: Salt River	Power Canal: [1]	*Feet.*	*Second-feet.*
	Intake	1,695	.....
	Lee	122	.....
	Wehrl cut-off—		
	No. 1	428	.....
	No. 2	129	.....
	No. 3	271	.....
	Wehri	151	.....
	Pinto	999	.....
	Chilton	1,027	.....
	Robinson	152	.....
	Gray	761	.....
	Moffet	214	.....
	Grapevine	872	.....
	No. 6	206	.....
	No. 7	342	.....
	No. 8	553	.....
	No. 9	320	.....

[1] Completed.

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Engineering data for projects when completed—Continued.

TUNNELS—Continued.

Projects.	Name.	Length.	Capacity.
Arizona: Salt River	Power Canal:	*Feet.*	*Second-feet.*
	No. 10	489	.....
	No. 11	625	.....
	No. 12	70	.....
	No. 13	110	.....
	Roosevelt: [1]		
	Sluicing	480	.....
	Outlet	167	.....
	Penstock	620	.....
Arizona-California: Yuma	Colorado River siphon [1]	930	1,400
Colorado:			
Grand Valley	Main Canal:		
	No. 1 [1]	3,723	1,425
	No. 2 [1]	1,655	1,425
	No. 3 [1]	7,292	670
Uncompahgre	Gunnison [1]	30,645	1,000
	South Canal: [1]		
	No. 1	482	1,300
	No. 2	395	1,300
	No. 3	1,000	1,300
	No. 4	400	1,300
	No. 5	390	1,300
	West Canal [1]	1,750	100
	West Canal Extension [1]	800	30
	Lower Selig Extension: [1]		
	No. 1	160	140
	No. 2	360	140
	No. 3	100	100
	No. 4	310	100
Idaho: Boise	Penitentiary	322	10
	Arrowrock Logway [2]	159	.....
Montana:			
Huntley	Main Canal:		
	No. 1 [1]	724	500
	No. 2 [1]	1,545	500
	No. 3 [1]	385	500
Sun River	Willow Creek [1]	639	725
	Sun River Storage	200	3,500
	Pishkun Canal:		
	No. 1 [3]	695	2,800
	No. 2 [3]	1,022	2,500
	No. 3 [3]	2,277	2,500
	Sun River Diversion Tunnel [1]	87	400
	Muddy Creek Reservoir	700	284
Nebraska-Wyoming: North Platte	Pathfinder: [1]		
	North [1]	480	6,000
	South [1]	360	6,400
	Drainage [1]	155	(4)
	Auxiliary [1]	209	(4)
	Crosscut [1]	55	(4)
	Fort Laramie Canal:		
	No. 1	2,700	1,430
	No. 2	2,150	1,430
	No. 3	3,700	360
Nevada: Truckee-Carson	Truckee Canal:		
	No. 1 [1]	901	1,200
	No. 2 [1]	309	1,200
	No. 3 [1]	1,515	1,200
	Gilpin Spillway [1]	115	1,200
New Mexico: Carlsbad	Spillway:		
	No. 1 [1]	97	8,000
	No. 2 [1]	103	8,000
Oregon: Umatilla	Spillway from Feed Canal [1]	34	450
Oregon-California: Klamath	Main Canal [1]	3,300	1,200
South Dakota: Belle Fourche	South Canal	1,306	350
Utah: Strawberry Valley	Strawberry [1]	19,897	600
	Strawberry Dam Sluicing	532	600
	Power Canal:		
	No. 1 [1]	800	500
	No. 2 [1]	705	500
	Highline No. 1 [1]	227	300
Washington:			
Okanogan	Conconully outlet [1]	395	900
Yakima, Tieton	Steeple, No. 1 [1]	55	350

[1] Completed.
[2] Not intended to carry water, but for the purpose of running logs which are carried over the dam and brought down through a cableway chute which ends in this tunnel.
[3] Completed to first development capacity of 1,000 second-feet.
[4] Not designed for discharge.

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Engineering data for projects when completed—Continued.

TUNNELS—Continued.

Projects.	Name.	Length.	Capacity.
		Feet.	*Second-feet.*
Washington—Continued.			
Yakima, Tieton	Steeple, No. 2[1]	48	350
	Trail Creek[1]	3,120	300
	Columnar[1]	1,200	300
	Tieton[1]	2,729	300
	North Fork[1]	3,811	300
Wyoming: Shoshone	Shoshone:[1]		
	Lower outlet	498	6,000
	Spillway	405	30,000
	Upper outlet	315	
	Corbett[1]	17,355	1,000
	Ralston Reservoir[1, 2]	245	
	Frannie[1]	1,330	317
	Shoshone Road:[1]		
	No. 1	39	
	No. 2	45	
	No. 3	14	
	No. 4	28	
	No. 5	136	
	No. 6	166	
	Highline Canal:[1]		
	No. 1	4,497	600
	No. 2	247	600
	No. 3	2,100	600
	No. 4	835	600
	No. 5	265	600
	No. 6	2,025	600
	No. 7	290	560
	No. 8	283	560
	No. 9	120	380
	No. 10	185	335
	Willwood:		
	No. 1	560	300
	No. 2	365	300
INDIAN PROJECTS.			
Montana: Flathead	Newell[3]	1,800	2,500
	Tabor Reservoir Outlet	1,620	400
	Pablo 31A[1]	441	200
	Camas A	1,100	150
Fort Peck	Missouri River	4,300	625
Total		162,567	

[1] Completed.
[2] Ralston Reservoir tunnel is a sluicing tunnel for the settling basin of Corbett Tunnel.
[3] 1,703 feet driven. Completed for first development (unlined).

IRRIGABLE AREA.

State, project, and unit.	Public land.			State land.	Indian land.	Private land.		Total.
	Entered.	Open.	Withdrawn.			Railroad.	Other.	
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
Arizona: Salt River	16,170			11,030			164,877	192,077
Gravity system								183,077
Pumping system								9,000
Arizona-California: Yuma	6,500		38,500	5,800	8,500		50,700	110,000
Arizona			38,500	5,800			50,700	95,000
California	6,500				8,500			15,000
Units—								
Yuma Valley (Ariz.)			6,900	3,100			45,000	55,000
Mesa pumping (Ariz.)			31,600	2,700			5,700	40,000
Reservation (Cal.)	6,500				8,500			15,000
California: Orland							20,533	20,533
North side							6,809	6,809
South side							13,404	13,404
Vested water rights							320	320
Colorado:								
Grand Valley	13,305	1,701	14,064				20,930	50,000
Gravity system	10,775	1,701	10,034				17,490	40,000
Pumping system	2,530		4,030				3,440	10,000
Uncompahgre Valley	19,157	3,100	1,772				75,971	100,000
South Canal system	2,560	480	13				6,323	9,376
West Canal system	2,506	29	14				4,025	6,574

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Engineering data for projects when completed—Continued.

IRRIGABLE AREA—Continued.

State, project, and unit.	Public land.			State land.	Indian land.	Private land.		Total.
	Entered.	Open.	Withdrawn.			Railroad.	Other.	
Colorado—Continued.								
Uncompahgre Valley—Con.								
Montrose and Delta Canal system	*Acres.* 5,498	*Acres.* 372	*Acres.* 107	*Acres.*	*Acres.*	*Acres.*	*Acres.* 23,227	*Acres.* 29,204
Loutzenhizer Canal system	231	22					6,451	6,704
Selig Canal system	3,715	1,190	1,539				7,465	13,909
Ironstone Canal system	925	247					16,874	18,046
East Canal system	3,714	760	99				8,935	13,508
Garnet Canal system	8						2,671	2,679
Idaho: Boise	67,452		3,160	3,350			253,758	327,720
Present project lands, including vested water-right lands	67,452			350			206,418	274,220
Proposed extensions, including pumping			3,160	3,000			47,340	53,500
Idaho: King Hill	9,026	371		1,071			5,908	16,376
Idaho: Minidoka	96,016	552		21,062			3,375	121,005
Montana: Huntley	26,214	1,401	1,372				3,992	32,979
First unit	23,669	1,401	683				3,158	28,911
Second unit	1,010						834	1,844
Third unit	1,535		689					2,224
Montana: Milk River	42,508		24,346	8,348	28,000		96,798	200,000
Dodson north canal	3,339		560	481			7,588	11,968
Dodson south canal	6,521		6,200	1,033			5,507	19,261
Bowdoin Canal	3,243		2,606	629			4,602	11,080
Beaver Reservoir Canal	2,105		7,021	708			2,166	12,000
Nelson Reservoir north	5,850		1,600	300			4,250	12,000
Nelson Reservoir south	10,190		2,220	2,540			7,150	22,100
Vandalia south	6,885		1,734	2,142			15,050	25,811
Chinook	4,375		2,405	515	28,000		50,485	85,780
Montana: Sun River	55,653	1,252	36,805	12,389		260	67,436	173,795
Fort Shaw	11,213	1,252	525	169		260	2,676	16,095
Sun River Slope	480		10,000	1,440			3,080	15,000
Greenfields and Mill Coulee	38,500		22,000	6,000			8,500	75,000
Greenfields Lake	5,460		4,280	1,120			4,140	15,000
Benton				1,520			19,480	21,000
Vaughn and Sunnyside				2,140			29,560	31,700
Montana-North Dakota: Lower Yellowstone	14,813	91	1,812	1,653		3,839	37,908	60,116
First unit								42,288
Extensions								17,828
Nebraska-Wyoming: North Platte	108,103	80	35,083	12,514			73,998	229,778
Interstate unit	82,408	80	610	5,338			41,342	129,778
Nebraska	79,789	80	610	5,338			23,292	109,109
Wyoming	2,619						18,050	20,669
Units—								
North Platte Canal & Colonization Co.							17,837	17,837
First lateral district	32,956	80	337	2,128			4,124	39,643
Second lateral district	20,663		126	1,012			11,753	33,623
Third lateral district	28,789		147	2,198			7,628	38,762
Fort Laramie unit	25,695		34,473	7,176			32,656	100,000
Nebraska	8,542		7,191	3,315			26,179	45,227
Wyoming	17,153		27,282	3,861			6,477	54,773
Nevada: Truckee-Carson	21,743	4,304	96,663	120	5,450	26,900	50,820	206,000
Lahontan Valley (Lower Carson)								151,100
Truckee Canal district								14,800
Lahontan Bench								7,200
Churchill Valley								14,000
Pyramid Lake extension								18,900
New Mexico: Carlsbad	166			1,220			23,389	24,775
First	10						19,945	19,955
Second	156			1,220			3,444	4,820
New Mexico-Texas: Rio Grande	553		4,890	2,602		360	146,595	155,000
New Mexico	553		4,890	2,602			101,955	110,000
Texas						360	44,640	45,000
Units—								
Palomas Valley			574	119			6,292	6,985
Rincon Valley			256	1,867			19,658	21,781
Mesilla Valley, Leesburg unit	114		900	279			35,479	36,772

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Engineering data for projects when completed—Continued.

IRRIGABLE AREA—Continued

State, project, and unit.	Public land.			State land.	Indian land.	Private land.		Total.
	Entered.	Open.	Withdrawn.			Railroad.	Other.	
New Mexico-Texas: Rio Grande—Continued.								
Units—Continued.								
Mesilla Valley, other units	*Acres.* 439	*Acres.*	*Acres.* 3,160	*Acres.* 337	*Acres.*	*Acres.*	*Acres.* 56,496	*Acres.* 60,432
El Paso Valley						360	28,670	29,030
North Dakota: North Dakota pumping	303	532	78	1,073			24,287	26,273
Buford-Trenton	249	212	78	1,006			13,480	15,025
First division	249	212	78	91			3,420	4,050
Extensions				14			1,361	1,375
Upper bottom division				501			2,099	2,600
Lower bottom division							4,000	4,000
Trenton Flat				400			2,600	3,000
Williston	54	320		67			10,807	11,248
First division	54	320		67			7,707	8,148
West bottom division							1,900	1,900
East bottom division							1,200	1,200
Oregon: Umatilla	5,031	341	2,398			3,342	25,188	36,300
First	386					320	6,262	6,968
Second	541	2				78	3,677	4,298
Third	1,249					919	1,789	3,957
Fourth	349					90	1,537	1,976
Fifth	189	18						207
Sixth	38	102				23	956	1,119
First, W. E	643	165				399	1,092	2,299
Second, W. E	1,279					265	1,404	2,948
Third, W. E	310	54				92	1,153	1,609
Future	47		2,398			1,156	7,318	10,919
Oregon-California: Klamath	2,651	132	27,300				111,599	141,682
Oregon	2,240	72	4,300				102,198	108,810
California	411	60	23,000				9,401	32,872
Units:								
First	62	23					29,414	29,499
Second							7,482	7,482
Third	2,589	109					3,232	5,930
Marginal lands (Tule)			27,300				241	27,541
Sand Hollow							13,500	13,500
Horsefly							22,000	22,000
Pine Grove							3,730	3,730
Additional units							32,000	32,000
South Dakota: Belle Fourche	35,880	2,007	15,300	4,520			40,209	97,916
First								20,910
Second								28,401
Third								16,913
Fourth								12,366
Fifth								4,745
Willow Creek extension								5,896
Nine Mile extension								8,685
Utah: Strawberry valley	1,846	54					48,100	50,000
Mapleton and Springville							10,000	10,000
Lake Shore							2,500	2,500
High Line	1,846	54					17,100	19,000
Spanish Fork							18,500	18,500
Washington: Okanogan							10,099	10,099
First							2,018	2,018
Second							6,085	6,085
Third							464	464
Old water rights							1,381	1,381
Town of Okanogan							151	151
Washington: Yakima	4,625	15	39	3,404			134,745	142,828
Sunnyside unit	2,588		39	1,158			107,043	110,828
Vested water-right lands							47,247	47,247
Public-notice lands	1,622		39	920			40,495	43,076
Irrigation-district lands	966			238			19,301	20,505
Tieton unit	2,037	15		2,246			27,702	32,000
Wyoming: Shoshone	47,896	3,619	86,400	6,326		750	2,237	147,228
First unit								15,133
Second unit								14,787
Third unit								2,734
Fourth unit								6,180
Fifth unit								3,566
Sixth unit								13,007
Subsequent units								91,821

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Engineering data for projects when completed—Continued.

IRRIGABLE AREA—Continued.

State, project, and unit.	Public land.			State land.	Indian land.	Private land.		Total.
	Entered.	Open.	Withdrawn.			Railroad.	Other.	
INDIAN PROJECTS.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
Montana: Blackfeet	11,000	.....	50,020	.....	61,480	.....	.....	122,500
Cutbank North	11,000	.....	4,320	.....	4,680	.....	.....	20,000
Cutbank South	.....	.....	13,180	.....	4,820	.....	.....	18,000
Two Medicine	.....	.....	19,120	.....	28,880	.....	.....	48,000
Badger-Fisher	.....	.....	13,000	.....	20,000	.....	.....	33,000
Birch	.....	.....	400	.....	3,100	.....	.....	3,500
Montana: Flathead	35,780	.....	6,720	[1] 9,635	[2] 81,375	.....	990	134,500
Jocko	680	.....	220	700	13,900	.....	.....	15,500
Mission	1,000	.....	250	1,470	19,290	.....	990	23,000
Post	8,300	.....	2,700	2,450	12,550	.....	.....	26,000
Crow	700	.....	50	100	13,150	.....	.....	14,000
Pablo	15,200	.....	2,950	3,600	15,250	.....	.....	37,000
Polson	200	.....	220	85	5,495	.....	.....	6,000
Big Arm	500	.....	290	630	1,580	.....	.....	3,000
Camas	9,200	.....	40	600	160	.....	.....	10,000
Montana: Fort Peck	9,713	107	.....	180	141,600	.....	400	152,000
Little Porcupine	.....	.....	.....	.....	2,610	.....	.....	2,610
Poplar River	.....	.....	.....	.....	28,290	.....	400	28,690
Big Porcupine	.....	.....	.....	.....	4,000	.....	.....	4,000
Big Muddy	.....	.....	.....	.....	18,930	.....	.....	18,930
Missouri River	.....	.....	.....	.....	77,770	.....	.....	77,770
Galpin Bottom pumping	9,713	107	.....	180	.....	.....	.....	10,000
Milk River	.....	.....	.....	.....	10,000	.....	.....	10,000
Total, all projects	652,104	19,659	446,722	106,297	326,405	35,451	1,494,842	3,081,480
Per cent	21.2	0.6	14.5	3.4	10.6	1.2	48.5	100.0

[1] Largely leased and sold under contract.
[2] Allotments of deceased and incompetent Indians sold at semiannual sales.

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CROP STATISTICS.

Summary of crop reports on Government reclamation projects in 1917—areas (acres).

State and project.	Cereals.						Other grain and seed.						Hay and forage.							
	Barley.	Corn, Indian.	Oats.	Rye.	Wheat.	Total.	Alfalfa seed.	Clover seed.	Sorghum (grain).[1]	Flaxseed.	Millet seed.	Total.	Alfalfa hay.	Clover hay.	Other hay.	Corn fodder.	Peas.	Other forage.	Pasture.	Total.
Arizona: Salt River	9,309	1,851	900	.....	3,794	15,854	100	.....	25,471	.....	.....	25,571	67,865	.....	2,443	1,031	.....	.....	53,222	124,561
Arizona-California: Yuma	716	346	.....	.....	184	1,246	4,643	.....	6,883	.....	.....	11,526	12,901	.....	306	.....	.....	309	1,857	15,373
California: Orland	.....	.....	.....	.....	.....	.....	.....	.....	2,495	.....	.....	2,495	5,331	.....	316	.....	.....	.....	2,994	8,641
Colorado:																				
Grand Valley	64	343	631	2	857	1,897	4	.....	.....	.....	20	24	409	.....	193	335	.....	456	65	1,458
Uncompahgre	377	1,419	5,640	28	10,405	17,869	38	48	.....	.....	.....	86	19,436	110	376	254	10	382	2,241	22,809
Idaho:																				
Boise	3,217	1,414	3,205	132	25,676	33,644	375	4,496	21	.....	9	4,901	34,087	7,678	513	440	.....	43	6,555	49,316
Minidoka—																				
Gravity unit	780	132	2,957	166	5,553	9,588	173	696	.....	.....	.....	869	25,957	1,135	.....	.....	134	120	4,647	32,002
Pumping unit	550	7	1,726	.....	9,524	11,807	32	2,398	.....	.....	.....	2,430	16,803	992	77	17	390	16	2,775	21,070
Montana:																				
Huntley	109	186	2,420	.....	4,330	7,045	13	120	.....	11	.....	144	6,002	100	397	66	.....	6	1,450	8,021
Milk River	108	10	682	.....	2,310	3,110	2	.....	.....	534	.....	536	2,067	.....	5,605	.....	.....	.....	66	7,738
Sun River	89	.....	439	.....	1,160	1,688	62	.....	.....	110	.....	172	4,250	.....	294	.....	7	.....	810	5,361
Montana - North Dakota: Lower Yellowstone	798	156	1,526	28	2,963	5,471	28	.....	.....	1,239	.....	1,267	7,481	.....	622	266	.....	.....	606	8,975
Nebraska-Wyoming: North Platte	3,052	6,051	10,173	471	3,128	22,875	40	.....	.....	.....	309	349	34,374	.....	1,015	763	.....	42	3,946	40,140
Nevada: Truckee-Carson	1,116	.....	27	.....	2,532	3,675	.....	.....	.....	.....	.....	.....	22,501	.....	940	.....	.....	.....	10,100	33,541
New Mexico: Carlsbad	120	729	423	15	1,459	2,746	2,113	.....	221	.....	.....	2,334	5,556	.....	643	707	.....	.....	4,175	11,081
New Mexico-Texas: Rio Grande	3,610	10,566	1,145	65	11,714	27,100	33	.....	1,894	.....	.....	1,927	26,112	.....	440	2,113	114	.....	2,158	30,937
Oregon: Umatilla	4	130	.....	.....	9	143	83	.....	.....	.....	3	86	4,047	.....	221	110	.....	.....	1,293	5,671
Oregon-California: Klamath	6,153	.....	3,238	678	2,821	12,890	.....	.....	.....	.....	.....	.....	9,811	.....	1,971	.....	.....	.....	7,836	19,618
South Dakota: Belle Fourche	2,286	2,902	4,955	76	5,122	15,341	942	.....	.....	870	.....	1,812	19,702	.....	4,475	1,166	.....	.....	6,100	31,443
Utah: Strawberry Valley	503	382	2,180	74	8,541	11,680	.....	.....	.....	.....	.....	.....	7,162	.....	233	14	.....	.....	984	8,393
Washington:																				
Okanogan	.....	112	.....	.....	60	172	.....	.....	.....	.....	.....	.....	1,933	30	140	58	.....	.....	138	2,299
Yakima—																				
Sunnyside unit	764	5,796	304	.....	2,919	9,783	.....	.....	.....	.....	.....	.....	31,678	.....	1,209	1,260	.....	1,414	4,031	39,592
Tieton unit	781	603	604	.....	3,912	5,900	.....	.....	.....	.....	.....	.....	10,529	185	544	60	.....	188	1,224	12,730
Wyoming: Shoshone	303	11	7,371	7	5,841	13,533	49	354	.....	.....	.....	403	13,483	173	137	66	.....	.....	2,035	15,894
Total	34,809	33,146	50,546	1,742	114,814	235,057	8,730	8,112	36,985	2,764	341	56,932	389,477	10,403	23,110	8,726	655	2,985	121,308	556,664

[1] Harvested and fed in various forms.

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State and project.	Vegetables and truck.						Fruit and nuts.							
	Beans.	Onions	Potatoes, white.	Potatoes, sweet.	Truck.	Total.	Apples.	Peaches.	Pears.	Prunes.	Citrus fruit.	Small fruit.	Miscellaneous.	Total.
Arizona: Salt River	1,425	.....	373	69	4,380	6,247	.....	595	91	.....	967	462	[1] 341	2,456
Arizona-California: Yuma	367	.....	.....	.....	746	1,113	.....	.....	.....	.....	.....	.....	155	155
California: Orland	79	40	65	.....	279	463	.....	.....	.....	40	121	6	223	390
Colorado:														
Grand Valley	597	3	171	.....	101	872	505	39	110	.....	.....	4	.....	658
Uncompahgre	1,951	570	5,940	.....	115	8,576	2,350	128	6	12	.....	69	.....	2,565
Idaho:														
Boise	475	16	2,165	7	691	3,354	3,126	177	5	266	.....	53	.....	3,627
Minidoka—														
Gravity unit	773	34	2,940	.....	555	4,302	590	.....	.....	.....	.....	18	.....	608
Pumping unit	113	14	2,906	.....	390	3,423	94	.....	.....	.....	.....	3	.....	97
Montana:														
Huntley	129	.....	164	.....	203	496	2	.....	.....	.....	.....	.....	.....	2
Milk River	23	.....	87	.....	31	141	.....	.....	.....	.....	.....	.....	.....	.....
Sun River	.....	.....	165	.....	56	221	.....	.....	.....	.....	.....	3	.....	3
Montana-North Dakota: Lower Yellowstone	88	.....	249	.....	116	453	.....	.....	.....	.....	.....	.....	.....	.....
Nebraska-Wyoming: North Platte	2,304	17	4,833	.....	291	7,445	.....	.....	.....	.....	.....	.....	.....	.....
Nevada: Truckee-Carson	.....	.....	322	.....	555	877	.....	.....	.....	.....	.....	.....	.....	.....
New Mexico: Carlsbad	118	.....	.....	5	32	155	.....	.....	.....	.....	.....	.....	.....	.....
New Mexico-Texas: Rio Grande	4,011	11	7	338	2,940	7,307	378	228	814	.....	.....	115	.....	1,535
Oregon: Umatilla	4	2	106	.....	61	173	342	160	10	.....	.....	49	.....	561
Oregon-California: Klamath	.....	.....	229	.....	106	335	.....	.....	.....	.....	.....	.....	32	32
South Dakota: Bell Fourche	217	.....	285	.....	161	663	.....	.....	.....	.....	.....	.....	.....	.....
Utah: Strawberry Valley	172	.....	434	.....	104	710	33	.....	.....	.....	.....	.....	140	173
Washington:														
Okanogan	117	2	142	.....	82	343	4,637	74	13	5	.....	17	[1] 17	4,763
Yakima—														
Sunnyside unit	968	88	5,394	.....	1,426	7,896	10,677	999	1,481	252	.....	339	.....	13,748
Tieton unit	774	82	1,636	.....	279	2,771	5,275	362	674	.....	.....	47	.....	6,358
Wyoming: Shoshone	131	7	568	.....	251	957	5	.....	.....	.....	.....	2	.....	7
Total	14,856	886	29,181	419	13,951	59,293	28,014	2,762	3,204	575	1,088	1,157	908	37,708

[1] Apricots.

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Summary of crop reports on Government reclamation projects in 1917—areas (acres)—Continued.

State and project.	Miscellaneous.					Duplicated areas.	Total cropped.	Irrigated, no crop.					Total irrigated.
	Beets, sugar.	Cotton.	Cane.	Other.	Total.			Young alfalfa.	Young fruit.	Fall plowing.	Miscellaneous.	Duplicated.	
Arizona: Salt River	.....	23,445	69	[1] 317	23,831	10,020	188,500	.....	5,748	.....	12,352	5,000	201,600
Arizona-California: Yuma	.....	12,706	.....	[1] 303	13,009	6,844	35,578	.....	.....	.....	1,378	.....	36,956
California: Orland	.....	.....	.....	88	88	2,469	9,608	660	1,618	.....	843	.....	12,729
Colorado:													
Grand Valley	456	.....	.....	1,598	2,054	2,440	4,523	370	145	968	.....	717	5,289
Uncompahgre	1,310	.....	.....	68	1,378	566	52,717	2,890	274	1,727	1	4,501	53,108
Idaho:													
Boise	25	.....	.....	495	520	6,630	88,732	8,638	1,313	914	3,087	7,160	95,524
Minidoka—													
Gravity unit	2,753	.....	.....	1,553	4,306	.....	51,675	4,645	384	340	35	1,279	55,800
Pumping unit	2,126	.....	.....	.....	2,126	172	40,781	1,455	130	424	1,570	1,140	43,220
Montana:													
Huntley	3,366	.....	16	15	3,397	.....	19,105	.....	17	.....	.....	.....	19,122
Milk River	.....	.....	.....	26	26	658	10,893	165	.....	.....	.....	.....	11,058
Sun River	.....	.....	.....	.....	.....	.....	[2] 7,445	.....	.....	.....	20	.....	[2] 6,675
Montana-North Dakota: Lower Yellowstone	307	.....	.....	46	353	860	15,659	.....	.....	.....	85	.....	15,744
Nebraska-Wyoming: North Platte	9,357	.....	.....	594	9,951	.....	80,760	8,280	.....	.....	666	6,503	83,203
Nevada: Truckee-Carson	2,168	.....	.....	.....	2,168	1,025	39,236	.....	.....	.....	1,156	.....	40,392
New Mexico: Carlsbad	.....	4,015	428	.....	4,443	5,030	15,729	111	.....	.....	2,488	1,446	16,882
New Mexico-Texas: Rio Grande	1,078	.....	.....	5	1,083	6,263	63,626	39	1,188	.....	545	1,090	64,308
Oregon: Umatilla	.....	.....	.....	77	77	1,165	5,546	906	518	82	380	97	7,335
Oregon-California: Klamath	54	.....	.....	.....	54	.....	32,929	.....	.....	.....	706	.....	33,635
South Dakota: Belle Fourche	1,771	.....	.....	169	1,940	1,173	50,026	2,275	14	.....	.....	2,043	50,272
Utah: Strawberry Valley	5,157	.....	9	.....	5,166	502	25,620	.....	.....	.....	1,527	.....	27,147
Washington:													
Okanogan	.....	.....	.....	43	43	1,306	6,314	139	881	.....	860	194	8,000
Yakima—													
Sunnyside unit	1,976	.....	.....	122	2,098	7,314	65,803	2,569	1,055	.....	12,590	1,517	80,500
Tieton unit	247	.....	.....	324	571	3,905	24,425	689	1,520	.....	581	1,815	25,400
Wyoming: Shoshone	773	.....	.....	.....	773	13	31,554	2,467	132	281	159	1,829	32,764
Total	32,924	40,166	522	5,843	79,455	58,355	[3] 966,784	36,298	14,937	4,736	41,029	36,331	[3] 1,026,663

[1] Broom corn. [2] Figures for Sun River project are for 176 irrigated farms, which included 770 acres cropped without irrigation and 20 acres irrigated, but not cropped.

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Summary of crop reports on Government reclamation projects in 1917—Total yields.

State and project.	Cereals.						Other grain and seed.						Hay and forage.						
	Barley.	Corn, Indian.	Oats.	Rye.	Wheat.	Total.	Alfalfa seed.	Clover seed.	Sorghum [1] (grain).	Flaxseed.	Millet seed.	Total.	Alfalfa hay.	Clover hay.	Other hay.	Corn fodder.	Peas.	Other forage.	Total.
	Bush.	*Bush.*	*Bushels.*	*Bush.*	*Bushels.*	*Bushels.*	*Bush.*	*Bush.*	*Bushels.*	*Bush.*	*Bush*	*Bushels.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Bush*	*Tons.*	*Tons.*
Arizona: Salt River	320,000	59,500	47,750	.....	88,540	515,790	217	.....	1,001,000	.....	.....	1,001,217	285,030	.....	4,642	5,362	.....	.....	295,034
Arizona-California: Yuma	21,578	10,230	.....	.....	3,479	35,287	26,475	.....	280,540	.....	.....	307,015	43,177	.....	882	.....	.....	1,770	45,829
California: Orland	.....	.....	.....	.....	.....	.....	.....	.....	70,970	.....	.....	70,970	25,700	.....	431	.....	.....	.....	26,131
Colorado:																			
Grand Valley	799	6,958	11,145	30	13,095	32,027	30	.....	.....	.....	133	163	1,162	.....	120	845	.....	.....	2,127
Uncompahgre	9,989	39,864	164,362	579	247,427	462,221	104	120	.....	.....	.....	224	54,057	125	447	1,457	280	2,773	58,857
Idaho:																			
Boise	65,618	53,600	81,790	1,540	544,800	747,348	843	17,138	108	.....	200	18,289	132,805	15,570	725	2,887	.....	430	152,417
Minidoka—																			
Gravity unit	20,105	3,267	85,502	1,807	128,276	238,957	1,065	4,018	.....	.....	.....	5,083	96,809	3,501	.....	.....	1,601	2,038	102,396
Pumping unit	11,358	160	46,814	.....	189,030	247,362	116	8,955	.....	.....	.....	9,071	56,374	2,063	101	75	4,048	252	58,987
Montana:																			
Huntley	1,304	3,497	70,470	.....	83,450	158,721	56	508	.....	5	.....	569	14,062	117	401	106	.....	18	14,704
Milk River	602	180	11,503	.....	14,805	27,090	16	.....	.....	1,915	.....	1,931	3,313	.....	3,289	.....	.....	.....	6,602
Sun River	2,192	.....	10,924	.....	21,716	34,832	392	.....	.....	439	.....	831	7,087	.....	275	.....	65	.....	7,364
Montana-North Dakota: Lower Yellowstone	14,646	4,252	39,530	466	41,850	100,744	93	.....	.....	7,295	.....	7,388	14,135	.....	540	606	.....	.....	15,281
Nebraska-Wyoming: North Platte	94,868	117,008	243,764	3,434	47,467	506,541	51	.....	.....	.....	2,799	2,850	58,656	.....	853	1,191	.....	444	61,144
Nevada: Truckee-Carson	26,834	.....	938	.....	43,233	71,005	.....	.....	.....	.....	.....	.....	73,171	.....	763	.....	.....	.....	73,934
New Mexico: Carlsbad	926	11,947	6,021	195	13,738	32,827	6,542	.....	4,865	.....	.....	11,407	9,762	.....	237	787	.....	.....	10,786
New Mexico-Texas: Rio Grande	91,679	265,836	40,294	1,210	261,970	660,989	139	.....	38,566	.....	.....	38,705	64,569	.....	677	6,188	1,240	.....	71,471
Oregon: Umatilla	48	3,799	.....	.....	150	3,997	256	.....	.....	.....	15	271	14,834	.....	195	571	.....	.....	15,600
Oregon-California: Klamath	109,259	.....	82,708	4,896	39,753	236,616	.....	.....	.....	.....	.....	.....	31,158	.....	2,837	.....	.....	.....	33,995
South Dakota: Belle Fourche	55,164	46,290	106,309	1,500	67,095	276,358	2,335	.....	.....	2,129	.....	4,464	35,692	.....	.....	1,918	.....	.....	37,610
Utah: Strawberry Valley	24,311	6,320	76,169	334	203,753	310,887	.....	.....	.....	.....	.....	.....	22,588	.....	418	26	.....	.....	23,032
Washington:																			
Okanogan	.....	2,679	.....	.....	758	3,437	.....	.....	.....	.....	.....	.....	4,588	43	136	135	.....	.....	4,902
Yakima—																			
Sunnyside unit	23,779	274,000	13,452	.....	58,380	369,611	.....	.....	.....	.....	.....	.....	143,551	.....	3,627	8,820	.....	21,210	177,208
Tieton unit	16,510	22,468	19,313	.....	81,653	139,944	.....	.....	.....	.....	.....	.....	32,244	275	813	211	.....	1,948	35,491
Wyoming: Shoshone	4,491	196	185,198	40	114,365	304,290	173	1,528	.....	.....	.....	1,701	30,258	256	114	362	.....	.....	30,990
Total	916,060	932,051	1,343,956	16,031	2,308,783	5,516,881	38,903	32,267	1,396,049	11,783	3,147	1,482,149	1,254,782	21,950	22,523	31,547	7,234	30,883	1,361,902

[1] Harvested or fed in various forms; the figures are in terms of grain.

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Summary of crop reports on Government reclamation projects in 1917—Total yields—Continued.

State and project.	Vegetables.				Fruits and nuts.								Miscellaneous.			
	Beans.	Onions.	Potatoes, white.	Potatoes, sweet.	Apples.	Peaches.	Pears.	Prunes.	Citrus fruit.	Small fruit.	Miscellaneous.	Total.	Sugar beets.	Cotton.	Cotton-seed.	Cane.
	Bush.	*Bush.*	*Bushels.*	*Bush*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Tons.*	*Pounds.*	*Pounds.*	*Tons.*
Arizona: Salt River	38,900	.....	37,300	115	.....	3,336,760	118,730	.....	[1]6,560,000	[1]3,500,000	2,046,500	15,561,990	.....	5,861,000	16,410,000	172
Arizona- alifornia: Yuma	4,454	.....	.....	.....	.....	.....	.....	.....	.....	.....	[1]300,000	300,000	.....	5,253,454	12,380,000	.....
California: Orland	602	10,000	3,900	.....	.....	.....	.....	76,000	81,600	[1]20,000	150,210	327,810	.....	.....	.....	.....
Colorado:																
Grand Valley	4,576	328	13,826	.....	1,492,000	260,330	293,940	.....	.....	4,300	.....	2,050,570	4,822	.....	.....	.....
Uncompahgre	21,770	147,575	1,315,382	.....	12,760,850	795,250	18,560	30,750	.....	139,750	.....	13,745,160	10,954	.....	.....	.....
Idaho:																
Boise	4,800	1,770	350,450	540	6,578,000	770,000	5,000	307,650	.....	53,000	.....	7,713,650	375	.....	.....	.....
Minidoka—																
Gravity unit	19,930	1,865	601,756	.....	782,110	.....	.....	.....	.....	18,000	.....	800,110	35,364	.....	.....	.....
Pumping unit	1,216	1,002	647,975	.....	85,810	.....	.....	.....	.....	2,450	.....	88,260	23,825	.....	.....	.....
Montana:																
Huntley	376	.....	21,272	.....	1,800	.....	.....	.....	.....	.....	.....	1,800	28,553	.....	.....	105
Milk River	150	.....	7,563	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sun River	.....	.....	28,704	.....	.....	.....	.....	.....	.....	2,070	.....	2,070	.....	.....	.....	.....
Montana-North Dakota: Lower Yellowstone	563	.....	28,557	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,443	.....	.....	.....
Nebraska-Wyoming North Platte	14,224	1,695	1,119,626	.....	.....	.....	.....	.....	.....	.....	.....	.....	99,790	.....	.....	.....
Nevada: Truckee- arson	.....	.....	56,433	.....	.....	.....	.....	.....	.....	.....	.....	.....	11,048	.....	.....	.....
New Mexico: arlsbad	492	.....	.....	398	.....	.....	.....	.....	.....	.....	.....	.....	.....	754,987	1,212,480	866
New Mexico-Texas: Rio Grande	46,058	43	630	21,290	262,960	400	837,612	.....	.....	193,530	.....	1,294,502	8,420	.....	.....	.....
Oregon: Umatilla	21	226	10,311	.....	772,720	438,834	22,100	.....	.....	[1]100,000	.....	1,333,654	.....	.....	.....	.....
Oregon- alifornia: Klamath	.....	.....	24,323	.....	.....	.....	.....	.....	.....	.....	[1]32,000	32,000	549	.....	.....	.....
South Dakota: Belle Fourche	1,155	.....	27,310	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,502	.....	.....	.....
Utah: Strawberry Valley	1,649	.....	51,286	.....	87,500	.....	.....	.....	.....	.....	[1]140,000	227,500	52,888	.....	.....	34
Washington:																
Okanogan	722	[1]300	13,383	.....	18,017,680	266,100	94,535	20,500	.....	[1]50,000	103,050	18,551,865	.....	.....	.....	.....
Yakima—																
Sunnyside unit	18,706	8,820	1,252,333	.....	94,982,400	8,487,500	12,573,500	3,798,525	.....	[1]1,000,000	.....	120,841,925	19,760	.....	.....	.....
Tieton unit	12,457	12,123	284,275	.....	21,234,350	1,345,400	1,747,480	.....	.....	146,890	.....	24,474,120	2,103	.....	.....	.....
Wyoming: Shoshone	769	1,410	118,788	.....	1,280	.....	.....	.....	.....	1,650	.....	2,930	7,075	.....	.....	.....
Total	193,590	187,157	6,015,383	22,343	157,059,460	15,700,574	15,711,457	4,233,425	6,641,600	5,231,640	2,771,760	207,349,916	318,471	11,869,441	30,002,480	1,177

[1] Estimated roughly.

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Summary of crop reports on Government reclamation projects in 1917—Crop values.

State and project.	Cereals.						Other grain and seed.					
	Barley.	Corn, Indian.	Oats.	Rye.	Wheat.	Total.	Alfalfa seed.	Clover seed.	Sorghum. (grain).	Flax-seed.	Millet seed.	Total.
Arizona, Salt River	$422,415	$66,636	$39,395	.....	$159,369	$687,816	$1,600	.....	$1,260,810	.....	.....	$1,262,500
Arizona-California, Yuma	24,366	10,757	.....	.....	6,314	41,437	262,928	.....	281,120	.....	.....	544,048
California, Orland	.....	.....	.....	.....	.....	.....	.....	.....	106,455	.....	.....	106,455
Colorado:												
Grand Valley	1,118	13,333	10,120	$ 54	26,345	50,970	234	.....	.....	.....	$240	474
Uncompahgre	13,682	58,653	135,520	856	472,111	680,822	906	$766	.....	.....	.....	1,672
Idaho:												
Boise	78,742	80,416	81,790	2,156	1,089,600	1,332,704	8,430	222,794	216	.....	300	231,740
Minidoka—												
Gravity unit	20,105	3,267	68,402	1,807	228,331	321,912	9,585	56,252	.....	.....	.....	65,837
Pumping unit	11,358	160	37,451	.....	336,473	385,442	1,044	125,370	.....	.....	.....	126,414
Montana:												
Huntley	1,570	5,100	54,915	.....	156,838	218,423	820	4,800	.....	$10	.....	5,720
Milk River	602	180	9,202	.....	28,129	38,113	240	.....	.....	5,688	.....	5,928
Sun River	2,192	.....	9,285	.....	41,260	52,737	4,228	.....	.....	1,273	.....	5,501
Montana-North Dakota, Lower Yellowstone	14,646	5,953	27,671	699	82,863	131,832	1,209	.....	.....	21,825	.....	23,034
Nebraska-Wyoming, North Platte	113,842	175,512	170,635	5,151	85,440	550,580	510	.....	.....	.....	4,200	4,710
Nevada, Truckee-Carson	33,540	.....	938	.....	82,143	116,621	.....	.....	.....	.....	.....	.....
New Mexico, Calsbad	2,032	18,998	5,744	351	27,515	54,640	56,378	.....	8,566	.....	.....	64,944
New Mexico-Texas, Rio Grande	128,350	372,170	32,235	2,372	523,940	1,059,067	1,688	.....	46,267	.....	.....	47,955
Oregon, Umatilla	60	7,395	.....	.....	315	7,770	2,625	.....	.....	.....	100	2,725
Oregon-California, Klamath	118,000	.....	66,166	8,911	77,518	270,595	.....	.....	.....	.....	.....	.....
South Dakota, Belle Fourche	68,955	92,580	74,416	2,550	127,480	365,981	18,680	.....	.....	4,790	.....	23,470
Utah, Strawberry Valley	36,466	6,067	76,169	601	387,131	506,434	.....	.....	.....	.....	.....	.....
Washington:												
Okanogan	.....	3,257	.....	.....	1,966	5,223	.....	.....	.....	.....	.....	.....
Yakima—												
Sunnyside unit	33,290	342,500	13,450	.....	116,760	506,000	.....	.....	.....	.....	.....	.....
Tieton unit	21,463	28,085	17,382	.....	146,975	213,905	.....	.....	.....	.....	.....	.....
Wyoming, Shoshone	5,165	294	148,159	46	211,575	365,239	1,903	16,808	.....	.....	.....	18,711
Total	1,151,960	1,291,313	1,079,045	25,554	4,416,391	7,964,263	373,078	426,880	1,708,434	33,586	4,840	2,541,818

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Summary of crop reports on Government reclamation projects in 1917—Crop values—Continued.

State and project.	Hay and forage.								Vegetables and truck.					
	Alfalfa hay.	Clover hay.	Other hay.	Corn fodder.	Peas.	Other forage.	Pasture.	Total.	Beans.	Onions.	Potatoes, white.	Potatoes, sweet.	Truck.	Total.
Arizona, Salt River	$4,275,450	.....	$64,988	$134,050	.....	.....	$1,064,444	$5,538,932	$192,375	.....	$50,353	$16,500	$551,985	$811,213
Arizona-California, Yuma	642,870	.....	8,811	.....	.....	$75,962	24,278	751,921	20,329	.....	.....	.....	80,617	100,946
California, Orland	362,370	.....	7,110	.....	.....	.....	18,992	388,472	3,250	$2,015	2,925	.....	18,837	27,027
Colorado:														
Grand Valley	15,861	.....	1,596	4,562	.....	2,355	654	25,028	23,044	600	15,480	.....	7,467	46,591
Uncompahgre	651,608	$1,263	4,590	12,555	$720	23,426	18,082	712,244	111,342	175,898	1,070,955	.....	10,313	1,368,508
Idaho:														
Boise	1,992,075	233,550	8,700	14,435	.....	2,150	62,250	2,313,160	28,800	2,124	262,840	1,180	50,263	345,207
Minidoka—														
Gravity unit	1,452,135	52,515	.....	.....	4,803	10,190	71,728	1,591,371	119,580	4,476	451,317	.....	45,173	620,546
Pumping unit	845,610	30,945	1,515	750	12,144	1,260	48,222	940,446	7,296	2,405	485,981	.....	26,415	522,097
Montana:														
Huntley	206,840	1,944	6,921	1,180	.....	180	9,237	226,302	2,330	.....	16,300	.....	12,797	31,427
Milk River	62,947	.....	82,225	.....	.....	.....	465	145,637	1,290	.....	13,612	.....	3,430	18,332
Sun River	120,479	.....	4,147	.....	97	.....	4,136	128,859	.....	.....	25,533	.....	5,890	31,723
Montana-North Dakota, Lower Yellowstone	216,266	.....	6,750	6,363	.....	.....	7,575	236,954	6,090	.....	32,941	.....	11,921	50,942
Nebraska-Wyoming, North Platte	997,152	.....	10,236	2,382	.....	2,220	50,990	1,062,880	85,344	3,814	895,700	.....	28,865	1,013,723
Nevada, Truckee-Carson	1,097,565	.....	7,630	.....	.....	.....	46,010	1,151,205	.....	.....	50,790	.....	43,480	94,270
New Mexico, Carlsbad	214,444	.....	4,244	8,903	.....	.....	32,550	260,141	2,789	.....	.....	955	2,363	6,107
New Mexico-Texas, Rio Grande	1,743,363	.....	13,540	99,008	5,208	.....	64,740	1,925,859	173,078	61	787	12,774	295,145	481,845
Oregon, Umatilla	227,940	.....	2,565	4,630	.....	.....	15,895	251,030	160	325	11,680	.....	7,310	19,475
Oregon-California, Klamath	467,370	.....	42,555	.....	.....	.....	35,262	545,187	.....	.....	20,674	.....	6,650	27,324
South Dakota, Belle Fourche	535,380	.....	49,728	15,344	.....	.....	66,709	667,161	6,930	.....	24,579	.....	11,906	43,415
Utah, Strawberry Valley	338,820	.....	4,180	130	.....	.....	9,694	352,824	9,148	.....	33,849	.....	7,086	50,083
Washington:														
Okanogan	68,826	645	2,041	1,348	.....	.....	2,165	75,025	4,362	431	8,041	.....	9,215	22,049
Yakima—														
Sunnyside unit	2,871,020	.....	79,795	52,920	.....	169,680	100,775	3,274,190	104,754	11,025	1,001,865	.....	206,540	1,324,184
Tieton unit	580,392	4,125	12,195	1,055	.....	14,610	30,600	642,977	74,742	21,215	213,206	.....	34,875	344,038
Wyoming, Shoshone	453,870	3,840	1,710	5,430	.....	.....	46,825	511,675	4,614	2,115	83,152	.....	25,920	115,801
Total	20,440,653	328,927	427,772	365,045	22,972	302,033	1,832,178	23,719,480	981,637	226,504	4,772,760	31,409	1,504,463	7,516,773

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State and project.	Fruit and nuts.								Miscellaneous.					Total.
	Apples.	Peaches.	Pears.	Prunes.	Citrus fruit.	Small fruit.	Miscellaneous.	Total.	Beets, sugar.	Cotton and cotton seed.	Cane.	Other.	Total.	
Arizona, Salt River	.....	$66,735	$3,560	.....	$272,439	$97,393	$51,162	$491,289	.....	$4,838,050	$4,300	$7,900	$4,990,250	$13,692,000
Arizona-California, Yuma	.....	.....	.....	.....	.....	.....	7,544	7,544	.....	2,280,823	.....	25,950	2,306,773	3,752,669
California, Orland	.....	.....	.....	$5,320	2,448	700	7,448	15,916	.....	.....	.....	5,700	5,700	543,570
Colorado:														
Grand Valley	$23,511	7,478	7,213	.....	.....	213	.....	38,415	$33,754	.....	.....	3,728	37,482	198,960
Uncompahgre	180,057	14,192	771	730	.....	7,472	.....	203,222	78,323	.....	.....	6,877	85,200	3,061,668
Idaho:														
Boise	98,670	7,700	150	5,394	.....	2,650	.....	114,554	2,250	.....	.....	46,930	49,180	4,386,545
Minidoka—														
Gravity unit	15,612	.....	.....	.....	.....	2,700	.....	18,312	247,548	.....	.....	110,229	357,777	2,975,785
Pumping unit	1,716	.....	.....	.....	.....	368	.....	2,084	166,775	.....	.....	.....	166,775	2,143,258
Montana:														
Huntley	40	.....	.....	.....	.....	.....	.....	40	207,560	.....	1,075	283	208,918	690,530
Milk River	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	325	325	208,335
Sun River	.....	.....	.....	.....	.....	310	.....	310	.....	.....	.....	.....	.....	212,130
Montana-North Dakota, Lower Yellowstone	.....	.....	.....	.....	.....	.....	.....	.....	15,980	.....	.....	1,015	16,995	450,557
Nebraska-Wyoming, North Platte	.....	.....	.....	.....	.....	.....	.....	.....	748,425	.....	.....	4,742	753,167	3,385,060
Nevada, Truckee-Carson	.....	.....	.....	.....	.....	.....	.....	.....	88,381	.....	.....	.....	88,381	1,450,490
New Mexico, Carlsbad	.....	.....	.....	.....	.....	.....	.....	.....	.....	222,510	15,476	.....	237,986	623,318
New Mexico-Texas, Rio Grande	10,518	16	25,128	.....	.....	5,806	.....	41,468	42,100	.....	.....	150	42,250	3,598,424
Oregon, Umatilla	13,639	5,895	760	.....	.....	4,205	.....	24,490	.....	.....	.....	5,905	5,905	311,395
Oregon-California, Klamath	.....	.....	.....	.....	.....	.....	900	900	3,294	.....	.....	.....	3,294	847,200
South Dakota, Belle Fourche	.....	.....	.....	.....	.....	.....	.....	.....	68,263	.....	.....	2,949	71,212	1,171,239
Utah, Strawberry Valley	1,093	.....	.....	.....	.....	.....	9,755	10,848	370,216	.....	340	.....	370,556	1,290,745
Washington:														
Okanogan	495,486	5,322	2,701	410	.....	3,011	2,061	508,991	.....	.....	.....	5,352	5,352	616,640
Yakima—														
Sunnyside unit	1,899,650	212,188	439,970	132,948	.....	50,850	.....	2,735,606	138,320	.....	.....	27,930	166,250	3,006,230
Tieton unit	424,687	33,635	34,950	.....	.....	10,282	.....	503,554	14,721	.....	.....	58,400	73,121	1,777,595
Wyoming, Shoshone	64	.....	.....	.....	.....	165	.....	229	49,525	.....	.....	.....	49,525	1,061,180
Total	3,164,764	353,161	515,203	144,792	274,887	186,125	78,770	4,717,702	2,275,338	7,391,383	21,191	314,365	10,002,277	56,462,313

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Cost of plowing with tractor outfits, Sun River project. G. A. Benjamin. (From May Reclamation Record.) Eng. and Cont., June 19, 1918, vol. 49, pp. 616–617.

Plowing with tractors, Sun River project. G. A. Benjamin (from May Reclamation Record), Western Engineering, July, 1918, vol. 9, p. 283 (short news item of cost).

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Flow conditions, Congo Low Line Flume, North Platte project, with diagram. John S. Longwell, Reclamation Record, Aug. 1917, vol. 8, pp. 387–388.

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Why some irrigation canals and reservoirs leak. illus., A. P. Davis, Eng. News-Record, Apr. 4, 1918, vol. 80, pp. 663–665.

NEW MEXICO, HONDO PROJECT.

Why some irrigation canals and reservoirs leak, illus. A. P. Davis, Eng. News-Record, Apr. 4, 1918, vol. 80, pp. 663–665.

NEW MEXICO-TEXAS, RIO GRANDE PROJECT.

A comparison of the Elephant Butte and Arrowrock Dams. Jos. E. Sater, Concrete, Dec., 1917, vol. 11, p. 183. (From Rec. Record.)

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Safety for two great dams, illus. (abstract of article by Jos. E. Sater in Oct., 1917, Reclamation Record). Mine and Quarry, July, 1918, vol. 10, pp. 1066–1067.

Undeveloped water power in the Southwest, illus. (view of Elephant Butte Dam). F. H. Fowler, Journal of Electricity, Sept. 15, 1918, vol. 41, pp. 246–249.

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Cost of the Cold Springs Dam (letter). V. P. Strange, Eng. Record, June 20, 1908, vol. 57, p. 792.

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GENERAL INDEX.

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CHAPTER VI

Department of the Interior
United States Reclamation Service
Rio Grande Project - New Mexico, Texas.
Annual History - 1918.

HISTORY OF DRAINAGE
ON THE
RIO GRANDE PROJECT

To December 31st, 1918.

INVESTIGATIONS, PLANS and ESTIMATES
SURVEYS and CONSTRUCTION.

by

L. R. F I O C K,
Ass't. Eng.

El Paso, Texas.
Feb. 1919.

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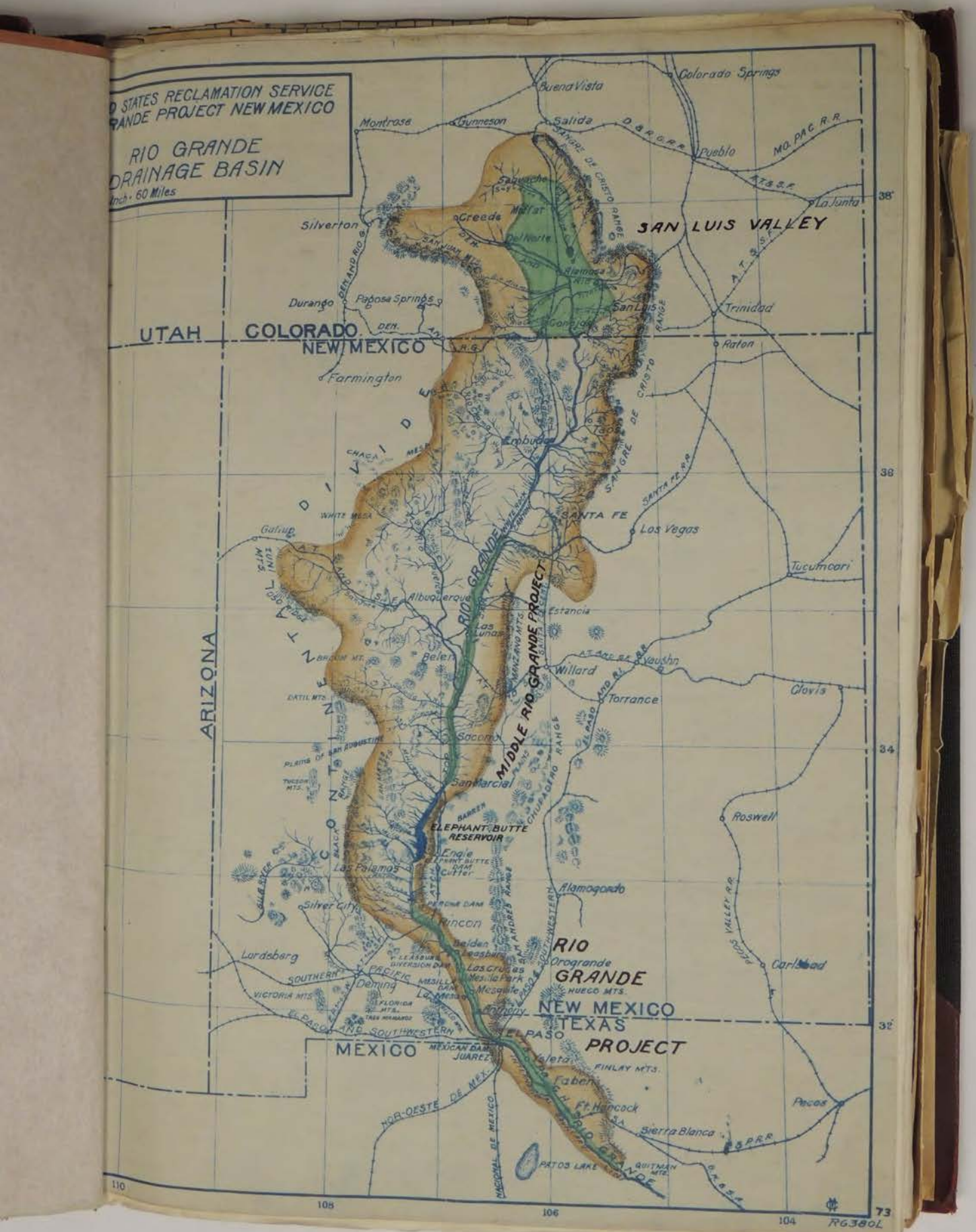

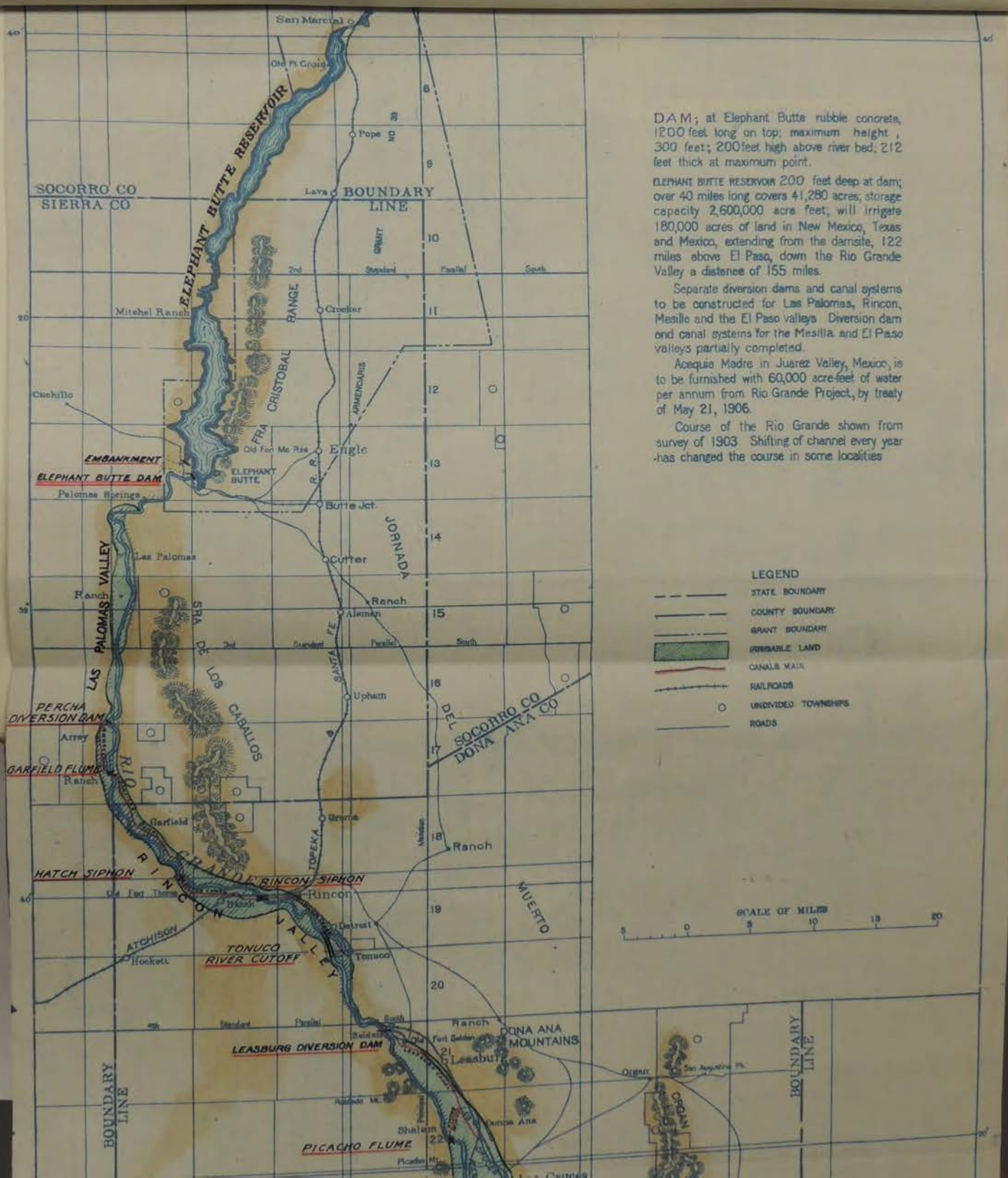

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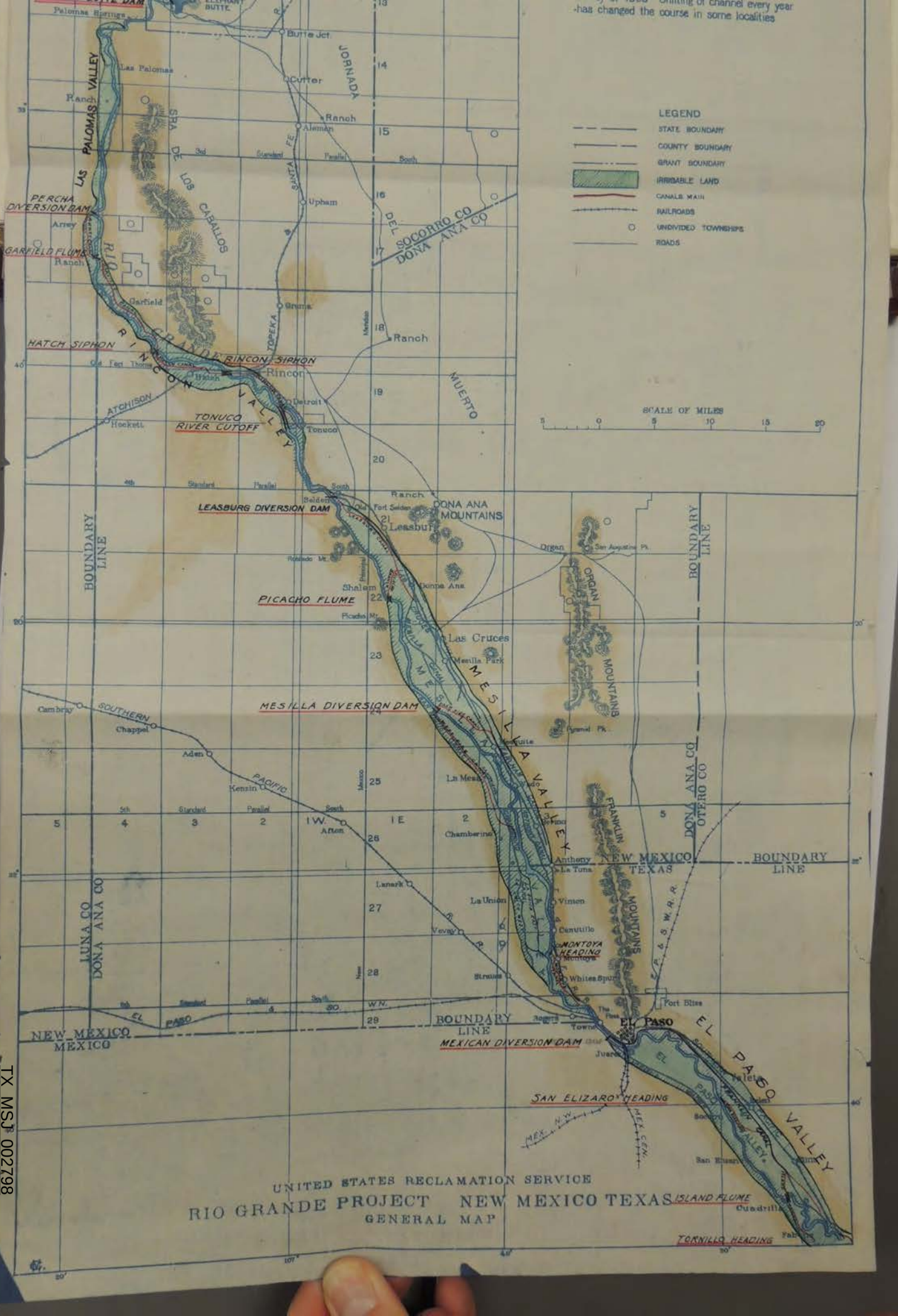

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CHAPTER VI

Drainage on the Rio Grande Project.

by

R. L. Flock
Ass't Eng.

Organization:-

Reports and Records

Outline of Reports

GENERAL OUTLINE

Introduction:-

Units and Features Active

El Paso Valley

Mesilla Valley

Rincon Valley

Organization:-

Drainage Engineer

El Paso Office

Field Headquarters

El Paso Valley

Mesilla Valley

El Paso Machine Shop

Dragline Excavators

Structures

Organization Charts

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Investigations and June 1918

Ground Wate Dec. 1918

Organization sheets and Pay Roll Dec. 1918

Ground Water Rise

Curve of Fluctuation of Ground Water

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Reports and Records

Outline of Reports

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Monthly

Set of Report Forms, Their Purpose and Use.

Operators Daily Report

Recordman's Monthly Summary of

Test Wells

Operator's Daily Report

Excavating Machine Operation (Cost)

Excavating Machine Efficiency

Seeped Areas

Monthly Summary of Operators Efficiency

Monthly Summary of Machine Efficiency

Structure Foreman's Daily Report

Engineer's Monthly report on Structures

Chief of Party-Daily-Monthly Report

Motor Vehicles - Daily-Monthly Report

Engineer's Monthly Summary

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Investigations and Studies:-

Ground Water

Test Well Sections; description of

Ground Water Rise

Curve of Fluctuation of Ground Water

being average of 20 Wells in El Paso

Valley

Test Wells

Number Set

Description of method of

Setting and Tools used.

Seeped Areas

Seeped areas on the Project

Table showing extend of seeped areas

and depth of Ground Water.

Seepage Maps

Method of Preparation

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Accumulation of and its appearance on the Surface.

Tables of Analysis of Drain and River Water.

Effects of Constructed Drains.

Effects on Water Table

Slope of Water Table to Drains

Lateral Effect

Effect along Canals and River

Areas Reclaimed and Protected.

Table of Areas

Cost per acre

Discharge of Drains

Gagings on Constructed Drains

Fluctuation in and out of irrigation seepage.

Discharge per mile of Drain

" " acre constituting

Table for December 1918

" " August 1918

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Plans and Estimates for Total System.

Board Report Jan. 1917.

Extracts from Contract with

Condition of Constructed Drains

Caving Banks and Rising Grade

Tumble Weeds.

Tules and Moss.

Photograph showing Caving Banks

and High Bottoms.

Bank Protection.

Purpose.

Discription and Cost.

Photographs.

Rio Grande; River Investigation.

Cross Sections.

Water Surface Profile.

Discharge Measurements for

Loss and Return flow.

Tonuco River Cut Off.

Fabens River Cut Off.

Plans and Estimates.

Plans and Estimate.

Board Reports April 1915.

Beginning of Construction

Board Report Feb. 1917.

Estimates for Contract with

Irrigation District.

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Plans and Estimates for Total System.

Board Report Jan. 1917.

Extracts from Contract with

Irrigation District.

El Paso County Improvement District No.

Elephant Butte Irrigation District.

Estimates for Authority.

April 1918.

January 1919.

Designs and Drafting.

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Location Surveys.

Right of Way.

Petition Form.

Cost of Investigation and Surveys.

Construction.

Construction Program.

Construction Plant.

Dragline Plant.

4 Photographs.

Instructions to Dragline Operators.

Motor Vehicles.

Materials and Supplies.

Cost and Efficiency of Plant Operation.

Complied from Engineering Data.

" " Cost Records.

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Structures

Major Structures.

Minor Structures.

Number of Structures Built and Cost of.

Contract Work

Leasburg Drain Contract No. 800.

With the Jennings Construction and Engineering Co.

Construction Progress.

Engineers Yearly Summary.

Construction Progress by Months.

Maps.

El Paso Valley.

Mesilla Valley.

Construction Cost.

Actual Cost to Date Compared with Estimate.

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CHAPTER VI

By

L. R. Fiock, Asst. Engr.

INTRODUCTION

Activities in drainage operations along the line of investigations, surveys and construction progressed during the year in the various units of the project as indicated below.

(1) El Paso Valley, including San Elizario Island, Location and Construction of open drains, excavation and structures, additional and progressive ground water measurements and studies.

(2) Mesilla Valley, Location and construction of open drains, excavation and structures, progressive ground water measurements and studies.

(3) Rincon Valley, Location of drains in Hatch District, additional and progressive ground water measurements and studies.

ORGANIZATION.

Drainage Engineer: All drainage activities were carried on under the direction of Mr. J. L. Burkholder, as drainage engineer in charge of this feature. The organization performing the duties connected with the development of the feature is shown by six month's intervals on the accompanying diagrams.

Mr. Burkholder was away from the project on a number of trips, first in connection with the perfecting and in-

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spection of excavating machinery and then on consulting trips to other projects. Below are the dates on which he was away from this project.

Jan. 15 to Jan. 26, San Francisco, selecting engines for draglines.

Jan. 31 to Feb. Denver, Conference to contract for longer engines on Draglines.

July 12 to Aug. 8, Evansville, etc. to inspect draglines.

Aug. 31 to Oct. 18, Drainage Investigation, Denver, North Platte San Luis, Arkansas Valleys.

Nov. 2 to Nov. 28, Drainage Consulting, North Platte, Truckee, Carson.

Dec. 28 to Jan. 12, Denver.

El Paso Office: It has been the functions of the El Paso office to direct all investigations and to assemble and work up the data collected; to formulate and project the plans of drains locations for the guidance of the field engineers, and the preparing of estimates. All construction records are compiled in this office and progress and efficiency reports prepared. Several structure designs, both standard and special, have been prepared and a great deal of machine drafting has been done for the master mechanic and in the preparation of a catalog of repair parts. All right of way plats and descriptions are prepared in this office.

Field Headquarters: There are two field headquarters, one in each valley in which the drainage construction feature is active. Each of these headquarters consists of an office, storehouse, material yard, and storage tanks for fuel and oil. It is the residence of the field engineer in charge of the unit and all engineering and supervision on surveys and construction

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is accomplished from these quarters. All material for structures and supplies to excavators is delivered from these points by motor trucks. A field timekeeper and costkeeper and store house clerk working under the direction of the chief clerk take care of the clerical work.

The El Paso Valley Headquarters are at Clint, Texas. On December 1st the drainage and lateral features in the El Paso Valley were combined under one field engineer.

The Mesilla Valley Headquarters are at Berino, N.Mex. and here a camp and mess is maintained in connection with the plant.

El Paso Machine Shop: Was founded primarily to take care of repair work on the excavators but handles all the mechanical repair work for the project, except the heavier work and castings. A master mechanic is in charge of all mechanical repair and shop work. In connection with this shop there is a garage for automobile repair, and the project main storehouse which is operated under the direction of the chief clerk.

Dragline Excavators: Are each in the immediate charge of a chief operator who operates the day shift. Under him are two other operators, the machines being operated three eight hour shifts a day. Engineering and general supervision of the operation of the machines and the work done by them is under the direction of the field engineer or his assistant. The mechanical supervision is a part of the duties of the master mechanic.

Structure: Construction is accomplished by structure

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crews in charge of a foreman who reports to the field engineer or his assistant. It often occurs that one foreman will have work going on on several structures at the same time in which case he delegates sub-foremen to look after each structure.

Organization Charts: Are attached for
June 1918 and
December 1918.

Monthly Pay Roll for December, 1918; Showing personnel, designation, rate and amount earned is also included.

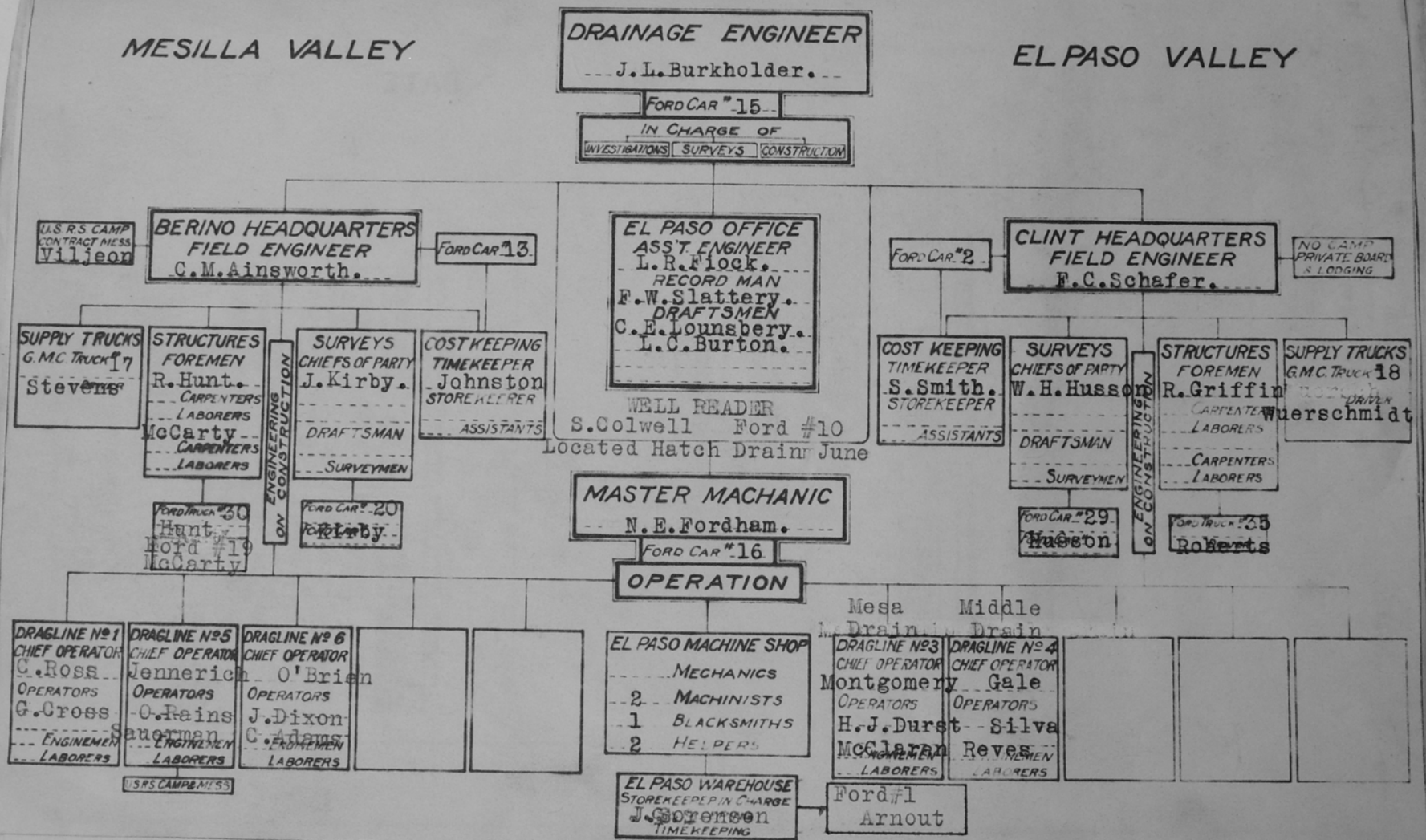
TX_MSJ_002809

RIO GRANDE PROJECT N.M-TEX.

L.M.Lawson. ----Project Manager.

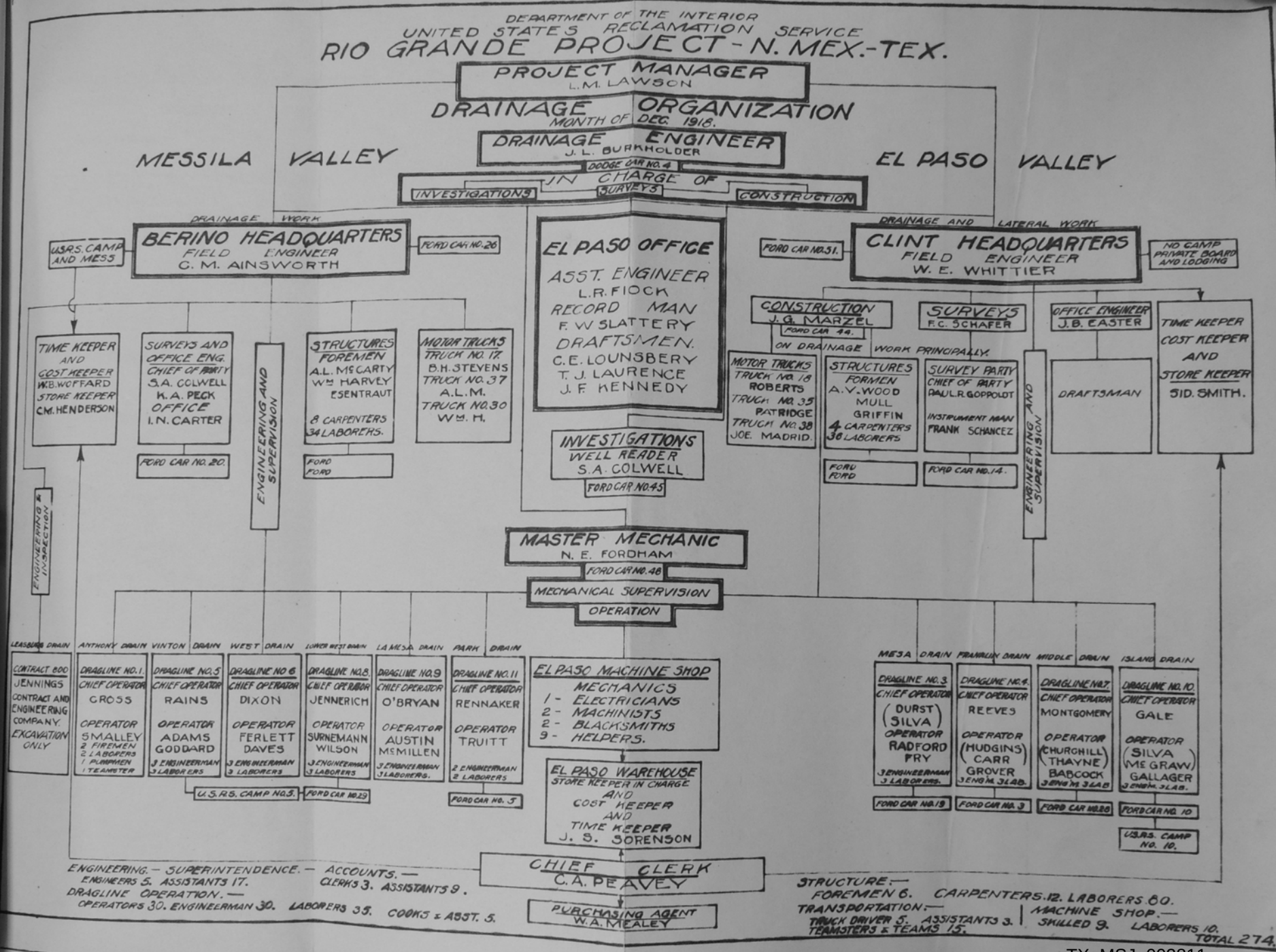
DRAINAGE ORGANIZATION

MONTH OF June 1918.



Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations
RG No. 115

TX_MSJ_002810



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Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

ORGANIZATION SHEET FOR DECEMBER, 1918, SHOWING RATES.

ENGINEERS AND ASSISTANTS

Designation	Name	Net Rate	Amount Earned Including Increased Compensation
El Paso Office:			
Drainage Engineer	J. L. Burkholder	$250.00	$233.33
Asst. Drainage Engineer	L. R. Fiock	155.00	159.50
Recordman	F. W. Slattery	130.00	140.00
Draftsman	C. E. Lounsbery	125.00	135.00
"	J. F. Kennedy	120.00	130.00
"	T. J. Lawrence	115.00	125.00
Berino:			
Field Engineer	C. M. Ainsworth	135.00	145.00
Rodman	Ike Carter	90.00	100.00
Chief of Party	S. A. Colwell	120.00	130.00
Rodman	Nathan I. Reiter	80.00	90.00
Rodman	John A. Wright	80.00	87.00
Rodman	Chas. R. Douglas	80.00	90.00
Instrumentman	K. A. Peck	115.00	50.00
Rodman	Jas. T. Matthews	100.00	18.33
Rodman	W. K. Carlisle	75.00	22.67
Clint:			
Superintendent of Construction	W. E. Whittier	200.00	210.00
Chief of Party	F. C. Schafer	135.00	145.00
Assitant Engineer	J. G. Marzel	170.00	180.00
Office Engineer	J. B. Easter	135.00	145.00
Instrumentman	Paul R. Goppoldt	125.00	135.00
Rodman	F. M. Sanchez	80.00	n90.00

CLERKS

El Paso Warehouse:			
Storekeeper	John Sorenson Jr.	110.00	120.00
Storehouse Clerk	Geo. S. DeWolf	95.00	105.00
" "	Frank P. Barron	85.00	41.16
Watchman	Jas. S. Bond	75.00	85.00
Storehouse Clerk	W. H. Hoagland	90.00	100.00
" "	H. C. Ivey	90.00	26.67
Berino Warehouse:			
Storehouse Clerk	Mayo C. Henderson	85.00	63.33
Costkeeper	W. B. Wofford	110.00	120.00
Storehouse Clerk	C. J. Currie	85.00	95.00
" "	W. S. Yantes	100.00	55.00

TX_MSJ_002812

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Clint Warehouse:			
Timekeeper	Sid Smith	110.00	120.00
Watchman	D. L. Loony	70.00	80.00

CHIEF DRAGLINE OPERATORS, MESILLA VALLEY

NAME	RATE	
Geo. Cross	145.00	155.00
O. V. Rains	165.00	175.00
John Dixon	165.00	175.00
W. G. Jennerich	165.00	175.00
Ray H. O'Bryan	165.00	175.00
S. E. Rennaker	150.00	128.00

CHIEF DRAGLINE OPERATORS, EL PASO VALLEY

Wm. J. Montgomery	165.00	175.00
Wright Reeves	165.00	175.00
H. J. Durst	165.00	87.50
A. B. Gale	165.00	175.00

DRAGLINE OPERATORS, MESILLA VALLEY

John B. Coyne	140.00	75.00
Ross Smalley	4.32	143.92
Clark Adams	4.80	158.80
W. C. Goddard	4.32	77.94
Earl Grover	4.32	88.41
Jess Daves	4.32	130.31
T. A. Ferlet	4.32	143.92
M. B. Wilson	4.32	143.92
O. M. Austin	4.48	148.88
N. W. McMillen	4.32	143.92
Geo. Truitt	4.32	143.92
W. F. Saurenmann	4.80	158.80

DRAGLINE OPERATORS, EL PASO VALLEY

Geo. Gallagher	4.32	115.84
Harry Silva	155.00	159.50
C. S. Grover	4.32	4.65
Henry Hudgins	4.48	24.07
H. A. Radford	4.88	161.28
L. R. Fry	4.32	143.92
Winston G. Churchill	4.92	47.28
A. E. Babcock	4.32	143.92
W. C. Hammers	4.32	128.36
R. J. Carr	4.32	138.72

TX_MSJ_002813

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

NAME	RATE	AMOUNT EARNED INCLUDING INCREASED COMPENSATION
ENGINEMEN, MESILLA VALLEY		
Allen Pankey	$3.28	$108.40
E. L. Daves	3.28	65.04
Robert Taylor	3.28	111.68
George Dalrymple	3.28	111.68
M. G. Marten	3.28	36.13
M. D. Odum	3.28	108.40
Ray A. Baker	3.28	104.29
E. H. Stewart	3.28	72.27
J. White	3.28	25.29
John G. Maxwell	3.28	86.72
Victor Quimones	3.00	103.00
Jno. E. Latham	3.28	10.84
Clarence Dixon	3.28	36.13
Raymond Wallace	3.28	111.68
W. E. Wallace	3.28	21.68
Otis Anderson	3.28	50.59
C. R. Kingstrom	3.28	111.68
H. Veck	3.28	10.84
N. D. Rolinson	3.28	111.68
F. Basham	3.28	111.68
B. M. Daves	3.28	111.68
J. L. Smith	3.28	111.68
L. T. Smith	3.28	72.27
Robert Pollock	3.28	7.23
Ralph Hove	3.28	3.61
ENGINEMEN, EL PASO VALLEY		
Arthur C. Long	3.28	112.01
Arris Celum	3.28	28.91
M. M. Brown	3.28	86.72
Geo. L. Cantelow	3.28	111.68
J. L. Powell	3.28	111.68
J. A. Radford	3.28	111.68
W. S. Willcox	3.28	36.13
S. H. Sparrow	3.28	111.68
A. J. Koen	3.28	75.88
W. F. Hargrowe	3.28	75.88
D. D. Grumbles	3.36	48.01
W. J. Hamilton	3.28	101.17
Elmer Thayne	3.36	99.72
GROUNDMEN, MESILLA VALLEY		
Helario Aguirre	1.88	64.19
Francisco P. Lopez	1.68	62.08
Jesus Morales	1.32	49.60
F. Contreras	1.32	14.88

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Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Toribis Contreras	$1.32	$ 13.23
Felix Elias	1.32	11.57
Jose Vasquez	1.92	65.35
Eutemio Moreno	1.32	42.97
Rafael Provencio	1.32	39.68
Francisco Martinez	1.68	62.08
Jose Cordoba	1.32	14.88
Candelario Tarin	1.68	62.08
Willard Fogal	1.68	14.09
Luciano Numez	1.32	4.96
Miguel Hernandez	1.32	50.92
Jose Provencio	1.32	8.27
F. Contreras	1.32	26.45
Gregorio Mediosa	1.32	19.84
Atancio Rivera	1.32	23.15
Ed Sanchez	1.32	6.61
Dionecio Acosta	1.40	51.58
Manuel Escarciga	1.32	1.65

GROUNDMEN, EL PASO VALLEY

F. Lopez	1.56	58.36
Juan Madrid	1.56	53.01
A. Chavez	1.44	10.64
Jose Bustamenta	1.76	64.56
Jesus "	1.56	47.33
Jesus Banon	1.56	58.36
David Montez	1.52	57.09
A. Pardo	1.56	45.44
Jesus Rodriguez	1.56	58.36
F. Villagram	1.76	64.56
Fernando Mendoza	1.52	51.01
Fernando Calderon	1.56	56.80
A. Villegram	1.76	64.56
Jose Ruada	1.56	58.36

STRUCTURE FOREMEN, MESILLA VALLEY

A. L. McCarty	165.00	175.00
J. P. Eisentraut	120.00	78.00
A. L. Keith	155.00	49.50
Wm. M. Harvey	150.00	21.33

STRUCTURE FOREMEN, EL PASO VALLEY

R. I. Griffin	145.00	155.00
A. V. Wood	4.64	125.58

CARPENTERS, EL PASO VALLEY

C. Baston	4.66	149.80
L. H. McGonagill	4.64	144.53

TX_MSJ_002815

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

CARPENTERS, MESILLA VALLEY

W. R. Newsome	$ 4.64	$149.17
J. B. Levereau	4.36	132.05
Wm. Bosworth	3.88	19.18
Wm. Hula	4.12	75.79
A. O. Blaxom	3.88	122.10
Homer C. Sacket	4.64	144.53
J. O. Seeber	3.88	8.53
Geo. P. Luce	4.12	22.52

LABORERS, MESILLA VALLEY

NUMBER	RATE	AM'T EARNED
2	.97	17.64
28	1.32	631.56
15	1.40	540.95
3	1.84	172.58
1	2.68	36.16

LABORERS, EL PASO VALLEY

4	1.16	80.66
12	1.28	440.17
16	1.52	692.80
2	1.56	22.72
1	1.68	20.13
7	1.88	377.17
1	2.12	65.09
1	2.64	81.25
2	3.12	194.27
1	3.16	13.97
1	3.24	97.45
1	3.48	103.93
1	4.36	113.54

TRUCK DRIVERS, MESILLA VALLEY

L. C. Cunningham	110.00	48.00
B. H. Stevens	120.00	130.00

TRUCK DRIVERS, EL PASO VALLEY

L. R. Roberts	110.00	120.00
Clayton Koen	90.00	73.33
Joe Madrid	75.00	85.00

MACHINE SHOP

Designation	Name	Rate	Amount Earned
Master Mechanic	N. E. Fordham	215.00	225.00
Machinist	Jas. H. Baker	5.20	171.20

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Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Blacksmith	R. Schuler	4.92	136.59
"	W. F. Kienle	4.66	139.81
Elec. Assistant	Paul A. Wuerschmidt	140.00	150.00
Machinist	W. T. Anthony	4.12	113.69
Blacksmith Helper	Manuel Lopez	2.68	84.37
" "	Francisco Valenciana	2.44	85.64

LABORERS

NUMBER	RATE	AMOUNT EARNED
2	1.38	77.30
1	1.88	39.59
1	2.12	51.42
1	2.40	74.77
1	2.96	101.76

EL PASO GARAGE

DESIGNATION	NAME	NET RATE	AM'T EARNED
Foreman	John A. Wiseman	120.00	130.00
Garageman	H. B. Brooks	100.00	110.00
Special Laborer	Abe Aguilar	3.48	73.02
" "	Manuel Badilla	4.48	144.40
Garageman	Chas. E. Armstrong	90.00	100.00
"	T. Q. Lafayette	105.00	115.00

TEAMSTERS WITH TEAMS

Number	Net Rate	Amount Earned, Inc. Inc. Compensation
MESILLA VALLEY		
32	3.88	1409.84
1	4.28	54.66
EL PASO VALLEY		
2	4.12	166.63

COOKS

Elizabeth Grabel	85.00	95.00
Francisco Guerra	50.00	30.00
Miss Kenyon	85.00	44.33
Mrs. Anna Winters	90.00	56.67
Eulogia Medraus	50.00	42.00

Total monthly payroll for drainage, Feature No. 6, $21,820.62

NOTE: The rates given above are all net or base rates, to which the increased compensation amounting to $10. per month should be added. To monthly rate add $10. per month; to daily rate add 33-1/3¢ for a 30-day month and 38-1/3¢ for a 26-day month.

TX_MSJ_002817

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

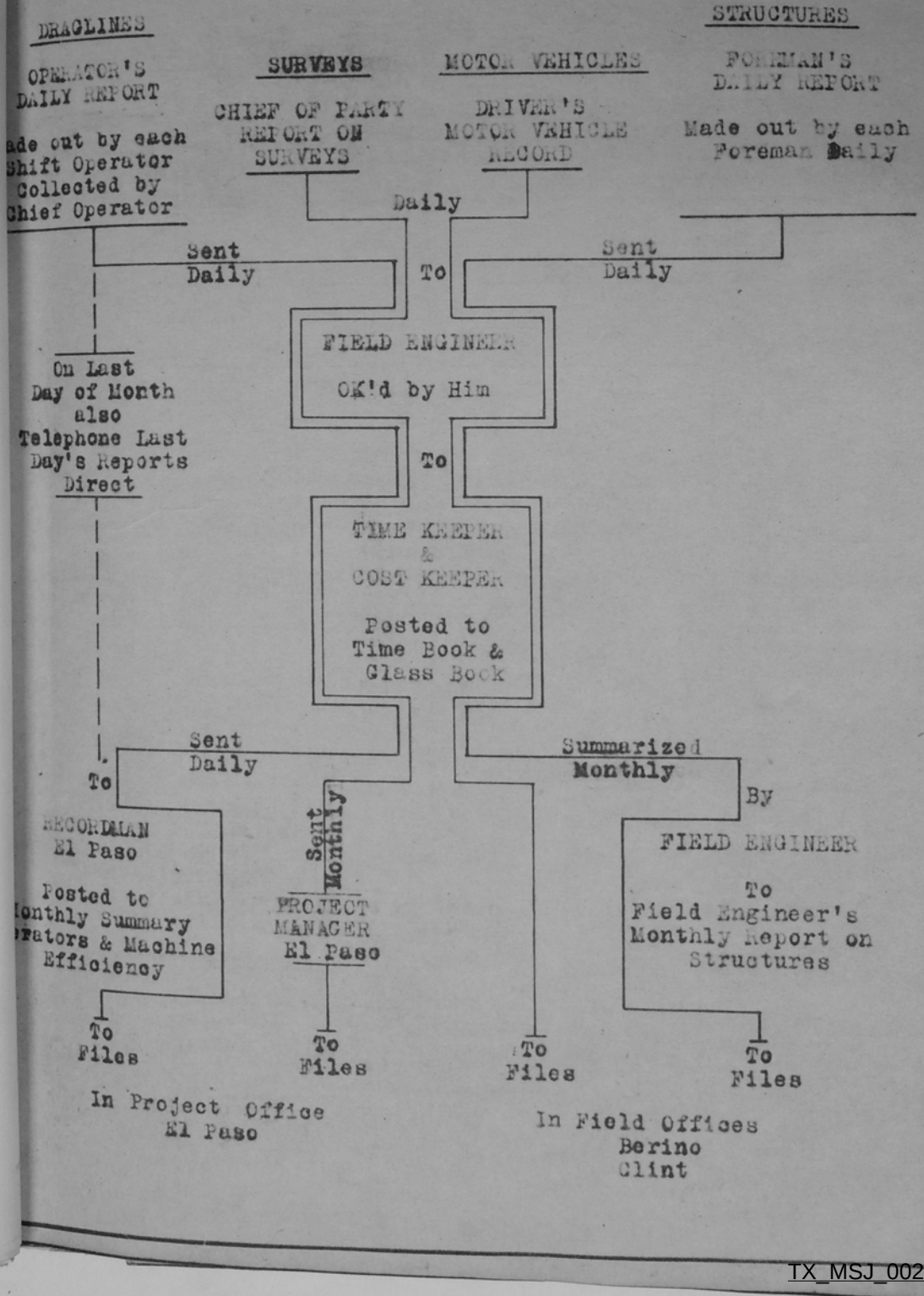
Reports and Records: Probably there is no better way to convey an idea of the system of reports and records in use than by outlining the system and attaching a copy of each form with a note concerning its use and purpose. The system and forms used for carrying it through have been the results of the process of steady evolution until we believe we now have about what we have been arriving at. To be sure there is a great deal of work connected with it, but beyond any doubt the results obtained from instilling into the men a spirit of competition appealing to their pride and sense of sportsmanship as our system surely does, together with the added advantage of being able to tell just what each man and machine is doing will far more than offset the extra work required to get out the reports. There is no question but that we could get better structure results also if we could keep as close a check on the foremen and ~~fixxxx~~ furnish them with the same sort of information that is given on the dragline operator's reports.

TX_MSJ_002818

Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations
RG No. 115

Department of the Interior
United States Reclamation Service
Rio Grande Project, New Mexico - Texas

DRAINAGE - DAILY REPORTS



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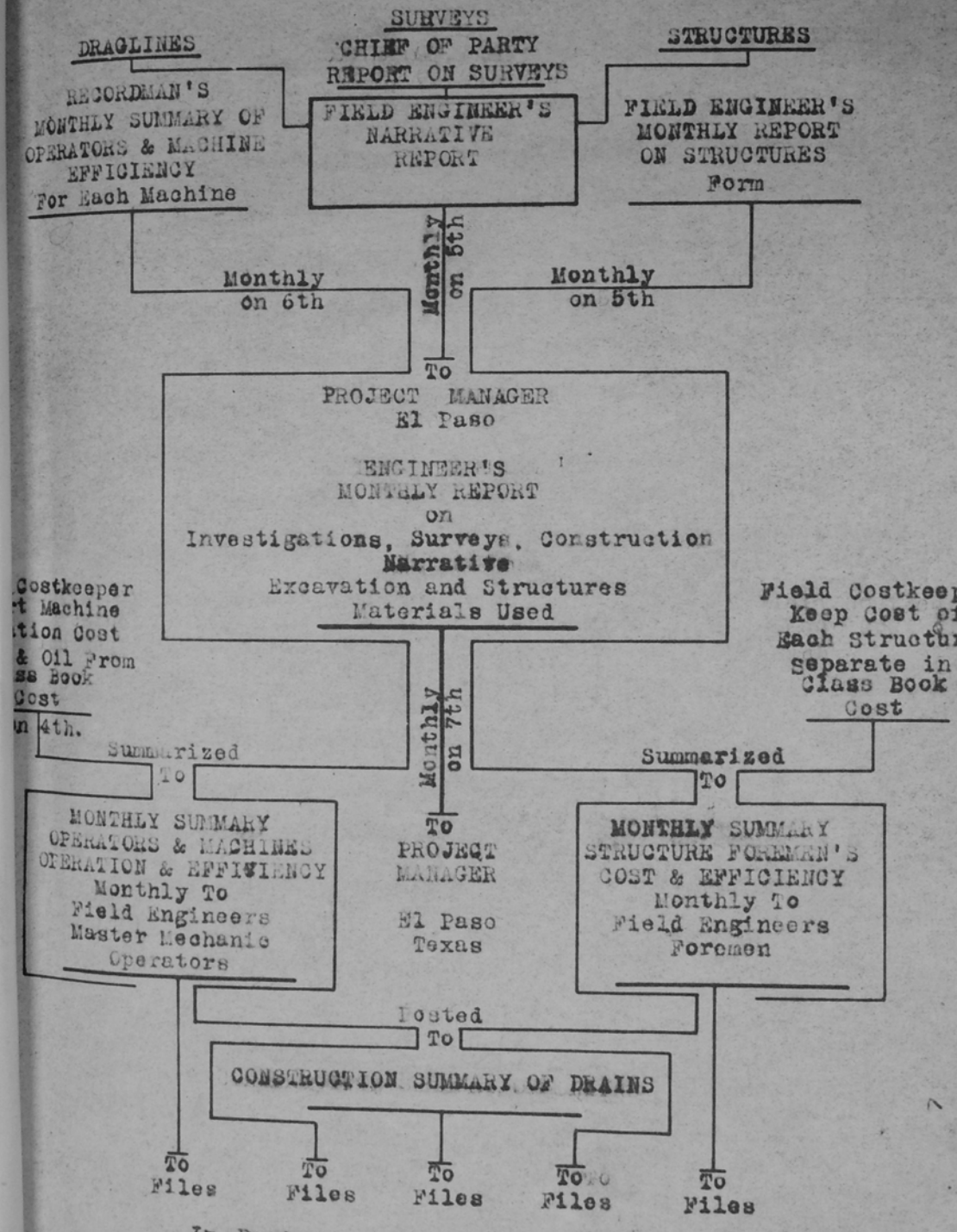
Records in
Administration, Rocky Mou
Archival Operations

RG No. 115

Department of the Interior
United States Reclamation Service
Rio Grande Project, New Mexico - Texas

DRAINAGE - MONTHLY REPORTS



In Project Office, El Paso, Texas

TX_MSJ_002820

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DRAGLINE OPERATORS on each shift must report on this form daily, taking care to correctly report the time of the crew, to properly distribute the time according to the work done and to accurately state results accomplished, giving station to station and lineal feet excavated, name of drain, numbe- of machine, and date and shift operated, remembering that this report is the timekeeper's authority for allowing time to any member of the crew.

The CHIEF OPERATOR must collect the reports of all shifts and send them daily to the FIELD ENGINEER in charge for his O. K. and direction.

The TIMEKEEPER AND COSTKEEPER must post to the time book and class book, making a notation showing whether the charge was made to plant, operation, structure work, work in lieu of right of way or lateral construction, then forward the reports to the PROJECT OFFICE.

The RECORDMAN posts the reports to the Monthly Summary of Operators' Daily Reports on Excavating Machine Operation and Efficiency, and files in PROJECT OFFICE.

This form is also used for machine efficiency in the monthly cost report.

TX_MSJ_002821

Records in the National Archives & Re
Administration, Rocky Mountain Regio
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE

7-1011 (Aug. 1917)

Operators and Machine Efficiency

.....Machine No..... .....191.....

Name of Ditch..... .....Shift

	THIS MONTH—DAY		TO DATE	
	Hours	%	Hours	%
ging (actual time)				
ing up				
ing to new work (moved....miles)				
Total operating time				
airs to motive power				
" traction machinery				
" other machinery				
Total repair time				
ting for power, fuel, water				
" blasting				
" inspecting or oiling				
e lost (Sundays or holidays with pay)				
r delays (what?)				
Total delays				
l hours crews were employed		100		100

n excavated.....lin. feet. Sta..... .....to Sta.....

ber of 8 hour shifts worked.....Average Cu. Yd. per shift.....

FUEL CONSUMPTION

(Cost F. O. B.....)	QUANTITY			UNIT COST	
	This Month	To Date	Per Cu. Yd. Earth	This Month	To Date
line used @.....per gal.					
sine " @..... " gal.					
oil " @..... " gal.					
" @..... " ton.					
ricity " @..... " kwh.					

RATE	NAME	WHAT DOING
ıtor @		
ıan @		
@		
ıman @		
@		
ers @		
@		
@		

rks:

ved.....191..... Prepared by:

Title..... .....

Costkeeper
Operator

TX_MSJ_002822

INSTRUCTIONS

1. The total time during which crews are employed either for excavation or general repairs will be charged against the efficiency record.

2. Unusual delays caused by serious break down or unsecured right of way, etc., should be explained.

3. The record will form the basis for determining the machine efficiency for the total construction period.

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

TX_MSJ_002823

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

The RECORDMAN summarizes the Operators' Daily Reports on this form, the yardage of excavation being supplied to him by the field engineer on form 7-516. It should be kept posted as promptly as the operators'daily reports are received, and totaled as soon as possible after the end of the month. Summaries arrived at on this form are carried to three other monthly report forms, namely:

1. Monthly Machine Efficiency of each machine to accompany Machine Operation Cost Sheet in Cost Report, forms 7-1010 and 7-1011 (same as used for Operators' Daily Report).

2. Monthly Summary of Operators' Efficiency.

3. Monthly Summary of Machine Efficiencies, all machines.

Copies of the above reports filled out for the month of December follow.

The purposes of the last two reports are to stimulate competition among the dragline operators, as well as for the information of those in charge as to what the various operators are doing. As soon after the end of the month as they can be compiled they are sent to the project Manager, Field Engineers, Master Mechanic and all chief operators, with a request to them to post on their bulletin boards.

They have a very marked and beneficial effect in keeping up interest and a competitive spirit among the operators. They are always eager to get them and are sure to be heard from if they believe they have been slighted or unjustly treated in the results shown thereon. Some chief operators are known to be keeping their machine running every available minute to make the highest monthly record and appear in first place, even during time when they have been asked to do general repair work and are not supposed to be running.

TX_MSJ_002824

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE

MONTHLY SUMMARY OF OPERATOR'S DAILY REPORT
EXCAVATING MACHINE OPERATION AND EFFICIENCY

EXCAVATOR No. _____

OPERATOR — MORNING SHIFT

DATE	EXCAVATION			OPERATION			REPAIRS			DELAYS			
	From Station	Lin. Ft.	Cu. Yds.	Hrs. Digging	Moving Up	Moving New Wk.	Motive Power	Traction Mch.	Machine Proper	Fuel, Wat. Power	Inspect. Oiling	Sundays Holidays	Miscel-laneous
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
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22													
23													
24													
25													
26													
27													
28													
29													
30													
31													
TOTAL													

OPERATOR — DAY SHIFT

EXCAVATION			OPERATION			REPAIRS			DELAYS				EXCAV
From Station	Lin. Ft.	Cu. Yds.	Hrs. Digging	Moving Up	Moving New Wk.	Motive Power	Traction Mach.	Machine Proper	Fuel, Wat. Power	Inspect. Oil. Ins.	Sundays Holidays	Miscel-laneous	From Station

OPERATORS AND MACHINE
PERFORMANCE OPERATION & EFFICIENCY

OPERATOR	EXCAVATION		OPERATION								REPAIRS								DELAYS									
	Lin. Ft.	Cu. Yds.	Digging		Moving Up		Moving New W.		Total		Motive Power		Traction Mch.		Mach. Proper		Total		Fuel, Wat. Pr.		Inspect. Oil'g.		Sun. & Holid.		Misce	
			Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	%	Hrs.	
MACHINE																										
PREVIOUS																										
TOTAL - THIS DRAIN																										
TOTAL - ALL WORK																										

TX_MSJ_002825

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE

NTHLY SUMMARY OF OPERATOR'S DAILY REPORTS
XCAVATING MACHINE OPERATION AND EFFICIENCY

EXCAVATOR No. _____
PHYSICAL FEATURE _____ DRAIN
_____ DRAIN
MONTH OF _____, 19____

_____ OPERATOR — DAY SHIFT

VATION		OPERATION			REPAIRS			DELAYS				
Lin. Ft.	Cu. Yds.	Hrs. Digging	Moving Up	Moving New Wk.	Motive Power	Traction Mach.	Machine Proper	Fuel, Wat. Power	Inspect. Oil. Ing.	Sundays Holidays	Miscel-laneous	

_____ OPERATOR — NIGHT SHIFT

EXCAVATION			ORERATION			REPAIRS			DELAYS				DATE	REMARKS
From Station	Lin. Ft.	Cu. Yds.	Hrs. Digging	Moving Up	Moving New Wk.	Motive Power	Traction Mach.	Machine Proper	Fuel, Wat. Power	Inspect. Oiling	Sundays Holidays	Miscel-laneous		
													1	
													2	
													3	
													4	
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													27	
													28	
													29	
													30	
													31	
													TOTAL	

OPERATORS AND MACHINE
ANCE OPERATION & EFFICIENCY

REPAIRS						DELAYS										PERFORMANCE				FUEL CONSUMPTION				COST	
ION. MCH.	%	MACH. PROPER	%	TOTAL HRS.	%	FUEL, WAT. PR. HRS.	%	INSPECT. OIL'G. HRS.	%	SUN. & HOLID. HRS.	%	MISCELLANE. HRS.	%	TOTAL HRS.	%	TOTAL HRS.	SHIFTS	CU. YDS. PR. HR. DIGGING	CU. YDS. SHIFT	HIGH RUN CU. YDS. SHIFT	HIGHEST RUN TO DATE	GASOLENE GALS.	DISTILATE OR KEROSENE	FUEL OIL-G. COAL-TON. ELECT. K.W.H.	LUB. OIL GAL.	PER C.Y. MONTH	PER C.Y. TO DATE

TX_MSJ_002826

Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations
RG No. 115

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE

7-1010. (Jan. 1917.)
CLEARING
Cost Report

Project Rio Grande
Div. or Unit Mesilla Valley
Excavating Machine Operation

Month of ..... 19....
Steam Shovel No. .....
Electric Shovel No. .....
Dragline Excv. No. 6
Trench Mach. No. .....
Power Scraper No. .....

s. Feat. No. .....
s No. 210. 210 x 8
hority No. .....

14-A-1 Dragline 6

ITEMS OF COST	COST This Month	COST To Date	UNIT COST This Month	UNIT COST Previous	UNIT COST To Date
Labor, machine crew					
" ground crew or pitmen	850.43	850.43	.013		.013
" miscellaneous (men and teams)	176.65	176.65	.003		.003
Power or fuel, cost of	105.08	105.08	.002		.002
" maintenance of transmission lines	736.14	736.14	.011		.011
Hauling fuel					
Cost of water	97.51	97.51	.001		.001
Lubricants	34.00	34.00	.0005		.0005
Wire rope depreciation	175.03	175.03	.003		.003
Moving to new work	44.58	44.58	.0005		.0005
Minor equipment repairs and supplies					
Minor miscellaneous expense					
Plant charge	494.01	494.01	.007		.007
Equipment charge					
Total cost	665.77	665.77	.010		.010
Credits—(indicate distribution in remarks or on attached sheet)	1531.54	1531.54	.021		.021
Balance—(debit or credit)	4708.69	4708.69	.071		.071
		81.63	Cr. bal. 12-31-18		
Quantity of Material Moved:		4708.69			
Excavation; Class		*81.63			
" " 1 Set	Cy. 66,577 "	Cy. 66,577 "			
" " Prior 1-1-19	"	170,547 "			
" "	"	"			
cost prior to 1-1-19			$11,060.04		.065
Total quantities and unit costs			16,768.73		
		237,119			.067

Station	to	Drain excavated	Depth	Bottom width	Side slope	Length
"	170 / 00 to	250 / 75	10 ft.	16 ft.	1½:1	5995 ft.
"	to		ft.	ft.		ft.
"	to		ft.	ft.		ft.

DESCRIPTION OF MACHINE

of machine .....
by Dragline
new job project Egyptus Co.
if transferred 1/2
of delivery or transfer $27,166 plus freight
of traction September, 1918
h of boom Caterpillar
f bucket 50'
(See attached sheet for machine description.)
ved: .....

Boiler H. P. 125 h.p. 4
Steam pressure cylinder
Hoist engine H. P. Atlas
Swing engine H. P. Gas
Hoist motor H. P. Engine
Swing motor H. P. .....

MOTOR
..... volts ..... phase ..... cyc

Prepared by: .....

Costkeeper.

TX_MSJ_002827

INSTRUCTIONS

1. This account is provided for use when more detail cost is desired than provided for under excavation (Class Nos. 352-357) and in assembling cost of operating large excavating machines. Where the operation of these machines comprise all the cost of excavation it may be used as a detail cost account the total expense being assembled on the feature summary supported by costkeeper's report on the forms provided similar to other detail costs. When used as a clearing account the net cost will be distributed monthly by transfer to the detail item for machine methods (No. 08-09) under excavation (Class Nos. 352-357). These items will be bracketed and the cost shown opposite in one item to indicate that it is transferred from a clearing account.

2. The detail items comprising this account are explained as follows:

01 to 08. Self-explanatory.

09. For the estimated depreciation on wire rope used. The cost of the rope will be charged to item 10 in plant account for Miscellaneous Equipment and Tools (Class No. 258). Each month a reasonable amount of the cost of rope will be debited to this number and credited to plant (Item No. 51) based on a flat rate per cu. yd. for material excavated.

10. Only the moving to new work will be charged to this account. Moving up will be charged to the appropriate items above (Nos. 01 to 09).

38. The minor repairs to equipment and tools used in connection with the work covered by this account and also cost of miscellaneous supplies not applicable to any specific account. Extensive repairs to equipment should not be charged to this account but to the repair account under plant.

39. This number is provided to take the cost of any minor item which cannot be consistently charged to any other number herein and which is not of sufficient amount to justify the assignment of a special account.

43. Plant charge is the proporition of cost of plant installation chargeable to this feature or account. The amount will be a flat rate as fixed in connection with the distribution of plant costs.

44. Equipment charge is the amount of depreciation or rental for the use of equipment and tools used for this work. The amount will be a flat rate fixed in connection with the distribution of equipment costs. (See instructions under Plant Accounts.)

50. This number should be used to take the credits for distribution of the cost of this account to other features. It should receive no debits except to correct errors in previous credits. Corrections or adjustments of previous debits to other items of this account should not be credited to this number, but to the number in the account to which the original entry was charged.

3. In case it is deemed necessary to add to any Clearing Cost Report one or more items of cost, recommendation should be made to the Chief of Construction for his consideration.

7-1010

Records in the National Archives & Records Administration, Rocky Mountain Region Archival Operations

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Administration, Rocky Mountain Region
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ost is desired than provided
ng cost of operating large
es comprise all the cost of
expense being assembled on
forms provided similar to
net cost will be distributed
ds (No. 08-09) under ex-
ed and the cost shown op-
learing account.

as follows:

he cost of the rope will be
ment and Tools (Class No.
will be debited to this num-
te per cu. yd. for material

is account. Moving up will

ection with the work covered
t applicable to any specific
d to this account but to the

r item which cannot be con-
f sufficient amount to justify

stallation chargeable to this
ked in connection with the

rental for the use of equip-
rate fixed in connection with
Plant Accounts.)

stribution of the cost of this
to correct errors in previous
items of this account should
count to which the original

g Cost Report one or more
of Construction for his con-

7-1010

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE

7-1011 (Aug. 1917)

Operators and Machine Efficiency

.....Machine No..... .....191.....

Name of Ditch..... .....Shift

	THIS MONTH—DAY		TO DATE	
	Hours	%	Hours	%
(actual time)				
ip				
o new work (moved....miles)				
tal operating time				
to motive power				
' traction machinery				
' other machinery				
tal repair time				
for power, fuel, water				
" blasting				
" inspecting or oiling				
t (Sundays or holidays with pay)				
lays (what?)				
tal delays				
urs crews were employed		100		100

cavated.....lin. feet. Sta.....to Sta.....

of 8 hour shifts worked.....Average Cu. Yd. per shift.....

FUEL CONSUMPTION

(Cost F. O. B.....)	QUANTITY			UNIT COST	
	This Month	To Date	Per Cu. Yd. Earth	This Month	To Date
used @.....per gal.					
" @..... " gal.					
" @..... " gal.					
" @..... " ton.					
ty" @..... " kwh.					

RATE	NAME	WHAT DOING
@		
@		
@		
n @		
@		
@		
@		
@		

s:.....

.....

.....

d.....191..... Prepared by:

.....

itle..... .....

Costkeeper
Operator

TX_MSJ_002829

INSTRUCTIONS

1. The total time during which crews are employed either for excavation or general repairs will be charged against the efficiency record.

2. Unusual delays caused by serious break down or unsecured right of way, etc., should be explained.

3. The record will form the basis for determining the machine efficiency for the total construction period.

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

TX_MSJ_002830

L. J. L. Kirkholder, Engineer

MONTHLY SUMMARY OF OPERATORS EFFICIENCY

Month of December 1918

Order No.	OPERATOR	Machine No.	EXCAVATION Lin. Ft.	EXCAVATION Cubic Yards	UNIT PERFORMANCE Shifts Oper'd This Mo.	Shifts Oper'd To Date	C.Yds.-Hr.Dig This Mo.	C.Yds.-Hr.Dig To Date	C.Yds.-Shift This Mo.	C.Yds.-Shift To Date	MACHINE COST Pr.C.Y This Mo.	MACHINE COST Pr.C.Y To Date	OPERATORS GRADE % This Mo.	OPERATORS GRADE % To Date	Order To Date
	All Chief Oper'a. 3-4-5-6		6,730	68,077	137	455.5	148	142	472	489	.074	.091			
	" Shift Oper'a 3-4-5-6-		9925	104,088	195.5	419.5	104	104	516	493	"	"			
	" Chief " 7-8-9-10		6,780	73,169	120.5	248	149	160	608	636	.068	.069			
	" Shift " 7-8-9-10		10,410	125,411	185	287	131	138	643	677	"	"			
	" Operators no.11		1,500	14,959	48	144	65	70	319	267	.055	.112			
	" " " 1		945	8,994	30	381	72	50	200	192	.147	.125			
1	Adams	5	2180	25,407	30	69	147	136	841	721	.047	.084	160	127	1
2	Goddard	5	1645	18,433	30	84	119	113	614	522	.047	.084	138	107	6
3°	Reins	5	1575	17,516	31	82	143	125	566	505	.047	.084	138	106	7
4	Austin	9	2085	24,385	30	54	137	157	812	781	.058	.068	122	106	8
5	McMillen	9	1910	22,041	31	70	134	137	711	662	.058	.068	114	100	14
6°	O'Bryan	9	1615	19,143	31	54	138	144	617	529	.058	.068	109	92	19
7	Montgomery	7	2000	19,892	28.5	53	171	169	699	684	.069	.078	107	98	15
8°	Rennaker	11	765	7,566	22	74	70	83	354	296	.055	.112	107	105	9
9°	Silva	3 & 10	2235	17,927	31	115	129	154	578	654	.0835	.0805	105	123	2
10	Saurenmann	8	1355	20,990	30	58	143	163	700	816	.070	.065	103	113	3
11°	Cole	18	2410	20,679	31	57	171	186	667	683	.074	.068	101	104	10
12	Smalley	1	480	4,547	15	68	64	38	303	162	.147	.125	101	92	20
13	McCraw	10	1240	11,624	17	17	116	116	685	685	.074	.068	99	101	13
14°	Cross	1	465	4,449	15	13	79	62	297	225	.147	.125	99	105	5
15	Wilson	8	1200	15,962	30	53	132	156	652	771	.070	.065	98	110	4
16	Babcock	7	1840	18,897	30	31	143	140	630	623	.069	.078	98	90	28
17	Truitt	11	735	7,293	26	70	60	56	284	238	.088	.112	96	95	18
18	Perlet	6	1340	18,444	29.5	66.5	97	103	425	483	.069	.085	95	103	12
19	Thayne	7	210	2,358	4	4	168	168	589	589	.069	.078	95	88	28
20	Hammers	4	540	7,966	15	15	94	94	531	531	.089	.103	93	98	16
21°	Dixon	6	1310	12,017	28	68	123	126	372	353	.069	.085	93	90	24
22	Radford	3	1995	16,603	30	103	113	117	554	480	.093	.093	93	89	27
23	Reeves	4	890	14,765	31	98	173	155	476	512	.089	.103	92	96	17
24	Callager	10	180	1,764	3	3	88	88	588	588	.074	.068	91	91	22
25	Carr	4	885	5,449	12	12	86	86	454	454	.089	.103	88	90	25
26	Dayes	6	980	9,292	27	27	80	80	344	344	.069	.085	87	88	29
27°	Jennerich	8	755	13,455	30	84	118	142	449	646	.070	.065	86	104	11
28	Churchill	7	420	4,398	10	17	116	118	440	576	.069	.078	83	87	30
29°	Hurst	3	720	5,843	16	91.5	174	170	366	420	.093	.093	78	92	21
30	Fry	3	1020	8,490	23	43	99	102	369	406	.093	.093	75	90	26
°	Chief Operators														

Grades are based on average results in cost and rate of excavation produced by all operators or comparable machines. Average shift excavation - 50%, average machine cost- 50%. Grades indicate whether above or below average by being over or under 100%. Chief Operators are graded on averages of cost and excavation produced by themselves as a class.

Remarks:- On this report Operators on machines no. 3,4,5 & 6 are graded as a class. Operators on machines no. 7,8,9 & 10 as a class, operators on machines No. 1 & 11 are graded seperately.

This report to replace previous report for Dec. 1918

Records in the National Archives & Records Administration, Rocky Mountain Region Archival Operations

TX_MSJ_002831

MONTHLY SUMMARY OF MACHINE EFFICIENCIES

J. L. Burkholder Engineer. Month of Dec. 1919

MACHINE NO.	COST OF EXCAVATION Cost Per Cu. Yd. This Mo.	To Date	Machine Order No. This Mo.	To Date	AMOUNT OF EXCAVATION Length Ft. This Mo.	Cubic Yards This Month	To Date	Cu. Yds. This Mo.	To Date	TIME CHARGED TO MACHINE OPERATOR Shifts Chgd. To Date	Operating % This Mo.	To Date	Repairs % This Mo.	To Date	Delays % This Mo.	To Date	
All	.070*	.091			36,290	394,704	2,954,666	542	499	736	62	57	20	26	18	17	53
5	.047	.084	1	5	5,340	61,356	475,943	674	485	91	68	57	14	31	18	12	2
9	.058	.068	2	3	5,580	65,569	105,113	712	652	93	68	63	20	25	12	12	0
7	.069	.078	3	4	4,470	45,545	93,932	628	548	72.5	62	62	19	17	19	21	2.5
6	.069	.085	4	6	3,630	33,753	465,227	400	404	84.5	57	52	33	35	10	13	8.5
8	.070	.065	5	1	3,310	53,407	170,542	594	745	90.0	64	67	17	15	19	18	3
10	.074	.068	6	2	5,490	47,379	79,340	707	754	67	62	61	19	9	19	20	0
4	.089	.103	7	8	1,715	28,180	475,349	434	373	65	66	46	15	44	19	10	0
3	.093	.093	8	7	4,310	55,560	542,465	424	464	84	55	52	22	30	23	18	0
11		.112	9	9	1,500	14,959	39,150	312	271	47	62	55	26	30	12	15	5
1	.147	.125	10	10	945	8,996	507,605	297	315	30	56	58	13	25	31	17	32

Remarks:-

Machine order is based on unit cost for the month

* Charged to Plant, Structure Work, Lateral Reconstruction, Work in Lieu of Right of Way, Etc.

Records in the National Archives & Records Administration, Rocky Mountain Region
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RG No. 115

TX_MSJ_002832

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE

FOREMAN'S DAILY REPORT

Date ....., 19....

Shift No. .....

LABOR MEN

Names or Number of—	Rate per day	What doing	Amount

Structure Foremen must make daily report on this form, stating definitely the kind of structure, or work, and its location, carefully reporting the time of all of his crew and accurately stating what they were doing, as this report is the timekeeper's and costkeeper's authority for entering time and cost into the time book and class book, for which reason it should be filed in the field office for reference in case of a dispute. The amount and kind of material used should be shown, especially, if placing concrete, state number of sacks of cement used each day. A brief statement of results accomplished should be made each day.

(Signed) .....

Foreman

TX_MSJ_002838

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

Form 7-1251
(June, 1917)

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE

FOREMAN'S DAILY REPORT

Date_____, 19____

n of work _____ Shift No._____
work _____

LABOR MEN

Names or Number of—	Rate per day	What doing	Amount
		Labor total	

LABOR TEAMS

Names or Number of—	Size	Rate per day	What doing	Amount
	2 up			
	4 up			
	6 up			
	____ up			
			Team Totals	

MATERIALS AND SUPPLIES USED

Material total	
Total for day	

WORK ACCOMPLISHED

0—8532

(Signed)_____

Foreman_____

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Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

MONTHLY REPORT ON STRUCTURES.

On this form the FIELD ENGINEER should report all structures built each month and it should accompany his monthly report on the 5th of the month to the Project Manager. On this form report all material used and work done in connection with drainage construction, except the excavation of the drains themselves, whether on structures or other work, such as concrete tile manufacture, lateral reconstruction, fence building, bank protection, plant or camp construction, etc. Data furnished on this form is posted by the recordman to the form for Construction Summary of Drains, which is the permanent record for this construction of any structure on each drain, and it also furnishes data required for the Project Monthly Report, as well as for cost reports.

Attempts have been made to work up a Foreman's Cost and Efficiency Report for comparison of the various foremen on the cost of similar structures or units, and a preliminary form has been made but it has not yet been perfected.

TX MSJ 002835

UNITED STATES RECLAMATION SERVICE
RIO GRANDE PROJECT NEW MEXICO – TEXAS
DRAINAGE CONSTRUCTION

FIELD ENGINEER'S MONTHLY REPORT ON STRUCTURES

CAMP _____ VALLEY _____ MONTH OF _____ 191

DRAIN	STA.	STRUCTURE	NAME	KIND	SIZE	MATERIAL USED — WORK DONE							FOREMAN & REMARKS
						LUMBER F.B.M.	CONCRETE CU.YD.	CEMENT SKS.	STEEL LBS.	EXCAV. CU.YD.	BACKFILL CU.YD.		
				Total To Date									
				% Complete						

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

RIO GRANDE PROJECT NEW MEXICO—TEXAS
DRAINAGE SURVEYS
CHIEF OF PARTY MONTHLY REPORT ON SURVEYS
Camp _____ Month of _____ 191

Date	Drain	Sta. To Sta.	Transit Location Traverse Ft.	Sec. Tie No.	Proj. Tie No.	Levels Proj. Ft.	Cross Stations Section Ft.	Cross Stations Section Ft.	Investigations Ft.	Office & Remarks
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
Total										

Chiefs of Party should report to the Field Engineer the results of each day's work on this form. By filling in the last column with the names or badge numbers of the members of the party it can become the timekeeper's authority for entering their time in the time book and distributing same to the class book.

At the end of the month it should accompany the field engineer's report to the Project Manager, and be filed in the project office.

Chief of Party

TX_MSJ_002837

UNITED STATES RECLAMATION SERVICE
RIO GRANDE PROJECT NEW MEXICO–TEXAS
DRAINAGE SURVEYS

CHIEF OF PARTY MONTHLY REPORT ON SURVEYS

Camp _____ Valley _____ Month of _____ 191 .

Date	Drain	Sta. To Sta.	Transit Location: Traverse Ft.	Transit Location: Sec. Tie No.	Transit Location: Prop. Tie No.	Levels: Profile Ft.	Levels: Check Mi.	Cross Section Ft.	Staking Structure Kind-No.	Investigations	Office & Remarks
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
Total											
Total Miles											

_____ Chief of Party

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TX_MSJ_002838

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

MOTOR VEHICLE RECORD

ine No. _____ Month of _____ 19 ____

Gas Gal	Oil Qts	Mileage Miles	Charge To	Freight Hauled Tons	Ton Mile	Hrs	By Whom	Repair Record What Doing

TRUCK DRIVERS DAILY REPORT

TRUCK NO. _____ DATE _____

Directions -- Furnish all information called for on this report, sign and transmit to your timekeeper each evening.

Destination Leave	Arrive	Time H	M	Odometer reads	Miles	Materials Hauled Tons	Kind	for what job	Ton Mi. used	Acct. No. No. Tkpr.

Gasoline Received Gallons Where

Oil Received Quarts Where

Trailer Used No Yes Trailer No. Miles

Drivers Mechanical Report

Sign Here

INVENTORY

d f Mo.	Quantity	Unit Price	Wheel	Date Inst	Trade Name	Miles To Date	Miles	Chg. To
al.			Left Front					
l			Right Front					
s			Left Rear					
eter			Right Rear					

TIME RECORD MILEAGE RECAP

tion of Machine

y _____

ower _____

Signature

Present Condition _____

TX_MSJ_002839

Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations

RG No. 115

MOTOR VEHICLE RECORD

Month of _____ 19 ____

ine No. _____

Gas Gal	Oil Qts	Mileage Miles	Charge To	Freight Hauled Tons	Ton Mile	Hrs	By Whom	Repair Record What Doing

INVENTORY

d of Mo	Quantity	Unit Price	
al.			Wheel
al			Left Front
s			Right Front
eter			Left Rear
			Right Rear

TIME RECORD

Date Inst	Trade Name

MILEAGE RECAP

Miles To Date	Chg. Miles	To

tion of Machine

y _____

ower _____

Signature

Present Condition _____

TX_MSJ_002840

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

This construction summary should accompany the Engineers' Monthly report to the Project Manager. It is a brief and concise statement of construction results accomplished during the month, and the status of drainage construction to date. It is compiled from the Field Engineer's monthly report on structures and the Recordman's Summaries of Dragline Operation, and percentages of completion from estimates for authority.

TX_MSJ_002841

DRAINAGE CONSTRUCTION SUMMARY & ENGINEER'S MONTHLY REPORT

_____, ENGINEER

MONTH OF _____, 19__

DRAIN	Machine No.	EXCAVATION						STRUCTURES						
		Shifts	Length Month Ft.	Length ToDate Miles	Cubic Yards Month	Cubic Yards ToDate	% Complt	Wood Bridges Highway No.	Wood Bridges Farm No.	Flumes No.	Inlets No.	Latrl. Recons C.Ys	Major Structures Name	Major Structures % Compl.

STRUCTURE SUMMARY	M.B.M. Woodwork	Cu.Yds. Concrete	Sks. Cement	Lbs. Rein.Stl.	Lbs. Str.Stl.	Ft.	Ft.	Ft.	Ft.	Ft.	No.	Ft.	No.	Ft.
						Total Length					Culverts		Bridges	

Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations
RG No. 115

TX_MSJ_002842

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

INVESTIGATIONS AND STUDIES.

Ground Water: Measurements were taken on all wells four times during the year and at closer intervals on lines under special observation. A complete new set of tracings for test well cross section profiles was made on a larger scale than any heretofore made out. On the old scale of 1" equals 1000 feet and 1" equals 10 ft. on cross section paper the intervals were too small to observe changes in water tables and effects of drains. The new sections were plotted on plate "A" profile paper on the scale of 1" equals 800 feet and 1" equals 4 feet which proves to be a very satisfactory scale. Negatives were made and the readings for the year plotted in colors on white prints. These cross sections having the water table as observed by readings on the test wells at intervals show by a different color for each set of observations, and plotted to the same datum elevations as the ground surface profile from the best means of observing graphically, the general movements of the water table up and down, aid materially in locating the drains if platted on sheets, one section directly above another in such a way that the proposed drain line can be easily spotted on them, and are certainly the most convenient and ready means of observing the effects of the drains on the water table. A set has been kept for each year's set of observations and besides we now have a set showing the high and low water table each year since the wells were set, which is very enlightening in conveying an idea of the constant yearly use of the whole water table. The original

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Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

set of sections should have the soil formations and classifications shown by depth and indicated by convenient letters or symbols. A complete set of sections for this project is on file in the Project office.

In several parts of the project there has been noticable increases in the elevation of the water table, but in no case has this happened in districts covered by drains, and where drains are constructed there has been a satisfactory lowering t of the water table. The rise as observed from test well reading and section has been quite variable in different localities. In some areas, especially where the water table was already closest to the surface, there was but little rise over the 1917 observations, the greatest rises for the past year took place where the water table was still farthest from the surface. In the El Paso Valley the greatest rise is noticed over the area south of the Franklin Canal and east of San Elizario. Here the rise seems to have been about one foot. There is also a noticable rise in the district from Ysleta to Socorro. In the Mesilla Valley the rise was small except in the whole of the Leasburg Unit from Ft. Selden to Brazito and of this the greatest rise has occured over the entire Las Cruces-Mesilla district of this unit where it has been observed to be from one half to two feet higher than for corresponding reading of 1917.

The following curve will convey graphically the movement of the ground water as it rises and lowers in the soil. It is probably a fair general average of the seasonal rise and fall and the permanent yearly rise of the ground water table over the whole of the project, baring of course the areas noted

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Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

in the exceptions just mentioned for the year 1918. It is a composite curve made up of the average of each set of observations taken on twenty representative wells selected at random from all over an area of 8500 acres lying between San Jose and Clint in the El Paso Valley. It can be noted that the permanent yearly rise for the three years preceding 1918 was 1.6 feet, that in the start it was almost equal to and simultaneous with the application of irrigation water on the surface and that as the water table approached the ground surface the rise becomesless and the highest point is reached earlier each season. Whether or not evaporation alone accounts for all this, the writer is not prepared to say.

TX_MSJ_002845

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Administration, Rocky Mountain Region
Archival Operations

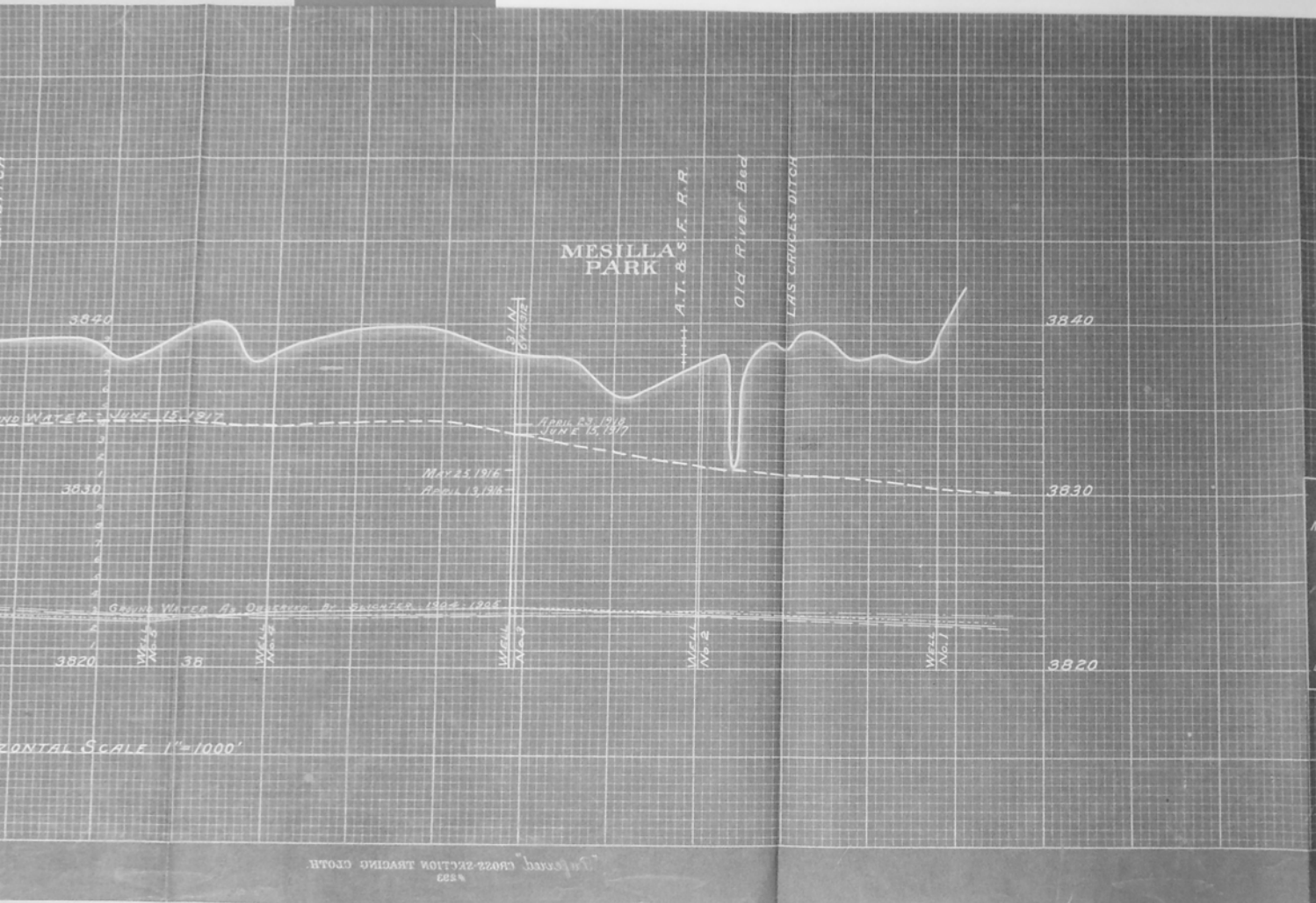
RG No. 115

Curve showing the fluctuation of ground water, application of irrigation water and rainfall over approximately 8500 acres in the Rio Grande Valley. The particular areas considered is that portion of the El Paso Valley lying between San Jose and Clint. The ground water curve is a composite showing the averages in 20 representative wells scattered over the area. The net area irrigated is 5300 acres, on which the average seasonal depth applied by irrigation was 4.3 feet, which would cover the gross areas of 8500 acres to a depth of 2.7 feet.

TX_MSJ_002846

Curve showing fluctuation of Ground Water and application of Irrigation Water on approximately 8500 acres in the Rio Grande Valley. Ground water curve is a composite showing averages in 20 representative wells scattered over area. The net area irrigated is 5300 acres on which the average seasonal depth applied by irrigation was 4.3 ft., which would cover the gross area of 8500 acres to a depth of 2.7 ft.

TX_MSJ_002847



DEPARTMENT OF THE INTERIOR
U.S. RECLAMATION SERVICE
MESILLA VALLEY DRAINAGE INVESTIGATIONS
PROFILE ACROSS MESILLA VALLEY
ALONG ROAD - MESILLA PARK TO SNOW RANCH
GROUND WATER - JUNE 1917
COMPARED TO THAT OF 1904
AS OBSERVED BY
C. S. SLICHTER
FROM WATER SUPPLY PAPER No. 141
DRAWN BY L.R.F. - EL PASO - SEPT. 28, 1917.

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Administration, Rocky Mountain Region
Archival Operations

RG No. 115

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Archival Operations

RG No. 115

Some special investigations have been made and additional wells set, several borings were made in the vicinity east of La Mesa to settle a dispute among, and satisfy, landowners, by proving to them that the drain was located where it should be. Three lines of wells were set across the outlet of the Leasburg Drain to observe the future effects of the outlet on land belonging to Holt and Gerber and the Santo Tomas Farms Company. Several additional wells were set on old lines adjacent to drains and canals to observe the action of the drains on the water table.

Some additional areas were covered by wells and in the Rincon Valley additional lines were set between lines already in through the Garfield district. The new areas were two more lines on the island and the inclusion of the Val Verde district.

The total number of tese wells set and being received to date is as follows:

Unit	Previous	Set in 1918	Total to Date
El Paso Valley	419		419
San Elizario Island	109	16	125
Val Verde		26	26
Mesilla Valley	683		683
Montoya	114		114
Special		25	25
Rincon Valley	164	58	222
Total	1489	125	1614

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Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DRAINAGE TEST WELLS SET IN EL PASO VALLEY

Year	Line	No. of Wells	Date Set	By Whom Set.	Readings Taken.
	27	6	Sept.	Stansbury	
		7			
1913	26.5	9			1913
	26	11			
	25.5	12	May		
	25	8	"		Dec.
	14 N	8	"		Feb.
	14.5 N	9	"		Apr.
	15 N	10	July		June
	15.5	10			Sept.
	17	10			Dec.
	17.5	11			
	18.5	9			
	18	13			1914
	19.5	13			Mar.
	20	12			May
	20.5	11	June		July
	13.5	12	"		Sept.
	13	15	"	Oct.	" " Nov.
	21	12	"		Feb.
	21.5	11	"		April
	22	13	"		June
	22.5	14	"		Aug.
	23	11	"		Oct.
	19	6	"		Dec.
	12.5 S	5	"		
	12 S	8	Nov.		
	11.5 S	1	"		
	11 S	5	"		
	9 S	2	"		
	8.5 S	2	"		
	8 S	286	"		
1915	24 N	7	"	Sept.	Colwell 1915
	24.5 N.	5	"		Jan.
	12.5 N.	3	"		Mar.
	12 N.	3	"		April
	11.5 N.	3	"		June
	11 N.	2	Oct.		Aug.
		23	Nov.		Oct.
		109			

Val Verde District.

	5	June 1918		1918
	9	"		
	7	"		Jan.
	3	"		May
	2	May		Aug.
Island				
	6	"		
	8	"		
	42			

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Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DRAINAGE TEST WELLS SET IN EL PASO VALLEY

Year	Line	No. of Wells		Date Set	By Whom Set.	Readings Taken.
		East of Railroad only				
1917	27.5	7	4	April	Colwell	Dec.
	28	6				
	28.5	6	5			
	29	7	7			
	29.5	7	7	May	"	
	30	6	6	"	"	1916
	24	7	8	"	"	Feb.
	24.5	8	8	"	"	Apr.
	16.5	10	8	July	"	June
	16	9	7		"	Sept.
	15	4	7		"	Dec.
	14.5	4	8		"	
	14	2	7		"	
	9.5	4	4		"	
	10	4			"	
	10.5	2	5		"	
	27 New Wells	4	6	June	"	
	25.5	1		"	"	1917
	23	1	106	"		
	21.5	1		"		Feb.
	21	1	6	"	Dec.	April
	20.5	1	5	"	"	June
	19	1	6	"	"	Aug.
	18.5	1	15	"	"	Oct.
	17.5	1	138	"	"	Dec.
	17	1		"		
	30.5	4	5	Nov.	Jan.	1914
		110				
		San Elizario Island				
	27.5	3		Nov.		
	28	4	2	"		
	28.5	5	1	"		
	29	4		"		
	29.5	3	1	"		
	30	6	2	"		
	30.5	14	4	"		
	31	14		Oct.		
	31.5	14	59	"		
	32	12		Nov.		
	32.5	12		"		
	33	10		"		
	33.5	8		"		
		109				
		Val Verde District.				
1918	5.5	5		June 1918		1918
	6	9		"		
	6.5	7		"		Jan.
	7	3		"		May
	7.5	2		May		Aug.
		Island				
	34	8		"		
	34.5	8		"		Nov.
		42				

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Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations
RG No. 115

DRAINAGE TEST WELLS SET IN MESILLA VALLEY

Year	Line East of Railroad	No. of Wells only	Date Set	By Whom Set	Readings Taken
1913	18	4	Oct.	V. S. Moir	Aug.
	18.5	4	" "	"	Oct.
	19	5	Sept.	Dickinson	Dec.
	19.5	7	"	"	
	20	7	"	"	
	20.5	6	"	"	
	21	8	"	"	
	21.5	8	"	Rapier	
	22	8	"	"	
	22.5	7	"	"	
	23	7	"	"	
	23.5	8	"	"	
	24	7	"	"	
	24.5	4	"	"	
	25	5	"	"	
	25.5	5	"	"	
	26	6	"	"	
		106	"	"	
	26 to R	6	Dec.	Schafer	
	25.5	5	"	"	
	24.5	6	"	"	
	24	15	"	"	1916
		138	"	"	Jan
			"	"	May
	23.5 to R	5	Jan.	"	1914
	23	1	"	" "	Feb.
	22.5	3	"	" "	April
	25	5	"	" "	June
1914	22 to W.S	17	"	" Colwell	July
	21.5 to R.	2	Nov.	" "	Aug.
	21	2	"	" "	Sept.
	20.5	1	"	" "	Nov.
	20 to W.S.	16	"	" "	1916
	19 to R.	1	"	" "	Nov. 20
	18.5 "	2	"	" "	Dec. 8
	18.	4	"	"	" 27
		59			
		114			
		211			

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	26	W. of R.	6	Jan.	Schafer	1915
	25		5	"	"	Jan.
	23		10	"	"	Mar.
	21		13	Feb.	"	Aug.
1915	19		12	"	"	Oct.
	12		14	May	Dickinson	Dec.
	18		10	"	"	
	30		20	"	"	
	36		9	"	"	
	42		5	"	"	
	0		8	July	"	Rapier
	4		11	June	"	"
Special	5	No. 1 9	14	June	"	"
	6	86	12		"	"
	8		14		"	"
	7		12		"	"
	13		17		"	"
	11		15	Aug.	"	Colwell
	9		12		"	"
	10		13	"	"	"
	14		17		"	"
	17		17		"	"
	15		16		"	"
	16		15		"	"
	27	1	15	Dec.	"	
		25	318		"	1916
			18	Jan.	"	Jan
			18	"	"	May
	28		14	"	"	May
	29		9	Mar.	"	June
	31		12	April	"	Sept.
	35		12	"	"	Nov.
	34		14	"	"	
	33		4	Nov.	Colwell	
Montoya	32	District	5	"	"	
	A		7	"	"	
	B		9	"	"	1916
	C		11	"	"	Nov. 20
	D		11	"	"	Dec. 8
	E		14	"	"	" 27
	F		15	"	"	
	G		6			
	H		12			
	I		12			
	J		3			
	K		5			
	L		114			
	M					
			211			

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Records in the National Archives & Records Administration, Rocky Mountain Region
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RG No. 115

DRAINAGE TEST WELLS SET IN RINCON VALLEY

Year	Line	No. of Wells	Date Set	By Whom Set	Readings
	37	9	Mar.	Colwell	1917
1917	38	7	"	"	Feb.
	39	12	"	"	April
	40	9	"	"	June
	41	5	"	"	Aug.
	43	6	"	"	Oct.
	44	4	"	"	Dec.
	45	5	"	"	1917
	36	2	"	"	Sept.
	3	9	July	"	
					1918
Special	No. 1	9	June	"	Jan-Feb.
		86			April
					Dec.
1918	A Santo	4	Aug.	Colwell	1918
	B Tomas	5	"		
	C District.	5	"		Jan.
	7	2			May
	17	4			July
	18	2			Nov.
	19	2			
	19.5	1			
		25			
		164	Sept.		
1918	00	5	Aug.	Hawley	
	0.5	4	"		1918
	1.5	5			Feb.
	12.5	5	Oct.		April
	13.5	6	Sept.		June
	14.5	5	"		Dec.
	15.5	7	"		
	16.5	7	"		
	17.5	6	"		
	18.5	8	"		
		58			

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Records in the National Archives & Records
Administration, Rocky Mountain Region
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RG No. 115

DRAINAGE TEST WELLS SET IN RINCON VALLEY

Year	Line	No. of Wells	Date Set	By Whom Set	Readings.
1917	24	4	May	Collings	
	23	6			
	22	6			
	21	4	June		1917
	20	5			Sept.
	19	6			
	18	6			1918
	17	5			Jan-Feb.
	16	6			April
	15	5			Dec.
	14	3	July		
	13	7			
	12	7			
	11	9			
	10	3	Aug.		
	9	6			
	8	5			
	7	7			
	6	7			
	5	8			
	4	5			
	3	7			
	2	4			
	1	8			
	0	7			
	A	3			
	B	6			
	C	6	Sept.		
	D	3			
		164			
1918	00	5	Aug.	Hawley	
	0.5	4	"		1918
	1.5	5	"		Feb.
	12.5	5	Oct.		April
	13.5	6	Sept.		June
	14.5	5	"		Dec.
	15.5	7	"		
	16.5	7	"		
	17.5	6	"		
	18.5	8	"		
		58			

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SUMMARY OF TEST WELLS SET

UNIT	1913	1914	1915	1916	1917	1918	TOTAL
EL PASO VALLEY	286		23		110		419
ISLAND					109	16	125
VAL VERDE						26	26
MESILLA VALLEY	138	59	312	97	77		683
SPECIAL						25	25
RINCON VALLEY					164	58	222
TOTALS	424	59	335	211	460	125	1614

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Records in the National Archives & Records Administration, Rocky Mountain Region
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Drainage Test Wells: For ground water investigations should be set on lines which will be as nearly as possible at right angles to the probable drain locations, and the profile stationing should refer to a common base on a line running parallel with the probable drain locations so that the profiles can be platted, one above the other in their relative positions enabling one to trace a projected location from one to the other. The base line can be at the edge of the area or outside of it and starting points on the profile scaled or computed, or it can be within the area and profile stationing be run each way from it stating of course the general direction each way from the base.

The distance between lines and the interval between wells must be governed by local conditions. In the Mesilla Valley of this project the lines are on section lines a mile apart with a well every quarter of a mile on line. In the El Paso Valley, the lines are a half mile apart with wells every 2000 feet on line, except in special cases where they are 1000 feet on line. Wells should always be placed where possible in the most protected spot, as near a fence etc. or if necessary to place in a cultivated field on a border leaving the top high enough to be seen in harvesting operations and the distance can be varied moderately to accomplish this or it would be permissible to set it a short distance to either side of the line to accomplish this end, stating the exact location in the water, but, never set a well or the bank of a large

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irrigation ditch or canal.

The numbering system should be as simple as possible. Beginning at one end of the area the lines should be numbered or lettered consecutively and then the wells should be numbered consecutively on each line so that a well can be described by line 6, Well 2 and not Line 33 North, Well 4 plus 2642 West, as is necessary on the Mesilla Valley system. In small areas the base line should be at one edge of the area. For large areas under conditions similar to those existing on this project our El Paso Valley system should be very satisfactory. There the Franklin Canal is the base line, the Railroad, however, is more nearly parallel to the axis of the valley, and well lines are run north and south from each half mile post. The number of the well corresponds to the nearest 1000 feet from the base, which is helpful also in giving an idea of its location and new wells inserted can be given that number plus the number of additional feet from the base. For study and investigation up to the time the drains are constructed, 2000 feet apart for wells has proven satisfactory. To observe the action of the drains, however, additional wells should be set or borings taken on either side of and closer to the drain to locate the water table.

In setting the test wells the profile levels can be carried along and the wells set at the same time, the distance being chained or measured by stadia, or the wells can all be set and the profiles run afterwards. The profile elevations must refer to the same datum as used for the topographic map. The prof

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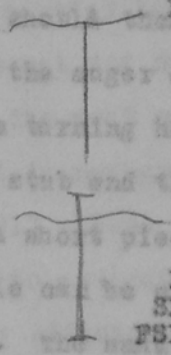
The profiles should extend far enough eacy way to locate the limits of the area, to the foot of the mesa or to and across the river, always get the cross section of the river if possible. Get the elevation of the top of the pipe and either paint the following data on the side of the pipe or stamp it with a steel die on the cap, number of line, number of well on the line and elevation of top of pipe. While sinking the well a log of the soil classification encountered should be recorded and shown by sketch on the right hand side of the level book opposite the station at which it is set. The depth from the surface to each class of material, also the ground water must be shown. This operation is facilitated by having the handle of the auger graduated in feet. The following legent can be used, both on profiles and in notes.



Boring test

Cased Test Well

s - Sand
f.s.- Fine sand
c.s.-coarse sand
g - Gravel
h.p.-Hand pan
r - rock
w - water

L - Loam
SL - Sandy loam
FSL - Fine sandy loam
A - Adobe
C - Clay

Be sure that each well line or the base line is accurately tied into the control system for the topographic map.

Pipe used for test wells is 2" wrought iron pipe. It lasts best in single lengths and 10 ft. is usually about

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right as the average depth of drains is about that. Wells put down in two lengths rust off xtkx at the joints and come apart when the cap is being removed. It has been found best to perforate the pipe and perforation consisting of two opposite rows of ¼" or 3/8" holes 6" on center and staggered for the bottom six feet of the pipe are being used. A much larger per cent of wells are found to work unsatisfactorily where they are not perforated. Perforations have been made by drilling and by burning these through with a welding torch. The top end of the pipe is fitted with a common 2" pipe cap.

Tools used for setting the wells consist of an auger, sand pump, steel numbering dies and stilson wrenches. The auger is made from a 2½" wood bit by breaking the screw point off and grinding a notch in its place, then welded to a piece of 3/4" pipe 10 or 12 feet long. This stem should then be graduated into feet and half feet from the auger end by circles cut with a pipe cutter. For a turning handle use an ordinary 3/4" turnbuckle with stub end threads onto which a ½" pipe T is riveted, and a short piece of hardwood stuck through it. This handle can be clamped at any desired positions in the stem. The sand pump consists of an 18" piece of 1½" pipe slipped over a ½" rod 12 ft. long or a 3/8" pipe 10 feet long, welded to 2 ft. of 3/8" rod tipped with a conical shaped burr large enough to close the 1½" pipe.

The hole for the pipe can be easily bored down until the water table is reached or sand is encountered. The 2"

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casing is then started and can be easily driven or forced down as the sand is pumped from the inside.

Seeped Area maps were prepared during the year for the following areas in addition to the areas covered by 1917 work and reports, San Elisario Island, Val Verde districts of the El Paso Valley and for Hatch district of Rincon Valley. The percentage of area with water less than 4 ft. from the surface was found to be somewhat greater than the 1917 observations on other areas.

Nearly all of the areas shown in the tables were determined from maps prepared from readings of ground water elevations in test wells taken before the construction of drains. There had been constructed, however, about 7.5 miles of the Mesilla Valley East Drain and 3.5 miles of the El Paso Valley Mesa Drain and the areas shown are with these drains in action. All of the areas have been changed by the lowering of the water table in areas covered by drains and its rise in areas not yet covered.

The most noticeable rises in the ground water table as noted in paragraph under ground water have been in areas which in 1917 showed the least percentage of seeped land, and it is safe to estimate that by now these areas have become about as badly affected as the worst seeped areas of 1917 which have not changed so much during the past year and that the percentage will now agree very closely with those areas and with outlying areas for which determinations were made in 1918, on this basis it is estimated that all areas not yet affected by

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Records in the National Archives & Records Administration, Rocky Mountain Region
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GOUND WATER CONDITIONS AND SEEPED AREAS--AS DETERMINED FROM GROUND WATER MAPS.

EL PASO VALLEY

District	Total Cross Area Acres	Depth to ground water from surface: On Surface		0 to 2 ft.		2 ft. to 4 ft.		Total Less than 4ft.	
		Acres	%	Acres	%	Acres	%	Acres	%
*To Fabens	45,096	2045	4	8802	20	20251	45	31098	69
Island	13,357	226	2	3129	23	7760	58	11115	83
Val Verde	1,452	353	24	254	18	561	38	1166	80
Total	59,905								

El Paso Valley, June 1917--Island, December 1917--Val Verde, June 1918.

* MESILLA VALLEY

District	Total Cross Area Acres	Depth to ground water from surface: On Surface		0 to 2 ft.		2 ft. to 4 ft.		Tot. Less than 4ft.	
		Acres	%	Acres	%	Acres	%	Acres	%
Dona Ana	10,797	341	3	2485	24	4406	40	7236	67
Las Cruces Mesilla	12,175	396	3	1346	11	2736	22	4478	37
East Side	27,189	1140	4	3900	14	12481	46	17521	64
West Side	20,539	1748	8	5244	26	8171	40	15163	74
La Union	17,985	175	1	3118	17	11027	61	14320	80
Montoya	4,374							2947	
Picacho	4,781								
River Bed	9,700								
**Isolated Tracts	1,225								
Total	108,765								

*Vinton 380 acres - West Side in T29S - 575 Acres, Montoya East of Railroad - 270 Acres.
**1917 Determinations all of June conditions except Montoya District which is of March.

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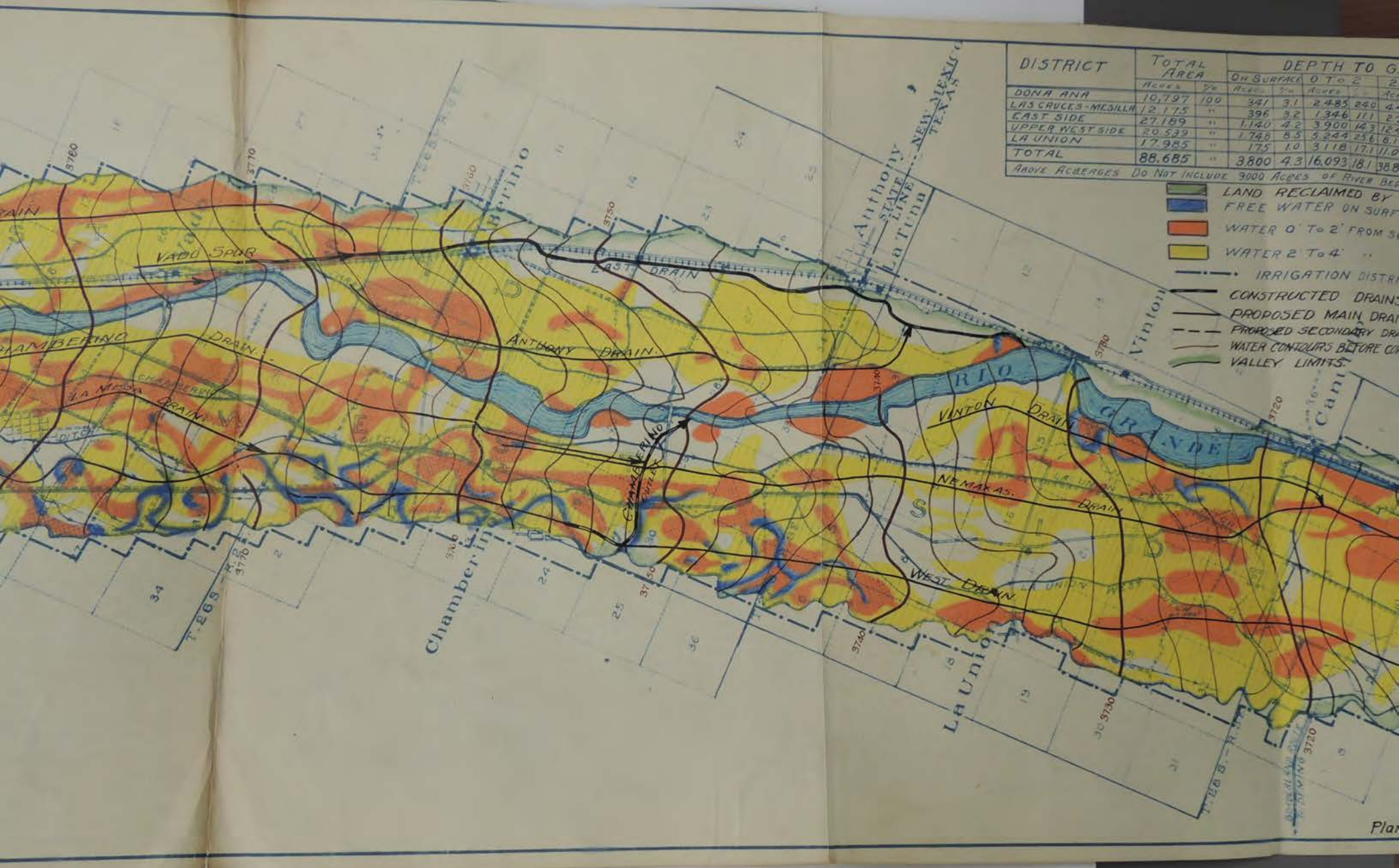
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

TX_MSJ_002866



Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations
RG No. 115

TX_MSJ_002867

DISTRICT	TOTAL AREA		DEPTH TO GROUND WATER									
			ON SURFACE		0 TO 2'		2' TO 4'		TOTAL LESS THAN 4'		TOTAL MINUS THAN 4'	
	ACRES	%	ACRES	%	ACRES	%	ACRES	%	ACRES	%	ACRES	%
DONA ANA	10,797	100	341	3.1	2,485	24.0	4,406	40.0	7,232	67.1	3,565	32.9
LAS CRUCES-MESILLA	12,175	"	396	3.2	1,346	11.1	2,736	22.4	4,478	36.7	7,697	63.3
EAST SIDE	27,189	"	1,140	4.2	3,900	14.3	12,481	45.9	17,521	64.4	9,668	35.6
UPPER WEST SIDE	20,539	"	1,748	8.5	5,244	25.6	8,171	39.8	15,163	73.8	5,376	26.2
LA UNION	17,985	"	175	1.0	3,118	17.1	11,027	61.4	14,320	79.5	3,665	20.5
TOTAL	88,685	"	3,800	4.3	16,093	18.1	38,821	43.8	58,714	66.2	29,971	33.8

ABOVE ACREAGES DO NOT INCLUDE 9000 ACRES OF RIVER BED NOR PICACHO AND MONTOYA DISTS.

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE
RIO GRANDE PROJECT, N.MEX.-TEX.

MAP OF

MESILLA VALLEY

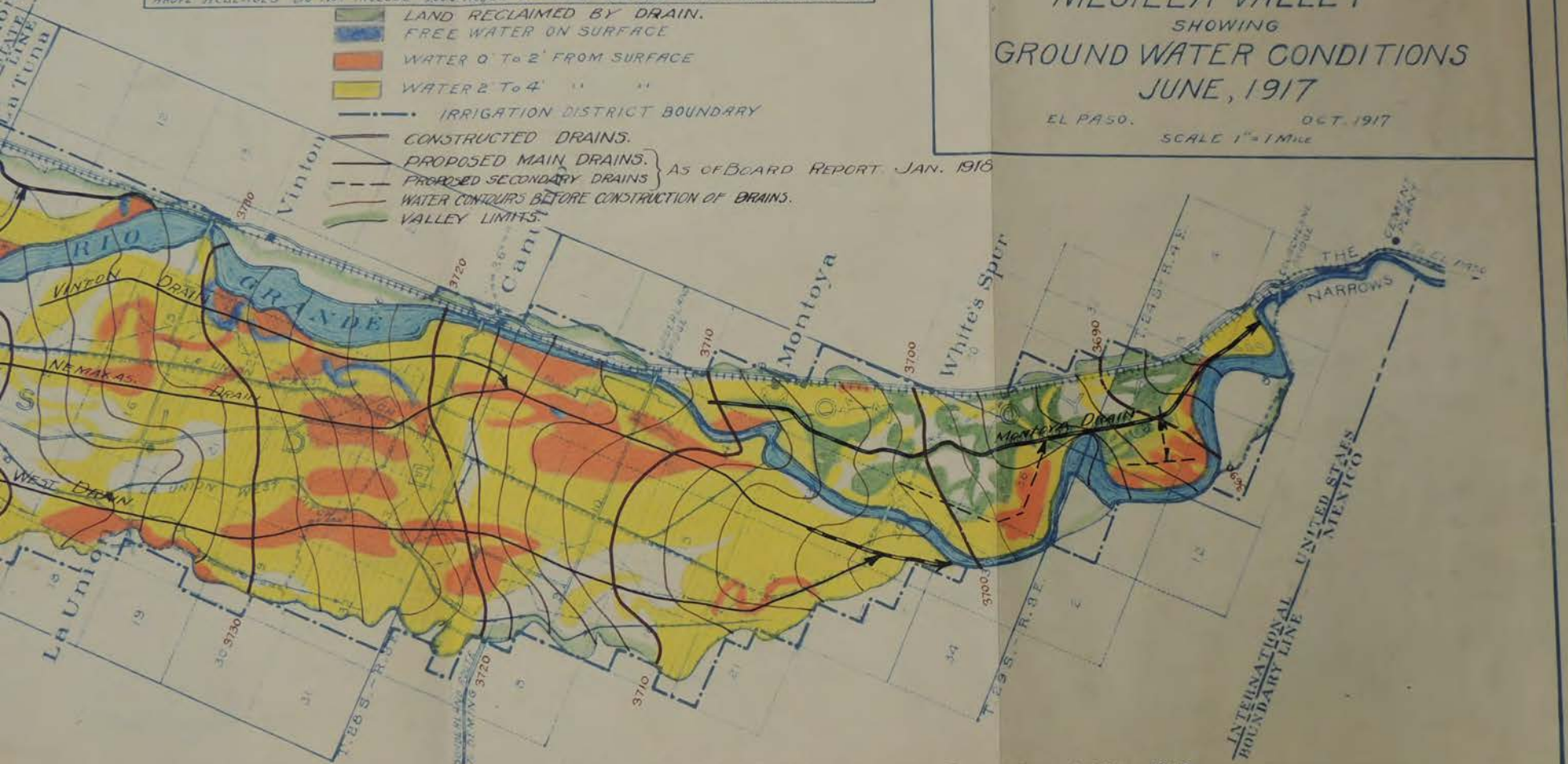
SHOWING

GROUND WATER CONDITIONS

JUNE, 1917

EL PASO. OCT. 1917

SCALE 1" = 1 MILE



Plan Adopted by Board, Accompanying Board Report of Jan. 1918.

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations
RG No. 115

TX_MSJ_002868



DRAINS.

DRAINS. } As of Board Report - Jan. 1918.
DRAINS. }

I M E.

PLAN ADOPTED
by
BOARD - JAN. 1918
Accompanying Board Report.

DEPARTMENT OF THE INTERIOR
United States Reclamation Service
RIO GRANDE PROJECT, N.M.-TEX.
EL PASO VALLEY

Drawn by G.A.T. Recommended
Checked Approved
1127 R68 El Paso, Texas, June 8, 17

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TOTAL AREA		DEPTH TO GROUND WATER								
		ON SURFACE		0 TO 2'		2' TO 4'		TOTAL LESS THAN 4'		TOTAL MORE THAN 4'
ACRES	%	ACRES	%	ACRES	%	ACRES	%	ACRES	%	ACRES %
45096	100	2 045	4.5	8802	19.5	20.251	45.0	31.098	69.0	13.998 31.0

ABOVE ACERAGE DO NOT INCLUDE VAL VERDE ISLAND OR TORNILLO DISTS.

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TOTAL AREA		DEPTH TO GROUND					
		ON SURFACE		0 TO 2'		2 TO 4'	
ACRES	%	ACRES	%	ACRES	%	ACRES	%
45096	100	2 045	4.5	8802	19.5	20.251	450

ABOVE ACERAGE DO NOT INCLUDE VAL VERDE.IS

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drains will now average 75% to 80% having water less than 4 ft. By far, the greatest rises in the water table during the past year resulting in the greatest increases of seeped areas as observed in the field and on test well records has occurred throughout the Las Cruces-Mesilla District, and this area which was least affected up to 1917, having then only 37% less than 4 ft. to water, as compared with 65% to 80% for other areas is now comparable to other parts of the project.

Seepage maps and areas for Rincon Valley as a whole have not been worked up for several reasons. Some of the test wells have not been in long enough to secure satisfactory readings. The canal systems are not yet complete and not all land is under irrigation that will be eventually, and to make the map more useful in the location of drains they should be made just previous to such location. However, for the purpose of locating drains in the Hatch District a map for that area was worked up in May, 1918, but no areas metered. At an estimate from this map and well sections the conditions will average with the rest of the project.

It is intended to prepare seepage maps for the whole project, using the maximum elevation attained by the water table before the construction of drains, for the purpose of comparing conditions before and after drainage construction. Seepage maps are made and seeped areas determined as follows: The test wells together with the observed ground water elevation in them for the date it is desired to make the determinations are spotted on a white print (cloth preferred) of the topographic map; interpolations are then made from the

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elevations and the ground water contours drawn in just as surface countours are drawn. The points of intersection of the ground water contours with surface contours having the sought for differences in elevation are spotted and properly connected so as to give lines having constant depths to water. If the ground water contours and the surface contours each have intervals of 2' we can then mark off lines having water at the surface, 2' from the surface, 4' from the surface etc. By using an appropriate color scheme, as blue for free water on the surface, orange for water 0' to 2' from the surface, yellow for water 2' to 4' from the surface etc. and tinting the intervals between the lines of equal depth accordingly, we are able to map out the areas which are then planimetered for area determinations.

Alkali is rapidly accumulating on many parts of the project where the water table is within the capillary limit. The increased quantity of salt on the surface and appearance of new areas are quite evidnet to one familiar with the valley. Some areas when humid conditions are just right are beginning to have the appearance of a passing snow storm. Most of the salts are white alkali, common salt predominating, but black alkali is evident in spots and several totally unproductive areas are fast increasing in extent, especially where drains are not yet constructed and the field is allowed to remain uncultivated.

Some alkali determinations and analysis should be made and experimental data collected on the effect of the drains on the leaching out of alkali from the soils. The capillary

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limit of the various soils should be determined by experiment also. The salt content of drain water should be also determined frequently and this should be made a part of the regular duties when drain discharges are measured, and the results platted on the same sheet as the discharge together with the length of drain for direct comparisons. An electric resistance bridge as used by the Bureau of Soils for determining salt content of water and soils has been secured on loan from that Bureau and it is proposed to secure the data mentioned above. Some analyses have been made on the salt content of the discharge of some of the drains and the results shown in the following tables. Analyses were made by V. E. Lieb at the El Paso School of Mines in the labratory. See his reports, one of July 3, 1918 and of November 2, 1918.

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RIVER AND DRAIN WATER ANALYSIS OF JUNE 20, 1918.

Parts Per Million

CONSTITUENT REPORTED AS	West Drain Mesilla Valley at Road	Rio Grande ½ mile Below Outlet of West Drain	Rio Grande Above Outlet of West Drain	Mesa Drain El Paso Valley at Highway	Rio Grande Below Mesa Drain	Rio Grande Above Mesa Drain
Silt in Suspension	Not determined	Not determined	33	178	246	261
Organic Matter in suspension	" "	" "	257	573	316	641
Specific Gravity	1.00044	1.00046	1.00028	1.00299	1.00286	1.00202
Sodium Chloride	284	170	71	1391	1844	2021
" Sulfate	211	144	114	559	300	101
Calcium "	226	144	48	739	706	749
" Carbonate	141	118	105	155	98	56
Magnesium "	2	Trace	2	6	20	84
Ferrous Carbonate	1	2	2	3	2	10
Silicon Dioxide	29	27	24	59	28	28
Volatile and undetermined	6	---	1	5	197	218
Total solids in solution	900	605	367	2917	3195	3266

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RIVER AND DRAIN WATER ANALYSIS OF JUNE 20, 1918. (Continued)

Parts per Million

CONSTITUENT REPORTED AS	Anthony Drain above ½mile mxmx outlet	Rio Grande Above Anthony Drain	Rio Grande ½ Mile Below Anthony Drain	Nemexas Drain at Guage Station	Rio Grande Below Nemexas Drain	Rio Grande Above Nemexas Drain
Silt in suspension	181	226	219	284	256	140
Organic Matter in suspension	283	480	229	128	724	634
Specific Gravity	1.0047	1.0011	1.0014	1.0031	1.002	1.0012
Sodium Chloride	3275	279	400	1546	201	152
" Sulfate	1328	174	355	685	52	87
Calcium "	419	94	26	306	194	110
" Carbonate	289	330	170	286	67	94
Magnesium "	2	10	10	5	Trace	Trace
Silicon Dioxide	14	16	16	51	23	20
Volatile and undetermined	---	57	86	69	5	3
Total Solids in solution	5329	942	1073	2951	546	470

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Tabulation of analysis

RIVER AND DRAIN WATERS ANALYZED OCTOBER 23, 1918

CONSTITUENT REPORTED AS	EAST DRAIN AT		RIO GRANDE AT BORDERLAND BRIDGE		RIO GRANDE BELOW EAST DRAIN		NEMEXAS DRAIN AT BORDERLAND ROAD.		RIO GRANDE 1-1/4 MI. ABOVE WEST DR.OUTLET		RIO GRANDE AT COURCHESNE		WEST DR. AT GAUGING STATION.	
	Parts per Million	Grains per gal.	Parts per million	Grains per gal.	Parts per million	Grains per gal.	Parts per million	Grains per gal.	Parts per million	Grains per gal.	Parts per million	Grains per gal.	Parts per million	Grains per gal.
Na Cl	2873	167	211	12,3013	370	21,5710	1268	73,9367	74	4,3168	242	14,1197	336	19,600
Na SO 2 4	884	51,5372	97	5.6585	137	7.9871	139	8.1050	99	5.7751	118	6.8797	135	7.8752
Ca SO 4	482	27.7006	111	6.4713	177	10.3191	586	34.1870	158	9.2169	193	11.2550	367	21.4083
Ca CO 3	293	17.0819	118	6.8797	94	5.4835	110	6.4168	60	3.5001	70	4.0834	108	6.3002
Mg CO 3	100	5.8335	6	0.3500	19	1.1084	59	3.4418	7	0.4083	6	0.3500	14	0.8167
Fe Co 3	14	0.8167	8	0.4667	12	8.7000	16	8.9333	25	1.4584	10	0.5833	11	0.6417
Si O 2	44	2.5667	23	1.3417	28	1.6334	39	2.2751	22	1.2834	21	1.2250	38	2.2167
Organic violatile & Undertermined.	58	3.3854	33	1.9250	6	0.3500	23	13417	5	0.2917	18	1.0500	33	1.9250
Total solids	4748	276.4159	607	35.3942	843	49.1525	2240	130.6374	450	26.2507	675	39.5461	1042	60.783

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The Action and Effects of Constructed Drains upon the ground water table have been observed and noted mostly from the test well readings and sections. The lowering of the water table has been noted on all sections crossed and on some lines additional wells have been set at shorter intervals and nearer to the drains, also some special lines have been set. On both of the latter, more frequent readings have been taken. Though all areas in which drains have been constructed there has been a noticeable lowering of the water table which, however, has been quite variable. The effect is never felt ahead of the excavation but the lateral action takes place very rapidly, after the construction of the drain, until the new equilibrium is reached. This lateral action has been quite variable depending on the source and amounts of water flowing toward the drain. In every case under observation there is marked loss of head on entrance from the water to the water surface in the drain. This seems to be about 1.5 ft. and takes place very near to the drain. It probably takes the form of a draw down curve but no tests have been made of near enough intervals to plat it. In areas where there is little or no irrigation after this entrance rise near the drain the surface of the water table takes a uniform slope rising one foot in 2000 or flatter, sometimes where the action seems to be interceptive rather than feeding, it even slopes away from the drain, remaining parallel to the original water table, but lower by the amount attained at the drain. Even on drains paralleling the river at distances of one half to three quarters of a

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miles under above conditions the water table takes a comparatively flat slope after the entrance rise and then an abrupt rise to the river water surface very near to the river bank probably in as short an interval as the entrance drop to the drain occurs. In areas where there is considerable irrigation and on the sides of the drains toward which there is a noticeable movement or piling up of water the action of the drain or the water table is quite variable, as is the case of the upper two miles of the Vinton Drain, located three quarters of a mile from the river, has drained completely the land between it and the river lowering the water table four and five feet while its effect on the land side is very slight. It has become an intercepting drain all right, but intercepting water flowing toward the river rather than away from it. This is also born out by the fact that the water contours on the seepage map indicate a distinct water ridge and flow down the valley just west and north of this point. On all drains through all parts of the valleys where conditions of cultivation, irrigation and slope are normal or average, there seems to be a very noticeably consistent slope of the water table toward the drains, of one foot in 1000 feet, to the point where the entrance head loss begins. Th us, if a drain is dug 10 feet deep, has 1.5 of water in it and there is an entrance head of another 1.5 feet, the water will be seven feet below the surface within a very few feet of the drain and will be within four feet of the surface three thousand feet away, providing the ground surface is level. But, the drains are usually located in the lowest areas and have the

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slope of the ground working to the advantage of drainage and are therefore frequently effective for greater distance than this. As more of the drains are constructed and the parallel system develops and some of the drains intercept water now going to other it is expected that the ground water slopes will flatten.

Drains built parallel to and four to five hundred feet from the largest canals on the project have been observed to lower the water table under and across the canal as if it were not present. Either the loss from the canal was negligible or the ground water is lowered and flows to the drain so rapidly that whatever losses there are from the canal percolate straight down to the water table and away toward the drain without any piling up effect being apparent. After the first draw down this drain seems not to be collecting an excessive amount of water although it parallels the canal for a distance of six miles through an extraordinarily sandy country

Area Reclaimed and Protected: is shown by the following table. Some of the portions of drains constructed will not be working to their maximum efficiency until other drains are constructed, some on account of temporary outlets and others because the parallel drains are needed to supplement and complete the function of each.

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AREAS RECLAIMED AND PROTECTED
To December 31, 1919.8

Drain	Length	Area Covered Acres	Area Reclaimed Acres	Area Protected Acres	Area Undrained at Outlet.
			El Paso Valley		
Mesa River)	16.2	10.560	Reclaimed are estimated at 2/3 of total which is		400
Middle) Clint)	10.9	7,104	the average % under which the water was less than 4'		600
Franklin	1.8	1.856	from the surface.		0
Island	2.1	1.920			920
			Mesilla Valley		
East	11.5	5888			100
Anthony	2.1	960	Protected area taken to be		0
Upper West	10.1	4800	1/3 of total which is the		0
Cham. Outlet	1.7	0	average % under which water		0
Lower West	3.2	1.920	was still more than 4'		156
Nemexas) Vinton)	10.4	6016	from the surface		300
La Mesa	2.0	928			100
Park	1.0	512			50
Leasburg	1.3	320			160
Total	74.3	42,784	28000	14,000	2,786

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Gross Area Reclaimed and Protected	42,000 Acres
Deduct 15% for non-irrigable areas	6,300 "
Net area Reclaimed and Protected	35,700
Total Cost to Date	$514,828.31
Cost Per acre, without Investigations and Surveys Charge	14.40
Estimated cost by Board Report of Jan. 1918.	22.10
Actual Cost per acre to date 65% of estimated cost.	

Estimated cost of Investigation and Survey $0.75 per acre to be added to each of above.

The total area covered as given above contains a larger per cent of undrained land at outlets than there will be of the total when all drains are complete.

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Discharge of Drains: Attempts have been made to secure regular discharge measurements on the constructed drains. This work was started in March by the project hydrographer and continued after October 1st by the Operation and Maintenance men in the respective valleys. The data has not been sufficiently worked up to tell whether there is an difference in and out of the irrigation seasons. Such a determination is not altogether feasible at present as the lengths of the drains and contributing areas are constantly increasing; nor is it possible yet to determine with a degree of accuracy what the drains will be eventually discharging ~~xxxxxthe~~using their present guagings as a basis for estimate for new areas are now constantly being tapped as the construction progresses, and the contribution is much larger than will be after an equilibrium is established. Discharges on drains on which guagings have been made are shown in the following table.

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DISCHARGE OF CONSTRUCTED DRAIN

December 1918.

Drain	Length Above Gauging Miles	Profile Area Contributing Acres	Discharge Cu.Ft. Sec.	Discharge per Mile length sec-ft.	Discharge per Acre contributing sec-ft.
		El Paso Valley			
Mesa	15	10,000	9.0	.60	.0009
Middle) Clint) Franklin)	10	8,000	10.0	1.00	.0012
		Mesilla Valley			
East	11	5,800	10.3	.94	.0018
Anthony	2	960	1.7	.85	.0018
Nemexas) Vinton)	8	5,000	16.5	2.06	.0033
Upper West	9	4,800	17.0	1.89	.0035
Total	55	34,560	64.5	1.17	.0019

Taking the above as a basis the 74.3 miles of constructed drains on the project would be discharging 87 sec-ft. which is not true because the gauging stations are all far enough above the outlets to keep back water from interfering and it is quite reasonable to expect that some of the drains at least lose water near the outlets rather than collect.

Having worked up the above table for December and noticing that some of the drains in spite of the constantly increasing length were flowing only about 2/3 as much water in December as in July and August it seemed worth while making the same determination for the maximum flows and a comparison might be enlightening as to what can be expected in and out of irrigation seasons.

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DISCHARGE OF CONSTRUCTED DRAIN.

August 1918.

Drain	Length Above Guaging Miles	Probable Area Contributing Acres	Discharge Cu.Ft.-Sec.	Discharge per mile of length Sec.Ft.	Discharge per acre contribution Sec. Ft.
		El Paso Valley			
Mesa	12.5	8000	16.0	1.28	.002
Middle) Clint)	5.8	4200	9.0	1.55	.0021
		Mesilla Valley			
East	11	5800	14.0	1.27	.0024
Nemexas) Vinton)	5.7	3600	14.0	2.46	.0039
Upper West	7.9	3600	22.0	2.78	.0061
Total	42.9	25,200	75.0	1.75	.003

Note: The Nemexas-Vinton Drain can be termed a river drain that is, it parallels the river but at from one half to three quarters of a mile. Our records and observations on test well sections and ground water maps, however, seem to indicate that this drain is receiving the bulk of its water from the west, or land side. The upper west tapped a chain of lakes and is parallel and about 600 feet from center line to center line of the west side canal. The location is across bends of old river beds which formed the lakes and the formation is predominated by a rather coarse sand nearly the total distance.

The East and Mesa Drain are comparable and are located approximately parallel to and one half to three quarters of a mile from the foot of the mesa.

The Middle, Clint and Franklin drains are being con-

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structed up through the central portion of the valley.

That these drains will all flow more during the heighth of the irrigation season or shortly thereafter than at any other time is quite evident and to be expected. But, as to whether the discharges will each season approximate those as observed for last August or whether they will be very much less once an equilibrium is established and the length of time to establish that equilibrium are all problematical. It is quite probable, however, that an equilibrium will be established in one year after the completion of all drains.

Cruves showing the discharge of the drains and the constructed length, both for comparison of discharge with length and observations on seasonal fluctuations are being kept up and are on file in the drainage office.

The Conditions of Constructed Drains: The conditions of constructed drains is not the most encouraging. The principal obsticals being caving banks and rising grade. In some soil formations, especially, a certain grade of sand of sand the tendency of the section to become wide and shallow with vertical banks and a resulting high bottom. Just what the action is which results in these conditions is a subject of discussion, but it can probably be traced to the drawing action of the water on the sand just at the water edge which undermines the bank a little and allows it to tumbler over into the drain. This process repeated many times results in the disappearance of the entire bank slope. The bank caving is multiplied when a large section caves off by the current being thrown against the opposite bank, cutting it. Probably

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all that would be necessary to remedy these conditions would be a bank protection of light construction, just enough to break up the action of the water just at its edge. The wind has also very damaging effects. Sand if spoiled on the west side is blown back into the drain and the east slopes of the drains through sand cuts are subjected to serious wind erosion, deep grooves being cut in the looser strata allowing the next one above to cave off.

Observations are made for rising grade by taking checking profiles at intervals and to preserve the original stationary it is being stenciled on the structures and bench marks are being set on them. Some of the drains have been found to be from one foot to nearly two feet above grade for considerable portions of their lengths six months after construction even though constructed below grade. There are places through sand where drains intended to be ten feet . Bottom widths are from 30 to 40 feet wide with vertical banks and are about two feet above grade.

Tumble weeds and Russian thistles give no end of trouble after the windy season begins. Weed jambs sometimes back the water up, raising it several feet, or they lodge against one bank and start the current to cutting the banks on the opposite side. Numerous fences of all kinds are being constructed across the drains and are a great nuisance in collecting weeds and trash. Farmers should be compelled to raise their fences high enough to not catch floating trash or take them out altogether. Tule growths have started in some places and require cutting once or twice a year but have not

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become a serious source of trouble. An abundant growth of moss has started in some of the drains. Cattle going down into the drains for water frequently get stuck in the quick-sand and die there.

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Middle Drain west of Dr. Turner's farm, near Clint, January, 1919. Shows the result of cutting bank and rising or filling bottom of the drains where construction is through sand. This section was constructed in June, 1918, with a 12 foot bottom and sloping sides. It is now 30 to 40 feet wide, with vertical banks, and almost 2 feet above grade. The two rows of posts set in the bottom of the drain in the distance are 12 feet apart and were set with the intention of putting in protection work to confine and protect the channel, but when the bottom was found to be so much above grade it was decided that machine work would be necessary to clean out the drain before the channel and bank protection should be placed.

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Bank Protection : Experiments on three types of bank protection have been carried out, the engineers report on same being attached, also some photographs of same. The intentions are that after the most practical type of bench protection has been determined upon, that the protection work should immediately follow the excavation and catch the drains while they are still down to grade. Previous experience and observations should be a guide in determining where bank protection is necessary.

If a great deal of cleaning, deepening and bank protection is going to be required, our very gratifying cost, as given to date will be materially increased and may run as high or higher than the estimate for completed drains. The engineer's report on bank protection shows that the cost of it might be as much or considerably more per foot than the cost of excavation of the drains.

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DEPARTMENT OF THE INTERIOR
United States Reclamation Service.

El Paso, Texas. Jan. 6, 1918.

From Construction Superintendent W. E. Whittier,

To Project Manager, El Paso, Texas.

Subject: Protection of side slopes on drains.

1. Referring to your letter of Dec. 5, 1918, three methods of drain protection have been installed on the Franklin Drain, each 300 feet long and extending from station 65 plus 11 to station 74 plus 11.

(a) 4"x4"x12' redwood posts, 8 ft. center to center, were jetted in vertically to a depth of 7 feet below grade on both sides of the drain, i.e., 12 feet apart across the drain. On the outside of these posts 58 inch hog wire was fastened securely. Arrowweeds to a height of approximately three feet above grade were tightly rammed against hog wire, which were covered with earth fill on a 2:1 slope toward the drain bank. The width of the bottom of the drain as excavated varies from 16 to 18 feet. The unit cost of this work as shown in cost reports is $0.564 per foot of bank protected, or $1.128 per foot of drain protected.

(b) 14 ft. cotton posts, 3 ft. center to center, were jetted in vertically to a depth of 8 ft. below sub-grade on both sides of the drain, and willow brush was laid and tamped in against posts and fastened with a few strands of wire. Willow brush was covered with earth fill on a 2:1 slope toward the drain bank. On a portion of the 300 lin. ft. of drain protected the brush was woven in and out between willow posts. The latter idea was abandoned as it left a very much more uneven surface. The unit cost of this work as shown in cost reports is $0.268 per ft. of bank protected, or $0.536 per foot of drain protected.

(c) 4"x4"x8' redwood posts, 8 feet center to center, were jetted in vertically to a depth of 5 ft. below sub-grade on both sides of the drain, and 2" x12"x16' rough redwood nailed to outside of posts, two boards high from subgrade of drain. Boards were backed with earth, 2:1 slope. The unit cost per foot of bank protected was $0.368 per foot of bank protected, or $0.736 per foot of drain protected.

2. The hog wire as installed will no doubt give the best results as a permanent vertical bank will probably be sodded before the hog wire gives out. It is probable that the willows as outlined under (b), will grow and thereby clog the drain. What will happen with the wood protection after lumber fails is problematic.

3. The hog wire protection may be made cheaper in a

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similar experiment by using 4"x4" posts 8 ft. long instead of 18'long, and also using 26" to 32" hog wire instead of 58" hog wire.

W. E. Whittier.

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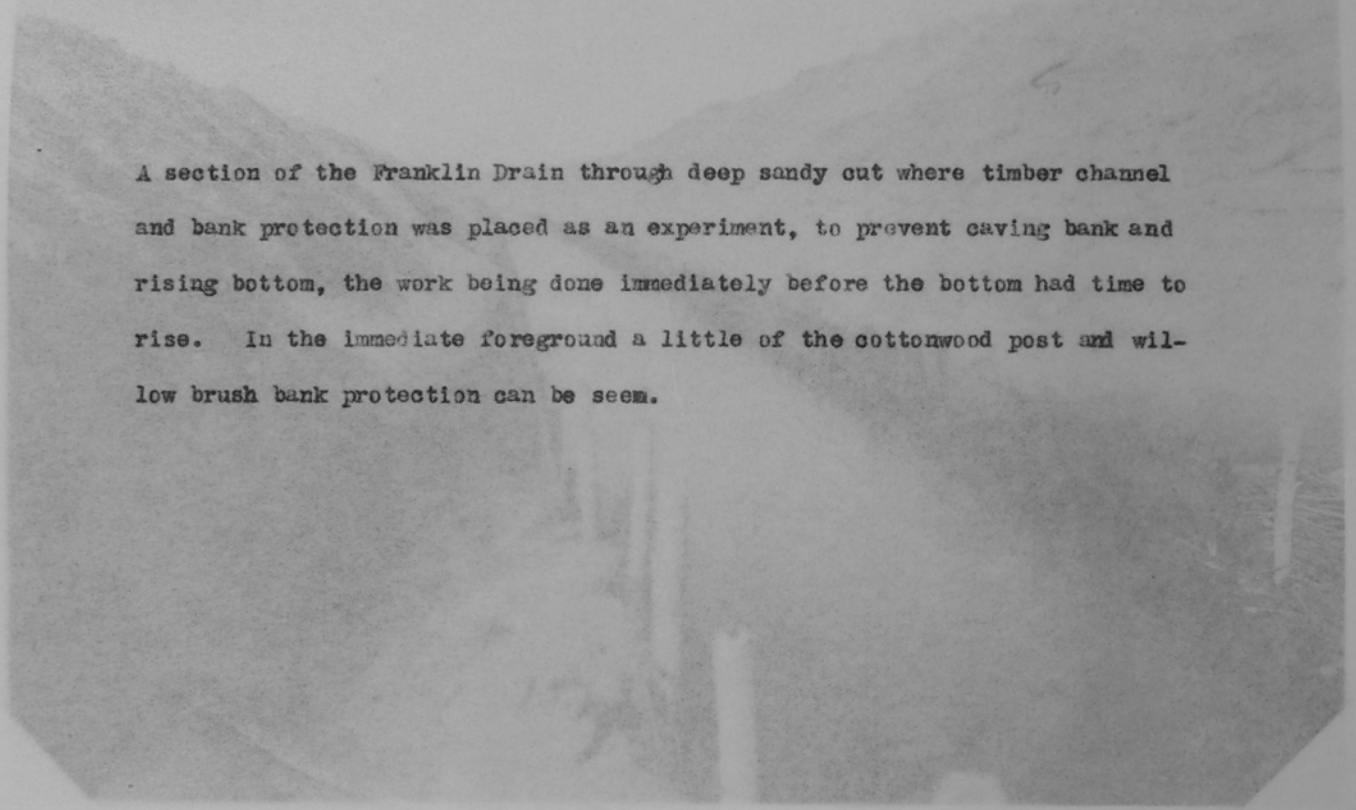

A section of the Franklin Drain through deep sandy cut where timber channel and bank protection was placed as an experiment, to prevent caving bank and rising bottom, the work being done immediately before the bottom had time to rise. In the immediate foreground a little of the cottonwood post and willow brush bank protection can be seem.

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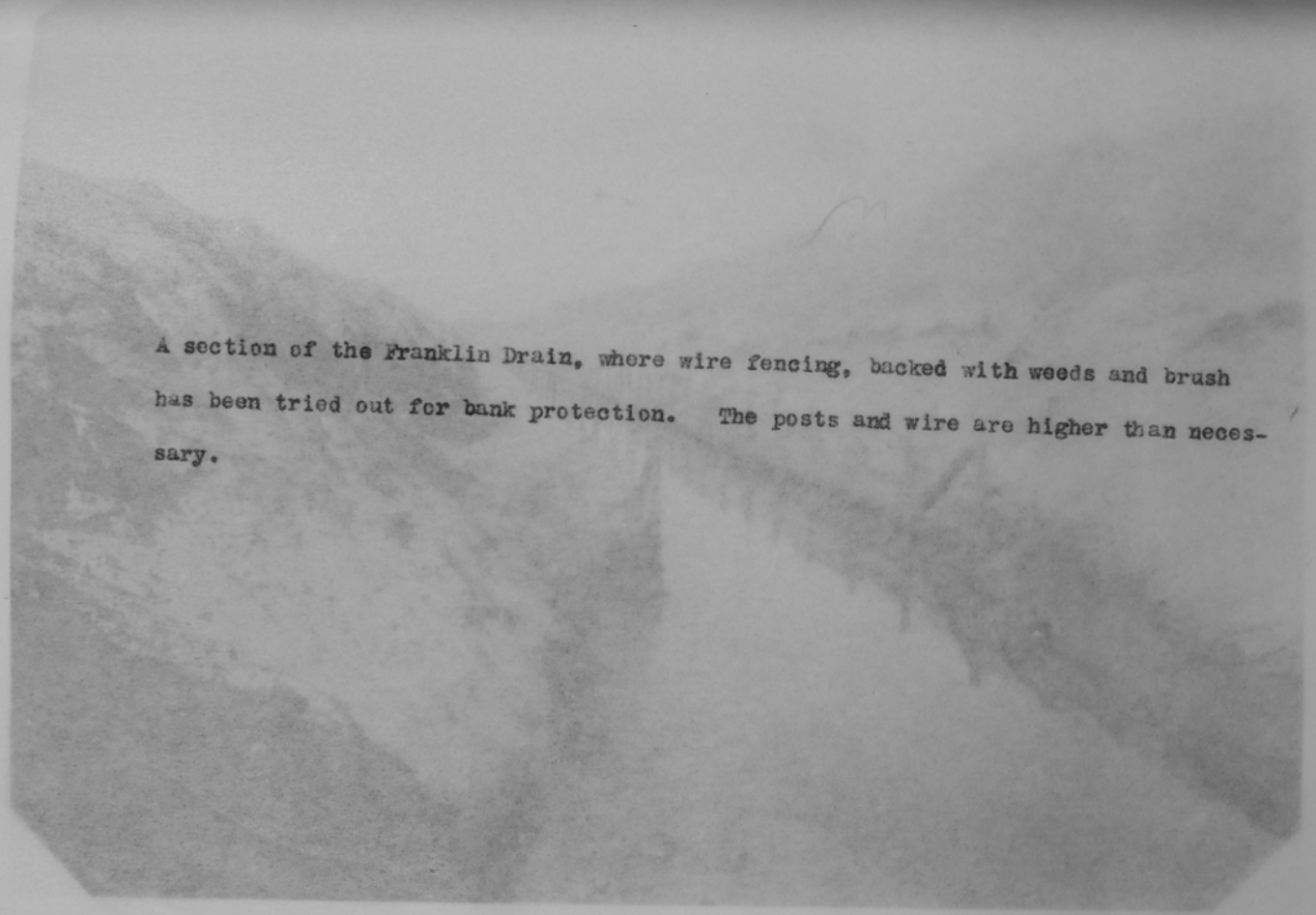

A section of the Franklin Drain, where wire fencing, backed with weeds and brush has been tried out for bank protection. The posts and wire are higher than necessary.

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Rio Grande River Investigations: during 1915 a number of points were selected along the Rio Grande from Percha Dam to Fabens, over which it was intended to take cross section profiles at intervals for comparison and observation on the cutting or filling of the channel. These sections have been read several times but the sections are necessarily few and far between. The best possible records for these observations would be to have taken details and complete profile across the river on each test well line at the time the wells were set, this was done only x on a few lines so in February 1918 the well reader was sent out to complete as many of them as he could before the water was turned in. These sections are close enough together so that by taking the river profiles again at any time it should be easy to observe just where and how the river bed is behaving.

River Discharge Gaging Elephant Butte to El Paso: In December 1917 and January and February 1918, three sets of gagings were made on the Rio Grande a distance of about six miles apart between Elephant Butte Dam and El Paso. These were taken while the water was shut off at Elephant Butte for observations on loss and flow. The results were plotted for comparison on a print of the small scale Rio Grande water surface profile as run

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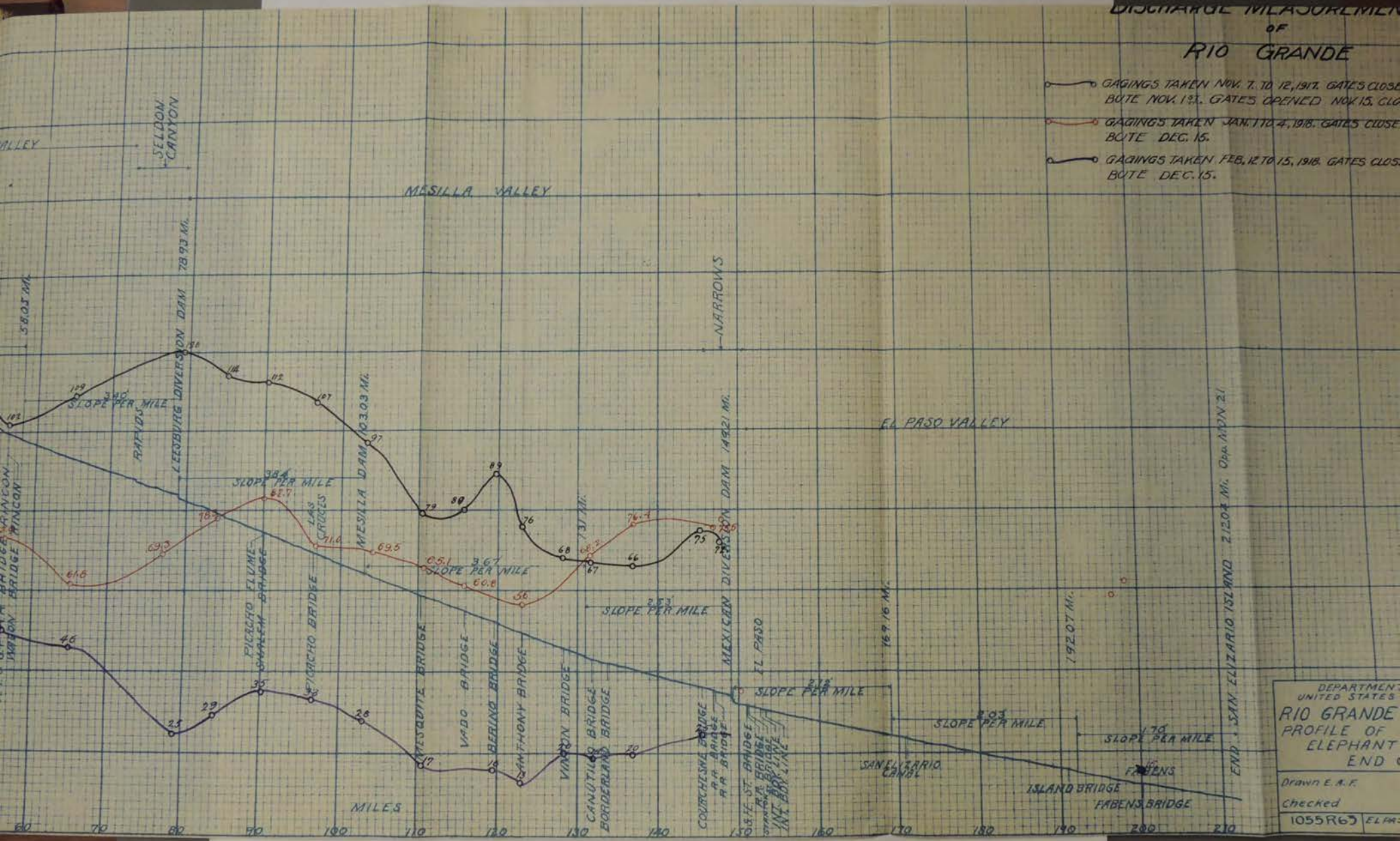

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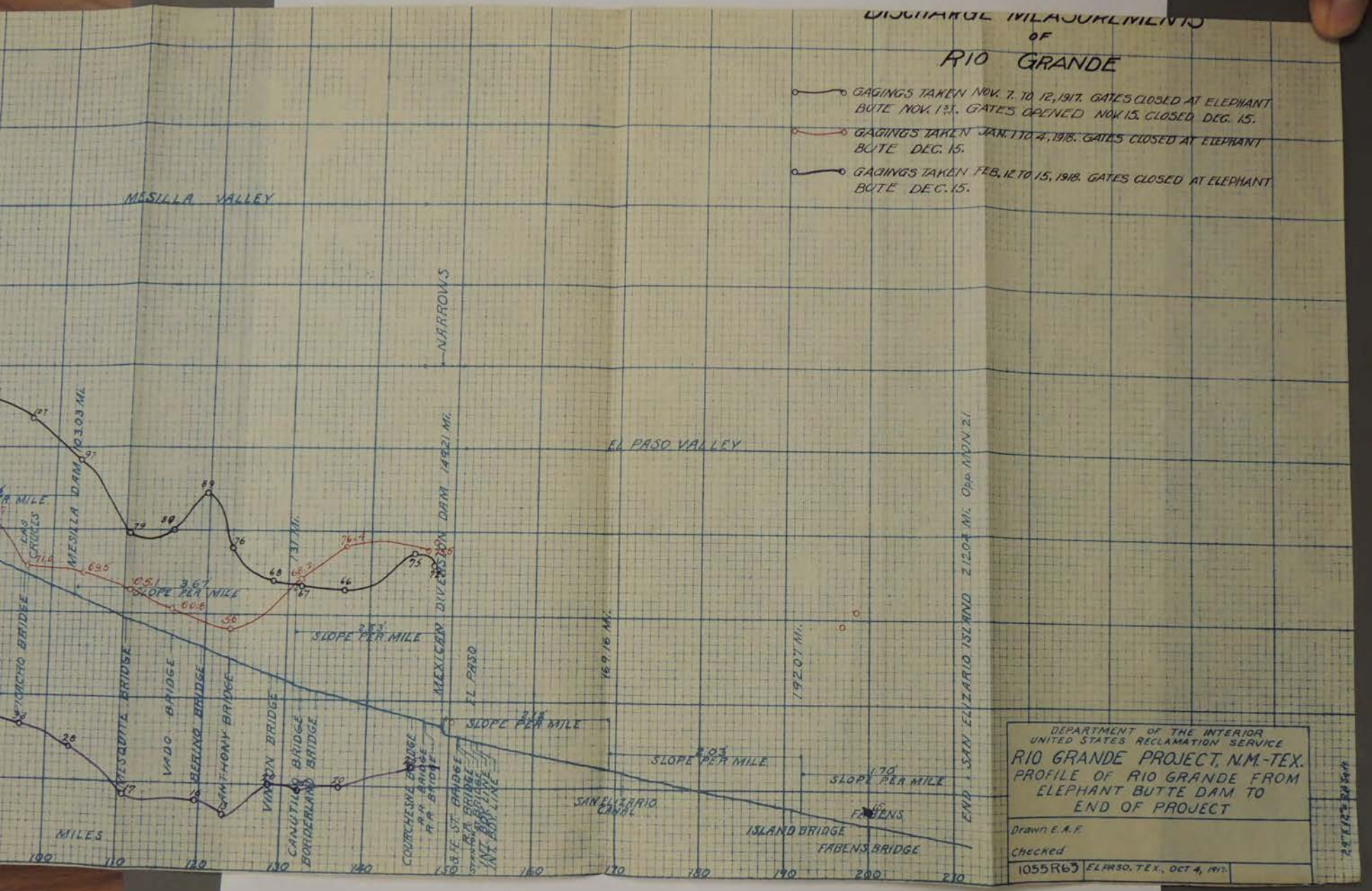

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in 1917 from Elephant Butte to the lower end of San Elizario Island.

Tonuco River Cutoff which is the subject of special reports has been investigated and recommended for construction. It is the first work to be done by a new Monighan 1 T Dragline excavator being purchased for drainage work in Rincon Valley, in the delivery expected about May 1919. This cutoff is located in the lower end of Rincon Valley and its construction is essential to both drainage and irrigation.

Fabens River Cutoff: The proposed river cutoff below Fabens was investigated and plans and estimates prepared which are the subject of a special report made in November 1917. Because of the uncertain results to be accomplished the possible difficulties in maintaining a channel under control, the possible location of diversion for the Tornillo District just at the lower end of the cutoff making a lowering of the channel undesirable and a proposed scheme of auxiliary deep drain to be siphoned across the river from the Island System to augment the outlet system of the El Paso Valley drains where they are two shallow to be effective, no further action has been taken in the matter.

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S 89° - 42' E S 89° - 41' E

El Paso, Texas, March 22, 1919

Tonuco River Cutoff

(Rincon Valley River Cutoff)

The following report was complied from correspondence, estimates, studies, and reports by Messrs, H. J. Sault, E.E. Teeter, H.S. Stanton, W. M. Hill and V. E. Lieb.

1. Location: The location of the proposed Tonuco Cutoff is on the Rio Grande, in Sections 27, 26 and 35, T. 19 S., and Section 2, T. 20 S., R. 2 W., N.M.P.M., in the lower end of the Rincon Valley, Dona Ana County, New Mexico, near and opposite to the stations of Detroit and Tonuco on the Santa Fe Railway.

2. General Description: It is proposed to cut an artificial channel across the neck of the large bend of the Rio Grande, beginning near the southwest corner of Section 26, T. 19 S., R. 2 W., N.M.P.M., and follow a southerly course through Sections 26 and 35, T. 19 S., entering the Rio Grande near the center of Section 2, T. 20 S., R. 2 W., N.M.P.M., with the objects and expected results as set forth in the following paragraphs.

3. Objects: (a) Irrigation. To provide a feasible method for the irrigation of the lower end of the Rincon Valley, the lands being in Sections 35 and 36, T. 19 S., and Sections 1, 2 and 12 T. 20 S., R. 2 W., N.M.P.M., covering a net irrigable acreage of approximately 1000 acres directly benefited by the proposed cutoff, and not otherwise irrigable except by the construction and maintenance of expensive river crossings or diversions.

4 (b) Drainage: To provide an adequate drainage system for the Rincon Valley, it will be necessary to make the proposed changes of the river channel. In its present location, the river in bending back from the railway in Section 26 tends to form a barrier to the passage of underground waters, as is evidenced by the presence of sloughs, swamps and alkaline areas, in Sections 16,22,23,26 and 27 T. 19 S., R. 2 W. This barrier is probably maintained by a rock outcrop in the river bed at the center of Section 36, which does not exist on the other side of the valley. With the increased slopes and lowered bed of the river resulting from the changed channel, a drain having its outlet in the lower end of the area reclaimed by the channel change will effectively relieve the waterlogged condition in the sections named, as well as improve the drainage of areas above t there. Without the results to be expected from the proposed channel change, the benefits of drainage would not be felt for some distance above the outlet of the drain, leaving the most of Sections 16, 22, 23, 26 and 27 undrained, so that the Tonuco Cutoff is an essential part of the proposed drainage scheme for the lower Rincon Valley.

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5. The approximate location of the proposed drain to be constructed for the Rincon District is shown on the map (1340-R-62) accompanying this report. At least 1500 acres of the land that will be immediately relieved by the cutoff are covered by the Rincon Canal, for which advertisements have recently been issued. The drainage of lands along the upper end of the Rincon Canal will be necessary at a latter date, and this can not be effectively accomplished without the lowering of the river water surface that will be brought about by the proposed cut-off.

6. Present Condition of Land Directly Involved; The bulk of the lands included in the bend across the neck of which it is proposed to turn the river are in their original state of li light to heavy bosque, only scattered areas being in cultivation. It is believed that all right of way necessary can be secured without charge, but the probable cost of the right of way, if purchased, is included in the estimate.

7. Proposed Changes of Channel: The distance, following the present river channel around the bend that it is proposed to eliminate, is approximately 20,800 feet, with a difference of elevation of 12.2 feet, a slope of .00051 or 2.7 feet per mile. The proposed new Channel is to be 9,035 feet long, with a slope of .00133 then constructed, and the following hydraulic properties: Section base width, 50 feet: side slopes, 1.1; depth, 3.6 feet, area 192.96 square feet: r 3.21: n .0225; v 5.24 q 1010. The estimate includes a 10-foot berm and an adequately constructed levee on the lower or east side of the channel when necessary, riprap or other protection where needed, anda diversion embankment at the head of the channel.

8. Adaptability of Present Channel Condition to the Proposed Channel Change: The course of the river currents above the head of the proposed channel change is at present such that the danger of the stream cutting around any artificial diversion works is at a minimum. The stream will enter the proposed cutoff on a broad, sweeping curve, as nearly as possible approximating natural conditions. Flowing through the artificial channel and again entering the natural channel, natural conditions are approximated to the degree that danger of losing control of the stream is reduced to the minimum. It is expected that scouring will quickly lower the bed of the artificial channel, and that a general lowering of the bed of the stream, with increased velocities will take place for some distance above the proposed change. These readjustments of the stream to meet the conditions imposed by the proposed channel change are highly desirable, and it is believed that they can be controlled throughout. There is apparently sufficient current in the river below to carry the material that will be removed by erosion, as time progresses, from and above the proposed channel change, and deposit this material in the river section some miles below, in localities where topography and velocity of the river will permit. The present water surface in the river below the pro-

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S 89° 42' E S 89° 41' E

-posed cut-off is shown in the accompanying map, No. 1340-62. To confine the river to the desired channel at these points it may become necessary to do some dredging along the lines of old channels for short distances. This would replace riprap or other forms of bank protection at these points.

9. Estimate of Cost: It is proposed to do the work by Government forces, the present plan being to have the excavation done by the dragline, which will, after completion of the cutoff, commence work on the Hatch Drain. This preliminary estimate is based on machine work.

Right of way, 42 acres @ $50		$ 2,100
New river channel excavation, 72,353 c.y. @ 15¢		10,853
Diversion Embankment, 6,667 c.y. @ 35¢		2,333
Spreading in levee		1,500
Riprap, 2' - 22.5' - 600', 1000 c.y.		
Jetties and deflectors 500 c.y.		
Riprap protection and deflection	1500 c.y. @ $3	4,500
Subtotal		21,206
Overhead charges estimated at 20%		4,257
Estimated total cost		25,543

10. Discussion of Results and Benefits: The results to be expected from the construction of the proposed channel cha nge as described are the deepening and increase of velocity in the river above and below the change, and the confining of the river to what probably was at one time its natural channel, there occupying the minimum of amount of space and rendering accessible and available for the lands at present not available, and improving the drainage possibilities where these lands are waterlogged. The principal benefits would be the aid to effective drainage of the areas described in paragraph 4, which is the principal reason for the construction of the work palnned. In addition about 1,000 acres are made available for reclamation by irrigation which would otherwise not be available, except at greater cost of construction and with problematical results.

11. In all, approximately 2500 acres will be immediately affected by the construction of the cutoff, and it will eventually benefit the whole of the district under the Rincon Canal amounting to 4500 a cres net of irrigable land.

12. The estimated costs of canal and drainage construction for the land under the Rincon Canal, including the Tonuco district, are as follows:

Rincon Canal, including siphon	$144,000
Tonuco cutoff	26,000
Laterals under the Rincon Canal	30,500
Proportionate share of Percha Dam	28,000

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Proportionate share of storage, farm unit surveys, permmanent improvements, etc.....	$126,000
Proportionate share of drainage.....	78,000
	$440,500

or 4500 acres at $98 per acre.

A preliminary estimate of the cost of canal system for the 1000 acres in the Tonuco district that will be available by the Tonuco cutoff amounts to $12,500, or $12.50 per acre. The total cost of the Rincon Valley canal system and the relation of the proposed work thereto is shown on the estimate for the Rincon Valley on Form 7-681, which is also forwarded herewith.

13. Status of Funds: The contract for drainage work with the Elephant Butte Irrigation District provides for $100,000 to be expended in flood protection, and it is understood that this sum was estimated chiefly for straightening the river channel. It is therefore proposed to charge this work to flood protection. The work would be taken up with the Elephant Butte Irrigation District in connection with the commencement of drainage construction in the Rincon Valley. Should the cutoff be constructed this fiscal year, the work would have to be charged to drainage, or funds might be diverted from the drainage feature to flood protection, and the fiscal year 1918 allotment revised accordingly.

14. Recommendation: That the construction of the river cutoff near Tonuco, as described herein, be approved, the work to be done as soon as the commencement of drainage work in the Rincon Valley is authorized. That the excavation be done by the machine that will be located in the Rincon Valley for drainage construction. That, in case it becomes possible to construct the cutoff during this fiscal year, the allotment be revised by diverting $26,000 from drainage to flood protection feature.

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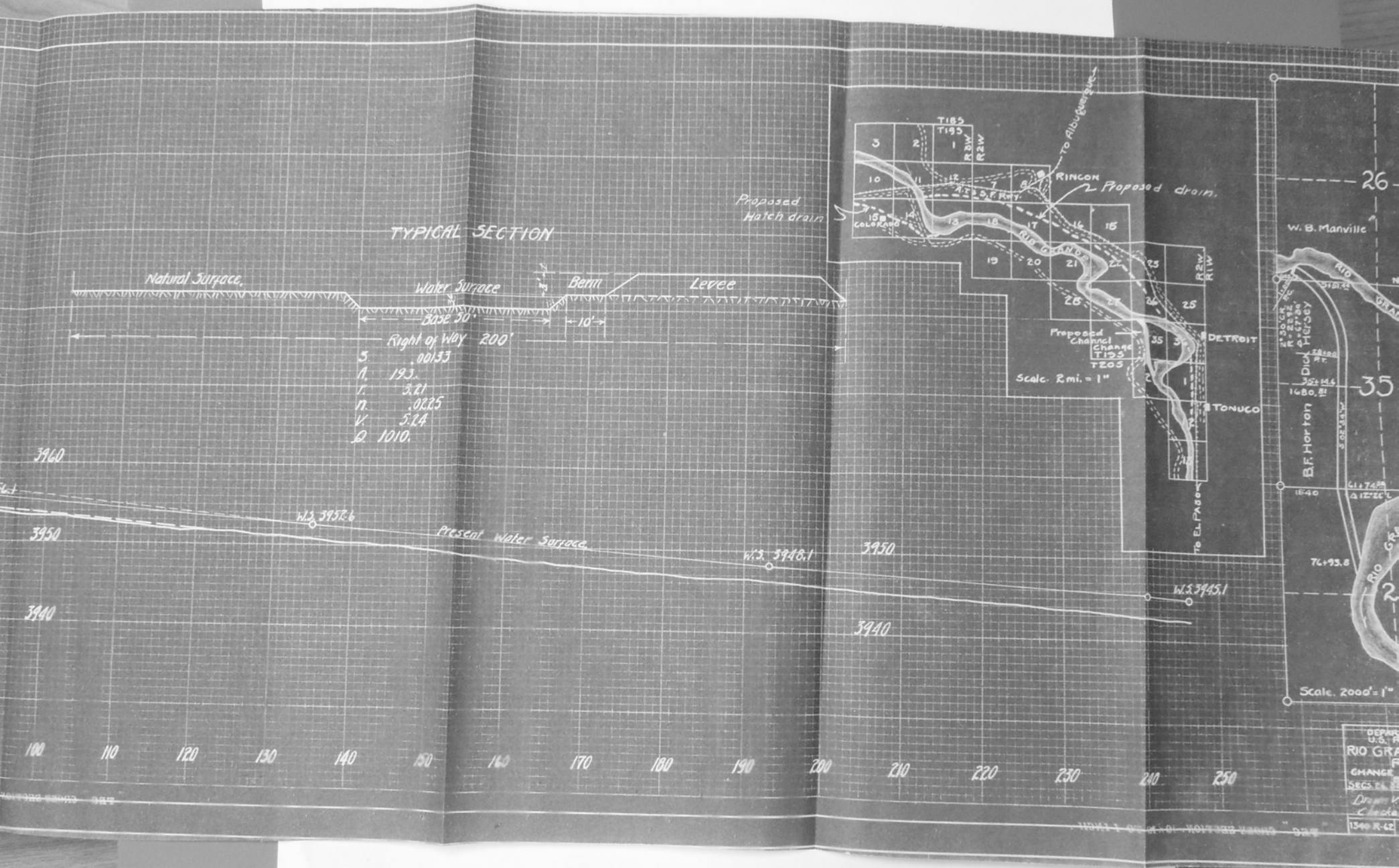

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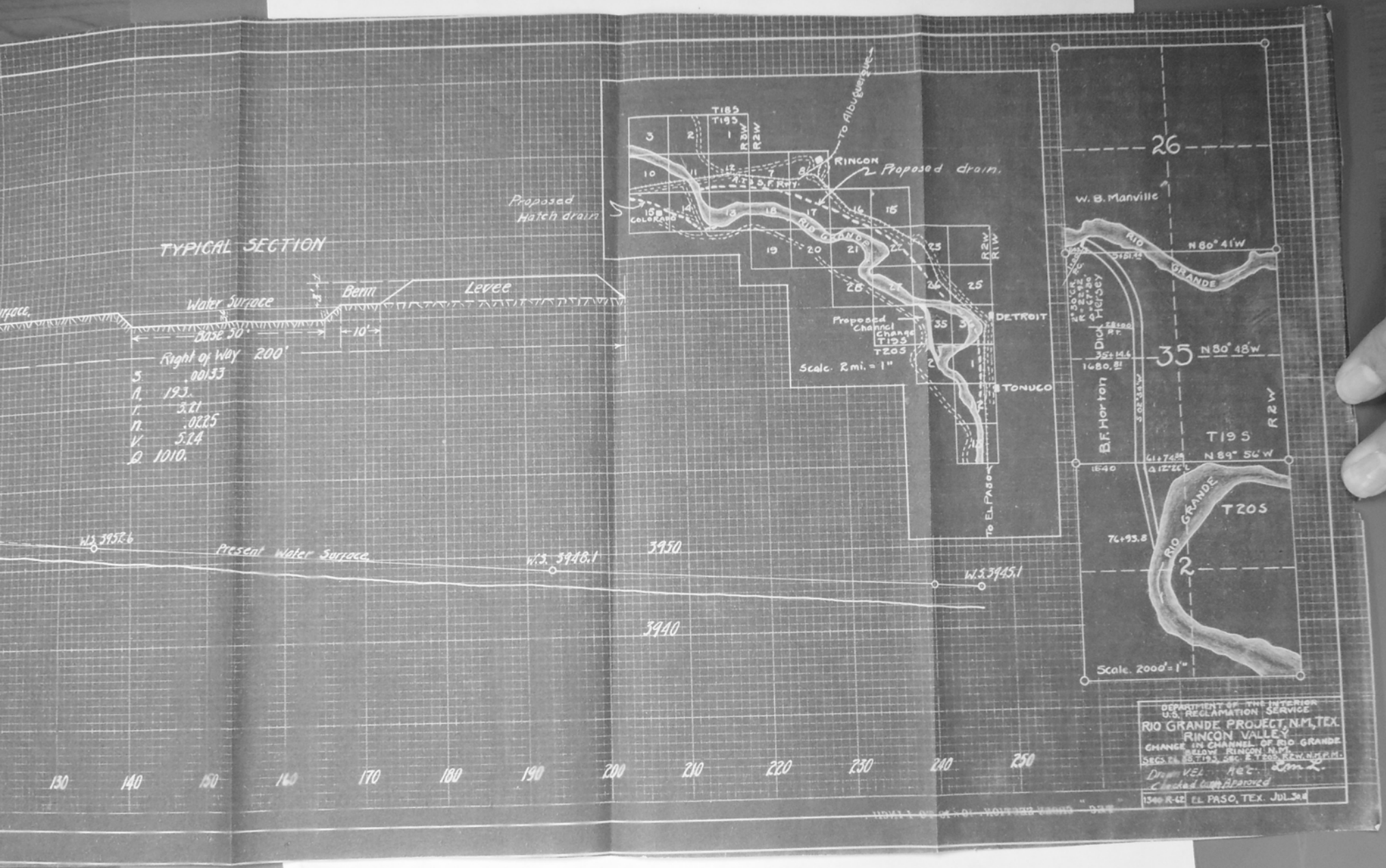

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RG No. 115

Fabens River Cutoff

Project Manager, Rio Grande Project.
Chief of Construction, Denver.
Proposed Change in Rio Grande Channel at Fabens, Texas - Rio Grande Project.

1. In selecting an experimental cutoff in the lower Rio Grande, after considerable study given to the situation, there is being furnished you, attached, a blue print, showing the location of a river change which this office recommends be constructed.

2. While a number of other bends on the lower river presented opportunities for accomplishing considerable in the line of straightening the course of the Rio Grande, they lack, at least at this time, fulfillment of any other object than straightening the channel. This office believes that at this time it is unwise to commit the Service to an extensive program of river straightening, but that such work in this line that may be shown as a direct benefit under proposed or constructed works should be carried out. In the case under consideration, drainage outlets for the drainage system of the El Paso Valley are located a short distance above the proposed cutoff. As shown on the map, a canal extension to take in the Tornilla District would be located in this vicinity, and be somewhat affected by such a river change. At this point this bend has caused considerable revetment as shown. The cutoff, besides lowering the bed of the river above this point and benefitting the drainage outlet, would make the location for the Tornilla Canal a more feasible one. The estimated cost of this work is as follows:

24,000 cubic yards excavation at 15¢	$ 3,600.00
Bank protection	2,000.00
Right of way, 13 acres @ $50	650.00
	$ 6,250.00
Contingencies	1,500.00
Estimated total cost	$ 7,750.00

3. It can be, of course, understood that a cutoff of this small extent would not have a great effect upon lowering the river bed, but this, in conjunction with others that may be made, would have a general tendency to this end and provide a lower channel and increasingly lower the water surface elevation. If your office approves this work, we will move, at once, a steam dragline located in the vicinity, formerly operated one of the drains, but replaced by a new gas engine driven Bucyrus. Such bank protection as would be needed would consist of timber deflectors rather than rock re-

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vetment. The cross-section as shown to be excavated will not handle the entire river flow, but with the erosion that would be present we have every reason to believe that the river can be kept in the course as shown.

L. M. Lawson.

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Fabens River Cutoff

Chief of Construction,
Project Manager, El Paso, Texas.
Proposed Change in Rio Grande Channel near Fabens, Texas -
Rio Grande Project.

1. Your letter of November 10th on the above subject has been received and given attention in this office in conference with the Director, and it has been decided that the present policy of the Service should be confined to such work on the river channel as is necessary to protect Government structures or to facilitate the operation of drainage ditches and the construction of distribution system.

2. The place under discussion will be of great advantage to the El Paso Valley drain as it should lower the grade of the river directly below the same and permit a lower elevation of the water in the river at the mouth of the drain.. Another place where the channel might be shortened to advantage is below Rincon where the construction of a cut-off will save two river crossings in the construction of the distribution system.

3. Before any work of this kind is undertaken, definite arrangements in writing should be made and approved with all interests which will be effected in order that it may be known in advance what the liability on account of changed conditions may amount to which procedure was brought out by the Director in his letter of November 23d to you.

4. Relative to the cut-off under discussion near Fabens, careful consideration should also be given to the plan of irrigation of the lands in the Tornilla District below Fabens provided the same was included in the project. The plan of Mr. Fessenden, who made the reconnaissance for this district, the report on which you will find in your files, was to construct a dam just below Fabens and advoid the expensive canal required above that point or the expense of enlarging the San Elizario Canal throughout its length. There is also an additional advantage to Mr. Fessenden's plan and that is a diversion dam located below Fabens would catch all of the return water of the valley which would make up a large part of the water needed for the Tornilla District, although the same would have to be augmented by Elephant Butte Reservoir supply to dilute the possible high alkali content, but no doubt the return water would be very valuable which would all be wasted if the irrigation were carried through the San Elizario Canal. It is the memory of Mr. Walter that the survey made by Mr. Fessenden showed the possibility of irrigating practica lly all the irrigable land in the Tornilla District from this heading, and if such is the case we should carefully consi-

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der this proposed cut-off in connection with this proposed work as the same would not be effective if a dam were placed in the river just below the end in which case the cut-off should possibly be made at some other location.

5. It is expected that Mr. Walter will spend some time with you early in December, and it is hoped that you will have all this information in shape to go over the matter with him at that time. You will be advised later of the exact date of his arrival, but it will probably be prior to December 10th.

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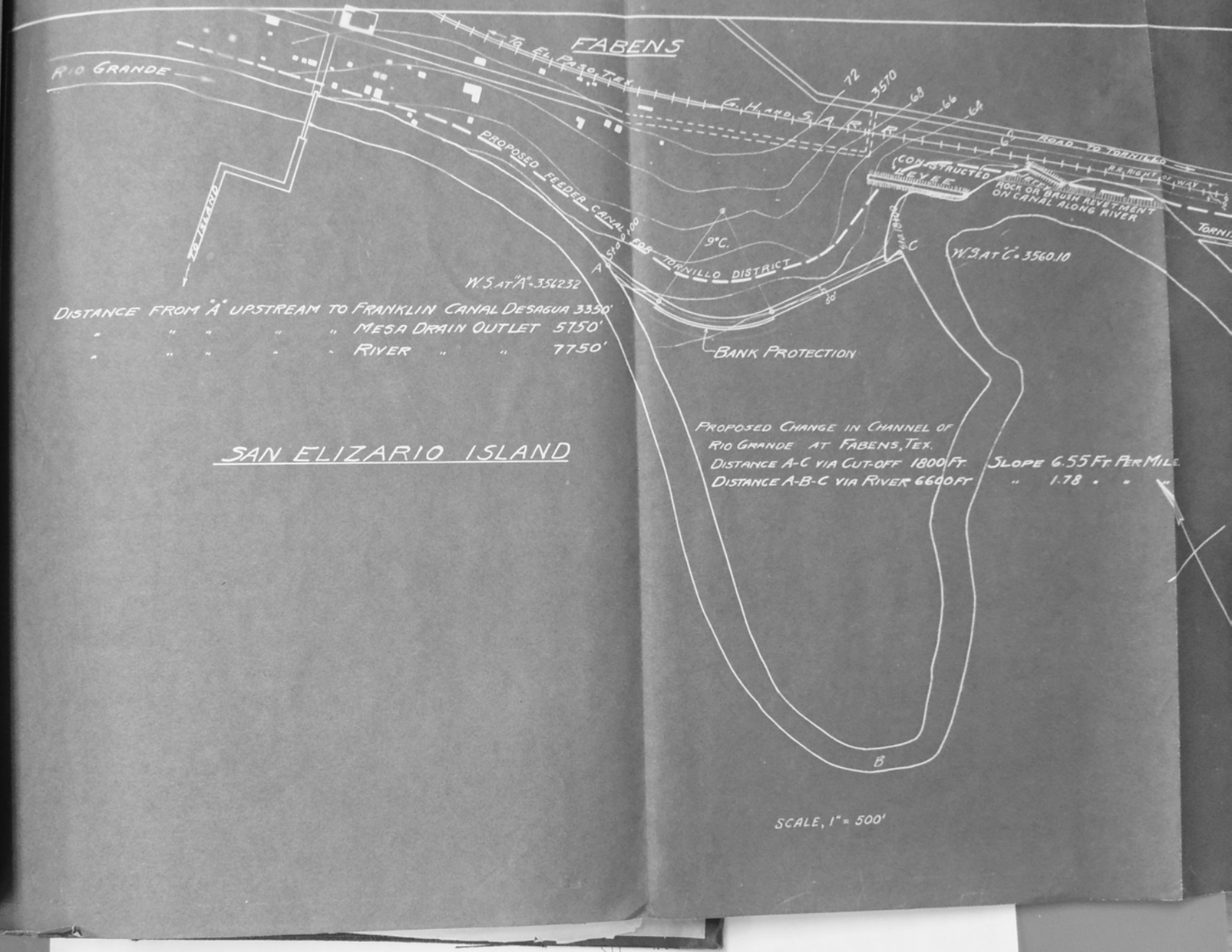

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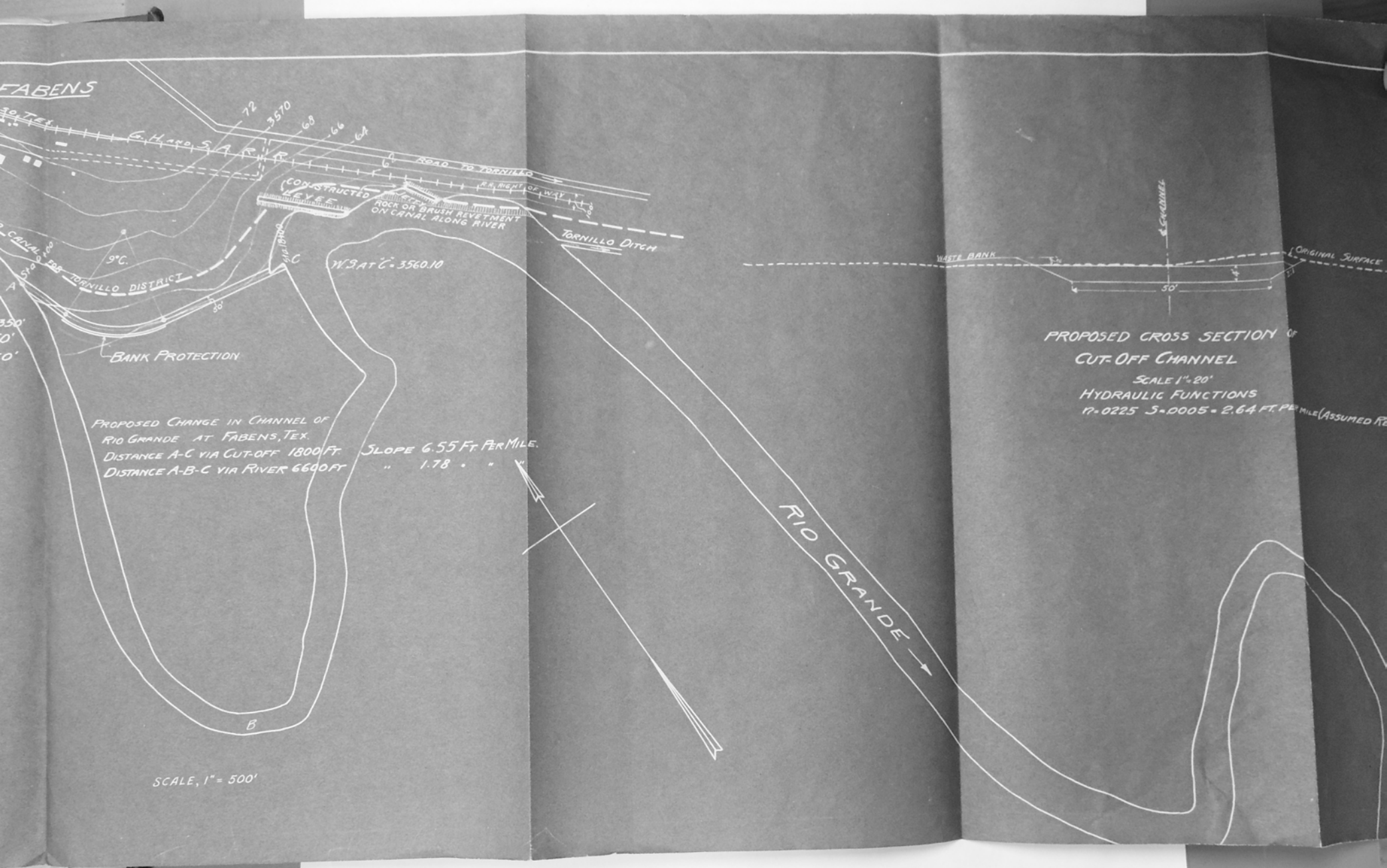

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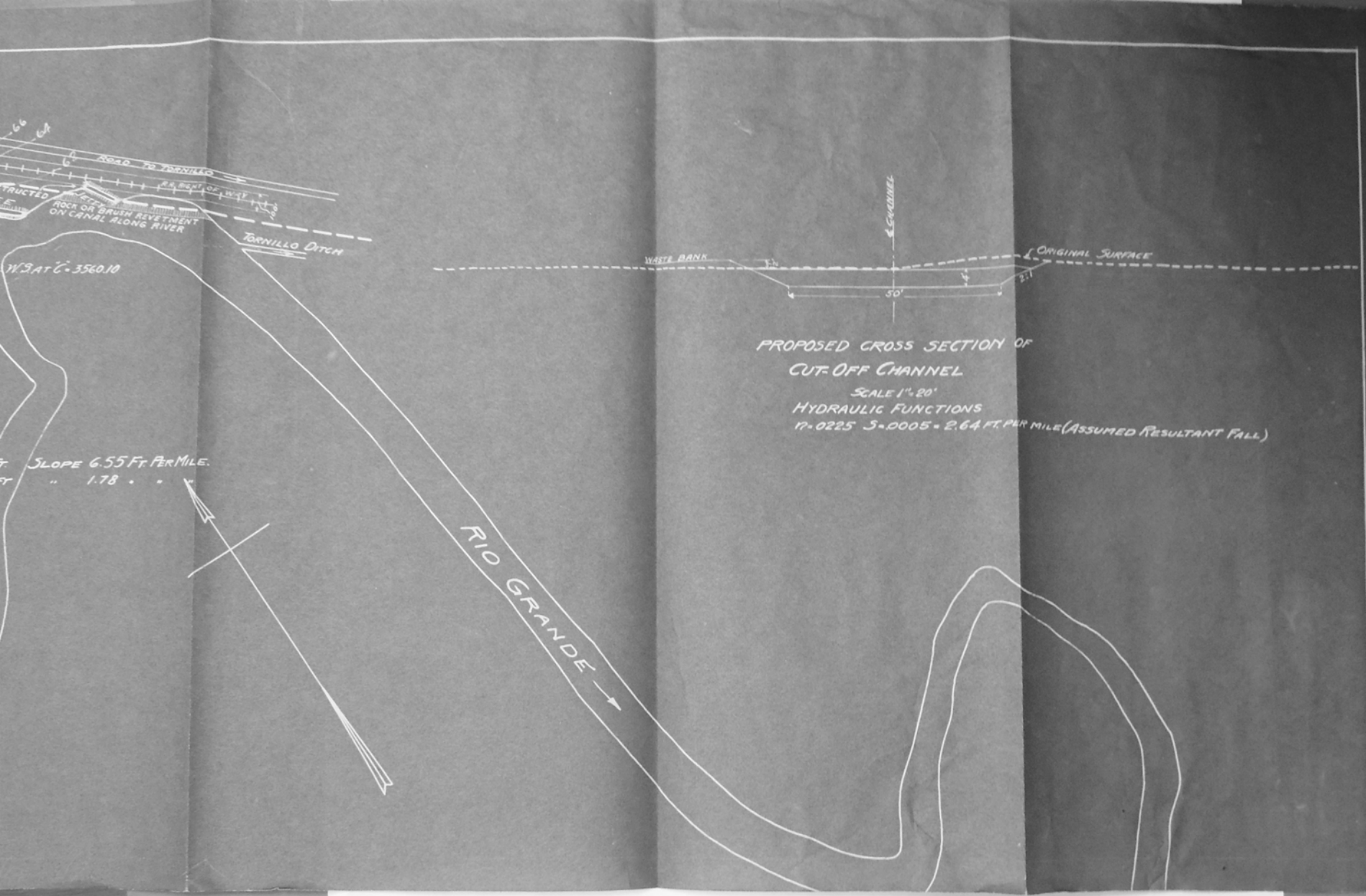

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RG No. 115

PLANS AND ESTIMATES.

GENERAL PLANS FOR THE LAYOUT OF THE DRAIN SYSTEM, BOARD OF ENGINEER'S MEETINGS.

DRAINAGE INVESTIGATION under the direction of drainage engineer D. W. Murphy were began on the Project in 1913.

BOARD OF ENGINEERS - APRIL 1915.

PLANS AND STUDIES for the locations of drains were began early in 1915 by drainage engineer, D. W. Murphy and were the subject of the report of a board of engineers, composed of E. H. Baldwin, Supervising Engineer; L. C. Hill, Consulting Engineer; D. W. Murphy, Drainage Engineer; L. M. Lawson, Project Manager, which board me on April 3d to 15th, 1915.

The alkali and seepage conditions on the project were reviewed, the necessity for drainage pointed out and a tentative plan worked out which called for three drains in the El Paso Valley, called River, Middle and Mesa, and provided for two drains on each side of the river in the Mesilla Valley, a river and a mesa drain. The river drains were considered the principal drains and were recommended for construction first to intercept river seepage. The drains proposed were considered a main outlet system covering the lower portion of the Mesilla Valley and the El Paso Valley. From these tentative plans estimates were prepared with the following results for the area considered. 175 miles of main drain, total cost

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$1,000,000. Area constituting 100,000 acres cost per acre $10.00, and it was assumed that this estimate would apply to the rest of the Project. Attention was called to the necessity for early action in constructing drainage works. $50,000.00 was available for construction work during F. Y. 1916. Recommendations were made:

(1) That investigation be continued and drainage plans for the entire project be prepared.

(2) That approval be requested from the Water User's Association for the expenditure of $10.00 per acre.

(3) That if approved, construction begin as soon as final plans for portions of the system be completed.

During the summer of 1915 preliminary surveys were made in the El Paso Valley under the direction of R. S. Fessender for the River and Mesa Drains, and in the Mesilla Valley under the direction of Geo. E. Gchobinger for the East River Drain and the West River Drain. Late in 1915 final locations were made for the first schedules, about the first four miles of the Mesa Drain in the El Paso Valley and the East Drain in Mesilla Valley, and Right of Way material turned over to committees of the Water User's Association.

Beginning of Construction No. 1

In April 1916 Dragline was moved from Mesilla Drain to Vado and on the 27th began the construction of the East Drain. In May 1916 Draftline No. 2 was transferred from Mesilla Drain to Fabens and on the 26th began work on the Mesa Drain (See progress tables.)

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BOARD OF ENGINEERS-FEBR. 1917.

In Febrary 1917, the "Drainage of El Paso and Mesilla Valleys" was again the subject of a report of a Board of Engineers which convened at El Paso, and was composed of the following members: D. C. Henney, Consulting Engineer; D. W. Murphy, Engineer in charge of Drainage; and E. H. Baldwin, Project Manager.

The seepage condition was reviewed and additional observation made, studies of the rising water table were made and the causes analysed, including river changes, canal seepage and irrigation losses. A seepage map or scale of 2000' to 1" showing October 1916 condition was very hurriedly made by L. H. Finch, Jr. Engineer.

MESILLA VALLEY

The rise of the water table near Mesilla where a cross section was taken in 1904 by Mr. Schlichte of the U. S. Geological Survey was compared with the following result. (See profile)

Year	Average below surface	Rise of water table. Period	Average per yr.
1904	11.5		
1915	7.0	4.5	0.41
1916	5.7	1.3	1.30

The average rise over the whole valley for the year Nov. 1915 to Nov. 1916 was .55 ft.

Of 82,000 acres of irrigable area 33,000 or 40% had water less that four feet from the surface.

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Canal losses in the East and West Side Canals amounted to 21% and 14.5% or 13,200 A. F. and 24,800 A. F. for season 1916.

Water deliveries in 1916 to 18,000 acres under Leasburg was 8.52 feet.

Water deliveries in 1916 to 28,000 acres under Mesilla Dam was 7.03 feet.

Delivery being made to head of community ditches.

The total seepage inflow, from irrigation losses was extended at 235,600 A. F. for 1916. As a remedy to take off the excess water going into seepage inflow, stress was laid on a reduction in irrigation use, expediting river erosion and lowering was mentioned, but caution was urged in its application. Having in mind the possible results to be secured by irrigation control and a few main outlet drains, some doubt was expressed as to the need of an extensive drainage system. If it developed that an extensive system would be required, some different types were suggested that might be adapted, as a trunk line dividing into a river main and a hillside main, or a trunk line with a herring bone system of laterals. Some apprehension was expressed for the river drains, the seepage from the river to the drain might be so great, as much as 7 S. F. per mile, as to greatly the efficiency of such drains. In view of the uncertainties and lack of definite information it was felt that the selection of the system, determination

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of capacities and details for the general plan should proceed with deliberation and be governed by the action of the outlet drains as they were constructed.

Certain features, however, could be selected without danger to serious error, which would be essential in any case; outlets to the river could be selected and the lower portions of the trunk drains located. The system for the east side could with advantage be designated with two outlets, one where the present outlet of the East Drain is and another some distance below Mesilla Dam. The West Side could probably be drained best through a single outlet at the extreme south end, although for immediate construction purposes a temporary outlet might be provided at a point three miles north of the New Mexico line. (This would be about where our permanent outlet for the La Mesa Drain now is.) The discharges of the drains could not at this time be known so construction should proceed with provision for future enlarging if necessary.

One steam machine had completed 5 1/2 miles of the East Drain, but was too small a machine for this class of work. Two Bucyrus 1 1/2 yard dragline with 50 ft. boom on caterpillar tractor with distillate engines were on contract for delivery in August. The purchase of two more was recommended as soon as the irrigation district should organize and execute contract. Contract work was not recommended as it did not allow the desired flexibility in location

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and design; on which basis the plans should proceed as observation and further investigation could be made.

EL PASO VALLEY

The El Paso Valley seepage and ground water conditions were reviewed, a seepage map showing Nov. 1916, condition was hurriedly prepared, and studies made as in the Mesilla Valley and were found to be very much the same, except that although only 16,600 acres out of 47,000 or 36% showed water less than four feet from the suface, as against 40% in the Mesilla Valley, and that only 3.85 feet of water had been delivered to community ditches, as against 7.68 for the upper valley, the average use in the ground water was .88 ft. for the last as against .55 for the Mesilla Valley, which fact could not be explained. (It has been the observation of the writer since, that the greatest rises take place where the water table is still further from the surface and that the yearly rise decreases very appreciably as the water table approaches the ground surface.)

The same suggestions were made about irrigation control as for the Mesilla Valley. It was recommended that the Senior Engineer be instructed to begin river control investigations in the lower end of El Paso Valley. The details of the design of the drainage system was to be left for further study and investigation, but the shape and

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Recommendations of Board of Engineers.

In Report of February 1917.

For Mesilla Valley Drainage.

We recommend:

(a) That every effort be made both by the Reclamation Service, local organizations of water users and public spirited men in the valley to remedy the present wasteful use of water.

(b) That during the current year the observation of wells for determination of ground water be continued, and that in addition, thereto, studies be made of canal and lateral seepage, of changes in river elevations to the Elephant Butte Dam, of disposition of seepage water and of the effect of drainage construction.

(c) That the desirability be determined of concreting part of Government canals for construction during next fall.

(d) That definite location be made of the lower ends of drains A, B, C and D in advance of the arrival of new machines.

(e) That upon compliance by the water users with such conditions as to irrigation district organization and repayment of cost as may be imposed, two additional machines be immediately purchased.

(f) That the general type of drain to be excavated conform as much as practicable to sketch on Exhibit D.

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El Paso Valley Drainage

We recommend:

(a) That every effort be made both by the Reclamation Service, local organizations of water users and public spirited men in the Valley to reduce as much as possible wasteful use of water.

(b) That during the current year the observation of wells for determination of ground water be continued and extended and that in addition, thereto, studies be made of canal and lateral seepage, river seepage, changes in river elevations and the effect of drainage construction.

(c) That definite location be made of the lower ends of a hill side, a central and so far as feasible, a river side drain in advance of the arrival of new machines.

(d) That as soon as feasible after compliance by the water users with such conditions as to district organization and repayment of cost as may be imposed, one additional machine be purchased.

(e) That the general type of drain to be excavated conform as much practicable to sketch on Exhibit "E".

(f) That the Senior Engineer be instructed to make a study of river deepening, in the vicinity of Fabens.

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condition of the valley appeared to exclude consideration of the herring bone system and as far as could be seen the general plan of the preious board report consisting of a river, middle and mesa drain, with a common outlet near Fabens seemed desirable, and it was recommended that location surveys proceed along that line in anticipation to the arrival of new machines.

A small steam machine had excavated three miles of the Mesa Drain. Two new Bucyrus machines were being purchased for delivery in July, making four of these machines coming to the project. The purchase of another machine was advised, although there seemed to be less uncertainties as to location and amount of drains in this valley than in the Mesilla Valley, the same was said about contract, work as was said for the Upper Valley.

With the lack of definite knowledge as to the amount of water which the drains would discharge, the absence of complete data as to ground water conditions, and the desirability of allowing the details of the system to develop as the effect on drains would be observed while construction was progressing, no attempt was made at this time to lay out a complete system and no estimates of cost were considered.

ESTIMATES FOR CONTRACTS WITH IRRIGATION DISTRICT

During the summer of 1917 while contracts were being formulated, which were to be voted on and executed by

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the El Paso County Improvement District No. 1 for further work by the Reclamation Service in the El Paso Valley and by the Elephant Butte Irrigation District for further work in the Mesilla and Rincon Valley, which Districts were themselves then in the process of formation, Estimates of cost for both drainage and canal work to be used stated in the contracts, were made by the office engineer at El Paso, the details of which for the El Paso Valley are as follows:

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Estimate of Cost of El Paso Valley Drainage System

Mesa Drain:

Length 23 mi.		
Excavation 915,000 c.y. @12¢		109,800.
Bridges - 1 highway	$4948.	
1 R.R.	2000.	
2 Highway @700.	1400.	
1 "	2500.	
40 Farm @ 250.	10000.	20,848.
Canal Structures		
2 Lateral Crossings @1000.	2000.	
40 Flumes at $350.	14000.	16,000.
Drainage Inlets		
80 at 100	8000.	8,000.
R.of W. ave width 140' 390 a @100		39,000.
		139,648
Engineering and Ad. 10%		19,352
Total Mesa Drain		213,000.

Middle Drain - Length 20.5 miles

Excavation 817500 c.y. at 12¢		98,100.
Bridges		
2 concrete county road bridges at $2500.	5000.	
3 railroad bridges at $2000.	6000.	
3 Timber county road bridges @$500.	1500.	
40 Bridges (farm) at $250.	10000.	
	22500	22,500.
Canal Structures.		
1 Franklin Canal Crossing	1700.	
1 " " "	1000.	
3 Lateral crossings at $1000.	3000.	
1 " "	800.	
40 Small Flumes at $350.	14000.	
	20500.	20,500.
Drainage Structures		
80 Inlets @$100.		8,000.
Right of Way, average width 140', 350 @$100.		35,000.
		184,100.
Engineering & administration 10%		18,400.
Total, Middle Drain,		202,500.

River Drain, 21 miles.

Excavation 621000 c.y. at 12¢	74,520.
Bridges:	
20 Farm Bridges at $250.	5,000.

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Canal Structures;

San Elizario Canal Crossings, 2 @	17000,	3400.
20 small flumes at $350.		7000.
		10400.
		10,400.
Drainage Structures		
50 Inlets at $100.		5,000.
Right of Way, average width 140', 350 A @ $50.		17,500.
		112,420.
Engineering and Administrat. 10%		11,240.
		123,660.

Summary of Estimate of Cost of El Paso Valley Drainage

Mesa Drain	213,000.	
Middle Drain	202,500	
River Drain	123,660	
	539,160	
Contingencies and addition work not forseen, 20%	107,840	
	647,000	
46200 acres to be benefitted, cost per acre $14.00		
Drainage on isalnd, 12260 A at $14.00	171,640.	
	818,640.	

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This estimate was made for the system of drains as outlined by the Board Report of April, 1915, and confirmed by the Board Report of February 1917. The excavation quantities for the Mesa and River Drain were taken from the locations run in the fall of 1915, and it can now be said that they were computed for a grade line laid too shallow and sections too small. The Middle Drain quantities xxxx xxxxxxxx were taken from a topog. profile. The Unit prices were based on cost for the lower end of the Mesa Drain which was thenunder construction with No. 2 Dragline. Attention is also called to the fact that the gross area is used in arriving at the $14.00 per acre cost.

To the total of $878,640 given in the estimate add $98,000 for approximately 7000 acres of Mesilla Valley in Texas, making a total of $916,640.00 for drainage in the El Paso District. To this add $15,00 per acre estimated for laterals, made a sum nearly twice as great as the liabilities which the District could assume, being limited by the State Irrigation District law to a certain per cent of the assessed property valuation. The contract was therefore finally drawn up and voted for the expenditure of $500,000. on Drainage and $500,000. on laterals, leaving the balance for the completion of the work to be taken care of on a second contract to be voted after legislative action could be secured to ammend the law.

ESTIMATE FOR THE ELEPHANT BUTTE DISTRICT CONTRACT

Having thus arrived at an estimate of $14.00 per acre for the El Paso Valley and pending more definite information in the Mesilla and Rincon Valleys, the same figure was

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applied to these valleys for estimating the cost of drainage to be included in the contract with the Elephant Butte Irrigation District, on the following areas.

	20% Deducted
Rincon Valley - 21,781 Acres Gross	17,425. Net
Mesilla Valley- 97,204 " "	77,763. "
	95,188.
Mesilla Valley in Texas.	9,266.
Net Irrigable Acres in District	85,922.
@$14.00 per Acre	1,202,908.
Previously Expended	63,616
To complete	1,139,292

Note: That here net area, at $14.00 per acre, was used while in the El Paso Valley it was the gross area upon which the cost of $14.00 per acre was estimated. If $14.00 per acre was applied on the gross area of 107,000 acres in the Mesilla and Rincon Valleys the cost would have been $1,500,000.

The revised physical feature estimate for the Project the completion of which this estimate became a part, gave for the total cost of the project, $11,908,500. At the suggestion of the Assistant Chief of Construction this was rounded out to $12,000,000, of which $1,000,000. has been appropriated by Congress under the Mexican Treaty to settle a damage suit with Mexico, leaving the liability to the districts, $11,000,000. In rounding out the estimate he suggested that the estimate for drainage be increased to $15.00 per acre for the entire project to keep pace with rising prices.

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Note: An error exists in the estimates from here on. 155,000 acres was used as the total net area of the Project excluding Palomas Valley, and including Tornillo District, whereas it includes both.

On the above basis there was considered 92,000 Acres net, 20% deducted instead of 85,900 net in the MNew Mexico District which at $15.00 gave $1,380,000.
70,000. Already expended
1,310,000

To this was added $100,000 for River Control and the contract as drawn calls for the expenditure of $1,400,000. in addition to $63,616 already spent for Drainage and $1,804,000 in addition to sums already expended for canal and lateral system.

Comprehensive Plans and Estimates

Mr. A. P. Davis, Director and Chief Engineer, visited the project in July 1917, in the interest of drainage and formation of Irrigation Districts. Meetings were held at various points through the valleys.

One June 6, 1917, Mr. J. L. Burkholder, Engineer, arrived on the Project to xxxxx take charge of the drainage feature, the drainage work on the Boise Project, of which he had charge being finished. He was soon followed by other members of the Boise organization, including C.M. Ainsworth, F. W. Blattery, W. E. Fordham, Master Mechanic and anumber of Dragline operators.

From June to December 1917, all test well data and well sections were brought up to date. See page maps on the large scale project topographic map, which had been

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started by the writer were completed. Studies and plans for a comprehensive and complete system as far as could be anticipated were made for both the El Paso and Mesilla valleys. Topographic profiles were picked off of the maps and estimates and comparisons made for various layouts all based on the general systems as outlined in previous Board Reports. Of all the locations projected, one layout was elected which looked to be the most practical and efficient and from this complete estimate of cost was prepared, the whole being assembled in shape for submission to a Board of Engineers.

Board of Engineers, January 1918.

In January a Board of Engineers, consisting of D. C. Henny, Consulting Engineer, L. M. Lawson, Project Manager, and J.L. Burkholder, Engineer, convened at El Paso, for the Purpose of viewing the plans and estimates prepared, and to establish the financial status of the drainage feature. Mr. Weymouth, Chief of Construction, was also on the Project at the time.

Special attention was given to the study of the effect of constructed drains. The basis for the estimate of capacities determined as follows were confirmed by the flow of existing drains and adapted.

Water diverted from River 4.5 a.f. per acre
Absorbed by plants and evaporation 2.5 a.f.per acre
To be carried off by drains 2.0 a.f. per acre.

For 80,000 acres in Mesilla Valley at at 2.0 a.f. per acre gives 160,000 a.f. for season, with a probable

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maximum monthly of 16,000 a.f. or a flow of 267 s.f. Total length of drains 174 or an average of 1.5 s.f. per mile. To this there was arbitrarily added 1 s.f. per mile for river drain making 2.5 s.f. per mile for such drains.

In general the plans and estimates as presented to the Board with minor changes in location, unit costs, etc. were accepted and adopted. More temporary outlets upon which to start more machines to work were suggested. The Board however, wished it understood that observations and studies of the action of the drains as they were constructed would govern and amend if necessary future locations and plans.

The status of funds necessary and available were thoroughly gone over. Specifications for contract work were prepared.

It was recommended that drainage work in both valleys be pushed so far as funds would permit.

River work near Fabens was not encouraged.

A summary of the estimates as revised by the Board and included in their Report, follows:

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MESILLA VALLEY DRAINAGE ESTIMATE(Picacho District Excluded)

Drain	Length: Miles	Excavation: Plus 10%	Major Structures: No.	Major Structures: Cost	Total Cost
		PRIMARY DRAINS			
East	20.1	900,000	4	$13,000.00	142,780.00
Anthony	8.5	332,000	1	1,500.00	51,520.00
Vado	3.8	170,000	1	1,500.00	26,020.00
Nemexas	29.7	1,650,000	7	20,000.00	243,780.00
West	27.5	1,328,000	9	12,700.00	200,000.00
Leasburg	19.3	1,035,000	4	12,000.00	153,720.00
Park	8.7	500,000	2	6,500.00	73,680.00
Dona Ana	3.4	172,000	3	8,000.00	31,930.00
Vinton	5.9	290,000	1	2,500.00	43,160.00
Montoya	6.8	175,000			29,020.00
Del Rio	15.6	1,076,000	4	6,000.00	144,500.00
TOTAL "PRIMARY"	149.3	7,628,000	36	83,700.00	$1,140,110.00
		SECONDARY DRAINS			
La Mesa	2.8	149,000	1	1,500.00	21,940.00
SantaTomas	3.7	160,000	1	1,500.00	24,830.00
DelRio Ext.	4.0	180,000			25,920.00
DonaAna Ext	4.5	180,000			26,910.00
Shalem	3.8	160,000	1	1,500.00	25,030.00
Montoya	5.8	229			34,390.00
TOTAL "SECONDARY"	24.6	1,058,000	3	4,500.00	159,020.00
TOTAL FOR VALLEY	173.9	8,686,000	39	88,200.00	1,299,130.00

Add 20% to "Major Structures" for Contingencies... 17,640.
Add 20% for Project General & Miscellaneous.....259,830.
Add $350. per mile for Investigations and Surveys. 60,800.555420.
Add for Excavation Contingencies, 25% of
$868.000. Excavation Cost..... 217,150.~~1854550~~
Total Estimate.....1854550.

Per MileNet : 1 : 50,000 : : 508.00: 7470.00
Total Cost per Mile for 173.9 Miles 10660.00

Total Gross Area in Mesilla Valley-
In New Mexico and Texas 108,000 Acres
Deduct for River Bed.....9,000.
" " Picacho District.....4,700.
" " Isolated Tracts..... 800. 14,500 "
Total Gross Area to be drained..... 93,500 "
Deduct 15% for non-irrigable areas..... 14,000 "
Total Cost per acre for-
Net area covered by Estimate..... 79,500 " -$23.34

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EL PASO VALLEY DRAINAGE ESTIMATE
(Including San Elizario Island)

Drain	Length: Miles	Excavation Net	Major Structures	Total Cost
Mesa	25	1,100,000	17,000	176,100
Middle	14	650,000	15,000	107,720
Franklin	20	1,000,000	10,000	150,000
San Elizario	5.4	210,000	4,000	36,160
Las Chinas	5.	200,000	2,500	38,000
Socorro	3.	120,000	2,500	20,350
Island	8.	320,000	5,000	52,200
Fabens	9.	360,000	4,000	57,100
Fabens Ext.Sys	4.5	180,000	18,000	44,550
Val Verde	2.5	100,000	5,000	19,700
Valley Gate	3.5	140,000	15,000	35,650
TOTALS	99.9	4,446,000	98,000	737,530

Add 20% for Project General and Miscellaneous Expense	147,506
Add 20% to Major Structures for contingencies	19,600.
Add for Investigations and Surveys, at $350. per mile	35,000
Add 25% to Excavation Cost for Contingencies	111,150.
Add for Excavation Contg. due to Increased Ydge. Mach. Delays, Quicksand, etc. 25% of 444,600	111,150
Total Estimate	1,050,780

	Per Mile Net			
Grand Total for 1	44,460.	980		7,375
Total cost per mile for 99.9 miles				10,507.00

Gross area of El Paso Valley proper	46,700	acres
" " " San Elizario Island	12,200	"
Total gross area	58,900	"
Probable area to remain undrained at lower end of Island	3,000	"
Total gross area to be drained	55,900	"
Deduct 15% for non-irrigable areas	8,385	"
Total cost per acre for - Net area covered by estimate	47,500	" - $22.12

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BASIS FOR ESTIMATE

Excavation.....$10¢ cu.yd.
(neat topog. profile quantities)

Right of way.....$40. per acre
(Average width of Right of Way, 120 Ft.)

Investigations and Surveys.....$350. per mile of drain.
(For Project, general and miscel. expense)
20% added to total estimate.

For Excavation Contingencies, due to Increased Yardage, Quicksand difficulties and Machine trouble, etc. add 25% to excavation cost.

For Major Structure Contingencies, add 20% to Major Structure Cost.

Minor Structures

Timber highway bridges,	1 per mile,	$250.
Timber private "	1 " " ,	200.
Flumes	2 " " ,	700.
Fences and Miscel.		250.
Total per mile		1400.

Major Structures

Discharge:	Canal X'ings :	Ry. X'ings :
10 S F :	$1500 :	$2500 :
25 S F :	2500 :	4000 :
50 S F :	3500 :	6000 :
75 S F :	5000 :	9000 :

SUMMARY AND TOTAL ESTIMATE FOR THE PROJECT

Valley or District	Miles of Drains	Excavation Cubic Yards	Structures Major	Structures Minor	Total Cost
Mesilla Valley (Inc. Montoya)					1,855,000
Primary	149.3	7,628,000	44	635	
Secondary	24.6	1,058,000	2	96	
*Picacho	9	400,000		38	81,000
*Rin.Val.	43	1,830,000	12	161	387,000
ElPasoVal Including Island	100	4,446,000	43	447	1,061,000
Total Project	326	15,362,000	101	1377	3,374,000.

*Estimates for Picacho District and Rincon Valley are tentative and yardage and costs are based on averages from Mesilla Valley estimate.

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SUMMARY OF COST BY DISTRICTS.

Elephant Butte Irrigation District.

Mesilla Valley-79,500 Acres Net.		$1855.000
Less 10,000 Acres-approximately in Texas @23.34		233.400
Balance.		1621.600
Picacho District 9 miles @ $9.000	approx.	81.000
Rincon Valley. 43 miles @ 9.000	approx.	387.000
Total.		$2089.600

El Paso County Improvement District No.1

El Paso Valley proper including Val Verde and Island. 47,500 Acres Net.	$1050.780
Plus 10,000 Acres approximately of Mesilla Valley in Texas.	233.400
Total.	$1284.180

Project Total

Rincon, Mesilla, El Paso Valleys Net including Tornillo	$3,373.780

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Limitations on Expenditures for Drainage as expressed in the Board report are as follows:

The drainage expenditures, besides being limited by funds available, are subject to limitations expressed in contracts with the Districts. The contract with the El Paso County Improvement District No. 1 imposed a total limit for drainage cost of $500,000 plus $50,856, previously expended. The total cost, exclusive of Montoya, is estimated at $1,047,000 It is understood, however, that the amount of $500,000 mentioned in the contract presents merely a temporary obstacle, made necessary by the Texas consittution. This has since been amended, which opens the way for favorable legislative action.

The limitations in the contract with the Elephant Butte Irrigation District are of a more serious nature. In the first place, the total cost for drainage is there limited to a balance determined as follows:

For drainage, including flood protection	$1,400,000.
For flood protection.....	100,000.
Balance for drainage.....	1,300,000.
Expended prior to contract.....	63,616.
TOTAL.....	1,363,616.

Estimated Cost:

Mesilla Valley.....	$1,855,000.	
Less 10,000A. in Texas @ 23.34	233,400.	
Balance.....	1,621,600.	
Picacho District, 9 miles @ 9,000.....	81,000.	Approx-
Rincon Valley, 43 miles @ 9,000.	387,000.	imate
TOTAL,	2,089,600.	

SHORTAGE, about .. .. $ 726,000.

or approximately 40% of the amount allowed. Thus, unless

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additional expenditure is authorized by contract, only about three-fourths of the work contemplated by the present plans can be completed.

The contract with the Elephant Butte Irrigation District further provides that the total project liability in both states shall in no case exceed $11,000,000. In the determination of this amount, an allowance for the entire project drainage was made of $2,072,000.

The estimate of drainage cost for the entire project may be summarized as follows:

Mesilla Valley, exclusive of Picacho...	$1,855,000.
El Paso Valley.....	1,051,000.
Picacho.....	81,000.
Rincon Valley.....	387,000.
TOTAL	3,374,000.

Thus, unless a transfer is possible from allowances for other features, amounting to nearly $1,000,000, either an amendment of the contract will be required, or the drainage system cannot be completed.

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EXTRACTS FROM CONTRACT
WITH
EL PASO COUNTY IMPROVEMENT DISTRICT NO. 1

ARTICLE 1. "The United States will expend in addition to the amount heretofore expended, the sum of $500,000 in the construction of drainage works."

	$500,000
Spent on drainage prior to contract	50,856
	$550,856

Plans prepared for Mesa Drain	23	miles
Middle Drain	20.5	"
River Drain	21	"
Island Drain	9	"
Approximately	11	" in West Side Mesilla Valley

ARTICLE 3. "The limitations upon the liability which the District may incur prevents it from entering at this time upon the contract for the full amount which it is expected that the drainage work distribution system contemplated will cost: and the sums mentioned which the United States agrees to spend upon that work are not expected to be sufficient to complete either system, but are to be expended for the construction, improvement and extension of the system and to be used primarily on such part of the district as will thereby be most benefitted, with the view to future arrangement for such additions, extensions, enlargements and alterations as may hereafter appear to be necessary or advisable, but nothing in this contract shall obligate the United States to greater expenditures than those mentioned herein."

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EXTRACTS FROM CONTRACT
WITH
ELEPHANT BUTTE IRRIGATION DISTRICT
- - - -

ARTICLE 1. The United States will expend in the construction of drainage works for the lands of the District $1,400,000

Flood protection	100,000
	1,300,000
Spent on drainage prior to contract	63,616
For drainage	1,363,616

"When the sum herein stated has been expended the United States shall be under no further obligation to make expenditures for the purpose specified in this article."

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 in amounts based upon the same rate per irrigable acre."

ARTICLE 9. "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 total liability in both states however ********** shall in no case exceed the aggregate sum of $11,000,000." The principal feature detail from which this is derived gives drainage $2,072,000 for project.

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Summary of Estimates of Cost to Accompany Request for Authority

to carry on Drainage Investigations and Surveys and to Construct Drains in Mesilla, El Paso and Rincon Valleys, Made in April, 1918.

DRAIN	Length (Ft.)	Cu. Yds.	No.	Major Structures: Cost	Total Cost	Cost per foot
Mesilla Valley						
East Drain to Vado(as Constructed)(Estimate based on Construction Cost)	60,800	425,000	5	18,032.	98,413.	1.62
Nemexas Drain(complete to end near Chamberino)	88,500	900,000	7	14,540.	182,512.	2.06
West Drain to San Miguel	120,000	1300,000	10	11,300.	272,950.	2.28
Leasburg Drain (Contract Schedule #11) Estimate based on Contract Price	51,000	500,000	8	13,452.	109,273.	2.14
La Mesa Drain (Complete)	70,000	642,000	7	11,574.	138,884.	1.98
Anthony Drain (Complete)	41,500	292,000	4	5,850.	72,095.	1.73
Chamberino Drain (Complete)	28,500	260,000	1	1,114.	53,718.	1.89
Vinton Drain (Complete)	22,000	180,000	1	1,114.0	38,920.	1.77
Investigations and Surveys Total Cost to July 1, 1919 including $23,133. already spent.Tot. for Mesilla Valley	482,300.	449,9000	43	76,976.	1,007,598.	1.75
El Paso Valley						
Mesa Drain (Completeto Alfalfa Station)	121,500	1,100,000	10	18,592.	2,383 90.	1.96
River Drain(To Junction with Middle Drain - Estimate based on Construction Cost)	10,450	95,580			19199.	1.84
Middle Drain (Complete)	73,400	655,000	8	13,168.	147,048.	2.00
Franklin Drain (Complete to end near Porcher)	67,000	584,000	7	15,430.	145,980.	2.18
Clint Spur (Complete)	5,600	30,000	2	3,622.	9,971.	1.78
Fabens Drain (Complete)	33,500	240,000	3	3,182.	53,899.	1.61
Investigations & Surveys Total to July 1, 1919, including 22,375. already spent						
Total for El Paso Valley	311,450	2,704,580	30	53,994.	650,134.	
Rincon Valley						
Investigations and Surveys Total to Jul.1,1919. including 2913. already spent					7,043.	
Grand Total					1,657,732.	

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Estimate of Cost for Authority

to Construct new Drains and to Revise old Drains included in Estimate of April, 1918, in Mesilla El Paso, and Rincon Valleys. Made in January 1919.

DRAINS	Length Ft.	Cu. Yds.	Major Structures: No.	Major Structures: Cost	Total Cost	Cost per Foot
Mesilla Valley						
Upper Leasburg Drain (Complete)	60,500	5,265,351	3	3162.	123,273.	2.03
Park Drain (Complete)	45,610	376,700	3	4690.	82,014.	1.79
Nemexas Drain (Revised from Estimate of April 1918, to include part of Vinton Drain and new alignment)	87,575	823,488	4	7060.	162,417.	1.85
Central Drain	15,000	148,445			28,566.	1.90
Vinton Drain(Revised from Estimate of Apr. 1918, with part deducted and added to Nemexas Drain](Based on Construction Cost)	16,930	160,000	1	1114.	29,595.	1.75
West Drain(Revised from Estimate of Apr. 1918, to include portion beyond San Miguel and San Miguel Spur)	121,676	1,362,700	11	15,640.	284,508.	2.33
Total for Valley	347,291	3,497,868	22	31,666.	710,373.	
El Paso Valley						
Island Drain (Complete)	55,500	4,700,000	3	3,102.	97,474.	1.75
Total for Valley	55,500	4,700,000	3	3 ,102.	97,474.	
Rincon Valley						
Hatch Drain (Complete)	46,700	417,100			81,242.	1.74
Colorado Spur (Complete)	13,916	116,040	1	1,034.	25,613.	1.84
Santa Teresa Spur (Complete)	8,244	57,130	1	1,034.	14,457.	1.75
	68,860	659,130	2	2,068.	121,312.	
Grand Total	471,651	4,626,998	27	36,836.	929,159.	

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Basis for Estimate.

Right of way	$40.00	per acre
°Excavation	.12	per cubic yard.
Minor Structures		
Farm Bridges	300.00	each
Highway Bridges	350.00	each
Flumes	350.00	each
Fence	.10	per foot.
Drain Inlets	300.00	each
Laterals	.20	per cu. yd.
Camp Maintenance	1%	
Superintendence and Accounts	5%	
Engineering Inspection	2%	
General Expense	10%	

°Major Structures (including overhead & general expense)

Standard Highway Bridges, 24' Span Concrete Abutments	1114.00 ea.
" Major Flumes #108 to #144 - Concrete Inlet and Outlet----------	1034.00 "
" Two Barrel Rein. Concrete Pipe Culvert 36" x 80". Concrete Headwalls	3462.00 "
Standard Single Barrel	2622.00 "

°Number, kind and size of all structures extimated from proposed alignment of drain on Topographic Map.

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Records in the National Archives & Records
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State of New Mexico)
) ss.
County of Dona Ana)

KNOW ALL MEN BY THESE PRESENTS, That we, the undersigned owners of lands situated in the County of Dona Ana, and State of New Mexico, being desirous of securing the drainage of our lands, in accordance with the plans formulated and hereafter to be formulated by the United States under the provisions of the Act of Congress, approved June 17th, 1902 (32 Stat. 388) and acts amendatory thereof and supplementary thereto, and pursuant to contract of January 7th, 1918, between the Secretary of the Interior and the Elephant Butte Irrigation District, for and in consideration of the benefits to be derived from the construction and operation of drainage works upon or in the vicinity of our said lands, and of other valuable considerations, hereby agree to convey to the United States or to the Elephant Butte Irrigation District the necessary right of way for any and all drainage ditches which may be required and be constructed by the United States or by said irrigation district. Such right of way shall be conveyed by quit-claim deed or deeds or other proper instrument or instruments in writing, as may be required, and shall be executed and delivered subject to proper compensation for the lands and other property rights so to be conveyed to be hereafter fixed and allowed by said irrigation district to the owners of land across and over which such right of way is conveyed, and pursuant to and in accordance with a resolution of the Board of Directors of the said Elephant Butte Irrigation District duly passed on the 13th day of April, 1918, which said resolution is in words and figures as follows, to-wit:

"BE IT RESOLVED that the Directors of the Elephant Butte Irrigation District hereby pledge to all land owners who submit a quit-claim deed without cost to the United States Government for a right of way for proposed drains, that a committee of appraisers shall go over the route of proposed drains to ascertain the benefits conferred and the damages inflicted by the said drains, and whatever damages said committee shall award for the taking of land for the said rights of way shall be deducted from the assessments payable to the United States Government as drainage construction cost by each owner of the land so taken for right of way until compensation thereof shall have been fully made."

Plans for said drainage system not having been fully matured so that the alignment of the necessary ditches may be determined and fixed at this time, it is understood and agreed that the location of said drainage ditches shall be hereafter made by the proper officials of the United States Reclamation Service, to the end that said drainage system may be laid out and constructed in a proper and efficient manner.

IN WITNESS WHEREOF, we have hereunto affixed our hands and seals this _____ day of _____, 1919.

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

TX_MSJ_002947

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

DRAGLINE EXCAVATORS

Draglines No's. 1 and 2 purchased from Monighan Machine Co., Chicago, Ill., in December 1914. Type KrA, 40 foot boom 1 cu. yd. bucket, contract price f.o.b. shipping point.....11,550.00

Draglines No's. 3,4 5 and 6 purchased under contract #743, Bucyrus Co., South Milwaukee, Wis., class 9½ 50 ft. boom, caterpillar traction, contract price..15,000.00

Bucket, 1½ c.y. furnished by Page Engineering Co., Chicago..... 928.62

Lighting outfit furnished by Globe Elec. Co..... 480.00

Generator of this lighting plant, driven by main engine, proved unsatisfactory and 2 h.p. vertical gas engines purchased from Novo Engine Co., Lansing, Mich. were installed..... 106.00

This arrangement failed to give desired result and entire lighting system replaced with Delco 2 k.w. lighting plants..... 330.75

Engines (included in contract price) 93 h.p., 6 cylinder, Twin City, manufactured by Minneapolis Steel and Machinery Co. On test found to be of insufficient power. Replaced with engines manufactured by Atlas Imperial Gas Engine Co., Oakland, Calif., 125 h.p. 300 r.p.m., 4-cylinder, 12"x12" bore and stroke, vertical, at $7440 each, with allowance of $1780 each for return of old Twin City engines..... 5,660.00

$22,505.37

(These costs f.o.b. shipping point with exception of Delco lighting plants, which were purchased locally)

Draglines No's. 3 and 4 delivered July 25, 1917, Atlas engines, Aug. 1, 1918.

Draglines No's. 5 and 6 delivered Aug. 1, 1917, Atlas engines, Aug. 15, 1918.

Draglines No's. 7,8,9 and 10 purchased under contract #762, Bucyrus Co., South Milwaukee, Wis. class 9½, 50 ft. boom, caterpillar traction, contract price..17,600.00

Bucket furnished by Page Engineering Co., Chicago, 1½ c.y..... 970.83

Lighting outfits furnished by Matthews EngineeringCo. 927.50

Substituting steel for wood housing, wider running boards, etc..... 800.00

Engines (substituted for original contract specifications) 125 h.p. Atlas Engines, 300 r.p.m. 4 cylinder, 12"x12" bore and stroke, vertical inaddition to original contract price..... 6,868.00

27,166.33

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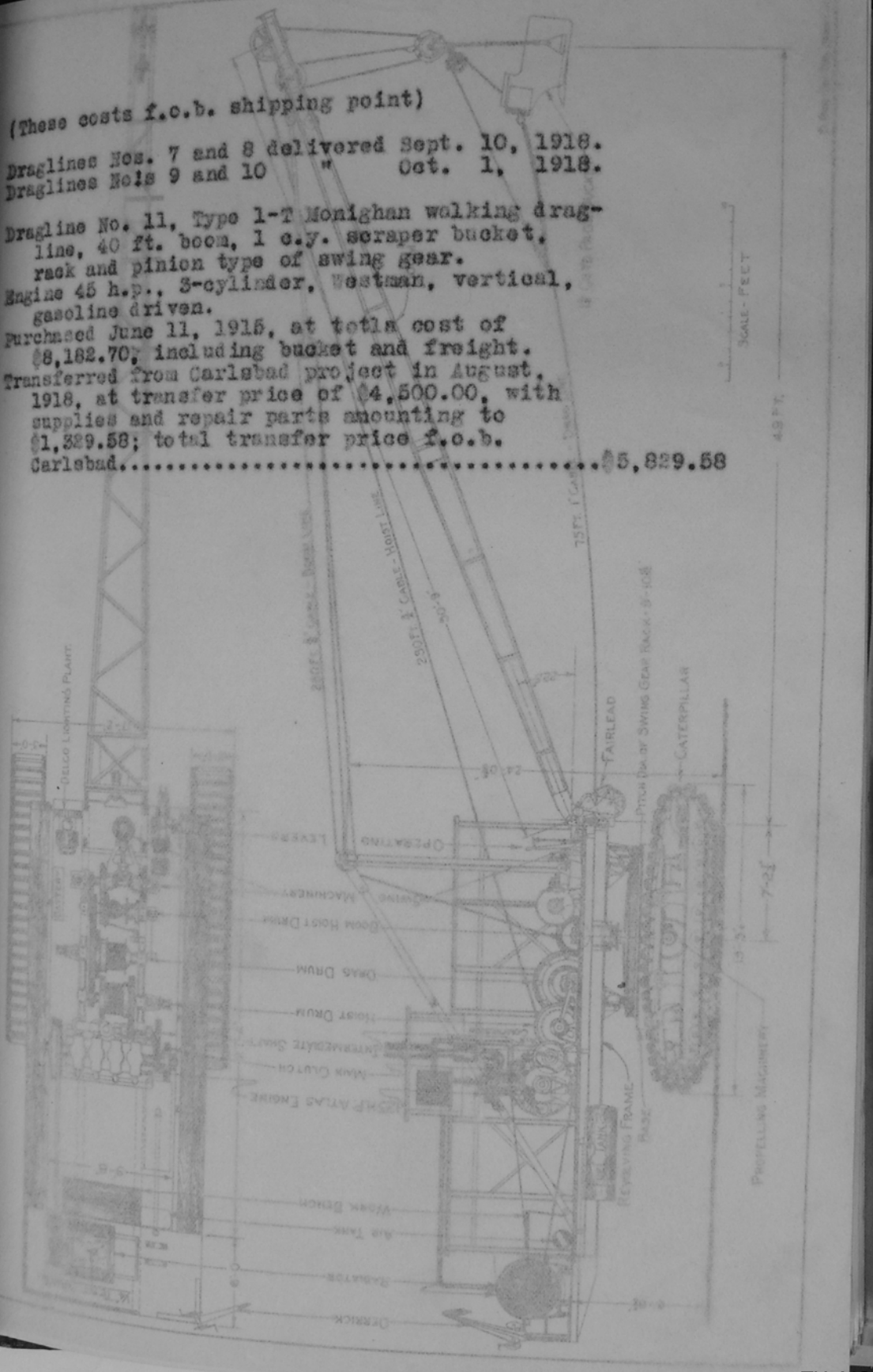
(These costs f.o.b. shipping point)

Draglines Nos. 7 and 8 delivered Sept. 10, 1918.
Draglines Nos 9 and 10 " Oct. 1, 1918.

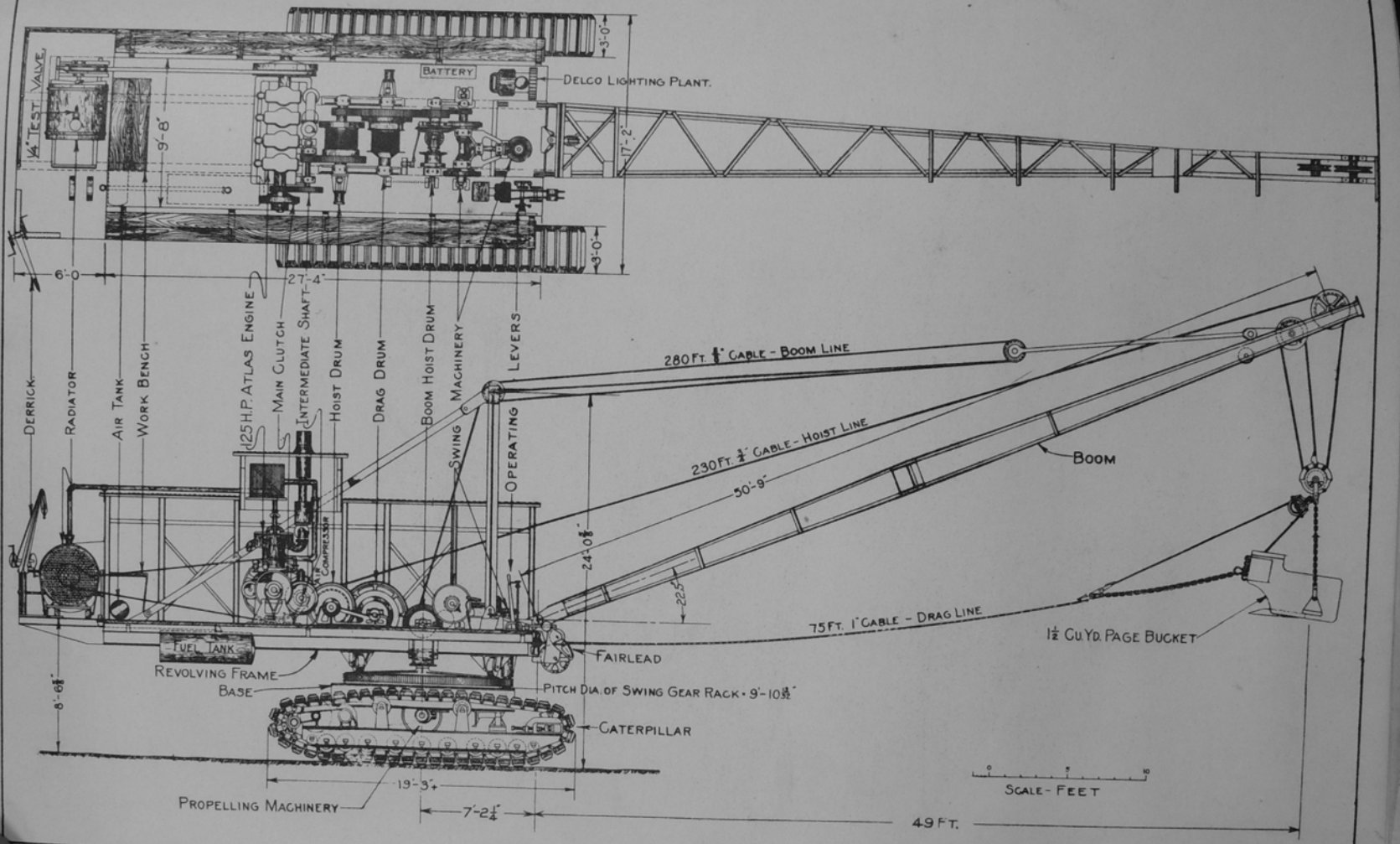
Dragline No. 11, Type 1-T Monighan walking dragline, 40 ft. boom, 1 c.y. scraper bucket, rack and pinion type of swing gear.
Engine 45 h.p., 3-cylinder, Westman, vertical, gasoline driven.
Purchased June 11, 1915, at total cost of $8,182.70, including bucket and freight.
Transferred from Carlsbad project in August, 1918, at transfer price of $4,500.00, with supplies and repair parts amounting to $1,329.58; total transfer price f.c.b. Carlsbad.....$5,829.58



TX_MSJ_002949

BUCYRUS CLASS 9½ DRAGLINE.

125 H. P. GAS ENGINE—CATERPILLAR TRACTION—50' BOOM—1½ CU. YD. BUCKET.



El Paso - Dec. 1918. Drawn C.F.I.

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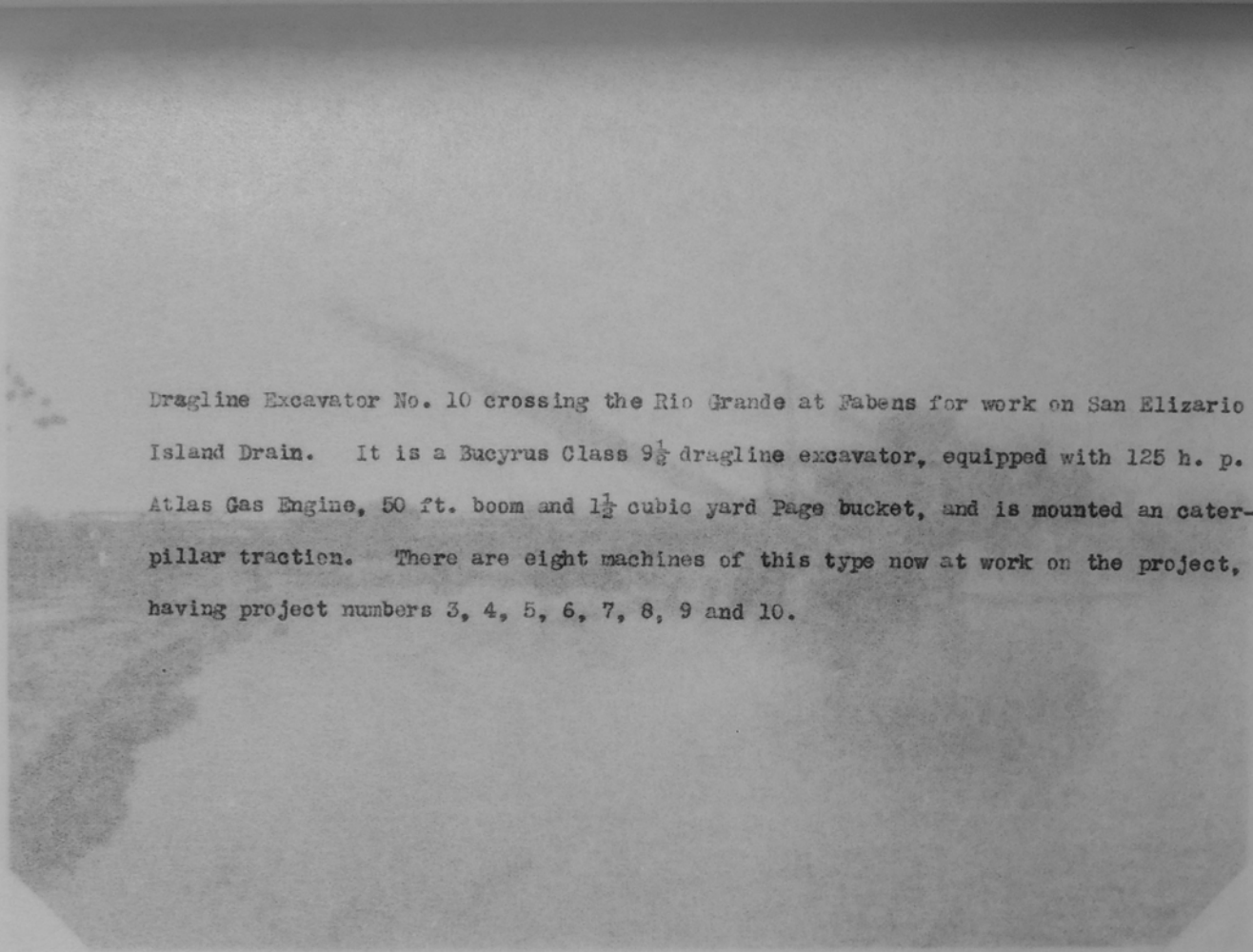

Dragline Excavator No. 10 crossing the Rio Grande at Fabens for work on San Elizario Island Drain. It is a Bucyrus Class 9½ dragline excavator, equipped with 125 h. p. Atlas Gas Engine, 50 ft. boom and 1½ cubic yard Page bucket, and is mounted an caterpillar traction. There are eight machines of this type now at work on the project, having project numbers 3, 4, 5, 6, 7, 8, 9 and 10.

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Bucyrus Class 9½ Dragline Excavator
showing boom and bucket in loading position.

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Records in the National Archives & Records
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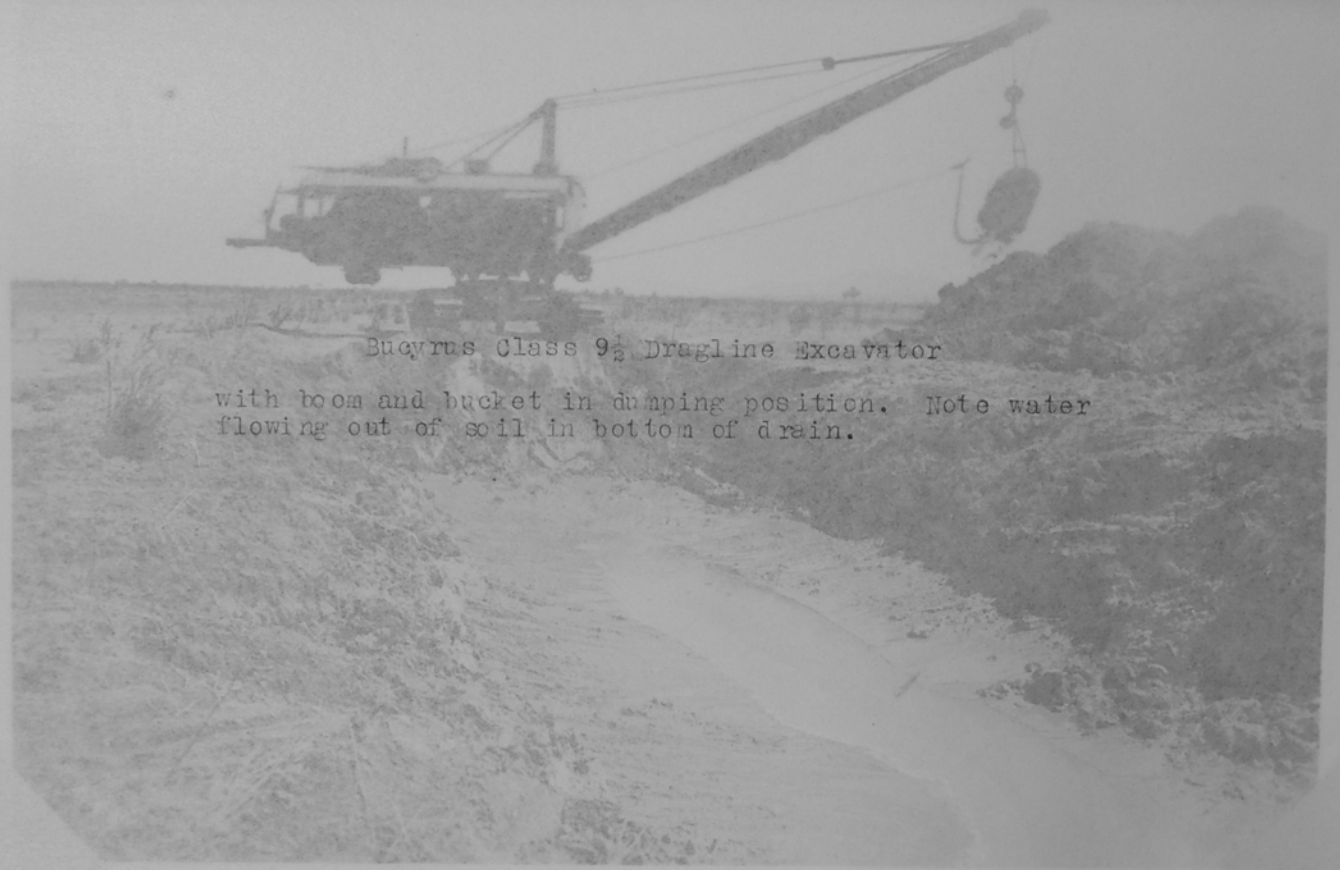
RG No. 115

TX_MSJ_002954





Bucyrus Class 9½ Dragline Excavator

with boom and bucket in dumping position. Note water flowing out of soil in bottom of drain.

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Bucyrus Class 9½ Dragline Excavator
in digging position showing drain excavated.

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Dragline No. 3, making a recut on the Mesa Drain in El Paso Valley.

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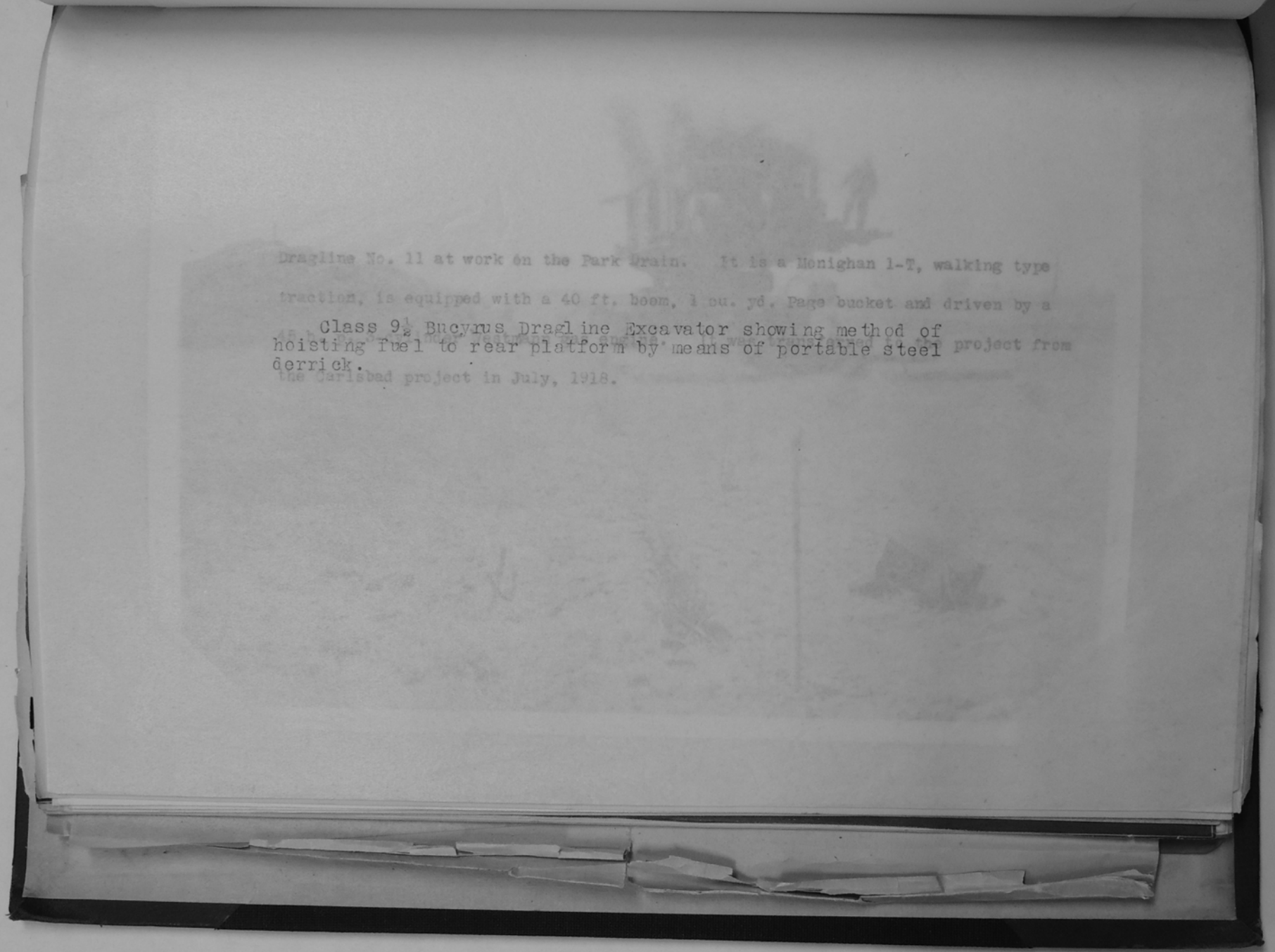

Class 9½ Bucyrus Dragline Excavator showing method of hoisting fuel to rear platform by means of portable steel derrick.

Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations
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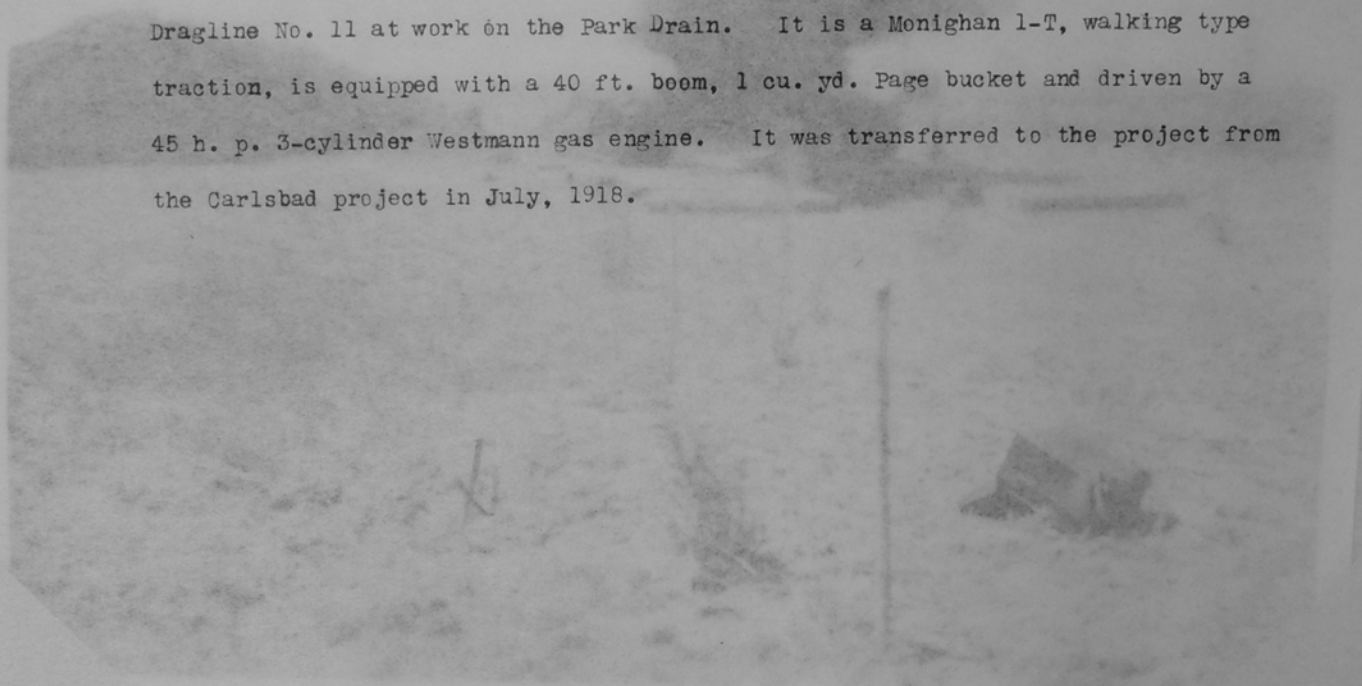
TX_MSJ_002961



Dragline No. 11 at work on the Park Drain. It is a Monighan 1-T, walking type traction, is equipped with a 40 ft. boom, 1 cu. yd. Page bucket and driven by a 45 h. p. 3-cylinder Westmann gas engine. It was transferred to the project from the Carlsbad project in July, 1918.

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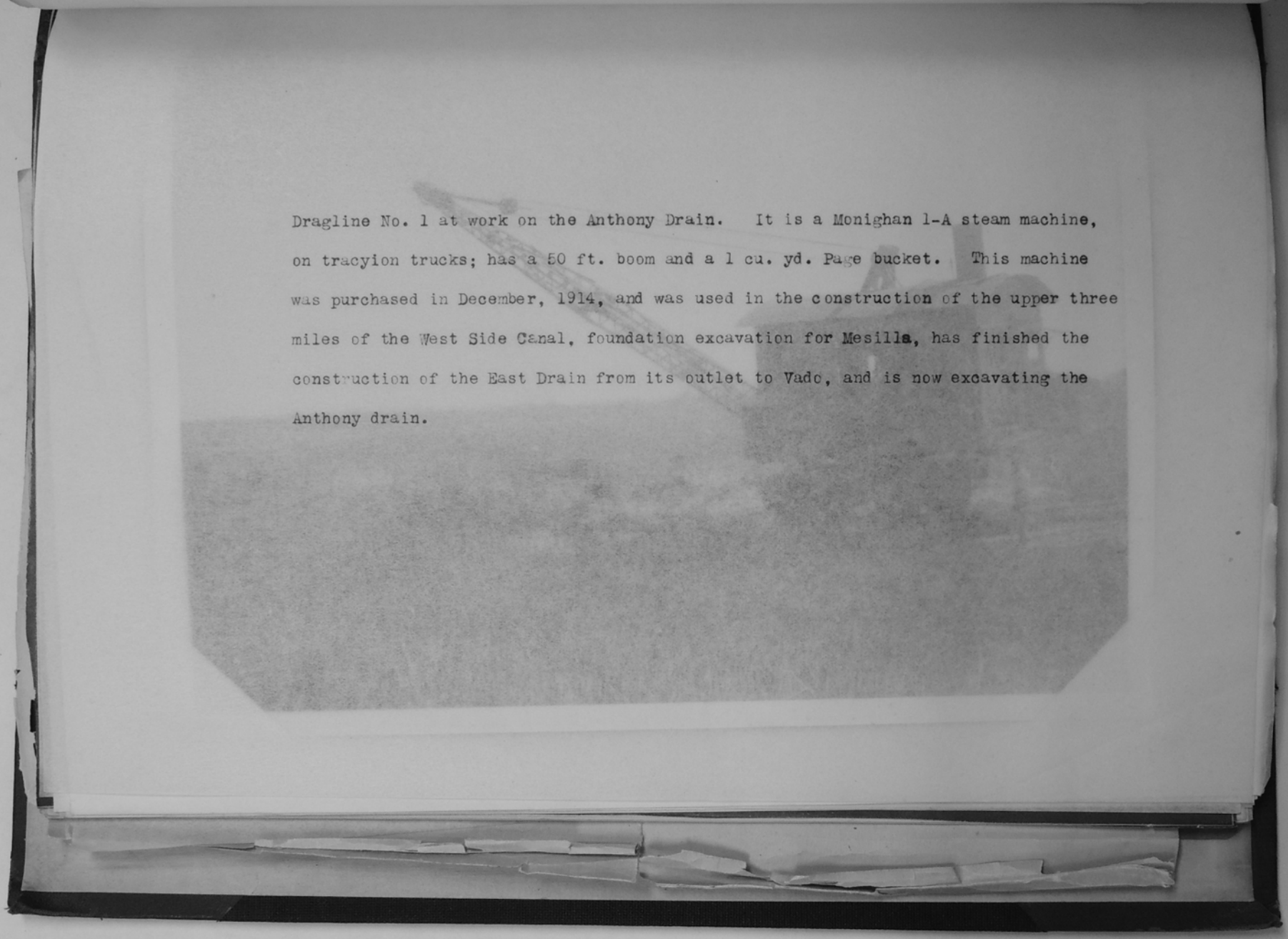

Dragline No. 1 at work on the Anthony Drain. It is a Monighan 1-A steam machine, on tracyion trucks; has a 50 ft. boom and a 1 cu. yd. Page bucket. This machine was purchased in December, 1914, and was used in the construction of the upper three miles of the West Side Canal, foundation excavation for Mesilla, has finished the construction of the East Drain from its outlet to Vado, and is now excavating the Anthony drain.

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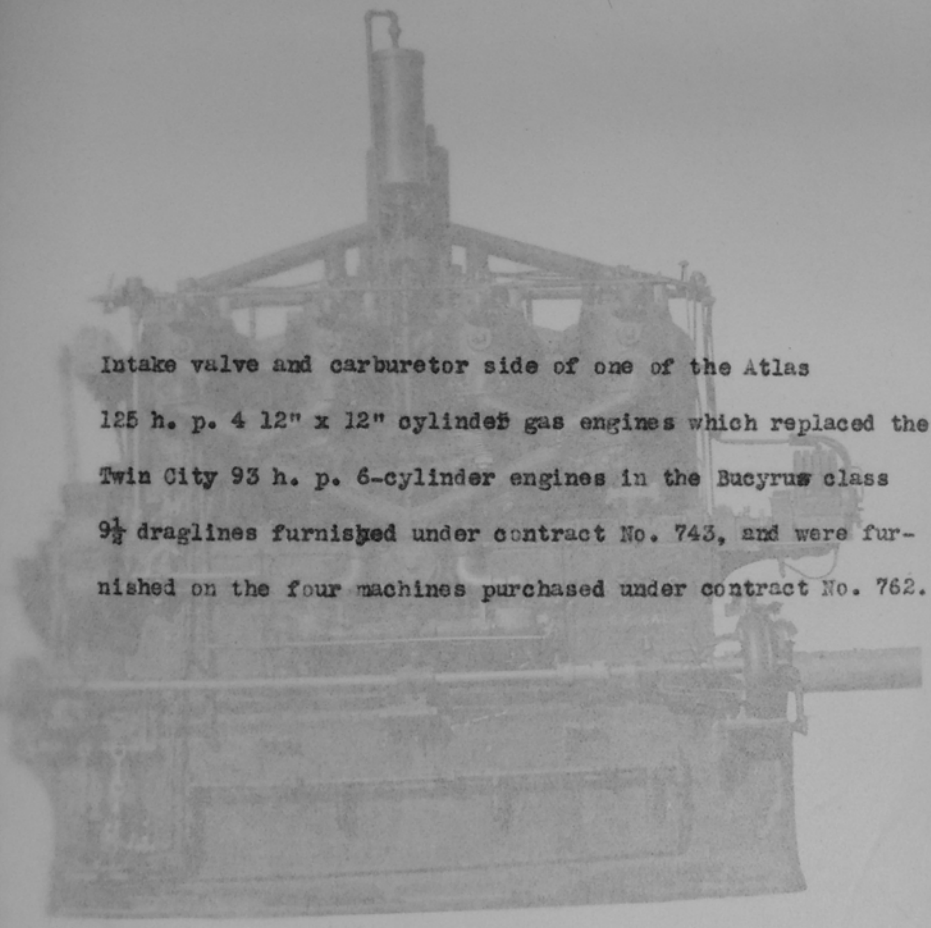

Intake valve and carburetor side of one of the Atlas 125 h. p. 4 12" x 12" cylinder gas engines which replaced the Twin City 93 h. p. 6-cylinder engines in the Bucyrus class 9½ draglines furnished under contract No. 743, and were furnished on the four machines purchased under contract No. 762.

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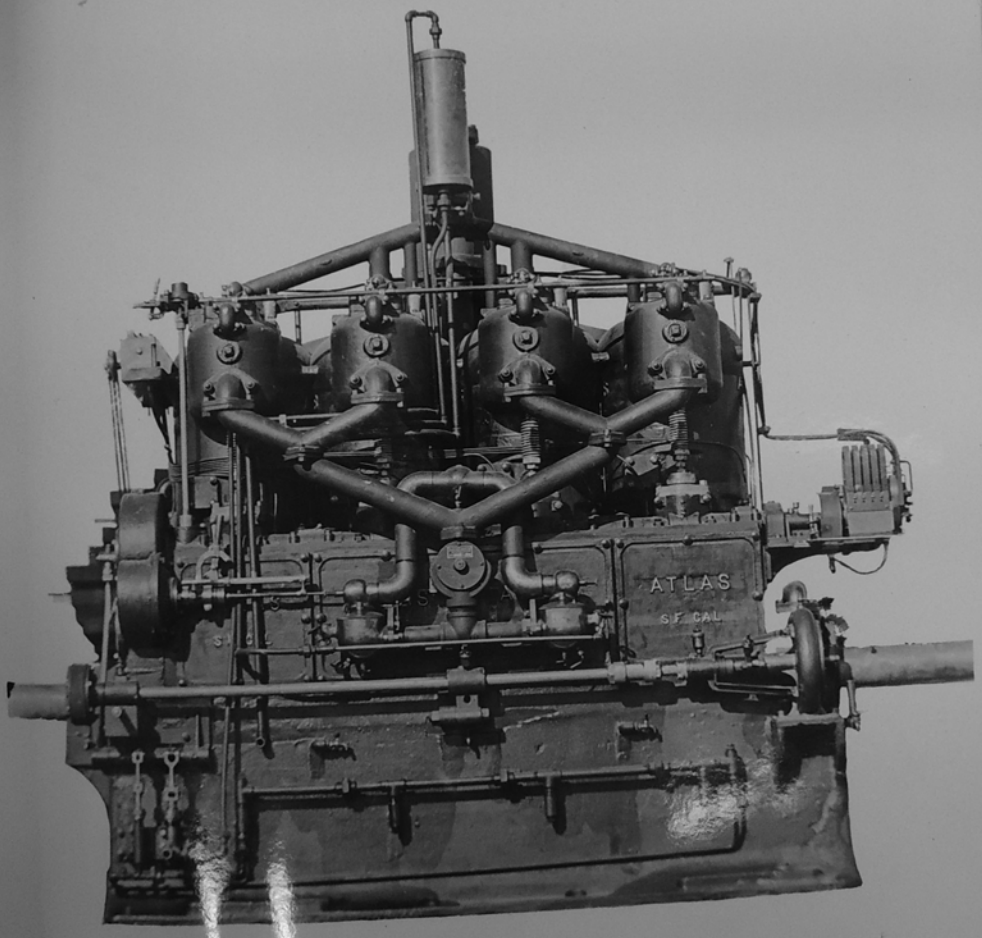

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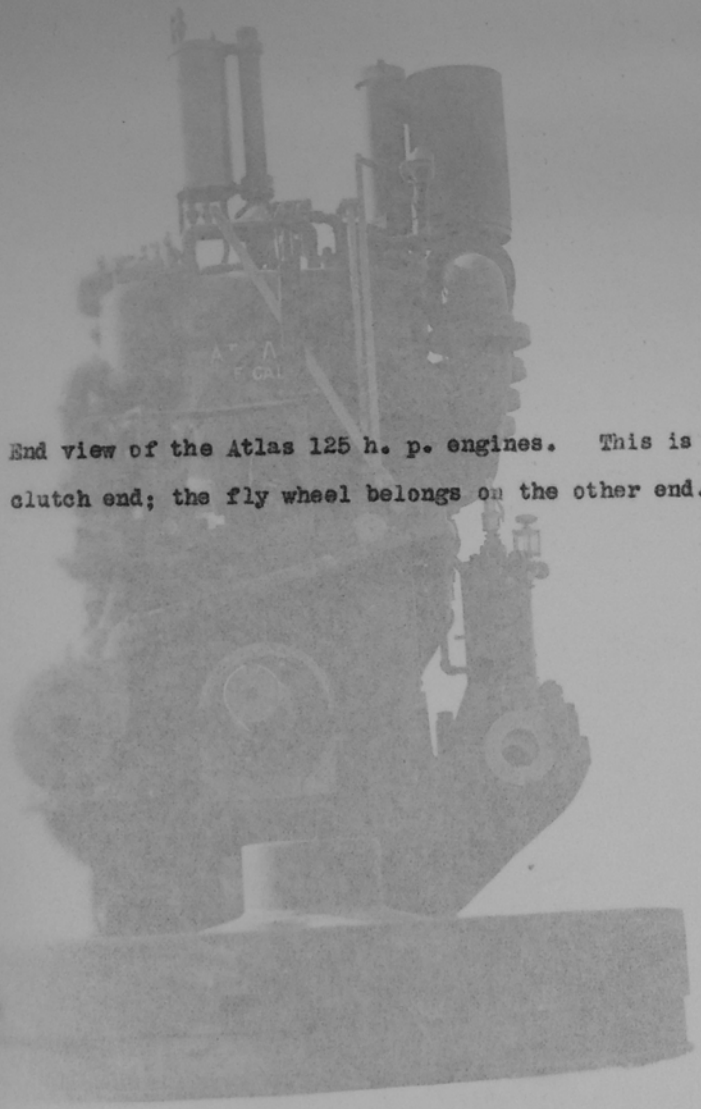

End view of the Atlas 125 h. p. engines. This is the clutch end; the fly wheel belongs on the other end.

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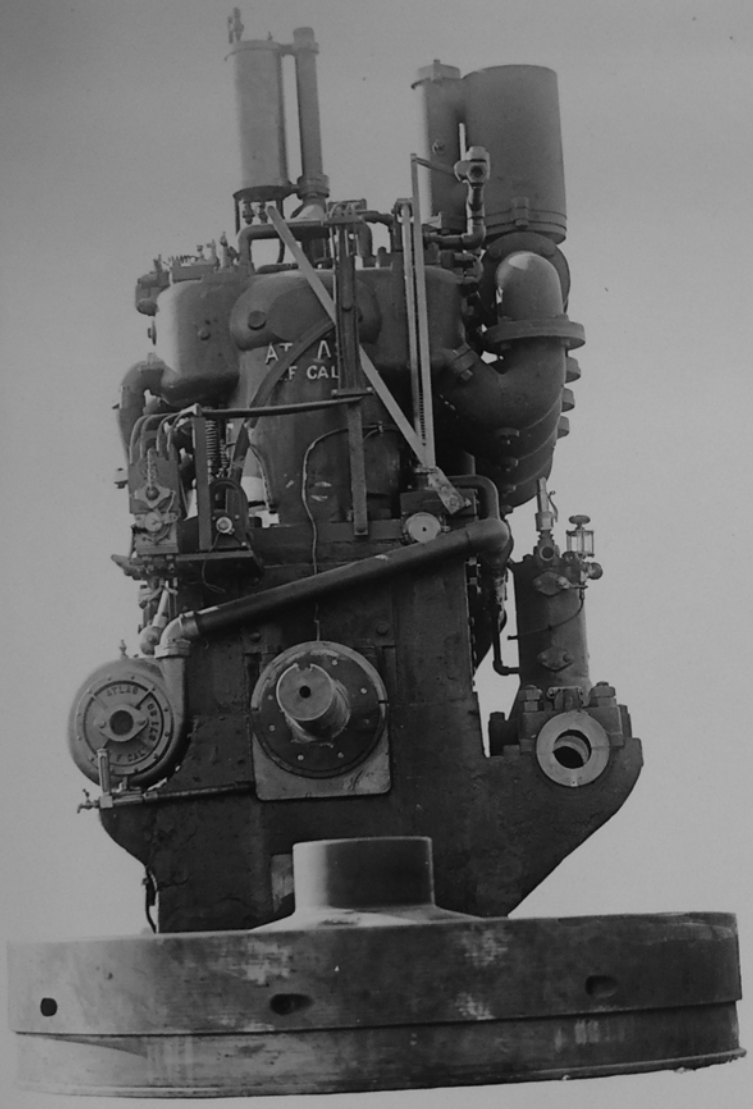

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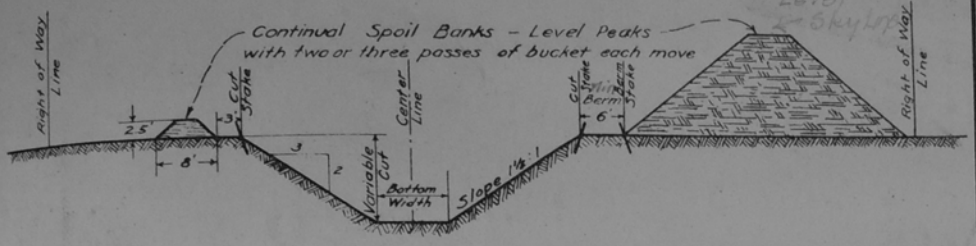
INSTRUCTIONS TO DRAGLINE OPERATORS



IDEAL SECTION SHOWING BERMS AND SPOIL BANKS

1. Make spoil banks continual, as shown, in order to keep out all surface water, with exceptions as noted below; Level off peaks with two or three passes of bucket each move as noted above so as to present a straight sky line:

   (a) Leave opening for bridges at road crossings unless otherwise directed by the engineer. Bridges will be raised about one foot, and in case of river drains about two feet above natural ground, so that surface and flood water may be kept out. Dump extra dirt at side of road on low spoil bank side in quantity sufficient to build approach where road is low.

   (b) Leave openings for flumes and drainage inlets only as directed and staked out by the engineer.

   (c) Large spoil bank should be on river side of drain and on hill side, respectively, depending on location of drain. Special instructions will be given in case of intermediate drains.

   (d) Increase size of small spoil bank in low ground and across old river beds so as to make a good levy to keep out surface or flood water.

   (e) Always leave Berms of minimum width, as shown in the sketch, between the excavation and spoil banks.

   (f) Never change sides of large spoil bank except upon definite instructions from the engineer: If for any reason you think they should be changed call up the engineer.

2. Check ditch for proper depth from cut stakes frequently; survey parties will also give grade stakes in bottom of ditch occasionally.

3. All Irrigation Ditches must be properly dammed when they are cut whether they are carrying water or not to avoid any possible cutting of the drain banks by water being turned in.

4. Fences and Structures must be carefully removed from the path of the excavator and all fence or structure material so removed shall be laid clear of the spoil banks. Special care must be exercised not to cover up or otherwise destroy any useable materials found along the right of way.

5. Necessary repairs to fences must be made by the excavator crews to keep stock from straying; Where this is impossible notify the engineer or structure foreman immediately.

6. Telephone lines must not be molested without giving proper notice; Where telephone lines are to be crossed the operators must inform the engineer four days in advance of the time he expects to cross so that the telephone company can be notifyed in writing to make arrangements to care for their wires, as agreed upon by contract.

7. Groundmen and other employees whose duties do not require them to come in contact with the working machinery must keep off the operating platform and away from moving machinery while in operation: The United States can not be held responsible for injury to employees, unless injured during the proper discharge of their duties. Operators shall not permit visitors on machines.

8. Daily Reports must be made out by each shift operator on the forms provided. Care must be taken to report the time of the crew, to properly distribute the time according to the work done, and accurately state results accomplished, giving station to station and lineal feet excavated, name of drain, number of machine, date and shift operated. The chief operator must collect the reports and send them daily to the engineer.

TX_MSJ_002971

SUMMARY OF OPERATION COST AND EFFICIENCY OF DRAGLINE EXCAVATORS

L.P. Fleck, Asst. Engr.

TO DEC. 31 1918

50' BOOM-1½ CU. YD. BUCKET – BUCYRUS CLASS 9½ EXCAVATORS 4 OLD MACHINES WITH TWIN CITY ENGINE 93 H.P.

PERIOD				EXCAVATION			TIME DISTRIBUTION				PERFORMANCE			COST OF OPERATION †				
MACHINE NUMBER	Began Excavation	Began Changing Engine	Months Operating	Lineal Feet	Miles	Cubic Yards	Shifts Charged Operation	Operating %	Repairing %	Delays %	Miles Per Month	Lin. Ft. Per Shift	Cu. Yds. Per Shift	Total Cost	Cost Per Cu. Yd.	Cost Per Foot	Cost Per Mile	Cost Per Shift
3	July 25.17	Aug 11.18	12.5	51,445	9.75	413,479	927.	45	37	18	.78	555	446	$ 37,088.39	$ .090	$ .72	$ 3,805.0	$ 40.00
4	July 24,17	Aug. 4,18	12.3	39,320	7.45	331,199	909.5	45	47	8	.61	433	365	37,520.24	.113	.95	5,036.0	41.30
5	Aug 25,17	Aug 20.18	12.1	43,065	8.15	344528	823.5	51	34	15	.67	419	419	32,452.35	.094	.94	4,980.0	39.40
6	Aug 24.17	Sept. 14,18	12.6	56,950	10.80	378,216	932.	52	34	14	.86	406	406	33,507.50	.089	.59	3,100.0	36.00
4 OLD MACHINES TWIN CITY ENGINE			49.5	190,780	36.20	1,467,422	3592.	49	38	13	.73	531	409	140,491.04	.096	.74	3,882.0	39.20
4 OLD MACHINES WITH ATLAS ENGINE 125 H.P.																		
3	Sept.5,18		3.8	14,185	2.8	130,217	298.5	55	23	22	.74	496	436	11,744.15	.090	.83	4,195.0	39.30
4	Aug 25,18		4.2	14,875	2.8	142,654	298.0	64	22	14	.66	500	479	11,707.64	.082	.79	4,190.0	39.40
5	Oct. 1, 18		3.0	13,365	2.5	134,993	225.	64	16	20	.83	594	600	8,425.09	.060	.63	3,368.0	37.40
6	Oct.		2.3	9,930	1.9	87,554	198.5	58	19	13	.83	500	441	6,545.71	.075	.66	3,445.0	33.00
4 OLD MACHINES ATLAS ENGINE			13.3	52,985	10.0	495,418	1020.0	60	22	18	.75	519	486	38,499.93	.078	.73	3,850.0	37.75
4 OLD MACHINES TO DATE			62.8	243,765	46.20	1962,840	4612.	51		14	.73	529	476	176,990.97	.091	.73	3,890.0	38.80
4 NEW MACHINES WITH ATLAS ENGINE																		
7	Sept. 13, 18.		3.5	13,010	2.5	94,142	169.	62	17	21	.71	770	556	7,326.93	.078	.56	2,932.0	43.35
8	Oct. 4, 18		2.9	17,080	3.2	170,542	229.	67	15	18	1.10	746	744	11,060.04	.065	.65	3,457.0	48.40
9	Oct. 29, 18		2.1	10,770	2.0	105,113	161.	63	26	12	.95	669	653	7,138.02	.068	.66	3,400.0	44.30
10	Nov 4, 18		1.9	11,200	2.1	79,313	108.	62	19	19	1.10	1037	480	5,396.54	.068	.48	2,568.0	50.00
4 NEW MACHINES ATLAS ENGINES			10.4	52,060	9.8	449,110	679.	64.	19	17	.94	767	661	30,921.53	.069	.59	3,106.0	45.55
8 MACHINES WITH ATLAS ENGINES																		
8 MACHINES WITH ATLAS ENGINES			23.7	105,045	19.8	944,528	1,699.	62	21	17	.83	618	555	69,421.46	.0735	.66	3,506.0	40.80
8 BUCYRUS MACHINES TO DATE																		
8 MACHINES TO DATE			73.2	295,825	56.0	2,411,950	5291	53	33	14	.77	559	456	209,912.50	.087	.71	3,750.0	39.70
OTHER MACHINES																		
NOS. 1 & 2-MONIGHAN-STEAM, ON TRACTION TRUCKS, 1 CU. YD. BUCKET, 40' BOOM - Prev. work on Mesilla Valley Canals																		
1	Apr. 27 '16		3.2	71,050	13.6	506,017	*925	*59	*25	*16	42	43	308	55,110.83	.110	.77	4083	33.50
2	May 26 '16	July 1 '17	14	19,400	3.7	149,601					.26			19,787.22	.122	1.01	5350	
No. 11 MONIGHAN-GAS ON WALKING DEVICE, 45 H.P., 1 CU. YD. BUCKET, 40 FOOT BOOM - Transfered from Carlsbad Proj.																		
11	Sept. 27 '18		4	5,200	1.00	39,150	147	55	30	15	.25	35	266	4,398.29	.118	.83	4400	30.0
ALL MACHINES			123.2	391,475	74.3	3,106,718								289,208.84	.093	.74	3,890	

* Time distribution from July 1st. 1917 to Dec. 31st. 1918 inc.

† From Engineering Records.

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FICIENCY OF DRAGLINE EXCAVATORS
918

EXCAVATORS 4 OLD MACHINES WITH TWIN CITY ENGINE 93 H.P.

TRIBUTION			PERFORMANCE			†COST OF OPERATION					
at-	Repairing %	Delays %	Miles Per Month	Lin. Ft. Per Shift	Cu. Yds. Per Shift	Total Cost	Cost Per Cu. Yd.	Cost Per Foot	Cost Per Mile	Cost Per Shift	Cost Per Month
	37	18	.78	555	446	$37,088.39	$.090	$.72	$3805.0	$40.00	$2965.0
	47	8	.61	433	365	37,520.24	.113	.95	5,036.0	41.30	3050.40
	34	15	.67	419	419	32,452.35	.094	.94	4,980.0	39.40	2682.0
	34	14	.86	406	406	33,507.50	.089	.59	3100.0	36.00	2670.0
	38	13	.73	531	409	140,491.04	.096	.74	3882.0	39.20	2838.0
ATLAS ENGINE 125 H.P.											
	23	22	.74	496	436	11,744.15	.090	.83	4,195.0	39.30	3090.0
	22	14	.66	500	479	11,707.64	.082	.79	4,190.0	39.40	2790.0
	16	20	.83	594	600	8,425.09	.060	.63	3368.0	37.40	2809.0
	19	13	.83	500	441	6,545.71	.075	.66	3,445.0	33.00	2845.0
	22	18	.75	519	486	38,499.93	.078	.73	38500	37.75	2894.0
		14	.73	529	476	176,990.97	.091	.73	3890.0	38.80	2869.0
ATLAS ENGINE											
	17	21	.71	770	556	7,326.93	.078	.56	2932.0	43.35	2093.0
	15	18	1.10	746	744	11,060.04	.065	.65	3457.0	48.40	3812.0
	26	12	.95	669	653	7,138.02	.068	.66	3400.0	44.30	3398.0
	19	19	1.10	1037	480	5,396.54	.068	.48	2568.0	50.00	2839.0
	19	17	.94	767	661	30,921.53	.069	.59	3,106.0	45.55	2975.0
ENGINES											
	21	17	.83	618	555	69,421.46	.0735	.66	3506.0	40.85	2930.0
DATE											
	33	14	.77	559	456	209,912.50	.087	.71	3,750.0	39.70	2865.0
ON TRUCKS, 1 CU. YD. BUCKET, 40' BOOM - Prev. work on Mesilla Valley Canals											
*	25	* 16	42	43	308	55,110.83	.110	.77	4083	33.50	1722.0
			.26			19,787.22	.122	1.01	5350		
1 CU. YD. BUCKET, 40 FOOT BOOM - Transfered from Carlsbad Proj.											
	30	15	.25	35	266	4,398.29	.118	.83	4400	30.0	1101.0
						289,208.84	.093	.74	3,890		

† From Engineering Records.

[redacted] CATERPILLAR TRACTION.

FUEL CONSUMPTION

	Ave. cost per gal.	Amount used. (Gal.) Total this yr.	Amount used. (Gal.) per shift	Yards per gal.	Cost per yard.
Kerosene	$0.13	8,425	46.8	7.1	.0183
Distillate	.144	16,230	38.4	13.9	.0109
Kerosene	.13	7,390	44.0	7.2	.0182
Distillate	.144	14,675	32.6	10.6	.0137
Kerosene	.13	3,238	33.8	7.3	.0174
Distillate	.141	19,345	43.7	13.1	.0108
Kerosene	.13	4,806	37.5	7.9	.0164
Distillate	.141	20,114	36.9	11.5	.0122
Kerosene	.13	25,859	41.0	7.3	.0177
Distillate	.143	70,964	37.9	12.3	.0116
Distillate	$0.16	12,595	42.2	10.3	.0155
Distillate	.16	12,610	42.3	11.3	.0141
Distillate	.153	10,092	44.8	13.4	.0114
Distillate	.153	6,995	35.2	12.5	.0122
Distillate	.156	42,292	41.5	11.7	.0133
Distillate only	$0.15	113,256	39.1	12.0	.0125
Distillate	$0.163	6,765	40	13.9	.0117
Distillate	.154	12,069	52.7	14.1	.0109
Distillate	.154	8,504	52.8	12.4	.0125
Distillate	.163	5,830	53.9	13.6	.0120
Distillate	$0.159	33,168	48.8	13.5	.0117
Distillate	$0.157	75,460	45.2	12.5	.0121
Distillate	$0.153	146,424	41.0	12.4	.0123
[redacted]					
Coal	Per Ton $6.65	Tons 560.5	Tons 0.8	Tons .0037	.0246
[redacted]					

No detail records kept previous to Jan. 1st, 1918.

*GASOLINE

	Ave cost per gal.	Amount used. (Gal.) Total this yr.	Amount used. (Gal.) per shift	cost per yd. for T. exc.
	$0.25	637	3.5	
	.25	2,257	6.3	
	.25	1,723	10.3	
	.25	1,963	1.1	
	.25	996	6.4	
	.25	2,089	1.6	
	.25	683	5.9	
	.25	2,318	1.2	
	.25	4,039	6.4	.0039
	.25	8,607	1.6	.0028
	$0.25	2150	7.3	
	.25	2057	6.9	
	.25	640	2.8	
	.25	538	2.7	
	.25	5,386	5.3	.0037
		13,993	4.8	.0028
	$0.25	1090	6.5	
	.25	1021	4.5	
	.25	638	4.0	
	.25	990	9.1	
	$0.25	3739	5.5	.0021
	$0.25	9125	5.4	.0024
	$0.25	17,732	5.0	.0027

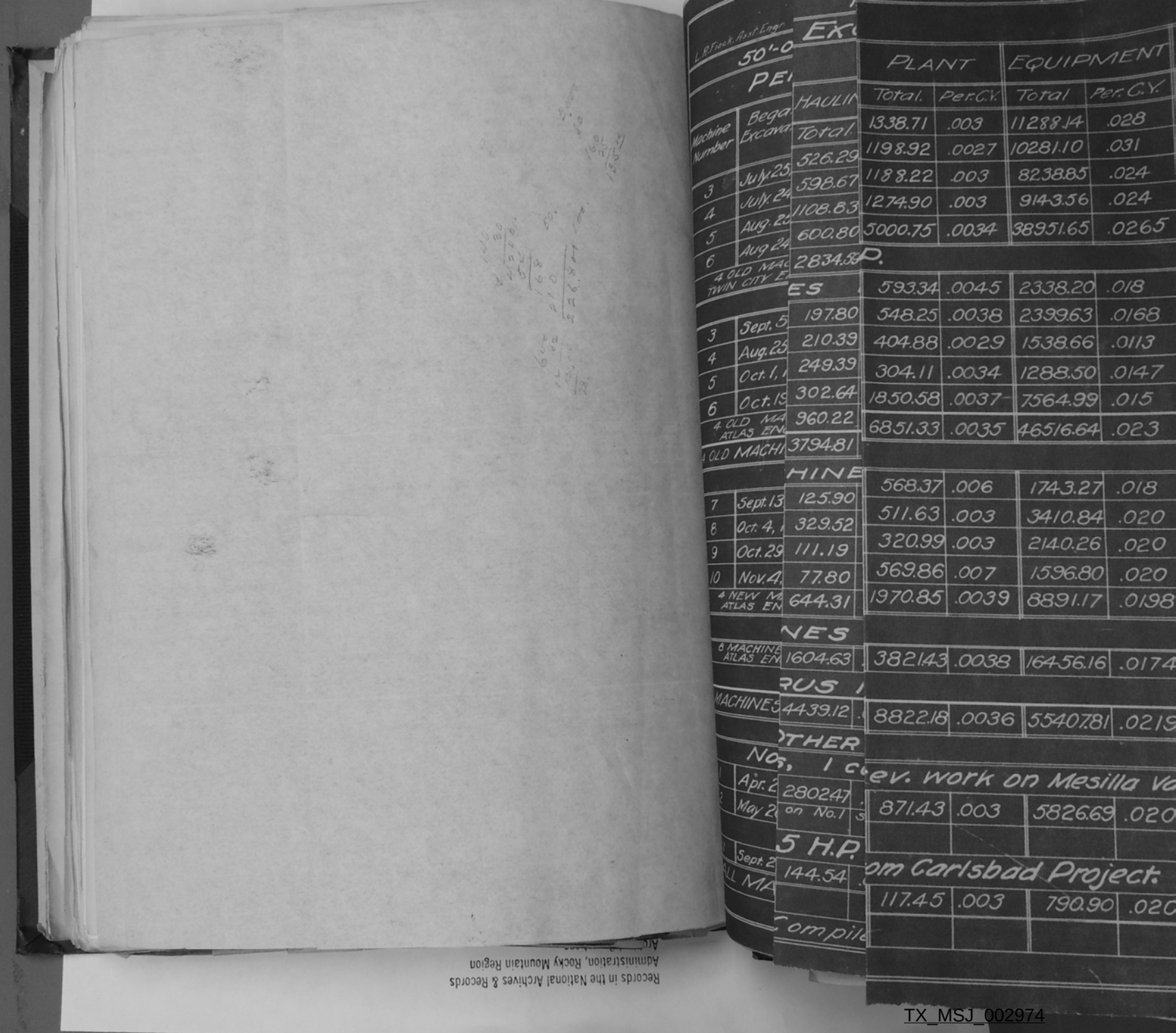
*Used for starting and lighting.

LUBRICATING OIL

	Ave cost per gal.	Amount used. (Gal.) Total this yr.	Amount used. (Gal.) per shift	cost per yd.
	$0.61	640	3.6	
	.61	2,189	5.2	
	.61	510	3.0	
	.61	2,078	4.6	
	.61	409	2.6	
	.61	2,439	5.3	
	.61	307	2.4	
	.61	2,243	4.1	
	.61	1,866	3.0	.0043
	.61	8,949	4.8	.0072
	$0.62	825	2.8	
	.62	898	3.0	
	.62	538	2.4	
	.62	641	3.2	
	.62	2,902	2.8	.0036
	.62	11,851	4.1	.006
	$0.62	660	3.9	
	.62	587	2.6	
	.62	159	1.0	
	.62	275	2.5	
	$0.62	1691	2.5	.003
	$0.62	4593	2.7	.003
	$0.618	13,542	3.8	.0052

Records in the National Archives & Records Administration, Rocky Mountain Region
Archival Operations
RG No. 115

TX_MSJ_002973



L.R.Fieck, Asst Engr.

50'-0

PE

Machine Number	Begin Excavat	HAULIN Total	PLANT Total	PLANT Per.C.Y.	EQUIPMENT Total	EQUIPMENT Per.C.Y.
3	July.25	526.29	1338.71	.003	11288.14	.028
4	July.24	598.67	1198.92	.0027	10281.10	.031
5	Aug.2	1108.83	1188.22	.003	8238.85	.024
6	Aug.24	600.80	1274.90	.003	9143.56	.024
4 OLD MA TWIN CITY E		2834.59	5000.75	.0034	38951.65	.0265
		ES	P.			
3	Sept.5	197.80	593.34	.0045	2338.20	.018
4	Aug.25	210.39	548.25	.0038	2399.63	.0168
5	Oct.1,	249.39	404.88	.0029	1538.66	.0113
6	Oct.19	302.64	304.11	.0034	1288.50	.0147
4 OLD MA ATLAS EN		960.22	1850.58	.0037	7564.99	.015
4 OLD MACHI		3794.81	6851.33	.0035	46516.64	.023
		HINE				
7	Sept.13	125.90	568.37	.006	1743.27	.018
8	Oct.4,	329.52	511.63	.003	3410.84	.020
9	Oct.29	111.19	320.99	.003	2140.26	.020
10	Nov.4,	77.80	569.86	.007	1596.80	.020
4 NEW M ATLAS EN		644.31	1970.85	.0039	8891.17	.0198
		NES				
8 MACHINE ATLAS EN		1604.63	3821.43	.0038	16456.16	.0174
		RUS				
MACHINES		4439.12	8822.18	.0036	55407.81	.0219
		OTHER				
		Nos, 1 c	ev. work on Mesilla Va			
1	Apr.2	2802.47	871.43	.003	5826.69	.020
2	May 2	on No.1				
		5 H.P.	om Carlsbad Project.			
1	Sept.2	144.54	117.45	.003	790.90	.020
ALL MA						
		Compile				

Records in the National Archives & Records
Administration, Rocky Mountain Region

TX_MSJ_002974

L. R. Fisack, Asst. Engr.

SUMMARY OF OPERATION COST AND EFFICIEN

To Dec. 31, 1918.

50'-0" BOOM 1½ CU. YD. BUCKET — BUCYRUS CLASS 9½ EXCAVATORS

PERIOD				EXCAVATION			Σ COST D										
							LABOR Machine & ground Crews		Miscellaneous LABOR & Minor Expense.		FUEL.		HAULING FUEL		WATER		WIR
Machine Number	Began Excavation	Began Changing Engines	Months Operating	Linear Feet.	Miles	Cubic Yards.	Total.	Per C.Y.	Total.	Per C.Y.	Total.	Per C.Y.	Total.	Per C.Y.	Total.	Per C.Y.	Tota
3	July 25, 17.	Aug. 11, 18.	12.5	51,446	9.75	413,479	8990.39	.021	385.68	.001	6205.15	.015	526.29	.001	4.24		792
4	July 24, 17.	Aug. 4, 18	12.3	39,320	7.45	331,199	9404.30	.028	314.34	.001	6245.85	.0126	598.67	.00066	6.67		770
5	Aug. 25, 17.	Aug. 28, 18	12.1	43,065	8.15	344,528	7815.48	.023	982.58	.003	5315.15	.016	1108.83	.003	9.15		834
6	Aug 24, 17.	Sept. 14, 18	12.6	56,950	10.80	378,216	8606.32	.023	638.56	.0017	5567.43	.015	600.80	.002	6.59		508
4 OLD MACHINES TWIN CITY ENGINES.			49.5	190,780	36.20	1,467,422	34816.49	.024	2321.16	.0016	23333.58	.016.	2834.59	.0019	26.65		2903
4 OLD MACHINES WITH ATLAS																	
3	Sept. 5, 18		3.8	14,185	2.8	130,217	3291.80	.025	71.54	.00054	2824.99	.022	197.80	.002			69
4	Aug. 25, 18		4.2	14,875	2.8	142,654	3505.67	.025	159.56	.001	2654.85	.0186	210.39	.001			30
5	Oct. 1, 18		3.0	13,365	2.5	134,993	2283.87	.017	467.60	.0034	1681.61	.012	249.39	.0018	26.12		20
6	Oct. 19, 18		2.3	9,930	1.9	87,554	2760.47	.035	90.43		1242.16	.0141	302.64	.0034	108.22	.0012	36
4 OLD MACHINES ATLAS ENGINES			13.3	52,985	10.0	495,418	11841.81	.024	789.13	.0016	8403.61	.017	960.22	.002	134.34	.0003	156
4 OLD MACHINES TO DATE			62.8	243,765	46.20	1962840	46658.30	.0237	3110.29	.0016	31737.19	.016	3794.81	.0019	160.99		447
4 NEW MACHINES WITH AT																	
7	Sept. 13, 18.		3.5	13,010	2.5	94,142	2112.00	.022	110.58	.001	1408.17	.015	125.90	.001			17
8	Oct. 4, 18.		2.9	17,080	3.2	170,542	2347.47	.014	390.80	.002	1798.49	.011	329.52	.002	52.50		34
9	Oct. 29, 18		2.1	10,770	2.0	105,113	1712.56	.016	112.70	.001	1358.98	.013	111.19	.001	45.93		15
10	Nov. 4, 18		1.9	11,200	2.1	19,313	1215.30	.015	201.93	.003	1193.40	.015	77.80	.001			19
4 NEW MACHINES ATLAS ENGINES			10.4	52,060	9.8	449,110	7387.33	.016	816.01	.0018	5759.04	.013	644.31	.001	98.43		87
8 MACHINES WITH ATL																	
8 MACHINES WITH ATLAS ENGINES.			23.7	105,045	19.8	944,528	19229.14	.020	1605.14	.0017	14162.65	.015	1604.63	.0017	232.77	.0002	24
8 BUCYRUS MACHINES TO																	
8 MACHINES TO DATE.			73.2	295,825	56.0	2,411,950	54045.63	.022	3926.30	.0016	37496.23	.015	4439.12	.0018	259.42		53
OTHER MACHINES																	
NOS. 1 & 2. MONIGHAN — STEAM, ON TRACTION TRUCKS, 1 CU. YD. BUCKE																	
1	Apr. 27, 16		32.	71,050	13.6	506,017	10354.63	.037	1839.07	.006	5484.00	.019	280247	.010	2277.07	.008	6
2	May 26, 16	July. 1, 17	14.	19,400	3.7	149,601					Cost Distribution		on No. 1	since	May 1,	1917.	
NO. 11 MONIGHAN GAS ON WALKING DEVICE, 45 H.P. 1 CU. YD. BUCKE																	
11	Sept. 27, 18.		4.	5,200	1.00	39,150	1342.98	.034	98.18	.003	806.21	.021	144.54	.004	24.50	.001	4
ALL MACHINES.			123.2	391,475	74.3	3,106,718											

Σ Compiled from Cost

Records in the National Archives & Records Administration, Rocky Mountain Region Archival Operations

TX_MSJ_002975

Y OF OPERATION COST AND EFFICIENCY OF DRAGLINE EXCAVATORS

To Dec. 31, 1918.

BUCYRUS CLASS 9½ EXCAVATORS — 4 OLD MACHINES WITH TWIN CITY ENGINS 93 H.P.

Σ COST DISTRIBUTION.

	LABOR Machine & ground Crews		Miscellaneous LABOR & Minor Expense.		FUEL.		HAULING FUEL		WATER		WIRE ROPE		LUBRICANTS		MINOR E. R. & S.		PLANT		EQUIPMENT		TOTAL.	
	Total.	Per C.Y.	Total.	Per C.Y.	Total.	Per C.Y.	Total.	Per C.Y.	Total.	Per C.Y.	Total	Per C.Y.	Total	Per C.Y.	Total.	Per C.Y.	Total.	Per C.Y.	Total	Per C.Y.	Total.	Per C.Y.
9	8990.39	.021	385.68	.001	6205.15	.015	526.29	.001	4.24		792.20	.002	2192.05	.005	5086.09	.012	1338.71	.003	11288.14	.028	37088.39	.090
9	9404.30	.028	314.34	.001	6245.85	.0126	598.67	.00066	6.67		770.11	.002	2346.96	.007	6352.56	.0126	1198.92	.0027	10281.10	.031	37520.22	.1132
8	7815.48	.023	982.58	.003	5315.15	.016	1108.83	.003	9.15		834.77	.002	1855.82	.0054	4635.06	.014	1188.22	.003	8238.85	.024	32452.25	.095
5	8606.32	.023	638.56	.0017	5567.43	.015	600.80	.002	6.59		508.00	.002	1941.09	.0051	5071.50	.013	1274.90	.003	9143.56	.024	33507.30	.0885
22	34816.49	.024	2321.16	.0016	23333.58	.016	2834.59	.0019	26.65		2905.08	.00199	8335.92	.0057	21145.21	.0144	5000.75	.0034	38951.65	.0265	140568.16	.0958
4 OLD MACHINES WITH ATLAS ENGINES 125 H. P.																						
	3291.80	.025	71.54	.00054	2824.99	.022	197.80	.002			690.40	.005	592.50	.005	1143.58	.0087	593.34	.0045	2338.20	.018	11744.15	.090
4	3505.67	.025	159.56	.001	2654.85	.0186	210.39	.001			308.20	.002	563.25	.0039	1267.25	.0088	548.25	.0038	2399.63	.0168	11707.66	.082
	2283.87	.017	467.60	.0034	1681.61	.012	249.39	.0018	26.12		204.75	.0015	264.30	.0019	1085.54	.0080	404.88	.0029	1538.66	.0113	8425.09	.0624
4	2760.47	.035	90.43		1242.16	.0141	302.64	.0034	108.22	.0012	366.22	.0042	479.74	.0054	1193.00	.0136	304.11	.0034	1288.50	.0147	6545.91	.0747
	11841.81	.024	789.13	.0016	8403.61	.017	960.22	.002	134.34	.0003	1569.57	.003	1899.79	.004	4689.37	.009	1850.58	.0037	7564.99	.015	38422.81	.07756
	46658.30	.0237	3110.29	.0016	31737.19	.016	3794.81	.0019	160.99		4474.65	.0023	10235.71	.005	21834.58	.011	6851.33	.0035	46516.64	.023	178990.97	.0911
4 NEW MACHINES WITH ATLAS ENGINES.																						
2	2112.00	.022	110.58	.001	1408.17	.015	125.90	.001			175.00	.002	424.10	.005	452.44	.005	568.37	.006	1743.27	.018	7326.93	.078
	2347.47	.014	390.80	.002	1798.49	.011	329.52	.002	52.50		342.26	.002	383.01	.002	1493.52	.009	511.63	.003	3410.84	.020	11060.04	.065
	1712.56	.016	112.70	.001	1358.98	.013	111.19	.001	45.93		156.27	.002	242.64	.002	930.65	.009	320.99	.003	2140.26	.020	7138.02	.068
	1215.30	.015	201.93	.003	1193.40	.015	77.80	.001			199.00	.003	182.45	.002	160.00	.002	569.86	.007	1596.80	.020	5396.54	.068
	7387.33	.016	816.01	.0018	5759.04	.013	644.31	.001	98.43		872.53	.002	1232.20	.0027	3036.61	.0067	1970.85	.0039	8891.17	.0198	30921.53	.069
8 MACHINES WITH ATLAS ENGINES.																						
3	19229.14	.020	1605.14	.0017	14162.65	.015	1604.63	.0017	232.77	.0002	2442.10	.0026	3131.99	.0033	7725.98	.008	3821.43	.0038	16456.16	.0174	69344.34	.0732
8 BUCYRUS MACHINES TO DATE.																						
9	54045.63	.022	3926.30	.0016	37496.23	.015	4439.12	.0018	259.42		5347.18	.0023	11467.91	.0045	24870.69	.0112	8822.18	.0036	55407.81	.0219	209912.50	.087
OTHER MACHINES.																						
M. ON TRACTION TRUCKS, 1 CU. YD. BUCKET, 40' BOOM.— Prev. work on Mesilla Valley Canals.																						
	10354.63	.037	1839.07	.006	5484.00 Cost Distribution	.019	2802.47 on No. 1	.010 since	2277.07 May 1,	.008 1917.	658.13	.002	257.14	.001	4241.80	.015	871.43	.003	5826.69	.020	55110.83	.109
																					19787.22	
AS ON WALKING DEVICE, 45 H.P. 1 CU. YD. BUCKET, 40' BOOM.- Transfered from Carlsbad Project.																						
	1342.98	.034	98.18	.003	806.21	.021	144.54	.004	24.50	.001	41.75	.001	276.85	.007	712.38	.018	117.45	.003	790.90	.020	4398.29	.1123
																					28920.84	.093

Σ Compiled from Cost Reports.

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

TX_MSJ_002976

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

MAJOR STRUCTURES

BUILT OVER DRAINS

To Dec. 31, 1918.

Drain	Structure	Cost Previous to 1918	Cost 1918
	Mesilla Valley		
East --	3 - Steel Truss Hiway Bridges 16' x 51' each		
	Pony Trusses from Elephant Butte		
	Culvert under A.T.& S.F.R.R.		
	Rein. Concrete Box 9'-6"x12'x41'	10,963.53	
	229 c.y. Concrete		
	Culvert under 3 Saints Ditch		
	1 bl. 30"x 68' Corrugated pipe.	572.73	
Anthony --	3 Saints Desagua Flume #168 Steel -45' long 44 c. y. concrete		2238.18
Upper West -	Culvert & Check 1 bl. 36"x 60' 36 c.y. concrete		1757.28

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Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

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Drain	Structure	Cost Previous to 1918.	Cost 1918.
Franklin -	Franklin Canal Culvert Rein. concrete tile. 2 bbl. 36" x 72' 60% complete 27 cu. yd. concrete		2787.53
Clint Spur-	County Road Culvert Rein. concrete tile 1 bbl. 36" x 66' 75% complete 24.2 c. y. concrete		2206.86
	Clint Ditch Culvert Vitrified pipe 1 bbl. 18" x 84' 75% complete		571.34

TX_MSJ_002978

Records in the National Archives & Records
Administration, Rocky Mountain Region
Archival Operations

RG No. 115

El Paso Valley

Drain	Structure	Cost Previous to 1918.	Cost 1918.
Mesa -	County Highway Bridge Rein. concrete 17' long 93.2 cu. yd. concrete	6762.77	
	C.H.& S.A. Culvert Rein. concrete box 6'x 6' x 42' 105 c.y. concrete	———	5910.77
	Clint - N.Loope Highway Bridge Timber 16' x 57' 8.6 cu. yd. concrete	———	1077.34
	Salatral Flume #144 Metal 66' long 24 c. y. concrete	———	861.20
	E. Loop Highway Bridge Pony Steel Truss from Elephant Butte 16' x 51' 8.8 c. y. concrete		1111.54
Middle -	Franklin Canal Culvert 2 bbl. 30"x 72' corrugated pipe	1281.07	———
	County Bridge Timber - Concrete abutments 16' x 24' 29.8 c. y. concrete	———	1673.35
	Culvert at Sta. 355 + Rein. concrete tile 1 bbl. 36" x 66' 70% complete	———	1211.10
	Culvert under Salatral Rein. concrete tile 1 bbl. 36" x 66' 30% complete		528.94

TX_MSJ_002979

Records in the National Archives & Records Administration, Rocky Mountain Region
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RG No. 115

Drain	Structure	Cost Previous to 1918.	Cost 1918.
Franklin -	Franklin Canal Culvert Rein. concrete tile. 2 bbl. 36" x 72' 60% complete 27 cu. yd. concrete		2787.53
Clint Spur-	County Road Culvert Rein. concrete tile 1 bbl. 36" x 66' 75% complete 24.2 c. y. concrete		2206.86
	Clint Ditch Culvert Vitrified pipe 1 bbl. 18" x 84' 75% complete		571.34

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Placing forms and reinforcing steel for reinforced concrete abutment highway bridge on improved roads over drains.

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Type of bridge used on improved highways over drains. Reinforced concrete abutments on pile foundation.

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CONTRACT WORK. It was not believed that contract work could be secured as cheaply as the work could be done by government force; but, as the conditions were becoming so bad at such a rapid rate, that to satisfy a demand from certain sections of the project, especially the Upper Mesilla Valley, for more machines and to satisfy advocates of contract work, it was decided to prepare and select a location for a contract, and specifications were prepared and proposals advertised for, for the construction of 500,000 cubic yards, being the first 510 stations of the Leasburg Drain. This drain was selected because it was considered the main outlet drain for the Leasburg District and to be one of the largest. Advertisements were issued under Specification No. 378 and bids opened at El Paso on April 8, 1919, although advertisements for proposals were sent to the following persons and firms.

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ADVERTISEMENT FOR PROPOSALS FOR APPROXIMATELY 500,000 CU. YDS. OF EXCAVATION.

LEASBURG DRAIN -- RIO GRANDE PROJECT.

Station 60 to Station 510.

Sent to Following Persons and Firms.

Date of Advertisement, March 2, 1918.
Bids to be opened April 8, 1918, at 2 P. M.

Armstrong Engineering Co., Taylorville, Ill.
Howard Kenyon, 427 Commercial Bank Bldg., Houston, Texas.
W. E. Hamilton, Tocos, Texas.
Edw. F. Hass, Merchants Exchange Bldg., San Francisco, Cal.
F. B. Hugh, 341 Pacific Electric Bldg., Los Angeles, Cal.
E. S. Fuller, 2224 Live Oak Street, Dallas, Texas.
Dunbar & Sullivan Dredging Co., Dime Bank Bldg., Detroit, Mich.
Dunbie & Quinn, 1036 Stock Exchange Bldg., Chicago, Ill.
C. C. Dorr, Grand Falls, Ward County, Texas.
The Orman Construction Co., 1000 Cateret Ave., Pueblo, Colo.
J. S. McWilliams, Box 597, El Paso, Texas.
McWilliams Northern Dredging Co., 1537 McCormick Bldg., Chicago, Ill.
J. H. Boyce & Sons, Wall Lake, Iowa.
The Control States Contract Reporter, Chicago, Ill.
Ross Construction Co., Sacramento, Cal.
Jennings Construction & Engineering Co., El Paso, Texas.
Lee Moor Contracting Co., El Paso, Texas.
Elephant Butte Water Users' Association, Las Cruces, N. M.
El Paso Valley Water Users' Association, El Paso, Texas.

Project Manager.

TX_MSJ_002986

ABSTRACT OF BIDS FOR CONSTRUCTION OF
LEASBURG DRAIN, SCHEDULE NO. 1, STA. 0 TO STA. 510
Approximately 500,000 cu. yds. of Excavation
Opened at El Paso, April 8, 1918.

Name of Bidder	Unit Price per cu.yd	Total Amount 500,000 c.y.	Make of Machine	Type of Machine	Motive Power	H. P.	Traction	Size Bucket	Length Boom Ft.	Present Location	Age	Begin Work in
Jannings Construction and Engineering Co. El Paso, Tex.*	$0.105	$ 52,500	BayCity	Land Dredge	Oil Engine	35	Trucks	1 c.y.	60	BayCity Mich.	New	60 days or sooner
Lee Moor Contracting Co. El Paso, Texas	.145	72,500	Monighan	Drag line	Steam	100	Rollers	3 c.y.	75	Pittsburg Kans.	3 yrs. good	40 days
Ross Construction Co. Sacremento, Calif.	.167	83,500	Bucyrus or Austin	Drag Line	Steam Cl.14 55 HP		Rollers	2½ cy	60	Bucyrus in Calif. Austin in Ariz.	250,000 c.y. 30 days	60 days

*Alternate bid:

If we are allowed to deposit spoil on both sides of ditch after depth of cut exceeds twelve feet, our bid will be nine and nine tenths cents ($0.099) per c. y.

NOTE:

Engineer's Estimate, See January, 1918, Board Report.	.125	$62,500

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As shown by the abstract of bids, only three bids were received. Of these three only one was from a firm engaged in this particular line of contract work and hiswas the high bid. The low bidder was the Jennings Construction & Engineering Co., a local firm engaged in general construction and building work. After due consideration and consultation with Mr. Jennings, President and General Manager of the Company, the awarding of the contract to the lowest bidder, as soon as the contract with the Elephant Butte Irrigation District could be approved and right of way insured, was recommended. (See letter from Project Manager and Drainage Engineer, Rio Grande Project and Chief Construction of April 11, 1918.)

The contract with the irrigation district was confirmedby the court on _____ 1918, and approved by the Secretary on _____ 1918. On May 8th, Denver wired that Secretary had approved award of contract to the Jennings Construction & Engineering Co. and Project Manager was notified by wire on May 10th to notify the company of award of contract to them. The contract, No. 800, was executed on behalf of the United States on May 24th , 1918, and by the terms of the proposal, work was to begin in sixty days or on July 23rd. The contractors specifies that the work shall be completed in 20 months from commencement or March 23rd, 1920. The contractors' machine arrived at Mesquite during July and on the 23rd when he started to move to the work he was stopped by landowners, the right of way not having been settled. An agreement was reached with Messrs. Holt and Gorba, but right of way for the outlet had to be secured by condemnation, and the contractor was notified that he could move on August 7th, having been delayed 17 days, for which he presented a claim. He had his machine erected and began excavation on Sept. 2.

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The status of the contractor on January 31st 1919, was as shown on the following table:

CONTRACT NO.800 - LEASBURG DRAIN.

JENNINGS CONSTRUCTION & ENGINEERING COMPANY.

- To January 31st, 1919 -

PROGRESS BY MONTHS.

Sept.	1918.	1690 Ft.	7144	Cu. Yd.
Oct.	"	2300 "	11100	" "
Nov.	"	1500 "	15749	" "
Dec.	"	1500 "	21574	" "
Jan.	1919	2600 "	26332	" "
Total.		9590 "	72,899	" "

	Date signed:	Time to: Begin	Date to: Begin	Period:	Extensions Allowed	Date to Complete
Contract	May 24,18.	60 days:	July.23d:	20 mo.:	22 days	Apr. 14,1920.
Actual	" "	101	Sept.21	6 mo.28d.		
%				30.2		

	Length in miles	Excavation Cu. Yard.	Unit price per Cu. Yd.	Contractor's cost.	Contractor earned.
Contract	9.65	500,000	$1.05		$52,500.00
Actual	1.81	72,899			* 6,934.77
%	18.8	14.5			13.2

* 10 per cent deducted.

Necessary rate from February 1st, 1919 to April 14th, 1920, to complete in alloted time, 2860 ft. per month.
29,580 Cu. Yd. per month.
Which shows that the contractor will have to materially increase his rate of output to complete on time.

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Land dredge - Bay City

Excavating machine of the Hennings Construction and Engineering Company on Contract No. 800, the construction of the Leasburg Drain, Schedule 1. It is a Bay City Land Dredge, which spans the cut. It is equipped with a 3/4 cu. yd. dipper on a 60-foot boom, and operated by a 35 h. p. gas engine.

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Sand Sbredge - Bay City

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Specifications No. 376.

DEPARTMENT OF THE INTERIOR

UNITED STATES RECLAMATION SERVICE

ADVERTISEMENT, PROPOSAL, SPECIFICATIONS AND DRAWINGS

RIO GRANDE PROJECT, NEW MEXICO-TEXAS

DRAINAGE EARTHWORK

LEASBURG DRAIN

STATION 00 TO STATION 510

Proposals will be received at El Paso, Texas, until 2 o'clock P. M., April 8, 1918.

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Advertisement.

Notice to bidders.

Proposal.

Guaranty of bond.

Schedules.

Specifications:

General conditions:

1. Form of proposal and signature.
2. Proposal.
3. Certified check.
4. The contract.
5. Contractor's bond.
6. Transfers.
7. Engineer.
8. Contractor.
9. Samples or specimens.
10. Material and workmanship.
11. Delays.
12. Suspension of contract.
13. Changes.
14. Extra work or material.
15. Delays—no extra compensation.
16. Changes at contractor's request.
17. Inspection.
18. Contractor's financial obligations.
19. Experience.
20. Specifications and drawings.
21. Local conditions.
22. Eight-hour law, foreign labor and convict labor.
23. Data to be furnished by the contractor.
24. Restrictions on disposition of plant, etc.
25. Damages.
26. Character of workmen.
27. Staking out work.
28. Methods and appliances.
29. Climatic conditions.

General conditions (continued):

30. Quantities and unit prices.
31. Removal and rebuilding of defective work.
32. Protection of work and cleaning up.
33. Roads and fences.
34. Bench marks and survey stakes.
35. Right of way.
36. Sanitation.
37. Intoxicants.
38. Sub-contractors.
39. Member of Congress clause.
40. Infringement of patents.

Detail specifications:

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41. The requirement.
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47. Section of drain.
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50. Provision for raising of bottom.
51. Leveling spoil banks.
52. Structures.
53. Repair of fences, etc.
54. Non-interference with irrigation ditches.
55. Determination of claims.
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58. Berms.
59. Responsibility for damages to drain.

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ADVERTISEMENT

DEPARTMENT OF THE INTERIOR,
UNITED STATES RECLAMATION SERVICE.

WASHINGTON, D. C., *March 2, 1918.*

Sealed proposals for the construction of a drainage ditch on the Rio Grande Project, involving about 500,000 cubic yards of excavation, will be received at the office of the United States Reclamation Service, El Paso, Texas, until 2 o'clock P. M., April 8, 1918, and will at that hour be opened. The work is located near Las Cruces, New Mexico.

For particulars address the United States Reclamation Service, El Paso, Texas, Denver, Colorado, or Washington, D. C.

A. P. DAVIS,
Chief Engineer.

NOTICE TO BIDDERS

The earthwork advertised herein is covered by one schedule, and contemplates the use of one excavating machine. No proposal will be considered for only part of schedule. Early commencement of work is essential and the date of commencement stated in proposal will be given weight in awarding contract.

Each proposal must be accompanied by a certified check payable to the order of the "Director, U. S. Reclamation Service," as a guaranty that the bidder will, if successful, promptly execute a satisfactory contract and furnish bond for the faithful performance of the work, as required by paragraph 5 of these specifications, in an amount not less than 50 per cent of the estimated aggregate payments to be made under the contract, said paragraph 5 being applicable in other respects. The certified check shall be drawn in the sum of two thousand dollars ($2,000.00).

After the hour fixed in the advertisement for opening bids, no bidder will be permitted to withdraw his proposal without rendering his certified check subject to forfeiture to the United States as liquidated damages, as in case of refusal to execute contract and bond after award.

Each proposal must be accompanied by the guaranty of responsible sureties to furnish bond as required, if the proposal is accepted.

Data relative to the bidder's excavating machine and the bidder's guarantee as to commencement of work shall be stated in the blanks provided therefor in the proposal under heading of Schedule 1. Failure to do this will be sufficient cause for rejection of the proposal.

The envelope enclosing the proposal must be marked "Proposal for Drainage Earthwork, Leasburg Drain, Rio Grande Project," and addressed "United States Reclamation Service, El Paso, Texas."

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GUARANTY OF BOND

We agree to furnish bond for this bidder as required by these specifications and the regulations of the Department of the Interior, in case contract is awarded on the basis of this proposal.

Signatures and addresses of guarantors of bond

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NOTE.—The above guaranty is not a bid bond and no Internal Revenue Stamps are required in connection therewith.

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PROPOSAL

Under the Act of Congress approved June 17, 1902 (32 Stat., 388), and acts amendatory thereof and supplementary thereto, for the excavation of about 9.65 miles of the Leasburg Drain, Rio Grande Project, New Mexico-Texas.

....., 1918.

To the Director,
United States Reclamation Service,
Washington, D. C.

Sir:

Pursuant to the foregoing advertisement, the undersigned bidder herewith submits proposal on the schedule attached hereto and made part hereof, and binds himself on award by the United States under this proposal to execute in accordance with such award, a contract with necessary bond, for performing and completing the said contract within the time required and at the prices named in the specifications and in the schedule hereto annexed.

The attached advertisement, notice to bidders and specifications are hereby made part of this proposal, and all provisions thereof are hereby accepted.

The bidder furthermore agrees that, in case of his default in executing a contract with necessary bond, the proceeds of the check accompanying this proposal shall be and remain the property of the United States.

Signature.....

.....

(CORPORATE SEAL) Address.....

.....

Names of individual members of firm or names and titles of all officers of corporation

.....

.....

.....

.....

.....

.....

.....

Corporation organized under the laws of the State of .....

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Schedule 1.

LEASBURG DRAIN, STATION 0 TO STATION 510.
9.65 Miles.

Item No.	Work or Material.	Quantity and Price.	Amount
1 . .	Drain Excavation, wet and dry	500,000 cubic yards ..... (Words) ..... ($ ..... (Figures)) per cu. yd.	$ .....

If contract is awarded under this proposal the bidder proposes to do the work on this schedule with the following described equipment and force (see Paragraphs 43 and 48):

Make of machine .....

Kind of machine ..... (Dragline, dipper, dredge, etc.)

Motive power ..... (Steam, electric, internal combustion)

Rated H. P. of engine or motor .....

Kind of traction ..... (Caterpillar, walking, trucks, etc.)

Size of bucket ..... cu. yds.

Length of boom .....

Present location of machine .....

.....

Age and condition of machine .....

.....

He agrees to commence excavation work within ..... days after execution of contract by the United States.

He agrees to operate machine ..... eight-hour shifts per day.

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Approved by Department January 17, 1916.
Printed, January, 1916.

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SPECIFICATIONS.

GENERAL CONDITIONS.

1. **Form of proposal and signature.**—The proposal shall be made on the form provided therefor and shall be enclosed in a sealed envelope marked and addressed as required in the notice to bidders. The bidder shall state in words and figures the unit prices or the specific sums, as the case may be, for which he proposes to supply the material or machinery and perform the work required by these specifications. If the proposal is made by an individual it shall be signed with his full name, and his address shall be given; if it is made by a firm it shall be signed with the copartnership name by a member of the firm, who shall also sign his own name, and the name and address of each member shall be given; and if it is made by a corporation it shall be signed by an officer with the corporate name attested by the corporate seal, and the names and titles of all officers of the corporation shall be given. No telegraphic proposal or telegraphic modification of a proposal will be considered.

2. **Proposal.**—Blank spaces in the proposal should be properly filled. The phraseology of the proposal must not be changed, and no additions should be made to the items mentioned therein. Unauthorized conditions, limitations or provisos attached to a proposal will render it informal and may cause its rejection. Alterations by erasure or interlineation must be explained or noted in the proposal over the signature of the bidder. If the unit price and the total amount named by a bidder for any item do not agree, the unit price alone will be considered as representing the bidder's intention. A bidder may withdraw his proposal before the expiration of the time during which proposals may be submitted, without prejudice to himself, by submitting a written request for its withdrawal to the officer who holds it. No proposals received after said time or at any place other than the place of opening as stated in the advertisement will be considered. Bidders, their representatives, and others interested, are invited to be present at the opening of proposals. The right is reserved to reject any or all proposals, to accept one part of a proposal and reject the other, and to waive technical defects, as the interest of the United States may require.

3. **Certified check.**—Each bidder shall submit with his proposal an unconditional certified check for the sum stated in the notice to bidders, payable to the order of "Comptroller, U. S. Reclamation Service" (hereinafter styled Comptroller). Certified checks should be drawn to the Comptroller impersonally, without mentioning that officer by name. Any condition or limitation placed upon a certified check will render it informal and may result in the rejection of the proposal under which such check is submitted. If the bidder to whom an award is made fails or refuses to execute the required contract and bond within the time specified in paragraph 4, or such additional time as may be allowed by the engineer, the proceeds of his check shall become subject to deposit in the Treasury of the United States as moneys belonging to the United States, the proceeds of said check being hereby agreed upon as liquidated damages to the United States on account of the delay in the execution of the contract and bond and the performance of work thereunder, and the necessity of accepting a higher or less desirable bid resulting from such failure or refusal to execute contract and bond as required. Upon receipt thereof by the Comptroller, all checks will be deposited in the Treasury of the United States and the proceeds thereof, when due, will be returned by disbursing officer's check. The proceeds of the check of the successful bidder will be returned after the execution of his contract and the approval of his bond on behalf of the United States; and the proceeds of the checks of the other bidders will be returned at the expiration of forty-five days from the date of opening proposals, or sooner if contract is executed prior to that time.

4. **The contract.**—The bidder to whom award is made shall execute a written contract with the United States and, if bond is required, furnish good and approved bond within fifteen days after receiving the forms of contract and bond for execution. The contract shall be in the form adopted by the Reclamation Service. This form may be examined at the offices of the Reclamation Service, or copies will be furnished on request to parties proposing to bid. If the bidder to whom award is made fails to enter into contract as herein provided, the award will be annulled, and an award may be made to the bidder whose proposal is next most acceptable in the opinion of the officer of the

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United States by whom the first award was made; and such bidder shall fulfill every stipulation embraced herein as if he were the party to whom the first award was made. The advertisement, notice to bidders, proposal, general conditions, and detail specifications will be incorporated in the contract. A corporation to which an award is made will be required, before the contract is finally executed, to furnish evidence of its corporate existence and evidence that the officer signing the contract and bond for the corporation is duly authorized to do so.

5. Contractor's bond.—Unless another sum is specified in the notice to bidders, the contractor shall furnish bond in an amount not less than 20 per cent of the estimated aggregate payments to be made under the contract, conditioned upon the faithful performance by the contractor of all covenants and stipulations in the contract. Bonds in amounts less than $1,000 will be made only in multiples of $100; in amounts exceeding $1,000 and less than $5,000, in multiples of $500; in amounts exceeding $5,000, in multiples of $1,000; provided, however, that the amount of the bond shall be fixed at the lowest sum that will fulfill all conditions herein set forth. If during the continuance of the contract any of the sureties die, or, in the opinion of the Comptroller, are or become irresponsible, the Comptroller may require additional sufficient sureties, which the contractor shall furnish to the satisfaction of that officer within ten days after notice, and in default thereof the contract may be suspended by the Comptroller and the materials purchased or the work completed as provided in paragraph 12.

6. Transfers.—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

7. Engineer.—The word "engineer" used in these specifications or in the contract means the Chief Engineer of the Reclamation Service. He will be represented by assistants and inspectors, authorized to act for him. On all questions concerning the acceptability of material or machinery, the classification of material, the execution of the work, conflicting interests of contractors performing related work, and the determination of costs, the decision of the Chief Engineer shall be final, and binding upon both parties.

8. Contractor.—The word "contractor" used in these specifications or in the contract means the person, firm, or corporation with whom the contract is made by the United States. The contractor shall at all times be represented on the works in person or by a foreman or duly designated agent. Instructions and information given by the engineer to the contractor's foreman or agent on the work shall be considered as having been given to the contractor. When two or more contractors are engaged on installation or construction work in the same vicinity the engineer shall be authorized to direct the manner in which each shall conduct his work so far as its affects other contractors.

9. Samples or specimens.—The contractor shall submit samples or specimens of such materials to be furnished or used in the work as the engineer may require.

10. Material and workmanship.—All materials must be of the specified quality and equal to approved samples if samples have been submitted. All work shall be done and completed in a thorough, workmanlike manner, notwithstanding any omission from these specifications or the drawings, and it shall be the duty of the contractor to call attention to apparent errors or omissions and request instructions before proceeding with the work. The engineer may by appropriate instructions correct errors and supply omissions, which instructions shall be as binding upon the contractor as though contained in the original specifications or drawings. All materials furnished and all work done must be satisfactory to the engineer. Work, material, or machinery not in accordance with these specifications, in the opinion of the engineer, shall be made to conform thereto. Unsatisfactory material will be rejected, and, if so ordered by the engineer, shall, at the contractor's expense, be immediately removed from the vicinity of the work.

11. Delays.—If any delay is caused the contractor by specific orders of the engineer to stop work, or by the performance of extra work ordered by the engineer, or by the failure of the United States to provide material, or necessary instructions for carrying on the work, or to provide the necessary right of way, or site for installation, or by unforeseen causes beyond the control of the contractor, such delay will entitle the contractor to an equivalent extension of time, except as otherwise provided in paragraph 29. Application for extension of time must be approved by the engineer and shall be accompanied by the formal consent of the sureties, but an extension of time, whether with or without such consent, shall not release the sureties from their obligations, which shall remain in full force until the discharge of the contract. If delays from any of the above-mentioned causes occur after the expiration of the contract period no liquidated damages shall accrue for a period equivalent to such delay.

12. Suspension of contract.—If the contractor fails to begin the delivery of the material or to commence work as provided in the contract, or fails to make delivery of material promptly as ordered, or to maintain the rate of delivery of material or progress of the work in such a manner as in the opinion of the engineer will insure a full compliance with the contract within the time limit, or if in the opinion of the engineer the contractor is not carrying out the provisions of the contract in their true intent and meaning, written notice will be served on him to provide within a specified time for a satisfactory compliance with the contract, and if he neglects or refuses to comply with such notice

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the engineer may suspend the operation of all or any part of the contract, or he may in his discretion after such notice perform any part of the work or purchase any or all of the material included in the contract or required for the completion thereof without suspending the contract. Upon suspension of contract, the engineer may in his discretion take possession of all or any part of the machinery, tools, appliances, animals, materials, and supplies used on the work covered by the contract or that have been delivered by or on account of the contractor for use in connection therewith, and the same may be used either directly by the United States or by other parties for it, in the completion of the work suspended; or the United States may employ other parties to perform the work, or may substitute other machinery or materials, purchase the material contracted for in such manner as it may deem proper, or hire such force and buy such machinery, tools, appliances, animals, materials, and supplies at the contractor's expense as may be necessary for the proper conduct and completion of the work. Any cost to the United States in excess of the contract price, arising from the suspension of the contract, or from work performed or purchases made by the United States either before or after suspension, and required on account of failure of the contractor to comply with his contract or the orders of the engineer issued in pursuance thereof, will be charged to the contractor and his sureties, who shall be liable therefor. A special lien to secure the claims of the United States in the event of suspension of the contract is hereby created against any property of the contractor taken into the possession of the United States under the terms hereof, and such lien may be enforced by a sale of such property under the direction of the Secretary of the Interior, hereinafter styled Secretary, and the proceeds of the sale, after deducting all expenses thereof and connected therewith, shall be credited to the contractor. If the net credits shall be in excess of the claims of the United States against the contractor the balance will be paid to the contractor or his legal representatives. If, in the opinion of the engineer, an emergency exists for the furnishing of certain material or the performance of certain work in order to insure compliance with the terms of the contract, and if the contractor fails to furnish such material or to perform such work within a reasonable time fixed by written notice from the engineer to the contractor, then the engineer shall have the power to furnish such material or to perform such work at the expense of the contractor and his sureties, who shall be liable therefor. In the determination of the question whether there has been such noncompliance with the contract as to warrant its suspension or the furnishing of material or the performance of work by the United States as herein provided, the decision of the engineer shall be final and binding upon both parties. Suspension of the contract, or any part thereof, shall operate only to terminate the right of the contractor to proceed with the work covered by the contract or the suspended portions thereof. The provisions of the contract permitting the United States to make changes and to make proper adjustment of accounts to cover any increase or decrease of cost on account of such changes, and all other stipulations of the contract except those giving the contractor the right to proceed with work on the items covered by the suspension, shall be and remain in full force and effect after such suspension and until the contract shall have been completed and final payment or final adjustment of accounts made.

13. **Changes.**—The engineer may, without notice to the sureties on the contractor's bond, make changes: (a) in the designs or materials of machinery; (b) in the plans for installation or construction; (c) in the quantities or character of the work or material required. The changes in plans for installation or construction may also include: (a) modifications of shapes and dimensions of canals, dams, and other structures; (b) the shifting of locations to suit conditions disclosed as work progresses. If such changes result in an increase or decrease of cost to the contractor, the engineer will make such additions or deductions on account thereof as he may deem reasonable and proper, and his action thereon shall be final. Extra work or material shall be charged for as hereinafter provided.

14. **Extra work or material.**—In connection with the work covered by this contract, the engineer may at any time during the progress of the work order work or material not covered by the specifications. Such work or material will be classed as extra work and will be ordered in writing. No extra work or material will be paid for unless ordered in writing. Extra work or material shall be charged for at actual necessary cost, as determined by the engineer, plus fifteen per cent for profit, superintendence, and general expenses. The actual necessary cost will include all expenditures for materials, labor, and supplies furnished by the contractor, and in connection with the manufacture of machinery a reasonable allowance for the use of shop equipment where required, but will in no case include any allowance for office expenses, general superintendence, or other general expenses. At the end of each month the contractor shall present in writing any claims for extra work performed during that month and extra material delivered during that month and, when requested by the engineer, shall furnish itemized statements of the cost and shall permit examination of accounts, bills, and vouchers relating thereto. No such claim will be allowed which is not presented to the engineer in writing within thirty days after the close of the month, during which the extra work or material covered by such claim is alleged to have been furnished, and any such claim not so presented will be deemed to have been waived by the contractor.

15. **Delays—no extra compensation.**—The contractor shall receive no compensation for delays or hindrances to the work except when, in the judgment of the engineer, direct and unavoidable extra cost to the contractor is caused

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by the failure of the United States to provide necessary information, material, right of way, or site for installation. When such extra compensation is claimed a written itemized statement setting forth in detail the amount thereof shall be presented by the contractor not later than sixty days after the close of the month during which extra cost is claimed to have been incurred. Unless so presented the claim shall be deemed to have been waived. Any such claim, if found correct, will be approved and the amount found due as actual extra cost will be covered by the next estimate thereafter paid under the contract. The decision of the engineer whether extra cost has been incurred and the amount thereof shall be final.

16. **Changes at contractor's request.**—If the contractor, on account of conditions developing during the progress of the work, finds it impracticable to comply strictly with these specifications and applies in writing for a modification of requirements or of methods of work, such change may be authorized by the engineer if not detrimental to the work and if without additional cost to the United States.

17. **Inspection.**—All materials furnished and work done under this contract will be subject to rigid inspection. The contractor shall furnish without cost to the United States complete facilities, including the necessary labor for the inspection of all material and workmanship. The engineer, or his authorized agent, shall have at all times access to all parts of the shop where such material under his inspection is being manufactured. Work or material that does not conform to the specifications, although accepted through oversight or otherwise, may be rejected at any stage of the work. Whenever the contractor on installation or construction is permitted or directed to do night work or to vary the period during which work is carried on each day, he shall give the engineer due notice, so that inspection may be provided. Such work shall be done without extra compensation and under regulations to be furnished in writing by the engineer.

18. **Contractor's financial obligations.**—The contractor shall promptly make payments to all persons supplying labor and materials in the execution of the contract, and a condition to this effect shall be incorporated in the contractor's bond pursuant to the act of February 24, 1905 (33 Stat., 811), and acts amendatory thereof.

19. **Experience.**—Bidders, if required, shall present satisfactory evidence that they have been regularly engaged in furnishing such material and machinery and constructing such work as they propose to furnish or construct and that they are fully prepared with necessary capital, machinery, and material to begin the work promptly and to conduct it as required by these specifications.

20. **Specifications and drawings.**—The contractor shall keep on the work a copy of the specifications and drawings and shall at all times give the engineer access thereto. Any drawings or plans listed in the detail specifications shall be regarded as part thereof and of the contract. Anything mentioned in these specifications and not shown on the drawings or shown on the drawings and not mentioned in these specifications shall be of like effect as though shown or mentioned in both. The engineer will furnish from time to time such detail drawings, plans, profiles, and information as he may consider necessary for the contractor's guidance, unless otherwise provided in the proposal, agreement, or detail specifications.

21. **Local conditions.**—Bidders shall satisfy themselves as to local conditions affecting the work, and no information derived from the maps, plans, specifications, profiles, or drawings, or from the engineer or his assistants, will relieve the contractor from any risk or from fulfilling all of the terms of his contract. The accuracy of the interpretation of the facts disclosed by borings or other preliminary investigations is not guaranteed. Each bidder or his representative should visit the site of the work and familiarize himself with local conditions; failure to do so when intelligent preparation of bids depends on a knowledge of local conditions may be considered sufficient cause for rejecting a proposal.

22. **Eight-hour law, foreign labor, and convict labor.**—In all construction work eight hours shall constitute a day's work. It is expressly stipulated and agreed, in accordance with the provisions of the act of June 19, 1912 (37 Stat., 137), that no laborer or mechanic doing any part of the work contemplated under this contract, in the employ of the contractor, or any subcontractor contracting for any part of the work contemplated to be performed hereunder, shall be required or permitted to work more than eight hours in any one calendar day upon such work, under a penalty for each violation of this provision of $5 for each laborer or mechanic for every calendar day in which he shall be required or permitted to labor more than eight hours upon said work. It is further understood and agreed that any officer or person designated as supervisor or inspector of the work to be performed hereunder, or to aid in enforcing the fulfillment of the provisions hereof, shall, upon observation or investigation, forthwith report to the proper officer of the United States all violations of the provisions of the act of June 19, 1912, together with the name of each laborer or mechanic who has been required or permitted to labor in violation of this stipulation, and the day of such violation, and the amount of the penalties imposed under this stipulation shall be withheld from any moneys due or thereafter becoming due under this contract, for the use and benefit of the United States, by the officer or person whose duty it shall be to approve the payment of moneys due or thereafter becoming due hereunder, whether the

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violations of the provisions of this contract are by the contractor or subcontractor. No Mongolian labor shall be employed under this contract. The importation of foreigners and laborers under contract to perform labor in the United States or the District of Columbia is prohibited. (Sec. 3738, Rev. Stat.; U. S. Acts, Aug. 1, 1892, 27 Stat., 340; June 17, 1902, sec. 4, 32 Stat., 388; Feb. 26, 1885, 23 Stat., 332; Feb. 23, 1887, 24 Stat., 414.) In the performance of this contract no persons shall be employed who are undergoing sentences of imprisonment at hard labor imposed by courts of the several States or municipalities having criminal jurisdiction. (Executive order, May 18, 1905.)

23. **Data to be furnished by the contractor.**—The contractor shall furnish the engineer reasonable facilities for obtaining such information as he may desire respecting the character of the materials and the progress and manner of the work, including all information necessary to determine its cost, such as the number of men employed, their pay, the time during which they worked on the various classes of construction, etc. The contractor shall also furnish the engineer copies of freight bills on all machinery, materials, and supplies shipped to or from the project in connection with the work under the contract.

24. **Restrictions on disposition of plant, etc.**—The contractor shall not make any disposition of the plant, machinery, tools, appliances, supplies, materials, or animals used on or in connection with the work, either by sale, conveyance, or incumbrance, inconsistent with the special lien of the United States expressly created by this contract.

25. **Damages.**—The contractor will be held responsible for and required to make good, at his own expense, all damage to person or property caused by carelessness or neglect on the part of the contractor, or subcontractor, or the agents or employees of either.

26. **Character of workmen.**—The contractor shall not allow his agents or employees, his subcontractors, or any agent or employee thereof, to trespass on premises or lands in the vicinity of the work. None but skilled foremen and workmen shall be employed on work requiring special qualifications, and when required by the engineer the contractor shall discharge any person who commits trespass or is in the opinion of the engineer disorderly, dangerous, insubordinate, incompetent, or otherwise objectionable. Such discharge shall not be the basis of any claim for compensation or damages against the United States or any of its officers.

27. **Staking out work.**—The work to be done will be staked out for the contractor who shall without cost to the United States provide such material and give such assistance as may be required by the engineer.

28. **Methods and appliances.**—The methods and appliances adopted by the contractor shall be such as will, in the opinion of the engineer, secure a satisfactory quality of work and will enable the contractor to complete the work in the time agreed upon. If at any time the methods and appliances appear inadequate, the engineer may order the contractor to improve their character or efficiency, and the contractor shall conform to such order; but failure of the engineer to order such improvement of methods or efficiency will not relieve the contractor from his obligation to perform satisfactory work and to finish it in the time agreed upon.

29. **Climatic conditions.**—The engineer may order the contractor to suspend any work that may be subject to damage by climatic conditions. When delay is caused by an order to suspend work given on account of climatic conditions that could have been reasonably foreseen the contractor will not be entitled to any extension of time on account of such order.

30. **Quantities and unit prices.**—The quantities noted in the schedule or proposal are approximations for comparing bids, and no claim shall be made against the United States for excess or deficiency therein, actual or relative. Payment at the prices agreed upon will be in full for the completed work and will cover materials, supplies, labor, tools, machinery, and all other expenditures incident to satisfactory compliance with the contract, unless otherwise specifically provided.

31. **Removal and rebuilding of defective work.**—The contractor shall remove and rebuild at his own expense any part of the work that has been improperly executed, even though it has been included in the monthly estimates. If he refuses or neglects to replace such defective work, it may be replaced by the United States at the expense of the contractor, and his sureties shall be liable therefor.

32. **Protection of work and cleaning up.**—The contractor shall be responsible for any material furnished him and for the care of all work until its completion and final acceptance, and he shall at his own expense replace damaged or lost material and repair damaged parts of the work, or the same may be done at his expense by the United States, and his sureties shall be liable therefor. He shall take all risks from floods and casualties and shall make no charge for detention from such causes. He may, however, be allowed a reasonable extension of time on account of such detention, subject to the conditions hereinbefore specified. The contractor shall remove from the vicinity of the completed work all plant, buildings, rubbish, unused material, concrete forms, etc., belonging to him or used under his direction during construction, and in the event of his failure to do so the same may be removed by the United States at the expense of the contractor, and his sureties shall be liable therefor.

33. **Roads and fences.**—Roads subject to interference from the work covered by this contract shall be kept open, and the fences subject to interference shall be kept up by the contractor until the work is finished. 6—4839

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34. **Bench marks and survey stakes.**—Bench marks and survey stakes shall be preserved by the contractor, and in case of their destruction or removal by him or his employees, they will be replaced by the engineer at the contractor's expense, and his sureties shall be liable therefor.

35. **Right of way.**—The site for the installation of machinery or the right of way for the works to be constructed under this contract and for necessary borrow pits, channels, spoil banks, ditches, roads, etc., will be provided by the United States.

36. **Sanitation.**—The engineer may establish sanitary and police rules and regulations for all forces employed under this contract, and if the contractor fails to enforce these rules the engineer may enforce them at the expense of the contractor.

37. **Intoxicants.**—The use or sale of intoxicating liquor is absolutely prohibited on the work, except for medicinal purposes, and every such use or sale shall be under the direction and supervision of the engineer.

38. **Subcontractors.**—The contractor shall furnish the United States the name and address of each subcontractor contracting directly with him, together with statement showing the character and location of work, time limit, if any, and amount of money involved in each subcontract. Each subcontract shall contain a reference to the agreement between the United States and the principal contractor, and the terms of that agreement and all parts thereof shall be made part of such subcontract in so far as applicable to the work covered thereby. Each subcontract shall provide for its annulment at the order of the engineer if in his opinion the subcontractor fails to comply with the requirements of the principal contract in so far as the same may be applicable to his work.

39. **Member of Congress clause.**—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).

40. **Infringement of patents.**—The contractor shall hold and save the United States, its officers, agents, servants, and employees harmless from and against all and every demand, or demands, of any nature or kind, for or on account of the use of any patented invention, article, or appliance included in the material or supplies hereby agreed to be furnished under this contract, and should the contractor, his agents, servants, or employees, or any of them, be enjoined from furnishing or using any invention, article, material, or appliance supplied or required to be supplied or used under this contract, the contractor shall promptly substitute other articles, materials, or appliances in lieu thereof, of equal efficiency, quality, finish, suitability, and market value, and satisfactory in all respects to the engineer. Or, in the event that the engineer elects, in lieu of such substitution, to have supplied, and to retain and use, any such invention, article, material, or appliance, as may by this contract be required to be supplied, in that event the contractor shall pay such royalties and secure such valid licenses as may be requisite and necessary to enable the United States, its officers, agents, servants, and employees, or any of them, to use such invention, article, material, or appliance without being disturbed or in any way interfered with by any proceeding in law or equity on account thereof. Should the contractor neglect or refuse promptly to make the substitution hereinbefore required, or to pay such royalties and secure such licenses as may be necessary and requisite for the purpose aforesaid, then in that event the engineer shall have the right to make such substitution, or the United States may pay such royalties and secure such licenses, and charge the cost thereof against any money due the contractor from the United States, or recover the amount thereof from him and his surety, notwithstanding final payment under this contract may have been made. The provisions of this paragraph do not apply to articles which the contractor is required to manufacture or furnish in accordance with detail drawings furnished by the United States and included in this contract. They shall apply, however, where such drawings and the specifications cover only the type of device without restriction as to details.

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DETAIL SPECIFICATIONS

SPECIAL CONDITIONS

41. The requirement.—It is required that there be constructed and completed in accordance with these specifications and the drawings hereinbelow listed, 9.65 miles of drain, involving about 500,000 cubic yards of excavation. This work consists of one schedule, and requires the use of one excavating machine.

Schedule No.	*Cu. Yds.*	*Miles of Drain.*	*Nearest Ry. point to Sta. 00.*
1	500,000	9.65	Ft. Filmore, N. M., 2 mi.

42. List of drawings.—Location map, profile and sections, Drawing No. 1173Q45 (17,761).

43. Commencement, prosecution and completion of work.—Work shall be commenced by the contractor within the number of days stated in the schedule, after the execution of the contract on behalf of the United States, and all work shall be completed within twenty (20) months from the date of commencement of work as stated in the schedule.

The contractor shall at all times during the continuance of the contract prosecute the work with such force and equipment as, in the judgment of the engineer, are sufficient to complete it within the specified time.

44. Failure to complete the work in the time agreed upon.—Should the contractor fail to complete the work in the time agreed upon in the contract, or within such extra time as may have been allowed for delays by extensions granted as provided in the contract, a deduction of twenty dollars ($20) per day will be made for each day, including Sundays and holidays, that the work remains uncompleted after the date required for such completion. The said amounts are hereby agreed upon as liquidated damages for the loss to the United States on account of all expenses due to the employment of engineers, inspectors, and other employees after the expiration of the time for completion and on account of the value of the operation of the irrigation works dependent thereon, and will be deducted from any money due the contractor under this contract, and the contractor and his sureties shall be liable for any excess.

45. Progress estimates and payments.—At the end of each calendar month the engineer will make an estimate of the amount earned to that date, under the terms of the contract, classified and computed on the basis of the items and unit prices named in the contract. To the estimate made as above set forth will be added the amounts earned for extra work to the date of the progress estimate. From the total thus computed, a deduction of ten per cent will be made, and from the remainder a further deduction will be made of all amounts due to the United States from the contractor for supplies or materials furnished or services rendered and any other amounts that may be due to the United States as damages for delays or otherwise under the terms of the contract. From the balance thus determined will be deducted the amount of all previous payments and the remainder will be paid to the contractor upon the approval of the accounts. One-half of the ten per cent deducted as above set forth will become due and payable upon the completion of the work to the satisfaction of the engineer and its acceptance by the United States. The remaining one-half of said ten per cent shall not be paid until release shall have been executed and filed as hereinafter provided. In case of suspension of the contract, the said ten per cent shall be and become the sole and absolute property of the United States to the extent necessary to repay to the United States any excess in the cost of the work above the contract price. When the terms of the contract shall have been fully complied with to the satisfaction of the engineer, and a release of all claims against the United States under or by virtue of the contract shall have been executed by the contractor and filed with the engineer, final payment will be made of any balance due, including the percentage withheld as above stated, or such portion thereof as may be due to the contractor.

EARTHWORK

46. Classification.—All materials moved in the excavation of drains shall be classified as Class 1 material, and will be measured in excavation only, to the neat lines as shown on the drawings or prescribed by the engineer, and all materials required to be excavated will be paid for at the unit price bid for excavation.

47. Section of drains.—The sections of the drains are shown on the drawings, but the undetermined stability of the material forming the slopes of drains may make it necessary to vary the slopes and dimensions dependent thereon. Increase or decrease of quantities excavated as a result of such changes shall be covered in the estimate and shall not otherwise affect the payments due to the contractor, unless it is found by the engineer that the unit cost is thereby increased, in which case the engineer will estimate, and include in the amount due the contractor the amount of such increase. The work is intended to be done by machinery and the excavation shall be as close to the neat lines as is practicable. In general the neat lines indicate the minimum excavation. Excavation beyond the neat lines shall not exceed one foot. Projections not over six inches within the neat

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lines will be permitted provided they occur only above the water line as designated by the engineer and provided they do not in the aggregate exceed the over excavation. Payment for excavation will be made to the neat lines only as shown on the drawings or as established by the engineer.

48. Machinery to be used in the construction of drains.—All excavation under this contract shall be made with suitable machinery of a type approved by the engineer. The contractor shall fill out in the schedule the blank spaces provided, giving the required information regarding the machinery he proposes to use on the work, and the number of shifts he intends to work. Failure to supply this information may be sufficient cause for the rejection of the bid.

49. Disposal of material.—In general it will be required that the maximum feasible portion of the excavated material be placed on one side of the drain as directed by the engineer, and as shown in the drawings. Where the material in the drain consists of fine sand or other material liable to slough or run, it may not be possible to excavate the drain in the first place to full depth. In such event the contractor, if ordered in writing by the engineer, shall excavate in the first operation to partial depth and in subsequent operations to full depth, as directed by the engineer, and an allowance will be made the contractor for the cost of additional moving of machinery in both directions, as determined by the engineer, plus 15% for profit, superintendence and general expense.

50. Provision for raising of bottom.—The sufficiency of depth of excavation to the neat bottom line shown in the drawings or as ordered by the engineer shall be tested from day to day by measurement at a point from 1800 to 2200 feet back of the machine, it being left to the judgment of the contractor to excavate to extra depth to provide for natural filling in of the bottom. If the full required depth is not attained as thus measured the contractor shall remove the material above the neat bottom line before the work will be accepted, and no additional allowance will be made either for the excavation of the extra depth or for such subsequent cleaning as may be required, such work being included in the contract price.

51. Leveling spoil banks.—The spoil banks shall be partially leveled by dragging the peaks deposited with each move of the excavator with from three to five passes of the drag bucket. It is not the intention to secure a smooth topped bank, but only to improve the skyline of the bank by making it generally level. The cost of this leveling shall be included in the unit price bid for excavation.

52. Structures.—All permanent structures on the drains will be built by the United States, but the contractor must construct at his own expense any temporary structures necessary to protect the finished drain or the excavator against surface water encountered in sloughs or lakes which the drain may cut. The United States may require the contractor to place pipe, backfill culverts or otherwise assist in structure work. Such work shall be ordered in writing by the engineer, and when so ordered shall be paid for at cost, as determined by the engineer, plus 15%; breakdowns and repair time to be excluded from the determination of cost. The contractor shall be required to leave openings in the spoil banks at all existing crossings with roads and irrigation ditches unless otherwise ordered by the engineer. He shall also be required to leave openings for proposed roads or irrigation ditches when ordered in writing by the engineer. No allowance for extra work will be made to the contractor for leaving such openings or for re-excavating the spoil banks in case of failure to leave openings as provided above in the ordinary progress of work.

53. Repair of fences, telephone lines and transmission lines.—The contractor shall repair in a substantial manner and at his own expense any fences, telephone lines or electric transmission lines which are crossed by the excavator in moving to and from the drainage lines or in excavating the drain.

54. Non-interference with irrigation ditches.—The drains will cross numerous irrigation canals, and the arrangements for such crossings will be made by the United States in advance whenever possible. The contractor shall not interfere with the operation of such canals, and will not cut such canals until so ordered by the engineer. Any loss to the contractor due to unavoidable increase of labor cost while waiting for water to be turned out of such canals or for temporary structures in connection with such crossings to be installed shall be determined by the engineer and allowance therefor shall be made at cost as determined by the engineer, plus 15%, provided the contractor makes written claim therefor within ten days after the occurrence.

55. Determination of claims.—Any claim for compensation for extra work or cost of delays made in accordance with these specifications shall exclude time spent in repairing the excavator, whether such repairs are in the nature of breakdowns or general overhauling work. No claim shall be considered for any delay as hereinbefore provided, unless such delay as determined by the engineer exceeds two hours continuous working time.

56. Contractor's foreman.—The foreman or designated agent of the contractor as provided in paragraph 8 shall be understood to mean the operator of the excavator on each shift during which machine is operated and all instructions given such operator by the engineer shall be considered as having been given to the contractor.

57. Clearing right of way.—The contractor shall at his own expense remove trees, fences and brush and do all other necessary clearing work. All buildings existing on the right of way shall be moved without expense to the contractor.

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58. Berms.—The required minimum width of berms is 6 feet, as shown by the drawings, and stakes will be set to the berm line by the United States. The contractor will be required to clear these stakes with spoil bank. The face of the spoil bank on the ditch side shall not be placed on a steeper slope than 1 to 1, from the staked berm line.

59. Responsibility for damages to drain.—The contractor's liability, arising from Paragraph 32 of these specifications, as to damages caused by flood waters, waste irrigation water, natural sloughing of slopes or filling of bottom of drain due to growth of vegetation and deposit of silt, is hereby limited to a distance of 2,000 feet below the point to which ditch is completed, as determined by the engineer. Such determination shall be made on or about the first and fifteenth of each month, in accordance with Paragraph 50 and such other inspection of slopes and spoil banks as the engineer may consider necessary, and the ditch shall in no case be considered completed to a point within a minimum distance of 2,000 feet below the machine. The engineer shall notify the contractor in writing of the point to which the ditch is found to be completed upon each such determination. The limitation of liability as provided in this paragraph does not operate as a final acceptance of any portion of the work, and it is expressly provided that in all respects not herein provided Paragraph 32 remains operative, and the contractor shall protect the drain at his own expense and repair all damages occurring in the length of drain specified above.

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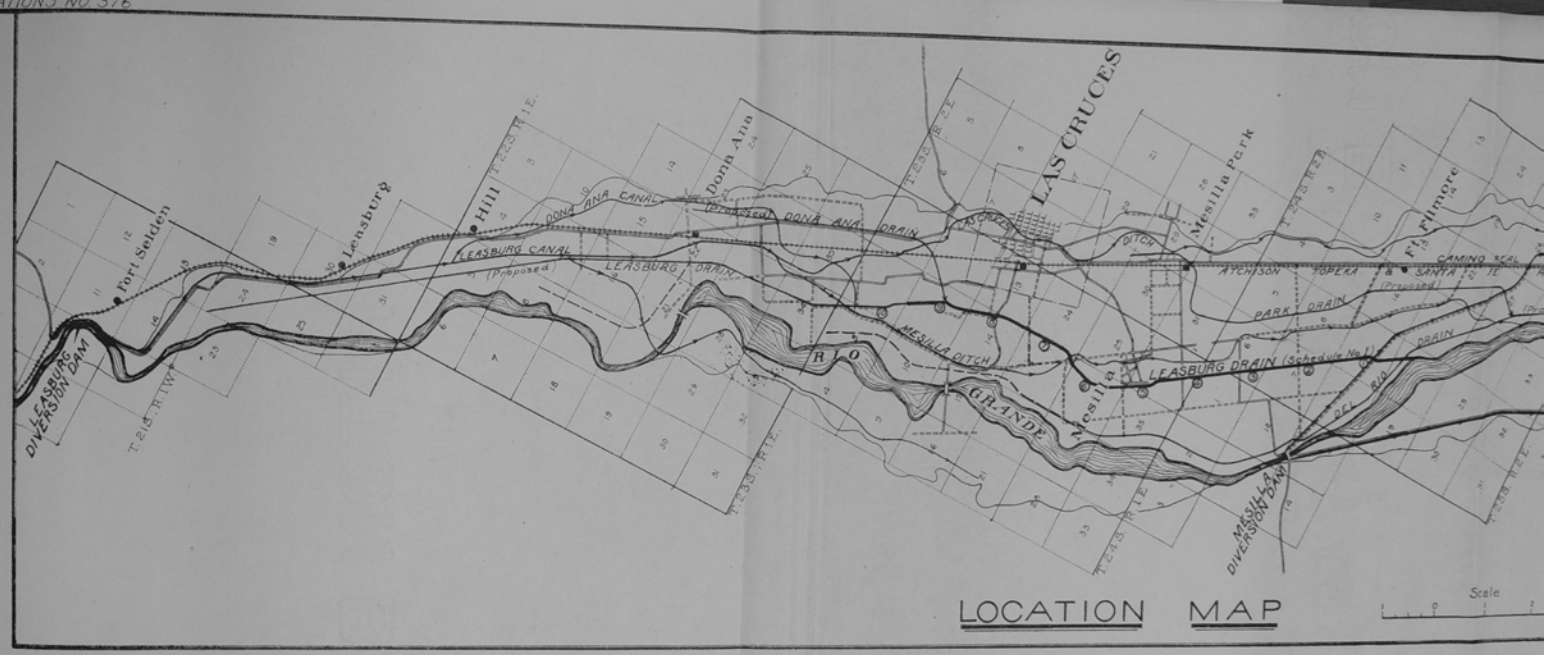

LOCATION MAP

Scale



PROFILE OF LEASBURG

SCHEDULE NO. 1 STA. 0 TO STA. 5+10

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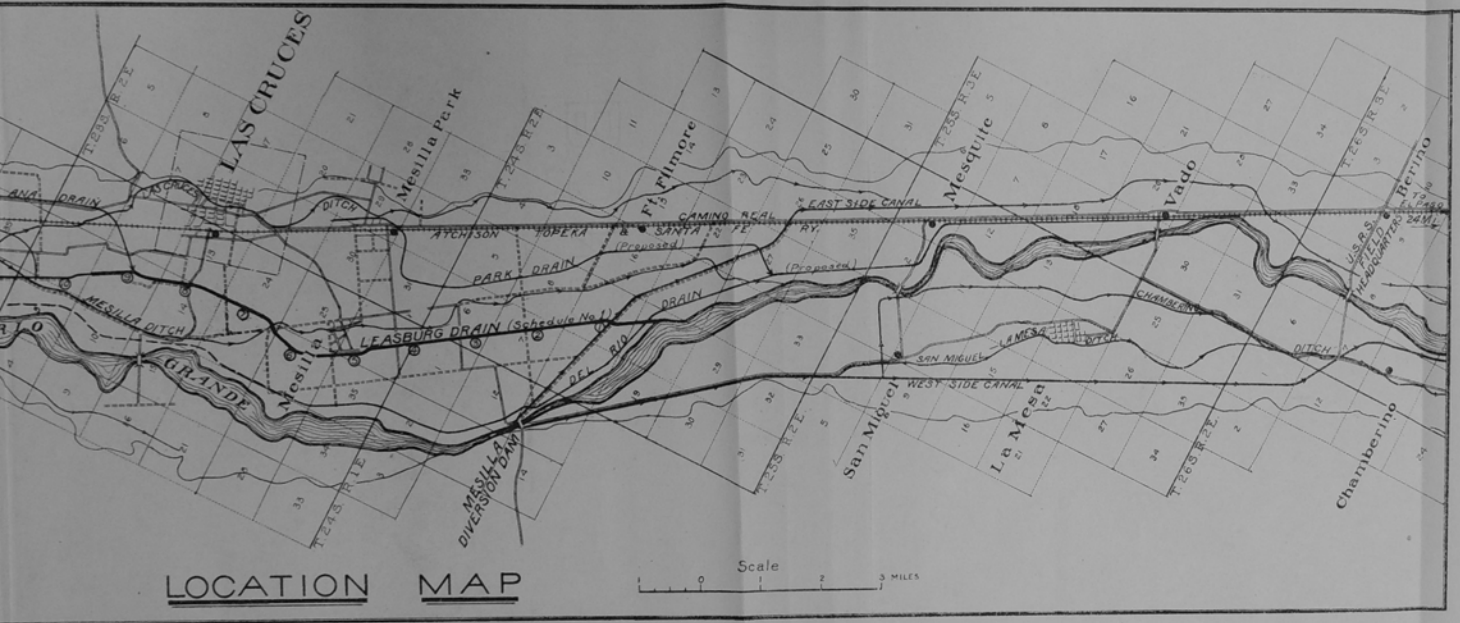
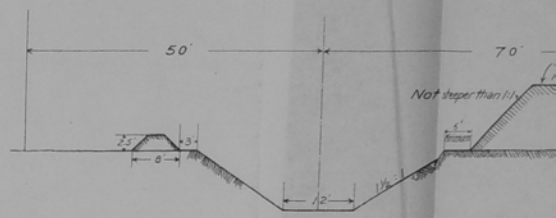
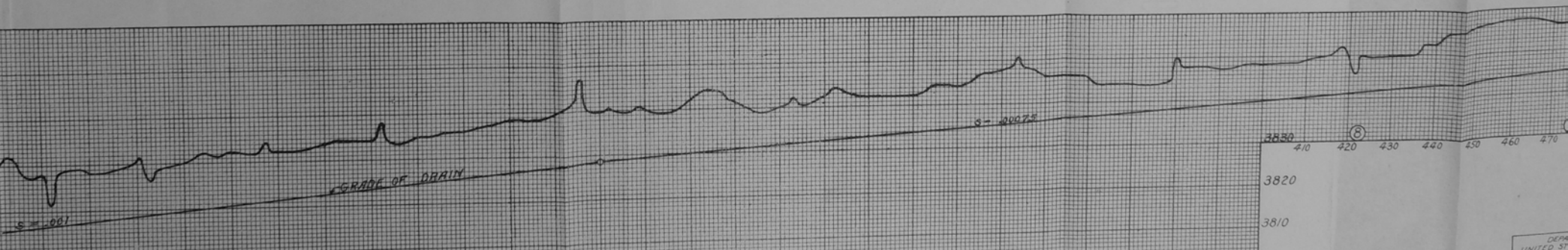


LOCATION MAP



TYPICAL SECTION
STA. 50 TO STA. 510

NOTE:—
SECTION FROM STA. 0 TO STA. 50 HAS A BOTTOM WIDTH OF 24 FEET



PROFILE OF LEASBURG DRAIN
SCHEDULE No. 1 STA. 0 TO STA. 510

DEPT. OF THE INTERIOR
UNITED STATES
RIO GRANDE PROJECT
MESILLA VALLEY
LEASBURG DRAIN
LOCATION
DRAWN BY
CHECKED
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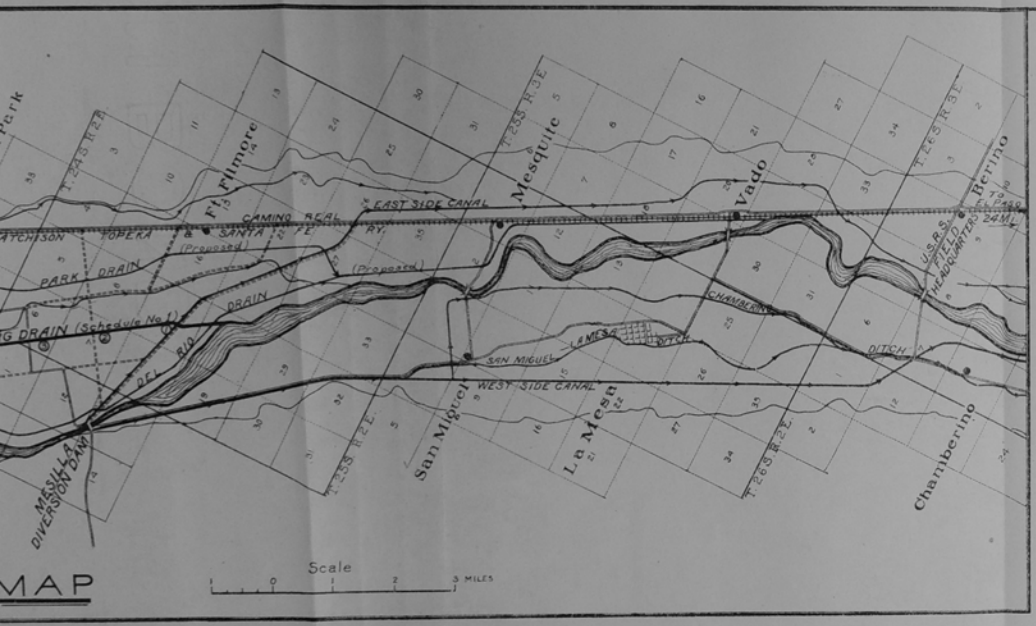
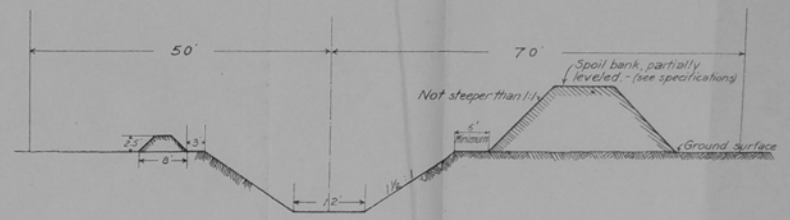


MAP



TYPICAL SECTION
STA. 50 TO STA. 510

NOTE:-
SECTION FROM STA. 0 TO STA. 50 HAS A BOTTOM WIDTH OF 24 FEET



PROFILE OF LEASBURG DRAIN
SCHEDULE No. 1 STA. 0 TO STA. 510

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE
RIO GRANDE PROJECT-N.M.-TEX.
MESILLA VALLEY DRAINAGE
LEASBURG DRAIN - SCHEDULE NO. 1.
LOCATION - PROFILES - SECTIONS
DRAWN BY L.R.F. RECOMMENDED BY L.M.L.
CHECKED APPROVED
1173 Q45 EL PASO, TEX.-FEB. 19.d 17761

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Department of the Interior
United States Reclamation Service
Rio Grande Project, N.Mex. -Tex.

DRAINAGE CONSTRUCTION SUMMARY - ENGINEER'S REPORT.

J. L. Burkholder - Engineer — YEARLY. — Year of 1918.

DRAIN	Machine No.	EXCAVATION Length MILES 1918	Length To Date Miles	Cubic Yards Cu. Yds 1918	Cubic Yards To Date	STRUCTURES - 1918 Com-plete	Wood Bridges Highwy. No.	Wood Bridges Farm No.	Flumes No.	In-lets No.	Major Structures Name
Mesilla Valley											
East	1	1.5	11.5	69,122	425,395	100	1	3	1	1	
East Cleaning	1			12,251	12,251						
Anthony	1	2.1	2.1	68,371	68,371	14		3	3		Three Saints Desagua $ 2238.18
Upper West	6	9.5	9.9	401,027	409,733	95	3	11	17	7	Culvert Sta. 1146 $ 1757.28
Cham. Outlet	6		1.7		54,693	100			1		
Trib. # 1	6	.2	2	2,251	2,251	100					
Memexas	5	6.4	7.8	292,678	332,573	40	1	8	7	1	La Union Flume $3986.37; Borderland Bridge $924.39
Vinton	5	2.6	2.6	87,362	87,362	55	1	1	3		Vinton Road Bridge $2006.37
Park	11	1.0	1.0	39,150	8						East Side Culvert $2169.81
Lower West	8	3.2	3.2	170,542	170,542	19		1		1	
La Mesa	9	2.0	2.0	105,113	105,113	16	1				
Leasburg	C	1.3	1.3	46,567	46,567	9					East Side Culvert, $3515.00
Total Valley		29.8	43.3	1,294,434	1,754,001	19	8	27	32	10	
El Paso Valley											($1077.34)
Mesa	3	9.7	16.2	428,976	705,411	64	3	14	14		G.H.&S.A.Culvert $3910.77; Clint N.Loope Bridge, Salatral Flume $861.20; N.Loope Bridge $1111.54
Middle	4 & 7	7.0	7.8	305,513	339,233	52	4	9	10		San Eliz.Bridge $1678.35; Paved Co.Road-Culvert $1211.10
											Clint Ditch Culvert $_____; Salatral Culvert $_____
Franklin	4	1.8	1.8	105,259	105,259	18	1	2			Franklin Canal Culvert
Clint	4 & 7	1.1	1.1	27,921	27,921	100	1				Paved Co.Road Culvert, $2206.86; Clint Ditch Culvert ($571.34)
River	4		2.0		95,580	XX		12			
Island	10	2.1	2.1	79,313	79,313	17					
Total Valley		21.7	31.0	946,982	1,352,717	31	8	27	24		
Total 1918		51.5		2,241,416		5	16	54	56	10	17
Tot. Previous		22.8		865,302		15	4	19	18	7	8
Tot. to Date		74.3		3,106,718		20	20	73	74	17	25
Unit Cost			$3890.0		$0.093		398.63	272.63	302.75	333.80	Concrete $23.88 per Cu. Yd. Woodwork $ 87.49 per M.B.M.

Cost per mile	$6,930.0	Excavation and Structures.
" " " estimated	350.0	For Investigations & Surveys
Total - - - - - - - - - - - -	7,280.0	Per mile

	Total Length				
	451	1710	2807	257	1918
	653	2484	3881	391	To Date

Cost

Concrete $ 11.86 per Cu.Yd.
Woodwork $ 62.90 per M.B.M.

Cement $2.95 per bbl
Lumber $20.00 to $24.00 per M.B.M
+ freight for approx $10.00
) Purchase price

MATERIAL USED

	1918	To Date
Lumber	478,739 F.M.B.	658,882
Cement	2,873 sks.	4.422
Rein. Steel	16,275 lbs	17,387
" concrete	646 cu. yds.	1,113

Add to Material Used.	1918	To Date
30" Cor. Iron Pipe	72 ft.	216
18" Vit Clay "	363 "	445
36" Rein. Con. pipe	1218 "	1218

36" Rein. Concrete Tile manufacture
Beimo 828 ft. cost $2.55 per ft.
Clint 594 ft. cost $3.46 per ft.

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DRAINAGE CONSTRUCTION COSTS COMPARED WITH ESTIMATED COSTS
To December 31, 1918.

Drain	Mach-ine No.	EXCAVATION Miles to Date	Cubic Yds. to Date	Cost per cu.yd. To Date	Cost per cu.yd. Auth. Estimate	% Com. Based on Est.	EXCAVATION AND STRUCTURE COSTS Cost per foot To Date	Cost per foot Est. for Authority	Cost per Mile To Date	Cost per Mile Est. for Authority	Total Money Spent
MESILLA VALLEY											
East	1	11.5	437,646	.108	.106	100	$1.49	$1.62	$ 7,867.20	$ 8,550.00	$ 90,447.27
Anthony	1	2.1	68,371	.152	.12	14	1.52	1.73	8,025.60	9,135.00	16,798.94
U. West	6	11.8	466,677	.085)	.12	95	1.14	2.28)	6,019.20	12,040.00)	79,013.30
L. West	8	3.2	170,542	.065)		19		2.33)		12,300.00)	
Nemexas	5	7.8	332,573	.099	.12	40	1.15	1.85	6,050.00	9,770.00	47,195.04
Vinton	5	2.6	87,362	.063	.12	55	1.22	1.75	6,460.00	9,240.00	16,797.15
Park	11	1.0	39,150	.118	.12	8	1.46	1.79	7,708.80	9,450.00	7,754.51
La Mesa	9	2.0	105,113	.069	.12	16	.93	1.98	4,895.00	10,455.00	9,787.53
Leasburg	C	1.3	46,567	.105	Contract	9	1.14	Contract	6,018.00		7,820.26
Total Valley		43.3	1,754,001	.093	.12	19	1.20	1.92	6,370.00	10,140.00	275,614.00
EL PASO VALLEY											
Mesa	2 & 3	16.2	705,411	.116	.12	64	1.55	1.96	8,184.00	10,350.00	128,844.86
Middle	4 & 7	7.8	339,233	.095	.12	52	1.44	2.00	7,603.20	10,560.00	59,772.62
Franklin	4	1.8	105,259	.091	.12	18	2.01	2.18	10,612.80	11,510.00	18,571.88
Clint	7	1.1	27,921	.127	.12	100	1.27	1.78	6,715.00	9,400.00	7,385.51
River	4	2.0	95,580	.127			1.72		9,055.00		18,123.92
Island	10	2.1	79,313	.068	.12	17	.72	1.75	3,775.00	9,240.00	6,515.52
Total Valley		31.0	1,352,717	.099	.12	31	1.46	1.93	7,715.00	10,190.00	239,214.31
Project		74.3	3,106,718	.093		20	1.31	1.93	6,930.00	10,190.00	514,828.31
Estimate of Board Report January, 1918		Excavation			.10			1.92		10,230.00	
		Contingencies			.025						
		Total			.125			unit			

Actual/cost to date equals 68% of estimated unit cost.

Cost per foot and cost per mile are total costs and include all structures and excavation plus overhead but do not include any charge for "Investigations and Surveys;" estimated cost for Investigations and surveys $350.00 per mile.

Yardage costs are excavating machine costs only and do not include any overhead but do include a plant and equipment charge of $0.023 per cubic yard.

Spent on Investigations and Surveys all districts $66,465.73 not distributed in above costs.

Total spent on Principal Feature No. 6, Drainage, $581,294.04.

$6930.00 ÷ 35000 = 7280.00 per mile = 68.7% of $10,600.00

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LEGEND

N OF EXCAVATORS DEC. 31, 1918

ONSTRUCTION PROGRESS	MILES	%
DRAINS TO BE CONSTRUCTED	135.5	75.8
ONSTRUCTED IN 1918	29.8	16.7
STRUCTED PREVIOUS TO 1918	13.5	7.5
ONSTRUCTED TO DEC. 31, 1918	43.3	24.2
ED DRAINAGE SYSTEM	178.8	100.

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LEGEND

(5) LOCATION OF EXCAVATORS DEC. 31, 1918

DRAINAGE CONSTRUCTION PROGRESS	MILES	%
PROPOSED DRAINS TO BE CONSTRUCTED	135.5	75.8
DRAINS CONSTRUCTED IN 1918	29.8	16.7
DRAINS CONSTRUCTED PREVIOUS TO 1918	13.5	7.5
TOTAL DRAINS CONSTRUCTED TO DEC 31, 1918	43.3	24.2
TOTAL PROPOSED DRAINAGE SYSTEM	178.8	100.

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DRAINAGE CONSTRUCTION PROGRESS	MILES	%
PROPOSED DRAINS TO BE CONSTRUCTED	66.5	68.
DRAINS CONSTRUCTED IN 1918	21.7	22.
DRAINS CONSTRUCTED PREVIOUS TO 1918	9.3	9.
TOTAL DRAINS CONSTRUCTED TO DEC. 31, 1918	31.0	31.8
TOTAL PROPOSED DRAINAGE SYSTEM	97.5	100.

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LEGEND

LOCATION OF EXCAVATORS DEC. 31, 1918

DRAINAGE CONSTRUCTION PROGRESS	MILES	%
PROPOSED DRAINS TO BE CONSTRUCTED	66.5	68.2
DRAINS CONSTRUCTED IN 1918	21.7	22.3
DRAINS CONSTRUCTED PREVIOUS TO 1918	9.3	9.5
AL DRAINS CONSTRUCTED TO DEC. 31, 1918	31.0	31.8
OL PROPOSED DRAINAGE SYSTEM	97.5	100.

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DEC. 31, 1918

ROGRESS	MILES	%
TRUCTED	66.5	68.2
18	21.7	22.3
s To 1918	9.3	9.5
c. 31, 1918	31.0	31.8
M	97.5	100.

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CHAPTER IX.

DRAINAGE

by

J.L.Burkholder, Engineer.

INTRODUCTION.

Drainage operations progressed throughout the year on the following units of the Project:

(1) El Paso Valley: Construction of open drains and sub surface water measurements and studies.

(2) San Elizario Island: Installation of test wells for sub surface water measurements.

(3) Mesilla Valley: Construction of open drains and sub surface water measurements and studies.

(4) Rincon Valley: Installation of test wells for sub surface water measurement.

During the year four Bucyrus, class 9 1/2, dragline operated by 93 H.P. internal combustion engines, and propelled on caterpillars, were received and placed in operation. The two steam, one yard Monaghan draglines were operated continuously on drainage construction up to July 1st., when the new Bucyrus excavators were received. At this time number two steam excavator, working in El Paso Valley was laid up and remained idle until the end of the year.

The construction of drains in both valleys progressed under authority of two contracts; one between the

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United States and the Elephant Butte Water Users' Association and one between the United States and the El Paso Valley Water Users' Association. These contracts were dated July 6, 1917 and October 13, 1917 respectively and provided that the above associations agreed to temporarily advance funds to carry on drainage construction work in the respective valleys until formal contracts could be voted by the people and approved by the Secretary of the Interior. Under provisions of these agreements the Elephant Butte Water Users' Association paid the United States $2000.00 and the El Paso Valley Water Users' Association paid the United States $2000.00

The efforts of the Water Users' to assure a broad drainage program in each valley resulted in contracts being drafted early in the year. These contracts, one covering work in the El Paso Valley and the other covering work in the Mesilla Valley, came up before the people in these Valleys for vote late in the Fall and carried by a large majority in each case.

Contract With El Paso County Improvement District # 1:

Contract voted November 17,1917; 77 votes "for", 9 "against". This contract is dated December 29,1917 and was signed by the Secretary of the Interior on March 4,1918. This contract provides for an expenditure of $500,000.00 for drainage in addition to funds in approximate amount of $51,000. spent prior to date of contract.

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Contract With Elephant Butte Irrigation District:

Contract voted on December 20,1917; result of vote, 700 "for", 27 "against". The directors signed the contract on January 7,1918 but at this date the contract has not been confirmed by the necessary court action and consequently has not been approved by the Secretary of the Interior.

This contract provided for an expenditure of $1,400,000. on drainage, within the district, in addition to such sums as may have been expended before date of contract. It also provides for an expenditure of $100,000. on flood protection work.

INVESTIGATION OF GROUND WATER CONDITIONS

Test Wells: In order to provide ready means of making ground water measurements numerous test wells have been placed in the various units of the project. These wells consist of ten foot lengths of 1 1/2 inch black wrought iron pipe fitted with standard pipe cap to keep out rocks and sticks, placed in rows or lines at approximately right angle to thread of valley. Recent experience with this pipe has proved the desirability of perforating the lower one half of pipe and pipe more recently installed has been thus perforated with two rows of 1/4" holes, each hole 6" apart and holes staggered.

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RECORD OF TEST WELLS INSTALLED

Unit	1917	1916	1915	1914	1913	Totals
El Paso Valley	110		23		286	419
San Elizario Island	109					109
Mesilla Valley	77	97	312	59	138	683
Montoya		114				114
Rincon Valley	164					164
Totals	460	211	335	59	424	1489

With the exception of the Val Verde District in El Paso Valley, the Pecacho District in Mesilla Valley and approximately two lines on the Island, the entire present boundaries of the project are covered with these test wells.

Measurements have been made every two months during the past year and a small party has been engaged on well measurement and installations during the entire year.

Ground Water Sections: The record of ground water measurements has been kept for each year on profile sections showing the various water readings referred to datum elevation and platted with reference to the ground surface. These sections are the basis of ground water studies and are used as an aid to the location of drains.

Seeped Areas: The ground water measurements referred to above

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have been utilized to determine the extent of seeped areas on the various units of the project. Topography maps on scale of 500' equals 1" had been previously prepared for other project purposes. Ground water measurements based on the June 1917 readings were platted on the topographic sheets and these readings served as basis for ground water contours which in turn were utilized, together with the surface contours, for establishing the seeped areas and other areas dangerously affected by ground water conditions.

Convenient color schemes were used on these maps to set out the areas covered by surface water, the areas having ground water from zero to two feet below the surface and the areas having ground water from two to four feet below the surface. The areas as this determined are listed herewith:

El Paso Valley Exclusive of Val Verde District and Island

Total Gross Area	Depth to Ground Water below Surface									
	On Surface:		0 to 2 Ft:		2ft to 4ft:		Total less than 4 ft.:		Total more than 4 ft.	
Acres	Acres:	%	Acres:	%	Acres:	%	Acres:	%	Acres:	%
45,096	2045	4.5	8802	19.5	20251	45	31098	69.0	13998	31.0

Estimate of Areas Reclaimed by Drainage

Division	1917		To Date		
	Area reclaimed	Area protected	Area reclaimed	Area protected	Area still seeped
El Paso Valley	2,695	965	5,289	1267	26,542
Mesilla Valley	4,020		4,150		54,564
Montoya*	1,304		1,304	1090	1,643

* Small drain constructed in this district by land owners.

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* District now taken over by Government.

Mesilla Valley

Exclusive of 9000 acres in River Bed and Picacho & Montoya Districts.

Total Gross Area	Depth to Ground Water below Surface									
	On Surface		0' to 2'		2' to 4'		Total less		Total more	
Acres	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
88,685	3800	4.3	16093	18.1	38821	43.8	54714	61.9	29971	33.8

The seepage conditions as shown by the above tables for June 1917 is representative of about the average condition throughout the irrigation season. The water readings for the month of April were slightly higher than the June readings in some localities, principally the non-irrigated areas and the August or October readings were slightly higher than the June readings in other localities.

It may be also stated that the seepage conditions on San Elizario Island are now known to be worse than the average, as shown above, for El Paso Valley and that the average conditions in Rincon Valley will closely approximate the average conditions, as shown above, for Mesilla Valley.

Alkali:

Seepage conditions, as set out above, are of course greatly intensified by the rise of alkali salts which exists to such an extent in both valleys as to render practically all shallow water impotable. In general these salts have already collected on the surface of areas having ground water within approximately two feet or less, to an extent that makes

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cultivation totally unprofitable. Surface conditions as regard alkali, vary considerably, however, due to soil conditions and the effort made by individual farmers to combat the menace. Thus tracts of land lying fallow are frequently white with salts and incapable of any production while adjacent tracts with similar ground water conditions are still producing fair crops. This collection of alkali salts on the surface will increase quite rapidly until the ground water is lowered by deep drains.

Location of Drains

The necessity for comprehensive drainage in both the El Paso Valley and the Mesilla Valley was set out in a report made in February 1917, by a Board of Engineers. This report also discussed locations for drains and outlined various river outlets in a preliminary way, based on the data then available. No general plan for drainage was developed, however, until the later part of the year and location work was confined to a continuation of drains under construction and to the additional lines necessary for the employment of the four excavators received in July.

The ground water data was utilized for various studies of drain locations later in the year with the idea of securing a general plan with estimates of cost covering the proposed work. It was fully realized that such plans would be subject to change with the collection of additional data on the effect of drains under

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construction.

The project large scale topographic maps when combined with the ground water data afforded excellent means for making paper projections and comparative estimates and by these means a tentative drainage plan complete for each valley had been developed at the close of the year.

Field locations were carried on for the period from January to August by one field party operating partly in each valley. This party was under the direction of Mr. W. C. Schafer and it accomplished location work on the East Drain and the Montoya Drain in the Mesilla Valley and the Mesa, River and Middle Drains in the El Paso Valley. In July a party was borrowed from the lateral location forces to locate the lower end of the Nemaxas Drain preparatory to starting one of the new draglines.

During August it was decided to establish field headquarters at Clint, Texas for work in El Paso Valley and at Berino, New Mexico for work in Mesilla Valley. A field party was organized the same month for Mesilla Valley work under the direction of Bryan Brown. This party, working from Berino camp, continued location work throughout the remainderof the year and upon the resignation of Mr. Brown in November the work was continued under the direction of C. M. Ainsworth.

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Construction of Drains

Plans for drainage provide for open drains of approximately ten feet average cut, 1 1/2 to 1 side slope and minimum base width of ten feet. The spoil bank is placed entirely on one side of the cut except in places where it is necessary to go over the drain a second time in order to attain the necessary depth of cut.

The materials encountered are sandy loam and sandy clay overlying the water bearing fine sands which vary from "quicksand" to "medium". At rare intervals pockets of medium coarse sand are encountered at grade depth and frequently the bulk of the cut is medium fine sand.

Dragline excavators are being used exclusively for this excavation work. In July four class 9 1/2 Bucyrus machines with 50 foot booms, 1 1/2 cu.yd. buckets and caterpillar tractors were received. These machines are operating by 93 H.P. internal combustion engines and in this respect these machines were of untried design. After erection these machines were moved some distance to their work and actual excavation was begun with all machines between the period from July 22nd. to August 25th.

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Progress of Excavation by Units

Division	1917 Miles exc.	1917 Cu.yds exc.	Prior to 1917 Miles exc.	Prior to 1917 Cu.Yds exc.	Total to Jan. 1st. 1918. Miles exc.	Total to Jan. 1st. 1918. Cu.yds. exc.
El Paso Valley	6.9	317,911	2.4	87,824	9.3	405,735
Mesilla Valley	8.8	322,708	4.7	136859	13.5	459,567
Montoya*	6.7	110,000			6.7	

*Excavation is approximate. Work done by landowners.

Progress of Excavation by Drains

Name of Drain	Mach. No.	lineal ft.exc	cu.yds Excav.	Width: base	Av. cut	Sta. to Sta.
River	4	10445	95580	24:	8.0:	0-00 to 104-45
Mesa	2	7110	73908	12:	9.0:	122-30 to 193-40
Mesa	3	15125	112427	12:	9.0:	193-40 to 344-65
Middle	4	4405	33720	10:	10.0:	0-00 to 44-05
Total to El Paso Valley		37085	315635			
East	1	27680	213414	12:	10.0:	250-00 to 526-80
Menaxas	5	7600	43465	30:	5.5:	0-00 to 76-00
Chamberion Outlet	6	8800	54693	30:	5.5:	0-00 to 88-00
West	6	1960	25219	12:	3.5:	687-00 to 706-60
Montoya	Bay City	55400	110000	8:	6.0:	0-00 to 554-00
Total Mesilla Valley		81440	446791			
El PasoValley		37085	315635			
Mesilla "		81440	446791			
Grand Total		118525	762426			

Efficiency of Excavators: Considerable trouble developed immediately upon commencement of excavation with the new machines. The design of the clutches operating the swinging machinery and also the main engine clutch, which was of similar design, proved defective and the engine developed insufficient power to operate at the designed speed. Later

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serious engine trouble developed due to variable loads and overloads. Connecting rod bearings had to be taken up as often as every twenty four hours and the main engine bearings each three or four days. Bearings were runined because of excessive heat and other troubles of a minor but very troublesome character appeared.

The Bucyrus Co. sent a representative to the field later in August and it was then decided to slow the machine operation by increasing the gear ratio and make other minor alterations. Clutch difficulties were solved locally to an extent to make operation possible.

Later, through the experience of the more serious engine troubles, it was learned that kerosene fuel was wholly unfit for use with these engines due to the variable load conditions with insufficient regulation of the fuel. The cylinders flooded from above causes and it was impossible to maintain good lubrication, due to the free kerosene which escaped part of the cylinders into the crank case. The use of kerosene as fuel, which use had been recommended by the manufacturers, was abandoned at the close of the year, for a high gravity distillate.

At the close of the year it was realized that in order to secure successful operation from the machines it would be necessary to so greatly reduce the operating speed that it would be economical to secure a more powerful engine.

The work of the small one yard Monaghan steam excavators was quite satisfactory considering the fact that these

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machines are too small for the ditches being excavated and that water conditions are very unfavorable. Boiler water is secured either direct from the river or through canals and laterals.

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MACHINE EFFICIENCY 1917

	Machine # 1		Machine # 3		Machine # 4		Machine # 5		Machine # 6	
	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%
Digging	1140.00	47.0	883.00	35.0	1032.25	35.0	410.75	32.0	494.25	29.0
Moving up	267.00	11.0	138.25	5.0	84.00	3.0	46.75	4.0	230.25	14.0
Motive power	262.00	11.0	703.00	28.0	1032.25	35.0	383.75	29.0	524.50	31.0
Traction Machine	52.50	2.0	6.75	--	55.50	2.0	37.50	3.0	11.00	1.0
Machine proper	251.75	10.0	420.25	17.0	601.50	20.0	294.00	23.0	275.25	16.0
Fuel, W.& Pow'r.	255.00	10.0	8.75	--	24.00	1.0	14.00	1.0	17.00	1.0
Insp'n. & Oiling			13.00	1.0	2.00		3.75			
Sun. & Holidays	64.00	3.0	64.00	3.0	64.00	2.0	40.00	3.0	60.00	3.0
Struct.	54.00	2.0								
Miscellaneous	93.75	4.0	267.00	11.0	72.00	2.0	66.50	5.0	73.25	4.0
Total	2440.00	100.0	2504.00	100.	2976.00	100.	1296.00	100.	1696.00	100.

Excavator	Lin. ft.	cu. yds.
Machine # 1	12,110	95,751
Machine # 3	14,945	118,427
Machine # 4	14,750	129,300
Machine # 5	7,600	43,465
Machine # 6	15,312	62,492

Machine # 1 is a one yd. steam, Monighan, dragline.
Machine #s 3, 4, 5, and 6 are 1 1/2 yard, gas engine driven, class 9 1/2 Bucyrus dragline.
Both tables cover results from July 1st to December 31st inclusive.

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Machine Shop: In connection with the operation of the dragline excavators a machine shop is being operated in El Paso under the same roof as the project storehouse. This shop is equipped with a lathe, radial post drill, air hammer, power saw, post grinder, welding outfit and the necessary smaller tools and equipment.

This shop employes a blacksmith and helper, and a machinist and helper, and in addition to the drainage work handles all usual project repair work.

Structure work: Two structure crews have been regularly employed; one in each valley with headquarters at Clint, Texas and Berino, New Mexico, respectively. These crews have installed the necessary structures, bridges, flumes, fences and culverts as required by the construction of drains.

In general metal type flumes with concrete inlet and outlet have been employed. Temporary flumes are constructed either of timber or metal with wooden outlet and inlet. See plan.

Timber Bridges of the three span type were regularly constructed for both highway and private crossings. More permanent bridges were provided on improved and surfaced highways. Several such crossings were provided with steel trusses 50 feet span, the steel utilized being used steel transferred from the Elephant Butte construction.

Structures of all kinds are comparatively expensive because of the lack of good foundation, materials and the quicksand usually encountered at grade depths. Mud sill fast-

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Archival Operations

RG No. 115

ings are impracticable and the common practice is to provide footings by jetting in ten foot lengths of r o u n d timber piling.

TX_MSJ_003032

DRAINAGE CONSTRUCTION SUMMARY
RIO GRANDE PROJECT
1917.

DRAIN		Mach. No.	EXCAVATION Length miles	cu. yds.	%Comp.		STRUCTURES Bridges Highway	Bridges Farm	Flumes No.	Inlets No.	Major Structures
MESILLA VALLEY											
East	1917:	1	5.3:	219.414		Began April 27,1916 continues to date.	3	2	4	6	3 steel Bridges;A.T.&S.F.culvert, Three Saints Culvert #5.
Chamberino	todate:		10.0:	356,273	33						
	1917:	6	1.7:	54,693		Began August 25,1917 to West Drain in Nov.'17.Part reconstructed in December 1917 .	3	11	9	7	5 structures.
							1				L2 Timber culverts, Temporary.
Outlet(Temp)	todate		1.7:	54,693	100						
West	1917:	6	0.4:	8,706		From Chamberino Outlet in Nov.& December 1917 to date.	1				
	todate:		0.4:	8,706	0.7						
Tornillo	1917:	5	1.4:	39,895		Began August 25,1917 to date					
	todate:		1.4:	39,895	2.4						
VALLEY	1917:		13.5:	322,708			4	2	4	6	5
	todate:			459,567	5.3		4	11	9	7	5
EL PASO VALLEY											
Vinton	1917	2	4.2:	188,610		Began May 26,1916 to July 1st,'17: Westback to construct Franklin Canal Desagua.Sept. Oct. 1916		3	5		1 G.H. & S.A. R.R. Culvert.
		1									Bed near Fabens.
	todate:	3	6.5:	276,434	25.	July 1st,1917 to date - #3		6	8		2-G.H. & S.A. R.R.Culverts &Co.Road/
River	1917:	4	2.0:	95,580		Began July 25,1917 Branched off to Middle Drain Dec.1,1917		2	1		
	todate:		2.0:	95,580	30			2	1		
Middle	1917:	4	0.8:	33,720		Branched for River Drain Dec.1, 1917 to date.	1				1 Cor. Pipe culvert. Franklin Canal.
	todate:		0.8:	33,720	5		1				Both tap. " " " " .
Valley	1917:		9.3:	317,910			1	5	6		2
	todate:			405,734	9		1	8	9		3
PROJECT											
TOTAL	1917:			640,618			5	7	10	6	7
	todate:		22.8:	865,302	5.6		5	19	18	7	8

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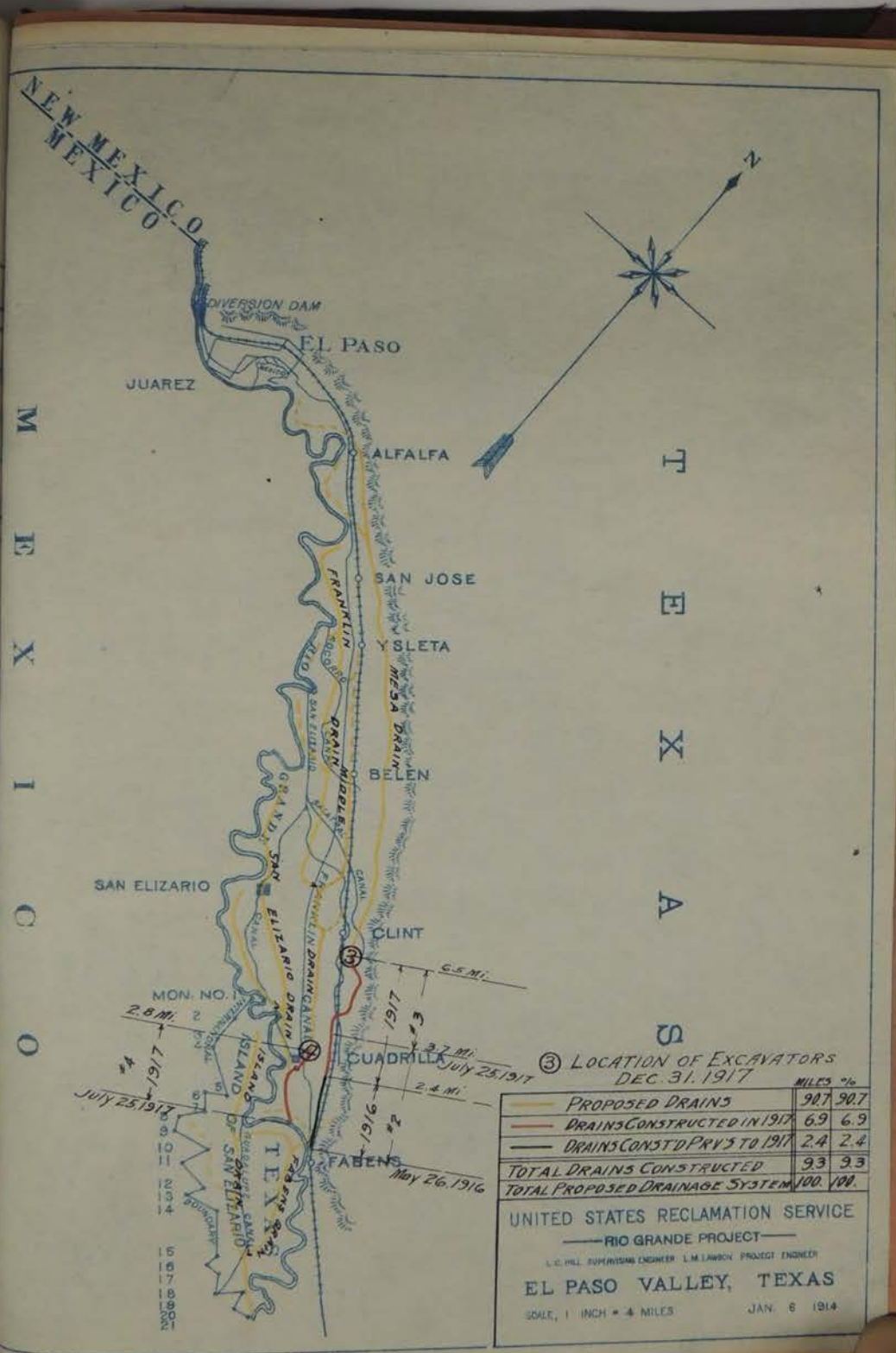

③ LOCATION OF EXCAVATORS DEC. 31. 1917

	MILES	%
PROPOSED DRAINS	90.7	90.7
DRAINS CONSTRUCTED IN 1917	6.9	6.9
DRAINS CONSTD PRYS TO 1917	2.4	2.4
TOTAL DRAINS CONSTRUCTED	9.3	9.3
TOTAL PROPOSED DRAINAGE SYSTEM	100.	100.

UNITED STATES RECLAMATION SERVICE
—RIO GRANDE PROJECT—
C.C. HILL SUPERVISING ENGINEER L.M. LAWSON PROJECT ENGINEER
EL PASO VALLEY, TEXAS
SCALE, 1 INCH = 4 MILES JAN. 6 1914

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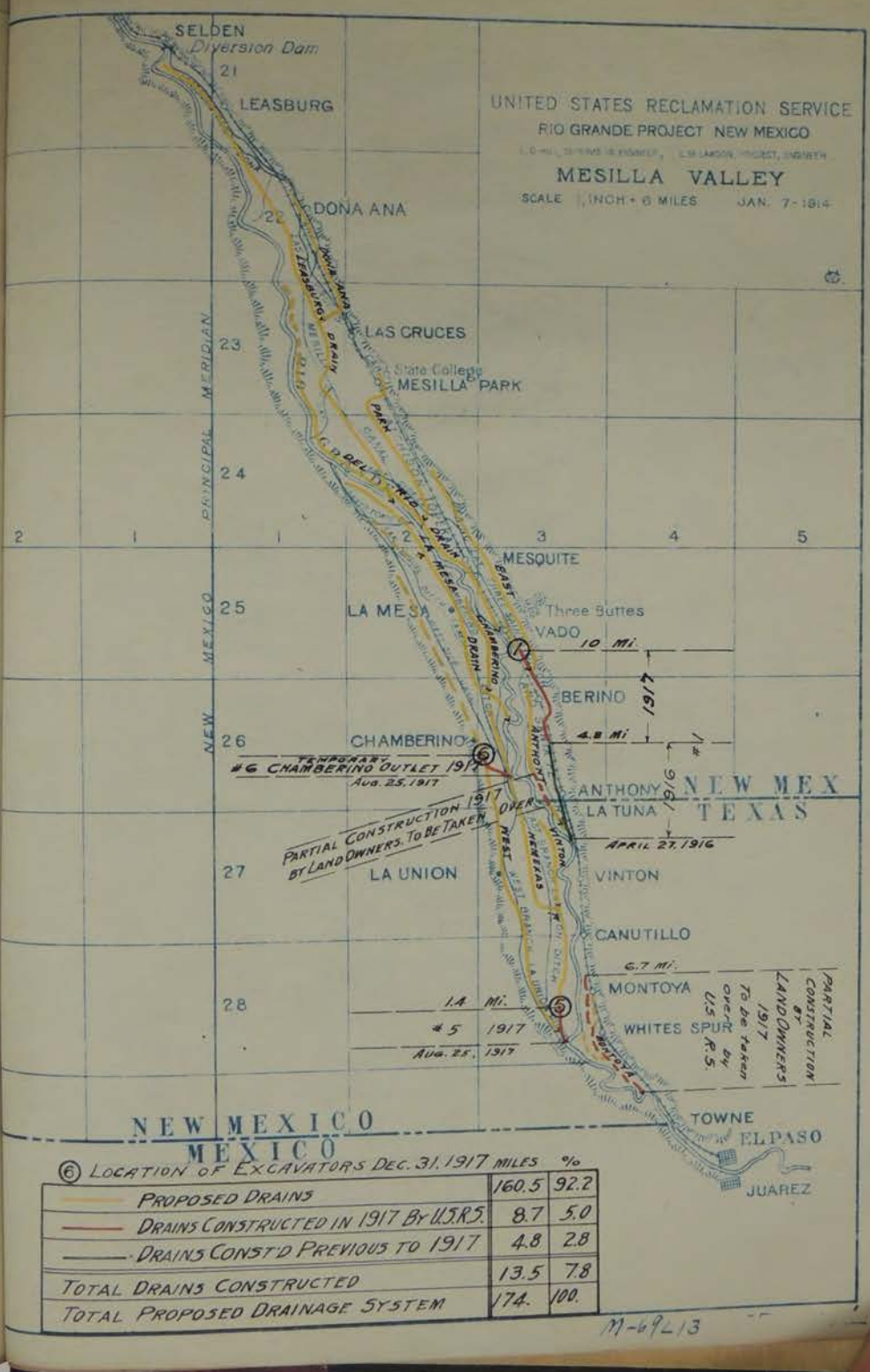

⑥ Location of Excavators Dec. 31. 1917	miles	%
Proposed Drains	160.5	92.2
Drains Constructed in 1917 By U.S.R.S.	8.7	5.0
Drains Const'd Previous to 1917	4.8	2.8
Total Drains Constructed	13.5	7.8
Total Proposed Drainage System	174.	100.

M-69L13

RIO GRANDE PROJECT N.M.-TEX.

DRAINAGE ORGANIZATION

MONTH OF DECEMBER 1917

DRAINAGE ENGINEER
J. L. Burkholder

FORD CAR # 15

IN CHARGE OF: INVESTIGATIONS | SURVEYS | CONSTRUCTION

MESILLA VALLEY

U.S.R.S. CAMP (HEADQUARTERS)
Mrs. Lipps

BERINO HEADQUARTERS
FIELD ENGINEER
C. M. Ainsworth

FORD CAR #

SUPPLY TRUCKS (G.M.C. TRUCK) 18
Ben Stevens — DRIVER

STRUCTURES
FOREMEN
R. Hunt
CARPENTERS
LABORERS
CARPENTERS
LABORERS

FORD TRUCK # — DRIVER

ENGINEERING ON CONSTRUCTION

SURVEYS
CHIEFS OF PARTY
J. R. Kirby
DRAFTSMAN
SURVEYMEN

FORD CAR # 13
FORD CAR #

COST KEEPING
TIMEKEEPER
W. F. Welch
STOREKEEPER
ASSISTANTS

EL PASO OFFICE
ASS'T. ENGINEER
L. R. Flock
RECORD MAN
F. W. Slattery
DRAFTSMEN

Well Reader
S. A. Colwell Ford #10

EL PASO VALLEY

FORD CAR #

CLINT HEADQUARTERS
FIELD ENGINEER
F. C. Schafer-Act.

NO CAMP
PRIVATE BOARD & LODGING

COST KEEPING
TIMEKEEPER
R. Gambrell
STOREKEEPER
ASSISTANTS

SURVEYS
CHIEFS OF PARTY
F. Schafer
DRAFTSMAN
SURVEYMEN

FORD CAR # 1
FORD CAR #

ENGINEERING ON CONSTRUCTION

STRUCTURES
FOREMEN
R. Griffin
CARPENTERS
LABORERS
CARPENTERS
LABORERS

FORD TRUCK # — DRIVER

SUPPLY TRUCKS (G.M.C. TRUCK) 17
P. Wuerschmidt — DRIVER

MASTER MACHANIC
N. E. Fordham

FORD CAR # 16

OPERATION

DRAGLINE No 1
CHIEF OPERATOR
C. Austin
OPERATORS
Cross
ENGINEMEN
LABORERS

DRAGLINE No 5
CHIEF OPERATOR
Jennerion
OPERATORS
Jonsoni
Jameson
ENGINEMEN
LABORERS

U.S.R.S. CAMP & MESS

DRAGLINE No 6
CHIEF OPERATOR
O' Bryan
OPERATORS
Dixon
Ross
ENGINEMEN
LABORERS

EL PASO MACHINE SHOP
MECHANICS
MACHINISTS
BLACKSMITHS
HELPERS

EL PASO WAREHOUSE
STOREKEEPER IN CHARGE
COSTKEEPING
TIMEKEEPING

DRAGLINE No 3
CHIEF OPERATOR
Montgomery
OPERATORS
Reeves
Schook
ENGINEMEN
LABORERS

DRAGLINE No 4
CHIEF OPERATOR
Gale
OPERATORS
Grover
Clow
ENGINEMEN
LABORERS

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RG 115 RECORDS OF THE BUREAU OF RECLAMATION

General Administrative and Project Records, 1919-1945

General Files, 1919-1929

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302.31 New Mexico Report dated June 1919 by Conkling & Dobler on Water Supply for & Possible Developments on Irrigation & Drainage Projects on the Rio Grande River above El Paso, Texas Transmitted by letter July 15, 1919

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SPECIAL

WATER SUPPLY FOR

and

POSSIBLE DEVELOPMENT

of

IRRIGATION AND DRAINAGE PROJECTS

on

THE RIO GRANDE RIVER

above

EL PASO, TEXAS

- - -

June - 1919

Special

JUN 23 55528
JUL 18 19 601

Harold Conkling,
Engineer.
and
Erdman Debler,
Asst. Engr.

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WATER SUPPLY FOR

and

POSSIBLE DEVELOPMENT

of

IRRIGATION AND DRAINAGE PROJECTS

on

THE RIO GRANDE RIVER

above

EL PASO, TEXAS

- - -

June - 1919

Harold Conkling,
Engineer,
and
Erdman Debler,
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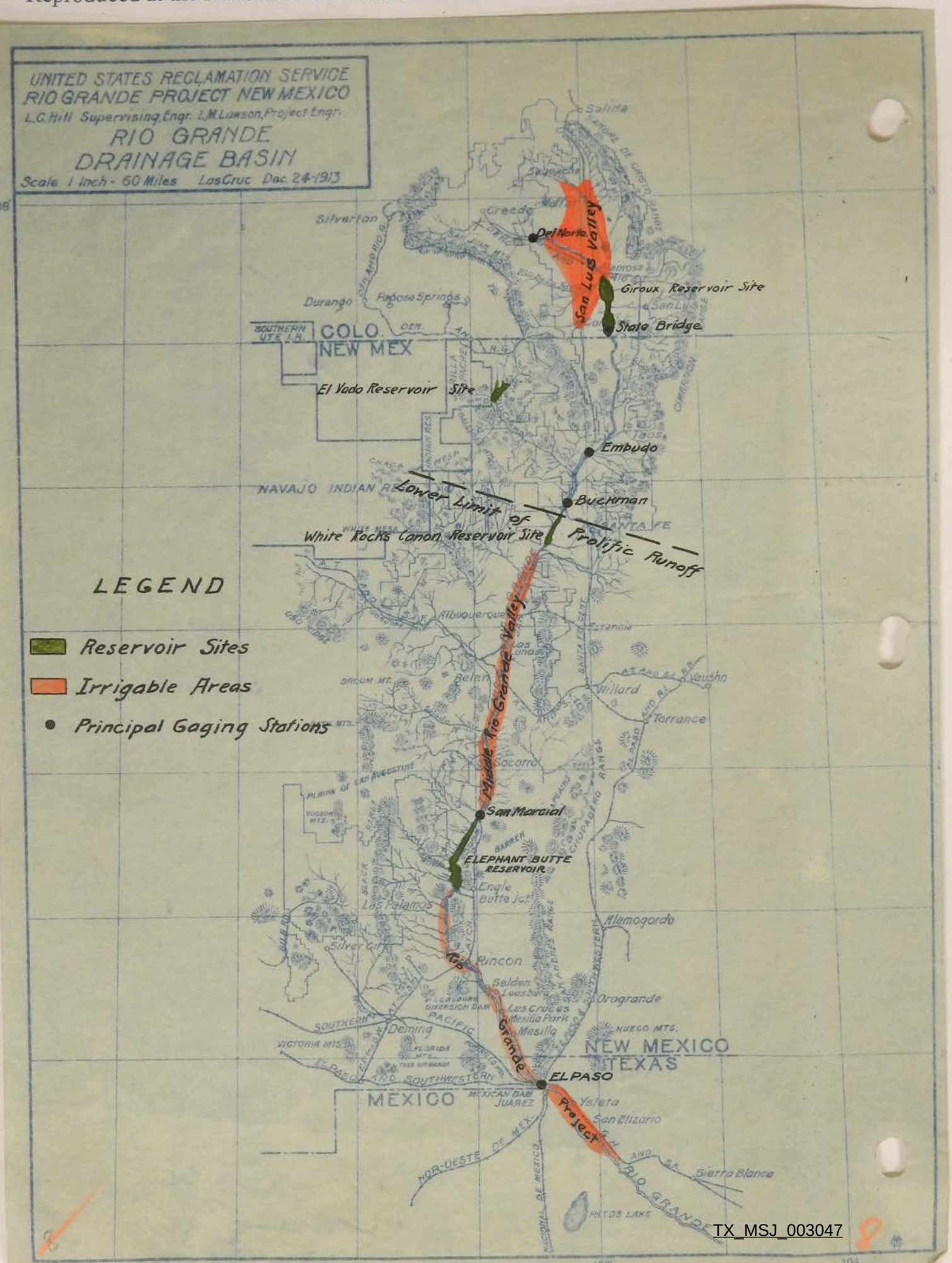

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PART I.

THE RIO GRANDE VALLEY

Introduction

---

1. This report presents the results of a study of water supply for possible irrigation development on the Rio Grande River from its headwaters in Colorado to the Rio Grande Project of the government in the vicinity of El Paso, Texas. The study has been limited to this portion of the river, which approximates 600 miles in length, because the Rio Grande Project exhausts the entire flow of the river which reaches that point and therefore may be considered the end of the upper portion of the river.

Previous Reports

2. Previous reports having to do with this portion of the river, in general, and which have been consulted in preparing this report are as follows:

TABLE I.

Index	Title	Year	Author	Dept.
a	Equitable distribution of the waters of the Rio Grande.	1896	W.W.Follett	State
b	Ground Waters in the Rio Grande Valley, W.S.141.	1905	C.S.Slichter	USGS.
c	Water Resources of the Rio Grande Valley in New Mexico, W.S. 188	1907	W.T.Lee	"
d	Silt in the Rio Grande	1915	W.W.Follett	State.
e	Profile surveys of Rio Grande, N.M: W.S.421.	1916	W.D.Henon	USGS.

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General Description

(See Frontispiece)

3. "The Rio Grande rises near the crest of the Continental Divide on the eastern slope of the San Juan Mountains in southern Colorado at an elevation of approximately 12,500 feet above sea level, takes a general southeasterly course and discharges into the Gulf of Mexico near Brownsville, Texas". Except for the first 100 miles, the course in the portion under consideration in this report is almost directly south. "From its source, the river follows an easterly course through a narrow canyon-like valley nearly to Del Norte, Colorado, where the steep sides of the valley recede to enclose the large, level, park-like region known as the San Luis Valley, which extends for 150 miles from north to south and has a maximum width of 50 miles, and through which the river flows for the most part between low banks and above the level of the surrounding country. From Del Norte, the course is southeast to Garland Junction, 100 miles below its extreme headwaters, and just below Alamosa, the principal town of the valley, where it becomes southerly. Below Alamosa the river drops below the level of the country and diversions from it are impossible.

4. "Four miles above the Colorado-New Mexico line, at the lower end of San Luis Valley, the river enters a canyon locally known as the Rio Grande Canyon, which

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continues to the head of Espanola Valley near Embudo. This canyon increases in depth from 100 feet at the State line to 700 feet near the mouth of Rio Hondo and appears from above as a gash in an otherwise level mesa. The fall of the river through the canyon is about 30 feet per mile. For a large part of its remaining course the stream passes through a succession of valleys or erosion basins which are separated by rock canyons and are limited in form and size by the character of the material in which they were excavated.

5. "From the lower end of the Rio Grande Canyon the river flows through Espanola Valley (which is 3 to 4 miles wide and extends to a point near San Ildefonso) and enters White Rock Canyon, a narrow gorge, about 20 miles long and in places 500 feet deep, which owes its existence to sheets of hard igneous rock that protect the underlying sands and gravels. The fall in this canyon is about 10 feet per mile.

6. "At a point almost directly west of Santa Fe the river enters Santo Domingo Valley, through which it flows to the upper end of San Felipe Canyon, 7 miles south of the Indian pueblo of Santo Domingo. This valley is 1 to 3 miles wide and contains about 13,000 acres of bottom land that has been irrigated for many years. The greater part of this land lies only a few

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feet above the bed of the river and is subject to frequent overflow.

7. "Passing through San Felipe Canyon, which is a short gorge, the river enters Albuquerque Valley, through which it flows for a distance of about 35 miles until it reaches Isleta Narrows. Albuquerque Valley ranges in width from 1 to 5 miles and comprises approximately 70,000 acres of bottom land. It is bounded on both sides by steep bluffs of sand and gravel.

8. "The narrowing at Isleta Narrows is caused by the presence of the hard igneous rock of an extinct volcanic cone west of Isleta. Below the narrows the river flows for 45 miles through Belen Valley, which extends to San Acacia and contains approximately 65,000 acres of bottom land.

9. "From Belen Valley the river passes through San Acacia Gorge - a short,narrow gorge 250 feet deep, cut through an arm of the lava sheet which crosses the river course - and enters Socorro Valley, which extends southward to San Marcial, a distance of 40 miles, and comprises about 60,000 acres of bottom land.

10. "Beginning a short distance below San Marcial is a narrow valley, about 40 miles long, which is cut in

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detritus and which differs from the others in being very narrow and having no bottom lands. This valley is the site of the Engle reservoir now built by the United States Reclamation Service. A few miles north of Elephant Butte the river enters a narrow rock canyon which extends to the end of the Caballos Mountains and in which, opposite Elephant Butte, is the Engle dam site.

11. "Below Elephant Butte Canyon the Rio Grande flows through Las Palomas Valley to Rincon, a distance of 50 miles. The bottom lands in this valley include about 26,000 acres. From Las Palomas Valley the river enters Selden Canyon, which is 18 miles long but not so uniformly narrow as the other canyons, for it contains about 8,000 acres of bottom land.

12. "Emerging from Selden Canyon at old Fort Selden, the river enters Mesilla Valley, the largest of the erosion basins of the Rio Grande, extending southward 50 miles to The Pass. The valley has a maximum width of 8 miles and contains approximately 150,000 acres of bottom land. It is cut in unconsolidated sand and gravel, its floor being 300 feet lower than the mesa level.

13. "Below Mesilla Valley, just above El Paso, the river flows through a narrow gorge about 90 feet deep, cut in a low ledge of hard rock.

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14. "From El Paso to its mouth the river forms the boundary between the United States and Mexico. For a distance of 100 miles below El Paso it flows in a broad lowland known as El Paso Valley, 250 feet below the general upland level. This plain becomes gradually narrower, until it terminates at a point 100 miles southeast of El Paso and the river cuts through a narrow gorge, 5 miles long, formed by the southeastern extension of the Quitman Mountains."

(All quotations from report (e)).

Historical

15. Irrigation along the Rio Grande antedates history. Quoting from report (a), page 285:

16. "Before the middle of the sixteenth century the Spaniards entered New Mexico and the valley of the Rio Grande and there found the Pueblo Indians, living in their many-storied towns and cultivating the land of the valleys, bringing water onto it by acequias, or irrigating ditches, many of which are still in use to this day. How long these Indians had been on the ground is unknown, but they were even then old inhabitants, and raised not only grain and fruit, but even flowers, as one poetical and doubtless homesick Spaniard wrote that roses bloomed along the acequias bank "as bloomed the roses of beautiful Aragon." There are some seventeen or eighteen of these

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settlements of Pueblo Indians in New Mexico, each holding a land grant 2 leagues square and each with its old pueblo, containing some 200 to 600 people. There were at least this number of pueblos when the Spaniards came to the country, and probably several more, as the ruins of three or four still exist. The inhabitants of each pueblo were then much more numerous also than now. In other words, prior to the middle of the sixteenth century, three hundred and fifty years ago, there were some 15,000 to 20,000 people living from products raised by irrigation in the Rio Grande drainage above the Jornado del Muerto, and the area of irrigated land probably exceeded 30,000 acres.

17. "While the Spaniards first entered New Mexico from Sonora and the Gulf of California, the first attempts at colonization were made from El Paso as a base, the Spanish conquest of Mexico having extended to the Rio Grande. This first attempt was made in 1598, and the first Spanish capital of New Mexico was then established at Chamita, in the Espanola Valley, just above the mouth of the Chama. This was abandoned in 1605, and the inhabitants and capital transferred to Santa Fe, where they and their descendants remained until 1680, engaged principally in mining. Then the Pueblo Indians revolted and drove the Spaniards from the country. In 1692 it

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was reoccupied by the Spaniards and permanently held. Bernalillo was founded about 1700 and Albuquerque in 1706. Settlements were made along the Rio Grande, both in the Albuquerque and Espanola valleys, and also up the Chama, the Abiquiu grant on the latter stream being made to the inhabitants of that town in 1739. El Rito, some 20 miles northeast of Abiquiu, was occupied in 1730.

18. "The Mexicans did not penetrate to the San Luis Valley, judging from the water rights there granted, until after 1850, the oldest water claim in that valley being that of the San Luis People's Canal, on Culebra Creek, whose appropriation dates back to 1852. For the ten or twelve years after 1852 the settlements in the San Luis Valley were confined to the country on the Costilla and Culebra and to the Conejos Valley, the town of Conejos being founded in 1855. In 1866 and 1867 settlements were started on the Rio Grande, San Luis, and Saguache, while the next three years saw farms opened and small ditches taken out on the Carnero, the La Gavita, Alamosa, and La Jara, but all of these, except those at Conejos, were confined to the little valleys back in the hills around the margin of the San Luis Valley proper. On these farms the principal product was hay. This the Mexicans fed in winter to their stock, to which the main valley furnished abundant pasturage for the greater portion of the year.

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19. "About 1873 or 1874 the Americans began to move into the San Luis, but still the farm lands were confined to the small side valleys. The first settlement in the San Luis Valley proper, outside of Conejos, was made by the Mormons, who founded Manassa in 1878 or 1879. Soon after this time the Denver and Rio Grande Railroad built into the valley. The main industry was still cattle raising, however, until about 1882. Then commenced the era of large canal building, which continued for ten years. During this time were built the Rio Grande, Monte Vista, Empire, San Luis Valley, Costilla, Prairie, and Farmers' Union canals, besides many others. All those named head on the Rio Grande between Del Norte and Alamosa, and, stretching 30 or 40 miles north and south from the river, cover the whole of the western half of the valley with their network of laterals. Colonists were brought in as rapidly as they could be found, and a great and brilliant future was predicted for the San Luis. But it was found that the water of the Rio Grande was not sufficient to supply these monster canals, that the soil was not in all cases as fertile as expected, and that the climate was very trying. For these reasons immigration was checked, and since 1892, the valley, instead of rapidly extending its irrigated areas, has not held its own.

20. "While quite a large native American population has come into the Rio Grande drainage in New Mexico since

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the construction of the 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. These people pursue their ancient methods of irrigation unaffected by modern progress."

21. Irrigation in the vicinity of El Paso also existed prior to the advent of the Spaniards. The first Spanish ditch is now in existence, heads near Juarez, opposite El Paso, and is said to have been constructed 300 years ago.

Possible Developments

22. With the exception of the Espanola Valley which needs neither drainage nor additional irrigation, the irrigable lands considered are limited to the San Luis Valley in Colorado, the Middle Rio Grande in New Mexico, comprising that portion of the valley from White Rock Canyon to San Marcial and the lower portion in the vicinity of El Paso now being fully developed by the government. There are various bodies which could be irrigated just below the Colorado-New Mexico state line but are not here considered because of insufficient water supply.

23. In all these areas, natural drainage is insufficient to dispose of the water applied to the land at present

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irrigated and this has resulted in a badly swamped condition. Except in the San Luis Valley where no sharp division exists between bottom lands and the general country, the course of the river through the areas mentioned above is bordered by flat bottom lands from which the bordering bluffs rise steeply 200 to 500 feet to the surrounding country. In some parts, this consists of flat mesas of good land on which irrigation would be desirable. Most of this mesa land is so far above the river, which itself has so flat a grade, that its irrigation is not considered in this report. In the vicinity of Albuquerque, particularly, are considerable areas of mesa on the east side of the river which may perhaps be reached at a not prohibitive cost, but no further mention of this or any other mesa lands is made in this report because water supply as determined in this report precludes the possibility of its irrigation.

24. On these mesas no drainage would be needed but with this exception any added irrigation along the Rio Grande must be preceded by drainage. While the water supply for these areas is sufficient under present conditions, drainage will so increase the irrigable area that study of the supply is advisable before drainage ditches are built.

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25. Since the Rio Grande Project is now developed, it is desired to know also the effect of drainage and additional irrigation in the areas above on its water supply.

Climate

26. Except in the high mountains surrounding San Luis Valley and in northern New Mexico, the climate of this section is intensely arid with only 7 to 10 inches of rainfall. The months of greatest precipitation are July and August. In New Mexico the precipitation occurs in the form of cloudbursts of heavy rains of short duration. There is a large percentage of clear days. During the spring months heavy winds occur.

Characteristic Data

27. In the following table is the essential data as to each division:

Table 2.

	San Luis Valley	Middle Rio Grande	Rio Grande Project
1.Elevation	7600'	4900'	3800'
2.Annual temperature	43°	58°	64°
3. " precipitation	7"	9"	10"
4. " evaporation	** 5'	** 6'	7'
5.Area irrigated	376,000 A.	49000 A.	65000 A.
6. " seeped	850,000 A.	96000 A.	?
7.A.F.water used or lost annually	1,000,000	508,000	* 288,000

**Estimated. *From San Marcial to El Paso. Before Elephant Butte dam constructed.

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International Questions

28. The waters of the Rio Grande which flow by the southern boundary of New Mexico were first used by whites in Mexico. For many years development in San Luis Valley and in New Mexico has been encroaching on this supply and this has been the subject of considerable diplomatic negotiations between Mexico and the United States. This was finally settled by agreement that Mexico would renounce her claim for damages and to all free flow of the river in exchange for an annual supply of 60,000 acre feet delivered at the headgates of the Mexican canal, previously mentioned. The ability to supply this water at the time of year stipulated depended on the construction of a reservoir. The outgrowth of the entire controversy was the decision to construct the Elephant Butte reservoir large enough to control the entire river discharge at that point, retaining water from high years to low and using the surplus above the 60,000 a.f. for Mexico in developing the irrigable lands below and in the United States. The general fund furnished $1,000,000 toward the construction of the reservoir while the Reclamation fund furnished the remainder.

River Discharges

29. Because of the international question of its administration, several stations have been maintained on the Rio Grande since an early date.

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Del Norte Colo.

690 000

Lobatos Colo.

591 000

Embudo N.M.

789 000

Buckman N.M.

1409 000

San Marcial N.M.

1150 000

El Paso Texas

860 000

AVERAGE ANNUAL DISCHARGE AT MAIN STATIONS OF RIO GRANDE RIVER

ACRE FEET

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TABLE 3.

Discharges of Rio Grande River

Station	Period maintained	Length record	Avg. annual discharge a.f.
El Paso, Texas	(1889-1891 (1897-1918	25 years	862,000
San Marcial, N. M.	1897-1918	22 "	1,150,000
Buckman, N.M.	(1895-1905 (1910-1918	19 "	1,390,000
Embudo, N.M.	(1889-1893 (1895-1903 (1913-1918	20 "	786,000
Sobatos, Colo.	1900-1918	19 "	590,000
Alamosa, Colo.	1912-1918	7 "	309,000
Del Norte, Colo.	1889-1918	30 "	690,000
Wasson, Colo.	1907-1918	12 "	512,000
30 Mile Bridge, Colo.	1909-1918	10 "	185,000

30. On the opposite page is a graph showing the average annual discharges at the principal stations. On the following page is a graph showing each year's discharge for the same stations.

31. A very noticeable feature of the second graph is that the average discharge at each station during the period from 1890-1904 is much below the average since then. The 6-year period from 1899-1904 was extraordinarily low. This particular period shows low discharges on streams throughout the West. At Salt Lake, as shown in La Rue's report on the development of the Colorado River, 1902 was the lowest year in sixty-five.

Form of Report

32. In the following pages, water supply is discussed under three heads:

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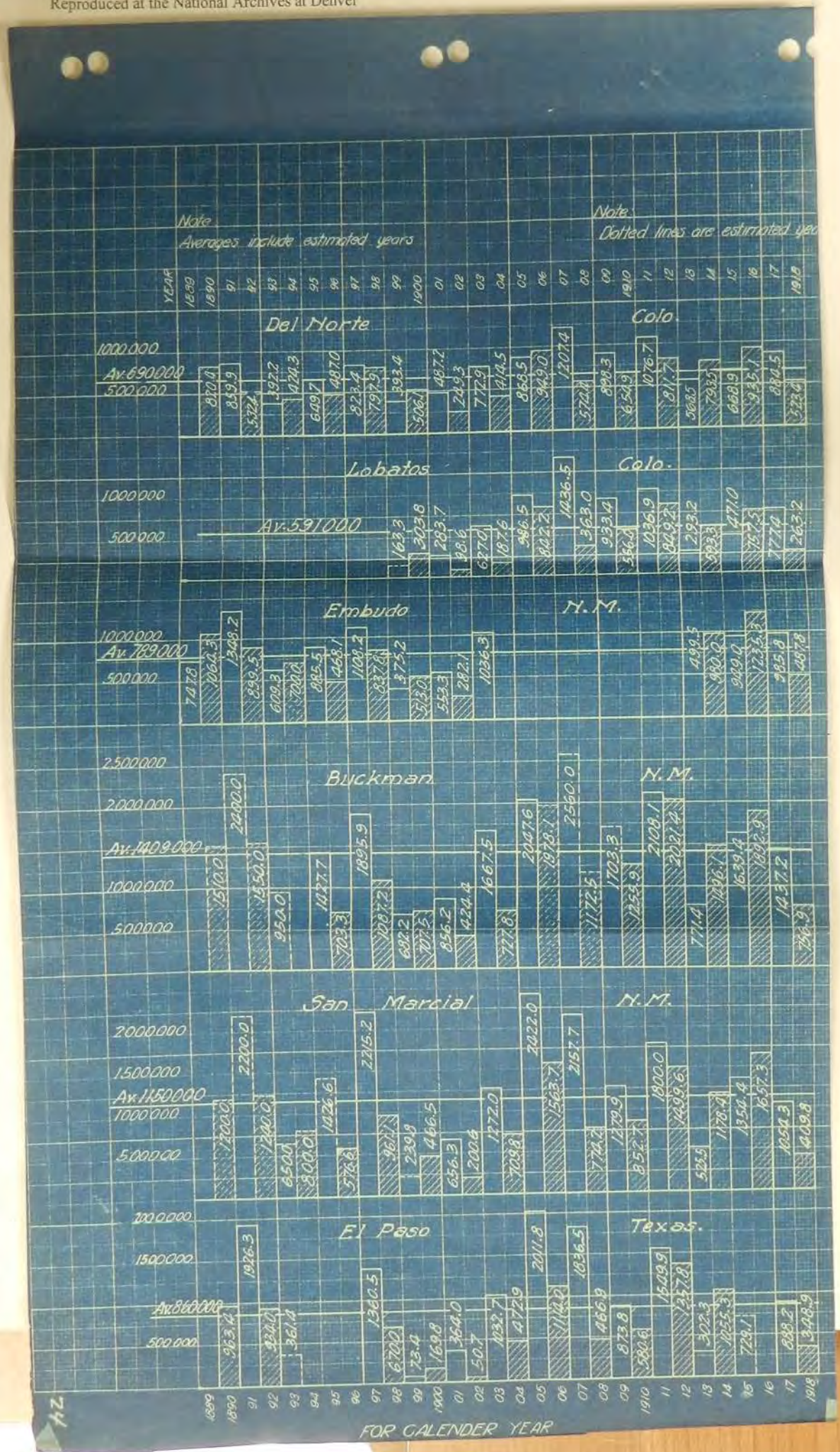

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1. San Luis Valley.
2. Middle Rio Grande.
3. Rio Grande Project.

The San Luis Valley is first taken up and an estimate made of the probable ultimate acreage which will be irrigated and the effect of this development on the recorded discharge available to the Middle Rio Grande. Next with this water supply the possibilities of the Middle Rio Grande are investigated. The remaining water supply is considered to be the total available for the Rio Grande Project of 155,000 acres net. An analysis of the sufficiency of this remainder for the project has been made.

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PART II.

SAN LUIS VALLEY

33. The situation in the San Luis Valley has been the subject of many reports, most of which are listed below:

Ref. letter	Name of paper.	Year	Writer	Bureau or Department
a	Soil survey	1902	J.G.Holmes	Bu.Soils.
b	Geology & Water Resources (W.S.240)	04	C.E.Siebenthal	U.S.G.S.
c	Report on Drainage	07	A.E.Morgan	U.S.D.A.
d	Report on Hydrographic Survey	10	J.A.French	U.S.R.S.
e	Report on Operations (Drainage investigations)	12 & 13	J.D.Stannard	"
f	Report on Operations (Drainage investigations)	13	"	"
g	Report on Operations (Drainage investigations)	14	"	"
h	Report on Operations	15	Stannard & Miller	U.S.R.S. & U.S.D.A.
i	State Engineer's Report	16		Colorado.
j	Waters of the Rio Grande B. 230	17	W.P.Headden	State A.C.
k	Black Alkali, B. 231	17	"	" "
l	Report on Land Values	18	J.N.Kerr	Fed.Land Bank
m	Possibilities in San Luis Valley	18	J.D.Burkholder	U.S.R.S.

34. The valley is a flat plain having a general elevation of over 7500 feet and almost completely surrounded by mountains which rise directly from the plain without foot hills. The Denver and Rio Grande Railroad furnishes the outlet and there are three small private railways. The valley floor covers about 2500 square miles and the

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entire basin from rim to rim about 7500.

Climate

35. The irrigation season covers about 150 days but the bulk of it only 100 days. Precipitation averages 7 inches with about 60 per cent in the growing season. A large percentage of sunshiny days and a high spring and early summer wind velocity are features.

Crops

36. Grains, forage crops, peas and potatoes are the main crops. Alfalfa produces two good crops with some pasture. Field peas, which are hogged down or harvested by other livestock, are grown on 60 per cent of the acreage of cultivated land. About 45 per cent of the entire irrigated area is in wild hay. This is grown along the course of the streams. As a whole, the valley is very productive where the water table is sufficiently below the surface.

Population

37. The population is about 30,000 with a larger proportion of Mexicans in the southwestern corner. The principal towns are:

Monte Vista	4000
Alamosa	4000
Del Norte	1500
Center	1000
Saguache	1000
La Jara	1000
Antonito	900
Hooper	150
Mosca	150

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Monte Vista is the center of the largest agricultural section. Alamosa is a railroad town with little cultivated land adjacent. The Denver and Rio Grande Railroad maintains division headquarters here. Del Norte is an old mining town, now at a standstill. Saguache is the center of the stock growing industry, is 17 miles from a railroad and does not want one. Hooper and Mosca are the market places for a once prosperous region now largely abandoned because of seepage but in which agriculture is being now gradually resumed with better understanding of conditions.

Physical Characteristics

38. The main stream in the valley is the Rio Grande River proper, which rises on the eastern slope of the Continental Divide and flows thence southeast to about Alamosa where it turns south. The drainage from the entire area north of the river and north of a line running somewhat northeast from Alamosa to Mount Blanca, comprising about thirty per cent of the mountain area and about forty per cent of the plain, does not reach the Rio Grande but is either evaporated from the ground or from sinks called San Luis Lakes lying in the east central part of the valley. Although it is stated that the marks of the old channel to the Rio Grande are still to be found, it is evident that the runoff is not large or the present conditions would not exist.

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39. South and west of the Rio Grande is a region of heavy runoff which enters the river. East of the Rio Grande and south of the dead area is a region of low runoff which is now entirely developed for irrigation.

40. The principal problem of the valley is drainage. The map on the succeeding page outlines the area said to be affected by ground water. It totals 850,000 acres. Fully as important, but not so strikingly apparent, is the problem of furnishing a water supply to the area if it is drained.

Southeast Corner

41. The southeast corner east of the Rio Grande from Mount Blanca south comprises the Trinchera and Costilla estates. Both of these are developing the entire runoff of the streams south of and including Trinchera Creek for irrigation of lands within the estates. The land lies on a high bench far above the river and is naturally well drained. As this area is already highly developed and is in an entirely different condition than the remainder of the valley, it receives no further notice in this report except in a general way to make assembled data complete. This report deals principally with drainage and water supply west of the valley trough.

Artesian Basin

42. The geological formation is such that an artesian basin exists under the valley floor (Report "B"). This

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CLASON'S MAP OF THE SAN LUIS VALLEY

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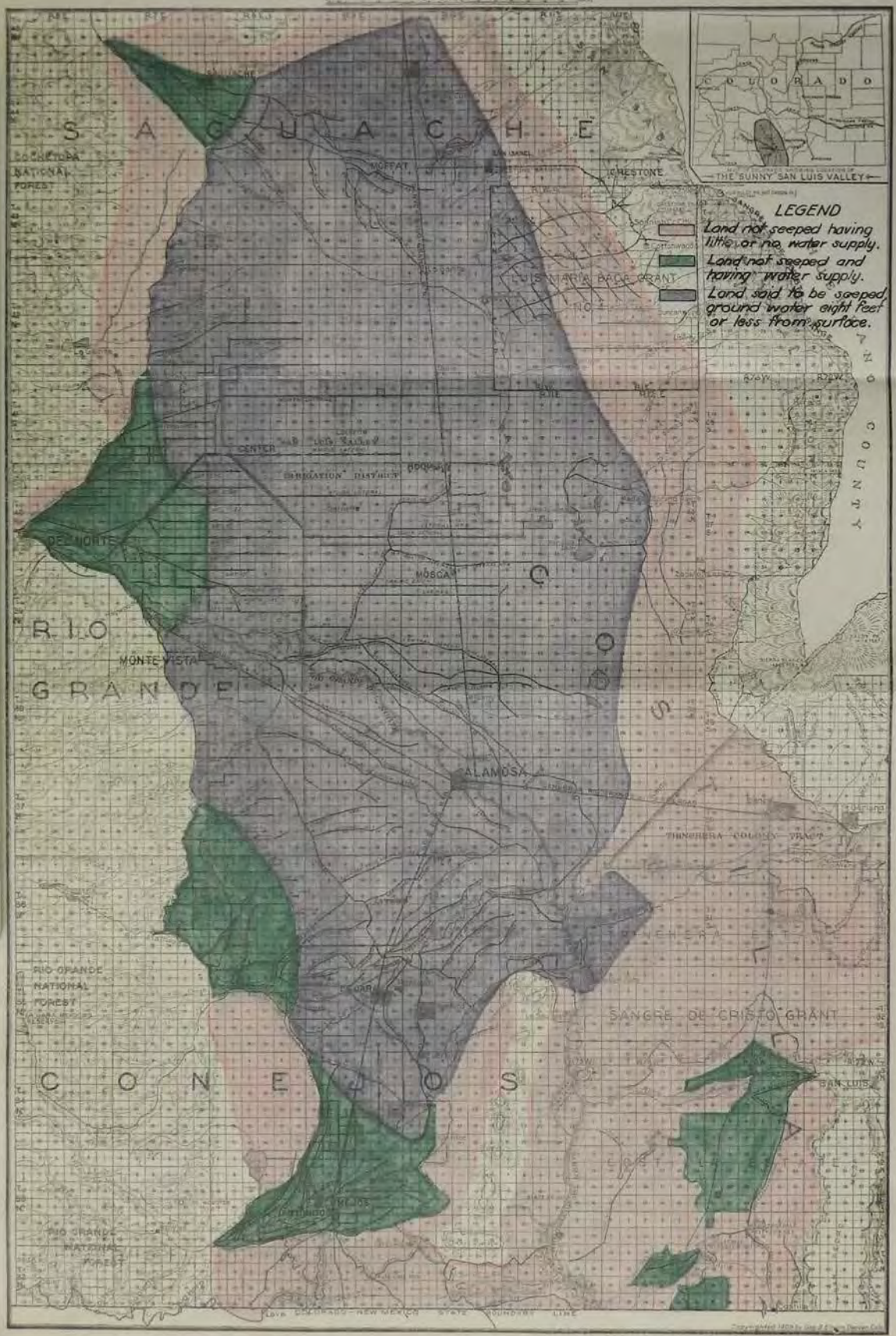

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basin is fed by creeks and rivers flowing across the outwash as they leave the mountains and possibly by percolation in the mountains themselves although it seems improbable that any large contribution occurs from this source. The calculated head of the flowing wells defines the altitude of the impermeable stratum which forms the top of the aquifers and as some of the larger canals divert above this altitude and above the point in the stream where measurements have shown seepage losses to occur, it is probable that the loss from canals is contributing to some extent to the basin and in succeeding calculatinns some estimates are made of this quantity.

43. In report "b", Siebenthal gives the number of artesian wells as 3234 with an average discharge of 40 gallons per minute. Estimates for this report were secured from the well drillers of the valley of the number drilled since 1904, the date of the estimate above, which show that there are 5850 wells now. The average size of the later wells is smaller and measurements of 908 gave an average discharge at present of 26 gallons per minute which is the figure used later in water supply calculations.

44. A growing practice is to cap the wells when not in use because continuous flow aggravates seepage troubles. The principal use is for stock water and irrigation, although successful irrigation is very limited because of the small

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flow. The wells are, in general, cased to the first clay bed which appears to be the upper confirming layer of the artesian basin; hence capping successfully conserves the water for use elsewhere and shuts off the contribution to ground water.

45. The estimated discharge if the flow is continuous throughout the year is 245,000 acre feet per annum. From inquiry among farmers, etc., it is believed that the wells are capped during so much of the year that the discharge is about 187,000 acre feet (Table 46). It was also found that the artesian basin had extended westward in the neighborhood of Center since Siebenthal's time. The maximum extension is about two miles and gradually diminishes from this distance to nothing near Saguache and Monte Vista. The only way of accounting for this is contribution to the basin which did not exist before irrigation began. If this is correct, when the basin finally reached a state of equilibrium there may be more outflow from the valley than is hereinafter estimated.

Springs

46. Besides the draft on the artesian supply by wells, there are numerous springs in the valley which probably originate in the artesian aquifers. The largest of these is the McIntyre, discharging 25 second feet. The discharges of each are shown in the following table:

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TABLE NO. 4.

Discharge of springs within San Luis Valley

1	2	3	4
Name of spring.	Location	Dischg in s.f.	Remarks.
McIntire	8 miles east of La Jara	25	Actual measurements-seepage investigatns.
Dexter	10 " " " " "	10	Estimated-see page 90 French report.
Sanford	5 " " " " "	5	Estimated-see page 90 French report.
Arroya	4 " " " " "	20	Estimated.
Spring Creek	7 " south of Monte Vista	15	
Russell	3 " northeast of Carnero	10	
Hunt	3 " east of Saguache	5*	"
Antelope	10 " northeast of Hooper	1	"
Medano	10 " east of Hooper	10	"
Washington	7 " " " Alamosa	2*	
Other	Various	25*	This quantity is an estimate of the total discharge of numerous small springs scattered over the entire valley but occurring almost entirely at the toe of the outwash slopes.
	Total	128	

Note - * Denotes guess without data.

Total annual discharge 128 x 2 x 30 x 12 = 92,160 a.f. say 90,000 a.f.

Source of supply is artesian basin.

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Drainage

47. The coarse sand and gravel subsoil as well as the even topography present conditions ideal for drainage. The following table gives the status of various small drainage districts now built or proposed while the map following page 48 shows their location.

TABLE NO. 5.

Drains constructed in San Luis Valley

Name	How organized	Approx. acreage.	Per cent complete	Cost per acre
Rio Grande	State law	30,000	65	* 6.00
San Luis Valley	" "	9,500	0	* 13.00
Waverly	" "	13,750	0	* 12.25
Carmel	" "	5,000	21	11.00
Norton	Private	12,000	60	15.00
Parma	"	1,200	100	
McLean	"	2,000	100	14.00
Gibson		10,000		
Sylvester			100	
Conejos				

*Estimated.

48. The bonds of the Waverly district were sold in April of this year and negotiations for the San Luis Valley district bonds are now under way.

49. Drainage has been very successful to date. The principal physical difficulty is the cost of the outlet drains, particularly for the dead area to the north. It has not been possible to bring the land owners together on a proposition to construct a main drain into which various drainage districts can discharge and the cost of such a

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drain has been considered prohibitive to any of the comparatively small districts up to this time.

50. For this reason, land owners of the valley are asking for government aid in the construction of main drain or drains, thinking that it will be possible to bring the various interests together on such ground. The question of government aid hinges largely on water supply, the determination of which is the purpose of this report.

Present Irrigation Development

51. The history of development up to 1896 has been given in paragraphs 16 to 20 of Part I. Since that time, there has been an increase of about 150,000 acres. Authentic data are unprocurable but there have been various estimates of irrigated acreage which are reproduced in the following Table No. 6. Previous estimates presumably show the gross irrigated acreage but for this report, a reduction from the gross of 20 per cent has been made to approximate the net which is the figure it is desired to deal with.

52. It is said that water supply proved insufficient for the large acreage developed under the colonization schemes of the early nineties, but a more serious condition soon obscured this phase of the situation. The water table rose to such an extent in the lower parts of the valley that

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Table 6

IRRIGATED AREA SAN LUIS VALLEY.

Note: Boundaries of Counties and water districts do not coincide so that comparison can only be made on totals.

Water Distr.	STREAM	FOLLET 1896	WATER COM. 1910	FRENCH 1910	CENSUS 1909	HEMPHILL 1912	WATER COM. Mean-1915 16,17,18	TAX. COM: Mean 1912 1913	MEEKER REVISION (Hemphill Basic) Gross	MEEKER REVISION (Hemphill Basic) Net 80%
1	2	3	4	5	6	7	8	9	10	11
20	Rio Grande	139800	248000	259200		252500	300000		269000	215000
	Ratton Spring									
	Rock, Cat Grs.									
21	Alamosa (Hot Cr)	37900	34100	*36300		39900	46000		# 33000	29000
	La Jara									
22	Conejos	60600	99100	ø99000		77400	‡ 95000		77000	62000
	San Antonio									
24	Culebra	7000	22300	ø23400		23500	32000		?23500	?19000
	Costilla					‡ Parshall				
25	Kerber	46300	No Data	ø53400		ø17600	‡ 20000		?20000	15 000
	San Luis									
	Cotton Rita Alta									
	San Isabel, etc									
26	Saguache	20200	" "	36300		28300	30700		28000	22000
27	La Garita	2700	" "	8000 (est)		ø 6200	◆ 3700		? 4000	3000
	Carnero									
35	Trinchera, N to Sand Cr	4200	3500	7800		ø 4200 ‡ Parshall	15000		?15000	11000
Total		318700	407000	523400	*09-460800	449600	542400	460000	469500	376000
		1890-300000 1892-400000			1899-300000 1889-147800		Mean-1917-18-339000		R.M.	

ø From State Engineer's Report #Survey 1915-16
* Water Com. data extended by French
** 1917 missing. ◆ 1915 missing

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Table 6.

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settlers were forced to move to the higher parts. The water table continued to encroach on the arable land and creep slowly to the west until now fully 80 per cent of the agricultural land on which it is possible to put water is or has been damaged to some extent by a high water table.

53. If the land is not irrigated for some years the water table lowers sufficiently so that isolated farms can be cultivated successfully. Since ditches cover almost the entire west ~~end~~ of the valley, a rather curious condition results, namely, isolated farmers have either held on or come back and fairly productive farms are found surrounded by all the evidence of alkalied and seeped land. In the vicinity of Mosca, particularly, is found a considerable area of land now farmed in this way.

54. It appears that a large part of the land which is usually called "seeped land" is not now seeped but is threatened with seepage. That is, abandonment of irrigation in any particular district lowers the water table to four or five feet below the surface - at which depth, with the coarse subsoil of the valley, there is little opportunity for capillarity to act and evaporation becomes negligible. If now a portion of this area is carefully irrigated, the ground water does not rise enough to cause seepage to reappear. When it is stated that 850,000 acres are seeped,

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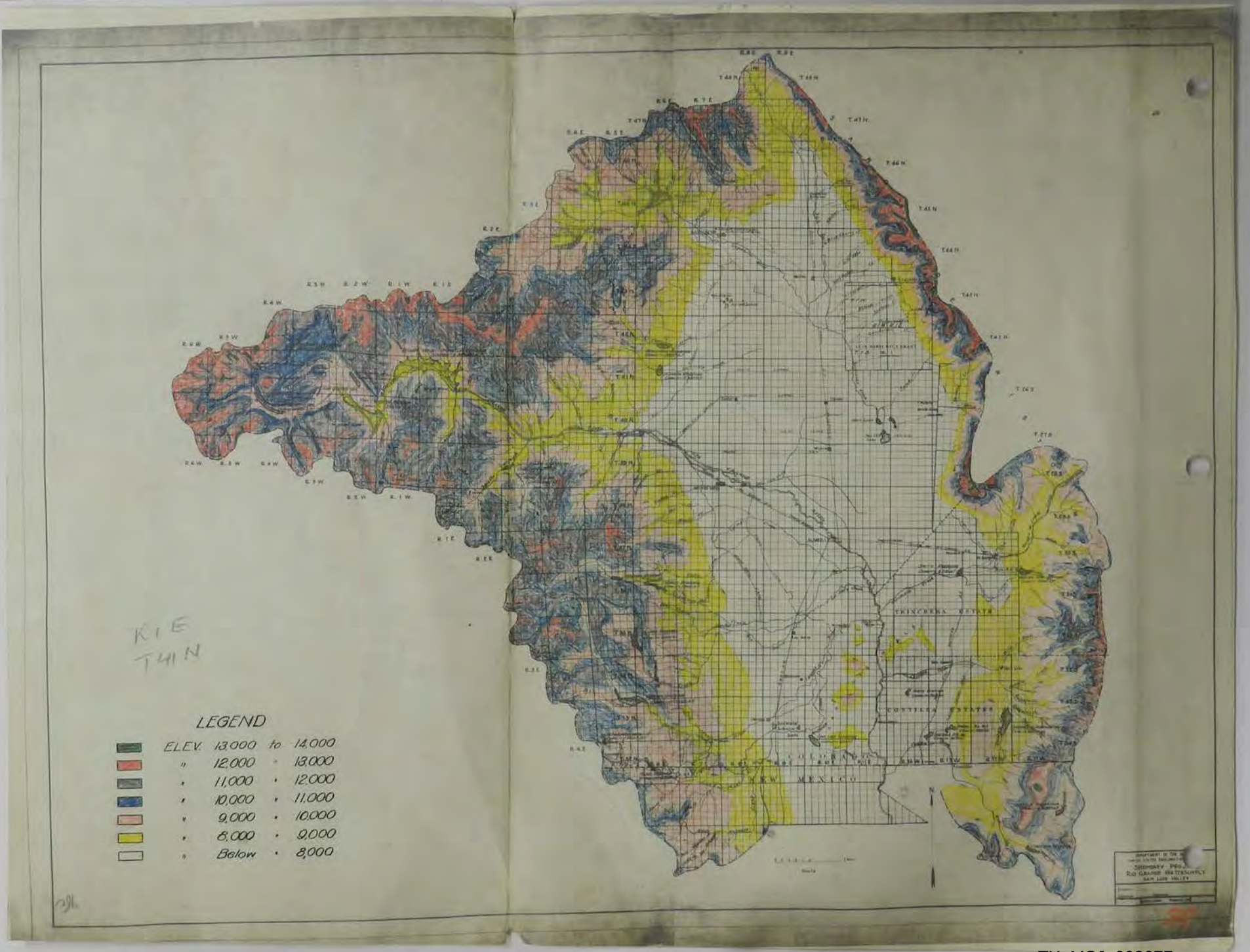

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an erroneous impression is created and it is possible that this has been the cause of the gross errors in estimates of the amount of water which can be regained by drainage. The land is not seeped but would be seeped, if farmed.

WATER SUPPLY

55. It is well known that precipitation in mountainous country increases with the altitude. The plat opposite shows an altitude map of the entire valley from rim to rim and from this is to be noted the higher elevation of the mountains in the southwest and northwest which leads to the expectation of higher runoff from their slopes.

56. Another factor which profoundly influences the mountain precipitation of the valley is a certain meteorological condition. The moisture laden winds of this section of the country are from the southwest. Thus the high San Juan mountains trending northwest from the southern and western corner of the valley intercept this moisture and make the precipitation on the slightly lower Saguache mountains, which form a spur projecting northeast from the San Juans, very small. On the northeast side the Sangre de Cristo range, still higher than the San Juan, receives a heavy precipitation from the upper filaments of air which have passed the San Juans unaffected, but as the area on the San Luis side of the Sangre de Cristo is small, the total contribution to the valley is correspondingly small. As it

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extends southward, the Sangre de Cristo range becomes lower and the moisture which would strike its slopes is intercepted by high mountains to the southwest in New Mexico. Near the State line, it becomes higher and the Costillo Creek drainage area is fairly prolific of runoff. Since it is used by Costilla estates development and enters below the State Bridge where the valley outflow is measured, it is not considered in this report.

57. On the plat opposite is shown a runoff map of the mountainous area of the valley (above 8500'). It is derived from discharge measurements which cover a considerable period for the larger per cent of the runoff and for short periods of the remainder. Its derivation is taken up in detail later. The comparative prolificity of the southwest and northeast ranges is rendered very apparent. The remainder of the valley below 8500, or the valley floor proper, averages only 7 inches precipitation and while undoubtedly at intervals it contributes a considerable discharge, yet its average annual runoff must be small and is not considered further in this report. It must be recognized, however, that it does contribute something and will increase the water supply estimates in these pages.

Measured runoff

58. The discharge of the Rio Grande at Del Norte since 1889 and of the Conejos since 1903 has been measured. The

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first contributes about 46 per cent of the annual discharge into the valley and the second about 16 per cent. Thus 62 per cent of the total valley discharge has records of great value. These streams originate in the most prolific area. The principal stream of the dead area is the Saguache which has been recorded since 1911 and gives a good basis for estimating the runoff of other streams in that vicinity. Fully 88 per cent of the mountain runoff of the valley has records of some value which by comparison with a stream with better record the drainage area of which is similar, can be used to make an estimate of the runoff.

59. On the following map is shown the measured drainage areas and also the unmeasured, the runoff from which is estimated by comparison. Also on following plat are shown graphically data as to records.

60. In the following Tables 7 and 8 are shown the derivation of average annual discharge from the mountain areas. As stated, most of the streams have records of some value, but for all but the Rio Grande at Del Norte the record started in the last fifteen years. The runoff at Del Norte for the first fifteen years up to 1904 averaged 70 per cent of the average since then while the grand average is 85 per cent of the average since then. Assuming that this same condition was true for the entire valley, it is necessary to reduce the discharges recorded to an annual

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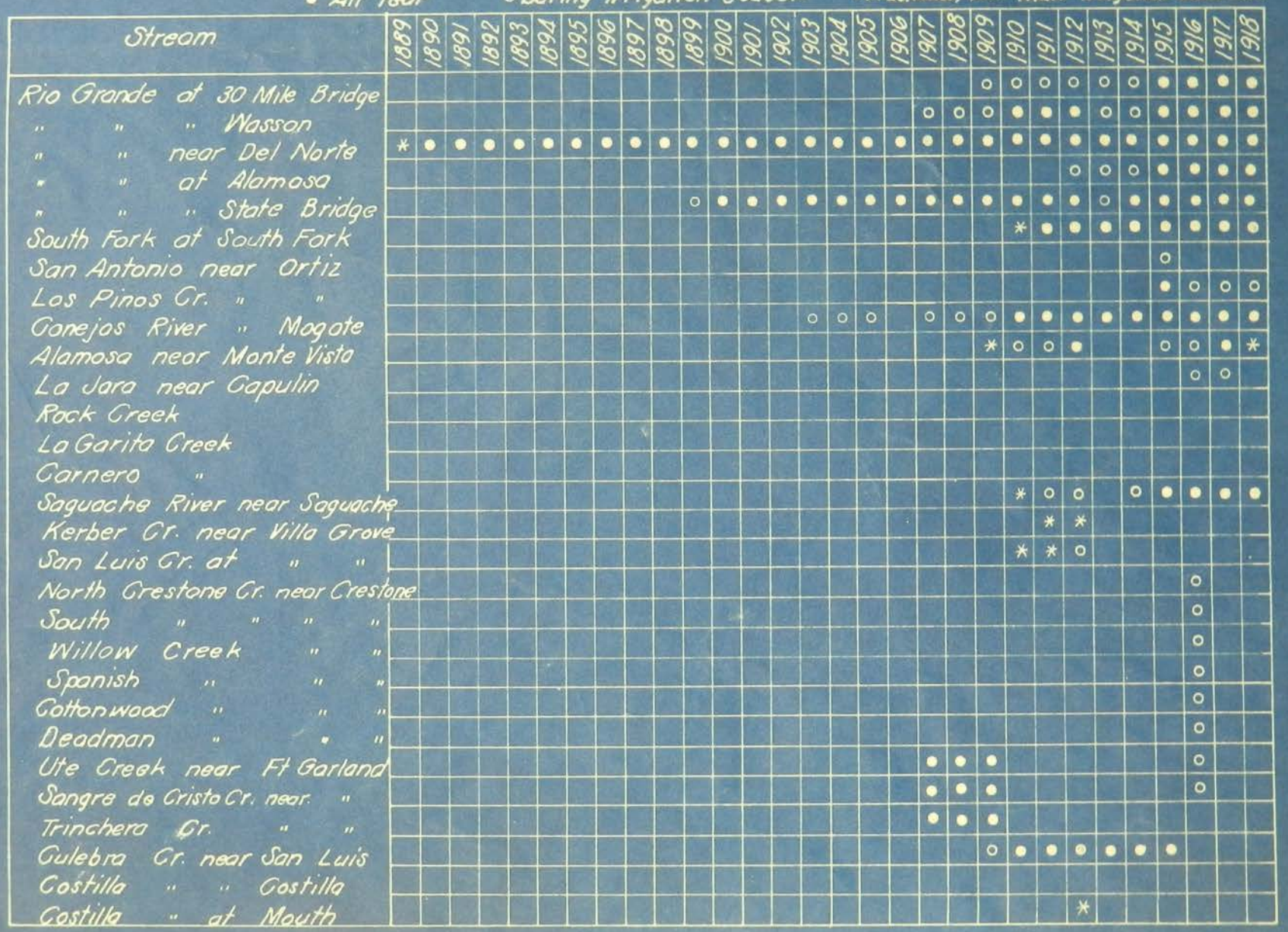
STREAM DISCHARGE RECORDS - SAN LUIS VALLEY

• All Year ○ During Irrigation Season * Fractional, less than Irrigation Season.



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average comparable to the Rio Grande.

61. In Table No. 7 the recorded discharge has been thus reduced and the annual discharge per square mile estimated for different elevations and different localities.

62. Above the gaging stations are areas in wild hay in some cases. The consumptive use has been taken at 1.0 acre feet per acre in accordance with results found on similar areas in other localities. There are some constructed reservoirs which are evaporating water and allowance is made for this. On some streams there are diversions above the gaging station for land below and for which a diversion of four acre feet annually is allowed. Column 10 shows the years of record used for comparison. It is generally the entire period for which complete records are available. Column 11 shows the average recorded discharge of the stream during the period of Column 10. Column 14 shows the percentage which the average runoff of the master stream during the period of Column 10 bears to the average for the period of record and from it is deduced the annual average of the stream in question, which is shown in Column 15 while Column 16 gives the runoff per square mile.

63. In Table 8 the runoff per square mile of the measured areas derived from Table 7 is extended to unmeasured areas shown on plat following page 29, giving a total mean annual discharge of 1,545,000 acre feet.

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TABLE-7

ORIGINAL RUNOFF FROM MOUNTAIN AREAS WITH RECORDED DISCHARGES

Stream	Control Station	Area under consideration. Description	Area in sq. mi.	Avg. elevation	Water losses above station. Cropped areas. Acreage	Consumptive use of water @ 1 AF per A. in 1000 A.F.	Water diverted above station for use below in 1000 A.F.	Reservoir evaporation & storage losses in 1000 A.F.	Runoff. Years of record used for comparison	Avg. rec. disch. 1000 A.F.	Avg. recorded annual discharge 1000 A.F.	Master stream used for comparison.	% of mean runoff in master stream during years in Col.10.	Computed mean annual disch. Col.11, Col.13, "7,8,9 in 1000 A.F.	Mean annual runoff in AF per sq.mi. Col 15, by Col 4.	Remarks.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Rio Grande	30 Mile Bridge	All above station	157	11900	None			3.8	1911-1918	181.1	181	Rio Grande at DelNorte	113	164	1050	Missing months computed by assuming same relation existing to Wasson as for months of record.
Rio Grande	Wasson	30 Mi.Bridge-Wasson	520	10800	4900	4.9		1.8	1911-1918	331.1	331	" "	113	300	580	Rio Grande Res.contained 16000 AF.Dec.1918,estimated evap. losses since construction 14,000 A.F.
Rio Grande	Del Norte	Wasson-Del Norte,exc.S.Fork	428	10200	6500	4.9			1911-1918	87.9	88	" "	113	83	190	Monte Maria Res.contained 8600 A.F. (ditto) 11400 A.F.
South Fork	South Fork	All above station.	225	10400	700	0.7	2.1		1911-1918	182.1	182	" "	113	164	730	Consumptive use of water reduced for inflow from areas irrigated with S.Fork water 40% of area north of river.
Saguache	Below Ford Creek	All above station.	95	10000	4500	4.5			1915-1918	59.4	59	" "	109	59	100	
San Luis Creek	Villa Grove	" " Villa Grove,inc.Kerber Creek	205	9600	3500	3.5	3.0		5/12-9/12	14.0	20	Saguache	131	22	110	Annual runoff,Col.12,based on relation of May-Sept.on Saguache River to total annual in 1915-1918,incl.
Kerber Creek	Clayton Cone	All above station	73	10300	500	0.5			4/12-6/12 (Apr. Oct.	10.5	18	"	129	14	190	Annual runoff,Col.12,based on relation of Apr-June on Saguache River to total annual for 1915-1918.
Alamosa Creek	Above Terrace Res.	" " "	102	10800	200	0.2			(1915-1918	86.8	97	South Fork	114	85	830	Ann.runoff,Col.12 based on relation Apr-Oct. on Alamosa to total annual for 1915-1918.
Conejos River	Above Mogote	" " "	275	10400	500	0.5			1910-1918	275.0	275	R.G.at Del.N.	112	246	890	Ann.runoff Col.12,6 mos.only-yearly runoff based on same mos.& relation to annual runoff of master stream.
La Jara	15 Mi.above Capulin	" " "	65	10200				2.0	5/16-10/16	19.2	21	Conejos	140	17	260	
Los Pinos	2½ Mi.above Ortiz	" " "	169	9600	1000	1.0			5/17-10/17			"	117	89	520	Ann.runoff Col.12,10 mos. (ditto).
San Antonio	" " " "	" " "	126	9300	500	0.5			1915-1918	102.8	103	"	94	14	110	Discharge based on spot measurements contained in Colorado State Engineer's Report 1915-1916.
N.Crestone,S.Crestone,	Willow,Spanish,Cottonwood & Deadman Creeks at Canon Mouths	All above station	48	10800					1/15-10/15	13.0	13					
Ute, Sangre de Cristo and Trinchera Creeks			276	9600	2500	2.5	0.8	3.3	1908 & 1915	36.0	36	Rio Grande @ Del Norte	113	32	740	
Culebra Creek	San Luis	All above mouth of Seco.	297	9600	8000	8.0		5.6	1908-1909	38.2	38	(ditto)	106	42	150	Sanchez reservoir completed 1911.Average area of water 1200 acres.Average evaporation loss 5000 A.F. annually. 15,000 A.F. holdover.
									1909-1915	54.0	54	(ditto)	113	62	210	

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TABLE-7
46

ALL RESEARCH ROOMS ARE UNDER ELECTRONIC SURVEILLANCE AND CAMERAS

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TABLE-7

OM MOUNTAIN AREAS WITH RECORDED DISCHARGES

on. reservoir apora- on & orage sses in: 00 A.F.	Runoff: Years of record used for comparison	Avg. rec. disch: 1000 A.F.	Avg. recorded annual discharge 1000 A.F.	Master stream used for comparison.	% of mean runoff in master stream during years in Col.10.	Computed mean annual disch. Col.11 Col.13 "7/8/9 in: 1000 A.F.	Mean annual runoff in AF per sq.mi. Col: 15 by Col 4.	Remarks.
9	10	11	12	13	14	15	16	17
3.8	1911-1918	181.1	181	Rio Grande at DelNorte	113	164	1050	Missing months computed by assuming same relation existing to Wasson as for months of record. Rio Grande Res. contained 16000 AF. Dec. 1918, estimated evap. losses since construction 14,000 A.F.
1.8	1911-1918	331.1	331	" "	113	300	580	Santa Maria Res. contained 8600 A.F. (ditto) 11400 A.F.
	1911-1918	87.9	88	" "	113	83	190	Consumptive use of water reduced for inflow from areas
	1911-1918	182.1	182	" "	113	164	730	(irrigated with S.Fork water 60% of area north of river.
	1915-1918	59.4	59	" "	109	59	100	
	5/12-9/12	14.0	20	Saguache	131	22	110	Annual runoff, Col.12, based on relation of May-Sept. on Saguache River to total annual in 1915-1918, incl.
	4/12-6/12 (Apr. Oct.	10.5	18	"	129	14	190	Annual runoff, Col.12, based on relation of Apr-June on Saguache River to total annual for 1915-1918.
	(1915-1918	86.8	97	South Fork	114	85	830	Ann. runoff, Col 12 based on relation Apr-Oct. on Alamosa
	1910-1918	275.0	275	R.G. at Del.N.	112	246	890	(to total annual for 1915-1918.
2.0	5/16-10/16 5/17-10/17	19.2	21	Conejos	140	17	260	Ann. runoff Col.12, 6 mos. only-yearly runoff based on same mos. & relation to annual runoff of master stream.
	1915-1918	102.8	103	"	117	89	520	
	1/15-10/15	13.0	13	"	94	14	110	Ann. runoff Col.12, 10 mos. (ditto).
	1908 & 1915	36.0	36	Rio Grande @ Del Norte	113	32	740	Discharge based on spot measurements contained in Colorado State Engineer's Report 1915-1916.
3.3	1908-1909	38.2	38	(ditto)	106	42	150	
5.6	1909-1915	54.0	54	(ditto)	113	62	210	Sanchez reservoir completed 1911. Average area of water 1200 acres. Average evaporation loss 5000 A.F. annually. 15,000 A.F. holdover.

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TABLE NO. 8

Total Run-off in San Luis Valley from Mountainous Area, being all above 8500 feet Elevation

WATERSHED	Computed Run-off from Table No.				Estimated Run-off from Additional Unmeasured Area				Total
	Area in sq. mi	Average elevation	Computed Mean Annual Run-off in A.F.per s.mi	Mean Annual Run-off in 1000 A.Ft.	Area in Sq.Mi	Average Elevation	Estimated Annual Run-off A.ft. per Sq. Mile.	Estimated Annual Run-off in 1,000 A.Ft.	Mean Annual Run-off in 1000 .A.F Col. 5 & 9
1	2	3	4	5	6	7	8	9	10
San Antonio River	126	9300	110	14	None				14
Los Pinos River	169	9600	520	89	None				89
Conejos River	275	10400	890	246	75	9000	80	6	252
La Jara Creek	65	10200	260	17	70	9000	80	5	22
Hat Creek					45	9200	100	4	4
Alamosa River	102	10800	830	85	35	9200	80	3	88
Cat Creek					35	9500	120	4	4
Rock & Eaton Creeks					50	10000	200	10	10
San Francisco Creek					45	9500	150	7	7
Pinos Creek					80	10200	200	16	16
Rio Grande River	1330	10700	530	711					711
La Garita					80	9800	80	6	6
Camero					105	10000	120	13	13
Lime Creek, etc.					55	9800	60	3	3
Saguache River	595	10000	100	59	33	9800	100	3	62
Kerber Creek	73	10300	190	14	73	10300	60	4	18
San Luis Creek	130	9100	170	22	70	10000	100	7	29
Cotton,Wild Cherry, Rio Alto & San Isabel Creeks					76	10500	350	25	25
So.Crestone, Willow,No. Crestone, Spanish, Cottonwood &									
Deadman Creeks	43	10800	740	32	10	9000	60	1	33
Sand,Medano,Mosca & other creeks to Ute Creek					80	10500	400	32	32
Ute, Sangre de Cristo & Trinchera Creeks	276	9600	150	42	None				42
Small Creeks on East Side					35	9500	100	3	3
Culebra Creek	297	9600	210	62					62
Totals	3462			1393	1052			148	1545

* Gaging station at Villa Grove within area where streams disappear and the final annual discharge is final Run-off from whole.

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Accuracy - Tables 7 and 8.

64. Comparing Column 15, Table 7, and Column 10, Table 8, it is found, as stated in paragraph 58, that 88 per cent of the estimated runoff has been recorded to some extent. Of the recorded runoff the longest records are on the Rio Grande, Conejos and Saguache Creeks, the drainage basins of which comprise 48 per cent of the mountain area and give 75 per cent of the measured runoff and 66 per cent of the total estimated runoff. These records, particularly the Rio Grande and Conejos, are of so long duration that the results may be considered very good. Seventy-seven per cent of the drainage area has records of some value of which 48 per cent are in the basins before-mentioned. Altogether, although this means of deriving the runoff leaves much to be desired, yet the results should be fairly accurate. It will be noted in examining the tables that the different unit discharges from different localities are clearly defined.

Loss to Artesian Basin

65. Not all of the discharge estimated reaches the floor of the valley through surface streams. It is a matter of common observation that the creeks from the Sangre de Cristo Mountains east of the dead area are entirely lost into the ground before the trough of the valley is reached and that those flowing into the southeast area diminish perceptibly. Seepage measurements have been made on the Rio Grande, Conejos and Alamosa Rivers reproduced in Table No. 9 which show as follows:

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TABLE NO. 9.

Seepage Measurements

Rio Grande River

Reference	Period of test	S.Fk. to Del Norte: Stage of River-s.f.	S.Fk. to Del Norte: Gain or loss-s.f.	Del Norte to Off Bridge: Stage of River-s.f.	Del Norte to Off Bridge: Gain or loss s.f.
W.S. No.358	Aug.20-30, 1900	194	±48	210	-4
" " "	1903	320	± 1	310	±13
" " "	Oct.1907	671	±27	572	± 9
" " "	Sept.Oct.'08	383	±32	413	-12
" " "	Oct.1913			650	-31
State.Eng.'14-"	1914	517	±25	550	-16

Note. Seepage measurements were made in 1896-1899, but as considerable doubt exists as to their accuracy, they are not listed here.

Conejos River

Source of Data	Time of test	Gag.Sta.-San Juan Bridge: Stage of Rivr.s.f.	Gag.Sta.-San Juan Bridge: Loss or gain-s.f.	San Juan Br.-Conejos Bridge: Stage of Rivr.s.f.	San Juan Br.-Conejos Bridge: Loss or gain s.f.
Ft.Collins Exp. Sta.Bull.180	Aug.1900:	25	± 2	25	-22
" " "	Jul.1901:	139	± 5	94	± 8
" " "	Oct.1902:	81	± 12	62	- 5
1907-08,State Eng.Report	Oct.1907:	103	- 11	82	± 4
" " "	Oct.1908:	98	- 9	73	-10
St.Engr.Recds.	Oct.1913:	97	- 6	75	± 3

Alamosa River

Source of Data	Time of test	Terrace Dam-E.Line T. 7.: Stage of Riv. s.f.	Terrace Dam-E.Line T. 7.: Loss or gain-s.f.	E.Line T.7 to Capulin: Stage of Riv., s.f.	E.Line T.7 to Capulin: Loss or gain s.f.
R.I.Meeker	Jul.1915:	140	± 9	210	-11
"	Aug.1915:	60	± 2	40	- 6

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66. The results on the Rio Grande show more losses than gains through the section below Del Norte, where such losses can normally be expected to occur, this being the upper portion of the alluvial cone as outlined by Siebenthal in W. S. Paper No. 240 (Report "b"). In addition to these measured losses, there are unmeasured gains from the underground flows of Pinos and San Francisco Creeks and the return flow from bottom lands irrigated within this area, although this loss is probably a negligible quantity in the measurements made in the fall.

67. Alamosa River has been tested only twice and shows an actual loss each time. In this stream a condition not found on other streams exists in that La Jara Creek runs parallel to the Alamosa in a channel considerably lower than that of the Alamosa. La Jara Creek is known to be fed from underground flows throughout the area where the Alamosa loses and very likely this accounts for some of the Alamosa River losses.

68. For the remainder of the streams, no data as to losses are available. Most of these streams are quite small since from the 40 per cent of the total mountain area drainage by the three streams above mentioned comes 70 per cent of the total runoff into the valley.

69. The only basis available for estimating the loss from these streams is the records of the investigations made by Lee in Owens Valley for the Los Angeles aqueduct water

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supply, W. S. Paper No. 294. Conditions in Owens Valley are apparently very similar to those in San Luis Valley. He found losses of from 15 per cent to 50 per cent of original stream water and from 5 per cent to 10 per cent per mile, the larger losses being in the smaller streams. Table No. 10 shows the results derived by Lee.

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TABLE NO. 10.

Stream Losses in Owens Valley from W.S.294.

Stream	Maximum measured original flow in sec.ft.	Derived formulas for loss of water based on original flow: Loss in s.f. per mile of stream legth	Length of channel	Total loss from stream. Total loss.
Taboose Creek	25	.105 x ∕0.03	4.8 mi.	.502 x ∕ .20
Oak Creek	100	.058 x -0.38	6.1 "	.358 x -2.30
Symmes Creek	40	.036 x .75	4.5 "	.164 x ∕3.38
Shepard Creek	70	.047 x .25	7.5 "	.352 x ∕1.85
Goodale Creek	20	.115 x	4.2 "	.480 x
Little Pine "	70	.062 x .16	3.2 "	.196 x - .50
Bairs Creek	40	.029 x .24	7.5 "	.216 x ∕1.85
George Creek	30	.062 x ∕ .20	5.5 "	.340 x ∕ .10
Lime Fork	2	.607 x ∕ .03	0.8 "	.460 x ∕ .02
Division Creek	30	.108 x	2.3 "	.250 x
Red Mtn.Creek	15	.109 x ∕ .08	3.4 "	.367 x ∕ 0.23
Tinemaha Creek	30	.048 x	3.6 "	.175 x

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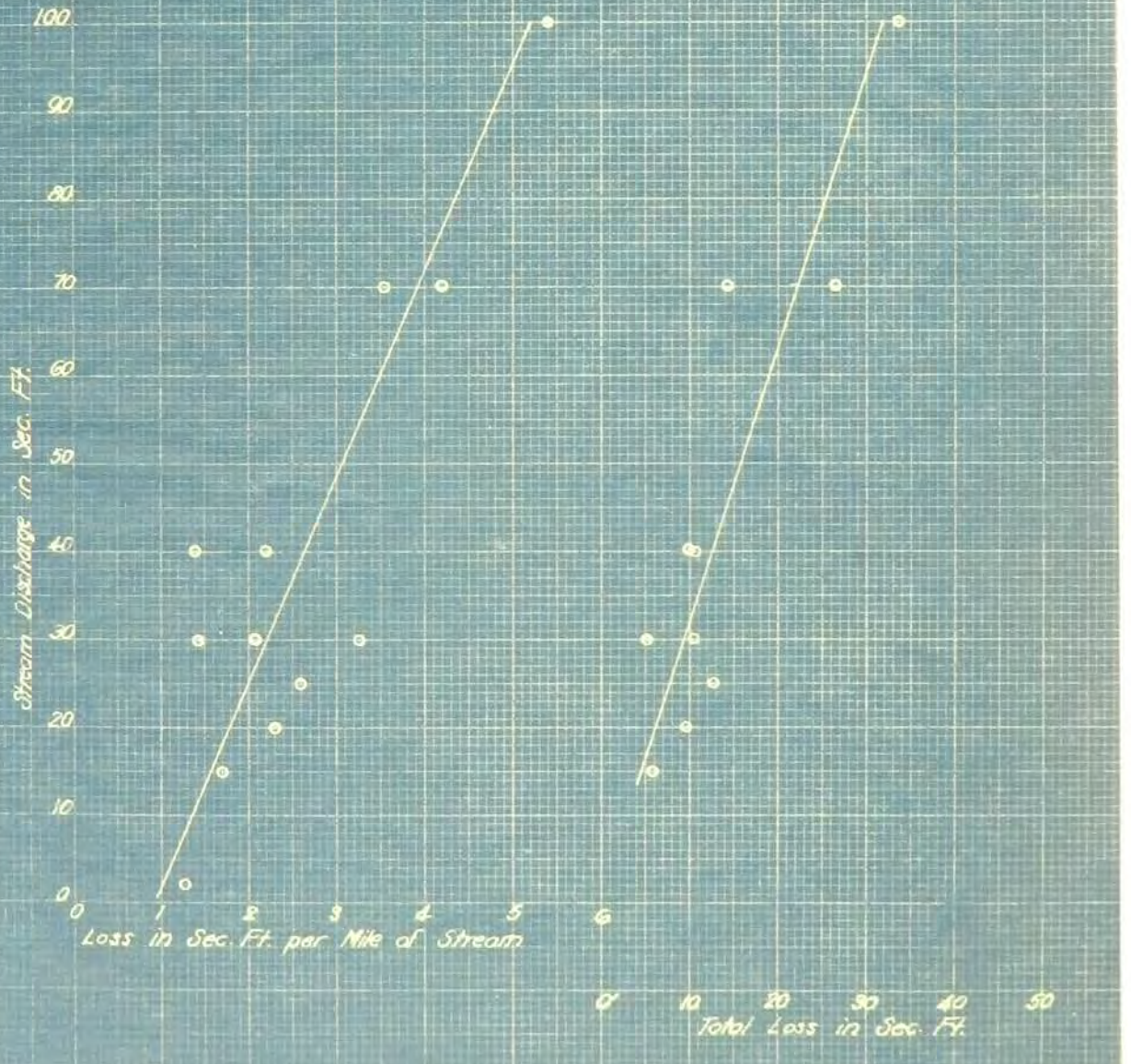
RELATION OF STREAM LOSSES TO STREAM DISCHARGE FROM WATER SUPPLY 294



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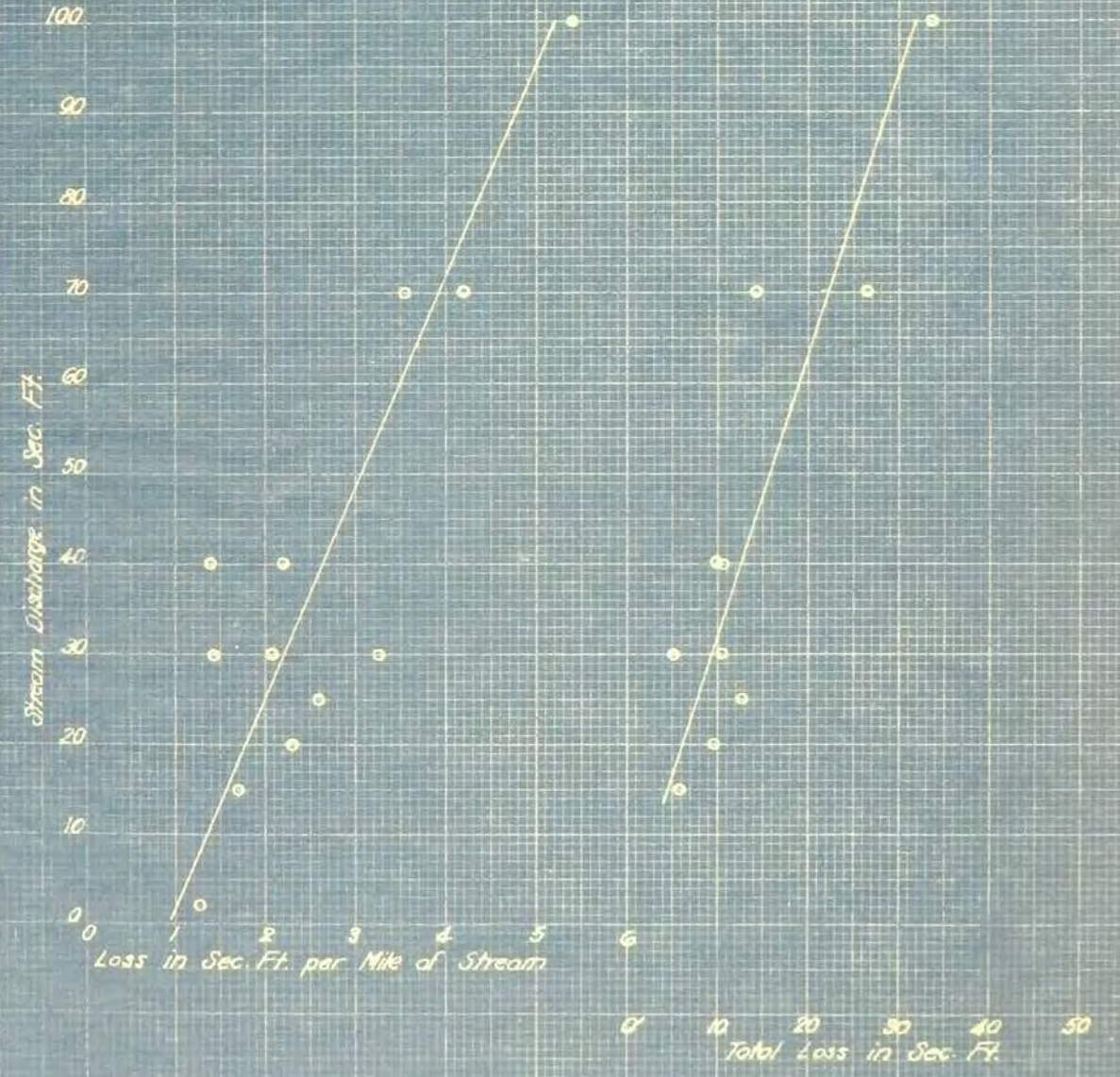
RELATION OF STREAM LOSSES TO STREAM DISCHARGE FROM WATER SUPPLY 294



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70. On the plat opposite, curves showing losses are derived from the foregoing table.

71. As noted heretofore, there is some irrigation in the mountain valleys before the main valley floor is reached. The following Table No. 11 shows an estimate of the average annual discharge which reaches the valley floor through surface streams. The depletion of the average estimated runoff of Table 8 is caused by irrigation above and by loss from stream bed. The loss from the smaller streams is estimated from the curves shown on the plat just mentioned. Whether the entire percolation from stream beds reaches the artesian basin is not certain but it is the opinion of those most familiar with the subject that it does.

72. The result arrived at is that the original runoff of 1,545,000 acre feet, irrigation in mountain valleys uses 44,000, percolation demands 200,000 and 1,301,000 is available for irrigation in the main valley.

Tabling this and using round figures:

Irrigation demand above valley floor. . . .	40,000 a.f.
Percolation.	200,000 "
Available to valley through surface streams.	1,300,000 "
	1,540,000 "

73. As noted before, this percolation, while lost to the stream and to the land in the immediate vicinity of the stream, is undoubtedly, at least in great part, one source

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Net Water Supply Available to Main Valley from Mountain Runoff TABLE NO. 11

STREAM	Orig. mean annual runoff in 1000 a.f. from table...	Losses by irrigation in upper valleys: Acreage irrigated	Losses by irrigation in upper valleys: Loss at 1.0 a.f. per a consumptive use 1000 AF	Volume affected by percolation loss Col 2,Col 4	Percolation Losses: Avg. flow in sec.ft. Col 5 ÷ by .720	Percolation Losses: Loss per mile in S.F.	Percolation Losses: Lgth. of Ch. in miles	Percolation Losses: Total loss in S.F.: Col.7 & 8	Percolation Losses: Total loss in AF: Col.9 .720	Net available water in 1000 AF. Col.5 Col. 10	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12
San Antonio River	14	1500	1	102	140	4.0	5	20.0	14	88	Loss reduced acct.
Los Pinos Creek	89										interference with
											Conejos River.
Conejos River	252	500		252	350			10.0	8	244	Loss based on actual measurements.
La Jara Creek	22	1000	1	21	30				none	21	Crk. in practice
Hot Creek	4			4	6	0.6	3	1.8	1	3	does not show loss
Alamosa River	88	200		88	120			8.0	6	82	" " " "
Cat Creek	4			4	6	0.6	4	2.4	2	2	
Rock & Ratton Crk.	10			10	14	1.0	6	6.0	4	6	
San Francisco Crk.	7	1000	1	6	8	0.7	4	2.8	2	4	
Pinos Creek	16	3000	3	13	18	1.2	6	7.2	5	8	
Rio Grande River	711	14000	20*	691	960			40.0	39	652	Loss based on
La Garito Creek	6	500		5	8	.8	4	3.2	2	4	actual measurements
Cornero Creek	13	200		13	18	1.5	4	6.0	4	9	
Lime Creek	3			3	4	1.2	3	3.6	2	1	Loss based on
Saguache Riv.	62	5000	5	57	80	4.5	6	27.0	19	38	small streams
Kerber Creek	18	500		18	24	1.0	4	4.0	3	15	
San Luis River	29	3500	3	26	35	5.0	3	15.0	11	15	Loss based on
Cotton, etc.Crks.	25			25	35	5.0	4	20.0	14	11	losses from small
No.Crestone, etc.	33			33	45	4.5	4	18.0	13	20	streams.
Sand, etc. Crks.	32			32	45	7.0	4	28.0	20	12	
Ute, etc. Crks.	42	2500	2	40	55	4.0	5	20.0	14	26	Loss based on 3
											streams.
Small Creeks	3			3	4	1.0	5	5.0	3	0	Loss based on
Culebra Creek	62	8000	8	54	75	4.0	5	20.0	14	40	small streams.
Total,....	1545		44	1501					200	1301	

*With Reservoir Evaporation Losses.

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Table 11.

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of supply to the artesian basin and hence when this is tapped becomes again available to the valley. Therefore, although it is probably physically possible to divert the water from the stream at a point above the area of percolation, yet such diversion would merely change the location of its use. It is probable that such diversion is either prohibitively expensive over most of the valley or that existing rights below the percolating area would be deprived of water. However, the water flowing from the Sangre de Cristo range east of the dead area is flumed across the talus slopes to some extent.

Water Used in Valley

74. The outflow of the valley is measured at the State Bridge, which has been maintained since 1900. Present development in the valley, if it had taken place before the period of record, would have caused some diminution in the recorded discharge.

75. As nearly as can be estimated from various water commissioners' reports and others, there has been an increase of 150,000 acres in the irrigated area of San Luis Valley from 1896 to the present, practically all of which took place before 1912 and the greater part of which probably took place shortly after the years of low runoff which ended in 1904. This increased acreage has not resulted in proportionate increase of use of water because of probable previous lavish use which had built up the water table and

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rendered further lavish diversion unsafe.

76. The plat on the next page shows this decrease in an approximate way. The Del Norte station measures the larger share of the inflow into San Luis Valley and the discharge of the other streams is practically proportionate thereto. Embudo gaging station is in New Mexico, 50 miles below the State line. By comparing years of similar run-off such as 1896 and 1918, a decrease may be noted in the later years.

77. The decrease can be shown with greater accuracy by comparing Del Norte and State Bridge or Lobatos Stations. State Bridge is 6 miles above the State line, measures the entire outflow from the valley and has been maintained since 1900. On the following plat with Del Norte discharges as ordinates and State Bridge discharges as abscissae, the records since 1900 have been platted. Through the platted points of records before 1912 the lower curve is drawn and through the records since 1912, since which time use of water has not increased, the upper curve is drawn. That is, taking the period prior to 1912, the upper curve shows the actual discharge at State Bridge while the lower curve shows that which would have occurred with present conditions. It is obvious that decrease could not be so great in low years as in high because the San Luis canals could not divert so much water in low years. This is shown in the curves by their greater divergence with increased discharge

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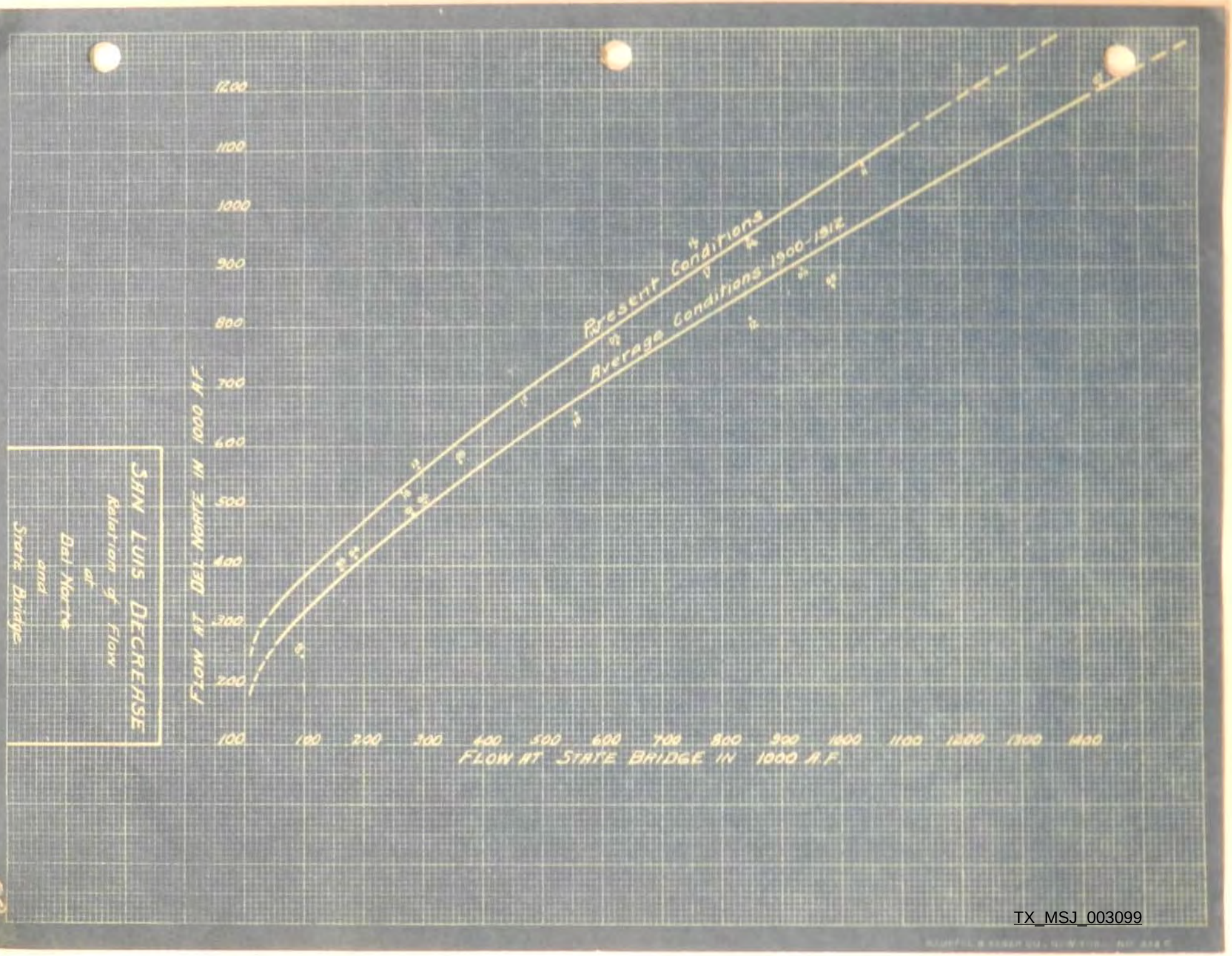

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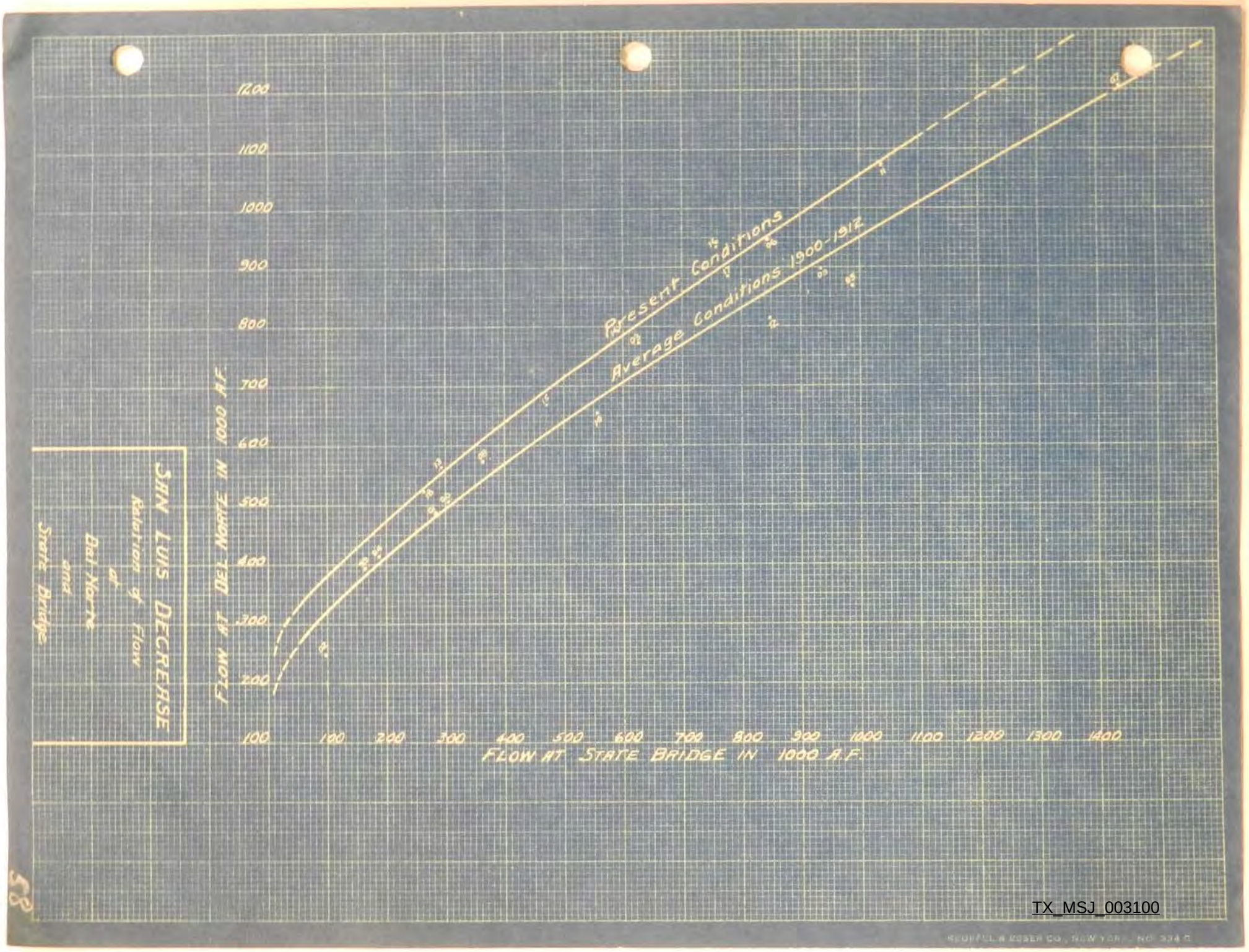

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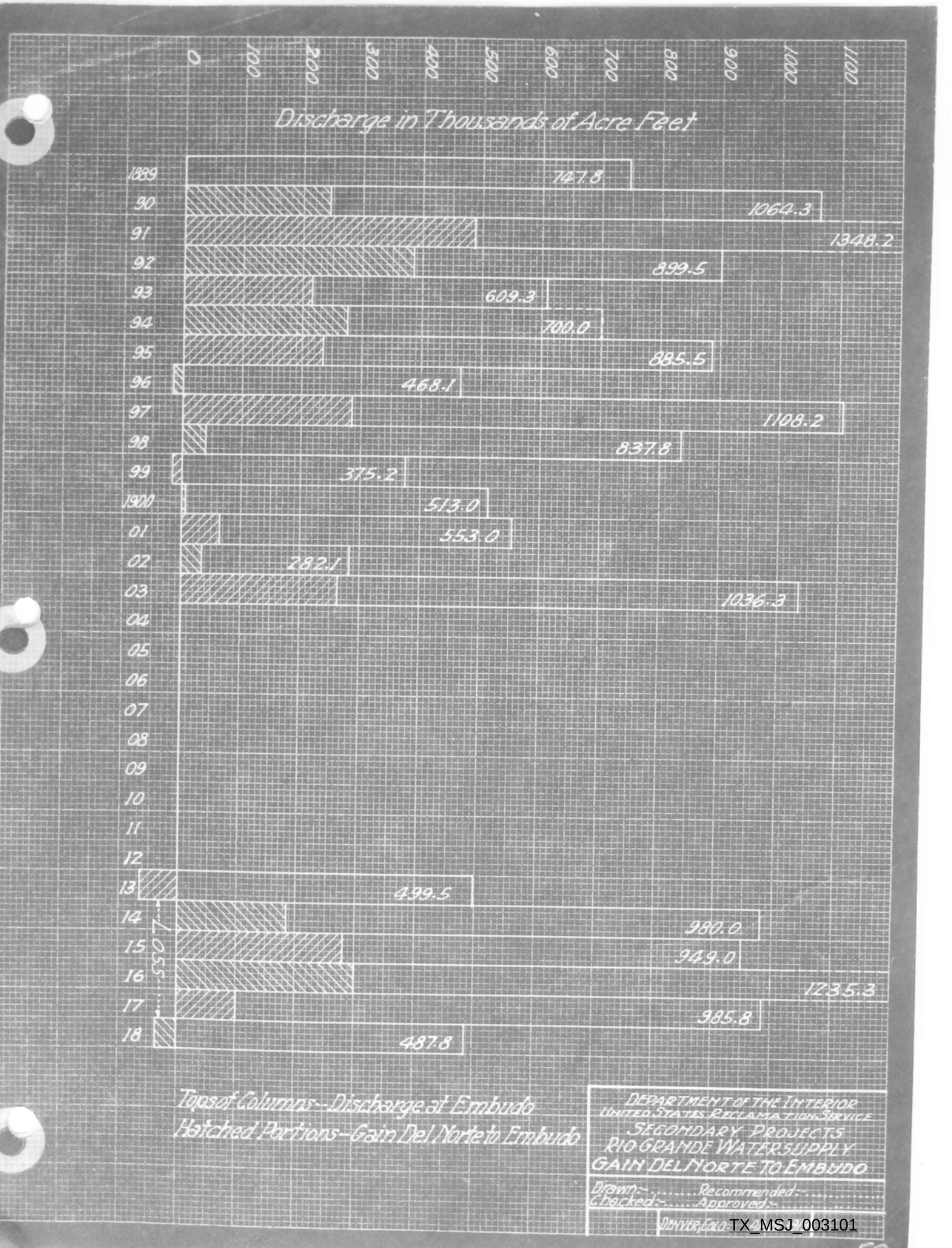

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at Del Norte.

78. The calculated flows at the bridge taken from the graph with present conditions and the actual flows are compared in the following Table 12. By referring to the actual monthly discharges, Columns 6 to 17, it will be seen that the calculated flow from the graph cannot represent true decrease in abnormally low years because in 1904, for instance, which had the lowest recorded discharge, the entire runoff of the valley during irrigation season was used in the valley after May and the flow passing the State Bridge was negligible. Obviously there could have been no decrease with increased acreage but the curve shows a decrease. Therefore a new table of probable decreases has been made after referring to the monthly discharges. Another item to consider is the fact that about 250,000 acre feet of reservoir capacity has been constructed during the period considered. The estimated decreased flow at State Bridge caused by filling these has been put in the month of April. The amount of decrease credited to each month is purely arbitrary but made after inspection of the recorded discharge of the month. After 1912, since when development has been stationary, it is assumed that there is no decrease in recorded flow. The total of column 18 has been kept at approximately the total for column 5.

79. It is apparent that the accuracy of the deduced

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TABLE 12

EFFECT ON STATE BRIDGE STATION OF INCREASE IN DIVERSIONS OF SAN LUIS VALLEY

UNIT - 1000 A.F.

Year	Flow at Del Norte	Actual flow at State Bridge	Flow at State Bridge from Graph	Decrease Col. 3 - Col. 4	Distribution of Decrease												Total Probable Decrease Col. 7+9 +11+13+ 15+17
					April *		May		June		July		August		September		
					Actual flow	Probable decrease	Actual flow	Probable decrease	Actual flow	Probable decrease	Actual flow	Probable decrease	Actual flow	Probable decrease	Actual flow	Probable decrease	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1895	649.7		416.0			45.0		20.0		30.0		20.0		0.0			115.0
1896	487.0		215.0			50.0		30.0		10.0							90.0
1897	823.4		655.0			45.0		30.0		40.0		10.0		0.0			125.0
1898	797.9		620.0			45.0		35.0		45.0		30.0		5.0			160.0
1899	393.4	163.3	82.0	81.0		40.0		10.0		0.0	2.6	0.0	3.3	0.0	6.1	0.0	50.0
1900	506.1	303.8	257.0	46.8	20.2	30.0	106.0	30.0	108.0	25.0	1.2	0.0	0.7	0.0	11.2	0.0	105.0
1901	487.2	283.7	220.0	63.7	16.8	45.0	124.0	35.0	66.0	20.0	5.0	0.0	3.4	0.0	2.6	0.0	100.0
1902	249.3	98.6	9.0	89.6	18.3	60.0	28.5	15.0	6.7	3.0	0.7	0.0	0.6	0.0	1.0	0.0	78.0
1903	772.9	627.0	569.0	58.0	18.7	20.0	124.0	40.0	379.0	50.0	72.4	20.0	2.9	0.0	5.4	0.0	130.0
1904	414.5	187.6	46.0	141.6	9.1	30.0	1.3	0.0	1.2	0.0	1.1	0.0	8.6	2.0	11.7	3.0	35.0
1905	868.5	986.5	834.0	152.5	46.0	65.0	350.0	50.0	430.0	40.0	16.7	5.0	10.0	2.0	3.8	0.0	162.0
1906	949.0	842.2	762.0	80.2	49.3	50.0	205.0	30.0	260.0	30.0	90.4	20.0	30.9	5.0	25.2	0.0	135.0
1907	1207.4	1436.5	1267.0	169.5	117.0	70.0	201.0	50.0	411.0	30.0	334.0	20.0	107.0	5.0	73.2	0.0	175.0
1908	574.4	363.0	378.0	-15.0	37.4	55.0	47.0	20.0	68.4	10.0	19.4	5.0	38.4	5.0	18.2	5.0	100.0
1909	896.8	938.4	652.0	244.4	63.1	35.0	213.0	40.0	269.0	20.0	37.3	10.0	28.7	3.0	140.0	0.0	110.0
1910	654.9	556.0	469.0	87.0	121.0	60.0	207.0	40.0	60.1	10.0	2.0	0.0	4.6	0.0	2.6	0.0	110.0
1911	1076.7	1036.9	798.0	238.9	27.4	40.0	129.0	20.0	243.0	15.0	222.0	10.0	35.6	5.0	41.6	5.0	95.0
1912	811.7	849.2	866.0	-17.8	50.0	30.0	262.0	20.0	306.0	20.0	49.5	5.0	17.3	5.0	11.7	0.0	80.0

* April decrease includes storage by reservoirs during preceding winter. 1913 to 1918 no modification as reservoirs were in general in full operation and increase in acreage irrigated was negligible.

TABLE 12

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TABLE 13.

Year	Recorded Discharge State Bridge	Reduction from Table. 12.	Revised Discharge	
1900	203,800 a.f.	105,000	98,800	
1901	283,600	100,000	183,600	
1902	98,700	78,000	20,700	
1903	627,000	130,000	497,000	Av.1900-04
1904	188,000	35,000	153,000	190,600
1905	986,500	162,000	824,500	
1906	842,000	135,000	707,000	
1907	1,436,500	175,000	1,261,500	
1908	356,000	100,000	256,000	
1909	933,400	110,000	823,400	
1910	556,000	110,000	446,000	Av.1900-11
1911	1,036,900	95,000	941,900	477,500
1912	849,200	80,000	769,200	
1913	288,200	0	288,200	
1914	593,300	0	593,300	
1915	471,000	0	471,000	
1916	762,500	0	762,500	
1917	777,400	0	777,400	Av.1912-18
1918	263,200	0	263,200	547,000
Av.	608,000	74,000	534,000	

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decrease is uncertain but nevertheless it is certain that decrease has taken place and some allowance must be made. These figures are submitted as the best result which could be obtained with the data at hand.

80. During the period from 1900 to 1918 the Rio Grande at Del Norte showed a discharge of 105.4 per cent of the average. Applying this to the grand average at the State Bridge gives a discharge of 578,000. Reducing this again by the 74,000 acre feet calculated reduction leaves an average outflow of 504,000 acre feet against an estimated inflow of 1,545,000 acre feet. The difference is due to evaporation from seeped lands and to useful consumption, the total being 1,041,000 acre feet.

81. The net present acreage of irrigated land is estimated at 376,000 in Table 6 of which 40,000 lies in the mountain valleys, leaving 336,000 acres in the main valley. A consumption of 1 acre foot has been ascribed to the mountain valleys. For the main valley where the season is longer, it is believed from various data from other irrigated areas that the beneficial consumptive use may be about 1.25 acre feet per acre. The beneficial use on this basis is

Mountain Valleys, 40,000 acres @ 1.00 a.f. =	40,000 af.
Main Valley, 336,000 acres @ 1.25 a.f. . . =	420,000 "
Total beneficial use.	460,000 "

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Wasted Evaporation

Inflow.	1,545,000	a.f.
Outflow	504,000	"
Used in valley. . .	1,041,000	"
Beneficial use	460,000	"
Wasted evaporation . and possible filling of artesian basin.	581,000	"

82. In other words, there is 1,041,000 acre feet used or lost in the entire valley of which 40,000 occurs in the mountain valleys and about 1,000,000 in the main valleys. The average annual amount which could be regained by 100 per cent efficient drainage is, if the irrigated acreage did not increase when the land is drained, 578,000 acre feet, giving a total annual average discharge at the State Bridge of 1,082,000 acre feet. During the period since 1904 the amount lost by evaporation must have been considerably more than the above figures.

83. Manifestly 100 per cent efficient drainage is impossible while extension of irrigation is certain with drainage and it remains to determine the probable expansion of irrigation with drainage and hence the new valley outflow or residue after irrigation.

Localization of Runoff

84. In Tables 8 and 11, the streams are listed in order around the valley beginning at the southwest corner. The discharge into the valley may be localized by areas as follows:

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TABLE No. 14.

	Mountain runoff	Stream loss to artesian basin & irrigation above	Available for diversion	Lost to basin from canals	Total for land	Artesian and spring outflow	Total available for land	% total
	1	2	3	4	5	6	7	8
Southwest	1217	107	1110	88	1022	97	1119	78
Dead area								
West	84	32	52	37	15	129	144	
East	137	64	73	11	62	14	76	
Total	221	96	125	48	77	143	220	15
Southeast	107	41	66	—	66	37	103	7
	1545	244	1301	136	1165	277	1442	100

Note: Col. 7 is 103,000 less than Col. 1. 44,000 of this is due to irrigation above gaging station and 59,000 to filling up artesian basin.

Dead Area

85. The southwest area, as stated before, may be neglected because extensive development will utilize the entire water supply. The 125,000 acre feet tributary to the dead area readily explains why it has become a dead area when considered in conjunction with the extremely flat slope of the land from San Luis Lake south, which is only 6 inches to the mile. Further more, only a part of this 125,000 acre feet now reaches the trough of the valley because of extensive irrigation use.

86. The tributary runoff is, however, not the only contribution to the water flowing into the dead area, the unused portion of which could be regained by a drainage system reaching to the Rio Grande. Practically all the waste water

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from diversion on the north side of the Rio Grande contributes also. In the following Table No. 15 is an estimate of the wasted water which is now lost by evaporation in the different areas of the valley. The diversions from the Rio Grande are the difference between discharge at Del Norte and Alamosa, and from the streams south of the Rio Grande are the difference between their discharge where they leave the mountains and the total at the State Bridge minus Alamosa. For other creeks, estimates are based on these calculated diversions. The period on which diversions are based is 1915, 1917 and 1918, with 1916 neglected because of faulty records. Undoubtedly the diversions in the low years prior to 1904 would have been much less so that the amount regained as shown in the table is higher than the average.

87. Summarized, this table gives the amount of water lost by evaporation from the various areas as follows:

Southwest	214,000 a.f.
Dead	
West. . . .	233,000 "
East. . . .	59,000 "
Total	292,000 "
Grand total	506,000 "

88. This may be used as an estimate of the value, from the point of water supply, of a main drain in the trough of the valley, over a diagonal drain further west which would intercept the Saguache. Apparently the main drain would regain 59,000 acre feet of water more than the diagonal drain.

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TABLE 13
USE OF WATER - SAN LUIS VALLEY
Based on 1915, 1917 & 1918 Diversions

Unit - 1000 A.F.

1916 not used because diversions abnormal.

Territory considered under Principal division	Source of water supply	Mean annual flow of streams after artesian losses within area from table 11	Diversions by canals based on estimates and Water Comm's reports	Use of Water Diverted from Streams: Loss to artesian basin from canals and irrigated areas along valley rim: Canal losses at 47% of diversions **	Irrigated area contributing to artesian basin inco.	Loss from Irr. area at 2.75 A.F. per acre ***	Beneficial use of Acreage irrigated	Beneficial use of water Beneficial use at 1.25 A.F. per acre	Total Col. 5+7 +9 unavoidable loss plus beneficial use.	Inflow from artesian basin. Total average output 277000 A.F. % for each district	Amount Col. 11 x 277	Water available for return flow Col. 4 - 10 + 12	Return flow #	Undiverted water lost by evaporation in dead area Col. 3-4 ##	Total water lost by evaporation & recovered by drainage Col. 13 - 14 + 15
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
South West Area	San Antonio to Rio Grande incl.	458	420 *	16	26000	72	141000	176	264	35	97	253	39		214
Dead Area	Rio Grande		281 *	11	7000	19	144000	180	210	35	97	168	0		168
	Carnero - La Garita	13	12	1			3000	4	5	8	22	29	0	1	30
West	Saguache	29	29	1	2000	5	17000	21	27	12	33	35	0	0	35
Total		42	322	13	9000	24	164000	205	242	55	152	232	0	1	233
Dead Area East	Kerber & San Luis South to Mt. Blanco	30	25	1	1000	3	4000	5	9	3	9	25	0	5	30
		43	35	1	2000	6	10000	12	19	2	5	21	0	8	29
Total		73	60	2	3000	9	14000	17	28	5	14	46	0	13	59
Total Dead Area		115	382	15	12000	33	178000	222	270	60	166	278	0	14	292
Grand Total			802	31	38000	105	319000	398	534	95	263	531	39	14	506

* Difference in discharges of Rio Grande at Del Norte and Alamosa for 1915, 1917 & 1918 average 421,000 A.F. Return flow assumed to balance artesian loss leaving 421,000 as canal diversions, divided to north and south areas in relation to their acreages, 281,000 and 140,000 resp.

** Based on losses in Rio Grande River

*** On assumption that diversions are at rate of 4 A.F. per Ac. with consumptive use at 1.25 A.F. per Ac. and balance of water to enter artesian basin.

\# None from dead area. Difference of flow at Alamosa and State Bridge represents undivided water in southwestern streams Col. 3-4, plus return flow from southwest area.

This applies to dead area only as undivided water flows to State Bridge on southwest area.

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However, the area irrigated would increase with drainage so that this quantity would be seriously depleted. It should be remembered, however, that the runoff from precipitation on the valley floor is neglected.

89. The foregoing estimates leave much to be desired. It is not to be expected tha t the results of the calculations made show more than an approximation of the truth. The best that can be said is that a fairly comprehensive idea of water supply can be gained.

Other Data - General Conditions

90. There remains to be shown such other data concerning various conditions of the valley as will be pertinent to discussion. This can be best shown by maps. There follows a series:

I. Drainage Districts.
II. Irrigated Lands from Report "L".
III. Irrigation Districts.

Note: The preceding tables present average values only, and this is done to present the general subject in its simplest form. In succeeding calculations these same things are gone into in a more detailed way and minor differences in results appear. For instance, the water which can be regained under present conditions from the northeast area is given in Table 15 as 60,000 acre feet. This is with a consumptive use of 1.25 acre feet. In figuring the same thing by an annual table, it is found that in some years there is not enough water for a consumption of 1.25 acre feet and that therefore the average consumption is reduced giving a larger annual outflow. These differences ~~xf~~ are of no moment and the explanation is noted here merely to avoid confusion.

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CLASON'S MAP OF THE SAN LUIS VALLEY

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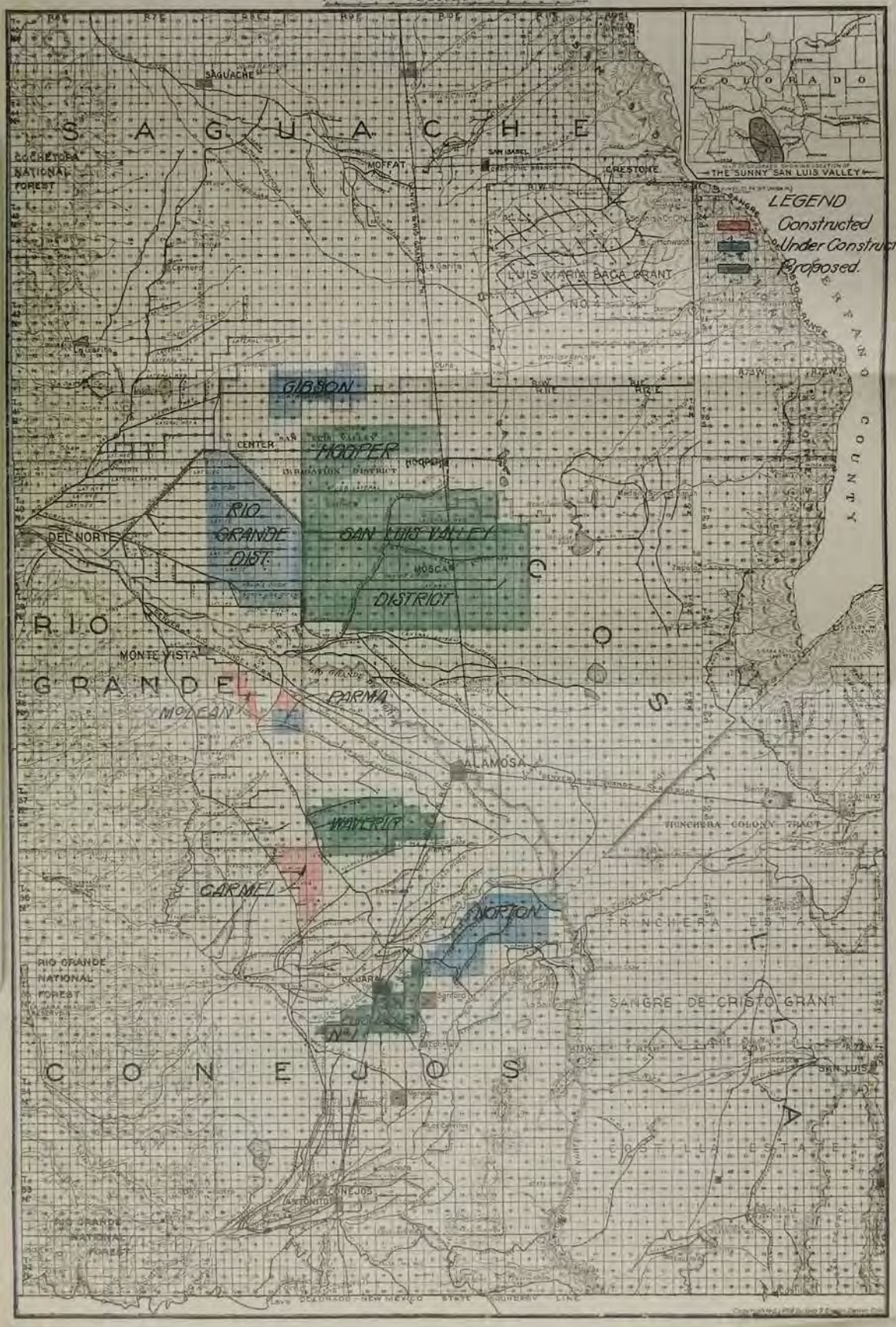

DRAINAGE DISTRICTS

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Meadow Lands. PRESENT IRRIGATION Agricultural Lands

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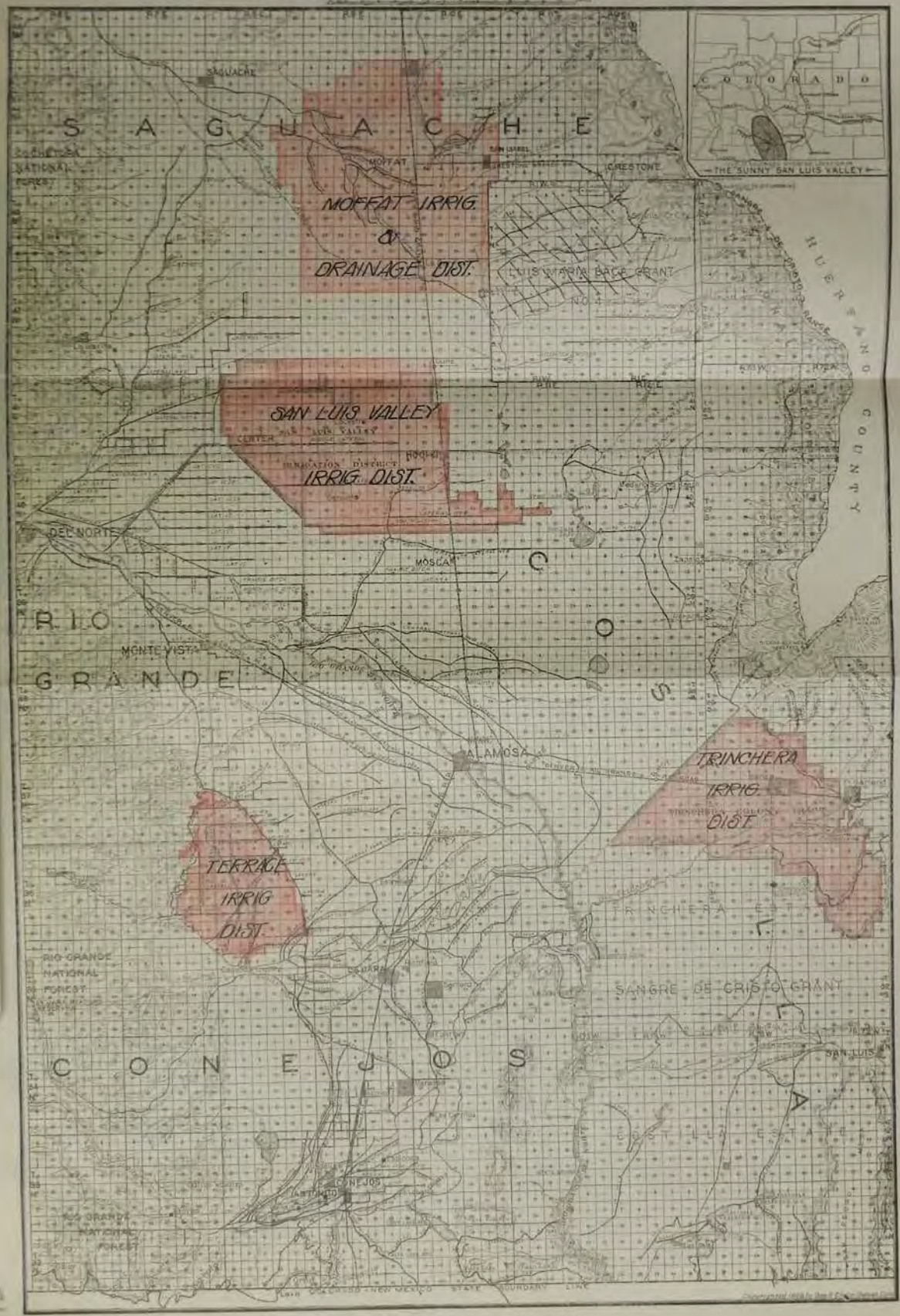

IRRIGATION DISTRICTS

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DEVELOPMENT OF SAN LUIS VALLEY

91. The foregoing pages give a survey and analysis of the water resources of the valley and their location. It remains to estimate the probable extent of the utilization of these resources in the valley and the effect of such utilization on water supply for irrigable areas below. Before doing this it is advisable to have clearly in mind the facts as to physical conditions in the valley and as to the laws of Colorado relating to irrigation.

92. The physical conditions are

(a) A flat plain of easily irrigated and easily drained fertile soil containing an area far in excess of any possible water supply. Practically all of this land is in private ownership.

(b) Canals and laterals already constructed to cover a large part of this acreage, or so easily built that their cost will be no bar to construction.

(c) The presence of a large underground lake of about 850,000 acres in area the surface of which will be lowered only a few feet below the ground surface by drainage.

(d) A climate which makes the stream runoff particularly favorable to irrigation from direct flow.

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TABLE NO. 16

Distribution of Runoff
Rio Grande River

Del Norte Station

	Average discharge	Percent total	
January	14,800 a.f.	1.9	
February	12,900	1.7	
March	21,200	2.8	
April	45,100	5.9	
May	161,500	21.2	
June	219,000	28.8	May to
July	105,500	13.9	August 71.5
August	57,600	7.6	per cent
September	39,000	5.1	
October	47,600	6.3	
November	21,900	2.9	
December	15,700	2.1	
		100.	

(e) The easy diversion from drainage ditches of the drainage return.

(f) A top soil generally very shallow and overlying a coarse gravel or sand subsoil.

93. The legal conditions are

(g) A body of decreed rights totaling from the streams under consideration

District	Stream	Sec.Ft.
20	Rio Grande	7316
21	La Jara-Alamosa	1871
22	San Antonio-Conejos	4591
27	La Garita-Carnero	47
		13845

Note. During the 30-year record on the Rio Grande, the discharge equalled the decreed rights only two weeks.

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(h) The fact that water rights are not appurtenant to the land but may be transferred. They are a private monopoly.

(i) The fact that these rights in large part have been used successively on different parts of the valley as the water table encroached on the arable land.

(j) The fact that since use on most of the abandoned land ceased because of high water table, it is uncertain that court would rule that these rights have been abandoned.

94. Given these conditions, an approximation of the results of development by drainage and irrigation may be made, under the assumption that rights are valid.

95. There are said to be 850,000 acres of seeped land in the valley. This is hardly true. There are 850,000 acres (see plat following page 18) under which the water table lies 8 feet or less of the surface. With the coarse subsoils of part of the valley this water table hardly affects the surface on a part of the valley and it can be successfully farmed. The area east of a north and south line 3 miles west of Mosca is in mind. At Mosca the water table is about 4 to 5 feet below the surface and about six miles east of Alamosa about 8 feet. It can be said with truth that there are 850,000 acres which should be seeped if more of the land were irrigated.

96. As shown on the plat referred to, there are areas unaffected by ground water on the outwash slopes of the Conejos

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Alamosa, Rio Grande and Saguache Rivers totaling 200,000 acres, giving a total, in addition to the small areas along the Sangre de Cristo Range, of 1,050,000 acres which are near the larger streams, are largely under ditches diverting from them or will have ground water very close to the surface with the best possible system of drainage.

97. As shown in Table No. 6, there are 346,000 acres now irrigated from the streams of the valley excepting the southeast area. Of this, a trifle more than 300,000 are on the valley floor. The average runoff is estimated to be 1,400,000 acre feet tributary to this area. It is evident that much more land can be irrigated than at present. Such extension depends largely on ability to control the discharge by reservoirs.

Duty of Water

98. There are very little authentic data on this subject. The Costillo estates contract to deliver 1.5 a.f. per acre at the land but so far has never delivered more than 1.3 and in 1918 delivered only 0.75. Failure to deliver has been due to lack of water although crops are said not to have suffered for lack of water with the larger delivery. Rainfall in that section averages 10 inches or 50 per cent more than on the entire valley and the soil is deep and finer than on the west side.

99. By using the difference in records between Del Norte and Alamosa, the diversions from the Rio Grande may be

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gotten much more accurately than from the Water Commissioner's reports. The acreage served from the Rio Grande is uncertain but has been estimated for this report at 192,000 acres. The average annual diversion since and including 1915 has been 421,000 acre feet or 2.2 acre feet per acre. A part of the land served is quite badly seeped and it seems probable that diversion would be more were this not the case. It is probable also that canal losses would be much larger with drainage because in some cases canals are gaining instead of losing due to high water table. It is believed by the better informed residents of the valley that 2.5 acre feet at the river heading is sufficient and that figure is used in succeeding computations.

TABLE NO. 17

Assumed distribution of demand - San Luis Valley.

	A.F. per acre	% total
April 14-30	0.15	6
May	0.50	20
June	0.80	32
July	0.50	20
August	0.30	12
September	0.15	6
Oct. 1-15	0.10	4
	2.50	100

Runoff for above Irrigable Area

100. Assuming that divergence from normal runoff is approximately the same on other streams as the Rio Grande, this may be used as a basis for estimating the supply during any period of years.

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101. An additional contribution to this area is from the artesian basin; roughly there may be 186,000 acre feet from this source annually which enters as a steady flow, plus 67,000 from springs.

TABLE NO. 18

Water available for San Luis Valley except southeast area.

Period	Years	Average Rio Grande discharge	Percent normal	Total surface discharge all streams.
1	2	3	4	5
Average	30	690,000	100	1,440,000
1890-1898	9	641,000	93	1,340,000
1890-1904	15	593,000	83	1,195,000
1899-1904	6	471,000	68	978,000
1905-1918	14	812,000	118	1,688,000

Reservoirs

102. On the Los Pinos and San Antonio in the southwest corner, there are no possible feasible sites. On all other streams on the west side reservoirs have been constructed or can be constructed at a not prohibitive expense. Los Pinos and San Antonio Creeks may be diverted to the Conejos River to supply water to canals from that river during the flood season while the reservoir on that river is storing the floods of the Conejos. In turn, Conejos reservoir water may be diverted to supply canals from the Los Pinos and San Antonio. Construction of these transfer canals apparently presents no difficulties so that except for winter flow, the Los Pinos, etc., may be almost as fully controlled by the Conejos reservoir as the other streams of the valley by reservoir in their own beds.

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103. Based on the foregoing duty, preliminary estimates show that reservoirs of capacity not more than 33 per cent of the average runoff of the river will completely control the stream.

TABLE NO. 19

Constructed Reservoirs

(For complete reservoir data see Table No. ____).

Stream	Name of Reservoir	Avg. annual Discharge	Present Reservoir Capacity	Capacity required
Alamosa	Terrace	88,000	17,000)	
La Jara	La Jara	22,000	14,000)	37,000
			31,000	
*South Fork of Rio Grande	Beaver Park		4,500)	
Rio Grande	Rio Grande	717,000	45,000)	239,000
Rio Grande	Santa Maria		44,000)	
			94,000	
*Saguache	Saguache	64,000	1,200	21,000

*Not used because of excessive seepage.

104. The Santa Maria is filled through a diversion pipe. It does not fill even when discharge is sufficient because of lack of pipe capacity. Its effective capacity is probably about 20,000 acre feet.

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TABLE NO. 20

Additional Reservoirs

Needed and Available

1 Stream	2 Discharge	3 Reservoir site	4 Additional Capacity required	5 Cap. of reservoir	6 Estimated cost per AF based on (5)
San Antonio) Los Pinos) Conejos)	354,000	Conejos	118,000	140,000	$23.
La Jara) Hot Creek) Alamosa)	115,000	Narrows	6,000	6,500	
Rio Grande	717,000	Vega Sylvestre	184,000	238,000	13.
La Garita) Cornero)	15,000	*Devils Gate	*5,000	18,000	
Saguache	64,000		21,000	25,000	35.

*No estimate but probably over $100 per acre foot.

Additional Reservoirs Available on Rio Grande

Continental	52,000 acre feet
Wagon Wheel Gap	995,000 " "

105. As building Wagon Wheel Gap reservoir would involve the reconstruction of between 15 and 20 miles of the Denver and Rio Grande Railroad at a probable cost of between $1,500,000 and $2,000,000, no estimate of this site has been made. As only about 184,000 acre feet capacity is needed, it is believed the Vega Sylvestre is the better site and although further upstream controls the discharge almost as well.

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106. It is apparent that there are sufficient reservoirs to completely control the streams in question.

107. As topography permits free interchange of water from one stream to another, there is no necessity of treating each stream separately but the whole can be treated as one project and water supply analyzed on that basis.

Unlimited Irrigable Area

108. The absence of definite limits to the irrigable area makes it difficult to approximate the acreage which will be irrigated. Court rulings up to the present time are not sufficient to state that acreage can be limited by law. Although direct flow rights of the Middle and Lower Rio Grande are senior to any rights in the San Luis Valley, yet the difficulty of enforcing these rights is enormous because of state lines. The storage right of the Elephant Butte reservoir is junior to practically all the rights of the San Luis Valley and although its case may be urged successfully against rights for land which has never been irrigated, yet the case is not so clear that such assumption can be made. The shortage in a reservoir of this kind is the result of a series of years of small supply. It would be very difficult to shut off diversions above until the year the reservoir went dry.

109. It would seem, if supply for lower projects is in jeopardy, that the present control of reservoir sites by the federal government could be continued and reservoir

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development not allowed and that such a course would effectually cut down the acreage to appoint where present rights below would not be in danger. However, as is shown in succeeding paragraphs, this prohibition would not be effectual in reducing the amount of water used in the valley because of possibility of pumping from ground water.

110. If there is a possibility that drainage of the entire area will jeopardize rights below, and if it be concluded that drainage is so difficult as to necessitate government reclamation, it would seem that only partial drainage would be the solution of the situation. However, the topography which makes irrigation and interchange of water so easy also makes it impossible to so limit the drained area. An outlet drain for the dead area will make it possible to cheaply drain practically the entire dead area. Besides this, as stated before, the construction of drainage ditches is so easy that if the government does not do the work, it will be done privately.

Possible Plans of Development

111. Assuming that drainage ditches have been dug, consideration of the physical features of the valley leads to the belief that, aside from the 19,000 acres in the southeast corner and the approximately 14,000 acres now irrigated from the Sangre de Cristo Creeks and San Luis Creek, irrigation will be confined to some part of the

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1,050,000 acres previously mentioned and to a possible extention to a total of 25,000 instead of the 14,000 above. Diversion of the Saguache to the north is difficult and it is practically an impossibility to take water which originates on the west side past the valley trough. Two possible ways in which the water in the valley may be utilized may be considered:

(a) By reservoir development to about 33% of the average annual runoff, and diversion of the drainage water where possible.

(b) By reservoir development on the Conejos approximately proportionate to that on the Rio Grande (about 10% of the average annual runoff) diversion from drains, pumping from drains and pumping from ground water.

112. It is difficult, as stated, to arrive at a basis for estimating the ultimate irrigated acreage. If the Reclamation Service were developing a project under similar conditions and had no stream flow records prior to 1905, the development would be based on these later records which are 18 per cent above the average and 42 per cent above the average for the fifteen years preceding. Since water rights in Colorado are private property which may be transferred or sold at a profit and since there is no method of limiting the acreage which may be irrigated, it is inevitable that private development will be such as to use the supply of the

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last fourteen years. Since the loss by evaporation, as shown in paragraph 81 is only 581,000 acre feet which approximates only 0.65 feet in depth per acre because of lack of capillarity of the soil, and since it is entirely improbable that the consumptive use of irrigation water would be so small, the additional area irrigated must be smaller than the area drained if the net runoff from the valley is to remain the same as in the past.

Consumptive Use

113. There are very little data on consumptive use of water in irrigation but it appears from what does exist that the quantity may be much more definitely fixed than can the diversion duty.

114. Data at hand are as follows:

Feet in depth per acre

Project	Area acres	Location	Years record	Diversion average	Precip. average	Total appln.	Con-sumed	Return flow
Boise	13,550	Idaho	2	4.08	0.94	5.02	2.13	2.89
Cache la Poudre	234,000	Colorado	9	1.25	1.26	2.51	2.18	0.35

Also the records on the Shoshone and Carlsbad Projects are sufficient to show that the consumptive use is less than 2.35 and 2.40 a.f. per acre, respectively.

115. The Cache la Poudre data is taken from carefully kept reports of the State Engineer which record the total inflow and outflow of the valley. The difference between

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these shows an average consumption of irrigation water only of 0.92 feet in depth.

116. This consumption consists of three items:

(1) Plant transpiration.
(2) Evaporation incidental to irrigation.
(3) Evaporation from undrained lands.

Item 1 has been the subject of investigation by agricultural research workers for more than 200 years and with advance in knowledge of the subject and more careful experiments, the results secured in the last several years in arid countries are fairly consistent. If the observed transpiration ratios for each kind of plant be applied to the average crops of the Reclamation projects, it is found that this item amounts to about one foot of water per acre and is not greatly different for southern than northern projects because, although alfalfa grows more luxuriously in the South, and therefore uses more water, other crops offset this to some extent. The value for Item 1 is therefore taken at 1 foot.

Item 2 is partially under the control of the irrigator and with an underground pipe system should be negligible. With ordinary methods of irrigation, it may be considerable and particularly so in hot windy countries. With a soil so pervious as the San Luis Valley which allows water to sink below the surface rapidly and if there is no considerable surplus to allow great surface waste, it should be small.

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It is estimated here at 0.25 feet in depth.

Item 3, because of easy drainage, should not be large in this valley but because of the small discharge of the artesian wells which will constitute a part of the water supply, is taken at 0.25 in depth for each acre irrigated.

117. The sum of these three items plus the precipitation gives the consumptive use as follows:

Plant transpiration	1.00
Incidental evaporation	0.25
Seeped land evaporation	0.25
Precipitation	0.60
	2.10

which is less than the total in the Cache la Poudre Valley. This is consistent because so large a part of the consumption in the Cache la Poudre is furnished by precipitation which suffers a larger percentage of evaporation than does irrigation water. That is, a considerable part of precipitation occurs in rains of half inch or less in depth which are generally evaporated without furnishing any appreciable water to plants. The percentage of evaporation on larger rainfalls, which are rarely greater than 1 1/2 inches, must also be more than on a 3 to 6 inch application of irrigation water.

118. On the other hand, the estimated consumption in the San Luis Valley may be too large as compared with the Cache la Poudre. However, the area of seeped land in the Cache la Poudre totals only 4000 acres while the probable

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area in the San Luis even with drainage will be several times that figure.

Probable Acreage

119. The discharge tributary to the 1,050,000 acres (this is different from the quantity in paragraph 97 because Sangre de Cristo drainage not considered) embraces all streams from the San Antonio River on the south to the Saguache on the north. The average discharge from these streams by Table No. 8 is 1,301,000 acre feet, of which 1,162,000 acre feet reach the valley floor on the surface (Table 11). The discharge since 1905 has been 18 per cent above this or 1,535,000 acre feet. The above diminution from stream bed percolation and mountain valley irrigation should not be greatly changed leaving about 1,400,000 acre feet of annual surface runoff tributary to this portion of the valley during the past fourteen years. In addition, there is an annual increment of about 186,000 acre feet from artesian wells plus 90000 acre feet from springs or a total of 1,676,000 acre feet.

120. If the consumptive use of irrigation water is 1.5 acre feet (paragraph 117), and the diversion 2.5 acre feet, there will be a drainage return of 1 acre foot of which from records of flow from drains on Reclamation projects, about 60 per cent will discharge in the irrigation season and which can, in the main, be diverted to additional acreage in the valley. From this additional acreage

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the return may be again diverted, etc., so that after allowing for a winter return of 40 per cent, the calculated number of acres which can be irrigated is 780,000. This is, of course, too high because this average flow embraces two extremely high years, a certain amount of drainage return in the summer will be lost to the valley, and it is doubtful that there is so large an irrigable acreage in the area under consideration.

121. As a preliminary step, 725,000 acres was adopted as the probable acreage and approximate estimates made of the possibility of furnishing a water supply to that area. This figure was finally adopted as the probable ultimate net acreage or about 425,000 acres more than now on the west side of the valley.

122. Based on a diversion duty of 2.5 acre feet, a reuse of the return flow and use of artesian water, Table 41, has been prepared, the results of which are embodied in the mass curve of reservoir operation following this sheet.

123. While rather severe shortages exist in the period from 1905, yet larger reservoirs would have decreased some of these shortages and it is believed the development is not larger, compared to the runoff, that any unrestricted private development would be. In the period preceding 1905, however, the severe and frequent shortages would prove disastrous unless some other method can be found to relieve the situation.

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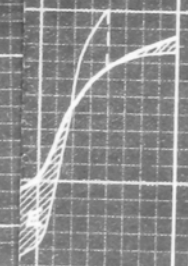


MASS CURVES of DEMAND and SUPPLY

and

CURVE of RESERVOIR OPERATION

for

725000 ACRE DEVELOPMENT

in

SAN LUIS VALLEY

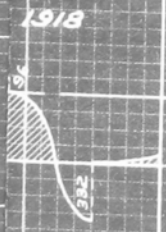
from

SAN ANTONIO to SAGUACHE RIVERS, INCL.

and

400000 ACRE FEET RESERVOIRS

June 1919



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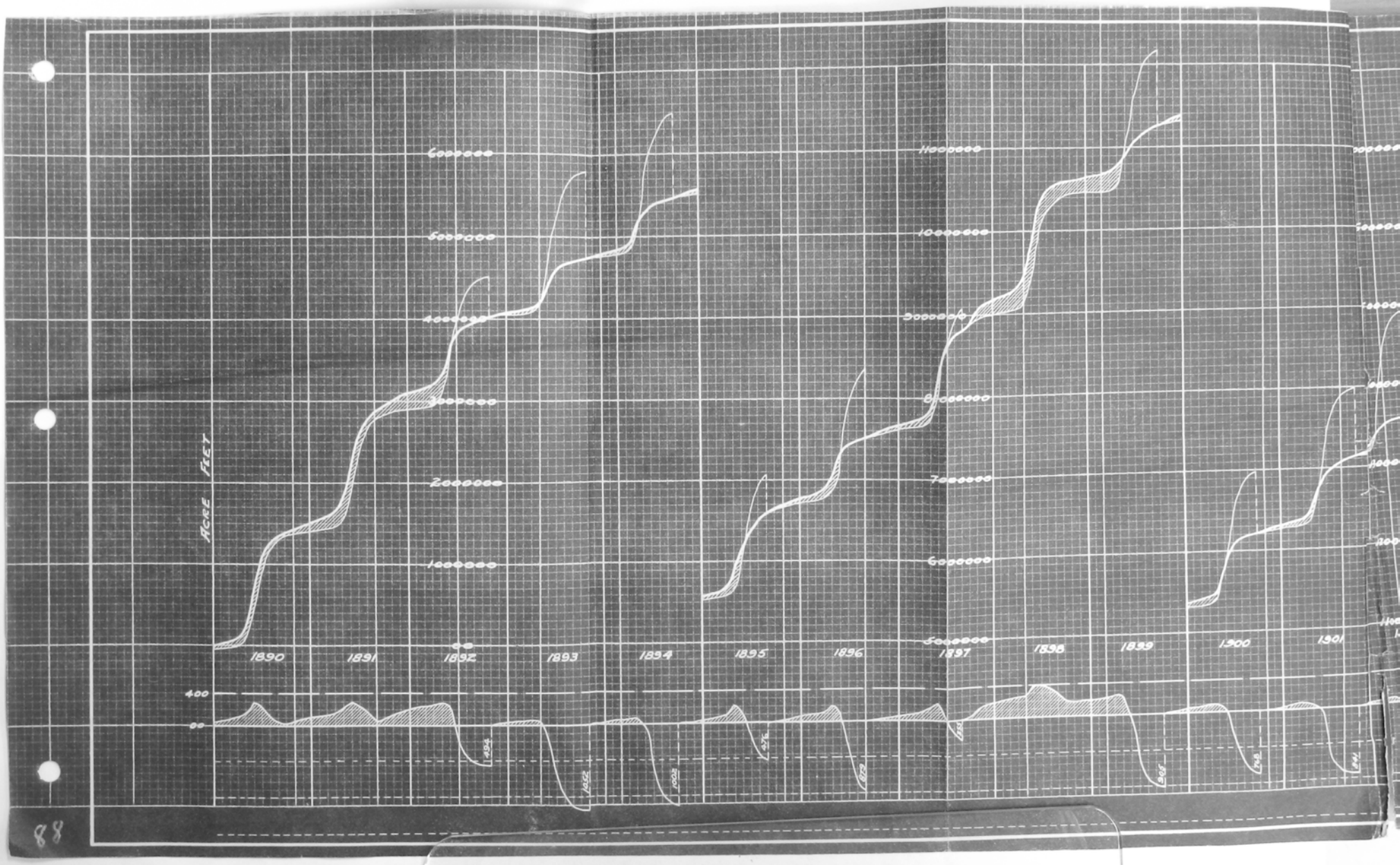

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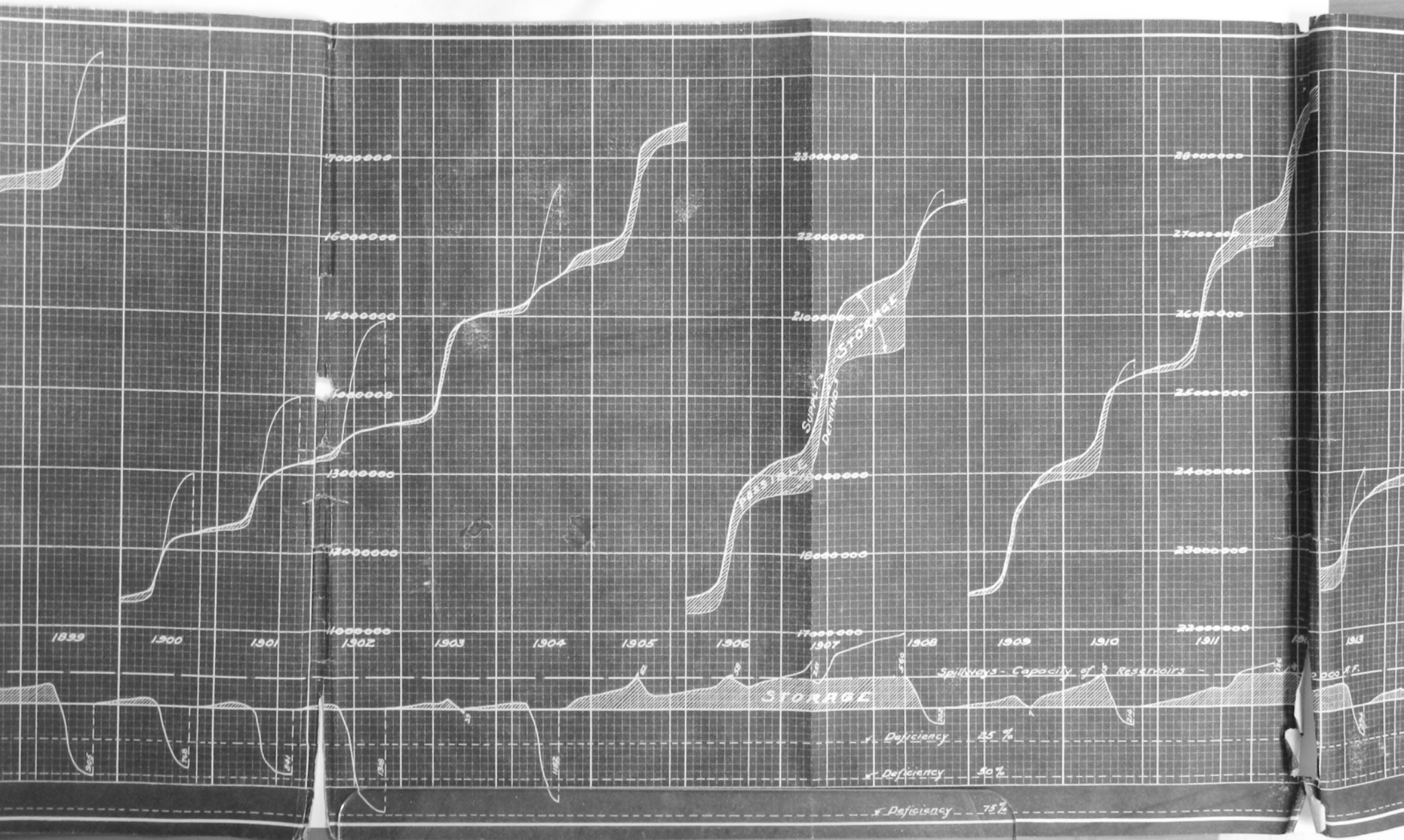

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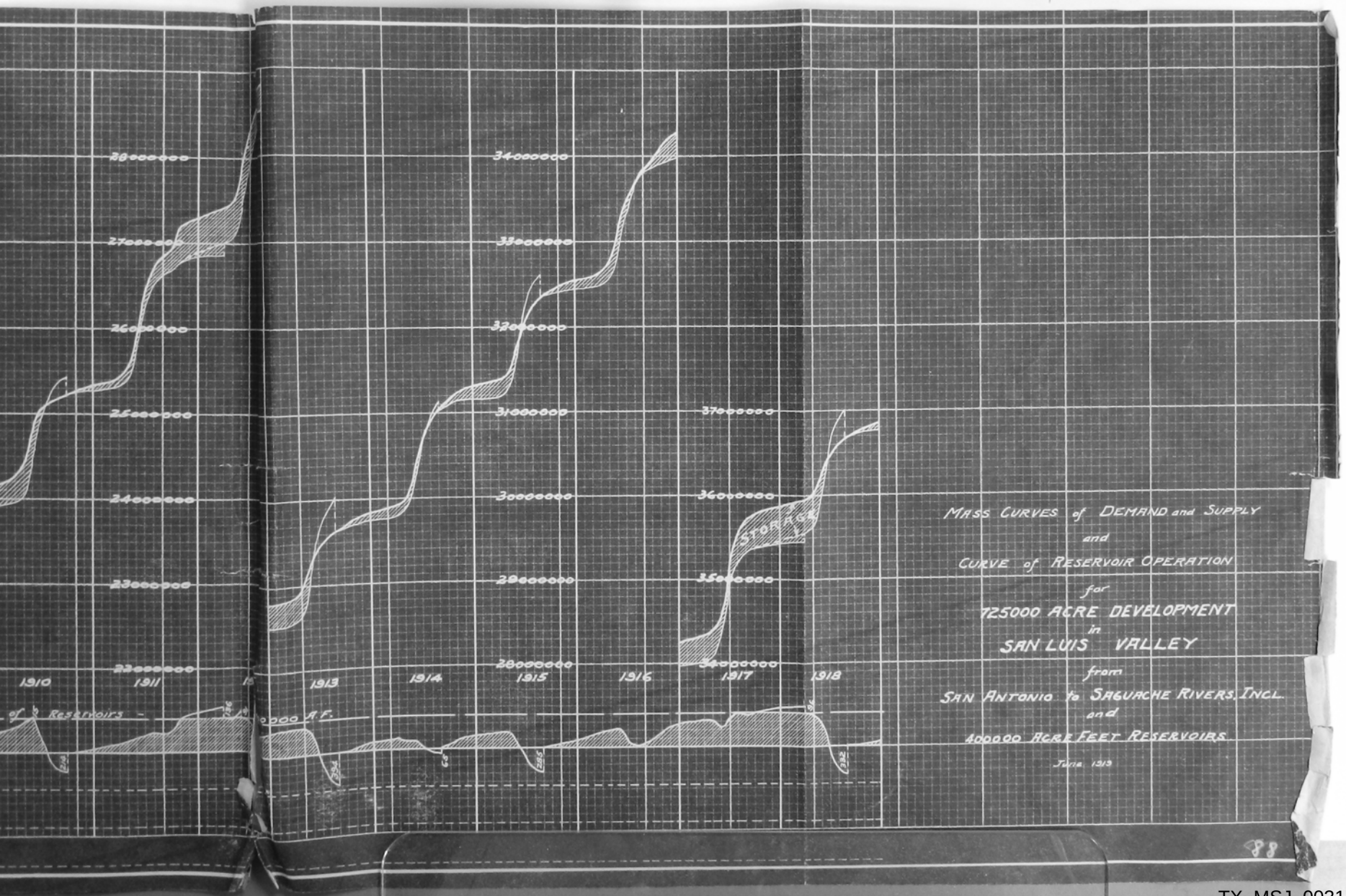

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124. It is entirely evident that, on such duty as was assumed, the water supply is insufficient for the acreage in question. Yet it is probable that development might approximate the figure in question if diversion could be regulated to the duty assumed and there was no restriction on reservoir building. Evidently also, even with the duty assumed, reservoirs do not appreciably help the water supply in the low years.

125. While the foregoing is presented to illustrate the undesirability of extensive reservoir development even with the apparently sufficient and reasonable duty assumed and the impossibility of furnishing a supply from surface water to the probable acreage which would be irrigated if drained, yet actual diversions are different and follow a regime which would effectually prevent storage in the irrigation season of most years.

126. In 1902, with possibly about 250,000 acres irrigated, no reservoirs built, and little development in the southeast corner, the total outflow from the valley measured at the State Bridge, averaged 40 second feet - June to September, inclusive. In 1904, from May to August, it averaged 50 second feet. In 1918, from May to August, inclusive, the discharge of the Rio Grande River at Alamosa, which is below the last diversion, totaled 16,000 acre feet while little ~~no~~ water was stored in the reservoirs during that period.

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The discharge of the Rio Grande in 1918 was 78 per cent of the average and 90 per cent of the average from 1899 to 1904.

127. The present acreage irrigated from the Rio Grande is about 192,000. With drainage, expansion is certain, so that in most years there would be little opportunity to store water during the summer if future use of water is proportionate to present. As only 18 per cent of the water is discharged outside of the irrigation season and as the reservoirs are so situated that they cannot control more than 60 per cent of the winter runoff, only about 10 or 11 per cent of the annual discharge could surely be stored so that reservoirs would supply only a comparatively small area. If late water is available to the remainder, it must come from pumping from ground water or drainage return.

128. Some individual installations of pumps for this purpose have been made in the past but have been little used because of the series of years of heavy runoff and perhaps because of faulty installation. Experiments on pumping in the vicinity of Moffat with a battery of six 6" wells connected to one power plant are said to have given a discharge of 3.2 second feet. The drawdown was 15 feet in a few hours but no further drawdown was made in the two weeks' duration of the experiment.

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129. Soil conditions in the remainder of the valley are fully as favorable as at Moffat for easy pumping, if not more so. Estimates of cost for internal combustion engine driven pumps show that installation can be made for from $20 to $25 per acre, while the cost of pumping including interest, depreciation and engineman should be about $5.00 per acre for a lift of 25 feet and a duty of 1.5 acre feet per acre. As gravity water would be available during a part of most years, it is probable that cost of pumping would vary from $2.00 to $5.00 per acre for individual installations.

130. It is also possible, as stated before, to divert from drains and where diversion is not practical to pump from drains at a probably somewhat less cost than from ground water. The return from the Rio Grande district is now being used in the vicinity of Mosca.

131. Since the land is all patented, there is no possible way of limiting construction by holding up right of way. Canals now constructed are sufficient to divert the entire flow of the streams, or if not, can be easily enlarged.

132. It seems probable that if pumping development is undertaken and is found to be successful, and there appears to be no reason why it should not be, canals will divert the entire flow save in the extremely high years and maintain the ground water against depletion by pumping,

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while the surplus water will be removed by drains.

133. What acreage would be developed under such circumstances is uncertain but the area over which pumping may be practiced is limited to the 850,000 acres of seeped land while the 200,000 on the outwash cones must have a reservoir supply or direct flow supply. Of the 1,050,000 acres in question, ordinary right of way reductions may be 100,000 acres while the hummocky land east of Mosca, the areas impossible of drainage and the stream beds may reduce it by another 200,000 leaving about 750,000 acres, or if the 25,000 acres from the Sangre de Cristo and San Luis Creeks be deducted, the acreage used is the same as for the preceding scheme. Another limitation may be the expense of pumping ground water for that acreage which cannot be supplied with gravity water most years for one irrigation. It is probable that depletion of ground water will not be a limit because the canal losses through the very pervious soil must be fully 50 per cent and capable of holding the water up.

134. It is evident that if pumping becomes general, in a series of low years ground water may be lowered sufficiently so that there will be little drainage outflow. In the estimates of outflow from the valley and water supply for this scheme, which follow, this is seen to be the case in the period 1899-1905 but the depletion, on the basis of 25 per cent voids, which is perhaps too small a percentage, would

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be not more than 5 feet.

135. For the critical years 1899-1904, a Table 41a was made showing estimated runoff for each month. This gives a basis for estimating the annual Table 42 of the same thing for all the years of record which follows Table 41a.

Comparison of Results

136. The water supply is insufficient with reservoir development alone to supply the acreage in the valley which would be drained. However, if pumping is successful, water supply is sufficient. The outflow from the valley is considerably different with the two schemes and the reduction more for the pumping scheme. (Table 21)

137. The probable development may be somewhere between these two schemes. The second scheme assumes a race of super-farmers who will install pumps if they do not have late water and who will always pump when they should. As a matter of fact, human nature will prevent operation on so efficient a basis. The tendency will be a reduction in acreage in the low years and some will go short of water rather than pump. However, the assumption is a factor of safety against an underestimate of acreage and so the results of the pumping scheme are used in succeeding calculations of water supply for projects below.

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TABLE NO. 21

Outflow from San Luis Valley
Acre Feet.

Year	Recorded Discharge 1	Estimated for Valley drained & reservoir development Table No.__ 2	Reduction Col. 1-2 3	Estimated for valley drained & pumping development Table No.__ 4	Reduction Col.1-4 5
1899	163,000	279,000	/ 116,000	150,000	13,000
1900	204,000	198,000	6,000	45,000	259,000
1901	284,000	200,000	84,000	47,000	237,000
1902	99,000	134,000	/ 35,000	39,000	60,000
1903	627,000	338,000	289,000	43,000	584,000
1904	188,000	283,000	/ 95,000	90,000	98,000
1905	987,000	474,000	513,000	73,000	913,000
1906	842,000	608,000	234,000	443,000	399,000
1907	1,436,000	1,277,000	159,000	1,261,000	175,000
1908	363,000	498,000	/ 135,000	202,000	161,000
1909	933,000	499,000	434,000	601,000	332,000
1910	556,000	444,000	112,000	253,000	303,000
1911	1,037,000	663,000	374,000	1,023,000	14,000
1912	849,000	628,000	221,000	540,000	309,000
1913	293,000	363,000	/ 70,000	189,000	104,000
1914	593,000	418,000	175,000	406,000	187,000
1915	471,000	384,000	87,000	281,000	190,000
1916	758,000	546,000	212,000	762,000	/ 4,000
1917	777,000	531,000	246,000	672,000	105,000
1918	263,000	405,000	/ 142,000	251,000	12,000
	586,000	458,000	128,000	326,000	245,000

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Discussion and Conclusions

138. It has often been urged that the government should construct a main drain up the trough of the valley to the dead area free of charge to the settlers in the dead area and charge the cost to projects below because of increment to water supply.

139. Undoubtedly drainage will result in a considerable immediate increment to the supply but the possible great extension to the irrigated area which will also be the result of drainage will cause a larger diversion from the streams which it is believed will ultimately more than off-set the gain from drainage. While such a possibility exists, it can hardly be recommended that lower projects bear any part of the cost in expectation of an increase in water supply.

140. As a government project, the development of the valley offers very few attractive features. The fact that canal systems are already built, or if not built, that physical conditions present no difficulties in the way of their building by private means removes that feature from the field of possible activity. The practical certainty of large extension of acreage, with consequent great competition among the diverse interests in the valley for spring and summer runoff, makes it equally certain that there will be little surplus water for storage except in the low winter

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months. This makes reservoir development unattractive.

141. It may be noted here that if reservoirs are built by private means, which is barely possible if government restriction is removed, and in the near future can secure enough water for filling, yet ultimately this water will be taken away by prior vested rights.

142. There remains only drainage as a possible government project. As stated, there is nothing so difficult in any feature of this as to necessitate government aid.

143. If the conclusions of the report are even approximately correct, the extension of irrigation will overtax the surface water supply if drainage is general throughout the valley but ultimate change from gravity supply to pumping will furnish a full supply. This change must come about very gradually and if a complete drainage system were installed even in the lapse of the next several years, it would so far anticipate water supply development that undoubted hardship would ensue.

144. There remains the building of a main drain to the dead area and possibly a main drain or drains to the southwest area. The former is the more important. As stated, there is no such difficulty in this from an engineering standpoing as to hinder private development but there is another phase to the situation. Private development will be the cheapest possible without regard to the best interests

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of the whole. It seems physically possible to drain most of the dead area into San Luis Lakes rather than into the Rio Grande River. Whether this would be cheaper than a diagonal drain from the river northwest is problematical. Opposed to such development will be the protests of the land owners in the trough of the valley before a great area should have been drained in that way but whatever water flows to these lakes is lost to the river unless the expensive main drain up the valley trough is constructed.

145. A much more clean-cut job of drainage of the dead area seems to be probable with a main drain northward to San Luis Lakes than with a diagonal drain northwest from Alamosa but from the standpoint of water supply made available to the river there is probably no great difference. The main drain if constructed by the valley will probably be on the diagonal location because cheaper and with it there is always the tendency mentioned that some loss to the river will occur by drainage of part of the area to San Luis Lakes. The probable amount so lost is so uncertain that it does not seem to warrant charging any portion of the cost of drainage to lower projects but does seem to warrant an effort on the part of the government to include the main drain in its construction program.

146. It might be urged that the valley shall bind itself to so limit development that a certain outflow from the drains shall be maintained and that in return the drain should be constructed by the government. Such an agreement, because of the various interests in the valley, would be inoperative.

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147. The entry of the government into the valley is predicated, of course, on sufficient desire on the part of the residents thereof to bind itself to repayment of construction charge. There appears to be no reason (except the problematical possibility of some loss in San Luis Lakes) for the government to wish to enter the valley to gain water for lower projects. From the viewpoint of its function as an agency for the development of the country, however, any aid which the Reclamation Service can render ti the valley is desirable.

148. It is believed that these conclusions can be safely made:

(1) The entire cost of Government construction should be borne by the benefitted lands in San Luis Valley.

(2) No increment to water supply may be expected for lower projects.

(3) In the absence of definite court rulings and because of the many conditions heretofore outlined, no method of restricting development is now apparent.

(4) The ultimate acreage irrigated in the entire valley may be more than 800,000.

(5) Government's proposition to the valley should be restricted to building a main drain to the dead area for the present with possible future enlargement of program.

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(6) Topography, soil fertility and climate unite to make the possibilities of the valley very attractive. 71

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PART III.

MIDDLE RIO GRANDE

149. The name "Middle Rio Grande" is applied to the river valley from the Indian village of Cochiti at the mouth of the White Rock canyon to the town of San Marcial at the head of Engle canyon, a division point on the Santa Fe Railroad. ~~(Pull out general map in rear for location.)~~

150. During 1918, the State Engineer of New Mexico completed a survey of the valley made preliminary to drainage. The following is condensed from his report.

151. Albuquerque, with a population of 18,000 and the largest town in New Mexico, lies in the northern third of the valley. Other towns from the north to the south are:

	Population
Bernalillo	1000
Los Lunas	900
Belen	2000
Socorro	1800
San Antonio	500
San Marcial	1200
	7400
Albuquerque	18000
Rural population-mostly	
Mexicans	14600
Indians	3000
	43000

152. Elevation varies from 5245 at the upper end to 4455 at the lower end. The entire length is 150 miles, the mean annual temperature varies from about 52 degrees at the upper to 58 degrees at the lower end. The growing season averages a trifle over six months with the hottest month

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July and the coolest January.

153. Principal tributaries to the Rio Grande in order from north to south are the Santa Fe, Jemez, Puerco and Salado. All are intermittent and the total area drained by them and other small tributaries is about 10,000 square miles. The discharge from these streams is usually in the form of flashy floods.

154. Irrigation was practiced by Indians before history of the valley begins. Heavy silt deposits and lack of thorough cleaning have raised the canals high above the adjacent bottom lands. These many canals criss-cross one another, each to reach its particular parcel of land.

155. The bottoms are very badly swamped and the total area cultivated is less than 50,000 acres, while the gross area, exclusive of river wash, is 180,000 acres. Back of the bluffs which border the bottoms lie hills for the most part, but east and southeast of Albuquerque lie beautiful mesas.

156. The following quotes from the State Engineer's report:

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

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

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

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

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

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

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or from year to year.

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

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

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

RECORDED LOSS OF WATER IN MIDDLE RIO GRANDE

157. Buckman station measures the discharge of the Rio Grande River into Middle Rio Grande Valley and San Marcial its outflow. The average annual loss for the 18 years of simultaneous records has been 204,000 acre feet and with five additional years estimated at Buckman to complete the record, 249,000 acre feet. In addition, all the tributary discharge noted in paragraph 153 is lost. The discharge of some of these tributaries, notably the Puerco, has been recorded since 1913. The average annual discharge from this river has been 93,000 acre feet since 1913, with a minimum of 28,000 acre feet and a maximum of 229,000. As the Puerco drains only about half of the 10,000 square

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miles, it is evident that the loss must be very large through the Middle Rio Grande.

158. The cause is probably lateral seepage from the river under the adjoining bottom land whence the water is lost by evaporation. At least this explanation seems sufficient to account for it and it is probable that if any underground channel did exist, it must long ago have been blocked with silt. A portion of this water is used beneficially on the 50,000 acres of cultivated land but if a beneficial consumption of 2 acre feet per acre be assigned to this, there remains a large total which can be saved by drainage.

Actual loss of water in Middle Rio Grande

159. As noted, the actual loss of water is much more than shown by comparison of Buckman and San Marcial gaging stations. It is necessary to approximate the true figure in order to determine the effect of drainage and irrigation of the Middle Rio Grande on the water supply for Elephant Butte Reservoir.

160. It is apparent that the loss will increase with increased discharge at Buckman; that with no inflow at Buckman and with no tributary inflow, it will be zero and that it will increase as fast as the inflow until a certain point is reached where evaporation is not sufficient to dissipate the entire inflow. At that point, some discharge appears at San Marcial. This will occur in summer, as shown

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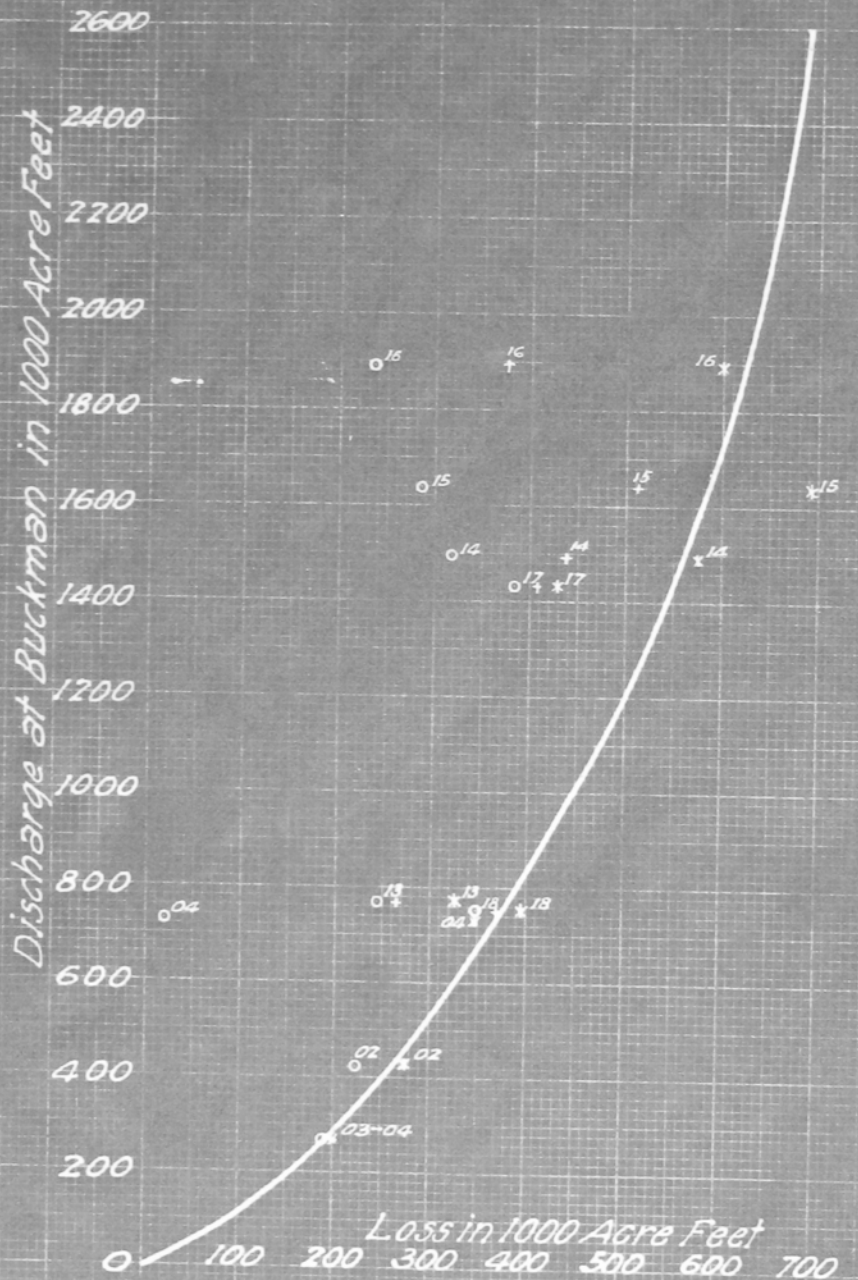

Losses in Middle Rio Grande Valley Based on Discharge at Buckman, New Mexico

LEGEND

- Measured Loss in Rio Grande River
- + Measured Loss plus inflow of Puerco River, Measured.
- * Measured Loss plus all tributaries

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by records, if there is no tributary inflow, with about 700 second feet at Buckman. As the inflow increases, the loss also increases but at a slower rate than formerly. This increase is due to larger free water surface and higher water table from higher water stage of the river. These items will not increase proportionally to the discharge and hence, as the discharge still increases, the rate of increase of the loss grows smaller.

161. The recorded tributary inflows plus recorded losses give a basis for an estimate of the actual losses. On the curve opposite are platted, as ordinates, the recorded annual discharges at Buckman since and including 1913, and as abscissae, the recorded loss between Buckman and San Marcial. The recorded discharge of the Puerca has then been added to the recorded loss and also an estimated additional tributary discharge. The estimate was made after comparing the precipitation records of the Puerca drainage area and other contributing areas for each one of the years in question. The years 1902 and 1903-04 are the lowest recorded on the main river, there was apparently very little tributary inflow and as practically all the discharge at Buckman was lost before reaching San Marcial, these points define the shape of the lower part of the curve quite accurately. The curve shown on the plat opposite

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was then drawn through the mean of these platted points, and as is apparent, is of the general shape of a parabola. It is intended to represent the actual loss between buckman and San Marcial. This loss for any year is obtained from it by entering the curve with the Buckman discharge.

162. It is apparent that the actual losses as taken from this graph are uncertain for any one year but it is also apparent that the results reached in this way are more nearly accurate than can be obtained by using the actual records only. It is probable also, the years of record being so many, that errors may largely counterbalance one another.

163. In the following Table No. 22 is a comparison of losses from record and "actual" from graph.

Water Demand of Middle Rio Grande

164. As estimated in Table No. 22, the average annual present loss in the Middle Rio Grande is 508,000 acre feet. The "Report on Drainage Investigations in the Middle Rio Grande" by the State Engineer, as quoted in paragraph 156, gives a classification of the land and it is to be expected that each class will be evaporating different quantities of water, the sum of which will account for the 508,000 acre feet lost. Before assigning values to each class, the total loss must be revised to approximate future conditions if the Middle Rio Grande is irrigated.

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TABLE NO. 22.

Present Losses in Middle Rio Grande Valley

Irrigation Years Units

Year	Discharge at Buck-man	Discharge at San Mar-cial	Net loss Col.2-Col.3.	Actual loss from graph	Inflow from tributaries Col.5-Col.4.
1	2	3	4	5	6
1895	1427.7	1426.6	1.1	545.0	543.9
1896	703.3	576.6	126.7	360.0	233.3
1897	1895.9	2215.2	*319.3	620.0	939.3
1898	1087.2	961.1	126.1	465.0	338.9
1899	682.2	239.8	442.4	350.0	-924.0
1900	707.5	466.5	241.0	360.0	119.0
1901	856.2	656.3	199.9	400.0	200.1
1902	424.4	200.6	223.8	260.0	36.2
1903	1667.5	1272.0	395.5	590.0	194.5
1904	727.8	709.8	18.0	365.0	347.0
1905	2047.6	2422.0	*374.4	640.0	1014.4
1906	1978.1	1563.7	414.4	630.0	215.6
1907	2560.0	2157.7	402.3	680.0	277.7
1908	1172.5	774.2	398.3	490.0	91.7
1909	1703.3	1279.9	423.4	590.0	166.6
1910	1255.9	852.7	403.2	510.0	106.8
1911	2108.1	1800.0	308.1	645.0	336.9
1912	2021.4	1499.6	521.8	635.0	113.2
1913	771.4	525.5	245.9	380.0	134.1
1914	1496.1	1178.4	317.7	560.0	242.3
1915	1639.4	1354.4	285.0	580.0	295.0
1916	1892.9	1657.3	235.6	620.0	384.4
1917	1437.2	1054.3	382.9	550.0	167.1
1918	756.9	409.8	347.1	375.0	27.9
Total	33020.5	26682.5	8766.5	12200.0	6433.5
Avg.	1375.9	1111.8	240.3	508.4	268.1

*Gain.

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165. In the period covered by Table No. 22, there were nine years during the summer in which the river was dry at San Marcial. If the river had not been dry, the losses would have been larger and as, if the area is irrigated, the river will not be dry in the future, to prorate the loss properly an estimate must be made of this probable additional loss.

166. The following table shows this estimate and is derived by comparison with periods having runoff similar to that expected under new conditions.

TABLE NO. 23

Additional loss-Middle Rio Grande if water in river.

1896	60,000	acre	feet
1899	55,000	"	"
1900	30,000	"	"
1902	45,000	"	"
1904	85,000	"	"
1908	10,000	"	"
1910	35,000	"	"
1913	30,000	"	"
1917	15,000	"	"
Average, 1895-1918. . .	15,000	"	"
Loss Table 13.	508,000	"	"
	523,000	"	"

167. The State Engineer's report shows a total of 206,000 acres in the Middle Rio Grande bottoms of which 61,100 acres consist of river wash and other areas - mostly deltas of tributaries which are too high to irrigate. He divides this area into the following districts, the division being dictated by topography:

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TABLE NO. 24.

Bernalillo	9118	acres
Corralis	3422	"
Albuquerque	14631	"
Barr	3696	"
Atrisco	15255	"
Peralta	20858	"
Belen	24097	"
San Juan	8159	"
San Francisco	7412	"
Lemitar	8338	"
Socorro	19156	"
	134143	"
San Marcial and Val Verde	10800	"

168. It is considered feasible to drain the 134,000 acres but the San Marcial and Val Verde acreage are considered to be too costly to drain at the present time.

169. The following Table No. 25 shows the assumption made of present loss (including the 15,200 acre feet of Table No. 23) by each class of land:

TABLE NO. 25.

Loss in Middle Rio Grande

	Acres from State Engr. report.	Assumed evaporation or use of water in a.f. per a.	Total 1000 a.f.
1. Cultivated, Class I	40100	2.5	100.2
2. " " II.	8700	3.0	26.1
3. Salt grass and alkali	52000	3.3	171.6
4. Swamp	6500	5.0	32.5
5. Timber	37600	1.4	52.7
6. River and river wash	27500	4.5	123.8
7. Other valley	33600	0.5	16.8

170. The pertinent items in the foregoing are the last two. Drainage will affect all the others but will

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cause no change in evaporation from river wash and probably very little from "other areas", although reduction of floods by control above may reduce the present river channel. At any rate, this assumption as to Item 7 is on the safe side.

Duty of Water

171. There is no local data on which to base an assumption. However, the Carlsbad Project, in southeastern New Mexico, has a similar climate and length of irrigation season but the rainfall averages 15" instead of 9". On this project the water delivered to farms has averaged 2.4 acre feet per acre in the 12-year period 1907-1918. This includes consumptive use and an unknown percolation. It is hardly possible that deep percolation is less than 0.4.

172. The Middle Rio Grande stretches for 150 miles up and down the river and diversions will occur at numerous places. Return flow will be immediately reused during most of the year. Thus the criterion is consumptive use rather than diversion. This is taken at 2.0 acre feet per acre per annum.

Total Annual Water Demand

173. In the following Table No; 26 is set out the assumption as to ultimate total demands if the Middle Rio Grande is drained, as compared with the water evaporated now. Cols. 1 to 4 consist of Table 25 repeated, while Cols. 5-12 show the assumed ultimate condition. The result

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TABLE NO. 26.

Total Water Demand - Middle Rio Grande Valley.

Item.	Class of Land	Present conditions: Acres from State Engr. Rept.	Present conditions: Loss of water in af per a annly	Present conditions: Total loss in 1000 af Col.2x Col.3 Tbl.10	Conditions with drainage installed: Drained portion. Gross acreage drained from State Engrs. rept.	Drained portion. Net acreage irrgtd within drained area 85% of Col.5	Drained portion. Use of water on net irr. acrg. @ 2.0 af in 1000 af	Drained portion. Loss of water on grs acreage 15% of Col.5@ 1.75 a.f.in 1000 af	Drained portion. Total use on drained area Col.7 + 8	*Undra.portn. Acrg. col.2 - col 5	*Undra.portn. Loss of water col.10 into col.3	Total demand water col.9 + col. 11
1		2	3	4	5	6	7	8	9	10	11	12
1	Cultivated, Cl.1 not badly seeped	40100	2.5	100.2	37800**	32100	64.2	9.9	74.1	2300***	5.8	79.9
2	Cultivated, Cl.2, badly seeped	8700	3.0	26.1	8300**	7100	14.2	2.2	16.4	400***	1.2	17.6
3	Salt grass & alkali	52000	3.3	171.6	49000	41700	83.4	12.9	96.3	3000	9.9	106.2
4	Swamp	6500	5.0	32.5	6000	5100	10.2	1.6	11.8	500	2.5	14.3
5	Timber	37600	1.4	52.7	33000	28000	56.0	8.7	64.7	4600	6.4	71.1
6	River & river wash	27500	4.5	123.8						27500	123.8	123.8
7	Other valley	33600	0.5	16.8						33600	16.8	16.8
	Totals	206000		523.6	134100	114000	228.0	35.3	263.3		166.4	429.7

*Includes all of San Marcial and Val Verde areas which would not be drained, and the entire river and "other valley" areas over the entire valley.
**From topographic map.
***Irrigable acreage without drainage from State Engr. report.

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Table No. 26

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is an estimated ultimate demand of 430,000 acre feet against a present estimated loss of 523,000 acre feet, a gain of 93,000 acre feet.

174. It was deduced in the case of San Luis Valley that the outflow from the valley will ultimately be reduced. This will cause a corresponding reduction in discharge through the Middle Rio Grande. As the loss in this latter depends on river stage, reduction in discharge will cause a decrease in loss through the Middle Rio Grande so that the reduction in water supply from the San Luis Valley development will be compensated for to some extent by smaller losses by evaporation in the Middle Rio Grande.

Distribution of Demand

175. As the consumptive use is the criterion on this project as in the San Luis Valley, the actual diversions are quite unimportant so long as the excess over consumptive use does not exceed drainage capacity and cause excessive evaporation from the ground surface. If they do, equilibrium will be regained by additional drainage or smaller diversion. The diversion duty here may be assumed to be sufficient to supply the consumptive use of 2.0 acre feet per acre plus evaporation from non-irrigated but drained land here estimated at 15 per cent of the total plus an additional amount of 1.5 acre feet to allow for deep percolation. In addition, the non-drained districts of San

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Marcial and Val Verde have a total of 2700 acres irrigated now which are assumed to draw water in accordance with the demand curve of the drained lands.

176. In this project seepage from the river is of some importance because of its effect on necessary reservoir capacity. During the period of spring floods water will seep laterally from the river more rapidly than later in the season and will return later through the drains - that is, there will be some ground storage which will take the place to some extent of reservoir storage. This lateral seepage is assumed in what follows to supply evaporation from areas which will be undrained but it is a matter of indifference whether this demand is thus supplied or supplied by seepage from canals.

177. In the following table No. 27, which shows the distribution of demand, Cols. 5 and 6 show an assumed seepage from the river based, in the absence of other data, on the square root of the average monthly flow while Cols. 10 and 11 show the assumed return of this seepage through the drains together with loss from canals and deep percolation. Monthly percentages of evaporation loss are derived from pan experiments at Albuquerque using 6 feet in depth as a basis. Cols. 12 and 13 show the final assumption as to the monthly distribution of the demand.

178. The foregoing table gives the estimated average demand for the Middle Rio Grande. A large item is the loss

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TABLE NO. 27

Distribution of Demand for Middle Rio Grande Valley on Basis of Drainage and Full Supply.

Mon.	Diversions: % of total demnd for ea.mo. (2)	Diversions: Ac.ft. diverted per acre (3)	Diversions: Irrigation demand for * 116700 acres. 61.3x116700 in 1000 a.f. (4)	Seepage loss: % of total for ea.mo. (5)	Seepage loss: Amount in 1000 a.f. (6)	Evaporation loss from stream bed: % of total for ea. month (7)	Evaporation loss from stream bed: Amount in 1000 a.f. (8)	Total demand Col.4/6/8 (9)	Drainage return: % of total for ea.mo. (10)	Drainage return: Amount in 1000 a.f. (11)	Net demand in irrigation season: Acre feet col.9-11 (12)	Net demand in irrigation season: Second feet col.12 ÷ 60 (13)
Jan.	0:	0	0	5	12.5:	2.3:	2.8:	15.3:	4	15.5:	-0.3:	
Feb.	0:	0	0	5	12.5:	2.8:	3.5:	16.0:	5	19.4:	-3.4:	
Mar.	4:	0.15	17.8	7	17.5:	6.9:	8.5:	43.8:	6	23.3:	20.5:	342
April	12:	0.46	53.4	11	27.5:	10.2:	12.6:	93.5:	8	31.1:	62.4:	1040
May	20:	0.76	88.9	16	40.0:	12.7:	15.7:	144.6:	12	46.6:	98.0:	1633
June	21:	0.80	93.2	14	35.0:	14.4:	17.8:	146.0:	14	54.4:	91.6:	1527
July	19:	0.72	84.5	9	22.5:	14.6:	18.1:	125.1:	13	50.6:	74.5:	1242
Aug.	12:	0.46	53.4	8	20.0:	13.3:	16.5:	89.9:	11	42.8:	47.1:	785
Sept.	8:	0.31	35.6	7	17.5:	10.6:	13.1:	66.2:	9	35.0:	31.2:	520
Oct.	4:	0.15	17.8	7	17.5:	6.6:	8.2:	43.5:	7	27.2:	16.3:	272
Nov.	0:	00	0	6	15.0:	3.6:	4.5:	19.5:	6	23.3:	-3.8:	
Dec.	0:	0	0	5	12.5:	2.0:	2.5:	15.0:	5	19.4:	-4.4:	
	100:	3.81	444.6	100	250.0:	100.0:	123.8:	818.4:	100	388.7:	*429.7:	

* 114000 acres table 17,col.6,plus 2700 ac.in Class I and II lands, col. 10.

Seepage loss percentages proportioned on basis of flow, no data being on hand to actually ascertain true relation. Flow modified slightly to take care of increased flow during late irrigation season under new conditions.

Basis of seepage computations flow by months, in 1000 A.F.

Jan.	39.4	6.3	May	358.6	18.9	Sept.	55.4	7.4
Feb.	37.6	6.1	June	295.4	17.2	Oct.	63.9	8.0
Mar.	83.7	9.2	July	104.0	10.2	Nov.	44.6	6.7
Apr.	186.8	13.7	Aug.	62.5	7.9	Dec.	42.5	6.5

Monthly percentages derived from pan experiments at Albuquerque as noted in W.S. #188.

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from stream bed and the evaporation from undrained areas. As the height of ground water changes with river stage, these two items will fluctuate widely from year to year and in a series of low years such as 1899-1904, when it would be much less than the average will, unless adjustment is made, show a smaller quantity reaching San Marcial than will actually do so. In other words, the loss will be less in the low years than in the high. The details of the adjustment for this condition are shown in Table 43. This is used in water supply computations for the Rio Grande Project.

Water Supply for Middle Rio Grande

179. The discharge at Buckman measures the supply of the Rio Grande River for this area, and in addition, there is available the discharge of the tributaries between Buckman and San Marcial. These latter are estimated (Table 22) to discharge an annual average of 268,000 acre feet. A large part of this comes in July and August in sudden floods. It is very erratic and undependable and even with a high annual discharge only a small portion could be diverted for irrigation.

180. Because of its erratic nature and probable difficulty of regulation, in what follows, no dependence is placed on the tributary inflow below Buckman to decrease

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demand on the reservoir except the low years when there is a shortage in Rio Grande supply. It is assumed that this inflow can be diverted and the shortage ameliorated to some extent. As the tributary inflow is small in low years, it probably can be largely diverted and therefore this assumption possibly approximates the truth.

Buckman Discharges

181. On the next 21 sheets are platted graphs of

A. Discharge, Rio Grande at Buckman, for all years of record.
B. Gain, State Line to Buckman, 1899-1904.

On Series "A" have been platted the average monthly discharges at State Bridge and above this the estimated demand of the Middle Rio Grande. This is done to subtract graphically the outflow from San Luis Valley in the belief that ultimately there will be no outflow in the irrigation season as was discussed in Part II. In Series "B", the gain has been platted to show the general regime of the gain in low years. In years 1902 and 1904, the outflow from San Luis Valley was negligible so this gain is the full supply above Buckman.

182. In all but the very highest years of Series "A" demand is in excess of the supply in late season nor does the recorded outflow from the valley appreciably help the supply in the majority of years.

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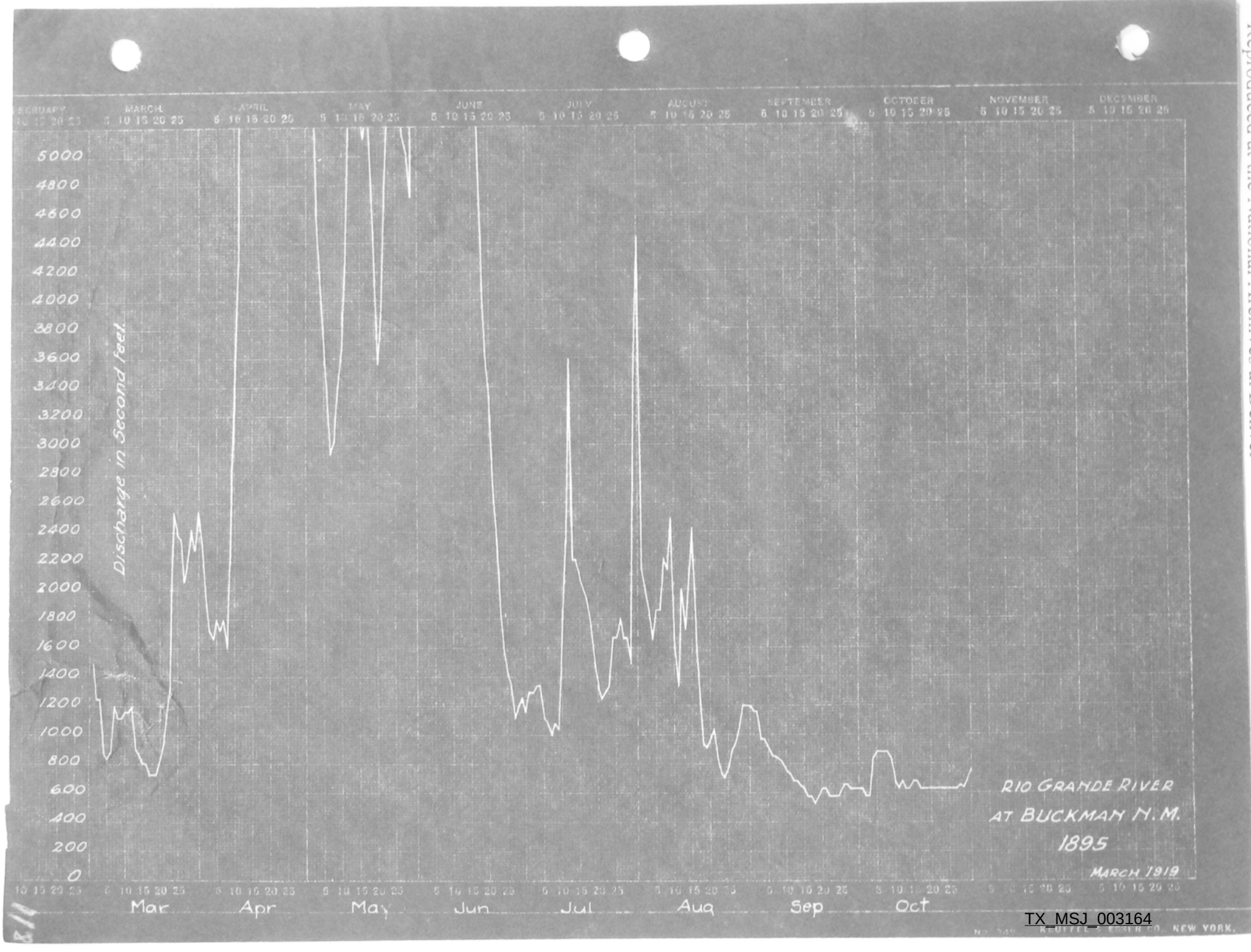

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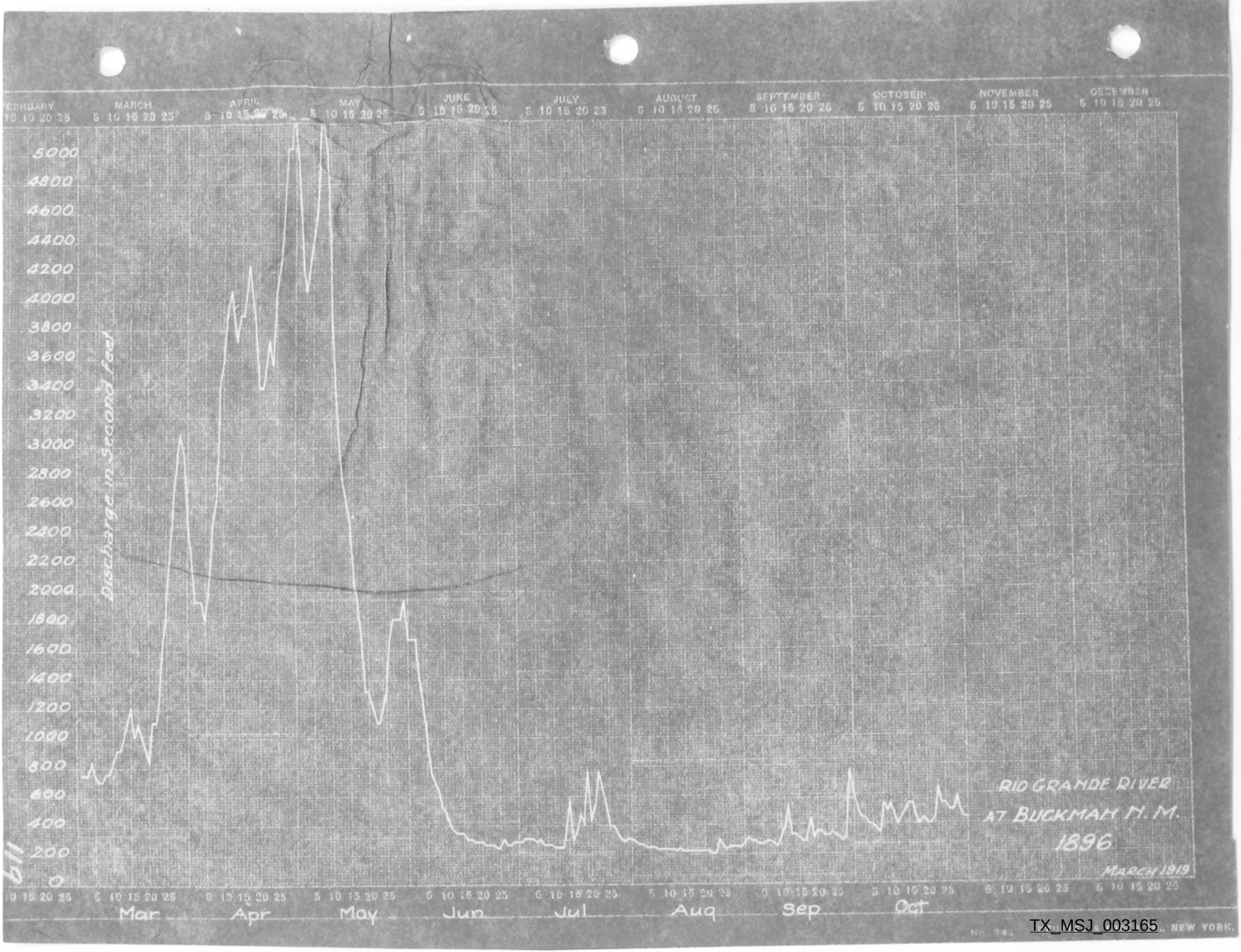

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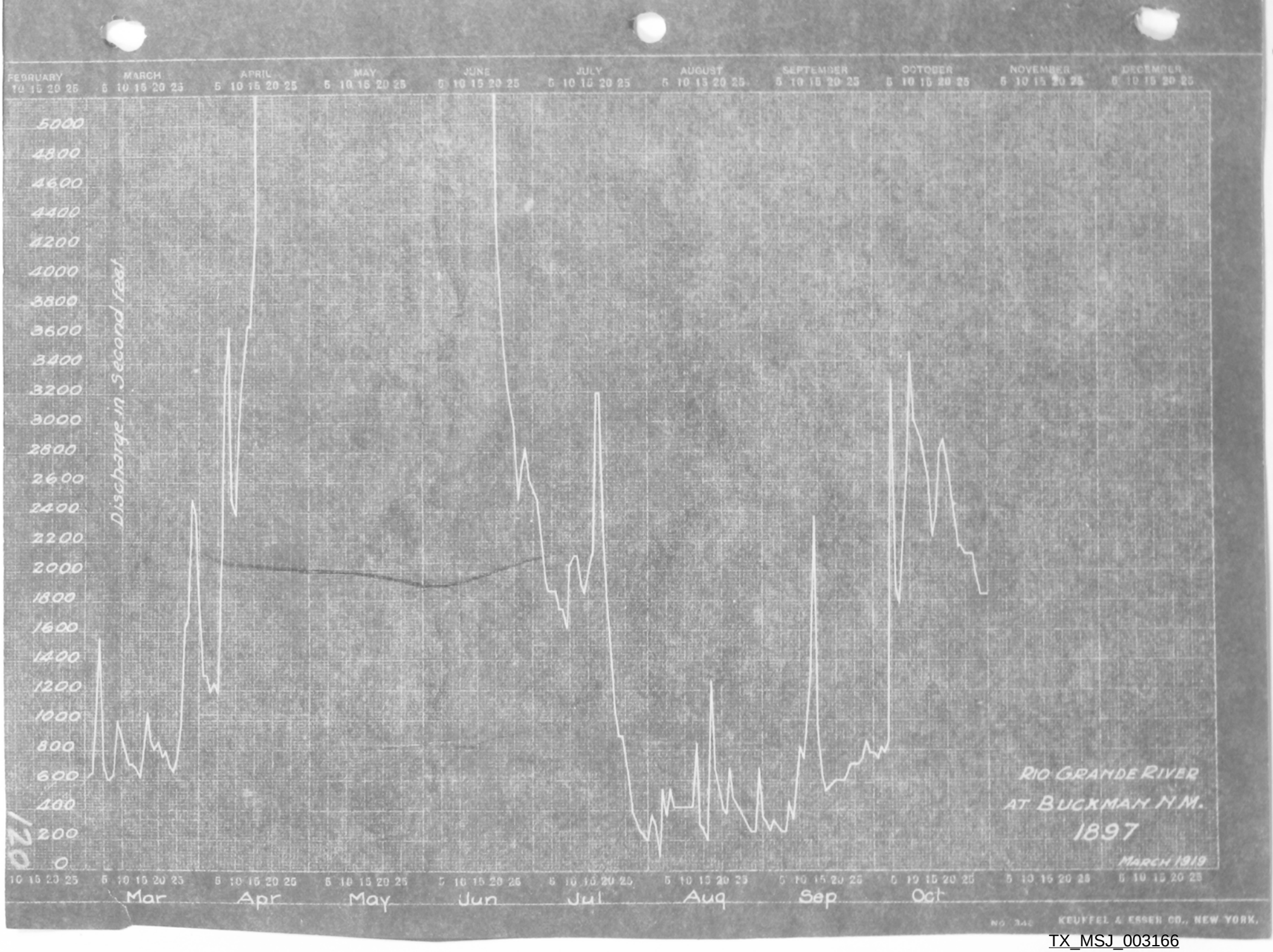

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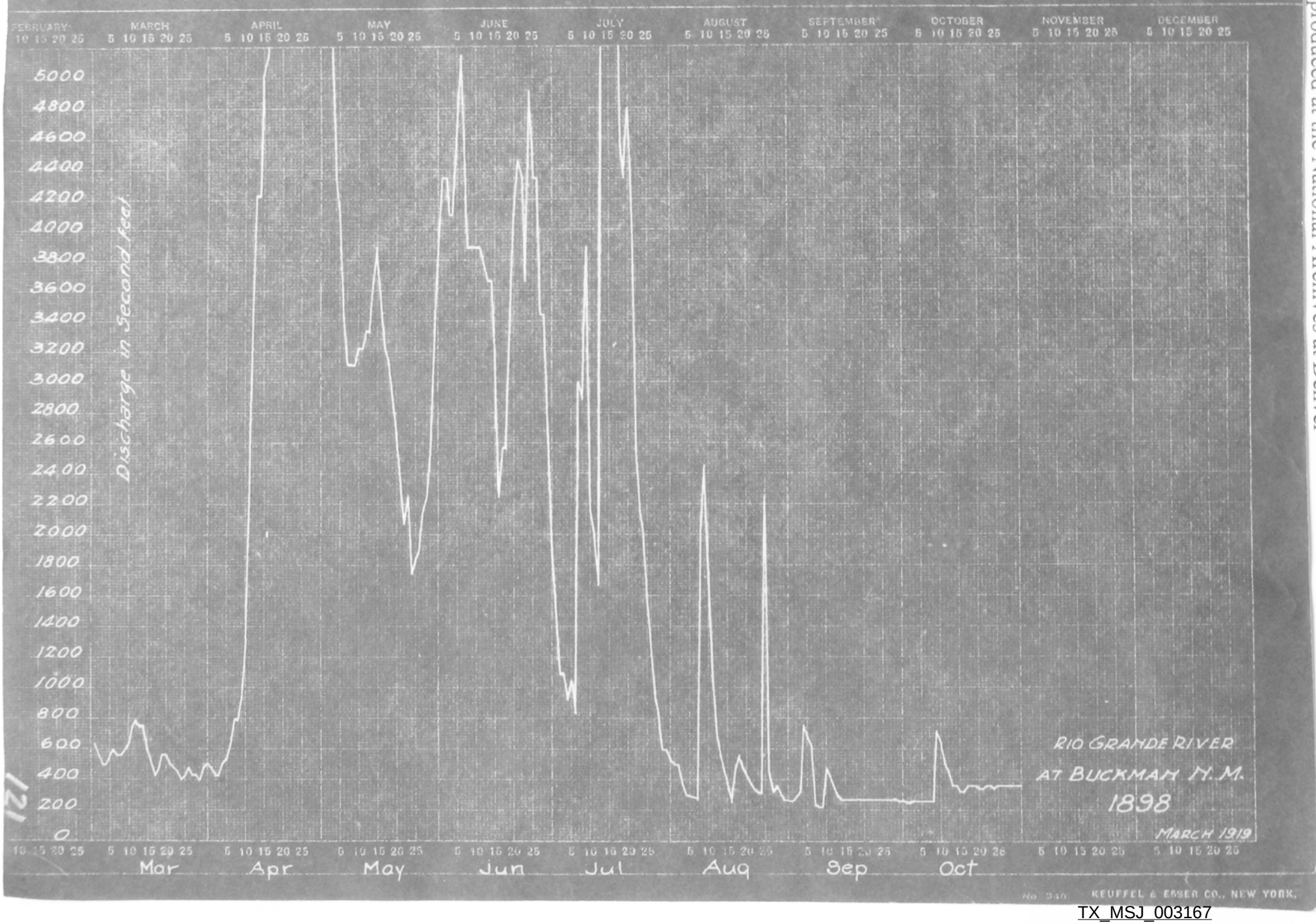

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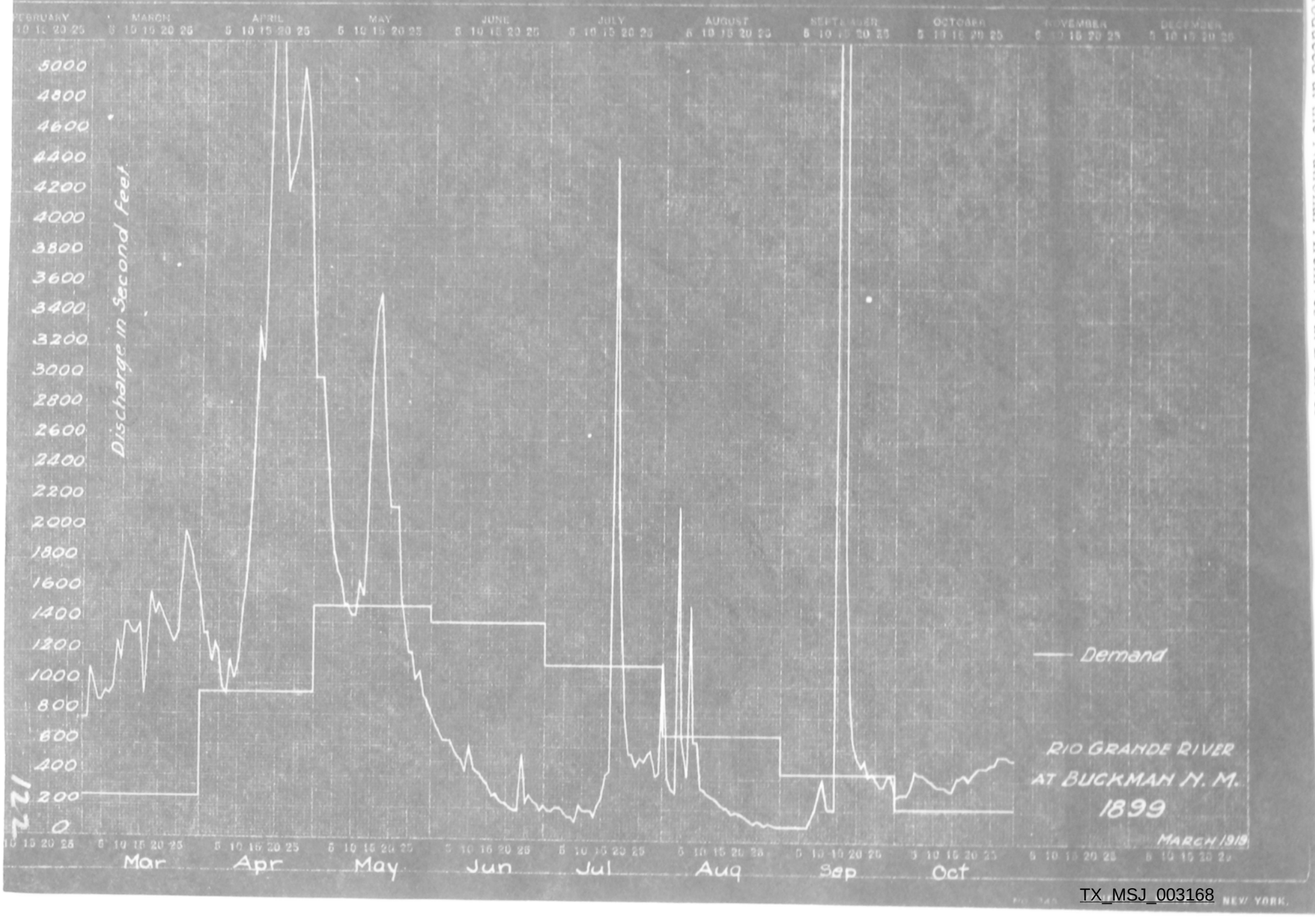

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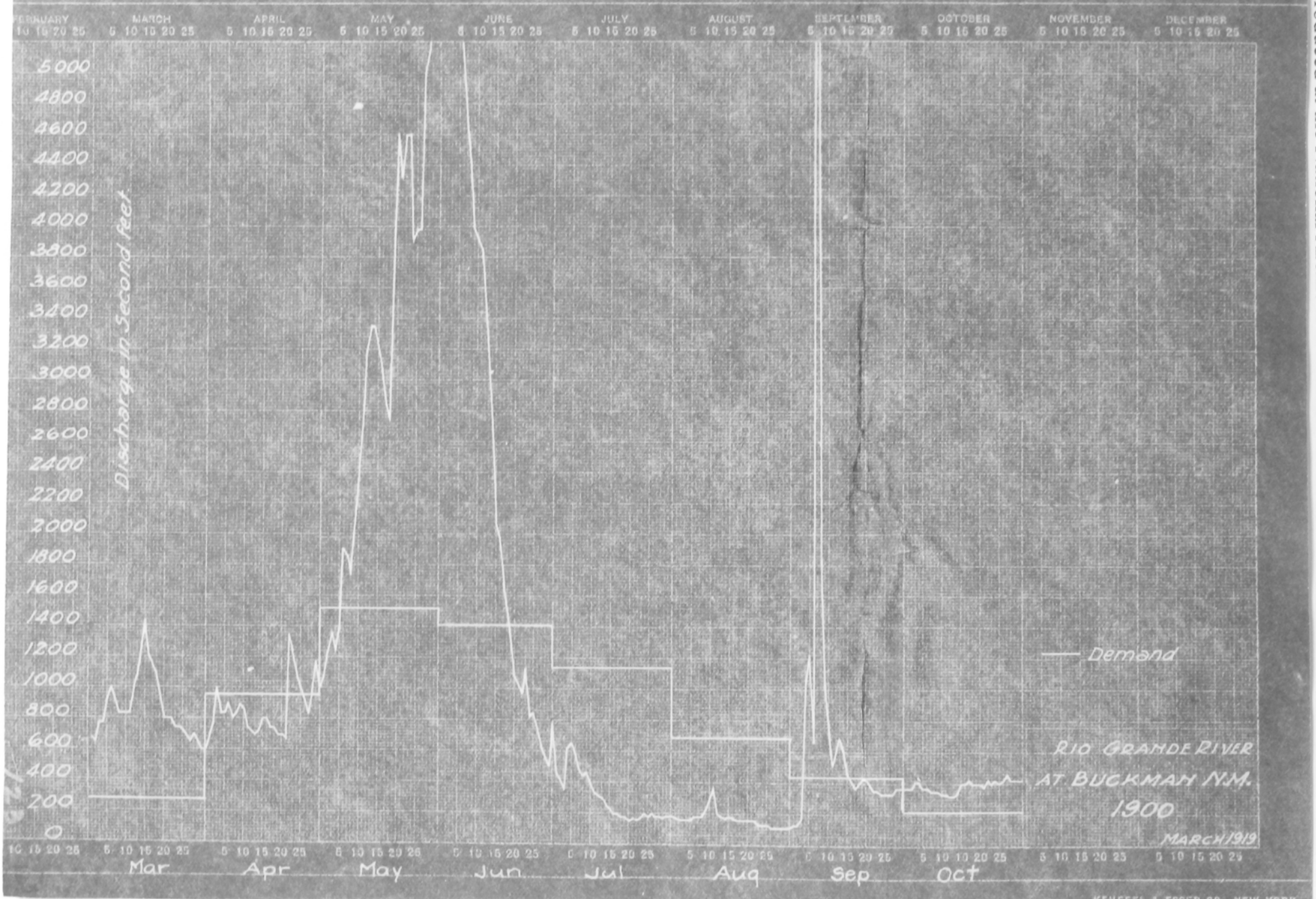

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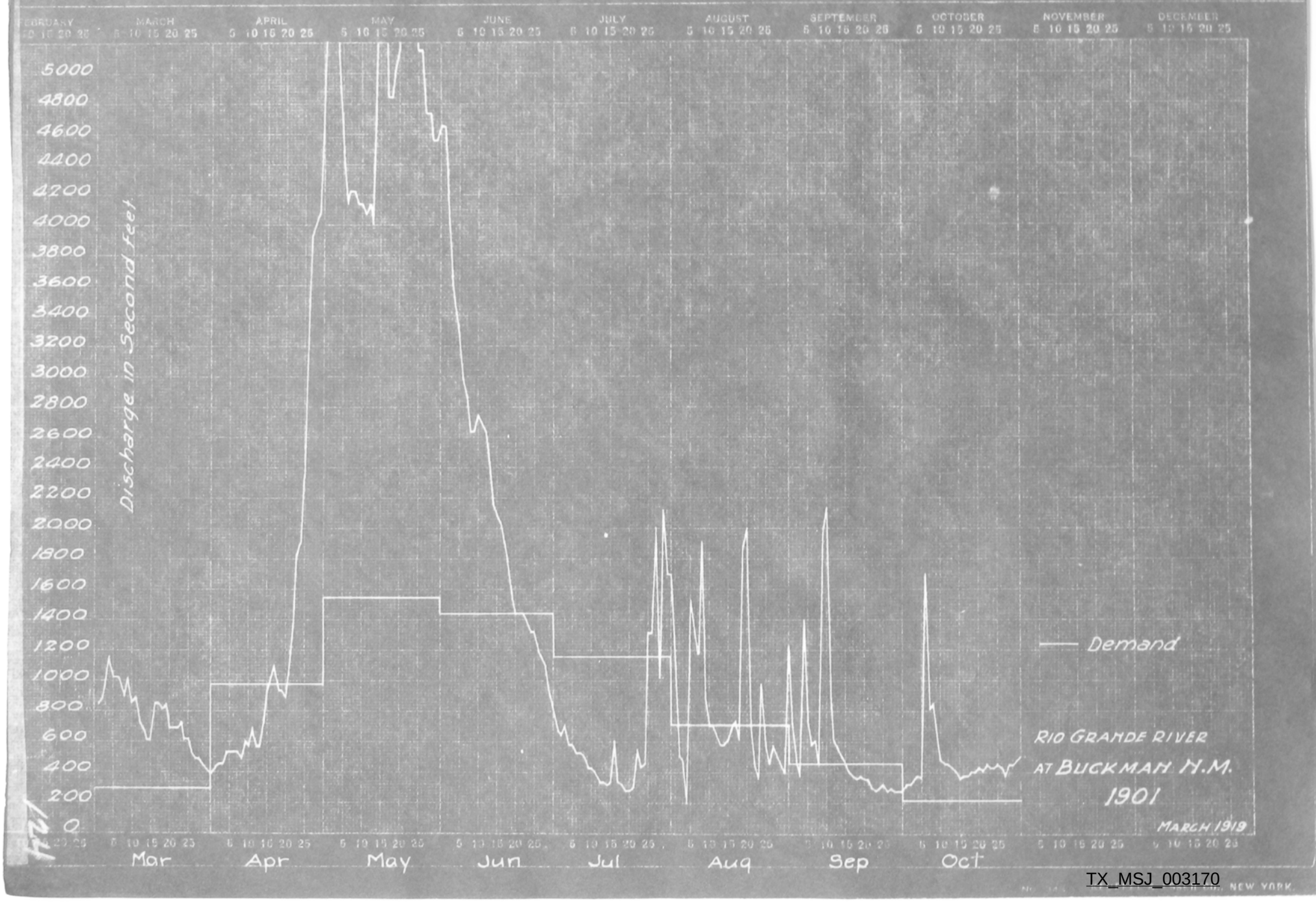

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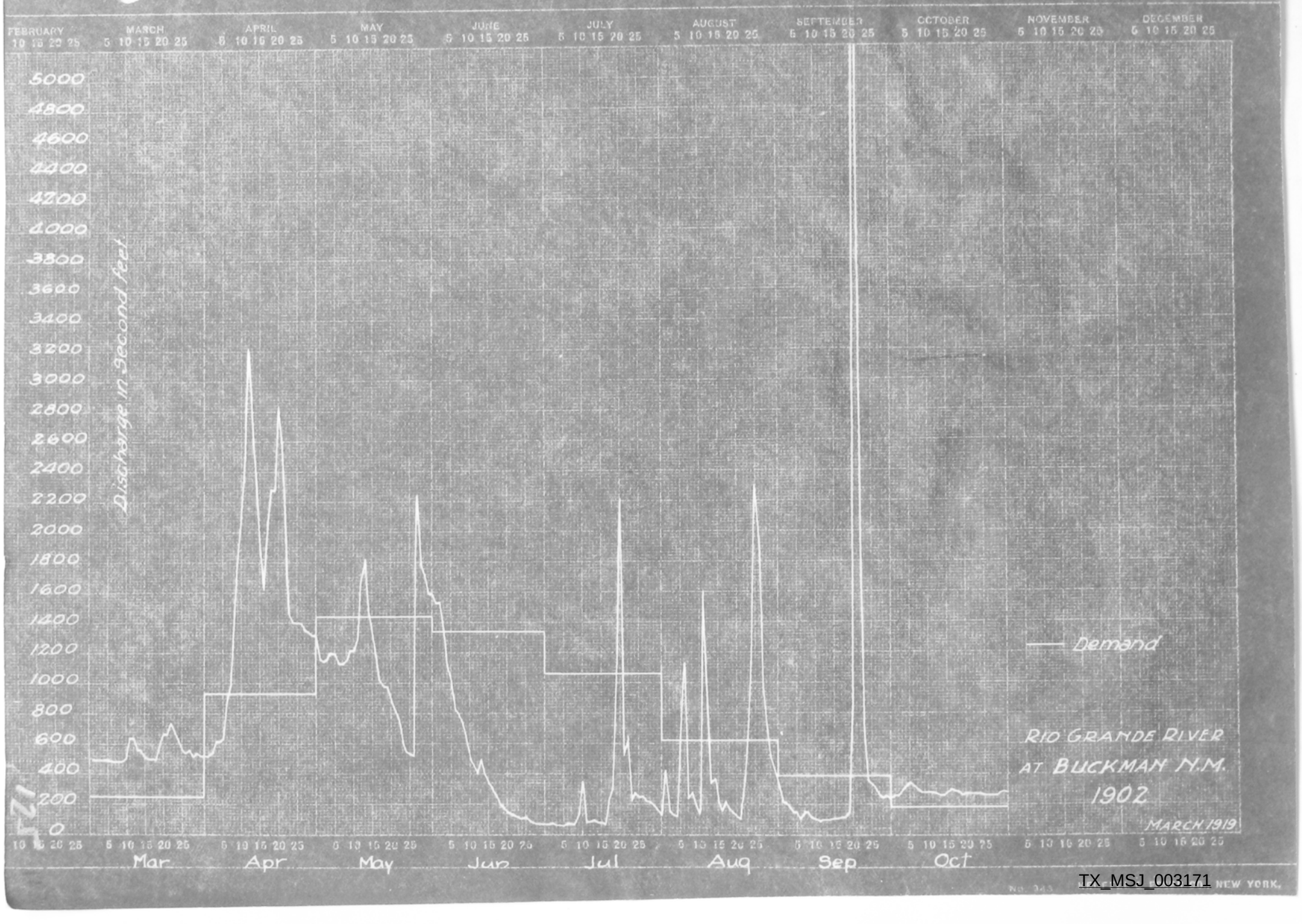

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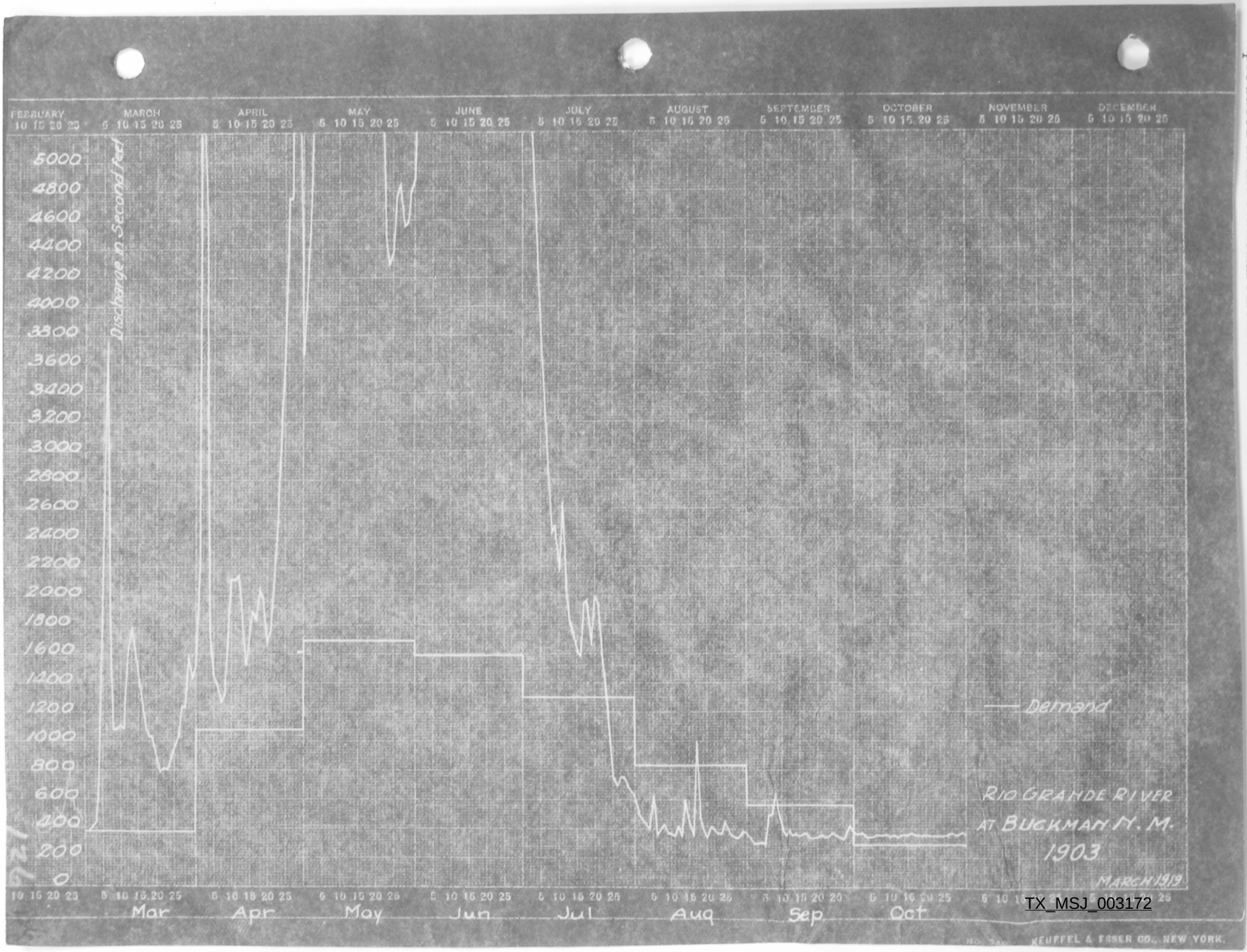

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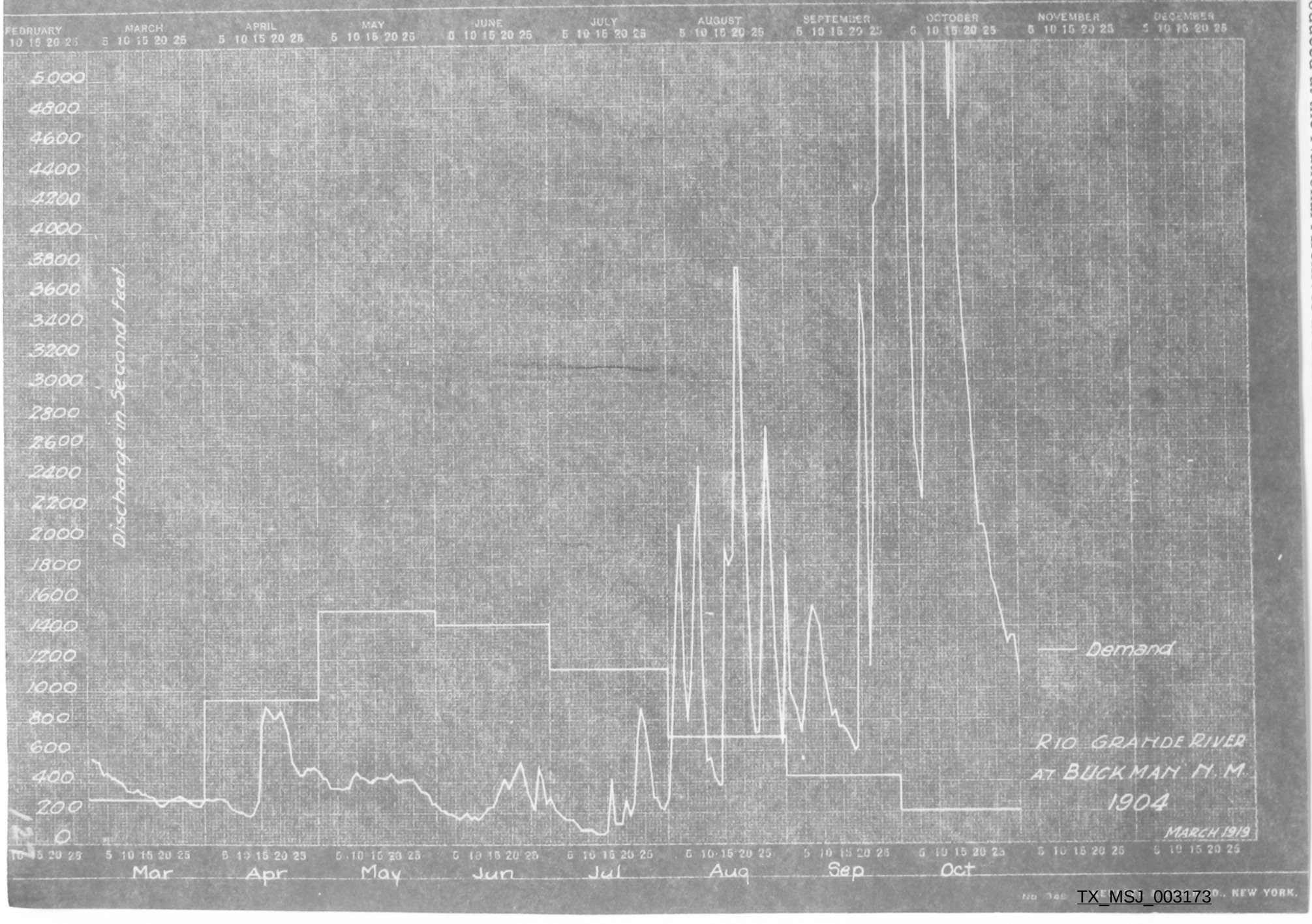

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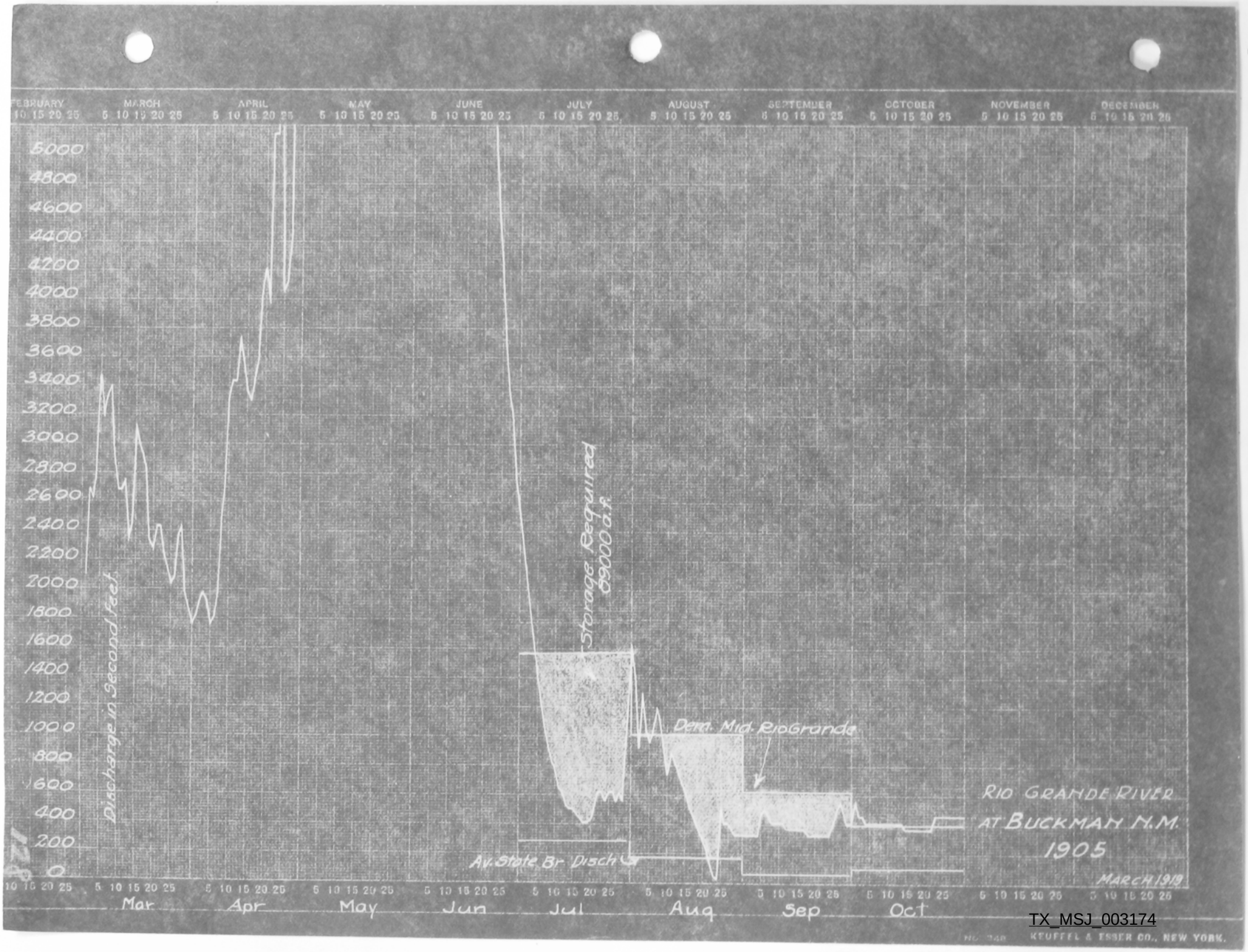

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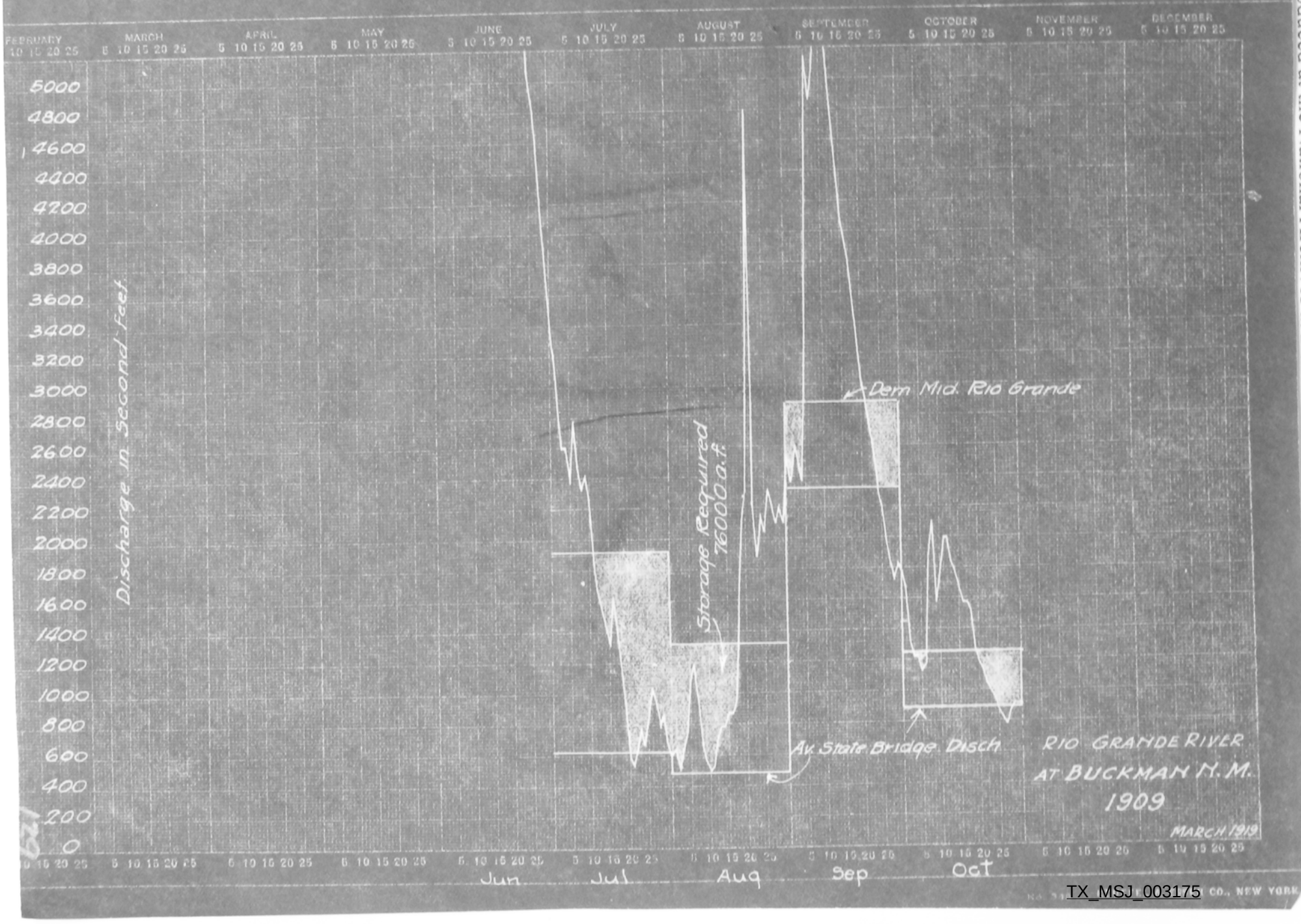

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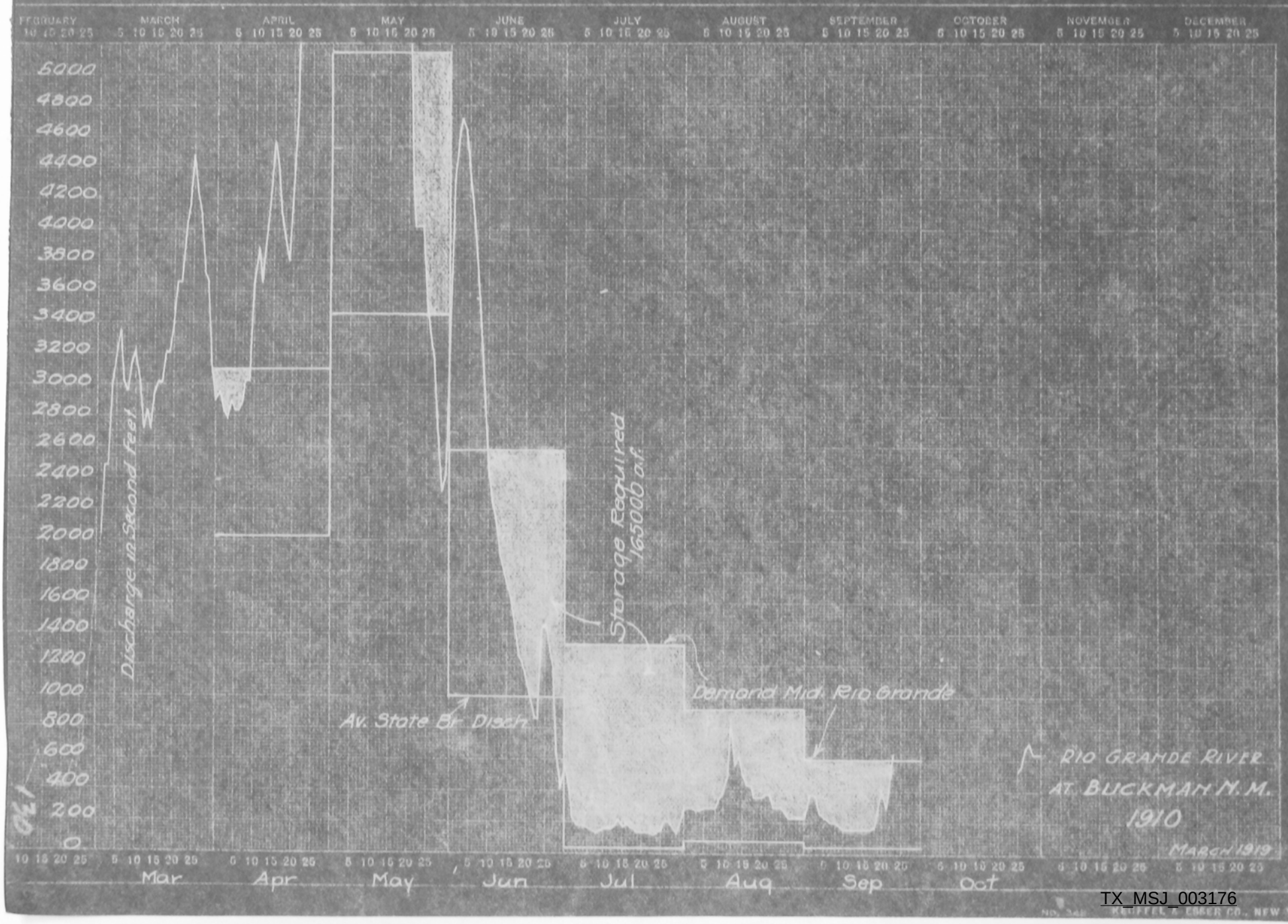

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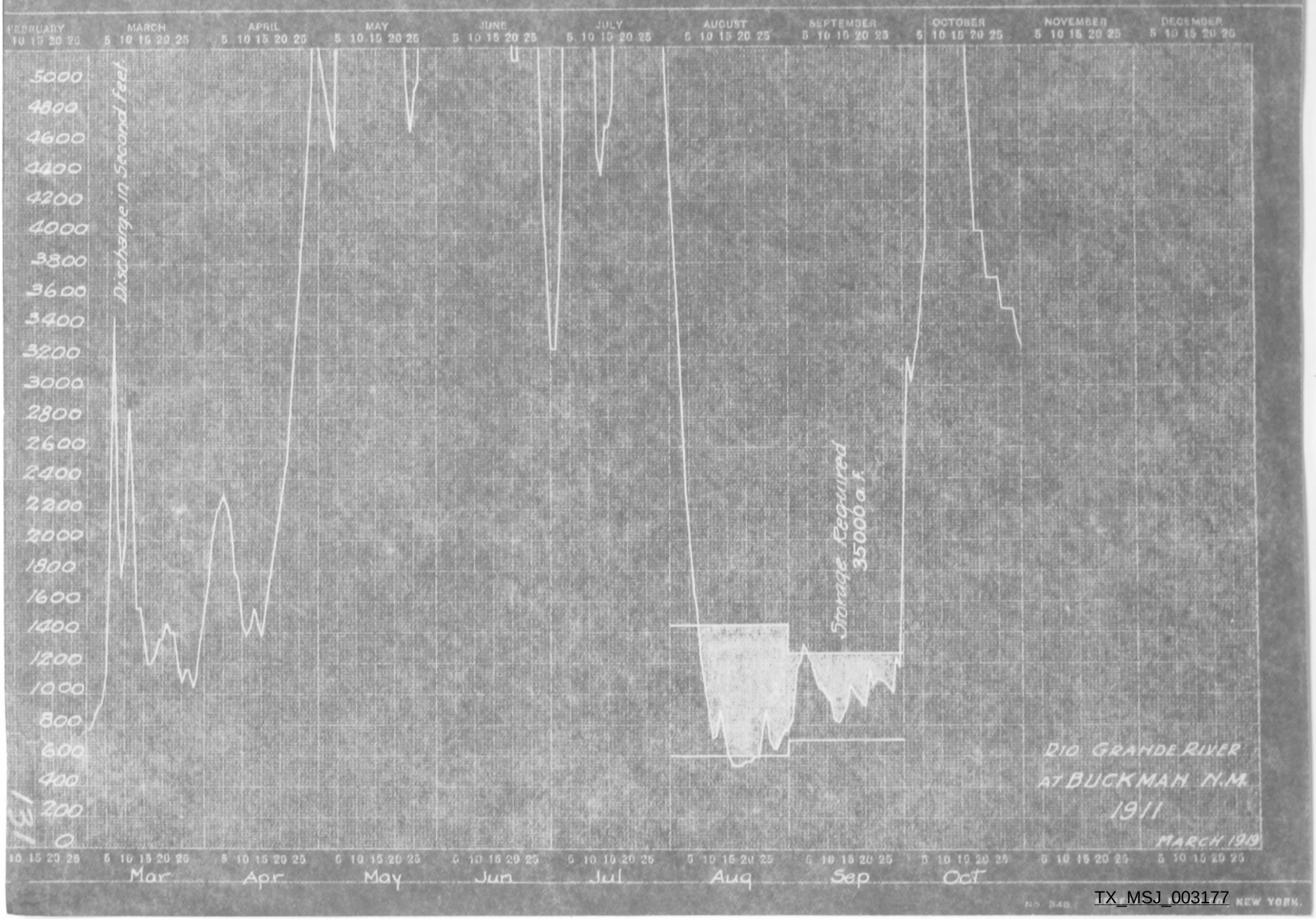

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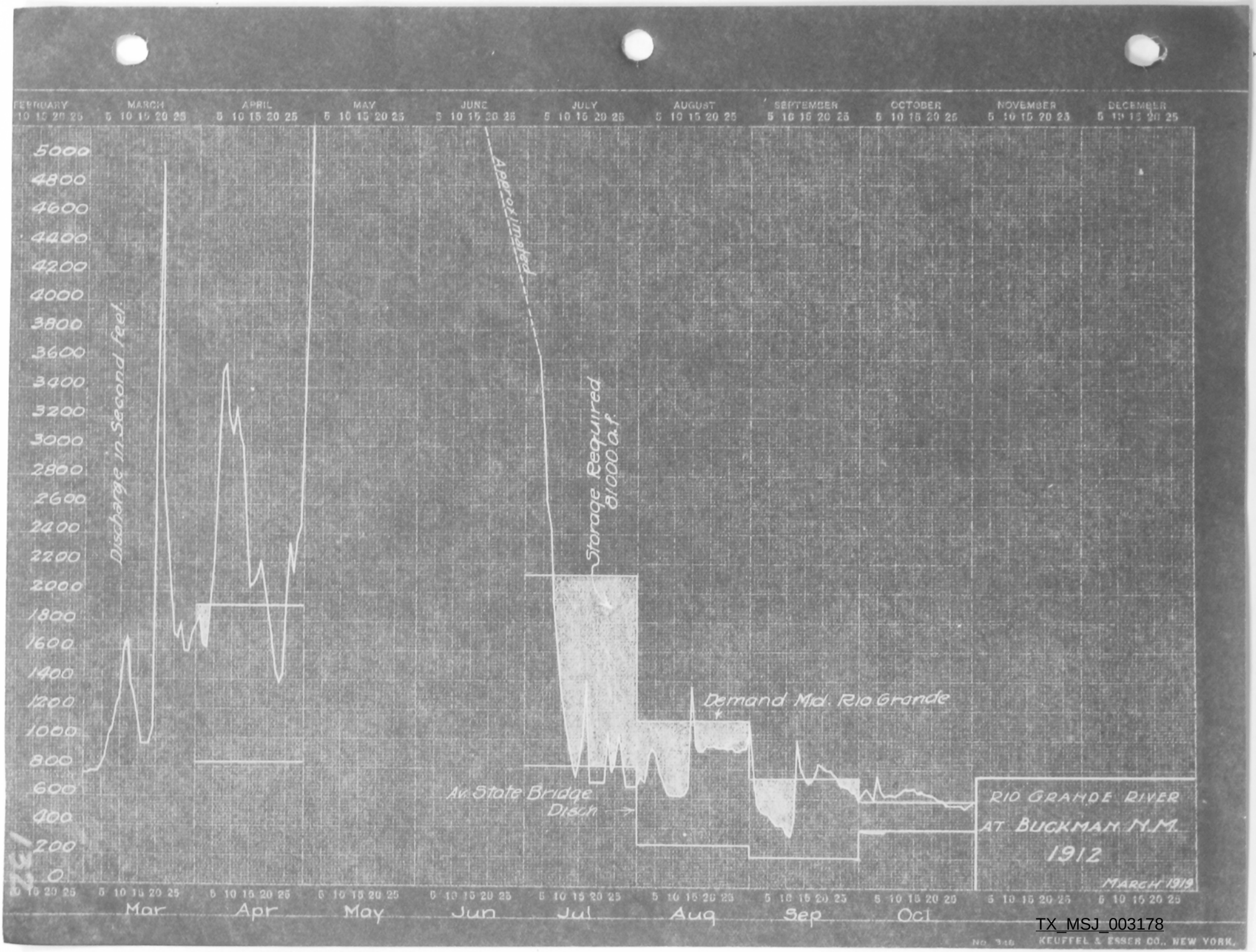

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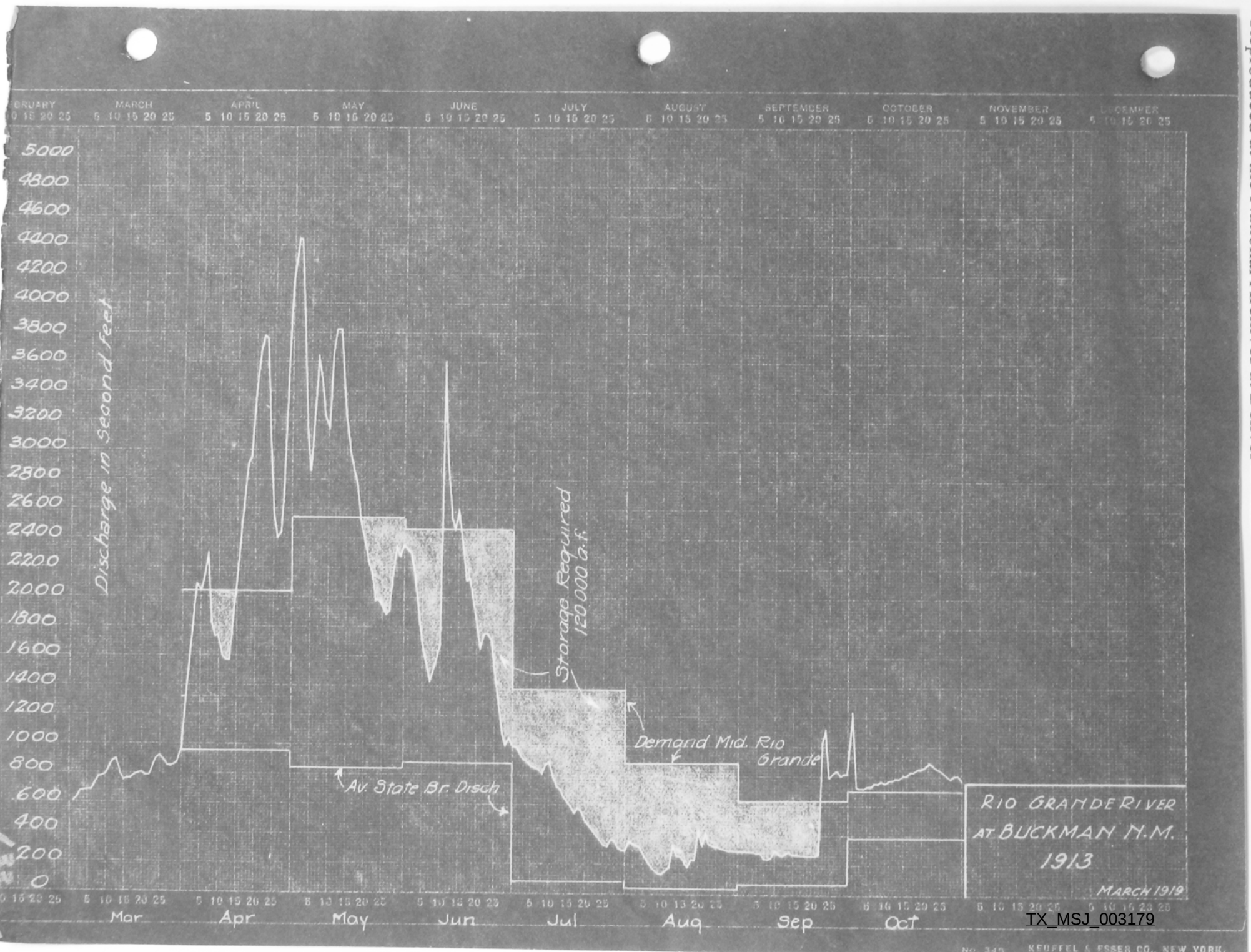

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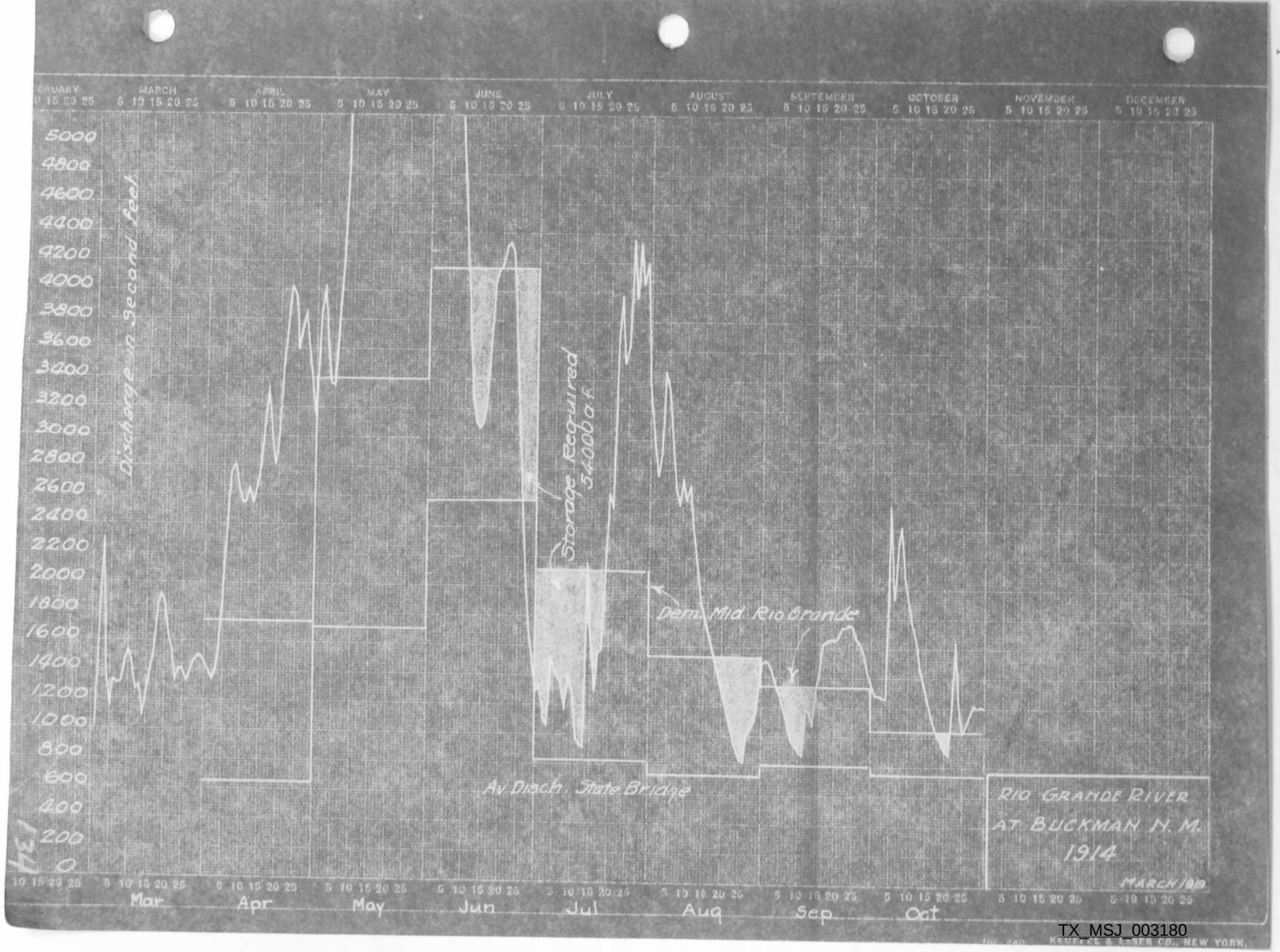

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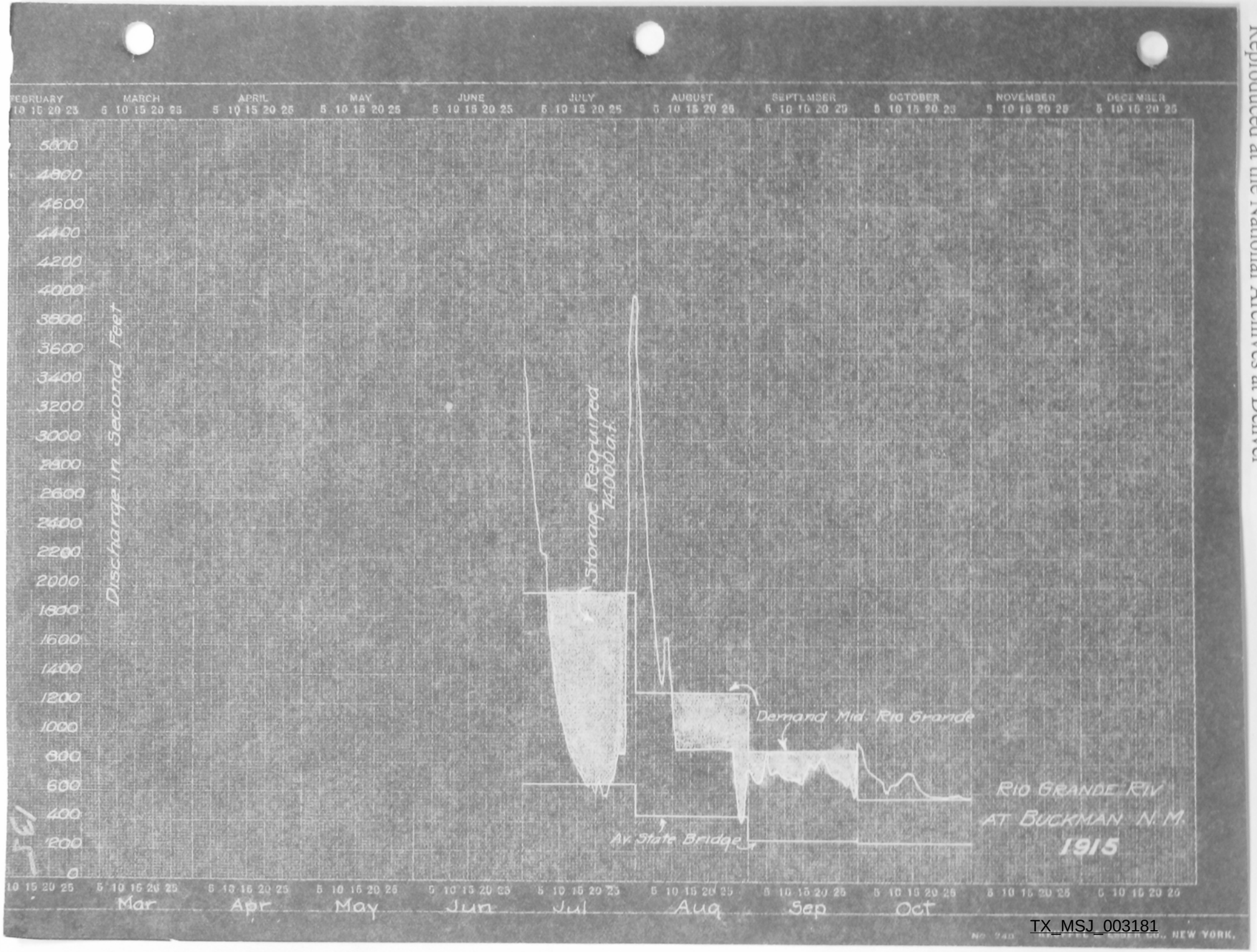

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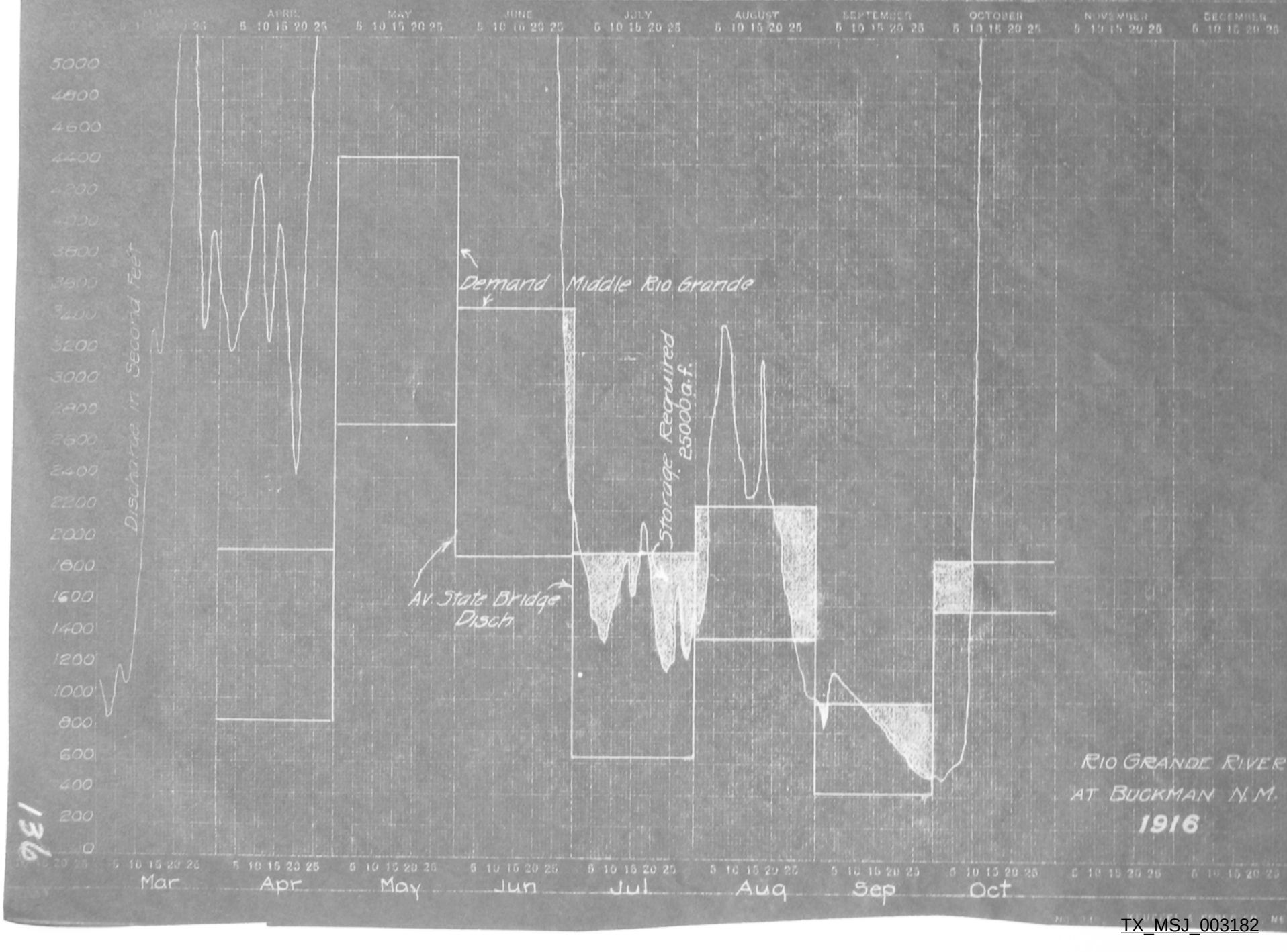

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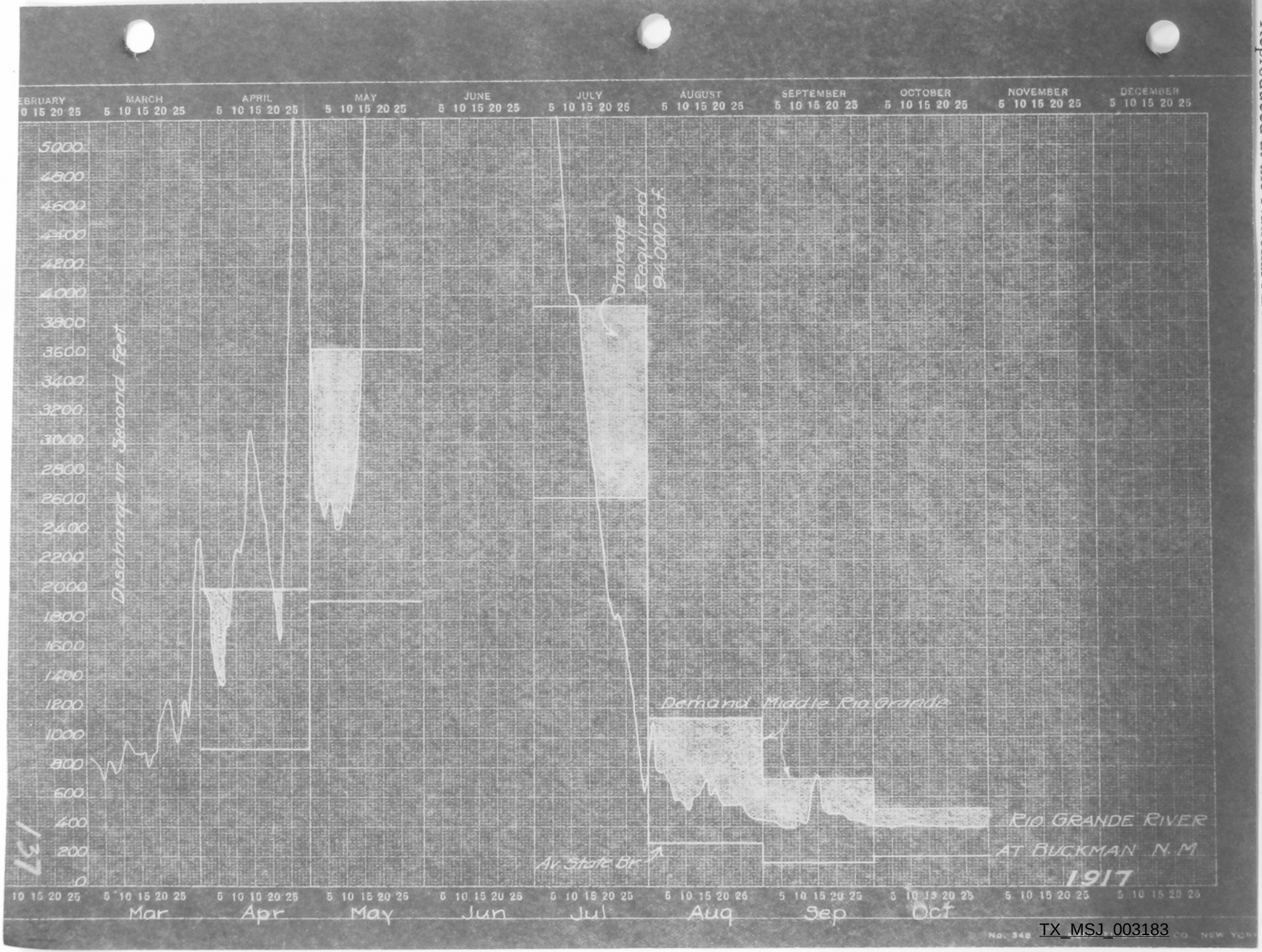

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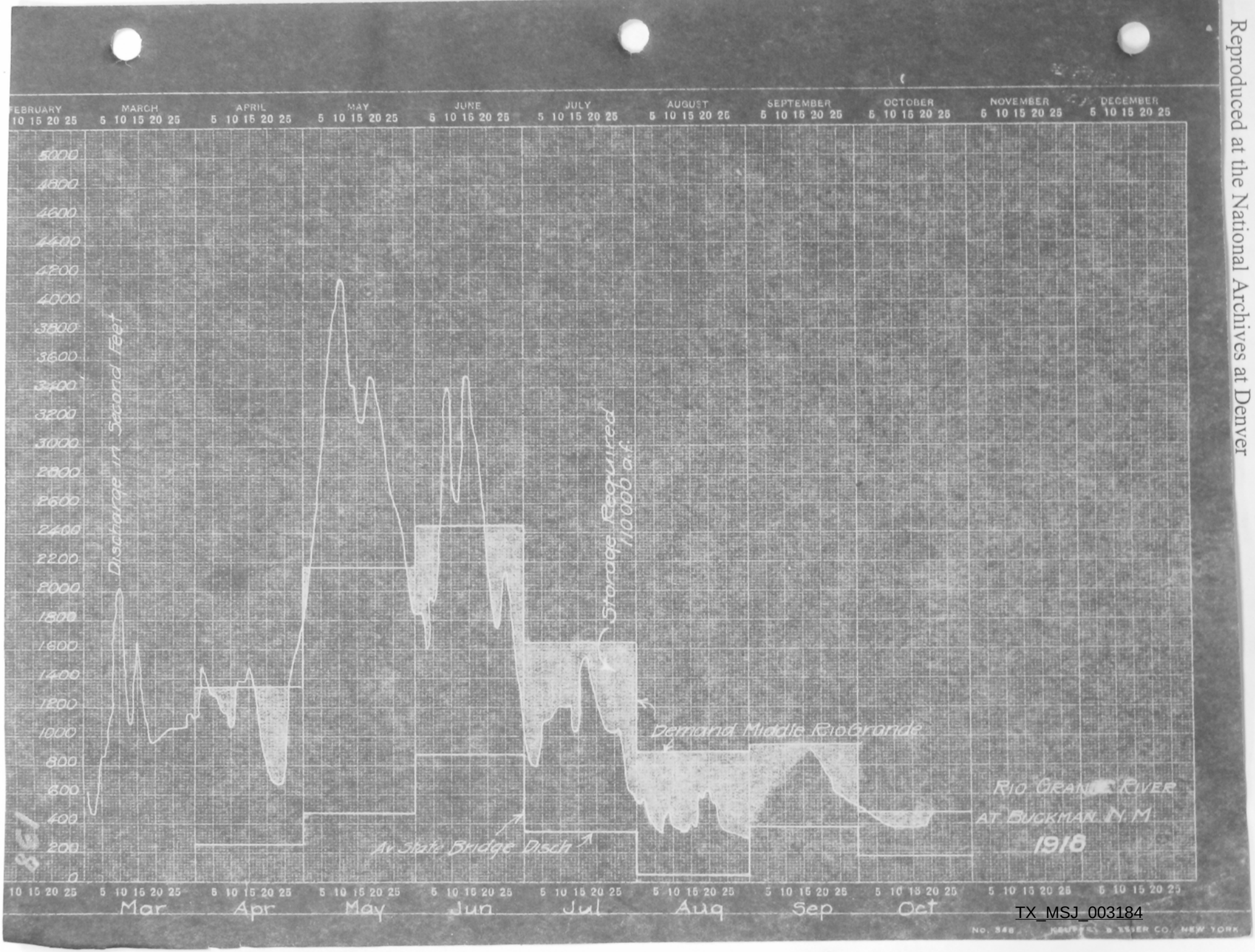

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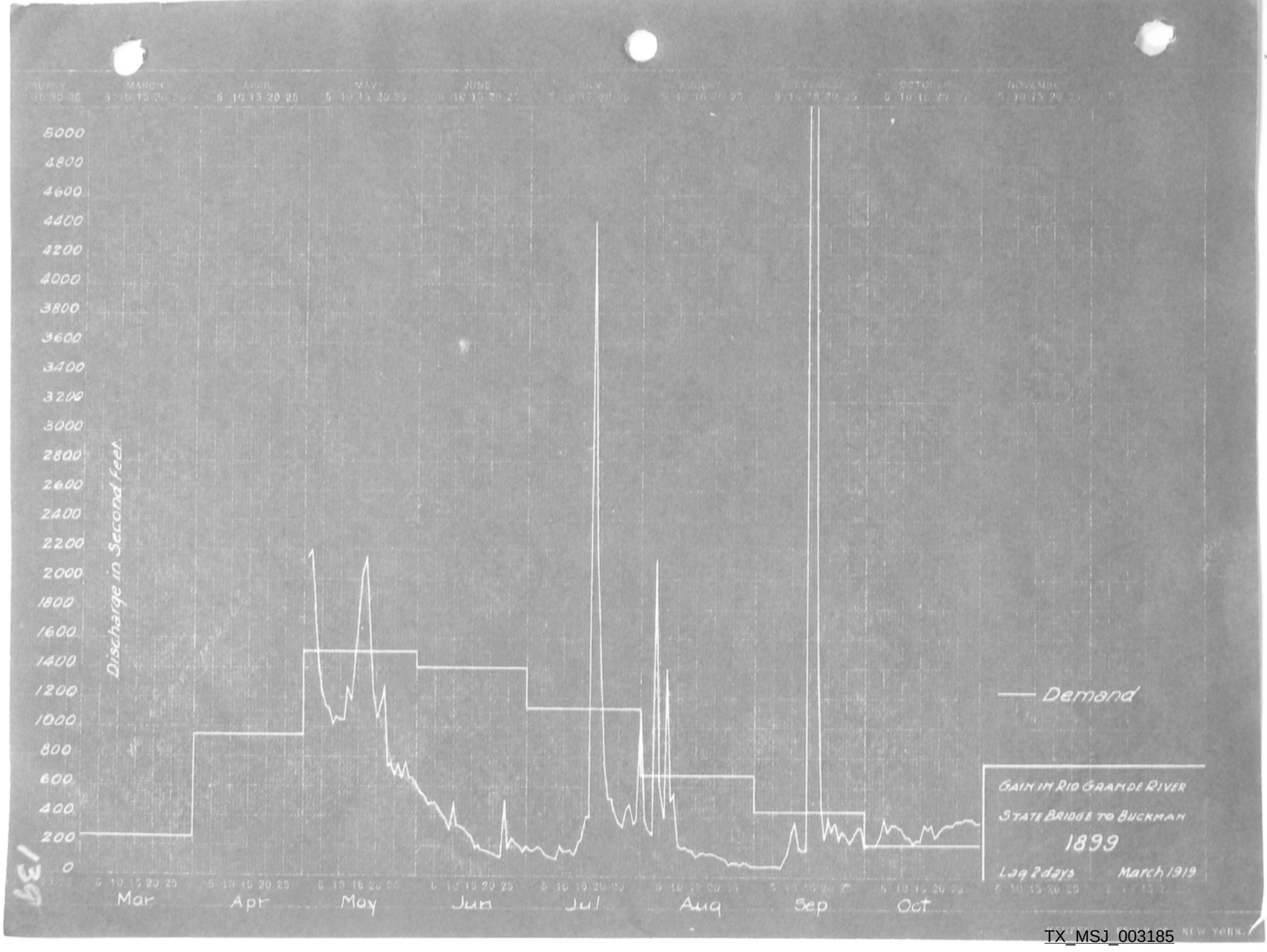

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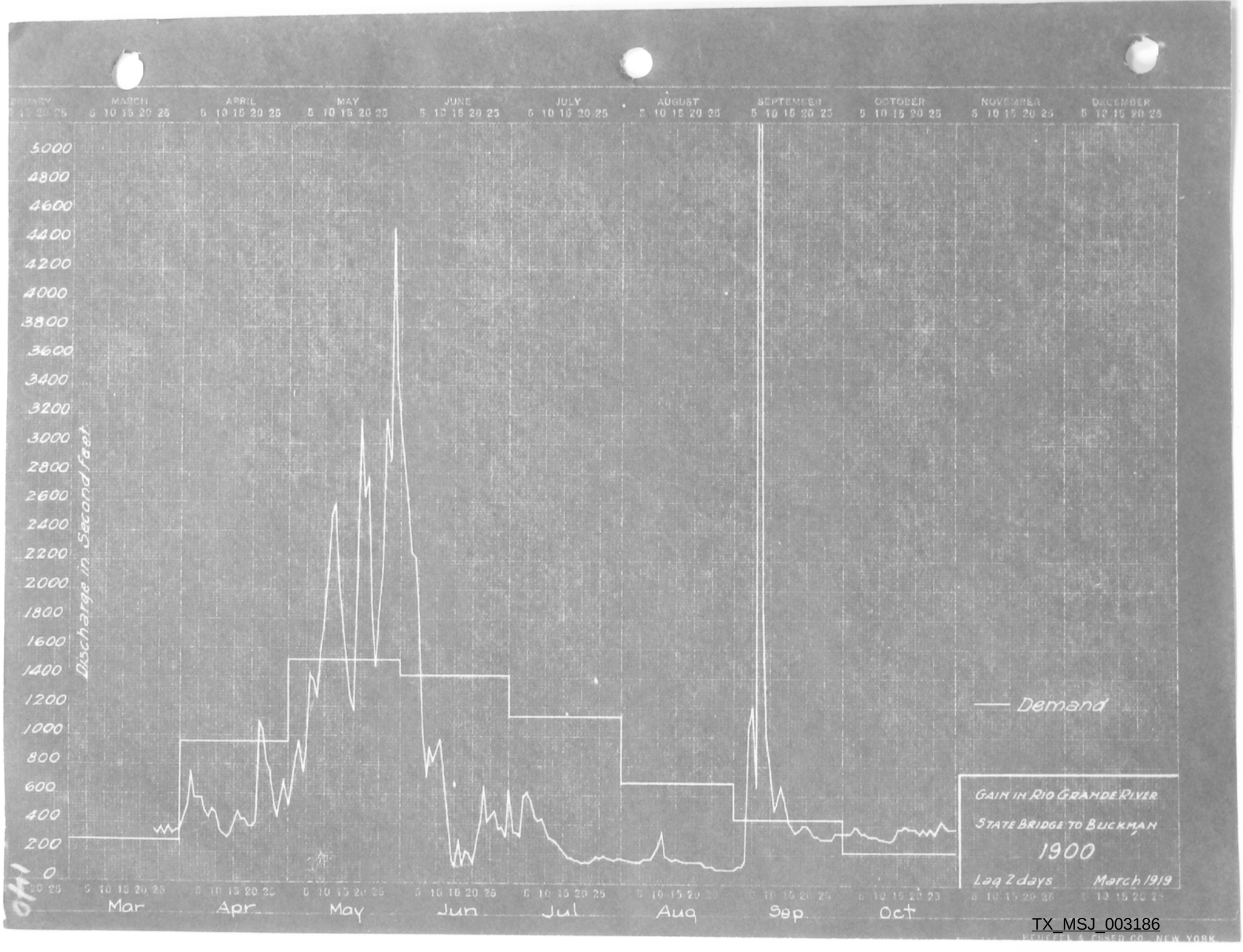

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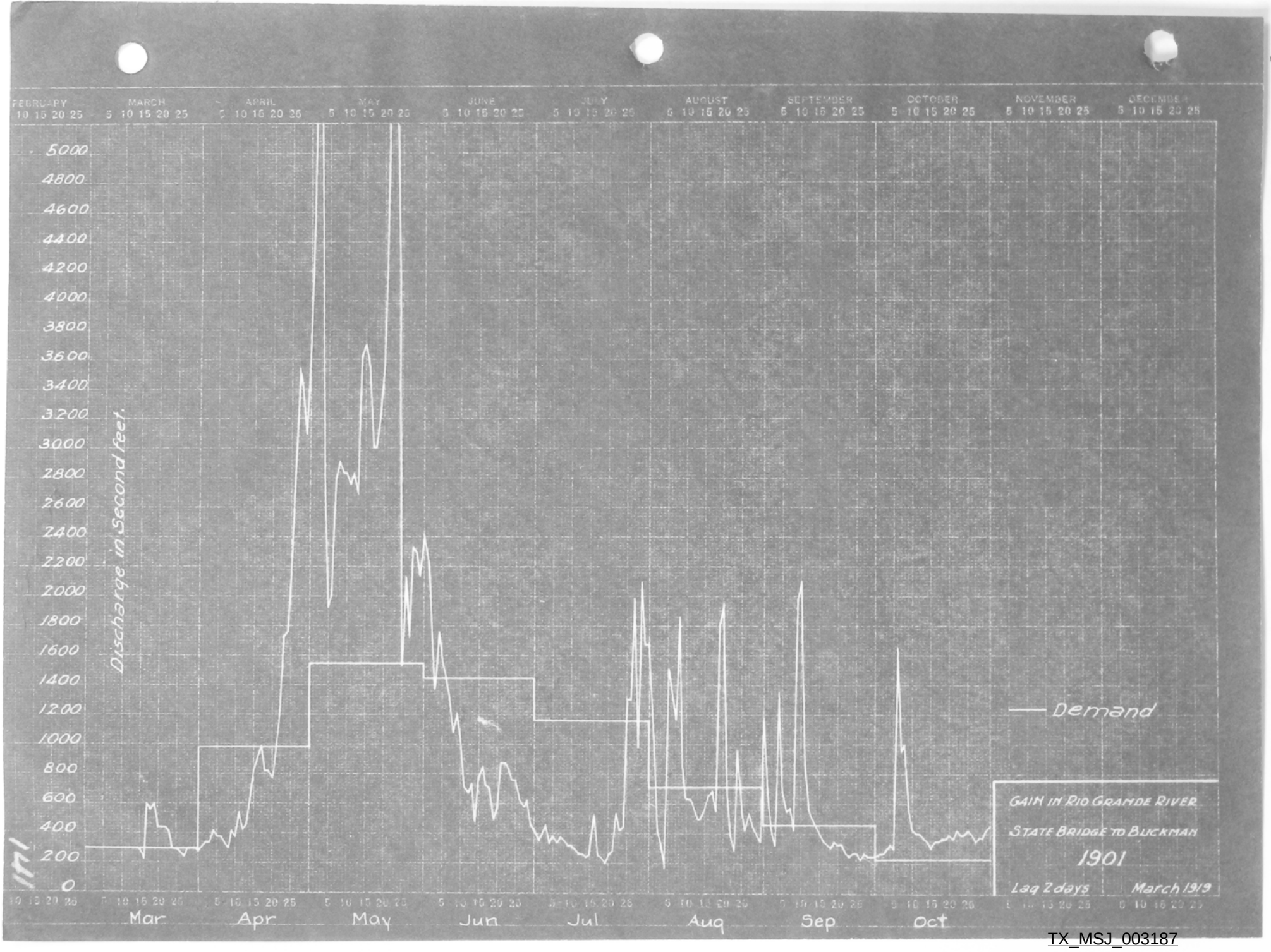

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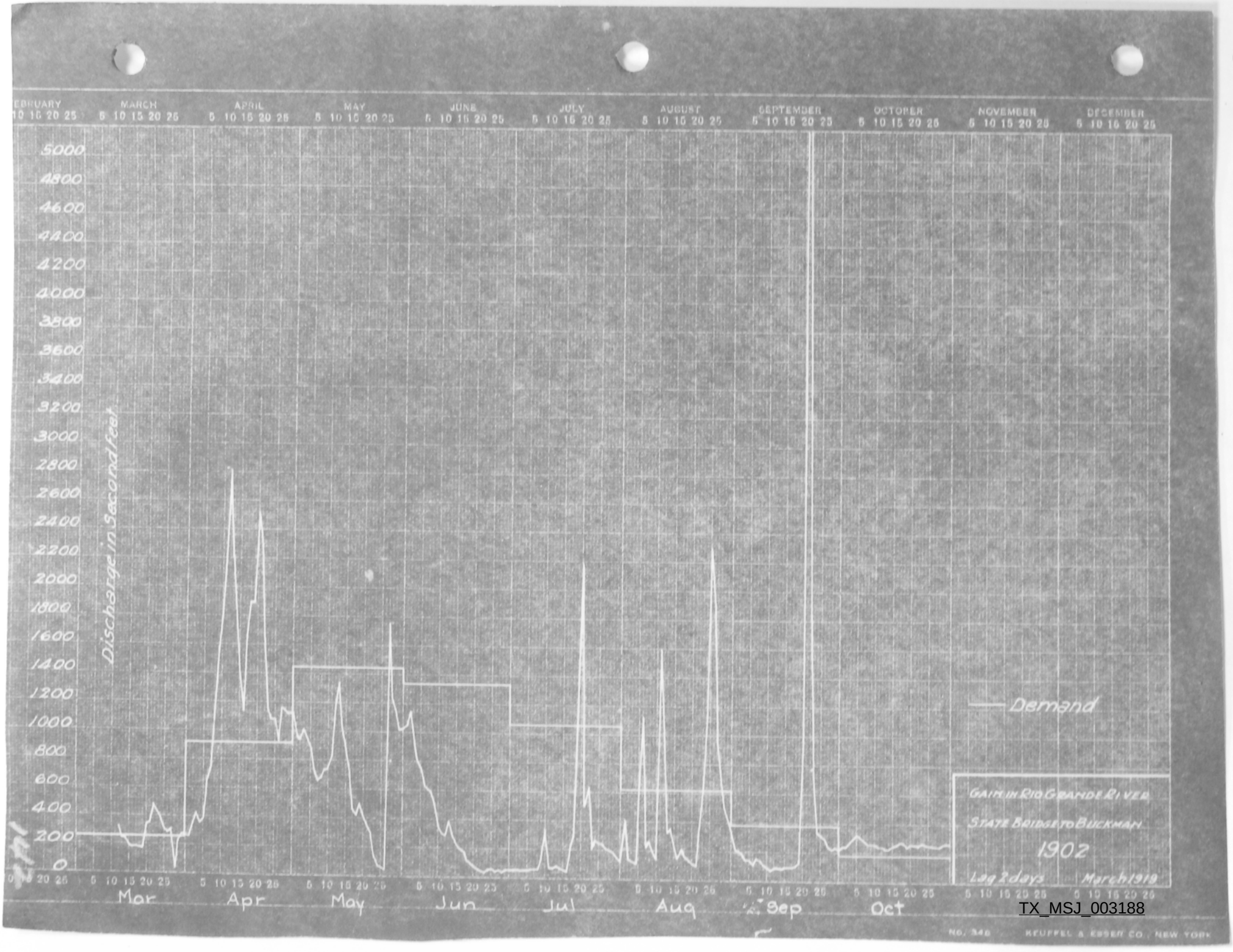

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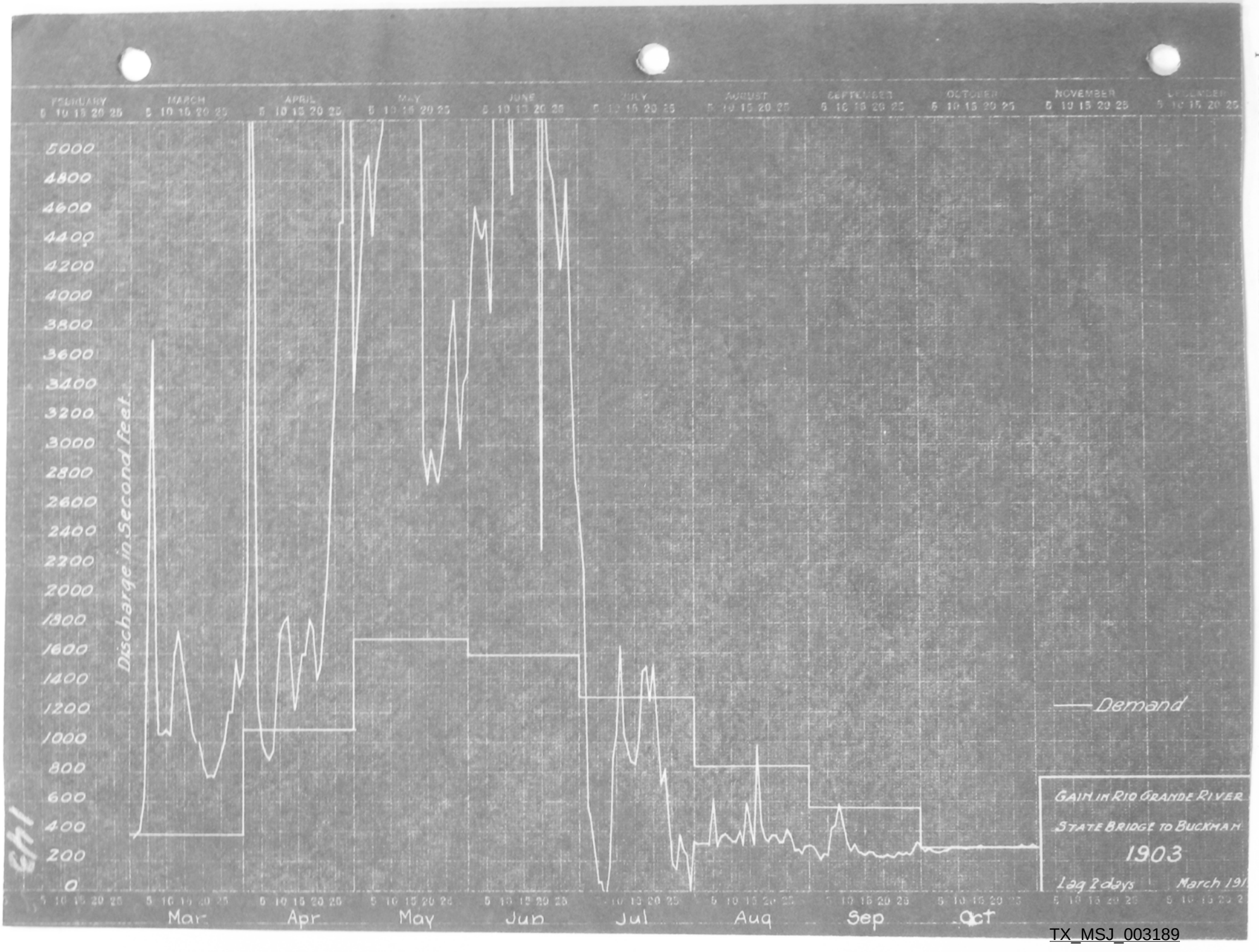

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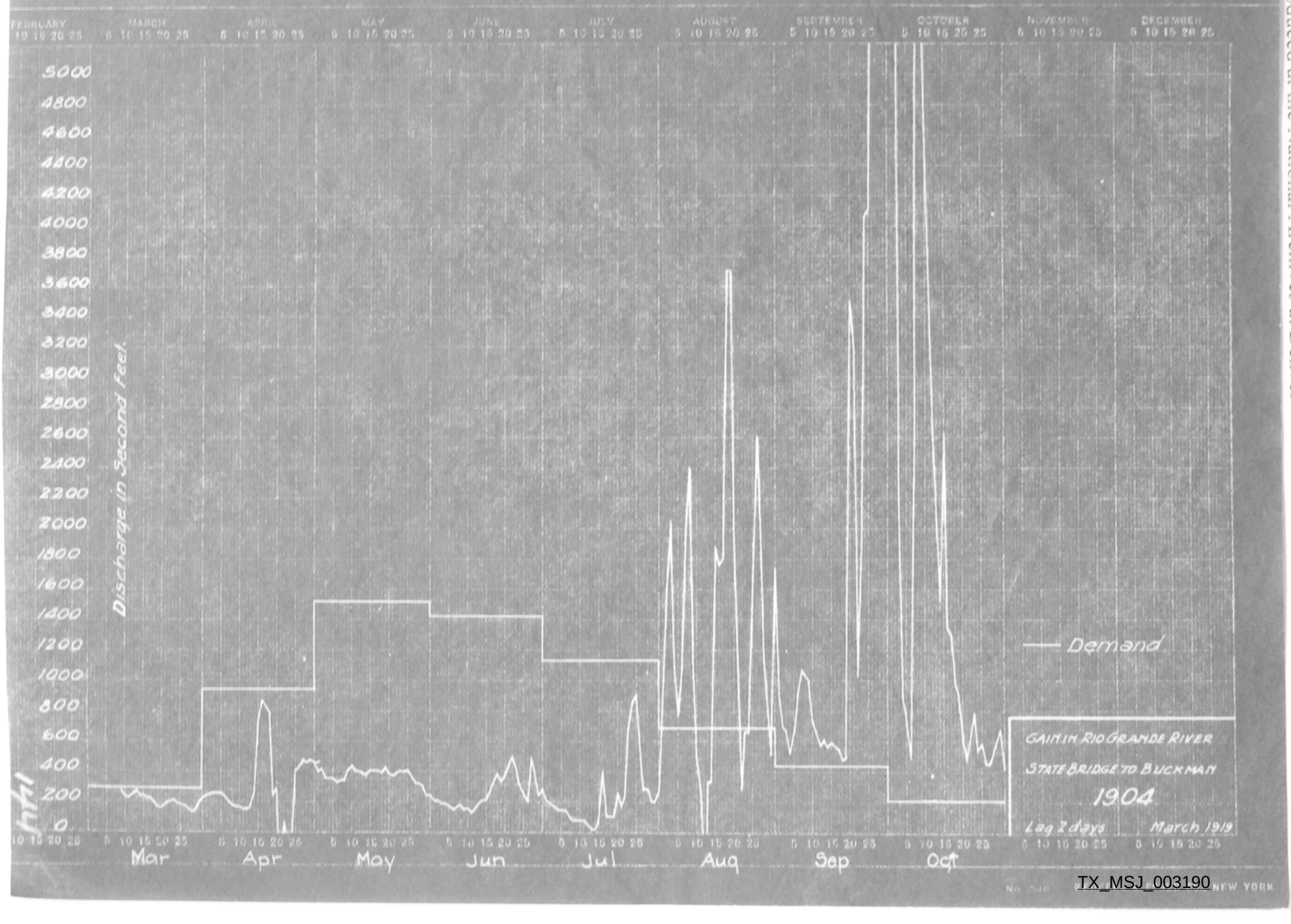

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193. These graphs show the erratic late season discharge noted in paragraph 179. The annual spring flood is the runoff from the high mountains of Colorado and New Mexico, just below the State line. The peaks in the late season are from the cloudbursts and brief heavy rains characteristic of New Mexico in the Rio Grande basin. This runoff is from the comparatively high area above Buckman. South of that point the general elevation is lower and the character of the flow even more flashy without a characteristic spring flood. It seems hardly probable that peaks from these tributaries will do much to ameliorate the lack of supply in the Rio Grande.

194. It is evident that storage is needed.

Storage for Middle Rio Grande

195. Three possible sites exist:

(1) Giroux reservoir on the Rio Grande in Colorado just above the New Mexico line.
Capacity. . . 1,500,000 acre feet.

(2) El Vada reservoir on the Chama in New Mexico at El Vada
Capacity. . . 146,000 acre feet, plus.

(3) White Rock Canyon Reservoir in White Rock Canyon, just below Buckman.
Capacity. . . 26,000 acre feet.

196. Borings made by a power company (State Engineer's files) show no bed rock for 250 feet below river bed at the last site above mentioned. The formation is loosely packed sand, gravel and boulders. The site is unsatisfactory and too small to be of great benefit. No estimate of cost has

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been made.

197. The estimated cost of Giroux reservoir for a 150,000 acre foot capacity is $7.80 per acre foot. As was developed in the discussion of the San Luis Valley, a supply for this reservoir which is just below State Bridge is extremely uncertain in low years.

198. El Vado reservoir (estimated cost per acre foot $11.75), has an excellent dam site. The capacity of 146,000 is from rough surveys and can be increased by higher dam. Right of way is somewhat complicated by the presence of a large lumber mill which will continue operations for another twenty years. The discharge of the Chama River at that point has been measured for only three years.

1914	311,000 a.f.
1915	348,000 "
1916	362,000 "

The State Engineer intends to maintain the station beginning this year.

199. Because of lack of records, it is impossible to make any complete table of reservoir operations. However, approximate discharges may be gotten by comparing it to the difference in discharge of the Buckman at Embudo stations on the Rio Grande. For the simultaneous years of record, El Vada discharge is 58% of the discharge at Chamiti and also 58% of the gain between Embudo and Buckman.

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Operation El Vado Reservoir

200. Although the data is meagre, yet an approximate table has been made up showing the reservoir capacity needed each year and the amount which would be contained in the reservoir at the maximum. This is derived from approximate calculations for years 1899-1904, and from the hydrographs showing shortage for the Middle Rio Grande, preceding page 93.

201. While incomplete, this table indicates that, aside from the severe shortages in the period 1899 to 1904, which appear inevitable to any development of the Rio Grande, 146,000 acre feet capacity is sufficient and while the records have not been gone into in detail, there is little doubt that in succeeding years there would have been no very severe shortages.

202. A much more complete series of records is needed, however, before the above conclusion can be made definite.

203. It is apparent from the foregoing that, allowing the shortages mentioned, there is sufficient water supply for the Middle Rio Grande even with development in the San Luis Valley as outlined in Part II.

Silt Control

204. The gradual silting up of Elephant Butte reservoir will have deleterious effect on the water supply for the Rio Grande Project. Irrigation in the Middle Rio Grande will control, to some extent, the floods in the river and it is believed will decrease the amount of silt carried to

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TABLE NO. 28

EL VADO RESERVOIR

Year	Storage needed	Approximate Annual Discharge at El Vado 58% gain Embudo to Buckman	Maximum in Reservoir	Shortage
1899	146,000	180,000	90,000	56,000
1900	140,000	113,000	46,000	94,000
1901	73,000	176,000	120,000	
1902	195,000	83,000	84,000	111,000
1903	82,000	368,000	146,000	
1904	238,000	174,000	81,000	157,000
1905	89,000*			
1906)				
1907)	No records at Buckman			
1908)				
1909	76,000*			
**1910	165,000*			
1911	35,000*			
1912	81,000*			
**1913	120,000	162,000		
1914	54,000	311,000#		
1915	74,000	348,000#		
1916	25,000	362,000#		
1917	94,000	262,000		
**1918	110,000	156,000		

* No records at Embudo

** Probable not severe shortages

\# Record at El Vado.

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the reservoir by replacing silty water with clear drainage water. In other words, the entire Middle Rio Grande will become a catch basin for silt now reaching the reservoir.

205. As pointed out in the case of the San Luis Valley, no effective measures for controlling development are now apparent. This is true also of the Middle Rio Grande. It is believed also that this development will take place with or without government aid.

206. Government construction should be more efficient than private because it would not be carried on piecemeal and would distribute the cost of storage over the entire acreage rather than concentrate it on the last districts drained.

207. From all standpoints, this appears to be a desirable project for the government to undertake.

(1) Because of probable increase of water supply for the Rio Grande project.

(2) Because of probable decrease in silt to Elephant Butte reservoir.

(3) Because water supply is approximately sufficient.

(4) Because fertile soil and favorable climate will make the region productive.

(5) Because of the better laid plan which can be made by the government.

(6) Because the cost should not be excessive and may approximate the following figure:

Drainage	$25.00 per acre
Storage	15.00 " "
Canal Revision	25.00 " "
	$65.00 " "

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the reservoir by replacing silty water with clear drainage water. In other words, the entire Middle Rio Grande may become a catch basin for silt now reaching the reservoir.

205. As pointed out in the case of the San Luis Valley, no effective measures for controlling development are now apparent. This is true also of the Middle Rio Grande. It is believed also that this development will take place with or without government aid.

206. Government construction should be more efficient than private because it would not be carried on piecemeal and would distribute the cost of storage over the entire acreage rather than concentrate it on the last districts drained.

207. This appears to be a desirable government enterprise for the following reasons:

(1) Because if drainage is done privately, it may not be so efficient as government drainage. As noted, the average gain is computed at 94,000 acre feet annually. However, if the computations are analyzed by periods, it is found that for the critical period 1898-1902, the estimates show a loss by irrigation and drainage of 21,000 a.f. annually (Table 43); also the gain when estimates are extended back to 1890 averages 70,000 a.f. annually. This makes apparent the fact that less efficient drainage may produce a very adverse effect at the critical time.

(2) Because of possible increase of water supply for the Rio Grande project.

(3) Because of possible decrease in silt to Elephant Butte reservoir.

(4) Because water supply is approximately sufficient.

(5) Because fertile soil and favorable climate will make the region productive.

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(6) Because of the better laid plan which can be made by the government.

(7) Because the cost should not be excessive and may approximate the following figure:

Drainage	$25.00 per acre.
Storage	15.00 " "
Canal Revision	25.00 " "
	$65.00 " "

208. If the above conclusions are acceptable and provided more thorough investigation of drainage demonstrates its feasibility, and if funds are sufficient, government construction will rest on the attitude of the residents of the valley. To bring these people together may be very difficult although the setiment of the leading citizens is now said to be largely in favor of government construction.

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PART IV.

RIO GRANDE PROJECT

209. At Elephant Butte reservoir, the upper end of which lies at the town of San Marcial, New Mexico, and which reaches southward forty miles to Elephant Butte dam, the discharge of the river is, for practical purposes, completely controlled and used for the Rio Grande Project and to satisfy the terms of the convention with Mexico, which engages to supply 60,000 acre feet to quiet the claims of the Mexican government for damages arising from diversions of water in the Upper Rio Grande against the interests of the prior users of Mexico.

210. Below Elephant Butte Reservoir, the Rio Grande Project lies in a succession of narrow valleys not over four miles at the widest. The gross acreage of these valleys in order down the river is as follows:

TABLE NO. 29

Valley	Gross area excl. of river wash.	Assumed waste land.	Assumed net area.	Percent net of gross.
Rincon	19000 a.	2,000	17,000	89
Mesilla	98000 "	15,000	83,000	85
El Paso	58000 "	11,000	47,000	81
Tornilla	9000 "	1,000	8,000	89
	184000	29,000	155,000	84

River Losses

211. The river threads its course through the valley oftentimes above the ground on either side and constantly decreases in volume except when the tributarues discharge the

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Reports consulted in connection with study of this project are:

Index	Title	Year	Author	Dept.
a	Ground Waters in Rio Grande Valley, W.S. 141	1905	Schlichter	USGS
b	Silt in Rio Grande	1912	Follett	State
c	Drainage in Rio Grande Project Mesilla & El Paso Valleys	1917	Board	USRS
d	Silt - Elephant Butte Res.	1916	Coghlan-Lieb	"
e	Drainage in Rio Grande Project	1918	Board	"
f	" " " " "	1915	"	"
g	Water Resources-Rio Grande Valley, W. S. 188	1907	Lee	USGS

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infrequent flashy floods characteristic of the region. This observed annual loss between San Marcial and El Paso, before Elephant Butte dam was constructed, averaged 288,000 acre feet and has given rise to the belief that there is an underground outlet into Mexico near Las Cruces and just above the range of mountains through which the river breaks at El Paso.

212. Geologists believe (Report "g") that at one time the river did flow southward into a fresh water lake in Old Mexico until the pass just mentioned had been cut but now the elevation of the plateau, which was the lake bottom, is not more than 100 feet below the river bed at Las Cruces and there is no indication of flow from the Rio Grande into the basin. Obviously the flow through soil must be slight in a distance of 150 miles with a head of only 100 feet.

213. It seems possible, also, that an igneous dike has been thrown up on the west side and parallel to the river from north of the Elephant Butte reservoir south to opposite El Paso, and if this is true, it probably deflected the river to its present course.

214. Another factor in cutting off underground flow in the old channel if it has not been effectually blocked by the igneous dike mentioned, is the silt carried by the river. This occurs in enormous quantities, and it would seem would

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soon cut off any underground outlet which may exist.

215. The probable cause of the loss is irrigation consumption and lateral seepage from the river to the low-lying border lands. From these, the water is disposed of by evaporation from the ground surface through the action of capillarity on the ground water and from the free water surface of occasional pools. Data on ground water are not sufficient to give a check on this assumption but the acreage of irrigated land and the extensive area of bottom lands would seem to be sufficient to account for the loss. The underflow at El Paso has been measured and found negligible (report "a"), so that no water is escaping underground in the direction of river flow.

Cause of Recent Ground Water Rise

216. In the past, the intermittent character of the stream gave rise to the practice of diverting all the water possible whenever possible and to wild flooding on unleveled land. There is little complaint of seepage in the past and evidently the water supply was so insufficient that evaporation from a comparatively deep water table was great enough to maintain a balance. Since Elephant Butte dam was built, a continuous discharge has been maintained in the river thus increasing the lateral seepage, while the irrigators have followed the ancient method of applying water whenever it was in the river. The result has been that evaporation from a comparatively deep water table is no longer able to take care

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of the situation and the ground water has steadily risen to the great detriment of the crops and the alarm of the farmers.

217. Steps are now being taken to relieve the situation by deep open drains and so far as work has proceeded at this time, the methods employed are effectual.

Duty of Water

218. To date, the diversions can hardly be considered to give much light on ultimate duty of water. Also the fact that until very recently the government has not maintained supervision over the community ditches has prevented keeping records of the disposal of the water after it is diverted from the main canal. Undoubtedly a great deal has been wasted back into the river but no data are at hand to determine this amount.

219. Previously, also, the charge for water was distributed to each acre by the community ditch management regardless of the amount used and this custom gave no incentive to economy.

220. The Reclamation Service is gradually taking over the management of all the community systems and it is to be expected that complete hydrographis records will be maintained from the year 1919 on. In 1918, due to a change in the system of charges in the El Paso Valley by which the water user pays an increased price for each acre foot used after the first three, the use of fully half of the settlers

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in that valley did not exceed three acre feet at the land. This economy took place with a high water table and it is expected that when drainage is accomplished the demand will be greater unless drastic regulation is made.

221. The diversion and acreage irrigated for the past five years is shown in the following table:

TABLE NO. 30.

Year	Acres Irrigated	Diversion in a.f. Total	Per Acre
1914	28,442	197,646	6.95
1915	38,876	256,288	7.57
1916	62,513	488,286	7.81
1917	64,308	622,177	9.68
1918	64,781	613,638	9.47
Averages	50,780	435,610	8.60

Canal Losses

221. The loss in main canals averaged 14 per cent for the entire project for 1918, and on the Franklin Canal in El Paso Valley was 23 per cent. The loss in lateral system under the Franklin Canal was only 4 per cent. This is the only system where measurements of deliveries to land were completely obtained. The loss is small - 27 per cent, and this is possibly due to the fact that portions of the ditches pass through seeped land. If this is true, when drains have been constructed, the loss will be more.

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Drainage Runoff.

222. The runoff from the 74 miles of open drain constructed up to December, 1918, was 64.5 second feet or 0.88 second feet per mile. This forms no criterion as to the future, however, because the tributary ground water had, in some portions, only partially lowered, in others irrigation was carried on to not more than 50 per cent of the ultimate and in still others, there was no irrigation whatever. As the unconsumed irrigation water will form a large part of the drain discharge, no present discharge with conditions as above can be used for future estimates.

Duty of Water - Carlsbad Project

223. It is apparent from the foregoing that there is little in past records on the Rio Grande Project to form an estimate of the future. However, the Carlsbad Project, as noted in Part III, in southeastern New Mexico, has a similar climate and length of irrigation season but the rainfall averages 15" instead of 10". On this the water delivered at farms has averaged 2.4 acre feet per acre in the 12-year period 1907-1918.

ANALYSIS OF DEMANDS ON RESERVOIR-RIO GRANDE PROJECT

224. The Rio Grande stretches for 150 miles down the river and consists of a series of valleys, as noted in paragraph 210, the last of which is only 9000 acres in extent.

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As the irrigation season is 10 months long, - February to November, - conditions are favorable for a reuse of almost the entire return flow.

225. The demands on Elephant Butte Reservoir, below the reservoir, will consist of the following items:

TABLE NO. 31.

1. Loss in stream bed.
2. Mexican convention - 60,000 a.f.
3. Demands for plant growth.
4. Evaporation incidental to irrigation.
5. Evaporation from areas not cultivated where the water table is close to the ground surface.
6. Loss past last headgate through sand trap at head of diversion canal.
7. Loss past last headgate because of difficulty of regulation from reservoir 150 miles awa.
8. Seepage from river into banks.

226. Taking up these losses in the above order to estimate amounts:

1. Loss in stream bed. The total area of river bed is now about 22,000 acres. In the past, floods have affected constant changes of channel and have kept this area larger than would probably have been the case if the river had been controlled by Elephant Butte reservoir, as now. Control and narrowing of the river

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channel have been the subjects of some study in the past but the effect of control by the reservoir, both because of flood diminution and the lack of silt in the water escaping from the reservoir, has been so salutary that it has of late been believed that the river would accomplish almost all of its own work in narrowing the channel. Lack of silt has already enabled the water to erode a channel for some distance below the reservoir much narrower than its old wash. It is to be expected that this effect will continue on down the river and that for eventual control only a small amount of artificial [redacted] work will be necessary. However, the flashy floods from tributaries may at times have serious effect and will probably make necessary work in the vicinity of their confluence with the main river. For this report, it is estimated that the ultimate wetted river area will be 10,000 acres. The evaporation from this surface for the irrigation season of ten months, February to November, inclusive, is taken at 66,000 acre feet.

2. The Mexican Convention recites that 60,000 acre feet shall be delivered annually to the Mexican dam, opposite El Paso. Since all transportation losses from Elephant Butte dam are taken care of in item 1 or succeeding items, no allowance is made under this head for such losses.

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3. Demands for plant growth. The water demands of plants were discussed in Part II, and as noted there, have been the subject of experimental work by agricultural research workers for the last two centuries and from the literature on the subject which has been fairly well crystallized, it is deduced that plant consumption can hardly be more than one foot in depth for crops of the Rio Grande Project.

4. Evaporation incidental to irrigation. In applying water by surface irrigation there must always be a large evaporation loss. This is partly within the control of the irrigator but in a region of almost continuous sunshine and heavy winds, such as the Rio Grande, and with ordinary methods of irrigation, it may be larger than plant consumption. The 2.4 acre feet applied to the Carlsbad Project supplies both the plant consumption and incidental evaporation and also, since some deep percolation is necessary in the ordinary practice of irrigation, it includes that item. It is probable that the deep percolation on the Carlsbad Project is about 0.4 ft. per acre giving a consumptive use of 2.0 acre feet but since the rainfall on the Rio Grande is 5" less, the extra water must be supplied from irrigation water. Altogether it is estimated that because of the heavy evaporation the incidental loss on

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the Rio Grande Project will be 1.5 feet in depth.

5. Evaporation from uncultivated areas. This is proportional to the depth to ground water, and in heavy soil, it will draw on water as far below the surface as 8 feet. In sandier soils of less capillary power, its effect may not reach further than four feet from the surface. What has just been said applies only to fallow land containing a growth of weeds for if there is no vegetation present, evaporation will not be felt to so great a depth. In this project, drains are constructed in the lowest lands and the water where it enters the drain may be eight or nine feet below the general surface. With a slope of 1 foot per 1000 away from the drain and drains averaging between one mile and one and one-half miles apart, it should be possible to maintain the average ground water six feet below the surface. Assuming in addition to the usual minimum of 10 per cent uncultivated land, another 6 per cent for waste areas and an evaporation from a six foot water table of 25 per cent of the free water surface evaporation of 7 feet gives 1.75 ft. annual evaporation from each acre of waste land or 0.35 ft. when prorated to each acre of irrigated land.

6. Lost through last sand trap. In operating the canals, it has been found necessary, in order to prevent sand and the heavier silt from entering, to install a sand

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trap which discharges the lower filaments of water into the river. This discharge is about 50 s.f. Only the last heading constitutes a draft on the reservoir because of re-use of waste from the other headings by lower canals.

7. Loss through difficulty of regulation can be cut to a minimum on this river because of the small number of canals and small rainfall. The principal difficulty will be due to the diurnal fluctuations caused by evaporation. As noted in item 1, the evaporation loss in the future is estimated at 66,000 a.f. most of which will take place in the day time. The diurnal fluctuation will total almost that amount in the course of the year and regulation losses will approximate that figure. The total annual has been placed at 60,000 a.f. for this report.

8. Seepage from river. This is taken up by evaporation. It is assumed that drainage will m ake the amount of loss from this item negligible in the future since the seepage will be almost immediately returned to the river through drains instead of being taken up by evaporation, as in the past. At the present time there is no movement on foot to drain the Mexican side and evaporation from these lands will be a prior draft on the river until they are drained and even after drainage, there seems to be no reason that pumping from ground water will not be practiced on the Mexican side.

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The Los Palomas Valley remains the only unirrigated land between Elephant Butte Dam and the lower end of the project through which the river runs but most of this is high enough to be unaffected by seepage from the river. Measurements made in November, 1917, and January and February 1918, show a gain instead of a loss through this valley. Many uncertainties rest in this item but because of the generous estimate of loss in items 6 and 7 which may be reduced in time , no further draft for item 8 is used.

227. Summarizing these different items, there are certain of them which constitute demands which must be satisfied before any land in the Rio Grande Project can be irrigated:

Item		
1.	Stream bed loss	66,000 a.f.
2.	Mexican convention	60,000 "
6.	Loss through last sand trap . .	30,000 "
7.	Regulation loss	60,000 "
		216,000 "

228. The demands for irrigation are as follows:

Item		
3.	Plant consumption	1.00 a.f. per A.
4.	Incidental evaporation	1.50 " " "
5.	Evaporation from uncultivated areas	0.35 " " "
		2.85 " " "

Return Flow

229. If irrigation were carried on the year round the sum of the items of paragraph 227 plus the items of paragraph 228 into the number of acres irrigated would be the annual demand below the reservoir. But as it is necessary to divert more water than is consumed, there will be an item of return

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flow to the river from the irrigated areas which cannot be utilized. That from the Tornilla, which is the lowest unit, will be entirely lost, while that which takes place from the remainder of the project will be lost out of the irrigation season and if diversion is large a part may also be lost in the late irrigation season. The Tornilla and San Elizario units can probably use the entire return from the El Paso Valley.

230. The amount of return flow depends on the excess of diversion over consumptive use. It consists of the transportation loss from canals and deep percolation from irrigated areas. In most projects these items are of considerable importance because they are lost to the project, but on the Rio Grande are comparatively unimportant if diversion is approximately as assumed, because of immediate rediversion by canal headings below. Deep percolation on the Rio Grande Project will maintain the ground water at such depth that the plant roots can take advantage of it and relieve, to some extent, the necessity of surface irrigation. On the other hand, if irrigation is lavish, it may raise the ground water so much that an unduly large amount will be wasted by surface evaporation from untilled areas.

231. The amount of water which can be handled by the drains, the construction of which is now contemplated, without undue rise in the water table, is uncertain, but is here assumed to be 1.5 acre feet per acre drained per year. Except for the return from the Tornilla unit, which is the lowest,

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and the winter return from the entire project this drainage is assumed entirely roused.

Diversion Duty

232. The diversion is assumed to be the consumptive use of 2.85 acre feet noted in 228, plus the 1.5 return giving a total of 4.35 acre feet per acre.

Demand on Elephant Butte except evaporation.

233. This may be divided as follows:-

Uses other than irrigation	216,000	a.f.
Tornilla Unit, 8000 a. at 4.35	35,000	"
Other units, 147,000 a. at 2.94.	432,000	"
	683,000	"

The details of distribution are given in the following Table:

(See next page for table)

TABLE NO. 32

DEMANDS - RIO GRANDE PROJECT — QUANTITIES IN ACRE FEET

MONTH	Diversion A.F. per Acre	Diversion % Tot	Return Flow A.F. per Acre	Return Flow % Total	Demand all Units except Tornillo 147,000 Acres Per A. Col.1-3	Demand: Total Tornillo Col. 1 x 8000 A.	Irrigation demand Col. 6 plus 7	Other Demands: Mexican Treaty	Riverbed Loss Evap. 10ths feet	Loss For 10000 acres	Loss thru last sand trap	Total Loss in regulation	Grand Total Demand on Reservoir - Col.8 plus 14 A. Ft.	Grand Total Demand on Reservoir - Col.8 plus 14 Sec.ft.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
JAN.			0.04	3.0						0.17					
FEB.	0.09	2.0	0.05	3.0	0.04	5800	720	6,520	1,090	0.31	3,100	3,000	6,000	13,190	19,710	330
MAR.	0.50	11.4	0.08	5.0	0.43	63100	4,000	67,100	5,460	0.59	5,900	3,000	6,000	20,360	87,460	1,460
APR.	0.57	13.1	0.12	8.0	0.45	66100	4,560	70,660	12,000	0.79	7,900	3,000	6,000	28,900	99,560	1,660
MAY	0.62	14.3	0.16	11.0	0.46	67600	4,960	72,560	12,000	0.97	9,700	3,000	6,000	30,700	103,260	1,720
JUNE	0.63	14.4	0.18	12.0	0.45	66100	5,040	71,140	12,000	0.98	9,800	3,000	6,000	30,800	101,940	1,700
JULY	0.62	14.3	0.20	13.0	0.42	61700	4,960	66,660	8,180	0.83	8,300	3,000	6,000	25,480	92,140	1,540
AUG.	0.51	11.8	0.19	13.0	0.32	47000	4,080	51,080	4,370	0.70	7,000	3,000	6,000	20,370	71,450	1,190
SEPT.	0.43	9.8	0.18	12.0	0.25	36700	3,440	40,140	3,270	0.59	5,900	3,000	6,000	18,170	58,310	970
OCT.	0.26	6.1	0.15	10.0	0.11	16100	2,080	18,180	1,090	0.52	5,200	3,000	6,000	15,290	33,470	560
NOV.	0.12	2.8	0.10	7.0	0.02	1800	960	2,760	540	0.32	3,200	3,000	6,000	12,740	15,500	260
DEC.			0.05	3.0						0.23						
	4.35	100.0	1.50	100.0	2.94	432000	34,800	466,800	60,000	6.60	66,000	30,000	60,000	216,000	682,800	

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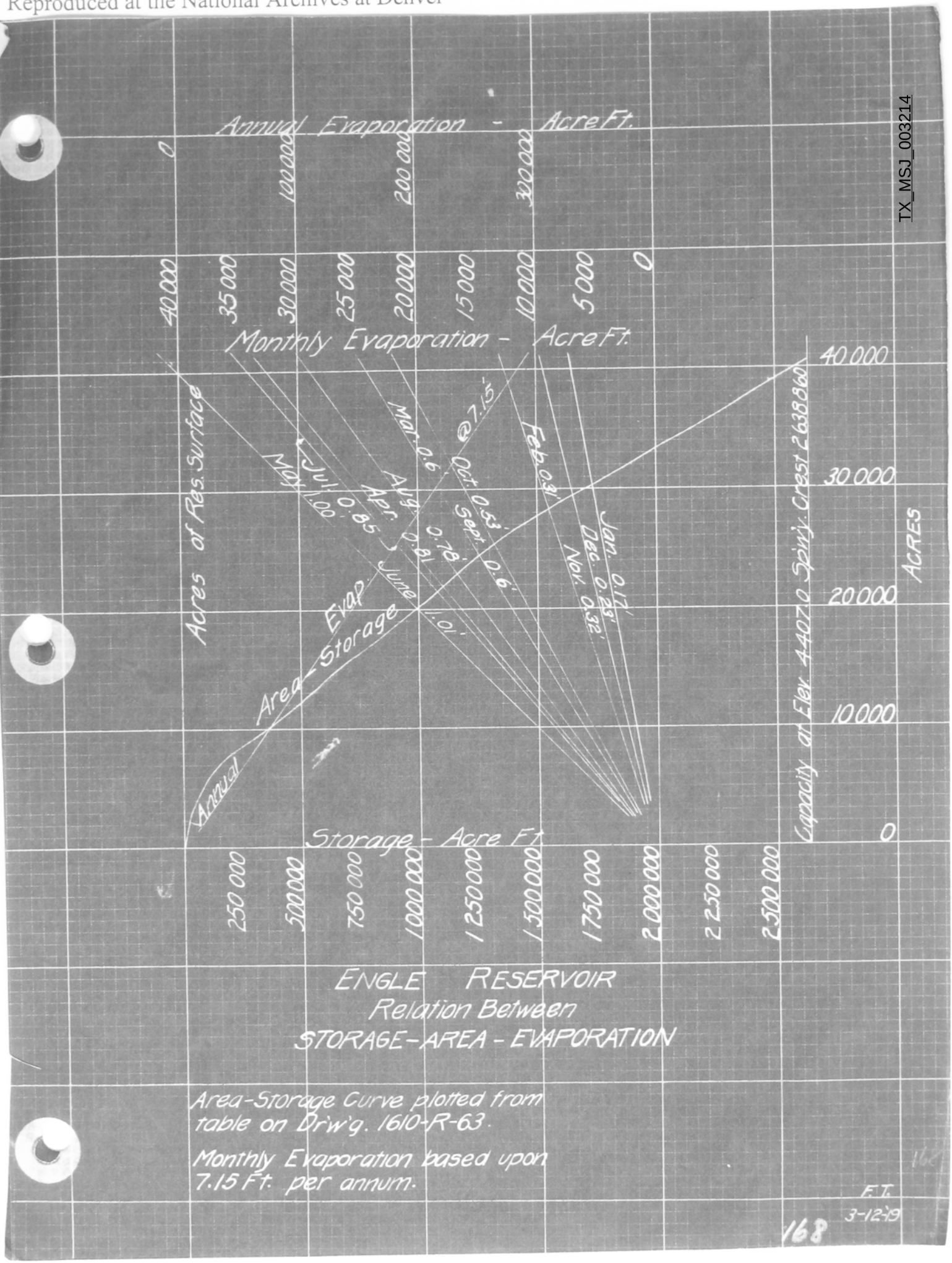

ENGLE RESERVOIR
Relation Between
STORAGE - AREA - EVAPORATION

Area-Storage Curve plotted from table on Dr'w'g. 1610-R-63.

Monthly Evaporation based upon 7.15 Ft. per annum.

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ELEPHANT BUTTE RESERVOIR

233. The plat opposite shows capacity and acreage curves of Elephant Butte reservoir. Its maximum capacity when built was 2,640,000 acre feet and surface area 40,000 acres. It fills the canyon for 40 miles below San Marcial.

234. Silt deposits in the reservoir have been the subject of considerable discussion and it is calculated now after five years operation that the capacity has been reduced to 2,627,000 acre feet (Reports B, D, and final graph of this report. It is not the purpose of this report to go into the subject. Various reports have been made which are available. The last and best is that of Rapier Coghlan and Victor E. Lieb (Report D). Silt content of the water entering the reservoir has been determined for many years (Report B). The point to be observed is that acreage irrigable from the reservoir should be more conservatively figured than were silt not present, since reduction in capacity will be continuous and should the condition of water supply which occurred in the cycle of years of runoff be repeated at some future time, it will find the reservoir contents less.

Evaporation from Reservoir

235. In the cycle of years 1916-1918, the reservoir partially filled and returned to an elevation somewhat below its starting point. From this, the loss per unit of area may be calculated without interference from bank storage. It is probable that this loss is entirely evaporation since there would seem to be little opportunity for escape from

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the reservoir. The following table shows the loss per acre submerged.

TABLE NO. 33

Evaporation loss - Elephant Butte Reservoir

Year	Av. area in acres	Total loss a.f.		Depth of loss
1916	15,590	145,000		9.33
1917	17,130	127,000		7.42
1918	10,250	35,000		3.32
Total - -	42,970	307,000	Avg.	7.15

Bank Storage

236. This will form an item which is not considered in succeeding calculations but which may be of help in overcoming the effect of siltage for some years to come. It should be noted also that the silt may form a considerable reservoir in itself since it contains about 40 per cent voids.

TABLE NO. 34

Bank Storage - Elephant Butte Reservoir.

	Area beginning period	Area end of period	Diff.	Total loss a.f.	Evap. on avg. area @ 7.15	Diff.= Col.4-5 Seepage	Seepage per a. col 6÷3
	1	2	3	4	5	6	
1916	10,230	19,010	8,780	145,000	109,000	36,000	4.1
1917	19,010	13,280	-5,730	127,000	120,000	7,000	1.2
1918	13,280	7,690	-5,590	35,000	72,000	-37,000	-6.6
				307,000	301,000	6,000	

Over 4 feet of water seeped into the ground on the new areas submerged in 1916 and was regained as the reservoir lowered. The slight discrepancy of 6000 a.f. may be due to the fact that the entire bank storage had not yet had opportunity to return by the end of 1918. For the entire 40,000 acres, this gives

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160,000 acre feet of bank storage assuming that it does not seep entirely away from the reservoir at some higher elevation. This seems unlikely because of the local formation but the uncertainties preclude any use of this item in calculations.

Increased San Luis Valley Demands

237. During the cycle of years of record of inflow into the reservoir, there has been an increased use of water above which, if it had been present at the time, would have reduced the recorded discharge at San Marcial. This development has taken place not only in the San Luis Valley but in other parts of the drainage basin also. However, the most definite information obtainable concerns the San Luis and the other development is comparatively negligible so that the reduction in discharge caused by Colorado development is the only one discussed. This was discussed fully in Part II and the estimated reduction calculated in Table 12.

Reservoir Operation

238. The demands on the discharge at San Marcial are:

1. Annual draft of 683,000 acre feet
2. Annual evaporation of 7.15 feet in depth.
3. Additional demands above reservoir.

Curves of operation of the reservoir have been worked out for two conditions:

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1. Water supply with present conditions above. This water supply is the recorded discharge at San Marcial minus the estimated reduction in discharge from the San Luis Valley caused by development during the period of record. For convenience, this reduction is treated as a demand.

2. Water supply with the estimated discharge from San Luis Valley after ultimate development by pumping, as outlined in Part II - a total of 750,000 net acres in the valley plus mountain valley irrigation plus irrigation in the southeast corner (about 810,000 acres in all), and with the Middle Rio Grande bottom lands developed to a total of 116,000 net acres.

239. The period of record at San Marcial covers the six years of extremely low runoff from 1899-1904, inclusive, when the reservoir is entirely depleted. Hence the probable contents of the reservoir prior to the beginning of records in 1895 is important.

240. For estimating this there are two sources of information: Follett's report on the "Equitable distribution of the waters of the Rio Grande" (Report "a", page 1), and the discharge records at El Paso prior to 1895.

241. From inquiry in 1896, Follett compiled the following information as to discharge at San Marcial, or in that general region, during the summer season:

1884.	.Big flood.
1885.	.Flood.
1886.	.Flood.
1887.	.Average.
1888.	.Possibly dry.
1889.	.Dry
1890.	.Sufficient water.
1891.	.Contradictory records at various points. Some say sufficient water; others not.

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1892. . . . . Dry.
1893. . . . . Short of water.
1894. . . . . Short of Water.
1895. . . . . Fair supply.

242. Discharge records are available at El Paso from 1890-1892, inclusive, and for part of 1893. The relation between San Marcial and El Paso discharges is very close as shown by plat following page 14.

	Recorded discharge El Paso	Estimated discharge San Marcial
1890	963,000 a.f.	1,200,000 a.f.
1891	1,926,000 "	2,200,000 "
1892	934,000 "	1,550,000 "
1893	*361,000 "	650,000 "

*Partially estimated.

1890-1918 AV.	860,000 "	1,150,000 "

243. From Follett's information, which extends back to 1860 but which is not quoted entire, it is probable that the reservoir would have been well toward the top between 1880 and 1888 and would have lowered considerably in 1888 and 1889. The large flood of 1891 would surely have completely filled it and if the monthly discharges at El Paso are referred to, it is found that supply exceeded demand up to August 1.

244. Starting with reservoir full on August 1, 1891, a mass curve of supply and demand for Condition I has been drawn together with reservoir operation and follows this page. Table 44 supports the curve.

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245. It is evident from the curve that with present conditions there exists a surplus water supply and that if this were not depleted above, there is sufficient water for some extension below.

Supply with Development Above.

246. Following the above is a mass curve and curve of operation of reservoir is shown in form parallel to the foregoing, the estimated operation of the reservoir with the changed water supply caused by development in the San Luis Valley and Middle Rio Grande, as developed in Parts II and III, Table 45, supports this curve.

247. The small plat following these two is for convenience in comparison of the two.

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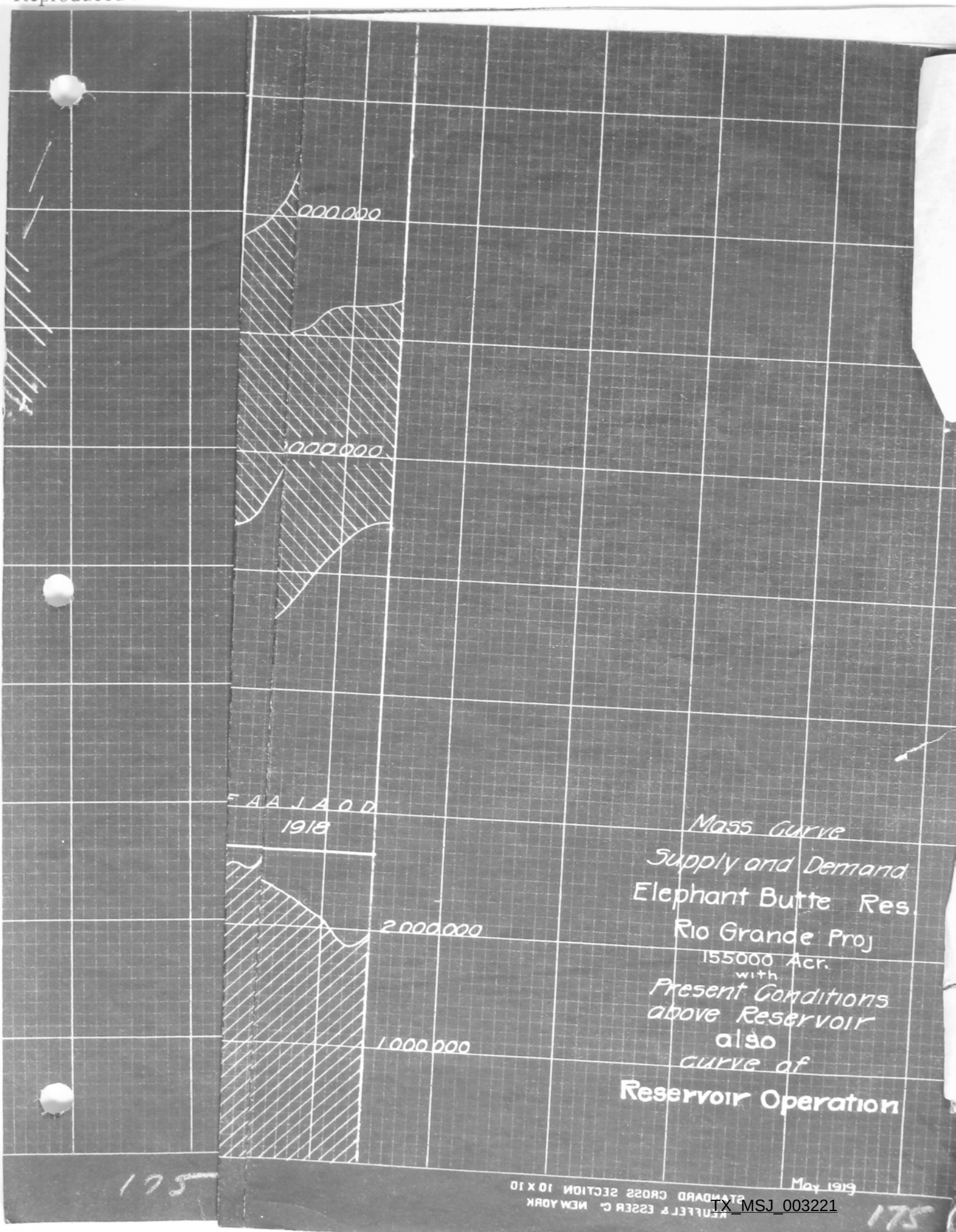

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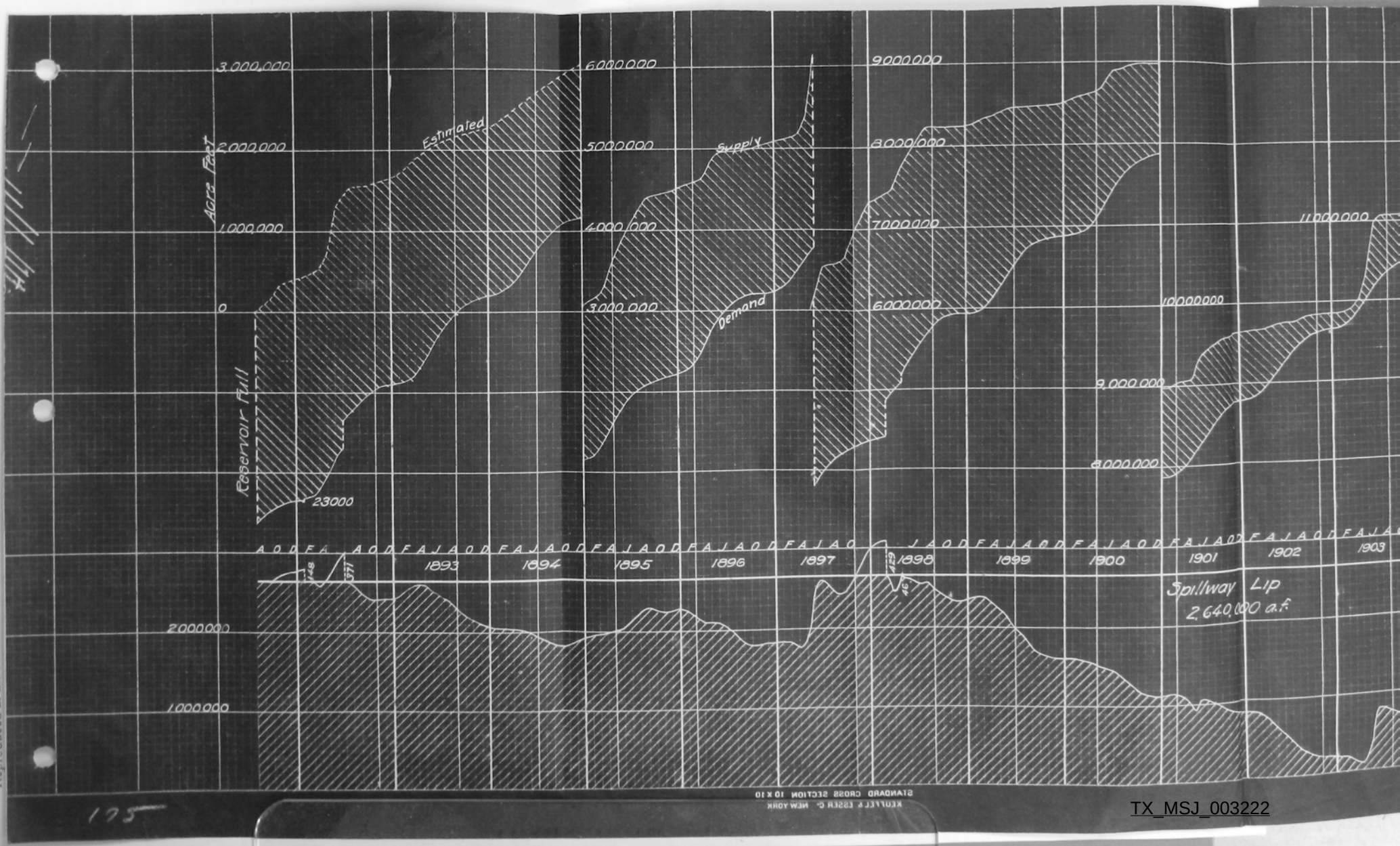

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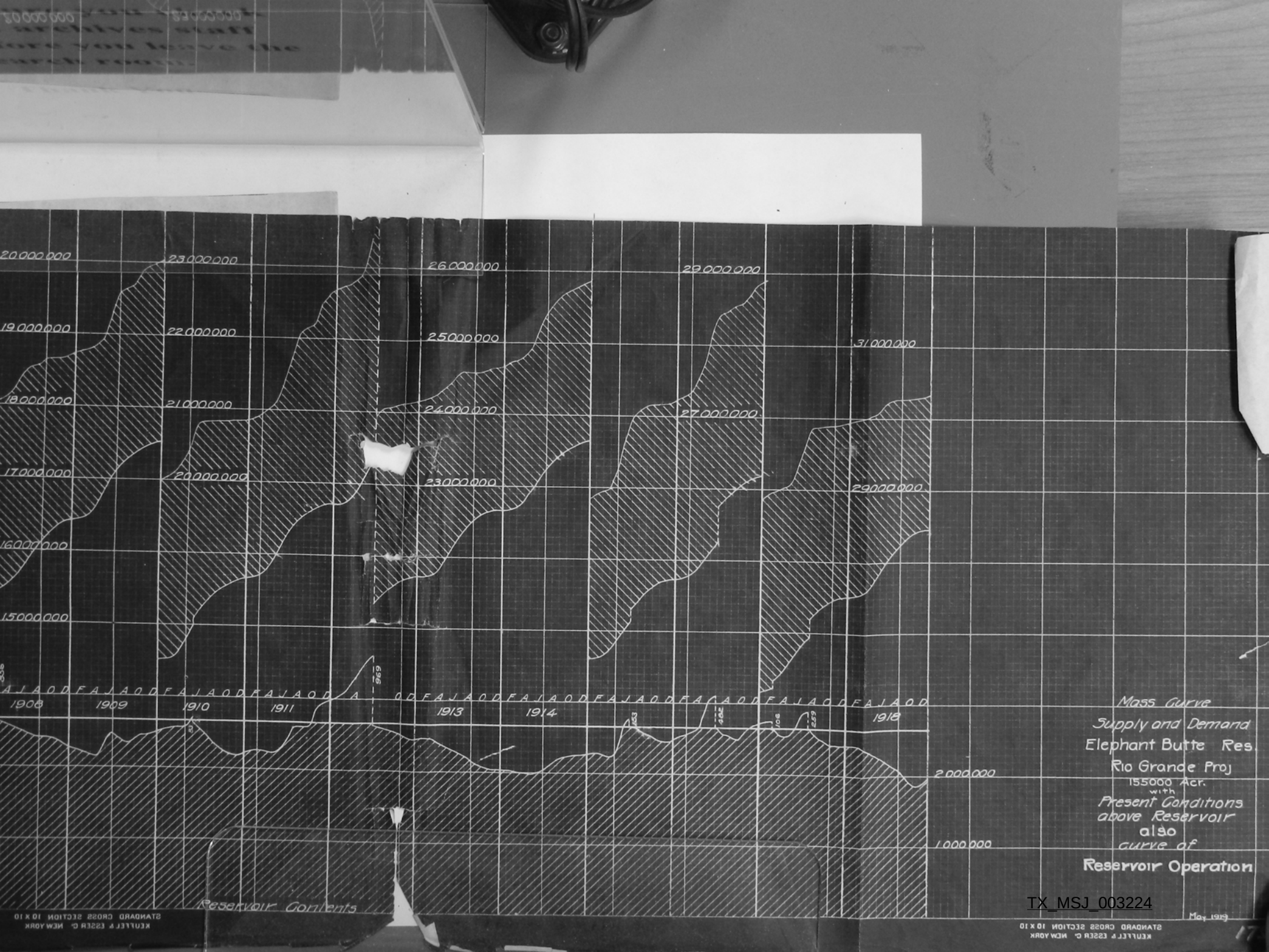
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1908
1909
1910
1911
1913
1914
1918
2,000,000
1,000,000
Reservoir Contents
Mass Curve
Supply and Demand
Elephant Butte Res.
Rio Grande Proj
155000 Acr.
with
Present Conditions
above Reservoir
also
curve of
Reservoir Operation
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May 1919

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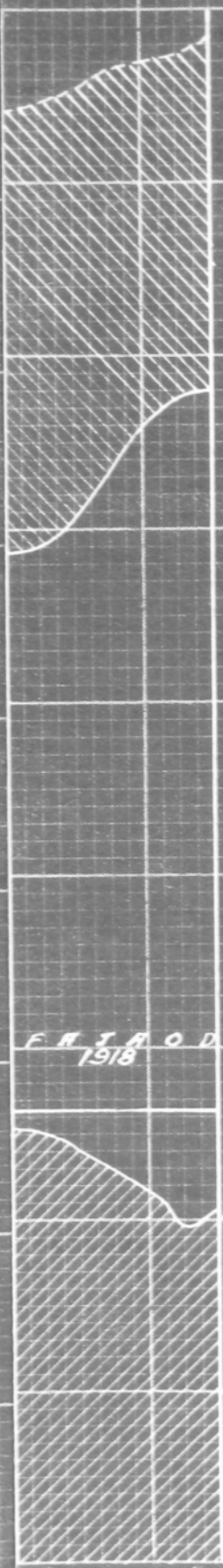

Mass Curve
Supply and Demand
Elephant Butte Reservoir
Rio Grande Project
155000 Acres
with
San Luis Valley
and
Middle Rio Grande Valley
Fully Developed
also
Curve of
Reservoir Operation

June 1919

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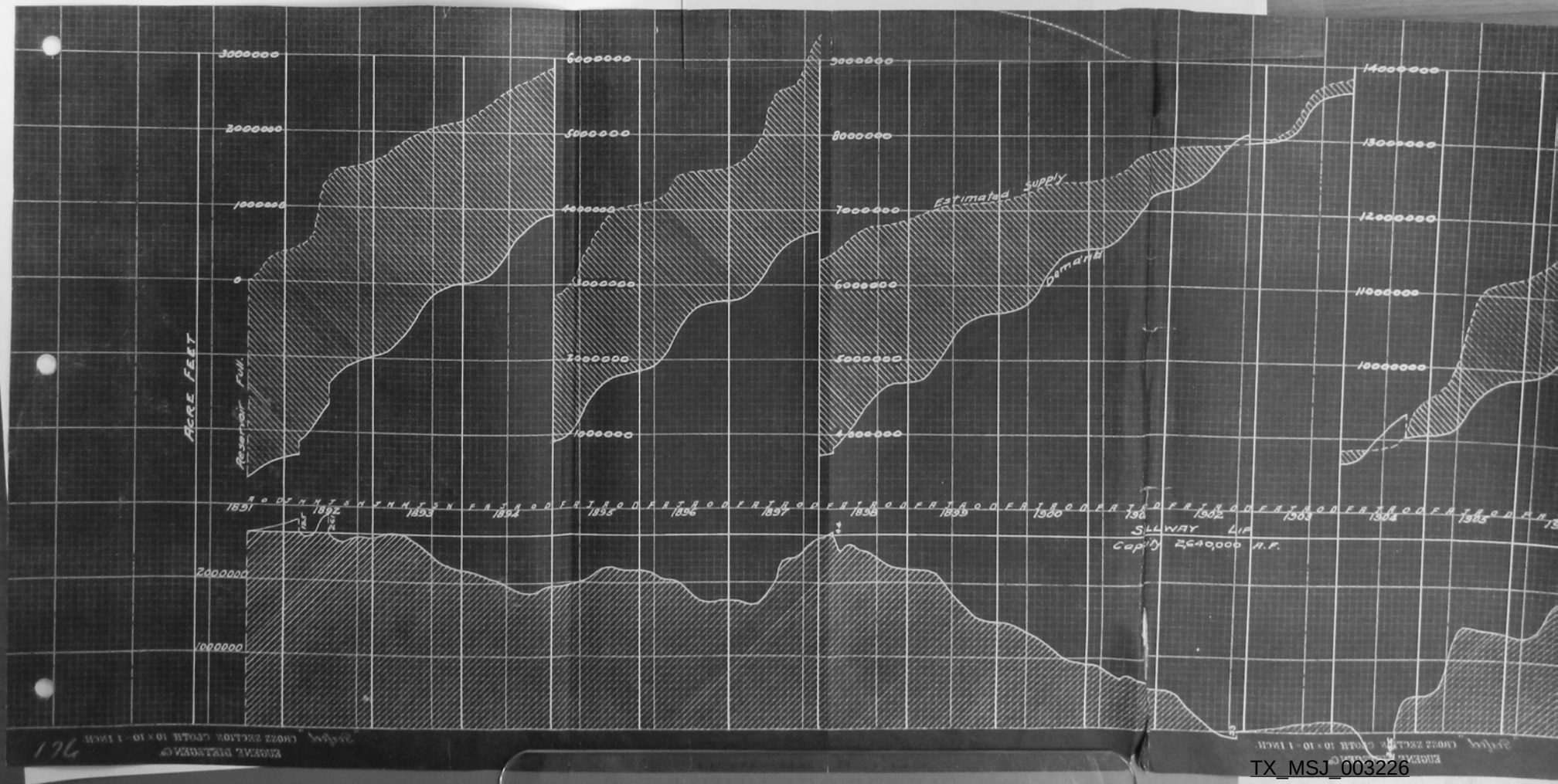

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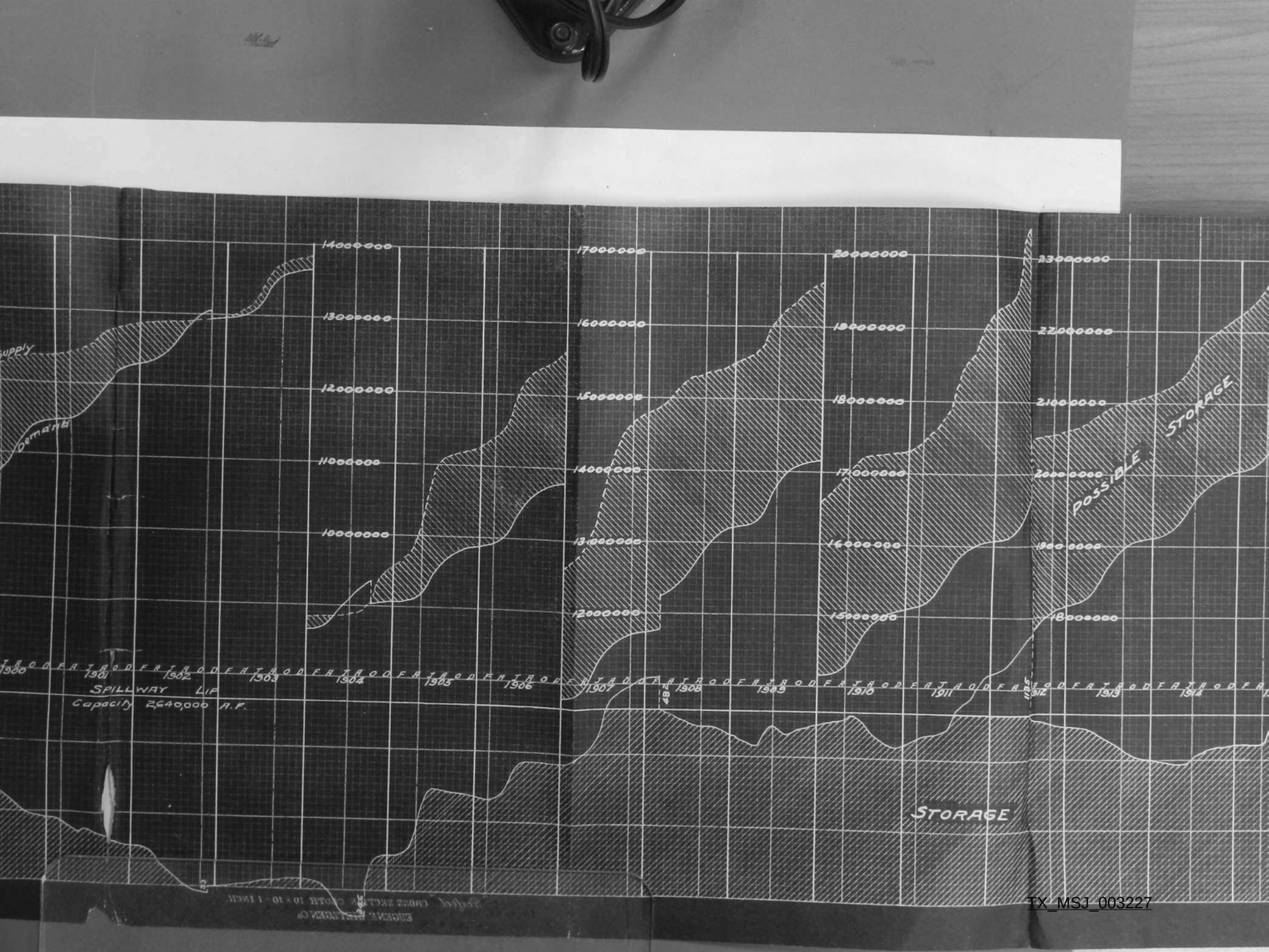

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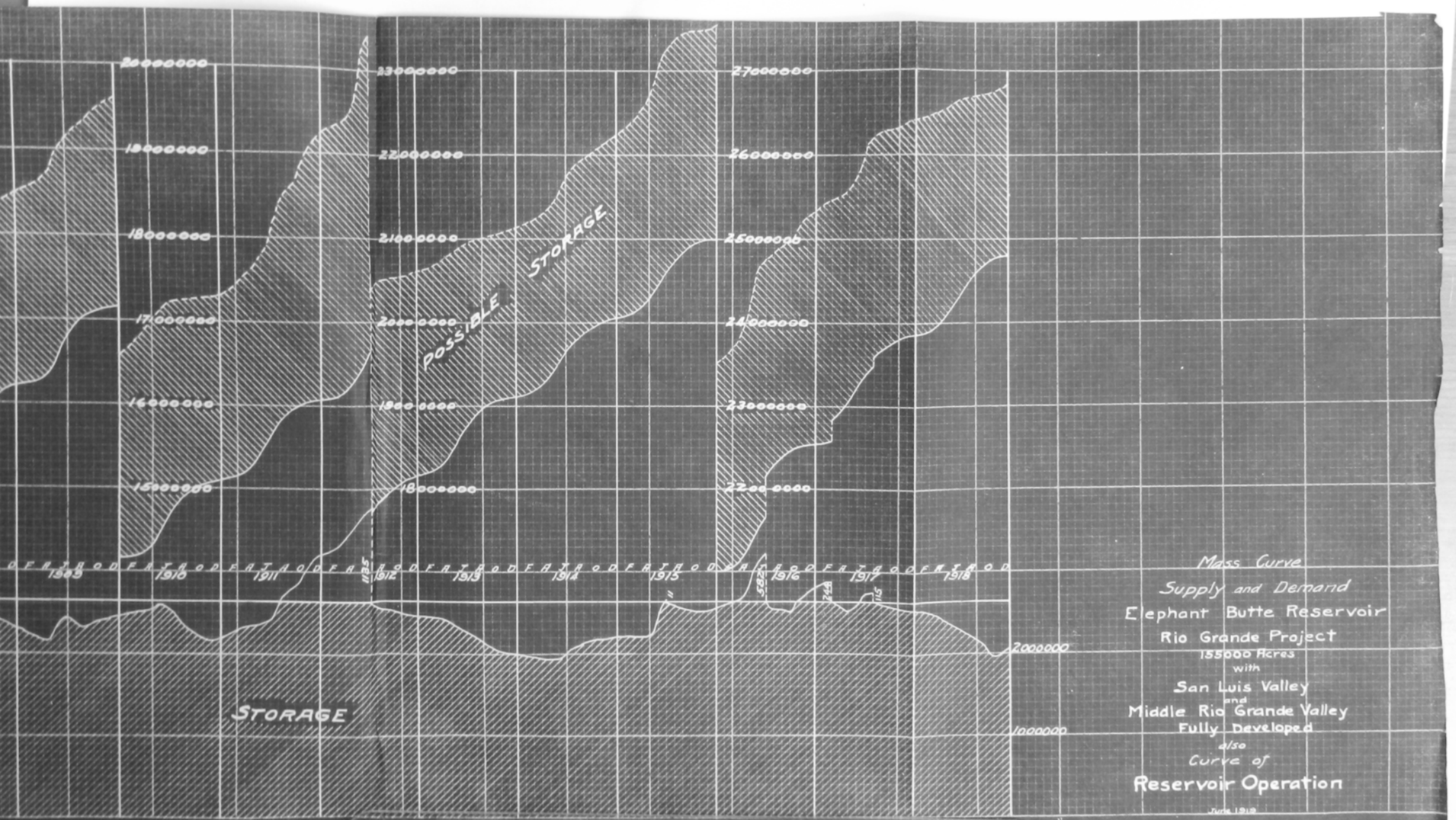

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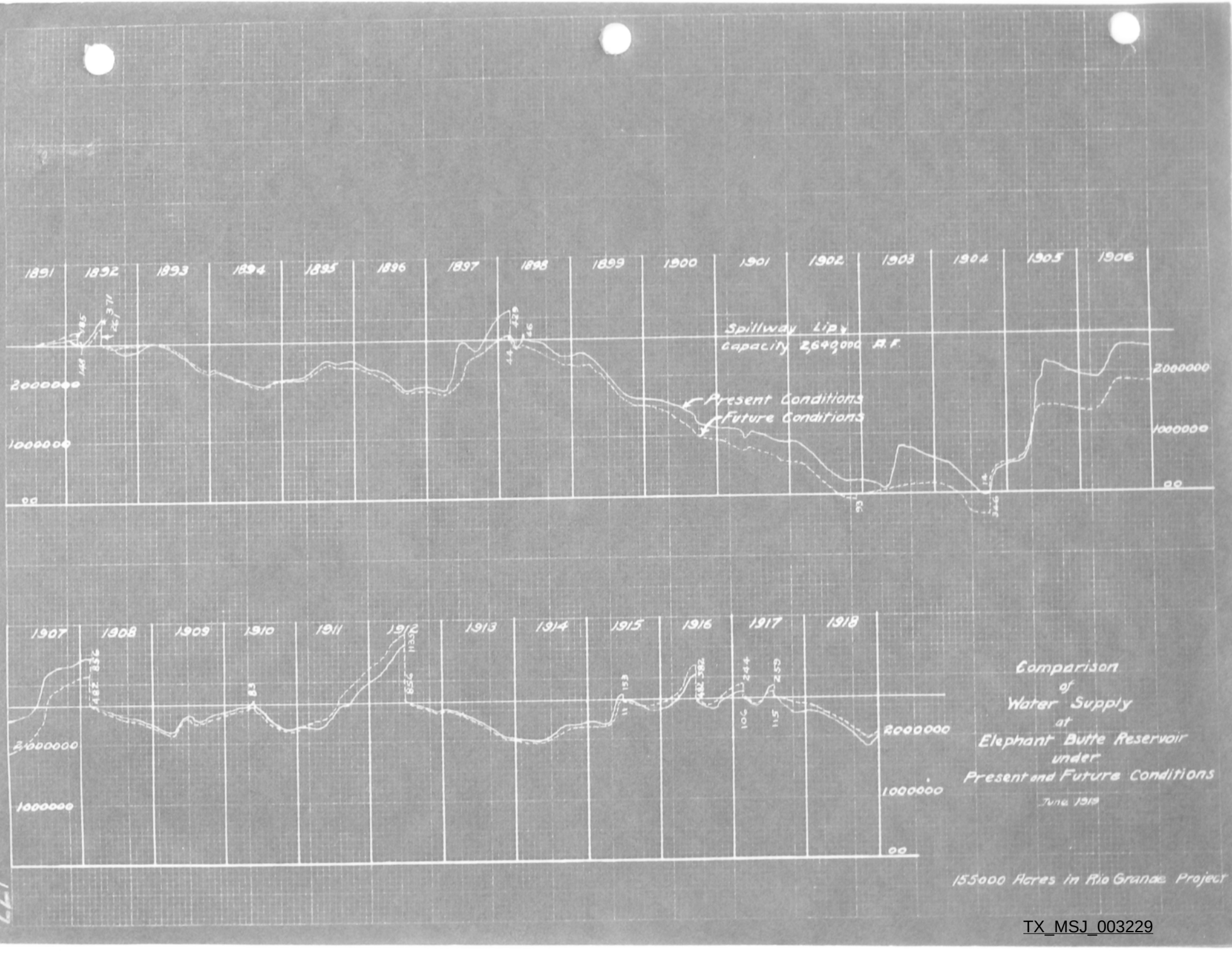

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DISCUSSION AND CONCLUSION

248. The discharge at San Marcial for the second condition (development above) is used in the following ways:

TABLE NO. 35

Distribution of San Marcial Discharge
(1892 - 1918 - Table No. 43)

Future average annual discharge . . . . . 980,000 a.f.

	a.f.	% Total
1. Reservoir evaporation	226,000	22.5
2. Mexican Treaty	60,000	6.0
3. Stream bed loss	66,000	6.6
4. Evaporation from waste land. .	54,000	5.4
5. Evaporation incidental to irrigation	233,000	23.2
6. Unavoidable waste- lower end project	115,000	11.5
7. Plant consumption	155,000	15.5
8. Shortage in project supply . .	16,000	- 1.6
Total use below	667,000	66.5
9. Reservoir spill	109,000	10.9
Total	1,002,000	100.0
10. Reservoir decrease	22,000	2.2
	980,000	

249. The amount used beneficially is surprisingly low (Item 7) but the others are indirectly beneficial and incident to the directly beneficial use.

250. Most of the items are not directly controllable but items 4 and 5 are controllable to some extent. Certainly by the careful application of water which will be necessary in times of shortage, the evaporation incidental to irrigation can be reduced. Also careful irrigation will lower the

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water table and thus reduce loss from waste areas.

251. Assumptions on which the foregoing is based have been taken as fairly as possible from known data in other projects and estimates of probable development above also, but the ultimate result is not necessarily reliable. This result shows one severe shortage in 1904 for the 27 year cycle. An underestimate of future supply or demand would aggravate this shortage to some extent but would seriously increase the shortage of 1902 and might even make 1901 short. However, the calculations also show some spill in low first half of the cycle and considerable spill in the second half.

252. The result reached is predicated on efficient drainage in the Middle Rio Grande which might not be true if drained privately. It is also predicated on perhaps too severe a reduction in supply from the San Luis Valley.

253. There appears to be no reason, however, at present appearent why land values will not bring about irrigation of a part of the 29,000 acres assumed unirrigable in the Rio Grande Project.

254. With these possible reductions in supply to the project in view, the question of extension lies in whether the Reclamation Service believes it advisable to extend the project to an acreage where it seems fairly certain that severe shortages would have been incurred in 1902 and 1904.

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255. It is believed that experimental work to arrive at correct consumption of water should be preliminary to final decision.

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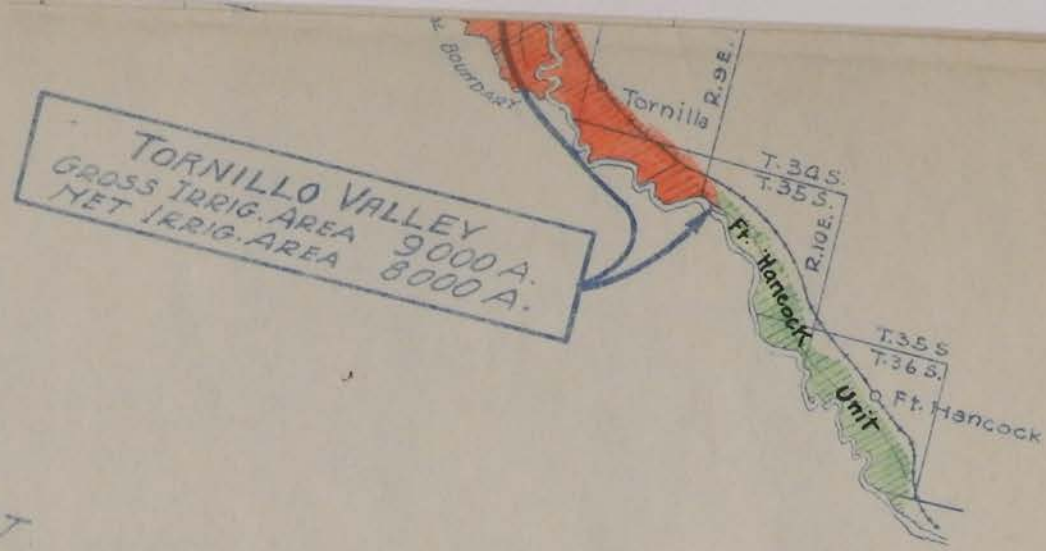

TORNILLO VALLEY
GROSS IRRIG. AREA 9000 A.
NET IRRIG. AREA 8000 A.

RIO GRANDE PROJECT
TOTAL IRRIGABLE AREA
GROSS 184,000 A.
NET 155,000 A.

LEGEND

Present Project

Possible Extensions

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE
SECONDARY PROJECTS
RIO GRANDE WATERSUPPLY
RIO GRANDE VALLEY

Drawn:- ..... Recommended:- .....
Checked:- ..... Approved:- .....

DENVER, COLO. APRIL 1919

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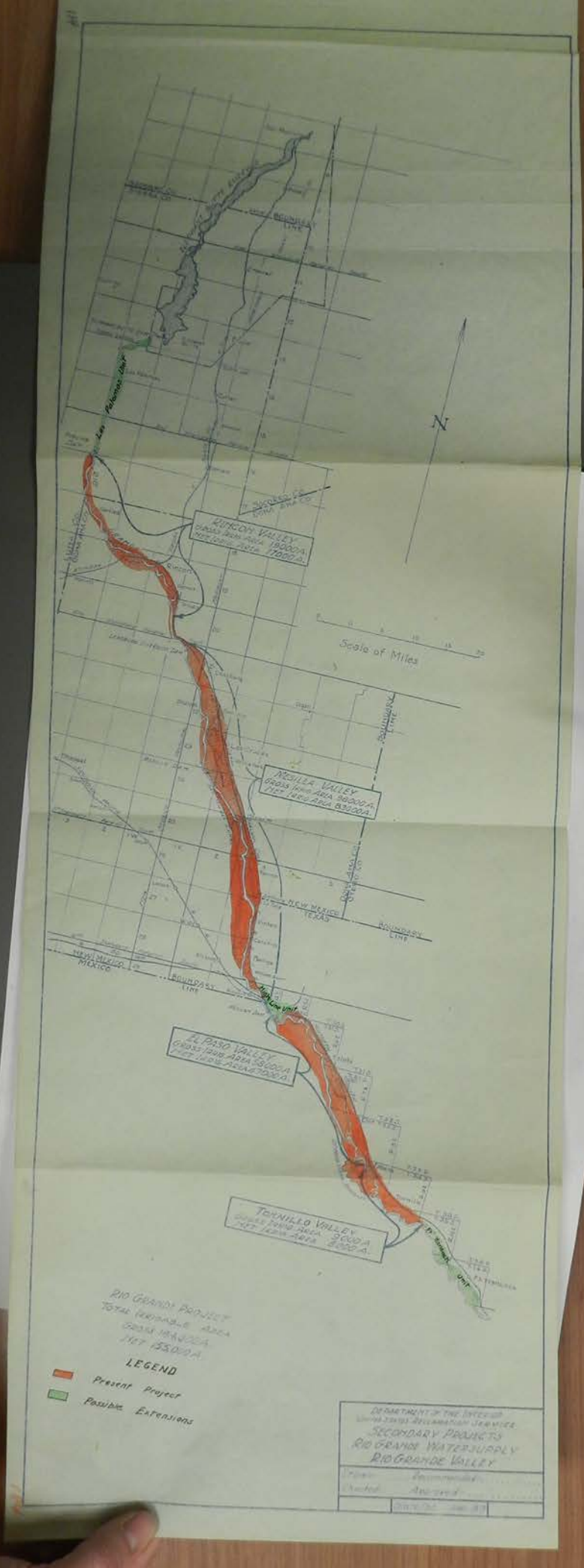

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TABLE NO. 36

RESERVOIR DATA - SAN LUIS VALLEY

Reservoir	Owner	Capacity: A.F.	Source	Type	Completed
Sanchez	Costilla Estates D. Co.	103,200	Culebra	Compacted earth	Dec.1911
Santa Maria	Travellers Insurance Co	45,000	Clear Creek	Hydraulic fill	Nov.'13
Rio Grande	Farmers Union	44,000	Rio Grande	Earth & loose rock	Aug.1913
Mt. Home *	Trinchera Irrig. Dist.	20,000	Trinchera	" & loose rock	1913
Terrace	Terrace Ir."	17,000	Alamosa	Hydraulic fill	1912
La Jara	" " "	14,000	La Jara	Earth fill	1910
Cove Lake	A.J.Jordan	6,000	Conejos	Masonry	1883
Smith **	Trinchera Irrig. Dist.	5,340	Trinchera	Loose rock	1914
#Beaver Park	Mosca Irrig. District	4,500	So. Fork	" "	? 1912
##Eastdale #1	Costilla Estates Div.	3,470	Costilla & Culebra	Earth fill	? 1910
Eastdale #2	" " "	3,040	" "	" "	? 1910
Mesita x	" " "	2,610	" "	" "	? 1911
Saguache xx	Saguache Co.	1,200	Saguache	" "	1895
Road Canyon	B.C.Hosselkus	900	Road Canyon	" "	1912
Regan	" "	?1,390	House "	" "	1908
Lost Lakes	" "	?2,470	Lost Lakes	?	1912

REMARKS:- * Height 100-128'
** Height 37.5'& 48'
# Concrete face
Failure - heavy seepage
x Heavy seepage losses
xx Heavy seepage, not used.

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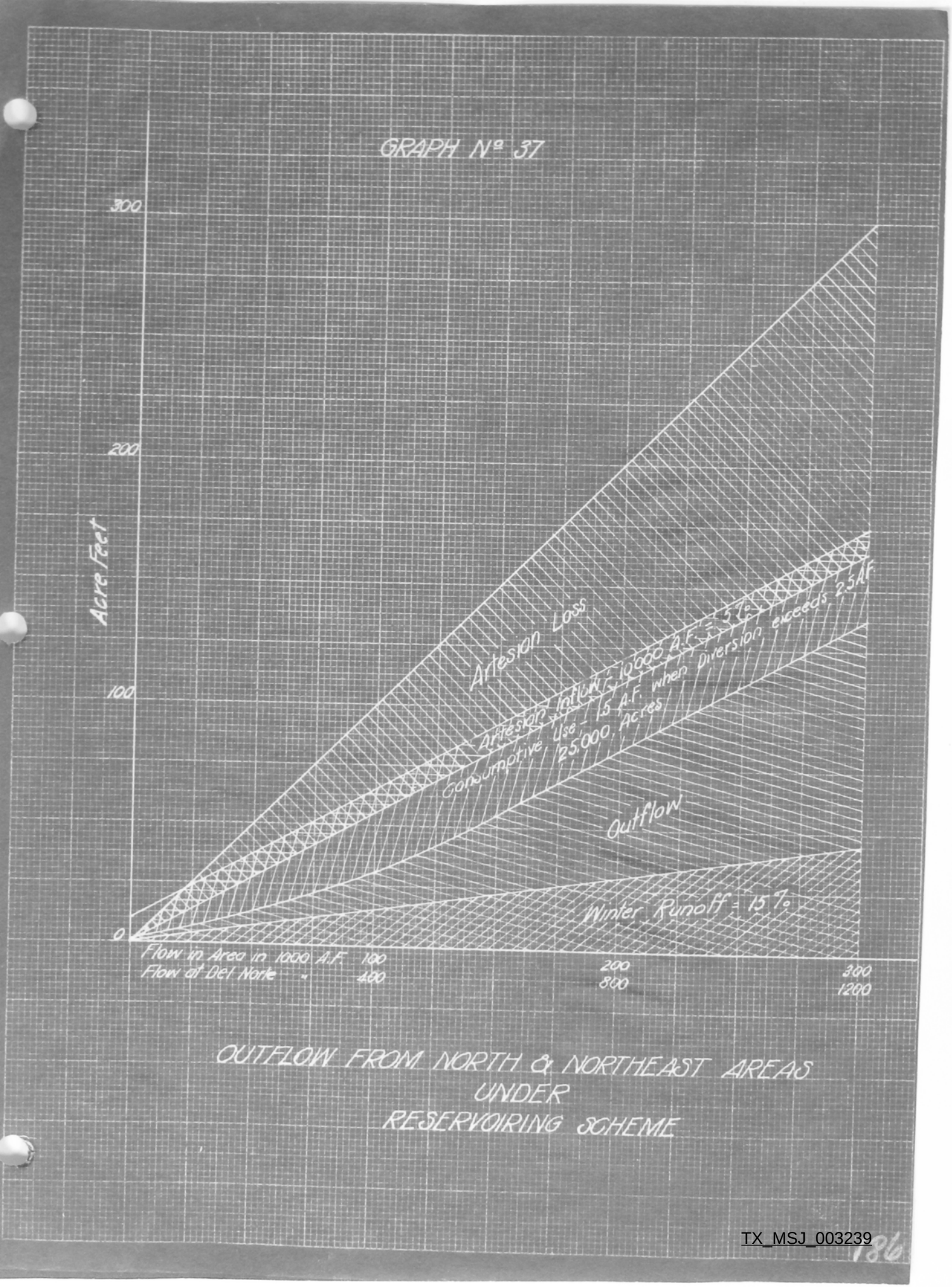

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TABLE Nº 38

FLOW OF ALL STREAMS ON WEST SIDE OF SAN LUIS VALLEY

FROM SAN ANTONIO TO SAGUACHE RIVERS INCLUSIVE

AT

1847 OF RIO GRANDE AT DEL NORTE

UNIT - 1000 A.F.

YEAR	MONTH												TOTAL
	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	
1890	25	20	50	100	489	418	172	69	42	53	38	34	1510
1891	31	26	49	154	372	454	191	75	58	96	41	35	1582
1892	31	27	36	115	295	238	84	50	29	29	26	20	980
1893	18	18	28	58	221	191	45	37	30	30	26	20	722
1894	20	18	34	101	271	117	41	43	39	41	31	25	781
1895	23	20	49	219	259	256	118	83	49	47	38	34	1195
1896	31	29	56	167	278	95	45	30	55	51	33	26	896
1897	25	20	50	118	399	372	125	54	69	166	73	44	1545
1898	37	31	50	210	308	480	186	58	35	29	24	20	1468
1899	20	18	34	68	156	119	79	68	41	54	44	23	724
1900	17	20	28	46	322	295	62	25	27	39	27	23	931
1901	23	18	26	78	290	213	66	53	48	30	31	20	896
1902	18	15	26	70	133	68	17	20	28	27	24	18	459
1903	16	17	28	82	320	569	188	59	56	40	28	17	1422
1904	11	10	22	71	131	78	38	78	76	164	46	38	763
1905	35	29	64	83	387	667	123	65	41	49	32	23	1598
1906	20	18	35	119	434	545	213	88	79	101	60	34	1746
1907	31	29	92	208	276	653	516	170	92	62	53	38	2222
1908	33	29	64	83	192	321	121	105	38	31	22	18	1057
1909	18	17	28	90	361	522	171	98	182	75	46	45	1653
1910	36	30	73	153	387	265	70	56	37	41	33	24	1205
1911	28	24	38	105	376	528	317	110	73	278	59	45	1981
1912	38	29	32	63	422	478	199	92	49	44	29	19	1494
1913	17	16	28	88	265	230	121	78	54	64	42	34	1037
1914	28	24	29	34	317	423	237	123	69	100	30	26	1460
1915	20	23	29	68	195	379	213	114	72	62	33	23	1231
1916	31	31	63	102	333	361	228	182	70	184	89	47	1721
1917	28	18	22	70	210	661	339	120	62	46	32	19	1627
1918	22	20	30	53	213	263	118	89	63	41	29	21	963

TABLE Nº 39

SAN LUIS VALLEY DEVELOPMENT WITH RESERVOIRS

DEMAND ON STREAMS

Year	Irrigation demand on streams [Col. 7+8 +1813 - 60% Col. 23] table	Jan. to Mar. incl. 40% Col. 3 of table	Irrigation Season: Apr. 5% of Col. 2	May 23% of Col. 2	June 37% of Col. 2	July 20% of Col. 2	Aug 10% of Col. 2	Sept. 3% of Col. 2	Oct. 2% of Col. 2	Nov. and Dec. 40% of flow
			Plus the summer spill for each month							
1	2	3	4	5	6	7	8	9	10	11
1890	1391	38	70	320	514	278	139	42	28	29
1891	1398	42	70	322	517	280	140	42	38	30
1892	1594	38	80	367	589	319	159	48	32	18
1893	1730	26	86	398	640	346	173	52	35	18
1894	1719	29	86	396	635	344	172	52	34	22
1895	1588	37	79	366	586	318	159	48	32	29
1896	1707	46	85	392	632	342	171	51	34	24
1897	1512	38	76	347	561	302	151	45	66	47
1898	1397	47	70	321	517	279	140	42	28	18
1899	1713	29	86	394	634	343	171	51	34	27
1900	1678	26	84	385	621	336	168	50	34	20
1901	1694	27	85	390	626	339	169	51	34	20
1902	1742	24	87	400	646	348	174	52	35	17
1903	1390	25	70	319	514	278	139	42	28	18
1904	1743	17	87	400	646	349	174	52	65	34
1905	1392	51	70	320	515	278	139	42	28	22
1906	1397	29	70	321	517	280	140	42	40	38
1907	1421	61	83	327	526	284	142	43	28	37
1908	1485	50	74	342	549	297	148	45	30	16
1909	1380	25	69	317	511	276	138	41	28	36
1910	1489	56	74	343	550	298	149	45	30	23
1911	1388	36	69	320	512	278	139	42	111	42
1912	1409	40	70	324	522	282	141	42	28	19
1913	1568	24	78	360	580	314	157	47	32	30
1914	1403	32	70	323	519	281	140	42	28	22
1915	1513	29	76	348	560	303	151	45	30	22
1916	1390	50	70	319	514	278	139	42	74	54
1917	1401	27	70	322	519	280	140	42	28	20
1918	1546	29	77	356	572	309	155	46	31	20

To arrive at pecentage of demand on stream for the different months the diversions from return flow which average about one-third those from stream flow are merged with the stream flow to form the total demand.

Month	Total Demand: % for each month	Total Demand: Col. 2 x 4	Return Flow: % of annual	Return Flow: % of Apr. to Oct.	Col. 3 - 5	Demand on stream flow % for each month
1	2	3	4	5	6	7
Apr.	6	24	6	9	15	5
May	20	80	8	11	69	23
June	32	128	11	16	112	37
July	20	80	13	19	61	20
Aug.	12	48	13	19	29	10
Sept.	6	24	11	16	8	3
Oct.	4	16	8	10	6	2

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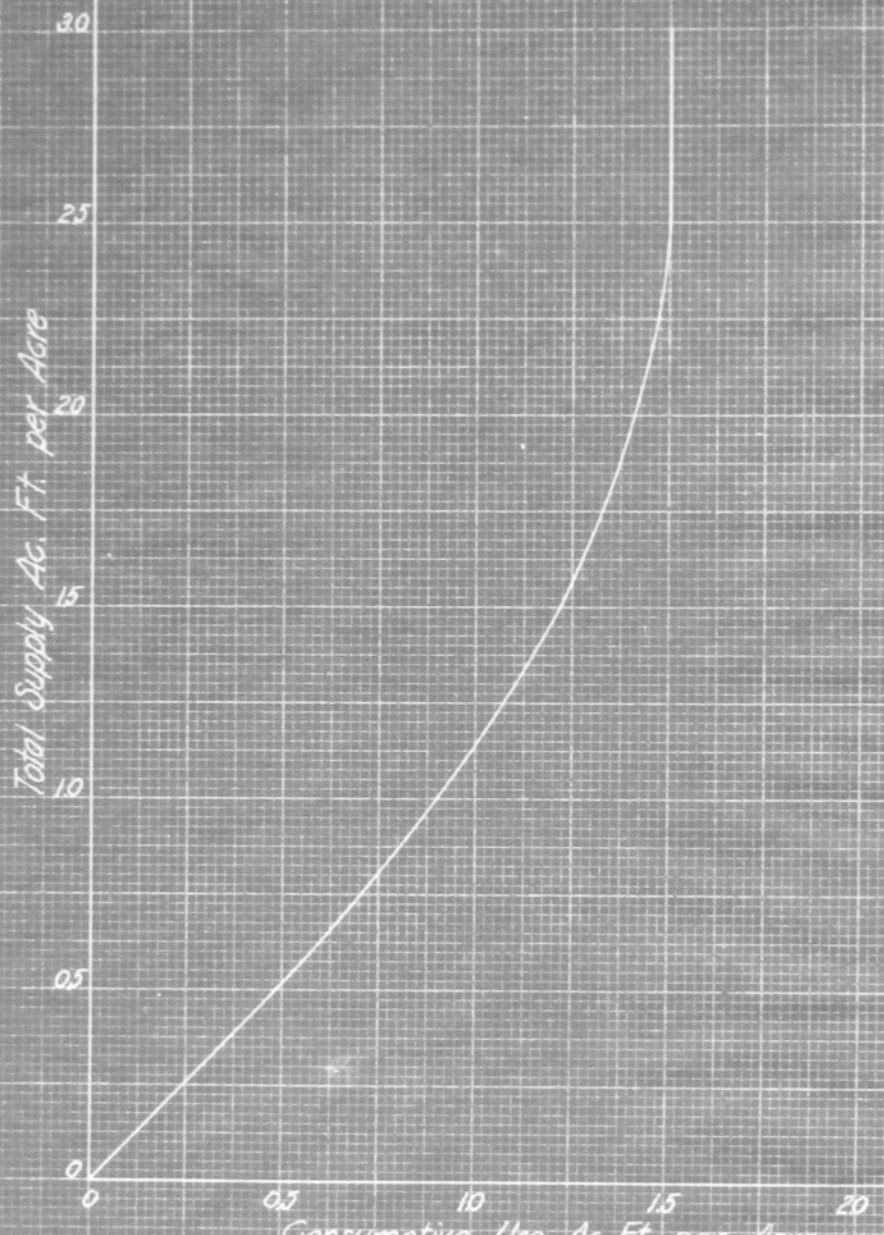
GRAPH Nº 40



SAN LUIS VALLEY
RESERVOIR OPERATION

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TABLE NO. 41

San Luis Valley Development

of

725,000 acres on west side with 400,000 acre feet of reservoirs.

25,000 acres on north and northeast portion without reservoirs.

Explanation of Table

Col. 2 is total flow of all streams from San Antonio River, on the south, to Saguache River on the north, based on an estimated discharge for all equalling 184% of the Rio Grande at Del Norte. For estimated monthly discharges see Table 38.

Cols. 3 and 4 give the estimated flow outside of irrigation season. This is divided into two parts for convenience in computing later columns of the table.

Col. 5 "Stream Flow available for Irrigation" is the sum of Col. 2 minus 40% of Col. 3 which is the part originating below reservoirs and therefore uncontrollable, minus Col. 4 plus 60% of Col. 4 for the previous year which is the portion of the discharge which can be controlled by the reservoirs.

Col. 6 "Total annual water available for use", Col. 5 plus 60% of Col. 23. Col. 23 is the total return flow and it is estimated from records of drainage return on various

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Reclamation projects that 60% will return during irrigation season. This table was worked up in conjunction with the graph of reservoir operation following page 64, so that certain columns are determined with its help.

Col. 7 "Stream Losses to Artesian Basin". The estimated loss in these streams is 108,000 acre feet of which it is assumed that 83,000 will occur in the irrigation season. This is based on the comparative discharges in and out of the irrigation season. This loss should vary also somewhat with the wetted perimeter and therefore the total loss is assumed to vary as the square root of the discharge.

Col.8 "Reservoir Evaporation Loss" is estimated at 3 feet in depth over an assumed area based on capacity curves of the reservoirs.

Col. 9 "Summer Waste" is that part of the flow occurring in April and October which is uncontrollable by the reservoirs and which exceeds the irrigation demands.

Cols. 10 and 11 "Water supplied to reservoirs in irrigation season", Col. 10 "When reservoir empties in irrigation season". This is the increase in reservoir contents occasioned in the occasional year by heavy floods in August and September which exceed the deficiency in supply for any year.

Col. 18 "Storage at end of irrigation season" is the

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amount in Col. 10 or the sum of Col. 11 for the current year plus the storage at end of preceding year.

In Cols. 19 to 23 the amount of return flow is estimated.

Col. 19 gives the total supply for irrigation in any year, while Col. 20 gives the same information in acre feet per acre.

Col. 21 "Consumptive use". The consumptive use is estimated at 1.5 acre feet when there is a full supply, or 60% of the total. If there is not a full supply, the water will be used more carefully and the percentage of consumptive use increased, although the absolute amount is reduced. The graph following shows the basis of estimating the consumptive use for different supplies.

Cols. 22 and 23 "Supply to return flow". The 179,000 acre feet from artesian basin is the estimated flow from wells in the area considered. The rise of water for irrigation which comes from the artesian basin has been allowed for in Col. 6. The two columns were worked together by cutting and trying until a balance was reached.

The preceding columns were calculated in irrigation years for convenience. The irrigation season is so long on Rio Grande projects that it is more convenient to use the calendar year. Hence the outflow from the valley or "Supply to State Bridge" which is part of the supply for lower projects is calculated by calendar years.

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Col. 24 gives all the different uncontrollable items of discharge on the west side minus an estimated loss to the artesian basin during the non-irrigation season.

Col. 25 is the supply from return flow 40% of which is assumed to occur out of the irrigation season.

Col. 26 "Inflow from north and east areas". This is the inflow from the creeks from San Luis Creek southward to Mount Blanca. Reservoir capacities are insignificant as compared to discharge and it is not possible to make calculations for these parallel to calculations for west side discharges. The basis for this is the plat which follows. The discharge is estimated from records at 25% of Del Norte. The first demand is loss to artesian basin which is assumed to increase with greater discharge. Of this an estimated 10,000 acre feet returns from the artesian wells in the area. The remainder of the loss probably travels underground across the valley and is a supply to the west side. Consumptive use, as on the other side, is estimated to decrease below 1.5 acre feet when the supply is not sufficient to divert 2.5 acre feet for the 25,000 acres estimated ultimate acreage. "Outflow" is the summer unconsumed runoff if the dead area is drained and it is estimated that 15% of the total runoff comes in the winter. The resulting outflow for the different annual discharges is shown in Col. 26.

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Col. 27 totals the various sources of outflow.

Cols.28 and 29 give the past outflows and the estimated decrease.

- - -

TABLE Nº 41

SAN LUIS VALLEY DEVELOPMENT

OF

725000 ACRES ON WEST SIDE WITH 400000 ACRE FEET OF RESERVOIRS
25000 ACRES ON NORTH AND NORTHEAST PORTION WITHOUT RESERVOIRS

UNIT = 1000 Ac. Ft.

				IRRIGATION YEAR															GALENDER YEAR									
	Total flow at all Streams for	Flow for Jan. Feb. &	Flow for Nov. &	Stream flow available	Total annual water	Stream losses to	Reservoir evapora-	Summer waste	Water supplied to reservoirs in irrigation season.		Reservoir Spills from	Total demand on stream	Demand on holdover	Supplied from holdover	Deficiency		Storage at end of irr.	Return Flow				Supply to State Bridge						
															In acre	In %		Total supply for irrigation	Consumptive use	Supply to return flow		Wastes	From return	Inflow from north	Total	Present flow	Change
Year	Calender Year	Mar.		demands Col 2-40	for use average	83000	tion losses estimated		When reservoir empties within Irr. season from mass curve	When reservoir does nd empty Col. 6- Col. 13	Mass Curve	Col. 7+8+ 9+10+11+ 725000 at 2.5 AF. per ac. or 1813000 Ac. Ft.	Col. 13- Col. 6		Col. 14- Col. 15	÷ 1813	Col. 10 of [Col. 11+ previous year in Col. 18	Col. 16	In ac. ft. per ac. Col. 19 ÷ 725	In ac. ft. per ac. From Graph No. 40	In ac. ft. Irr. in ac. ft. per ac. Col. 20 -Col. 21	From 725+179 from artesian supply	Total Col. 22 x 1813- Col. 16	Col. 31+ +9+12- 25000 loss to artesian flow	16 % of Col. 23 of prev. jous year +24 % d graph Col. 23	and east areas from No. 37	Col. 24 + 25+26		- 28
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1890	1510	95	72	1450	1992	95	25	0	0	59	0	1933	0	0	0	0	59	1813	250	1.50	1.00	904	42	362	83	487		
1891	1562	106	76	1507	2049	97	30	10	0	99	0	1950	0	0	0	0	158	1813	250	1.50	1.00	904	58	362	88	508		
1892	980	94	46	942	1250	79	10	0	0	0	0	1902	652	158	494	27	0	1319	182	1.36	46	513	31	268	45	344		
1893	722	64	46	678	833	62	10	0	0	0	0	1885	1052	0	1052	58	0	761	1.05	94	11	259	19	144	30	193		
1894	781	72	56	724	892	64	10	0	7	0	0	1894	1002	0	1002	55	7	811	1.12	98	14	280	26	108	34	168		
1895	1195	92	72	1120	1440	80	15	0	15	0	0	1923	453	7	476	26	15	1337	1.85	1.36	49	534	41	173	60	274		
1896	896	116	59	834	1024	69	15	0	21	0	0	1918	694	15	879	48	21	934	1.29	1.10	.19	317	45	162	40	247		
1897	1515	95	117	1395	1808	92	20	36	123	0	0	2084	276	21	255	14	124	1558	215	1.45	.70	687	96	216	69	395		
1898	1468	118	44	1447	1989	91	35	0	0	50	0	1939	0	0	0.	0	174	1813	250	1.50	1.00	904	40	327	80	447		
1899	724	72	67	654	835	71	10	0	20	0	0	1914	1075	174	905	50	20	908	1.25	1.08	.17	302	31	218	80	279	163	116
1900	931	65	50	895	1111	74	10	0	5	0	0	1899	788	20	768	42	5	1045	1.44	1.19	.25	360	21	134	43	198	204	-6
1901	896	67	51	848	1047	70	10	0	0	0	0	1893	846	5	841	46	0	972	1.34	1.13	.21	331	22	138	40	200	284	-84
1902	459	59	42	424	549	44	10	0	0	0	0	1867	1318	0	1318	73	0	495	68	64	.04	208	15	103	16	134	99	35
1903	1422	63	45	1377	1903	88	15	0	26	0	0	1942	39	0	39	2	26	1774	245	1.49	.96	876	18	243	77	338	627	-289
1904	763	43	84	689	827	58	10	30	124	0	0	2035	1208	26	1182	65	123	631	87	80	.07	230	56	195	32	283	188	95
1905	1598	128	55	1542	2054	91	30	0	0	68	82	2016	0	0	0	0	191	1813	250	1.50	1.00	904	130	254	90	474	987	-513
1906	1746	73	94	1656	2198	91	35	12	0	189	58	2009	0	0	0	0	380	1813	250	1.50	1.00	904	144	362	102	608	842	-234
1907	2222	152	93	2124	2666	110	40	12	0	20	671	2646	0	0	0	0	400	1813	250	1.50	1.00	904	779	362	136	1277	1436	-159
1908	1057	126	40	1023	1466	89	25	0	0	0	140	2067	602	400	202	11	0	1611	223	1.46	.77	737	126	362	50	498	363	135
1909	1653	68	91	1561	2099	90	15	34	154	0	0	2106	7	0	7	0	154	1806	249	1.50	.99	897	71	383	95	499	933	-434
1910	1205	139	57	1147	1577	86	20	0	11	0	15	1945	368	154	214	12	11	1599	220	1.46	.74	716	68	316	60	444	556	-112
1911	1981	90	104	1875	2417	92	25	83	0	389	15	2028	0	0	0	0	400	1813	250	1.50	1.00	904	213	362	118	693	1037	-374
1912	1494	99	48	1468	2010	98	40	0	0	0	212	2163	153	153	0	0	247	1813	250	1.50	1.00	904	184	362	82	628	849	-221
1913	1037	61	76	996	1313	82	20	0	39	0	0	1954	641	247	394	22	39	1419	196	1.41	.55	578	30	284	49	363	293	70
1914	1460	81	56	1418	1926	88	10	12	107	0	0	2030	104	39	65	4	107	1748	241	1.49	.92	846	42	296	80	418	593	-175
1915	1231	72	56	1180	1579	84	15	0	59	0	0	1971	392	107	285	16	59	1528	211	1.44	.67	665	26	295	83	384	471	-87
1916	1721	125	136	1569	2111	89	30	46	0	133	0	1978	0	0	0	0	192	1813	250	1.50	1.00	904	125	323	98	546	758	-212
1917	1627	68	51	1631	2173	90	40	0	0	208	22	1965	0	0	0	0	400	1813	250	1.50	1.00	904	76	362	93	531	777	-246
1918	963	72	50	915	1288	66	20	0	27	0	74	2020	732	400	332	18	27	1481	204	1.43	.61	621	67	294	44	405	263	142
Average	1270	89	67	1209	1603	81	21	9	25	42	44	1996					115	1444	1.99	1.33	.66	635	91	264	67	458*	586*	128*

* Average 1899 to 1918, balance 1890 to 1918

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196

DEVELOPMENT OF 750,000 ACRES IN NORTH AND SOUTHWEST PARTS OF VALLEY IN CONJUNCTION WITH PUMPING - 1899-1904

- - -

:Dec.:	20 :	8:	17 :	2 :	15 :	:	:	:	7 :	41 :	41 :	-916 :	15
Total :	414 :	414:	865 :	110 :	755 :	3000 :	665 :	876 :	100 :	599 :	-277 :	-916 :	90
1905 :Jan.:	19 :	8:	17 :	2 :	15 :	:	:	:	6 :	68 :	68 :	-848 :	15
:Feb.:	16 :	6:	13 :	2 :	11 :	:	:	:	5 :	56 :	56 :	-792 :	11
:Mar.:	35 :	14:	29 :	4 :	25 :	:	:	:	5 :	56 :	56 :	-736 :	25
:Apr.:	45 :	45:	94 :	11 :	83 :	180 :	83 :	36 :	6 :	68 :	32 :	-704 :	0
:May :	210 :	210:	439 :	56 :	383 :	600 :	383 :	81 :	8 :	90 :	9 :	-695 :	0
:June:	362 :	362:	750 :	96 :	660 :	960 :	660 :	113 :	11 :	124 :	11 :	-684 :	0
:July:	67 :	97:	203 :	26 :	177 :	600 :	177 :	159 :	13 :	146 :	-13 :	-697 :	0
:Aug.:	36 :	51:	107 :	13 :	94 :	360 :	94 :	100 :	13 :	146 :	46 :	-651 :	0
:Sept:	22 :	37:	77 :	10 :	67 :	180 :	67 :	42 :	11 :	124 :	82 :	-569 :	0
:Oct.:	26 :	26:	54 :	7 :	47 :	120 :	47 :	27 :	8 :	90 :	63 :	-506 :	0
:Nov.:	18 :	7:	15 :	2 :	13 :	:	:	:	7 :	80 :	80 :	-426 :	13
:Dec.:	12 :	5:	10 :	1 :	9 :	:	:	:	7 :	79 :	79 :	-347 :	9
Total :	868 :	868:	1814 :	230 :	1584 :	3000 :	1511 :	558 :	100 :	1127 :	569 :	-347 :	73
1906 :Jan.:	11 :	4:	8 :	1 :	7 :	:	:	:	6 :	73 :	73 :	-274 :	7
:Feb.:	10 :	4:	8 :	1 :	7 :	:	:	:	5 :	61 :	61 :	-213 :	7
:Mar.:	19 :	8:	17 :	2 :	15 :	:	:	:	5 :	61 :	61 :	-152 :	15
:Apr.:	65 :	65:	136 :	17 :	119 :	180 :	119 :	23 :	6 :	73 :	50 :	-102 :	0
:May :	236 :	236:	493 :	63 :	430 :	600 :	430 :	64 :	8 :	98 :	34 :	- 68 :	0
:June:	296 :	296:	618 :	78 :	540 :	960 :	540 :	158 :	11 :	134 :	-24 :	- 92 :	0
:July:	116 :	143:	299 :	38 :	261 :	600 :	261 :	127 :	13 :	160 :	-33 :	-59 :	0
:Aug.:	48 :	62:	130 :	16 :	114 :	360 :	114 :	92 :	13 :	160 :	68 :	+ 9 :	9
:Sept:	43 :	56:	117 :	15 :	102 :	180 :	102 :	29 :	11 :	134 :	105 :	+105 :	105
:Oct.:	55 :	55:	115 :	15 :	100 :	120 :	100 :	7 :	8 :	98 :	91 :	+ 91 :	91
:Nov.:	32 :	13:	27 :	3 :	24 :	:	:	:	7 :	86 :	86 :	+ 86 :	110
:Dec.:	18 :	7:	15 :	2 :	13 :	:	:	:	7 :	86 :	86 :	+ 86 :	99
Total :	949 :	949:	1983 :	251 :	1732 :	3000 :	1666 :	500 :	100 :	1224 :	724 :	00 :	443

Table A1a

1914

TX_MSJ_003249

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DEVELOPMENT OF 750,000 ACRES IN NORTH AND SOUTHWEST PARTS OF VALLEY IN CONJUNCTION WITH PUMPING - 1899-1904

Year	No.	Flow of Rio Grande at Del Rio adjusted to 1000 AF winter storage	Flow at Del Norte	Flow of Rio Grande at Del Norte	Stream losses	Avail- able for diver- sion	Demand from streams	Diversion from streams	Pumped from ground water: artesian basin (Col. 8-6, per A.	Supply to drains and ground water: (1.5 AF per A. consumptive use)	Net supply to drains (Col. 9-10-11)	Outflow from drains	Supply to State Bridge	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10	Col. 11	Col. 12	Col. 13	Col. 14	Col. 15
		1000 AF	1000 AF	1000 AF	1000 AF	1000 AF	1000 AF	1000 AF	1000 AF	1000 AF	1000 AF	1000 AF	1000 AF															
1899	Jan.	11	4	8	1	7					6	36	36	-36	45													
	Feb.	10	4	8	1	7					5	30	30	-20	37													
	Mar.	18	7	15	2	13					5	30	30	-20	43													
	Apr.	37	37	77	10	67	180	67	42		6	36	-6	- 6	0													
	May	85	85	178	23	155	600	155	167		8	48	-119	-125	0													
	June	65	65	136	17	119	960	119	315	11		66	-249	-374	0													
	July	43	66	138	17	121	600	121	180	13		77	-103	-477	0													
	Aug.	37	48	101	13	88	360	88	102	13		77	-25	-502	0													
	Sept.	22	53	69	8	61	180	61	45	11		66	21	-481	0													
	Oct.	29	29	60	8	52	120	52	28	8		48	22	-459	0													
	Nov.	24	10	21	3	18				7		42	42	-417	18													
	Dec.	13	5	10	1	9				7		42	42	-375	9													
Total		393	393	821	104	717	3000	663	877	100		578	-279	-375	150													
1900	Jan.	9	4	8	1	7					6	44	44	-331	7													
	Feb.	11	4	8	1	7					5	37	37	-294	7													
	Mar.	15	6	13	2	11					5	37	37	-257	11													
	Apr.	25	25	52	6	46	180	46	50		6	44	-6	-263	0													
	May	175	175	366	46	320	600	320	105		8	58	-47	-310	0													
	June	160	160	335	42	293	960	293	250	11		81	-169	-479	0													
	July	34	52	109	14	95	600	95	189	13		95	-94	-573	0													
	Aug.	14	23	48	6	42	360	42	119	13		95	-24	-597	0													
	Sept.	15	25	52	7	45	180	45	52	11		81	29	-568	0													
	Oct.	21	21	44	6	38	120	38	31	8		58	27	-541	0													
	Nov.	13	6	13	2	11				7		52	52	-489	11													
	Dec.	12	5	10	1	9				7		51	51	-438	9													
Total		306	306	1058	134	924	3000	879	796	100		738	-63	-438	45													
1901	Jan.	12	5	11	1	10					6	43	43	-395	10													
	Feb.	10	4	8	1	7					5	35	35	-360	7													
	Mar.	14	5	11	1	10					5	35	35	-325	10													
	Apr.	42	42	88	11	77	180	77	39		6	43	4	-321	0													
	May	158	158	330	42	288	600	288	117		8	67	-60	-381	0													
	June	116	116	243	31	212	960	212	281	11		78	-203	-584	0													
	July	37	56	117	15	102	600	102	187	13		92	-95	-679	0													
	Aug.	28	38	79	10	69	360	69	109	13		92	-17	-696	0													
	Sept.	26	36	75	10	65	180	65	42	11		78	36	-660	0													
	Oct.	16	16	33	4	29	120	29	34	8		57	23	-637	0													
	Nov.	17	7	15	2	13				7		50	50	-587	13													
	Dec.	11	4	8	1	7				7		49	49	-538	7													
Total		487	487	1018	129	889	3000	842	809	100		709	-100	-538	47													
1902	Jan.	10	4	8	1	7					6	27	27	-511	7													
	Feb.	8	3	6	1	5					5	22	22	-489	5													
	Mar.	14	6	13	2	11					5	22	22	-467	11													
	Apr.	38	38	79	10	69	180	69	42		6	27	-15	-482	0													
	May	72	72	151	19	132	600	132	176	8		35	-141	-623	0													
	June	37	37	77	10	67	960	67	335	11		49	-286	-909	0													
	July	9	26	54	7	47	600	47	207	13		58	-149	-1058	0													
	Aug.	11	19	41	5	36	360	36	122	13		58	-64	-1122	0													
	Sept.	12	20	42	5	37	180	37	54	11		49	- 5	-1127	0													
	Oct.	15	15	31	4	27	120	27	35	8		35	0	-1127	0													
	Nov.	13	5	10	1	9				7		31	31	-1096	9													
	Dec.	10	4	8	1	7				7		31	31	-1065	7													
Total		249	249	520	66	454	3000	415	971	100		444	-527	-1065	39													
1903	Jan.	10	4	8	1	7					6	62	62	-1003	7													
	Feb.	9	4	8	1	7					5	52	52	-951	7													
	Mar.	15	6	13	2	11					5	52	52	-899	11													
	Apr.	44	44	92	12	80	180	80	38		6	62	24	-875	0													
	May	174	174	364	46	318	600	318	106		8	83	-23	-898	0													
	June	309	309	646	82	564	960	564	149	11		114	-35	-933	0													
	July	102	120	250	31	219	600	219	143	13		135	- 8	-941	0													
	Aug.	32	41	86	11	75	360	75	107	13		135	28	-913	0													
	Sept.	31	39	82	10	72	180	72	40	11		114	74	-839	0													
	Oct.	22	22	46	6	40	120	40	30	8		83	53	-786	0													
	Nov.	15	6	13	2	11				7		74	74	-712	11													
	Dec.	10	4	8	1	7				7		73	73	-639	7													
Total		773	773	1616	205	1411	3000	1368	813	100		1039	426	-639	45													
1904	Jan.	6	2	4	1	3					6	36	36	-603	3													
	Feb.	5	2	4	1	3					5	30	30	-573	3													
	Mar.	12	5	10	1	9					5	30	30	-543	9													
	Apr.	39	39	82	10	72	180	72	40		6	36	- 4	-547	0													
	May	71	71	148	19	129	600	129	177		8	48	-129	-676	0													
	June	43	43	90	12	78	960	78	331	11		66	-265	-941	0													
	July	21	41	86	10	76	600	76	197	13		78	-119	-1060	0													
	Aug.	42	83	110	14	96	360	96	99	13		78	-21	-1081	0													
	Sept.	41	51	107	13	94	180	94	32	11		66	34	-1047	0													
	Oct.	89	89	186	24	162	120	120		8		48	48	-999	42													
	Nov.	25	10	21	3	18				7		42	42	-957	18													
	Dec.	20	8	17	2	15				7		41	41	-916	16													
Total		414	414	865	110	705	3000	668	876	100		599	-277	-916	90													
1905	Jan.	19	8	17	2	15					6	68	68	-848	15													
	Feb.	16	6	13	2	11					5	56	56	-792	11													
	Mar.	36	14	29	4	25					5	56	56	-736	25													
	Apr.	45	45	94	11	83	180	83	36		6	68	32	-704	0													
	May	210	210	439	56	383	600	383	81		8	90	9	-695	0													
	June	362	362	756	96	660	960	660	113	11		124	11	-684	0													
	July	67	97	203	26	177	600	177	159	13		146	-13	-697	0													
	Aug.	36	51	107	13	94	360	94	100	13		146	46	-651	0													
	Sept.	22	27	77	10	67	180	67	42	11		124	82	-569	0													
	Oct.	26	26	54	7	47	120	47	27	8		90	63	-506	0													
	Nov.	18	7	15	2	13				7		80	80	-426	13													
	Dec.	12	5	10	1	9				7		79	79	-347	9													
Total		868	868	1814	230	1584	3000	1511	558	100		1127	569	-347	73													
1906	Jan.	11	4	8	1	7					6	73	73	-274	7													
	Feb.	10	4	8	1	7					5	61	61	-213	7													
	Mar.	19	8	17	2	15					5	61	61	-152	15													
	Apr.	65	65	136	17	119	180	119	23		6	73	50	-102	0													
	May	226	226	472	63	430	600	430	64		8	98	34	- 68	0													
	June	296	296	618	78	540	960	540	158	11		134	-24	- 92	0													
	July	116	143	299	38	261	600	261	127	13		160	-53	-59	0													
	Aug.	48	62	130	16	114	360	114	92	13		160	68	9	9													
	Sept.	43	56	117	15	102	180	102	89	11		124	106	106	106													
	Oct.	66	66	115	15	100	120	100	7	8		98	91	91	91													
	Nov.	32	13	27	3	24				7		85	86	86	110													
	Dec.	18	7	15	2	13				7		86	86	86	99													
Total		949	949	1983	251	1732	3000	1666	500	100		1224	734	00	443													

Table 41a

ALL RESEARCH ROOMS ARE UNDER ELECTRONIC SURVEILLANCE AND CAMERAS

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TABLE Nº 42

SAN LUIS VALLEY WITH 750000 ACRES DEVELOPED BY PUMPING ANNUAL OPERATION

UNIT 1000 A.F.

Year	Flow of Rio Grande at Del Norte	Flow of all Streams 209.7% of Col. 2	Stream losses to artesian basin Col. 2 = 69.1% - 183	Available for diversion Col. 3 - Col. 4	Diverted from Streams Flow Apr. to Oct. (incl. up to January)	Pumped (15 - 4.0 = 11.0) Col. 6	Total water applied Col. 6 + Col. 7	Supply to drains + ground water Col. 8 - 1125 cons. use + 183 artesian flow	Net supply to drains + ground water Col. 9 - Col. 7	Outflow from drains	Accumulated deficiency	Supply to State Bridge Col. 5 - 6 + 11	Recorded flow at State Bridge	Change in State Bridge Col. 13 - 14
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1890	820	1714	217	1497	1422	592	2014	1072	480	480	0	555		
1891	660	1797	228	1569	1486	567	2053	1111	544	544	0	627		
1892	532	1112	141	971	908	785	1693	751	- 34	120	-154	183		
1893	392	819	104	715	665	877	1542	600	-277	0	-431	50		
1894	424	886	112	774	715	857	1572	630	-227	0	-658	59		
1895	650	1358	172	1186	1044	733	1777	835	102	0	-556	142		
1896	487	1018	129	889	799	825	1624	682	-143	0	-699	90		
1897	628	1720	218	1502	1337	623	1960	1018	395	0	-304	165		
1898	798	1668	211	1457	1323	628	1951	1009	381	77	0	211		
1899	393	821	104	717	663	877	1540	598	-279	96	-375	150	163	-13
1900	506	1058	134	924	879	796	1675	733	-63	0	-438	45	304	-259
1901	487	1018	129	889	842	809	1651	709	-100	0	-538	47	284	-237
1902	249	520	66	454	415	971	1386	444	-527	0	-1065	39	99	-60
1903	773	1616	205	1411	1368	613	1981	1039	426	0	-639	43	627	-584
1904	414	865	110	755	665	876	1541	599	-277	0	-916	90	188	-98
1905	868	1814	230	1584	1511	558	2069	1127	569	0	-347	73	986	-913
1906	949	1983	251	1732	1666	500	2166	1224	724	377	0	443	842	-399
1907	1207	2528	320	2208	2036	361	2397	1455	1094	1094	0	1261	1436	-175
1908	574	1200	152	1048	973	760	1733	791	31	127	-96	202	363	-161
1909	896	1877	236	1639	1543	547	2090	1148	601	505	0	601	933	-332
1910	655	1369	174	1195	1105	711	1816	874	163	163	0	253	556	-303
1911	1077	2251	286	1965	1681	495	2176	1234	739	739	0	1023	1037	-14
1912	812	1697	215	1482	1414	595	2009	1067	472	472	0	540	849	-309
1913	564	1179	149	1030	967	763	1730	788	25	126	-101	189	293	-104
1914	794	1659	210	1449	1294	640	1934	992	352	251	0	406	593	-186
1915	669	1398	177	1221	1077	722	1799	857	135	137	- 2	281	471	-190
1916	935	1954	248	1706	1321	629	1950	1008	379	377	0	762	758	+ 4
1917	884	1848	234	1614	1476	572	2048	1106	534	534	0	672	777	-105
1918	523	1093	139	954	814	820	1634	692	-128	111	-239	251	263	-12
Average 1890-1918	691	1443	183	1260	1152	693	1845	903	210	218		326		
" 1899-1918												369	591	222

Col. 3 From table 8 the mean annual flow of all streams east and northeast portion of valley from Los Pinos River to but not including Ute Creek, is 209.7% of the flow of Rio Grande at Del Norte.

Col. 4 From table 11 the artesian losses from above streams is 183,000 ac. ft. and for this table is taken to vary as the annual flow.

Col. 6 The demand is taken at 4 ac. ft. per year from Apr. to Oct. on the basis of 6% in Apr. 20% in May. 32% in June. 20% in July. 12% in Aug. 6% in Sept and 4% in Oct. Small reservoirs will control 60% of the flow from Nov. to Mar. inclusive and deliver as needed in summer. When the flow is greater than the demand outlined the balance will pass on to State Bridge.

Col. 7 The pumping requirement is taken at 1.5 ac. ft. per acre distributed same as direct demand.

Col. 9 The consumptive use is taken at 1.5 ac. ft. per acre to cover actual use and inefficient drainage and the 183,000 ac. ft. of water lost by streams is here taken to be released to the drains.

Col. 11 When any year is started with a full water table the drainage return for Jan. to Mar. inclusive flows out before the irrigation season starts. After March outflow will only occur if the drainage return for the remainder of the year is greater than the pumping demand.

TX_MSJ_003251

1977

TABLE No. 43

REVISED FLOW AT SAN MARCIAL
ON BASIS OF
PUMPING DEVELOPMENT OF 750000 ACRES IN SAN LUIS VALLEY
AND
FULL DEVELOPMENT IN MIDDLE RIO GRANDE VALLEY

Year	Recorded Flow at State Bridge	Revised Flow at State Bridge from table 42	Loss at State Bridge Col. 3 - 2	Recorded Flow at Buckman	Past losses Buckman - San Marcial from graph	Revised Flow at Buckman Col. 5 + 4	Losses with Middle Rio Grande Developed: Total loss with present conditions and revised flow from graph	Loss in undrained area 32% of Col. 8	Deficiency for irrigation from table 28	Used for irrigation 266 - Col. 10	Winter loss in return flow	Total consumption Col. 9 + 11 + 12	Gain in Middle Rio Grande Col. 6 + 13	Change in Flow at San Marcial Col. 4 + 14	Recorded Flow at San Marcial	Revised Flow at San Marcial Col. 15 + 16	Demand below San Marcial table 45 Col. 2 + 7
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1890	*780	555	-225	*1510	565	1285	520	161		266		427	138	-87	*1200	1113	
1891	*860	627	-233	*2400	675	2167	655	210		266		476	199	-34	*2200	2166	**275
1892	*350	183	-167	*1550	570	1883	540	173		266		439	131	-36	*1240	1204	960
1893	*180	50	-130	*950	435	820	400	128		266		394	41	-89	*650	561	933
1894	*210	59	-151	*1100	460	949	435	139		266		405	55	-96	*800	704	918
1895	*520	142	-378	1428	545	1050	460	147		266		413	132	-246	1427	1181	931
1896	*290	90	-200	703	360	503	290	93	*150	116	35	244	116	-84	577	493	943
1897	*790	165	-625	1896	620	1271	515	165		266		431	189	-436	2215	1779	940
1898	*750	211	-539	1087	465	548	310	99	*50	216	15	330	135	-404	961	557	965
1899	163	150	-13	682	350	669	350	112	56	210	17	389	11	-2	240	238	921
1900	304	45	-259	708	360	449	275	88	94	172	26	286	74	-185	466	281	871
1901	284	47	-237	856	400	619	335	107		266		373	27	-210	656	446	826
1902	99	39	-60	424	260	364	240	77	81	185	24	286	-26	-86	201	115	772
1903	627	43	-584	1668	590	1084	470	150		266		416	174	-410	1272	862	763
1904	188	90	-98	729	365	631	340	109	157	109	37	255	110	+12	710	722	745
1905	986	73	-913	2048	640	1135	485	155		266		421	219	-694	2422	1728	823
1906	842	443	-399	*1978	630	1579	575	184		266		450	180	-219	1564	1345	988
1907	1436	1261	-175	*2560	680	2385	675	216		266		482	198	+23	2158	2181	964
1908	363	202	-161	*1172	490	1011	450	144		266		410	80	-81	774	693	981
1909	933	601	-332	*1703	590	1371	495	159		266		425	165	-167	1280	1113	953
1910	556	253	-303	1256	510	953	430	138	*50	216	15	369	141	-162	853	691	955
1911	1037	1023	-14	2108	645	2094	650	208		266		474	171	+157	1800	1957	953
1912	849	540	-309	2021	635	1712	600	192		266		458	177	-132	1500	1368	969
1913	293	189	-104	771	380	667	350	112	*100	166	25	303	77	-27	526	499	943
1914	593	406	-187	1496	560	1309	525	168		266		434	126	-61	1178	1117	941
1915	471	281	-190	*1639	580	1449	550	176		266		442	138	-52	1354	1302	964
1916	758	762	+4	1893	620	1897	625	200		266		466	154	+158	1657	1815	969
1917	777	672	-105	1437	550	1332	520	166		266		432	118	+13	1054	1067	954
1918	263	251	-12	757	375	745	380	122	*50	216	15	353	22	+10	410	420	913
Average	571	326	-245	1397	514	1153	464	148	27	239	7	394	120	-125	1150	1025	915

* Estimated ** Aug. to Dec. only - Reservoir spilling in July 1891

REVISED FLOW AT SAN MARCIAL ON BASIS OF PUMPING DEVELOPMENT OF 750000 ACRES IN SAN LUIS VALLEY AND FULL DEVELOPMENT IN MIDDLE RIO GRANDE VALLEY 19

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TABLE NO. 44

Operation of Elephant Butte Reservoir-Rio Grande Project -

Present conditions above-155,000 A.

Year	Mon.	1 San Marcial disch.	2 Demnd. below reser.	3 San Luis retro-active demand	4 Total Col. 2/ 3	5 Diff. Col. 1- 4	6 Evapo-ration	7 Final res. cont.	8 Shortage or spill.
1891	Aug.	100.0	71.5		71.5	28.5	29.0	2639.5	
	Sept.	80.0	58.3		58.3	21.7	24.0	2637.2	
	Oct.	140.0	33.5		33.5	106.5	21.0	2640.0	/ 82.7
	Nov.	50.0	15.5		15.5	34.5	12.5	2640.0	/ 22.0
	Dec.	30.0	0		0	30.0	9.4	2640.0	/ 20.6
		400.0	178.8		178.8	221.2	95.9		125.3
1892	Jan.	30.0				30.0	7.0	2640.0	23.0
	Feb.	30.0	19.7		19.7	10.3	12.5	2637.8	
	Mar.	50.0	87.5		87.5	- 37.5	23.0	2577.8	
	Apr.	210.0	99.6)		99.6	110.4	32.5	2640.0	15.7
	May	500.0	103.3)		203.3	296.7	40.0	2640.0	256.7
	June	240.0	101.9)	100.0	101.9	138.1	40.0	2640.0	98.1
	July	80.0	92.1)		92.1	- 12.1	34.0	2593.9	
	Aug.	0.0	71.5)		71.5	- 71.5	24.0	2498.4	
	Sept	0.0	58.3		58.3	- 58.3	23.5	2416.6	
	Oct.	50.0	33.5		33.5	16.5	20.0	2413.1	
	Nov.	30.0	15.5		15.5	14.5	12.0	2415.6	
	Dec.	20.0				20.0	9.0	2426.6	
		1240.0	682.8	100.0	782.8	457.2	277.5		393.5
1893		650.0	683.0	50.0	733.0	- 83.0	250.0	2094.0	
1894		800.0	683.0	60.0	743.0	57.0	235.0	1916.0	
1895		1427.0	683.0	115.0	798.0	629.0	248.0	2297.0	
1896		577.0	683.0	90.0	773.0	196.0	260.0	1841.0	
1897	Jan.	19.6				19.6	5.5	1855.1	
	Feb.	24.3	19.7		19.7	4.6	10.0	1849.7	
	Mar.	40.8	87.5		87.5	-46.7	19.0	1784.7	
	Apr.	212.5	99.6	45.0	144.6	67.9	24.5	1828.1	
	May	755.2	103.3	30.0	133.3	621.9	31.5	2418.4	
	June	366.4	101.9	40.0	141.9	224.5	38.0	2604.0	
	July	66.0	92.1	10.0	102.1	-36.1	34.5	2533.4	
	Aug.	6.1	71.5		71.5	-65.4	28.5	2439.5	
	Sept	114.2	58.3		58.3	55.9	23.0	2472.4	
	Oct.	281.7	33.5		33.5	248.2	20.5	2600.1	60.0
	Nov.	175.7	15.5		15.5	160.2	12.5	2640.0	147.9
	Dec.	152.7				152.7	9.5	2640.0	143.2
		2215.2	682.8	125.0	807.9	1407.3	257.0		551.1

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TABLE NO. 44 Continued.

Year	Mo.	1	2	3	4	5	6	7	8
1898	Jan.	57.7				57.7	7.2	2640.0	50.5
	Feb.	59.4	19.7		19.7	39.7	12.5	2640.0	27.2
	Mar.	62.2	87.5		87.5	-25.3	23.2	2591.5	
	Apr.	271.5	99.6	45.0	144.6	126.9	32.5	2640.0	45.9
	May	165.8	103.3	35.0	138.3	27.5	40.5	2627.0	
	June	126.3	101.9	45.0	146.9	-20.6	40.0	2566.4	
	July	167.1	92.1	30.0	122.1	45.0	34.0	2577.4	
	Aug.	13.8	71.5	5.0	76.5	-62.7	29.0	2485.7	
	Sept	3.7	58.3		58.3	-54.6	23.0	2408.1	
	Oct.	0.0	33.5		33.5	-33.5	20.2	2354.4	
	Nov.	10.2	15.5		15.5	- 5.3	11.7	2337.4	
	Dec.	23.4				23.4	8.8	2352.0	
		961.1	682.8	160.0	842.8	118.2	282.6		123.6
1899		240.0	683.0	50.0	733.0	-493.0	238.0	1621.0	
1900		467.0	683.0	105.0	788.0	-321.0	188.0	1112.0	
1901		656.0	683.0	100.0	783.0	-117.0	143.0	852.0	
1902		201.0	683.0	78.0	761.0	-560.0	89.0	203.0	
1903		1272.0	683.0	130.0	813.0	459.0	80.0	582.0	
1904	Jan.	16.8				16.8	2.5	567.7	
	Feb.	18.9	19.7		19.7	- 0.8	5.0	561.9	
	Mar.	6.1	87.5		87.5	-81.4	8.0	472.5	
	Apr.	0.0	99.6	30.0	129.6	-129.6	10.0	332.9	
	May	0.0	103.3		103.3	-103.3	10.0	219.6	
	June	0.0	101.9		101.9	-101.9	8.2	109.5	
	July	10.5	92.1		92.1	- 81.6	5.3	22.6	
	Aug.	56.0	71.5	2.0	73.5	- 17.5	2.0	3.1	
	Sept	44.7	58.3	3.0	61.3	- 16.6	0.5	- 14.0	- 14.0
	Oct.	463.2	33.5		33.5	429.7	4.5	425.2	
	Nov.	51.8	15.5		15.5	36.3	3.6	457.9	
	Dec.	41.8				41.8	2.8	476.9	
		L 709.8	682.8	35.0	717.8	- 8.0	62.4		
1905		2422.0	683.0	162.0	845.0	1577.0	140.0	1934.0	
1906		1564.0	683.0	135.0	818.0	746.0	255.0	2425.0	
1907	Jan.	60.6				60.6	6.5	2479.1	
	Feb.	67.7	19.7		19.7	48.0	12.2	2514.9	
	Mar.	92.5	87.5		87.5	5.0	23.5	2496.4	
	Apr.	222.9	99.6	70.0	169.6	53.3	31.0	2518.7	
	May	369.0	103.3	50.0	153.3	215.7	36.0	2640.0	58.4
	June	524.2	101.9	30.0	131.9	392.3	40.5	2640.0	351.8
	July	328.7	92.1	20.0	112.1	216.6	34.5	2640;0	182.1
	Aug.	165.5	71.5	5.0	76.5	89.0	29.0	2640.0	60.0
	Sept	160.9	58.3		58.3	102.6	24.5	2640.0	78.1
	Oct.	64.5	33.5		33.5	31.0	21.5	2640.0	9.5
	Nov.	56.5	15.5		15.5	41.0	12.5	2640.0	28.5
	Dec.	44.7				44.7	9.5	2640.0	35.2
		2157.7	682.8	175.0	857.8	1299.8	281.2		803.6

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TABLE NO. 44 Continued.

Year	Mo.	1	2	3	4	5	6	7	8
1908	Jan.	43.6				43.6	7.0	2640.0	36.6
	Feb.	48.0	19.7		19.7	28.3	12.5	2640.0	15.8
	Mar. to								
	Dec.	672.6	663.1	100.0	763.1	-90.5	278.0	2272.0	
									52.4
1909		1280.0	683.0	110.0	783.0	497.0	270.0	2499.0	
1910	Jan.	61.3				61.3	6.8	2553.9	
	Feb.	42.0	19.7		19.7	22.3	12.5	2563.7	
	Mar.	143.7	87.5		87.5	56.2	24.0	2595.7	
	Apr.	189.9	99.6	60.0	159.6	30.3	32.3	2593.7	
	May	308.6	103.3	40.0	143.3	165.3	35.8	2640.0	83.2
	June	63.1	101.9	10.0	111.9	-48.8	40.0	2551.2	
	July	1.1	92.1		92.1	-91.0	33.0	2427.0	
	Aug.	7.3	71.5		71.5	-64.2	27.2	2335.6	
	Sept	3.0	58.3		58.3	-55.3	22.0	2258.3	
	Oct.	0.6	33.5		33.5	-32.9	19.0	2206.4	
	Nov.	8.9	15.5		15.5	- 6.6	12.0	2187.4	
	Dec.	23.2				23.2	8.0	2202.6	
		852.7	682.8	110.0	792.8	59.8	272.6		83.2
1911		1800.0	683.0	95.0	778.0	1022	270.0	2640.0	315.0
1912	Jan. to								
	June	1294.0	412.0	70.0	482.0	812.0	158.0	2640.0	654.0
	Jul. to								
	Dec.	206.0	271.0	10.0	281.0	-75.0	128.0	2437.0	
1913		526.0	683.0		683.0	-157.0	260.0	2120.0	
1914		1178.0	683.0		683.0	495.0	258.0	2257.0	
1915	Jan.	33.2				33.2	6.5	2283.7	
	Feb.	38.0	19.7		19.7	18.3	11.8	2290.2	
	Mar.	53.2			87.5	-34.3	22.7	2232.8	
	Apr.	271.5			99.6	171.9	30.5	2274.2	
	May	393.8			103.3	290.5	38.8	2625.9	
	June	309.5			101.9	207.6	40.5	2640.0	153.0
	July	119.9			92.1	27.8	34.5	2633.3	
	Aug.	46.2			71.5	-25.3	29.5	2578.9	
	Sept	17.9			58.3	-40.4	24.0	2514.5	
	Oct.	13.1			33.5	-20.4	21.0	2472.7	
	Nov.	22.7			15.5	7.2	12.2	2469.7	
	Dec.	35.4				35.4	9.0	2494.1	
		1354.4			682.8	671.5	280.8		153.0
1916	Jan.	47.8				47.8	7.0	2534.9	
	Feb.	47.1			19.7	27.4	12.2	2550.1	
	Mar.	164.5			87.5	77.0	23.0	2664.1	
	Apr.	233.2			99.6	133.6	32.2	2640.0	65.4
	May	496.9			103.3	393.6	40.5	2640.0	353.1
	June	205.6			101.9	103.7	40.5	2640.0	63.2

Balance of year carried to next page.

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TABLE NO. 44 Continued.

Year	Mo.	1	2	3	4	5	6	7	8
1916 cont'd	July	45.7			92.1	-46.4	34.5	2559.1	
	Aug	97.9			71.5	26.4	28.5	2557.0	
	Sept	19.3			58.3	-39.0	24.0	2494.0	
	Oct.	162.3			33.5	128.8	21.1	2601.7	
	Nov.	88.0			15.5	72.5	12.5	2640.0	21.7
	Dec.	49.0				49.0	9.5	2640.0	39.5
		1657.3			682.8	974.4	285.5		541.9
1917	Jan.	45.6			[illegible]	45.6	7.0	2640.0	38.6
	Feb.	37.9			19.7	18.2	12.8	2640.0	5.4
	Mar.	38.8			87.5	-48.7	23.8	2567.5	
	Apr.	94.6			99.6	- 5.0	32.0	2530.5	
	May	238.5			103.3	135.2	39.0	2626.7	
	June	366.9			101.9	265.0	40.0	2640.0	211.7
	July	174.4			92.1	82.3	34.5	2640.0	47.8
	Aug.	6.1			71.5	-65.4	28.5	2546.1	
	Sept	7.7			58.3	-50.6	23.8	2471.7	
	Oct.	1.0			33.5	-32.5	20.5	2418.7	
	Nov.	14.5			15.5	- 1.0	12.0	2405.7	
	Dec.	28.3						2418.0	
		1054.0			682.8	343.1	270.9	[illegible]	303.5
1918		410.0			683.0	-273.0	230.0	1916.0	

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TABLE NO. 45

Operation of Elephant Butte Reservoir, Rio Grande Project, 155,000 acres - Pumping Development, San Luis Valley, of 750,000 acres in San Luis Valley and Middle Rio Grande drained.

1	2	3	4	5	6	7	8	9
Year	Month	San Marcial discharge	Demand below Elephant Butte	Reservoir evaporation	Total demand Col. 4+5	Diff. Col.3-6	Storage	Shortage or spill
1891	July						2640	
	Aug-Dec.	400	179	96	275	125	2640	125
1892	Jan.	50		7	7	43	2640	43
	Feb.	50	20	13	33	17	2640	17
	Mar.	60	88	23	111	- 51	2589	
	Apr.	180	100	33	133	47	2636	
	May	350	103	40	143	207	2640	203
	June	200	102	40	142	58	2640	58
	July	50	92	34	126	- 76	2564	
	Aug-Dec.	264	178	84	262	2	2566	
1893	All	561	683	270	953	- 392	2174	
1894	All	704	683	245	928	- 224	1950	
1895	All	1181	683	250 280	933	+ 248	2198	
1896	All	493	683	235	918	- 425	1773	
1897	All	1779	683	265	948	+ 831	2604	
1898	Jan-Feb.	120	20	20	40	80	2640	+44
	Mar-Dec.	437	663	250	913	- 476	2164	
1899	All	238	683	230	913	-675	1489	
1900	All	281	683	175	858	- 577	912	
1901	All	446	683	120	803	- 357	555	
1902	Jan-Nov.	100	683	65	748	- 648	0	93
	Dec.	15	0	1	1	14	14	
1903	All	862	683	45	728	+ 134	148	
1904	Jan-Sept.	180	634	40	674	-494	0	-346
	Oct-Dec.	542	49	6	55	487	487	
1905	All	1728	683	150	833	895	1382	
1906	All	1345	683	210	893	452	1834	
1907	All	2181	683	270	953	1228	2640	+422
1908	Jan-Feb.	100	20	20	40	60	2640	+ 60
	Mar-Dec.	593	663	275	938	-345	2295	
1909	All	1113	683	270	953	160	2455	
1910	All	691	683	270	953	-262	2193	
1911	All	1957	683	280	963	994	2640	+547
1912	Jan-June	1158	412	158	570	588	2640	+588
	Jul-Dec.	210	271	128	399	-189	2451	
1913	All	499	683	250	933	-434	2017	
1914	All	1117	683	245	928	+189	2206	
1915	Jan-June	1002	412	145	557	+445	2640	+ 11
	July-Dec.	300	271	130	401	101	2559	

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1	2	3	4	5	6	7	8	9
1916	Jan-June	1250	412	155	567	683	2640	⁄582
	July	50	92	34	126	- 76	2564	
	Aug.	100	72	28	100	0	2564	
	Sept.	35	58	24	82	- 52	2512	
	Oct.	180	34	21	55	130	2640	⁄ 2
	Nov.	120	16	12	28	92	2640	⁄ 92
	Dec.	80		10	10	70	2640	⁄ 70
1917	Jan.	70		7	7	63	2640	⁄ 63
	Feb.	50	20	13	33	17	2640	⁄ 17
	Mar.	50	88	24	112	-62	2578	
	Apr.	80	100	32	132	-52	2526	
	May	200	103	39	142	58	2584	
	June	300	102	40	142	158	2640	⁄102
	July	140	92	35	127	13	2640	⁄ 13
	Aug-Dec.	177	178	94	272	-95	2545	
1918	All	420	683	240	933	-503	2042	

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TABLE NO. 46.

Artesian Wells.

In 1904, Siebenthal made a survey of the wells in the valley, the results of which are embodied in W.S. No. 240. During 1905 comparatively little drilling was done and drillers kept very little record so that this year's new wells are covered by an estimate.

Beginning with 1906 there was considerable activity in drilling until 1912, and from inquiry among all the drillers who could be found of whom a number kept good records, the wells drilled since 1906 have been determined:

Size	Siebenthal 1904- W.S.240	Drilled in 1905	Drilled 1906-19	Wells as of 1919.
2")	3081	60	1881	3954*
3")		20	609	1697*
4" x 4½"	77	1	21	99
6"	76	1	18	94**
8"			1	2**
12"			4	4
Total	3234	82	2534	5850

*Siebenthal did not segregate 2" and 3" wells, and final total segregated in proportion found in measured wells.
**Siebenthal listed no.8" wells though one was in at that time.

To get an idea of the flow of the wells, a large number were measured over all parts of the valley and information obtained to as large an extent as possible as to the extent to which wells were run to capacity.

The wells naturally divide themselves into the town and country wells, the former having a much smaller flow per unit due to mutual interference and, in most cases, impossible of measurement owing to the way they are piped to various places of use.

As the country wells constitute the big majority of all wells, little error will result in the total from considerable possible error in the town wells.

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Country Wells

Size	Number measured.	Average capacity in gal. per m.	Total number of wells	Total capac. in gal. per m.	Average output in gal. per m. for ea. well.	For all wells of this size.
2"	563	16.7	3144	52505	12	37728
3"	288	42.2	1607	67815	34	54638
4"& 4½"	28	86.1	81	6974	75	6075
6"	27	184.6	92	16983	150	13800
8"	2	180	2	360	150	300
12"		100*	4	400	100	400
	Total			145037		112941

*Estimated.

Town Wells

The capacity of the town wells, largely estimated, is as follows:

Town	Large wells (over 3"): No.	Large wells (over 3"): Combined flow	Small wells. No.	Small wells. Combined flow	Total No.	Total Combined flow
Alamosa	8	1500	160	1600	168	3100
Monte Vista	2	100	500	1500	502	1600
La Jara	4	200	90	540	94	740
Sanford			40	200	40	200
Mosca	2	50	20	50	22	100
Hooper	3	50	20	60	23	110
Moffat	1	100	20	200	21	300
Center			50	1000	50	1000
	20	2000	900	5150	920	7150

The average output of the town wells can be roughly taken as 50% of their capacity.

From the foregoing, the capacity and average output of wells is as follows:

Capacity, 152,187 G.P.M. or 245,000 A.F. per annum.
Average output, 116,516 G.P.M. or 187,000 A.F. per annum.

COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS
UNIT 1000 A FEET

Year	Mon	CONTROL STATION: WASSON		DEL NORTE		STATE BRIDGE		EMBUDO		BUCKMAN		SAN MARCIAL		EL PASO	
		30 Mi. Bridge Disch	Disch	Incr. over 30 Mi. Bri	Disch	Incr over Wasson	Disch	Incr. over Del N.	Disch.	Incr. over St. Bri	Disch.	Incr over Embudo	Disch.	Incr over Buckman	Disch	Incr over San Ma
1889	Jan								26.5							
	Feb								26.3							
	Mar								48.2							
	Apr								135.0							
	May								211.0						136.0	
	June								174.0						157.0	
	July								29.0						14.6	
	Aug								12.7						9.0	
	Sept								12.6o						0.0	
	Oct								17.4						0.0	
	Nov								21.8						0.0	
1889&	Dec								33.3						4.4	
Total									747.8							
1890	Jan			13.5					26.9						12.1	
	Feb			11.1					30.7						16.1	
	Mar			27.4					41.9						26.1	
	Apr			54.3					124.0						130.3	
	May			266.0					305.0						354.9	
	June			227.0					244.0						262.0	
	July			93.2					98.0						52.5	
	Aug			37.6					50.1						45.1	
	Sept			22.8					32.4						10.5	
	Oct			28.9					34.6						4.0	
	Nov			20.2					36.7						15.9	
	Dec			18.4					40.0		**		**		32.9	
Total				820.4					1064.3		1510.0		1200.0		963.4	

* Estimated by Debler.
o Estimated by Meeker.
Estimated by Conkling.
**Record Extended.
x From State Eng. N.Mex.
/ From U.S.R.S. Project Manager.

** From Graph.
oo Revised

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS
UNIT 1000 A FEET

Year	Mon.	CONTROL STATION: WASSON		DEL NORTE		STATE BRIDGE		EMBUDO & BUCKMAN		SAN MARCIAL		EL PASO	
		30 Mi. Bridge Disch.	Disch.	Incr. over 30 Mi. Bri	Disch.	Incr. over Wasson	Disch.	Incr. over Del N.	Disch	Incr over St. Bri	Disch.	Incr. over Embudo	Disch	Incr. over San Mar.
1891	Jan				16.9				36.0					27.7
	Feb				13.9				34.2					44.9
	Mar				26.7				56.4					114.8
	Apr				83.9				141.0					253.8
	May				202.0				367.0					726.5
	June				247.0				300.0					399.5
	July				104.0				145.0				200.0	139.7
	Aug				40.8				57.4				100.0	40.7
	Sept				31.4				27.9				80.0	45.7
	Oct				51.9				103.0				140.0	91.5
	Nov				22.3				46.3				50.0	20.3
1891	Dec				19.1				34.0				30.0	21.2
Total					859.9				1348.2		2400.0		2200.0	1926.3
1892	Jan				16.9				30.6				30.0	20.0
	Feb				14.4				34.3				30.0	27.4
	Mar				19.4				64.6				50.0	46.2
	Apr				62.3				177.0				210.0	187.2
	May				160.0				301.0				500.0	436.2
	June				130.0				187.0				240.0	175.1
	July				45.5				33.1				80.0	46.1
	Aug				27.3				11.7				0.0	0.8
	Sept				15.6				9.0				0.0	0.0
	Oct				15.9				12.4				50.0	0.0
	Nov				14.3				18.9				30.0	0.0
	Dec				10.8				19.9				20.0	0.0
Total					532.4				899.5		1550.0		1240.0	934.0

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS
UNIT 1000 A FEET

Year	Mon	30. Mi Bridge disch	WASSON Disch	WASSON Incr. over 30 Mi Bri	DEL NORTE Disch.	DEL NORTE Incr. over Wasson	STATE BRIDGE Disch;	STATE BRIDGE Incr. over Del N.	EMBUDO Disch	EMBUDO Incr. over St.Br.	BUCKMAN Disch.	BUCKMAN Incr. over Embudo	SAN MARCIAL Disch	SAN MARCIAL Incr. over Buckman	EL PASO Disch	EL PASO Incr over San Mar
1893	Jan				9.8				20.4						8.2	
	Feb				9.7				23.0						8.0	
	Mar				15.4				30.8						2.2	
	Apr				31.7				85.4						48.1	
	May				120.0				192.0						231.5	
	June				104.0				151.0						13.4	
	July				24.3				13.9						(	
	Aug				19.9				14.1						(	
	Sept				16.1				17.1						(*	
	Oct				16.2				22.3						(50.0	
	Nov				14.3				19.6						(	
1893	Dec				19.8				19.7						(	
Totals					392.2				609.3		950.0		650.0		361.4	
1894	Jan				19.8				19.6							
	Feb				9.7				18.3							
	Mar				18.4											
	Apr				54.9											
	May				147.0											
	June				63.7											
	July				22.4											
	Aug				23.6											
	Sept				21.1											
	Oct				22.1				41.8							
	Nov				16.8				17.8							
1894	Dec				13.8				20.8							
Totals					424.3				700.0				800.0		*	

1894--An estimate only based on comparison of 1893 and 1894 as shown in Folletts report for International Boundary Commission.

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS.
UNIT 1000 A FEET

Year	Mon.	CONTROL STATION	WASSON		DEL NORTE		STATE BRIDGE		EMBUDO		BUCKMAN		SAN MARCIAL		EL PASO	
		30 Mi. Bridge Disch	Disch	Incr. over 30 mi. Bridge	Disch	Incr. over Wasson	Disch	Incr. over Del N.	Disch.	Incr. over State Bridge	Disch.	Incr. over Embudo	Disch	Incr over Buckman	Disch	Incr over San M Mar
1895	Jan				12.3				29.2		*34.0	4.8	* 50.0	≠ 16.0		
	Feb				10.6				27.9		32.8	4.9	53.8	≠ 21.0		
	Mar				26.7				46.5		84.3	37.8	128.9	≠ 44.6		
	Apr				119.0				151.0		338.0	187.0	279.0	- 59.0		
	May				141.0				165.0		284.0	119.0	222.9	- 61.1		
	June				139.0				180.0		276.0	96.0	233.4	- 42.6		
	July				64.6				82.1		109.0	26.9	149.5	40.5		
	Aug				45.2				66.4		91.1	24.7	179.1	88.0		
	Sept				26.7				37.8		43.0	5.2	* 25.0	- 18.0		
	Oct				25.8				30.4		42.1	11.7	* 30.0	- 12.1		
	Nov				20.4				36.4		49.6	13.2	* 50.0	≠ 0.4		
1895	Dec				18.4				32.8		43.8	11.0	* 25.0	- 18.8		
Totals					649.7				885.5		1427.7	542.2	1426.6	- 1.1		
1896	Jan				16.9				32.7		36.9	4.2	** 35.0	- 1.9		
	Feb				15.5				31.7		34.5	2.8	39.1	4.6		
	Mar				30.7				58.8		81.2	22.4	41.8	- 39.4		
	Apr				91.0				107.0		207.0	100.0	187.0	- 20.0		
	May				151.0				98.3		166.0	67.7	124.1	- 41.9		
	June				51.6				21.8		31.8	10.0	9.8	- 22.0		
	July				24.3				18.4		25.3	6.9	28.7	3.4		
	Aug				16.5				15.3		14.9	- 0.4	7.3	- 7.6		
	Sept				29.7				13.6		17.8	4.2	7.7	- 10.1		
	Oct				27.9				21.5		28.3	6.8	45.6	17.3		
	Nov				18.1				23.5		29.6	6.1	12.4	- 17.2		
1896	Dec				13.8				25.5		30.0	4.5	38.1	8.1		
Totals					487.0				468.1		703.3	235.2	576.6	- 126.7		

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS.
UNIT 1000 A Feet.

Year	Mon.	CONTROL STATION	WASSON	DEL NORTE		STATE BRIDGE		EMBUDO		BUCKMAN		SAN MARCIAL		EL PASO	
		30 Mi. Bridge disch	Disch.	Disch	Incr. over Wasson	Disch.	Incr. over Del N.	Disch	Incr. over St.Br.	Disch.	Incr. over Embudo	Disch.	Incr. over Buckman	Disch	Incr. over San Mar.
1897	Jan			13.8				24.2		28.7	4.5	19.6	-9.1	18.8	- 0.8
	Feb			11.1				22.7		30.1	7.4	24.3	-5.8	10.8	-13.5
	Mar			27.1				34.5		60.8	26.3	40.8	-20.0	4.4	-36.4
	Apr			63.5				101.0		303.0	202.0	212.5	-90.5	103.5	-109.0
	May			217.0				335.0		702.0	367.0	755.2	+53.2	511.1	-244.1
	June			202.0				275.0		366.0	91.0	366.4	0.4	362.7	- 3.7
	July			68.1				78.3		97.3	19.0	66.0	-31.3	81.8	+ 15.8
	Aug			29.2				20.8		27.4	6.6	6.1	-21.3	8.1	+ 2.0
	Sept			37.5				20.5		40.5	20.0	114.2	+73.7	42.0	- 72.2
	Oct			90.5				94.6		136.0	41.4	281.7	+145.7	108.1	-173.6
	Nov			39.6				67.7		71.9	4.2	175.7	+103.8	67.4	-108.1
1897	Dec			24.0				33.9		32.2	- 1.7	152.7	+120.5	41.8	-110.9
Totals				823.4				1108.2		1895.9	787.7	2215.2	+319.3	1360.5	-854.5
1898	Jan			20.0				30.0		21.7	- 8.3	57.7	+ 36.0	30.1	- 27.6
	Feb			16.7				26.2		24.9	- 1.3	59.4	+ 34.5	33.7	- 25.7
	Mar			27.7				42.7		33.4	- 9.3	62.2	+ 28.8	20.7	- 41.5
	Apr			114.0				133.0		266.0	133.0	271.5	+ 5.5	97.9	-173.6
	May			167.0				132.0		200.0	68.0	165.8	- 34.2	140.2	- 25.6
	June			261.0				207.0		224.0	17.0	126.3	- 97.7	111.6	- 14.7
	July			101.0				158.0		162.0	4.0	167.1	5.1	196.3	+ 29.2
	Aug			31.3				29.4		39.2	9.8	13.8	- 25.4	31.2	+ 17.4
	Sept			19.0				20.1		19.3	- 0.8	3.7	- 15.6	2.3	- 1.4
	Oct			16.0	# 2.0	-14.0		17.4		21.9	4.5	0.0	- 21.9	0.2	+ 0.2
	Nov			13.1	# 5.0	- 8.1		21.2		35.6	14.4	10.2	- 25.4	0.1	- 10.1
1898	Dec			11.1	#15.0	3.9		20.8		39.2	18.4	23.4	- 15.8	5.7	- 17.7
Totals				797.9				837.8		1087.2	+249.4	961.1	-126.1	670.0	-291.1

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS
UNIT 1000 A FEET

CONTROL STATION

Year	Mon.	WASSON 30 Mi. Bridge Disch	WASSON Disch	WASSON Incr. over 30 Mi. Bri	DEL NORTE Disch.	DEL NORTE Incr. over Wasson	STATE BRIDGE Disch	STATE BRIDGE Incr. over Del N.	EMBUDO Disch	EMBUDO Incr. over St. Br.	BUCKMAN Disch.	BUCKMAN Incr. over Embudo	SAN MARCIAL Disch.	SAN MARCIAL Incr. over Buckman	EL PASO Disch	EL PASO Incr over San Mar
1899	Jan				11.1		* 15.0	3.9	28.9	13.9	26.0	- 2.9	27.9	1.9	12.9	-15.0
	Feb				10.0		* 15.0	5.0	26.7	11.7	35.6	8.9	24.6	- 11.0	11.3	-13.3
	Mar				18.4		* 20.0	1.6	46.8½	26.8	81.2	34.4	27.5	- 53.7	7.1	-20.4
	Apr				36.8		* 18.0	-18.8	64.9	46.9	176.0	111.1	54.1	-121.9	8.8	-45.3
	May				84.7		* 40.0	-44.7	58.8	18.8	118.0	59.2	35.0	- 83.0	10.3	-24.7
	June				64.9		* 5.0	-59.9	14.8	9.8	23.7	8.9	1.0	- 22.7	0.0	- 1.0
	July				43.2		2.6	-40.6	18.3	15.7	36.6	18.3	28.4	- 8.2	19.6	- 8.8
	Aug				36.7		3.3	-33.4	14.5	11.2	22.2	7.7	6.4	- 15.8	0.4	- 6.0
	Sept				22.0		6.1	-15.9	18.4	12.3	53.1	34.7	2.9	- 50.2	0.4	- 2.9
	Oct				29.2		7.2	-22.0	21.9	14.7	26.6	4.7	0.7	- 25.9	0.1	- 0.6
	Nov				23.8		15.4	- 8.4	31.8	16.4	45.0	13.2	9.5	- 35.5	0.1	- 9.4
1899	Dec				12.6		15.7	3.1	29.4	13.7	38.2	8.8	21.8	- 16.4	2.8	-19.0
Totals					393.4		163.3	-230.1	375.2	211.9	682.2	307.0	239.8	-442.4	73.4	-166.4
1900	Jan				9.2		12.3	3.1	27.9	15.6	36.8	8.9	40.6	3.8	8.1	-32.5
	Feb				10.6		13.9	3.3	26.4	12.5	32.3	5.9	35.1	2.8	5.7	-29.4
	Mar				15.4		18.4	3.0	38.6	20.2	52.8	14.2	33.2	- 19.6	0.5	-32.7
	Apr				24.9		20.2	- 4.7	27.8	7.6	51.5	23.7	5.3	- 46.2	0.3	- 5.0
	May				175.0		106.0	- 69.0	148.0	42.0	212.0	64.0	123.6	- 88.4	44.8	-78.8
	June				160.0		108.0	- 52.0	145.0	37.0	173.0	28.0	159.9	- 13.1	93.1	-66.8
	July				33.6		1.2	- 32.4	17.3	16.1	18.3	1.0	0.1	- 18.2	0.1	0.0
	Aug				14.0		0.7	- 13.3	10.6	9.9	10.1	- 0.5	0.0	- 10.1	0.0	0.0
	Sept				15.2		1.2	- 14.0	14.8	13.6	42.6	27.8	56.1	13.5	16.5	-39.6
	Oct				21.0		1.7	- 19.3	15.5	13.8	23.8	8.3	0.1	- 23.7	0.0	- 0.1
	Nov				14.9		3.3	- 11.6	19.3	16.0	25.3	6.0	2.4	- 22.9	0.0	- 2.4
1900	Dec				12.3		16.9	4.6	21.8	4.9	39.0	7.2	10.1	- 18.9	0.7	- 9.4
Totals					506.1		303.8	-202.3	513.0	209.2	707.5	194.5	466.5	-241.0	169.8	296.7

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS
UNIT 1000 A.FEET

Year	Mon.	CONTROL STATION: WASSON		DEL NORTE	STATE BRIDGE		EMBUDO		BUCKMAN		SAN MARCIAL		EL PASO	
		30 Mi. Bridge Disch	Disch	Incr. over 30 mi. Bri.	Disch	Incr. over Wasson	Disch	Incr. over Del N.	Disch	Incr. over St. Brd	Disch.	Incr.	Disch.	Incr.	Disch	Incr over San MAR
1901	Jan		12.3		15.4	3.1	21.1	5.7	24.4	3.3	21.0	-3.4	0.3	-20.7
	Feb		9.7		13.9	4.2	25.9	12.0	36.5	10.6	25.5	11.0	4.5	-21.0
	Mar		13.8		22.3	8.5	31.9	9.6	45.6	13.7	15.1	-30.5	3.7	-11.4
	Apr		42.2		16.8	-25.4	38.8	22.0	83.4	44.6	23.7	-59.7	0.0	-23.7
	May		158.0		124.0	-34.0	192.0	68.0	319.0	127.0	256.1	-62.9	158.1	-98.0
	June		116.0		66.0	-50.0	102.0	36.0	131.0	29.0	96.2	-34.8	77.0	-19.2
	July		36.5		5.0	-31.5	24.8	19.8	44.8	20.0	59.3	14.5	12.6	-46.7
	Aug		28.5		3.4	-25.1	27.7	24.3	50.8	23.1	65.5	14.7	60.7	-4.8
	Sept		26.5		2.6	-23.9	21.4	18.8	34.5	13.1	37.6	3.1	21.0	-16.6
	Oct		16.1		3.0	-13.1	20.4	17.4	30.2	9.8	17.0	-13.2	5.3	-11.7
	Nov		16.8		2.1	-14.7	21.2	19.1	27.5	6.3	20.1	-7.4	12.8	-7.3
1901	Dec		10.8		9.2	-1.6	26.1	16.9	28.5	2.4	19.2	-9.3	8.0	-11.2
Totals			487.2		283.7	-203.5	553.3	269.6	856.2	302.9	656.3	-199.9	364.0	-292.3
1902	Jan		9.8		11.1	1.3	26.4	15.3	29.6	3.2	22.7	-6.9	8.3	-14.4
	Feb		8.3		8.9	0.6	25.7	16.8	27.2	1.5	17.4	-9.8	5.8	-11.6
	Mar		14.1		18.8	4.7	32.7	13.9	33.7	1.0	8.0	-25.7	0.6	-7.4
	Apr		38.0		18.3	-19.7	39.4	21.1	97.6	58.2	40.1	-57.5	7.9	-32.2
	May		71.9		28.5	-43.4	49.1	20.6	73.6	24.5	26.8	-46.8	0.5	-26.3
	June		36.8		6.7	-30.1	26.2	19.5	28.2	2.0	6.4	-21.8	0.3	-6.1
	July		9.4		0.7	-8.7	9.7	9.0	16.7	7.0	0.0	-16.7	0.0	0.0
	Aug		11.1		0.6	-10.5	15.2	14.6	34.2	19.0	49.2	15.0	14.5	-34.7
	Sept		12.3		1.0	-11.3	13.6	12.6	28.8	15.2	13.3	-15.5	9.3	-4.0
	Oct		14.9		1.3	-13.6	14.2	12.9	17.2	3.0	0.8	-16.4	1.4	0.6
	Nov		12.9		1.1	-11.8	13.7	12.6	18.4	4.7	4.6	-13.8	0.3	-4.3
1902	Dec		9.8		1.6	-8.2	16.2	14.6	19.2	3.0	11.3	-7.9	1.8	-9.5
Totals			249.3		98.6	-150.7	282.1	183.5	424.4	142.3	200.6	-223.8	50.7	-149.9

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS

UNIT 1000 A Feet

Year	Mon.	CONTROL STATION	WASSON		DEL NORTE		STATE BRIDGE		EMBUDO		BUCKMAN		SAN MARCIAL		EL PASO	
		30 Mi. Bridge disch	Disch.	Incr. over 30 Mi. Bridge	Disch.	Incr. over Wasson	Disch.	Incr. over Del N.	Disch.	Incr. over St. Bri	Disch	Incr. over Embudo	Disch	Incr. over Buck-man	Disch	Incr. over San Mar
1903	Jan				o 10.0		1.5	- 8.5	19.5	18.0	23.1	3.6	17.2	- 5.9	0.6	- 16.6
	Feb				o 9.0		1.4	- 7.6	20.8	19.4	24.7	3.9	21.9	- 2.8	1.3	- 20.6
	Mar				o 15.0		2.1	-12.9	48.4	46.3	75.2	26.8	46.8	- 28.4	22.6	- 24.2
	Apr				44.5		18.7	-25.8	58.7	40.0	172.0	113.3	100.0	- 72.0	49.5	- 50.5
	May				174.0		124.0	-50.0	158.0	34.0	407.0	249.0	318.4	- 88.6	203.6	- 114.8
	June				309.0		379.0	70.0	534.0	155.0	709.0	175.0	660.5	- 48.5	586.9	- 73.6
	July				102.0		72.4	-29.6	92.6	20.2	137.0	44.4	77.8	- 59.2	158.2	80.4
	Aug				32.3		2.9	-29.4	20.5	17.6	26.6	6.1	3.1	- 23.5	4.3	1.2
	Sept				30.6		5.4	-25.2	20.7	15.3	22.3	1.6	1.4	- 20.9	1.0	- 0.4
	Oct				21.5		3.9	-17.6	19.9	16.0	21.8	1.9	0.5	- 21.3	2.0	1.5
	Nov				o 15.0		8.3	- 6.7	25.8	17.5	25.2	- 0.6	5.5	- 19.7	0.3	- 5.2
1903	Dec				o 10.0		7.4	- 2.6	17.4	10.0	23.6	6.2	18.9	4.7	2.4	- 16.5
Totals					772.9		627.0	-145.9	1036.3	409.3	1667.5	631.8	1272.0	-395.5	1032.7	- 239.3
1904	Jan				o 6.0		7.4	1.4			20.9		16.8	- 4.1	1.0	- 15.0
	Feb				o 5.5		6.3	0.8			24.2		18.9	- 5.3	0.4	- 18.5
	Mar				p 12.0		6.8	- 5.2			21.3		6.1	- 15.2	0.0	- 6.1
	Apr				38.8		9.1	-29.7			27.3		0.0	- 27.3	0.0	0.0
	May				71.2		1.3	-69.9			24.2		0.0	- 24.2	0.0	0.0
	June				42.6		1.2	-41.4			17.0		0.0	- 17.0	0.0	0.0
	July				20.7		1.1	-19.6			15.1		10.5	- 4.6	0.0	- 10.5
	Aug				42.4		8.6	-33.8			92.0		56.0	- 36.0	7.4	- 48.6
	Sept				41.2		11.7	-29.5			148.0		44.7	-103.3	11.0	- 33.7
	Oct				89.1		97.8	- 8.7			253.0		403.2	210.2	366.5	- 96.7
	Nov				o 25.0		17.9	- 7.1			49.4		51.8	2.4	48.4	- 3.4
1904	Dec				o 20.0		18.4	- 1.6			35.4		41.8	6.4	38.2	- 3.6
Totals					414.5		187.6	-226.9			727.8		709.8	- 18.0	472.9	- 236.9

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS.
UNIT 1000 ACRE FEET

Year	Mon.	CONTROL STATION: WASSON		DEL NORTE		STATE BRIDGE		EMBUDO		BUCKMAN		SAN MARCIAL		EL PASO	
		30 mi. Bridge Disch.	Incr. over 30 Mi Bridge	Disch.	Incr. over Wasson	Disch	Incr. over Del N.	Disch	Incr over St. Br	Disch	Incr. over Embudo	Disch.	Incr. over Buck-Man	Disch	Incr over San Mar
1905	Jan			o 19.0		21.5	2.5			43.5		39.1	- 4.4	35.9	- 3.2
	Feb			o 16.0		18.0	2.0			51.6		63.9	12.3	43.3	- 20.6
	Mar			p 35.0		55.2	20.2			158.0		217.9	59.9	188.5	- 29.4
	Apr			45.2		46.0	0.8			219.0		279.4	60.4	197.9	- 81.5
	May			210.0		350.0	140.0			785.0		962.2	177.2	546.0	- 416.2
	June			362.0		430.0	68.0			573.0		714.3	141.3	851.1	136.8
	July			67.1		16.7	- 50.4			53.7		35.8	- 17.9	58.8	23.0
	Aug			35.5		10.0	- 25.5			38.7		20.1	- 18.6	19.8	- 0.3
	Sept			22.4		3.8	- 18.6			23.2		5.3	- 17.9	3.3	- 2.0
	Oct			26.4		6.3	- 20.1			26.0		7.3	- 18.7	4.2	- 3.1
	Nov			17.6		13.6	- 4.0			38.0		42.4	4.4	25.5	- 16.9
1905	Dec			12.3		15.4	3.1			37.9		34.3	- 3.6	37.5	3.2
Totals				868.5		986.5	x118.0			2047.6		2422.4	374.4	2011.8	- 410.2
1906	Jan			11.1		16.6	5.5			o 45.0		36.5	- 8.5	27.0	- 9.5
	Feb			10.0		15.0	5.0			o 50.0		39.7	- 10.3	21.7	- 8.0
	Mar			18.8		20.9	2.1			80.0		56.9	- 23.1	25.3	- 31.6
	Apr			64.9		45.3	- 19.6			o210.0		163.1	- 46.9	88.0	- 75.1
	May			236.0		205.0	- 31.0			o600.0		500.7	- 99.3	349.0	- 151.7
	June			296.0		260.0	- 36.0			450.0		345.1	- 104.9	270.6	- 74.5
	July			116.0		90.4	- 25.6			o130.0		118.3	- 11.7	96.6	- 21.7
	Aug			47.7		30.9	- 16.8			o 78.0		43.2	- 34.8	49.2	6.0
	Sept			42.8		25.2	- 17.6			o 55.1		25.5	- 29.6	2.8	- 22.7
	Oct			54.8		56.8	2.0			* 80.0		70.8	- 9.2	38.2	- 32.6
	Nov			32.5		45.4	12.9			* 90.0		77.8	- 12.2	59.3	- 18.5
1906	Dec			18.4		30.7	12.3			*110.0		86.1	- 23.9	76.3	- 9.8
Totals				949.0		842.2	106.8			1978.1		1563.7	-414.4	1114.0	- 449.7

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS
UNIT 1000 A FEET

CONTROL STATION

Year. Mon.	WASSON		DEL NORTE		STATE BRIDGE		EMBUDO		BUCKMAN		SAN MARCIAL		EL PASO	
	30 Mi. Bridge Disch	Dischg	Incr. over 30 Mile Bridge	Dischg.	Incr. over Wasson	Dischg	Incr. over Del N.	Dischg.	Incr. over St.Bri	Dischg	Incr. over Embudo	Dischg	Incr. over Buck-men	Disch	Incr over San Mar
1907 Jan				o 17.0		30.7	13.7			* 90.0		60.6	-29.4	60.4	- 0.2
Feb				o 16.0		29.2	13.2			* 50.0		67.7	17.7	46.6	- 21.1
Mar				o 50.0		47.9	- 2.1			*100.0		92.5	- 7.5	60.0	- 32.5
Apr		11.2		o 113.0		117.0	4.0			*280.0		222.9	-57.1	175.6	- 47.3
May		102.0		o 150.0	48.0	201.0	51.0			*450.0		369.0	-81.0	269.4	- 99.6
June		226.0		355.0	129.0	411.0	56.0			*580.0		524.2	-55.8	442.6	- 81.6
July		213.0		280.0	67.0	334.0	54.0			*380.0		328.7	-51.3	337.4	8.7
Aug		62.7		92.4	29.7	107.0	14.6			*210.0		165.5	-44.5	135.3	- 30.2
Sept		37.4		50.2	12.8	73.2	23.0			*180.0		160.9	-19.1	166.7	5.8
Oct		20.7		o 33.8	13.1	35.4	1.6			* 80.0		64.5	-15.5	50.0	- 14.5
Nov		14.0		o 30.0	16.0	28.1	- 1.9			* 80.0		56.5	-23.5	54.9	- 1.6
1907 Dec		7.1		o 20.0		22.0	2.0			* 80.0		44.7	-35.3	37.6	- 7.1
Totals				1207.4		1436.5	229.1			2560.0		2157.7	-402.3	1836.5	-321.2
1908 Jan		* 10.0		o 18.0	8.0	# 22.0	4.0			* 70.0		43.6	- 26.4	33.0	-10.6
Feb		* 9.0		o 16.0	7.0	# 23.0	7.0			* 60.0		48.0	- 12.0	31.2	-16.8
Mar		11.0		o 35.0	24.0	41.7	6.7			*120.0		77.4	- 42.6	47.8	-29.6
Apr		28.7		** 45.0	16.3	37.4	- 7.6			*170.0		123.9	- 46.1	80.1	-43.8
May		73.2		104.0	30.8	47.0	- 57.0			*210.0		165.3	- 44.7	116.9	-48.4
June		137.0		174.0	37.0	68.4	- 105.6			*170.0		90.5	- 79.5	40.2	-50.3
July		55.6		65.8	10.2	19.4	- 46.4			* 90.0		49.0	- 41.0	16.3	-32.7
Aug		48.9		57.2	8.3	38.4	- 18.8			*130.0		95.7	- 34.3	58.6	-37.1
Sept		18.6		20.5	1.9	18.2	- 2.3			* 40.0		9.7	- 30.3	14.3	4.6
Oct		13.9		16.7	2.8	17.8	1.1			* 22.5		2.8	- 19.7	0.0	- 2.8
Nov		9.7		12.2	2.5	14.9	2.7			* 40.0		29.9	+ 10.1	5.1	- 24.8
1908 Dec		* 8.0		o 10.0	2.0	14.8	4.8			* 50.0		38.4	- 11.6	23.4	- 15.0
Totals		423.6		574.4	150.8	363.0	- 211.4			1172.5		774.2	-398.3	466.9	-307.

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS.
UNIT 1000 A FEET

Year	Mon.	CONTROL STATION	WASSON		DEL NORTE		STATE BRIDGE		EMBUDO		BUCKMAN		SAN MARCIAL		EL PASO	
		30 Mi. Bridge disch	Disch.	Incr. over 30 mil Bridge	Disch	Incr. over Wasson	Disch	Incr. over Del N.	Dischg	Incr. over State Bridge	Dischg	Incr. over Embudo	Dischg	Incr. over Buck-man	Dischg	Incr- over San Mar
1909	Jan:		* 8.0		o 10.0	2.0	18.4	8.4			* 50.0		- 41.6	- 8.4	22.3	- 19.3
	Feb:		* 7.0		o 9.0	2.0	19.4	10.4			* 30.0		34.3	4.3	17.2	- 17.1
	Mar:		* 10.0		o 15.0	5.0	30.1	15.1			* 70.0		52.6	- 17.4	28.8	- 23.8
	Apr:		30.1		** 49.0	18.9	63.1	14.1			*170.0		104.3	- 65.7	61.5	- 42.8
	May:		134.0		196.0	62.0	213.0	17.0			*450.0		336.2	-113.8	270.0	- 66.2
	June:	28.9	219.0		284.0	65.0	269.0	-15.0			**400.0		290.0	-110.0	234.0	- 56.0
	July:	27.3	70.1	42.8	93.5	23.4	37.3	-56.2			94.7		48.1	- 46.6	24.8	- 23.3
	Aug:	15.2	38.7	23.5	53.1	14.4	28.7	-24.4			89.8		52.7	- 37.1	19.0	- 33.7
	Sept:	27.8	76.2	48.4	98.8	22.6	140.0	41.2			203.0		179.0	- 24.0	117.8	- 61.2
	Oct:		26.7		40.6	13.9	53.4	12.8			81.2		59.7	- 21.5	35.3	- 24.4
	Nov:		16.8		24.9	8.1	33.9	9.0			29.1		39.6	10.5	20.3	- 19.3
1909	Dec:		12.1		24.4	12.3	27.1	2.7			35.5		41.8	6.3	22.8	19.0
Totals			648.7		898.3	249.6	933.4	35.1			1703.3		1279.9	-423.4	873.8	-406.1
1910	Jan:		11.1		19.7	8.6	24.0	4.3			37.4		61.3	23.9	43.5	- 17.8
	Feb:		8.3		16.3	8.0	19.7	3.4			31.3		42.0	10.7	19.7	- 22.3
	Mar:		29.7		39.7	10.0	76.2	36.5			200.0		143.7	- 56.3	92.9	- 50.8
	Apr:		53.6		83.3	29.7	121.0	37.7			305.0		189.9	-115.1	117.0	- 72.9
	May:		143.0		210.0	67.0	207.0	- 3.0			426.0		308.6	-117.4	273.6	- 35.0
	June:	10.4	107.0		144.0	37.0	60.1	-83.9			130.0		63.1	- 66.9	33.1	- 30.0
	July:	10.6	26.8	16.2	38.0	11.2	2.0	-36.0			11.0		1.1	9.9	0.1	- 1.0
	Aug:	6.2	19.9	13.7	30.3	10.4	4.6	-25.7			22.1		7.3	- 14.8	0.0	- 7.3
	Sept:	4.0	14.2	10.2	19.8	5.6	2.6	-17.2			**16.0		3.0	- 13.0	0.1	- 2.9
	Oct:	3.8	14.2	10.4	22.3	8.1	7.4	-14.9			**11.0		0.6	- 10.4	0.0	- 0.6
	Nov:	2.5	11.8	9.3	18.1	6.3	13.6	- 4.5			33.8		8.9	- 24.9	0.0	- 8.9
1910	Dec:		9.4		13.4	4.0	17.8	4.4			32.3		23.2	- 9.1	0.6	- 22.6
Totals			449.0		654.9	205.9	556.0	-98.9			1255.9		852.7	-403.2	580.6	-272.1

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS
UNIT 1000 A FEET

CONTROL STATION

Year. Mon.	WASSON		DEL NORTE		STATE BRIDGE		EMBUDO		BUCKMAN		SAN MARCIAL		EL PASO	
1911: 1912:	30 Mi. Bridge Disch	Dischg	Incr. over 30 Mi. Bridge	Dischg	Incr. over Wasson	Dischg	Incr. over Del N.	Dischg	Incr. over State Bridge	Dischg	Incr. over Embudo	Dischg	Incr. over Buck-man	Dischg	Incr over San Mar
1911: Jan		9.2		15.2	6.0	22.8	7.6			47.7		30.2	- 17.5	9.3	- 20.9
Feb		8.0		13.3	5.3	21.1	7.8			41.5		35.7	- 5.8	11.9	- 23.8
Mar		9.5		20.7	11.2	23.1	2.4			91.6		87.1	- 4.5	43.5	- 43.6
Apr	**10.0	29.0	19.0	57.0	28.0	27.4	- 29.6			150.0		92.4	- 57.6	31.9	- 60.5
May	39.8	110.0	70.2	204.0	94.0	129.0	- 75.0			408.0		303.9	-104.1	247.9	- 56.0
June	28.6	182.0	103.4	287.0	105.0	243.0	- 44.0			340.0		269.6	- 70.4	229.1	- 40.5
July	44.1	114.0	69.9	172.0	58.0	222.0	50.0			350.0		392.4	42.4	435.4	43.0
Aug	11.4	47.6	36.2	59.5	11.9	35.6	- 23.9			69.5		63.2	- 6.3	53.6	- 9.6
Sept	7.6	28.2	20.6	39.7	11.5	41.6	1.9			64.3		39.2	- 25.1	11.6	- 27.6
Oct	**23.0	79.9	56.9	151.0	71.1	193.0	42.0			336.0		312.8	- 23.2	294.5	- 18.3
Nov	* 7.0	24.6	17.6	32.3	7.7	47.6	15.3			132.0		116.5	- 15.5	118.8	2.3
1911: Dec		14.3		25.0	10.7	30.7	5.7			77.5		57.0	- 20.5	62.4	5.4
Totals		656.3		1076.7	420.4	1036.9	- 39.8			2108.1		1800.0	-308.1	1549.9	-250.1
1912: Jan		11.1		20.9	9.8	30.6	9.7			48.6		50.3	1.7	48.6	- 1.7
Feb		9.4		15.7	6.3	28.0	12.3			42.8		44.4	1.6	32.3	- 12.1
Mar		10.1		17.1	7.0	36.7	19.6			94.7		77.4	- 17.3	60.4	- 17.0
Apr	** 4.8	20.2	15.4	34.4	14.2	50.0	15.6			139.0		117.8	- 21.2	96.0	- 21.8
May	47.0	151.0	104.0	229.0	78.0	262.0	33.0			701.0		501.8	-199.2	382.5	-119.3
June	79.7	195.0	115.3	260.0	65.0	306.0	46.0			**700.0		502.1	-197.9	514.3	12.2
July	34.6	84.5	49.9	108.0	23.5	49.5	- 58.5			** 95.0		113.8	18.8	126.0	12.2
Aug	15.0	42.1	27.1	49.9	7.8	17.3	- 32.6			53.0		22.8	- 30.2	30.8	8.0
Sept	5.8	18.5	12.7	26.6	8.1	11.7	- 14.9			38.3		7.6	- 30.7	20.3	12.7
Oct	4.8	17.8	13.0	23.7	5.9	17.4	- 6.3	29.8	12.4	38.2	8.4	9.0	- 29.2	1.2	- 7.8
Nov	0.5	9.1	8.6	15.6	6.5	21.6	6.0	33.6	12.0	38.3	4.7	27.6	- 10.7	18.4	- 9.2
1912: Dec		* 6.0		10.8	4.8	18.4	7.6	27.1	8.7	32.5	5.4	25.0	- 7.5	27.0	2.0
Totals		574.8		811.7	236.9	849.2	+ 37.5			2021.4		1499.6	-521.8	1357.8	-141.8

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS
UNIT 1000 A FEET

Year	Mon.	CONTROL STATION	WASSON		DEL NORTE		STATE BRIDGE		EMBUDO		BUCKMAN		SAN MARCIAL		EL PASO	
			#0 Mi. Bridge Dischg;	Dischg; Incr. over 30 Mi. Bridge	Dischg;	Incr. over Wasson	Dischg;	Incr. over Del N.	Dischg.;	Incr. over State Bridge	Dischg;	Incr. over Embudo	Dischg;	Incr. over Buck-Man	Disegh;	Incr. over San Mar
1913	Jan		* 6.0		o 9.0	3.0	* 15.0	6.0	23.8	8.8	33.8	10.0	23.4	- 10.4	18.8	- 4.6
	Feb		* 5.0		o 8.5	3.5	* 14.0	5.5	25.0	11.0	35.9	10.9	38.1	2.2	35.0	- 3.1
	Mar	0.2	* 7.0	6.8	15.0	8.0	* 25.0	10.0	40.6	20.6	48.9	8.3	35.3	- 13.6	15.6	- 19.7
	Apr	4.0	19.5	15.5	**48.0	28.5	57.1	9.1	80.3	23.2	146.0	65.7	99.1	- 46.9	50.7	- 48.4
	May	31.5	76.9	45.4	144.3	67.4	50.5	-93.8	87.3	36.8	180.0	92.7	129.3	- 50.7	88.6	- 40.7
	June	26.1	72.5	46.4	125.6	53.1	52.7	-72.9	78.0	25;3	112.0	34.0	95.1	- 16.9	43.0	- 52.1
	July	32.7	59.3	16.6	65.7	6.4	4.9	-60.8	17.8	12.9	37.8	20.0	6.9	- 30.9	5-7	- 1.2
	Aug	16.9	34.7	17.8	42.2	7.5	2.3	-39.9	17.0	14.7	16.8	- 0.2	- 0.2	- 16.6	0.0	- 0.22
	Sept	7.7	19.8	12.1	29.2	9.4	4.1	-25.1	18.3	14.2	25.8	7.5	4.9	- 20.9	0,0	- 4.9
	Oct	14.6	* 24.0	9.4	34.6	10.6	23.6	-11.0	44.1	20.5	49.9	5.8	-33.1	- 16.8	6.7	- 26.4
	Nov	**7.0	* 14.0	7.0	22.8	8.8	24.0	1.2	41.6	17.6	49.3	7.7	-35.2	- 14.1	17.1	- 18.1
1913	Dec		* 12.0		18.6	6.6	* 20.0	1.4	25.7	5.7	35.2	9.5	24.9	- 10.3	21.1	- 3.8
Totals			350.7		563.5	212.8	293.2	-270.3	499.5	211.3	771.4	271.9	525.5	-245.9	302.3	- 223.2
1914	Jan		* 9.0		o 15.0	6.0	* 18.0	3.0	29.1	11.1	40.9	11.8	38.1	- 2.8	21.9	- 16.2
	Feb		* 8.0		o 13.0	5.0	* 20.0	7.0	30.7	10.7	42.8	12.1	40.1	- 2.7	23.2	- 16.9
	Mar		* 8.0		15.8	7.8	31.6	15.8	46.9	15.3	90.4	43.5	65.9	- 24.5	38.8	- 27.1
	Apr	* 3.0	18.0	15.0	18.7	0.7	38.5	19.8	76.2	37.7	170.0	93.8	115.7	- 54.3	- 73.0	- 42.7
	May	25.8	105.0	79.2	172.0	67.0	102.0	- 70.0	196.0	94.0	373.0	177.0	266.6	-106.4	259.4	- 7.2
	June	69.7	182.0	112.3	230.0	48.0	155.0	- 75.0	228.0	73.0	259.0	31.0	212.2	- 46.8	227.1	14.9
	July	47.7	96.0	48.3	129.0	33.0	48.4	- 80.6	92.8	44.4	140.0	47.2	159.8	19.8	147.0	- 12.8
	Aug	21.2	51.9	30.7	66.7	14.8	43.7	- 23.0	73.2	29.5	117.0	43.8	86.2	- 30.8	70.1	- 16.1
	Sept	6.0	37.2	31.2	48.6	11.4	48.6	0.0	68.4	19.8	83.3	14.9	33.1	- 50.2	8.2	- 24.9
	Oct	5.8	40.0	34.2	54.2	14.2	45.1	- 9.1	67.0	21.9	87.3	20.3	77.5	- 9.8	68.1	- 9.4
	Nov	4.1	14.1	10.0	16.5	2.4	25.5	9.0	41.1	15.6	56.0	14.9	43.2	- 12.8	51.0	7.8
1914	Dec		6.3		# 14.0	7.7	16.9	2.9	30.6	13.7	36.4	5.8	40.0	3.6	67.5	27.5
Totals			575.5		793.5	218.0	593.3	-200.2	980.0	386.7	1496.1	516.1	1178.4	-317.7	1055.3	-123.1

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS
UNIT 1000 A FEET

Year	Mon.	CONTROL STATION	WASSON		DEL NORTE		STATE BRIDGE		EMBUDO		BUCKMAN		SAN MARCIAL		EL PASO	
		30 Mi Bridge Dischg	Dischg	Incr. over 30 Mi Bridge	Dischg	Incr. over Wasson	Dischg	Incr. over Del N.	Dischg	Incr. over State Bridge	Dischg	Incr. over Embudo	Dischg	Incr. over Buck-man	Dischg	Incr. over San Mar
1915	Jan.	0.9	5.7	4.8	11.1	5.4	18.0	6.9	28.4	10.4	* 38.0	9.6	33.2	- 4.8	39.3	6.1
	Feb.	0.8	5.7	4.9	12.4	6.7	16.0	3.6	29.8	13.8	* 40.0	10.2	38.0	- 2.0	32.0	- 6.0
	Mar.	0.9	7.0	6.1	15.9	8.9	24.5	8.6	41.3	16.8	* 60.0	18.7	53.2	- 6.8	22.2	- 31.0
	Apr.	0.9	16.9	16.0	37.2	20.3	49.0	11.8	102.0	53.0	*301.2	199.2	271.5	- 29.7	37.8	-233.7
	May	13.0	60.8	47.8	106.0	45.2	102.0	- 4.0	256.0	154.0	*470.0	214.0	393.8	- 76.2	143.2	-250.6
	June	61.3	143.0	81.7	206.0	63.0	125.0	- 81.0	262.0	137.0	*410.0	148.0	309.5	-100.5	#183.4	-126.1
	July	50.0	91.6	41.6	116.0	24.4	39.7	- 76.3	65.8	26.1	91.5	25.7	119.9	28.4	# 76.7	- 43.2
	Aug.	24.3	53.7	29.4	62.1	8.4	26.1	- 36.0	45.1	19.0	71.2	26.1	46.2	- 25.0	# 88.3	42.1
	Sept	3.1	32.7	29.6	39.3	6.6	16.7	- 22.6	28.4	11.7	43.4	15.0	17.9	- 25.5	# 59.9	42.0
	Oct.	13.2	26.6	13.4	33.0	6.4	15.6	- 17.4	29.6	14.0	39.9	10.3	13.1	- 26.8	# 19.4	6.3
	Nov.	2.7	11.5	8.8	17.4	5.9	19.5	2.1	30.0	10.5	35.5	5.5	22.7	- 12.8	# 1.9	20.8
	Dec.	1.2	6.5	5.3	12.5	6.0	18.9	6.4	30.6	11.7	38.7	8.1	35.4	- 3.3		
Total		172.3	461.7	289.4	668.9	207.2	471.0	-197.9	949.0	478.0	1639.4	690.4	1354.4	-285.0		
1916	Jan.	3.2	9.2	6.0	17.0	7.8	22.6	5.6	31.3	8.7	44.1	12.8	x 47.8	3.7	# 3.4	- 44.4
	Feb.	2.8	9.3	6.5	16.6	7.3	26.2	9.6	37.0	10.8	49.6	12.6	47.1	- 2.5	# 16.3	- 30.8
	Mar.	5.4	17.5	12.1	34.1	16.6	47.8	13.7	67.0	19.2	194.0	127.0	164.5	- 29.5	# 36.5	-128.0
	Apr.	7.9	28.1	20.2	56.5	28.4	51.5	- 5.0	100.0	48.5	266.0	166.0	233.2	- 32.8	# 53.8	-174.4
	May	29.8	98.4	68.6	181.0	82.6	164.0	- 17.0	371.0	207.0	551.0	180.0	496.9	- 54.1		
	June	24.2	110.0	85.8	196.0	86.0	114.0	- 82.0	179.0	65.0	325.0	146.0	205.6	-119.4		
	July	40.8	86.7	45.9	124.0	37.3	37.7	- 86.3	61.3	23.6	98.5	37.2	45.7	- 52.8		
	Aug.	24.8	69.5	44.7	99.0	29.5	83.6	- 15.4	103.0	19.4	132.0	29.0	97.9	- 34.1		
	Sept	5.6	23.1	17.5	38.1	15.0	25.5	- 12.6	41.3	15.8	50.7	9.4	19.3	- 31.4		
	Oct.	36.1	74.4	38.3	100.0	25.6	94.1	- 5.9	120.0	25.9	31.6	- 88.4	162.3	130.7		
	Nov.	16.7	35.5	18.8	47.8	12.3	65.5	17.7	79.4	13.9	94.8	15.4	88.0	- 6.8		
1916	Dec.	* 4.0	* 17.0	13.0	25.0	8.0	* 25.0	0.0	45.0	15.0	55.6	10.6	49.0	- 6.6		
Totals		201.3	578.7	377.4	935.1	356.4	757.5	-177.6	1235.3	472.8	1892.9	657.6	1657.3	-235.6		

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COMPARATIVE FLOW OF RIO GRANDE RIVER AT VARIOUS STATIONS.
UNIT 1000 A FEET

CONTROL STATION

Year	Mon.		WASSON		DEL NORTE		STATE BRIDGE		EMBUDO		BUCKMAN		SAN MARCIAL		EL PASO	
		30 mi. Bridge Dischg	Dischg	Incr. over 30 Mi Bridge	Dischg	Incr. over Wasson	Dischg	Incr. over Del N.	Dischg	Incr. over State Bridge	Dischg	Incr. over Embudo	Dischg	Incr. over Buck-man	Dischg	Incr. over San Mar
1917	Jan	1.0	* 8.0	7.0	15.0	7.0	* 24.0	9.0	37.6	13.6	42.1	4.5	45.6	3.5 #	64.8	19.2
	Feb	0.3	* 5.0	4.7	10.0	5.0	* 20.0	10.0	33.9	13.9	41.5	7.6	37.9	- 3.6 #	65.7	27.8
	Mar	0.3	* 4.0	3.7	12.0	8.0	* 25.0	13.0	46.4	21.4	64.8	18.4	38.8	- 26.0 #	58.8	20.0
	Apr	0.4	17.0	16.6	37.9	20.9	55.8	17.9	73.4	17.6	163.0	89.6	94.6	- 68.4 #	54.2	- 40.4
	May	9.4	62.7	53.3	114.0	51.3	116.0	2.0	153.0	37.0	312.0	159.0	238.5	- 73.5 #	73.2	- 165.3
	June	109.0	237.0	128.0	359.0	122.0	296.0	- 63.0	298.0	2.0	455.0	157.0	366.9	- 88.1 #	76.2	- 290.7
	July	56.0	122.0	66.0	184.0	62.0	157.0	- 27.0	190.0	33.0	196.0	6.0	174.4	- 21.6 #	141.5	- 32.9
	Aug	21.2	52.4	31.2	65.2	12.8	17.6	- 47.6	34.0	16.4	37.6	3.6	6.1	- 31.5 #	81.1	75.0
	Sept	9.6	25.9	16.3	33.8	7.9	9.5	- 24.3	23.1	13.6	27.8	4.7	7.7	- 20.1 #	77.9	70.2
	Oct	9.1	18.9	9.8	25.2	6.3	12.1	- 13.1	25.7	13.6	24.8	- 0.9	1.0	- 23.8 #	85.1	84.1
	Nov	5.1	11.2	6.1	17.6	6.4	22.4	4.8	35.6	13.2	37.4	1.8	14.5	- 22.9 #	43.8	29.3
1917	Dec	0.4	5.7	5.3	10.8	5.1	22.0	11.2	35.1	13.1	35.2	0.1	28.3	- 6.9 #	65.9	37.6
	Totals	221.8	569.8	348.0	884.5	314.7	777.4	- 107.1	985.8	208.4	1437.2	451.4	1054.3	- 382.9	888.2	- 166.1
1918	Jan	0.5	5.8	5.3	11.7	5.9	17.3	5.6	27.5	10.2	32.7	5.0	28.0	- 40.7 #	2.3	- 25.7
	Feb	0.4	5.0	4.6	10.8	5.8	20.5	9.7	27.9	7.4	32.6	4.9	22.8	- 9.8 #	32.0	9.2
	Mar	0.5	8.4	7.9	16.4	8.0	33.0	16.6	45.1	12.1	67.8	22.7	45.6	- 22.2	48.7	3.1
	Apr	5.7	15.8	10.1	28.7	12.9	15.4	- 13.3	32.9	17.5	71.4	38.5	30.5	- 40.9	48.6	18.1
	May	31.7	70.7	39.0	116.0	45.3	28.1	- 87.9	74.2	46.1	185.0	110.8	117.0	- 68.0	46.4	- 70.6
	June	39.9	88.7	48.8	143.0	54.3	52.2	- 90.8	90.2	38.0	136.0	45.8	67.2	- 68.8	28.6	- 38.6
	July	14.3	41.0	26.7	64.0	23.0	21.1	- 42.9	42.8	21.7	65.5	22.7	22.4	- 43.1	28.3	5.9
	Aug	11.1	41.1	30.0	48.6	7.5	3.2	- 45.4	14.8	11.6	26.4	11.6	1.7	- 24.7	33.9	32.2
	Sept	3.0	23.4	20.4	34.2	10.8	22.5	- 11.7	37.8	15.3	** 30.0	- 7.8	0.0	- 30.0	19.5	19.5
	Oct	4.0	13.9	9.9	22.4	8.5	10.5	- 11.9	26.8	16.3	** 25.0	- 1.8	11.0	- 14.0	33.9	22.9
	Nov	* 3.5	9.0	5.5	15.6	6.6	19.7	4.1	32.1	12.4	** 40.0	7.9	24.2	- 15.8	20.3	- 3.9
1918	Dec	* 0.8	* 7.0	6.2	12.0	5.0	19.7	7.7	35.7	16.0	** 44.5	8.8	39.4	- 5.1	6.4	- 33.0
Totals		115.4	329.8	214.4	523.4	193.6	263.2	- 260.2	487.8	224.6	756.9	269.1	409.8	- 347.1	348.9	- 60.9

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DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF SAN ANTONIO CREEK AT Near ORTIZ.

UNIT OF RUN-OFF Acre feet. DRAINAGE AREA / SQ. MILES

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
1914										500*	250*	0*		
#1915	0	26	215	4540	4960	1540	510	566	298	295				

DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF LOS PINOS CREEK AT ORTIZ, COLORADO - Small flume 2½ miles above Ortiz.

UNIT OF RUN-OFF Acre-feet DRAINAGE AREA 167 SQ. MILES

Altitude 8100 feet.

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
1915	806	878	1460	14000	30500	28600	6270	2740	1170	4500* 1140	1500* 1170	800* 880*	89614	
1916	850*	1060*	1870*	15200	58200	37400	9220	3310	1810	6520	2680*	1790*	139910	
1917#	1070*	710*	1070*	6930*	32500	45700	12100	1980	1180	769	786	680*	105475	
1918#	500*	660*	1500	9100	34400	19300	5120	1430	1110	1030	1230	710*	76090	
1915-1918														
TOTAL	3226	3308	6900	45230	155600	131000	32710	9460	5270	9459	5866	4060		
MEAN	810	830	1480	11310	38900	32800	8180	2360	1320	2360	1470	1020	102750	

From State Engineer's Office.

* Estimated by Dobler in comparison with Conejos.

State Engineer Report 1915-16, page 240.

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DEPARTMENT OF THE INTERIOR
U. S. RECLAMATION SERVICE

RUN-OFF OF CONEJOS ~~CREEK~~ RIVER AT MOGOTE, COLORADO

UNIT OF RUN-OFF ACRE-FEET DRAINAGE AREA 282 SQ. MILES

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
1903				18000	79400	138000	39700	10600	9340	8490				
1904				16800	31300	19000	4680	19400	13900	31700				
1905				17400	94900	132000	32500	13100	5200	4400				
1907			8000* (21-31 5717)	28900	52100	109000	93300	26300	12900	6520	4921	6887		
1908			6000* (15-31 4384	13000	34700	69800	26600	17700	7020	6330	5224			
1909			E	19000	77700	119000	33900	19300	27700	9210	3957	4185		
1910	2945	2578	10427	29900	74900	41800	10900	10400	3810	3870	3511	3689	198730	
1911	3372	2491	4969	21600	85200	123000	70100	20500	17200	[illegible]	15000*	6000*	409432	
1912	4680	3144	5600	13200	114000	103000	38600	9510	3750	5020	3113	4000*	309617	
1913	2644	2444	3443	8930	55600	48700	12100	4120	3870	7380	3154	2200*	154585	
1914	2500*	3000*	6500* (8-31 5970)	17700	58600	80600	28100	18900	17000	13100	4380	2230	252610	
1915	2310	2820	3730	13400	45400	92800	43000	12900	5950	5000	3570	2470	238350	
1916	2360	2970	5230	21700	90400	129000	50200	24000	10800	20400	7500	5000*	369560	
1917	3000*	2000*	3000*	19400	46400	138000	76200	15400	5360	3080	2630	1910	316380	
1918	1400	1850	4870	12900	58400	89300	30100	9900	7140	4070	3380	2000*	225310	
TOTAL	19711	18297	38269	276830	999000	1433000	589980	232030	150940	158470	47340	21871		
MEAN	2820	2610	5470	18460	66600	95530	39330	15470	10060	11230	4300	3560	279400	

Note.- Totals and means apply to all full months of actual discharge record.

* Estimated by Dobler. (For 1915-16 see State Eng. Rept. 1915-1916 page 239
" 1913 " " " " 1913-1914 page 205 Part II

USGS WSP 356 Page 273
TO

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DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF LA JARA CREEK AT CAPULIN.

RIVER 13 mi. above Capulin. Alt. 8800 ft.

UNIT OF RUN-OFF Acre feet. DRAINAGE AREA 73 SQ. MILES

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
1916	* Oct.15-	Mar.16												
		1300		3690	6950	3460	3690	1300	613	658				
# 17	Nov 15-Mar 17	1300		3810	5790	3090	1750	1110	1140	1130	774			
TOTAL				7500	12740	6550	5640	2410	1753	1788				
MEAN				3750	6370	3275	2820	1200	880	900				

From State Engr.Office

* Estimated by Debler.

State Engr.Report 1915-16--Page 237.

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DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF RIO ALAMOSA ~~CIMERR~~ RIVER AT MONTE VISTA, COLO.
1000 feet below TERRACE RES. DAM

UNIT OF RUN-OFF ACRE-FEET DRAINAGE AREA 120 SQ. MILES
Altitude 8400 feet above sea level.

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
1909				*8000 (18-30 6000)	29200	37600	11200	7000*	3000*	3870	2900	6000		
1910	(1-16 2260)		(8-31 4720)	11400	29000	18900	5770	6640	1740	1200* (1-20 992)				
1911				7200	28600	40700	21400	7380	7200	18400				
1912			3380	4120	33600	33400	21800	10500	3180	*2100 (1-22 1800)	2600			
1913														
1914														
1915				2320	15000	39500	17700	5710	2980	2260				
1916														
✓1917		955	549	1230	6640	58100	36000	10600	2790	1410	756	131		
✓1918			2060	3390	18800	24900	9530 (1-22 3960)							
TOTAL														
MEAN														

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✓ From State Engineer's Office

* From State Engineer's report 1915-1916 Page 237. * Estimate by Debler USGS WSP 358 Page

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DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF ALAMOSA ~~CREEK~~ RIVER AT ABOVE TERRACE RES.

UNIT OF RUN-OFF ACRE-FEET DRAINAGE AREA 102 SQ. MILES

Altitude 8600 feet above sea level.

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
+1915				6070	17600	34900	14500	4880	2520	1900				
+1916				8630	32500	35500	13500	9530	3830	5760				
+1917			1240	5340	18800	25600	28500	7320	2890	1270	756			
+1918			2060	3390	18800	24300	10200	4050	3500*	1500 *				
Total				23430	87700	120300	66700	25780	12740	10430				
Mean				5860	21900	30100	16700	6440	3180	2610				

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+ From State Engineer's Office

* Estimated by Dobler.

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DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF So Fork of RIO GRANDE ~~CREEK~~ RIVER AT SOUTH FORK

UNIT OF RUN-OFF Acre feet. DRAINAGE AREA 228 SQ. MILES

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
#1910								3640	2418	3588	2941			
#1911	2228	1851	4003	15461	50259	71933	41363	10421	8614	35000°	8390	6545		
# 12	3600	2876	4195	8769	56972	64672	19312	5569	3219	4583	5176	4000*		
# 13	1955	2138	2619	17197	36892	32965	7133	3528	4641	5534	4165	3500°		
# 14	3000*	3000*	6000°	11000	37500	49300	17400	7900	8890	12400	4510	2140		
# 15	2040	3300	4990	11800	27900	56100	18300	6760	3860	3500	2650	2480	145680	
# 16	3060	3070	7870	18900	53100	73200	27100	12700	8570	18600	8000*	6000*		
# 17	5000*	4000*	3000*	12600	31400	100000	46500	9720	5110	3220	2760	2000		
# 18	1930	1850	4330	8870	29400	42700	12800	6150	5490	2820	3500	3000*	122840	
1911-1918 Inc.														
TOTAL	22813	22085	37007	104597	323423	490870	189908	62848	48394	85657	39151	29665		
MEAN	2850	2760	4640	13070	40430	61360	23740	7860	6050	10710	4890	3710	182070	

From State Eng. Office.

o Record extended by Debler.

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DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF SAGUACHE (Av. Elev. 10000) CREEK AT SAGUACHE. COLORADO.
RIVER Damsite Stark-Hagadorn Irrig.Co.

UNIT OF RUN-OFF ... Altitude 7800 ft above sea level. DRAINAGE AREA 565 SQ. MILES

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
1910								7-31 2560	2600	2570				
11			*3660	4120	8790	12900	13800	7990	3770	6640	* 2850			
12				4480	16600	14000	8170	7250	4000*					
13														
° 14						16500	10900	6760	3590	3140	1860	1020		
◆ 15	1350	1450	2630	7080	13600	14000	5700	3650	3040	2530	2160	1970	59160	
◆ 16	1640	2090	3090	3430	11300	11500	6580	9900	4180	4050	2790	2000#	62550	
# 17	1500#	1400#	2180	4610	11500	20500	11100	4490	2790	2590	2150	1580	66390	
# 18	1600	1690	2450	2800	8420	9160	5980	4470	4670	2910	2730	2500#	49380	
1915-1918														
TOTAL	6090	6630	10350	17920	44820	55160	29360	22510	14680	12080	9830	8050		
MEAN	1520	1660	2590	4480	11200	13790	7340	5630	3670	3020	2460	2010	59370	

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* Estimated. ° State Engr. Report 1913-14 Part II Page 202. # From State Engr. Office.
◆ From State Engineers report 1915-16, Page 234, #State Engrs. Office Book 10. U. S.G.S.W.P.358. Page 355
Estimated by Debler.

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DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF KERBER CREEK AT VILLA GROVE, COLORADO.
~~RIVER~~ six mi. above V.G. Sec 19, T 46 N R 9 E.

UNIT OF RUN-OFF Acre feet. DRAINAGE AREA 80 SQ. MILES

YEAR.	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
1911										18-31 387	904	416		
1912	246	282	678	1200	5250	4010								
TOTAL														
MEAN														

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DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF SAN LUIS CREEK AT VILLA GROVE, COLORADO.
RIVER Opposite V.G.P.O. below mouth of Kerber Creek

UNIT OF RUN-OFF Acre feet. DRAINAGE AREA 218 SQ. MILES

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
									8-30					
1910									101	137	94			
1911								908	760	1350	734			
1912					5640	4470	1630	1290	869					
TOTAL														
MEAN														

U.S.G.S. WSP. 358. Page 349.

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DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF No. Crestone. So. Crestone. Willow) Creek ~~Canyon~~ ~~River~~ AT Canon Mouths.
Spanish, Cottonwood, Deadman)

Unit of run-off - Acre feet.

~~POINT OF RUN-OFF~~ Altitud , 8400 ft above sea level. DRAINAGE AREA 43 SQ. MILES

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
1909	500*	500*	500*	1785	3443	9640	3935	6518	7260	3074	600*	445*	38200	
1915	500*	500*	500*	952	5042	12317	6731	2890	595	615	600*	458*	33700	
1913					2353	4633	3254	1044	1663	1725			30800**	
1914					6323	6356	4665	3806	1010				21700**	
TOTAL	1000	1000	1000	2737	8485	21957	12666	9408	7855	3689	1200	903		
MEAN	500	500	500	1370	4240	10980	6330	4700	3930	1840	600	450	26000	

1909 & 1915 Data from discharge measurements and data furnished by R.I.Meeker.

1913 & 1914 From estimates of stream discharge made weekly by Water Commissioner, & not considered reliable. 1909- 1915.

** Yearly discharge based on percentage of run off for some months in mean year, with 20% added for Deadman Cr. which was not included in base figures.

* Record extended by Debler.

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DEPARTMENT OF THE INTERIOR
U. S. RECLAMATION SERVICE

RUN-OFF OF UTE CREEK AT 1 mi. No. of FT. GARLAND. COLORADO.
RIVER

Unit of run-off - acre feet.

~~UNIT OF RUN-OFF~~ Altitude, 8100 ft above sea level. DRAINAGE AREA SQ. MILES

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
1907							2435	1145	1590	1220	1000	700		
1908	430	600	650	1080	1800	2260	2120	1445	690	745	740	420		
1909	309	306	560	1042	3255	4383	2036	1514	2455	915	840	E 600		
1908-1909.														
TOTAL	739	906	1210	2122	5055	6643	4156	2959	3145	1660	1580	1020	15590	
MEAN	370	450	600	1060	2530	3320	2080	1480	1570	830	790	510		

E- Estimated .

1907-1909 Data furnished by R.I.Meeker.

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DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF SANGRE DE CRISTO CREEK ~~River~~ AT 1 Mile East of Ft.Garland.

UNIT OF RUN-OFF-A.F. Altitude 7900 ft above sea level DRAINAGE AREA ..... SQ. MILES

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
1907							1180	710	465	1245	485	970		
1908	1160	8.30	1100	1985	1870	895	2145	355	70	205	355	305		
1909	337	537	656	1110	1415	995	700	925	571	420	250	250[E]		
1916	See Ute Creek.													
1908-1909														
TOTAL	1497	1367	1756	3095	3285	1890	2845	1280	641	625	605	555		
MEAN	750	680	880	1550	1640	940	1420	640	320	310	300	280	9710	

E-

1907-1909 Data furnished by R.I.Meeker.

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DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF TRINCHERA CREEK / RIVER AT 3 mi East, 2 mi South, near Ft Garland.

UNIT OF RUN-OFF Acre feet. Altitude- 8200 ft above sea level. DRAINAGE AREA Sq. MILES

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
1907							1805	1185	1065	890	845	820		
1908	445	950	650	2155	1475	2225	1450	1400	845	575	450	375		
1909	375	508	807	947	1475	2655	1541	1490	955	800	670	E 580		
1908-1909														
TOTAL	820	1458	1457	3102	2950	4860	2991	2890	1800	1375	1120	905		
MEAN	410	730	730	1550	1480	2430	1500	1440	900	690	560	450	12870	

E- Estimated.

1907-1909 Furnished by R.I.Meeker.

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DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF CULEBRA CREEK ~~RIVER~~ AT SAN LUIS

UNIT OF RUN-OFF Acre feet. DRAINAGE AREA 260 SQ. MILES

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
# 1909					8707	11459	7586	7938	8522	4962	3031	1830	54035	
# 1910	2406	2093	6079	7709	11780	6700	1832	3272	2165	2198	2349	1796	50379	
# 11	2252	1926	2440	2258	4706	3452	4585	3613	2019	4380	2544	2978	37153	
# 12	2588	2669	2298	2721	9999	11646	9566	4010	2303	2720	2387	2493	55400	
# 13	2204	1969	2459	2412	8610	9994	9117	4224	1289	2475	2378	1818	46949	
# 14	1740	1632	2207	1674	4223	15752	8835	4613	2507	2864	2936	2597	51580	
# 15	2520	2280	2280	2560	8920	19900	14200	5040	2370	2450	2630	2610	67770	
TOTAL	13710	12569	17763	19334	56945	78903	55721	32710	21175	22059	18255	16122		
MEAN	2280	2090	2960	3220	8140	11270	7960	4670	3020	3150	2610	2590	53960	

From State Eng. Office.

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DEPARTMENT OF THE INTERIOR

U. S. RECLAMATION SERVICE

RUN-OFF OF COSTILLA CREEK AT N.MEX.

~~RIVER~~

A mile above mouth on Guesta Road.

UNIT OF RUN-OFF Acre feet. DRAINAGE AREA SQ. MILES

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% MEAN
1912				27-30 684	11400	10200	1-7 454							
TOTAL														
MEAN														

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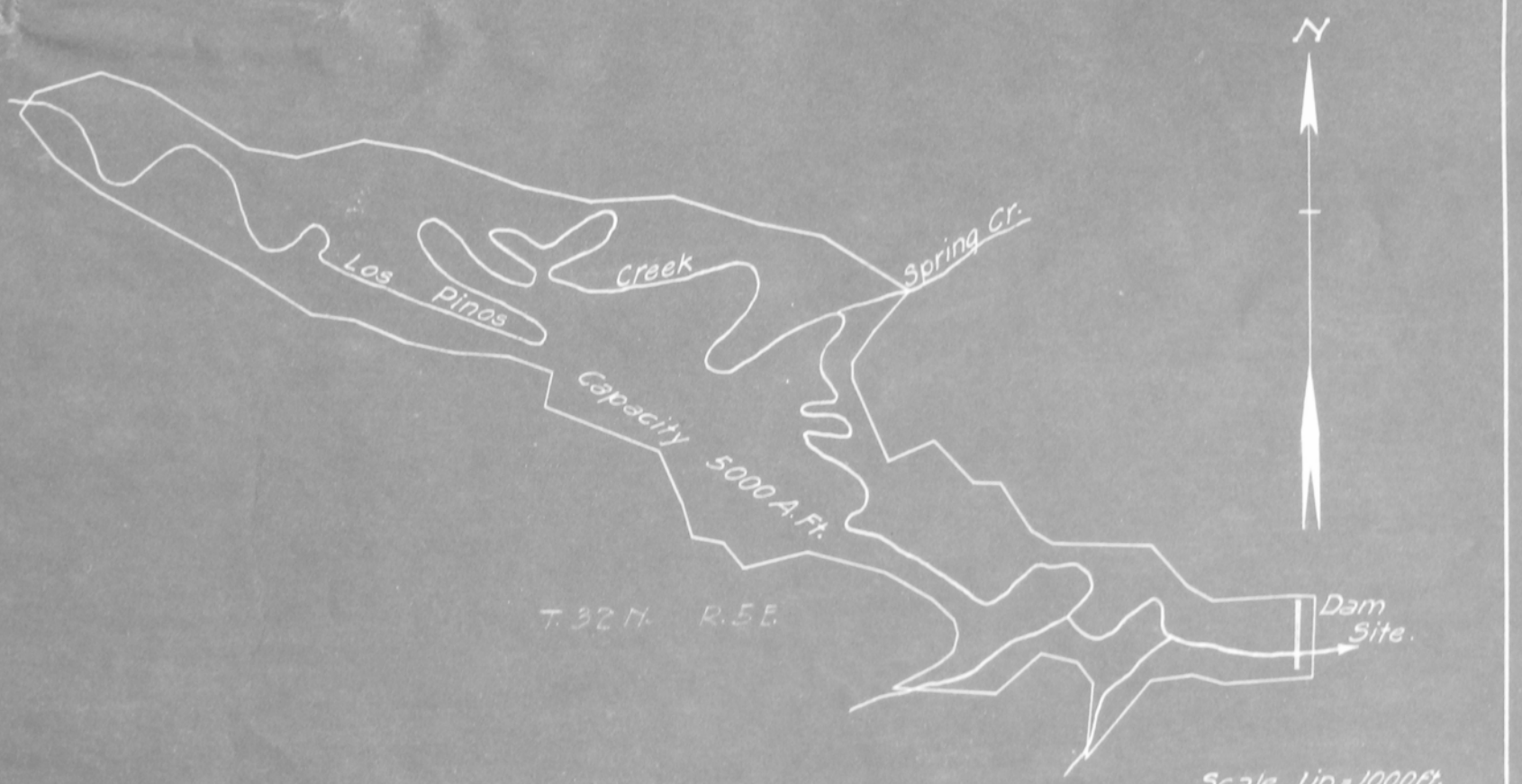

DEPARTMENT OF THE INTERIOR.
UNITED STATES RECLAMATION SERVICE.

SECONDARY PROJECTS
RIO GRANDE WATERSUPPLY
LOS PINOS RESERVOIR

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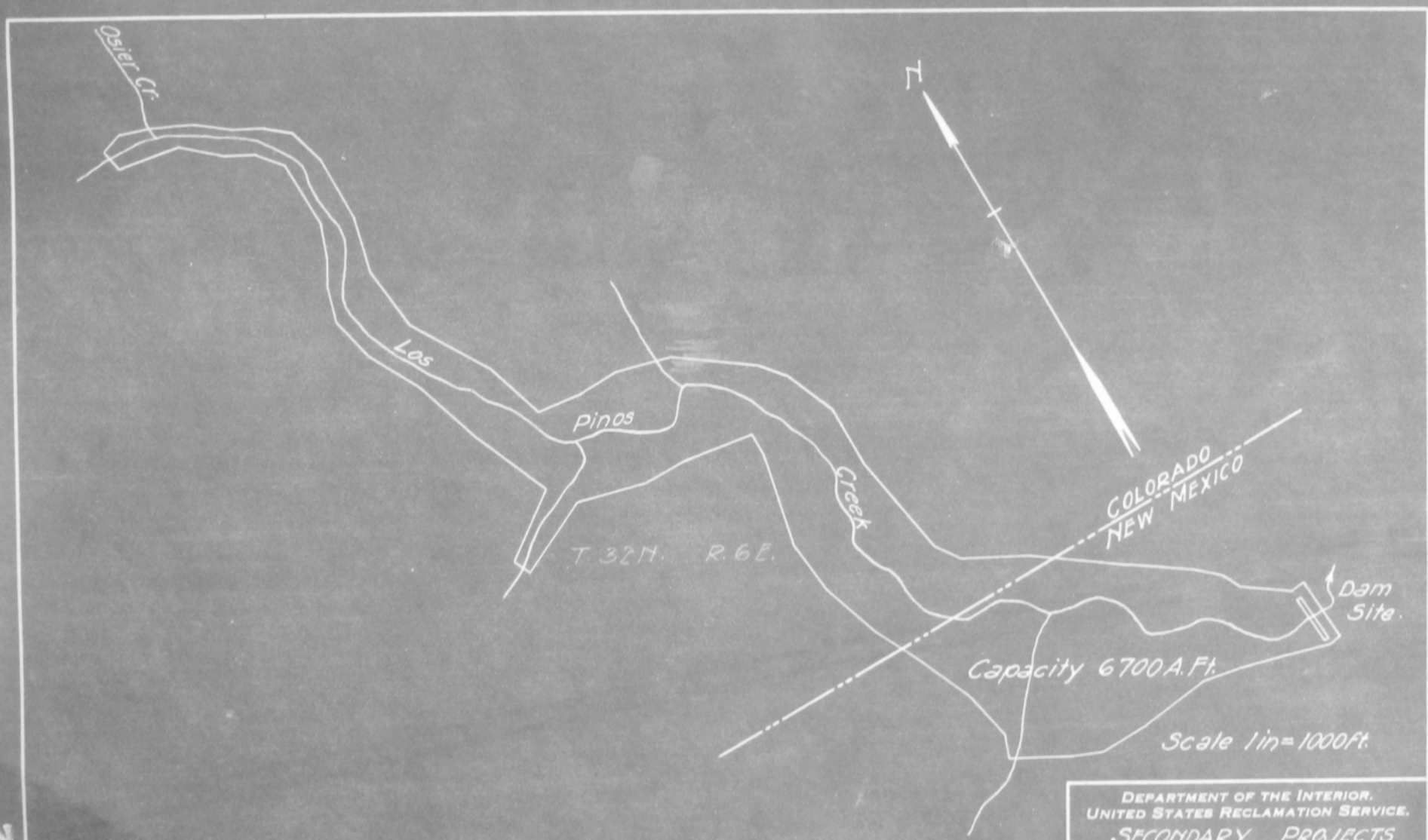

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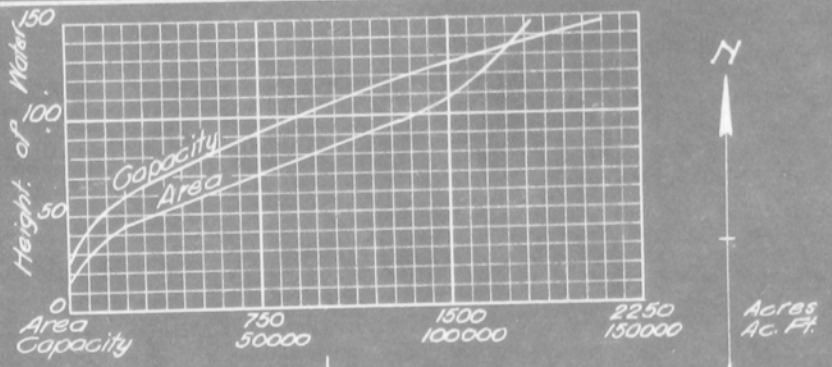
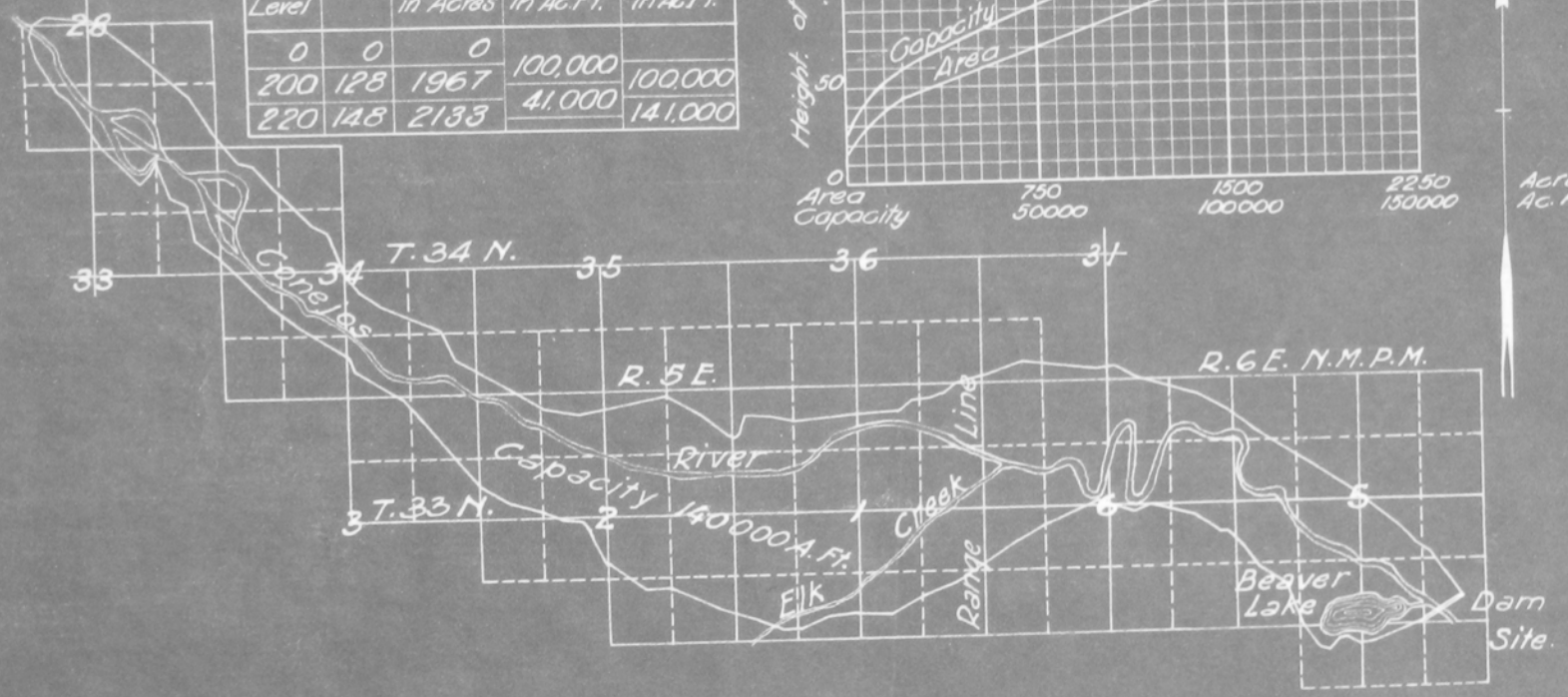
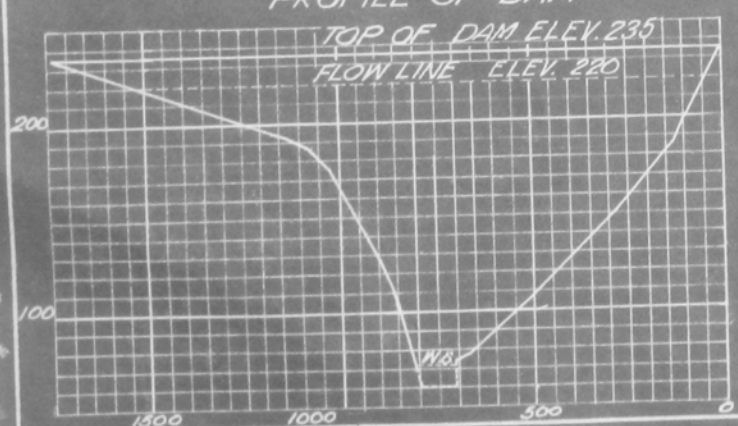
CAPACITY TABLE

Elev. of Water Level	Ht. of Water	Area of Water Surf. in Acres	Increment of Capacity in Ac. Ft.	Total Capacity in Ac. Ft.
0	0	0		
200	128	1967	100,000	100,000
220	148	2133	41,000	141,000





PROFILE OF DAM



Scale:
Vert. 1 in = 100 ft.
Hor. 1 in = 500 ft.

Scale 1 in. = 4000 ft.

DEPARTMENT OF THE INTERIOR.
UNITED STATES RECLAMATION SERVICE.
SECONDARY PROJECTS
RIO GRANDE WATERSUPPLY
CONEJOS RESERVOIR

DRAWN: R.E.E. RECOMMENDED:
CHECKED: APPROVED:

240 Vol

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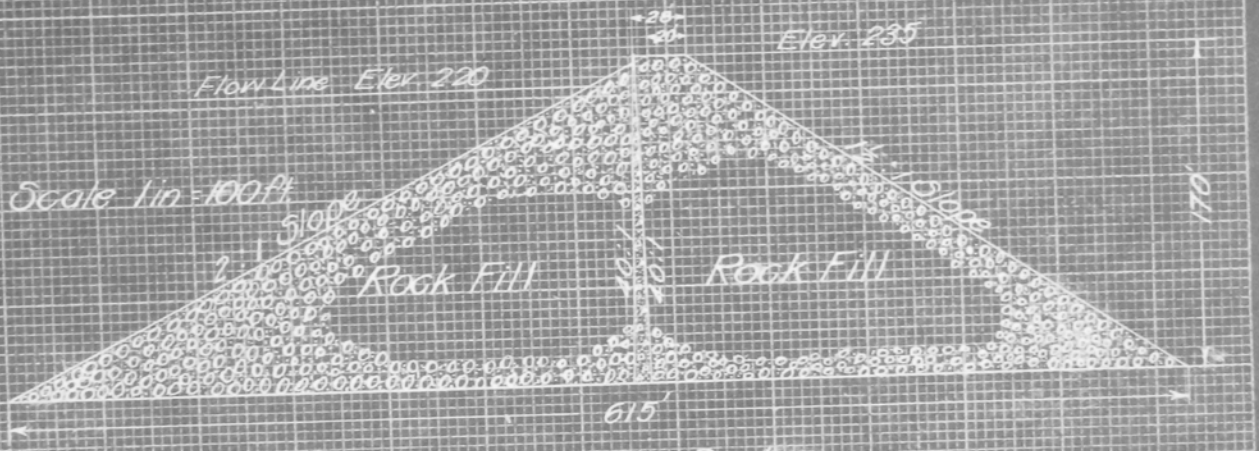
DAM FOR CONEJOS RESERVOIR



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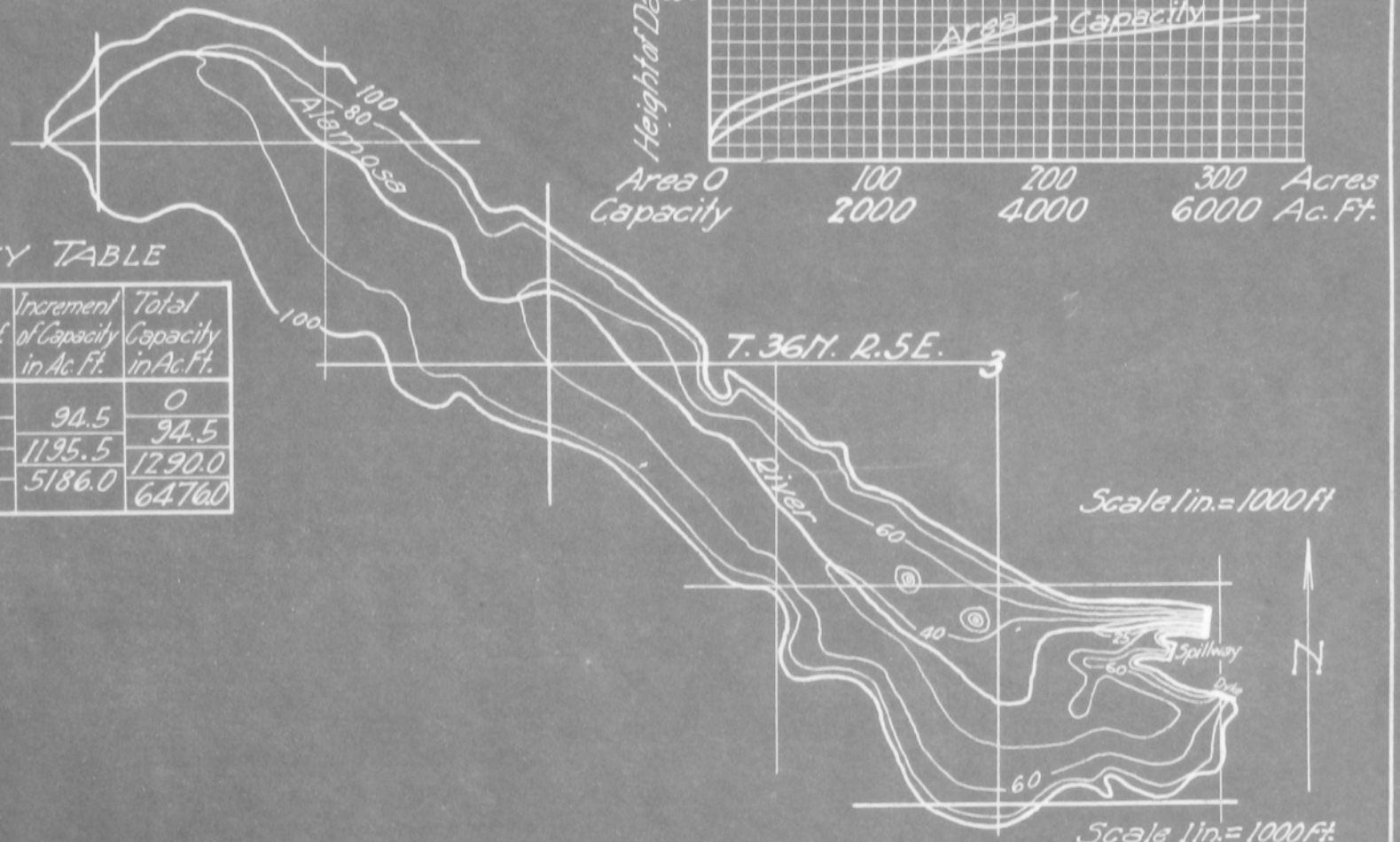
CONEJOS RESERVOIR

Maximum Height of dam 170 feet - Capacity 140,000 acre feet

Estimate is made for dam to be built of a mixture of earth and rock, the only material available.

Right of way - 480 acres at $50			$ 20,000.
Dam			
Excavation, Core Wall,	7500 c.y. @$1.00	$ 7,500	
Stripping	29300 " @ .75	22,000	
Embankment	985000 " @ 1.50	1,477,500	
Core wall 1:2:4 reinforced concrete	21300 c.y. @30.00	639,000	
			2,146,000.
Spillway - 6,000 second feet			
Excavation - 13,000 c.y. at $1.00		13,000	
Reinforced concrete 500 c.y. @ $30.		15,000	
			28,000.
Cylinder Gates & Mechanisms, 2,000 sec.ft.			180,000.
			$ 2,374,000.
Overhead & Contingencies - 35%			830,900.
Total (140,000 acre feet at $22.88)- - - - - - -			$3,204,900.



CAPACITY TABLE

Elev. of Water Level	Height of Dam	Area of Water Surf. in Ac.	Increment of Capacity in Ac. Ft.	Total Capacity in Ac. Ft.
8925	0	0		0
			94.5	
8940	25	21.6		94.5
			1195.5	
8965	50	91.6		1290.0
			5186.0	
8990	85	201.5		6476.0

DEPARTMENT OF THE INTERIOR.
UNITED STATES RECLAMATION SERVICE.

SECONDARY PROJECTS
RIO GRANDE WATERSUPPLY
HARROWS RESERVOIR

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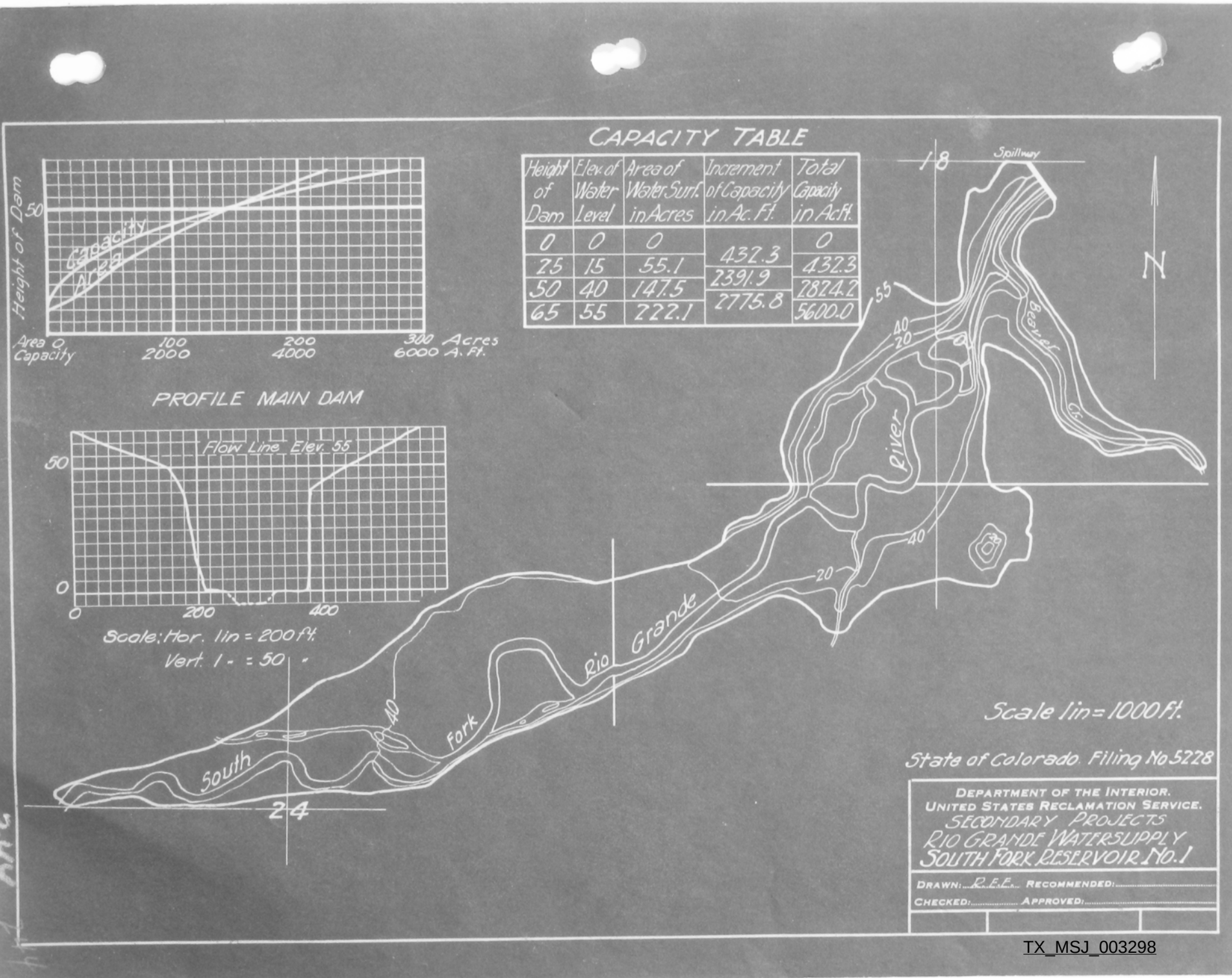

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SOUTH FORK RESERVOIR



Maximum Section

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SOUTH FORK RESERVOIR

ON SOUTH FORK OF RIO GRANDE RIVER.

Height of dam - maximum - 70 feet Capacity 5,600 acre feet.

Dam -				
Cut-off trench, excavation	2900 c.y.	@$1	$2,900.	
Stripping, 2 feet	5800 "	@ .75	4,350.	
Puddle trench	2900 "	@ 1.00	2,900.	
Embankment	91000 "	@ .75	68,250.	
Riprap, 2' thick	3900 "	@ 2.00	7,800.	
				$ 86,200
Spillway, 4,000 second feet				30,000
Outlet - 300 sec.ft., estimated by comparison with other structures				36,000
				$ 152,200
Add 35% for Overhead & Contingencies - - - - - - - - - - - -				53,270
Total (5600 acre feet at $36.69) - - - - - - - - - -				$205,470

TX_MSJ_003300

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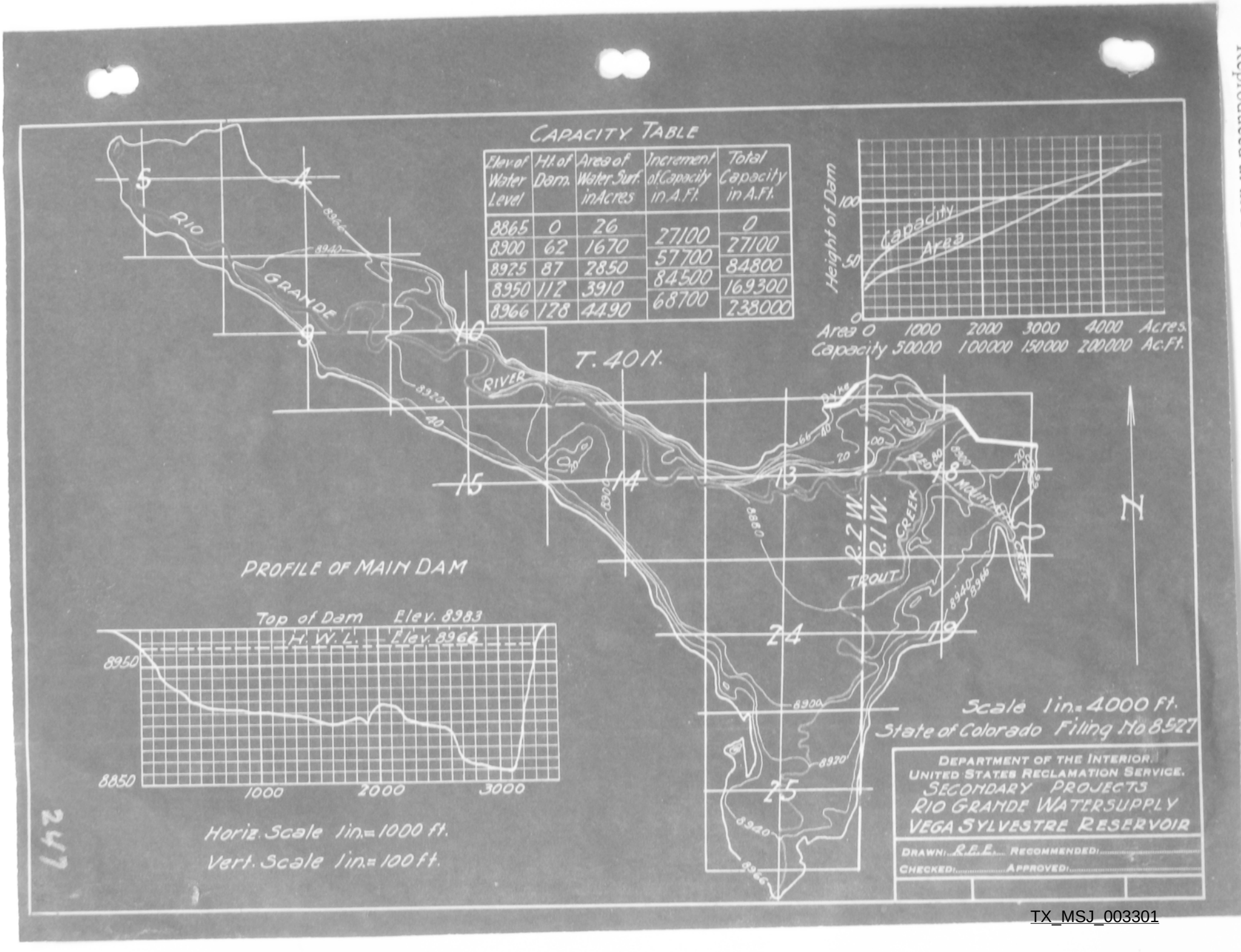

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VEGA SYLVESTER RESERVOIR



Maximum Section

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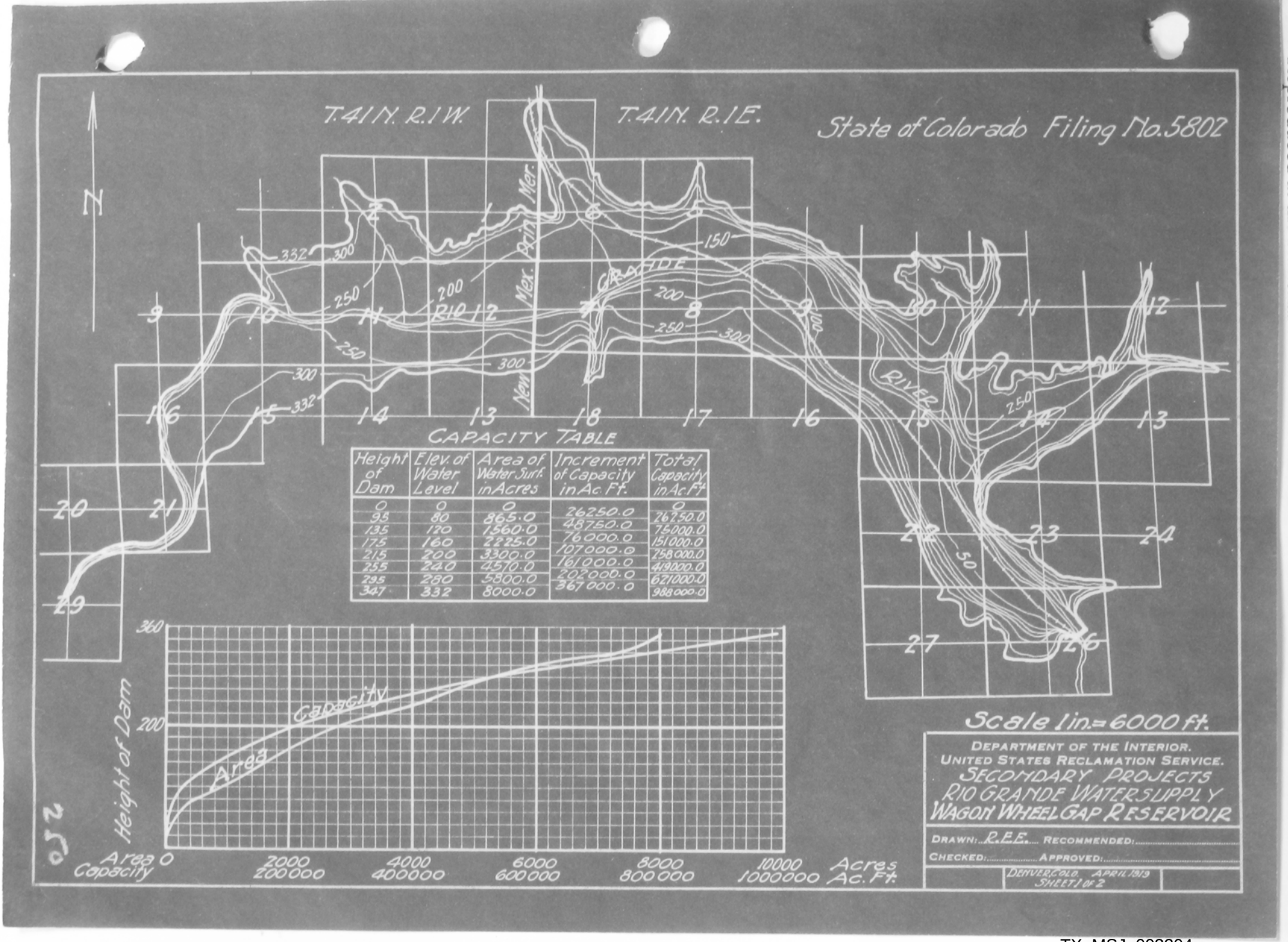
VEGA SYLVESTER RESERVOIR

Maximum height of dam - 128 feet - Capacity 238,000 A.F.

Earthfill dam.

Right of way - 2,000 acres at $50					$ 10,000.
Dam - Excavation, cut-off trench	30,600	c.y	@$ 1	30,600	
Stripping 2' deep,	96,200	"	@ 75¢	72,200	
Embankment earth	2,296,000	"	@ 75¢	1,722,000	
Puddle trench	30,600	"	@$1.	30,600	
Riprap	63,000	"	@ 2.	126,000	
					1,981,000.
Spillway - 10,000 second feet					50,000.
Cylinder gates & mechanism, 2,000 s.f.					180,000.
Outlet Tunnel - 630 feet in length					
Rock excavation - 6,100 c.y. @ $8.				48,800	
Concrete lining (1:2:4 plain & reinforced) 1,400 c.y. @ $20.				28,000	77,000.
					2,298,000.
Overhead & Contingencies - 35%					804,000.
Total (238,000 acre feet at $13.03)					$3,102,000.

TX_MSJ_003303



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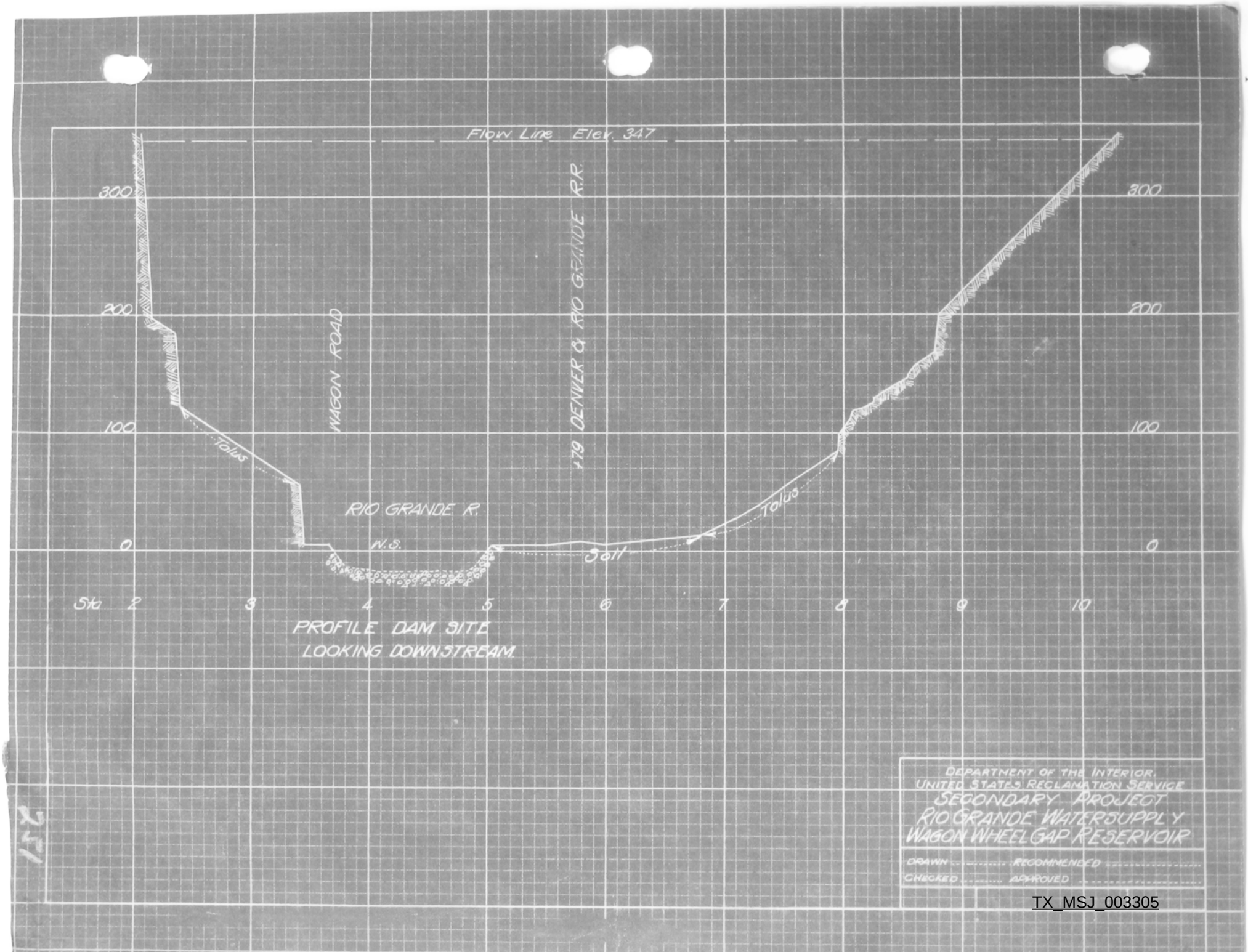

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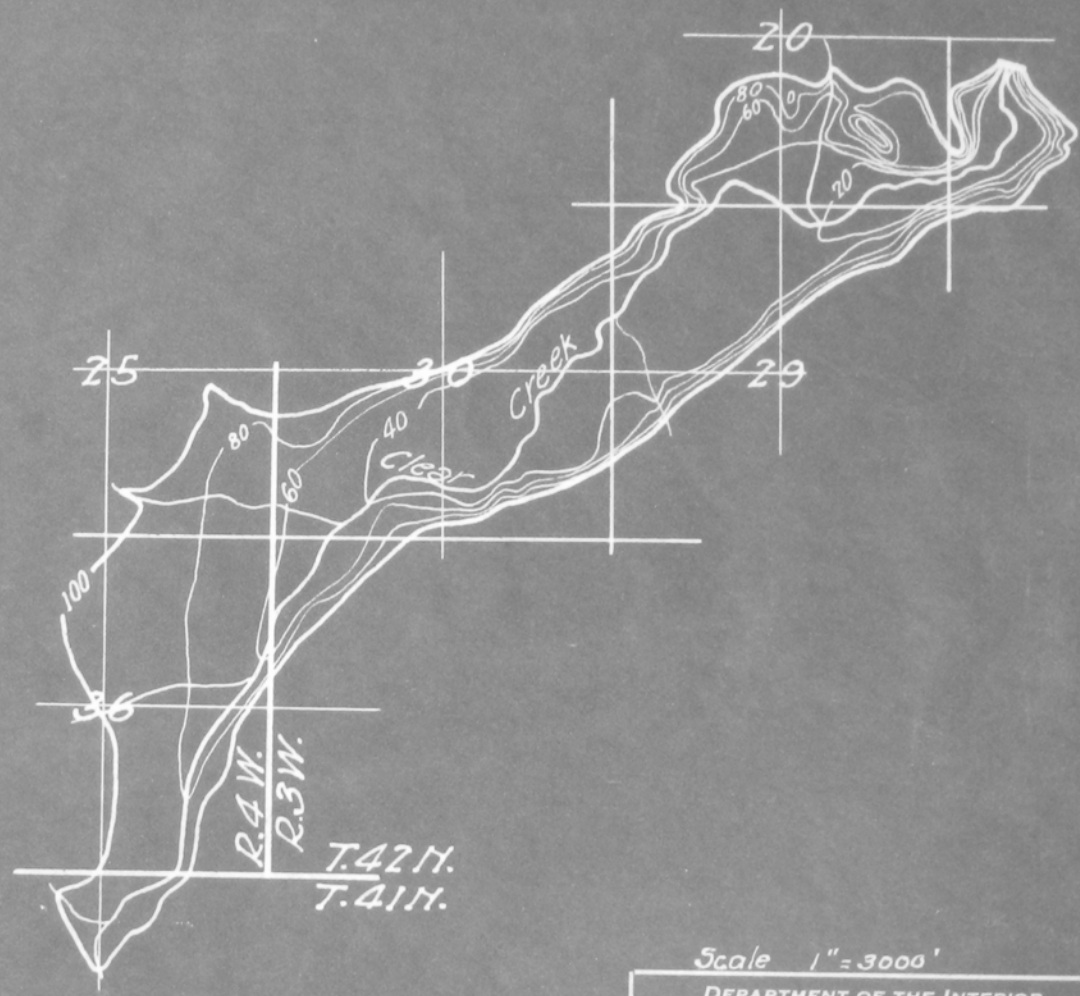

Scale 1" = 3000'

DEPARTMENT OF THE INTERIOR.
UNITED STATES RECLAMATION SERVICE.
SECONDARY PROJECTS
RIO GRANDE WATERSUPPLY
CONTINENTAL RESERVOIR

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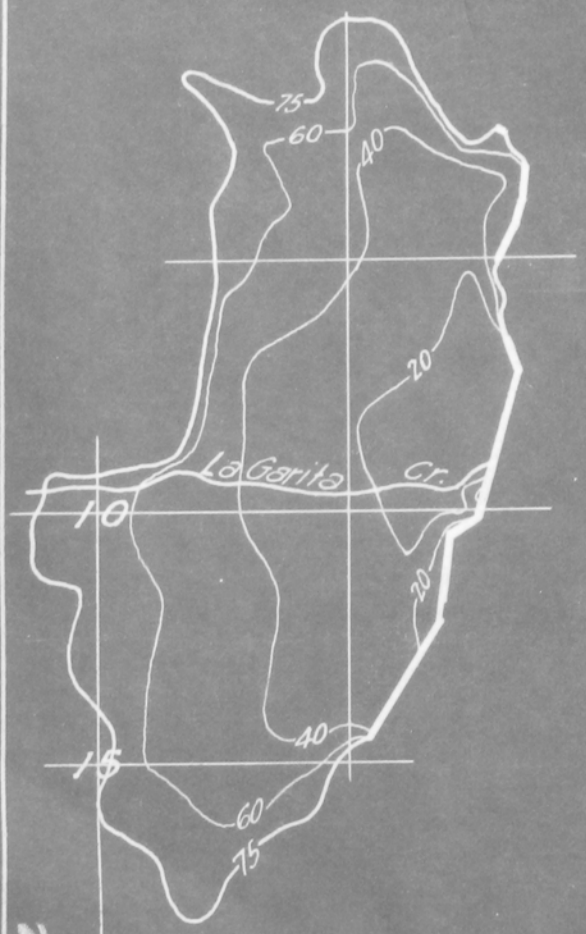

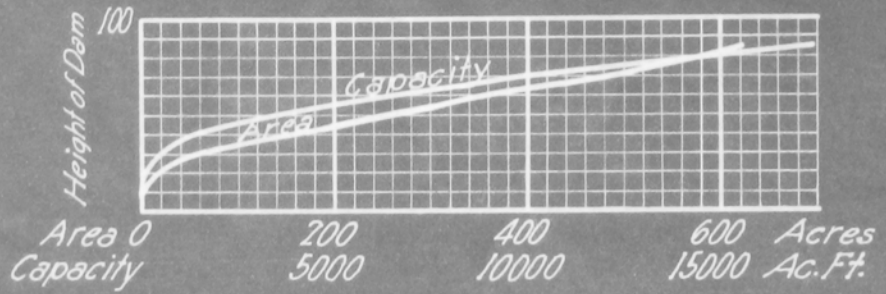



CAPACITY TABLE

Height of Dam.	Elev. of Water Level.	Area of Water Surf. in Acres.	Increment of Capacity in Ac. Ft.	Total Capacity in Ac. Ft.
0	0	0		0
			177.0	
25	15	34.0		177.0
			3333.0	
50	40	262.0		3510.0
			13790.0	
85	75	620.0		17300

State of Colorado Filing No 5280

DEPARTMENT OF THE INTERIOR.
UNITED STATES RECLAMATION SERVICE.
SECONDARY PROJECTS
RIO GRANDE WATERSUPPLY
LA GARITA RESERVOIR

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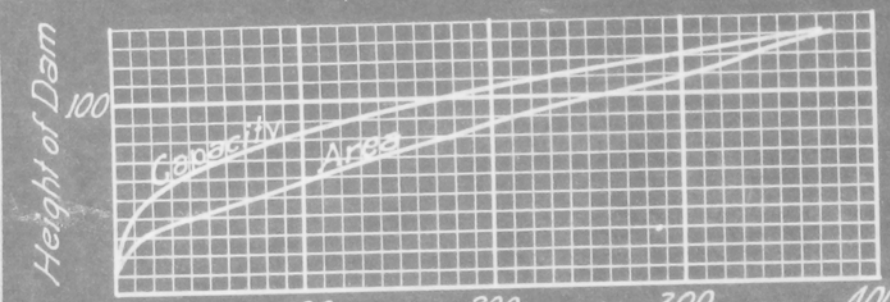
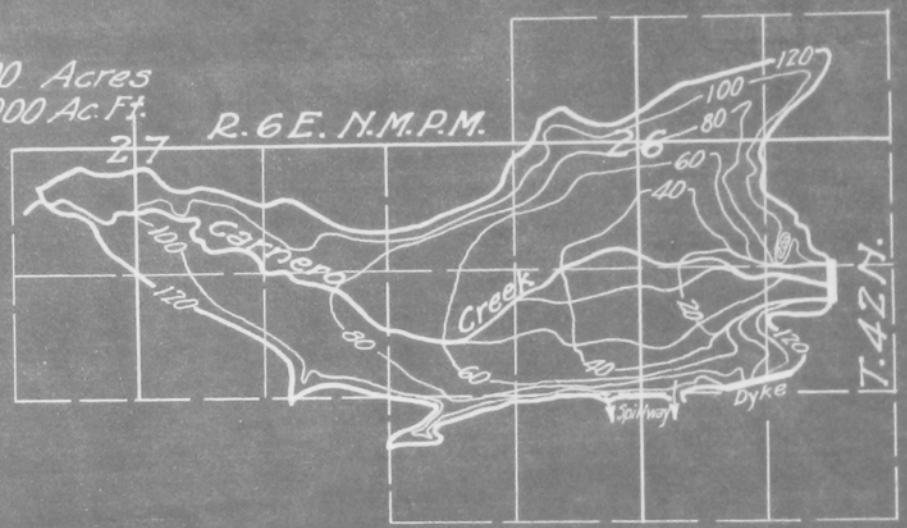


CAPACITY TABLE

Height of Dam	Elev. of Water Level	Area of Water Surf. in Acres.	Increment of Capacity in A.Ft.	Total Capacity in A.Ft.
0	0	0	966.0	0
50	40	75.0	7794.0	966.0
100	90	262.0	9790.0	8760.0
130	120	376.0		18550.0



Scale 1 in. = 2000 Ft.

State of Colorado Filing No. 7761

DEPARTMENT OF THE INTERIOR.
UNITED STATES RECLAMATION SERVICE.
SECONDARY PROJECTS
RIO GRANDE WATERSUPPLY
DEVILS GATE RESERVOIR

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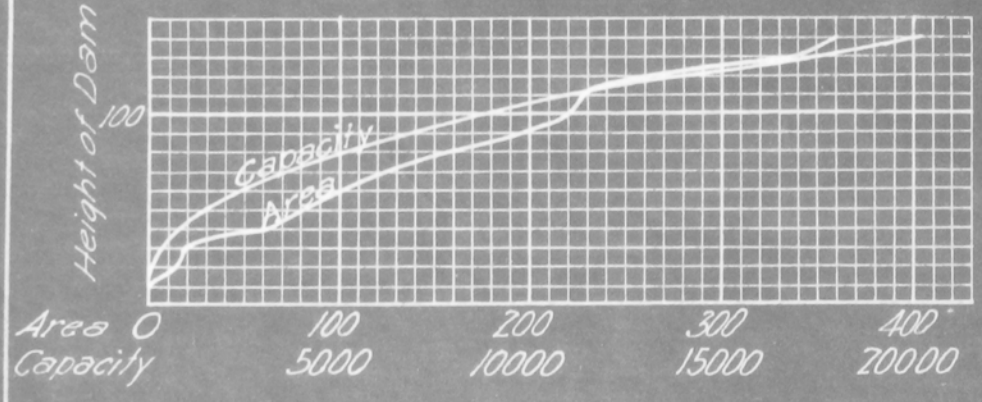
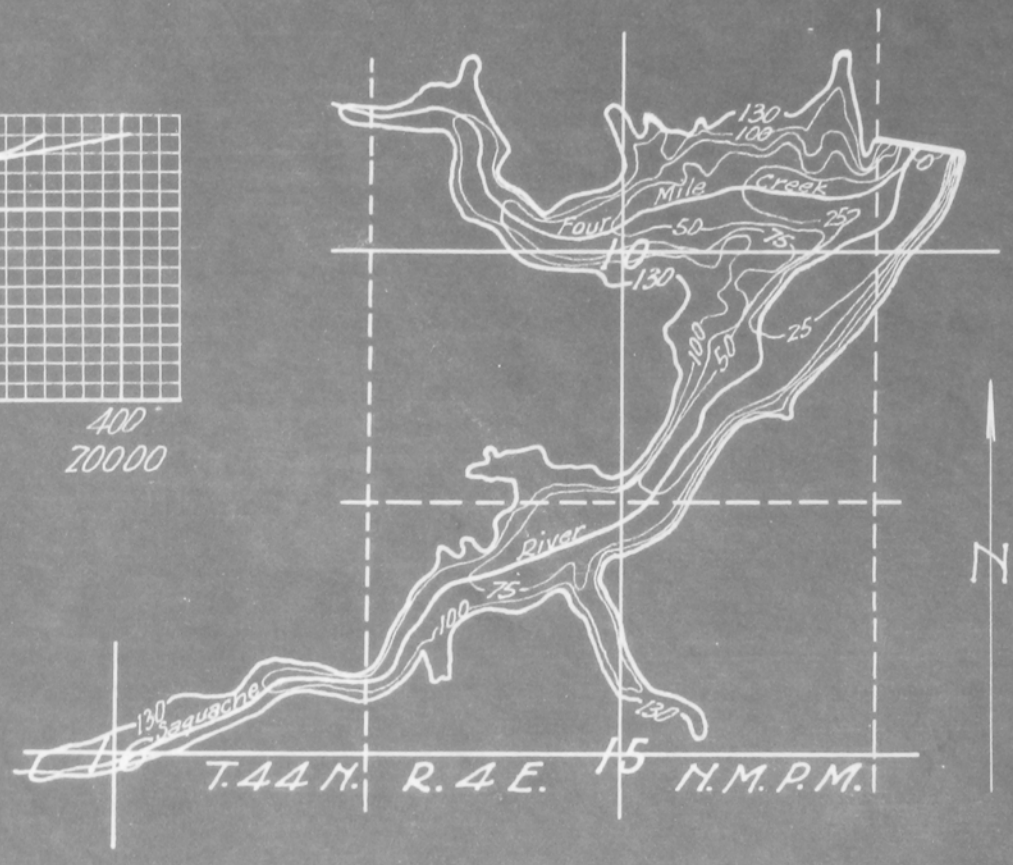


CAPACITY TABLE

Height of Dam	Elev. of Water Level	Area of Water Surf. in Acres	Increment of Capacity in A. Ft.	Total Capacity in A. Ft.
0	0	0	1480	0
50	40	84.0	7490	1480
100	90	222.0	11230	8970
140	130	360.0		20200



Scale 1 in. = 2000 ft.

State of Colorado Filing No. 6173

DEPARTMENT OF THE INTERIOR.
UNITED STATES RECLAMATION SERVICE.
SECONDARY PROJECTS
RIO GRANDE WATERSUPPLY
STARK-HAGADORN RESERVOIR

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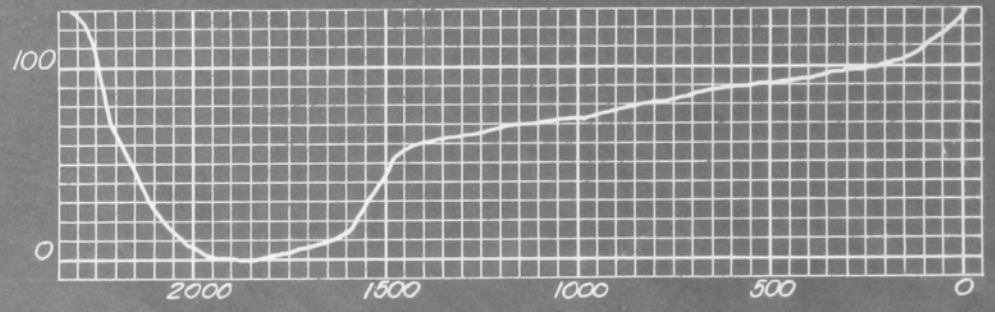
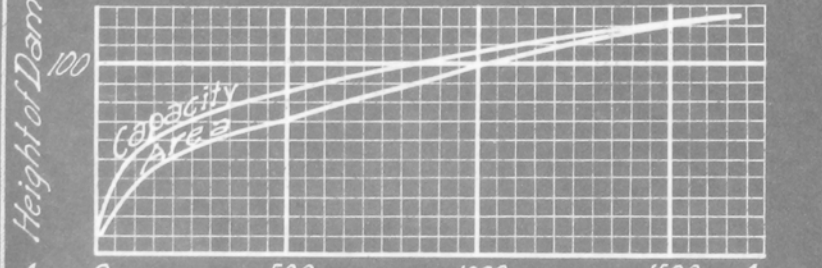
CAPACITY TABLE

Height of Dam	Elev. of Water Level	Area of Water Surf. in Acres	Increment of Capacity in Ac. Ft.	Total Capacity in Ac. Ft.
0	0	0		0
			3280.0	
50	40	186.0		3280.0
			29620.0	
100	90	1035.0		32900.0
			33200.0	
125	115	1680.0		66100.0

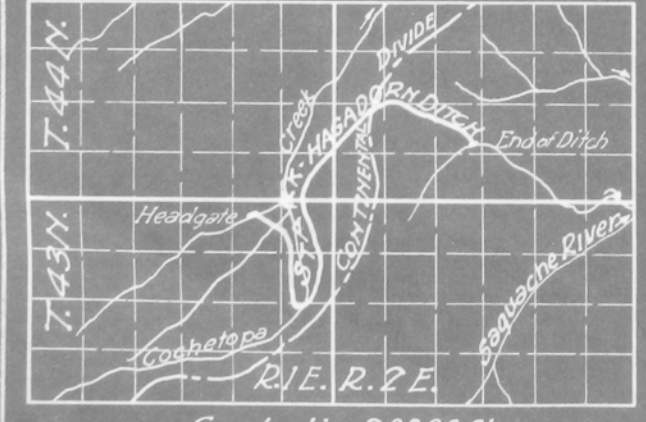
PROFILE OF MAIN DAM



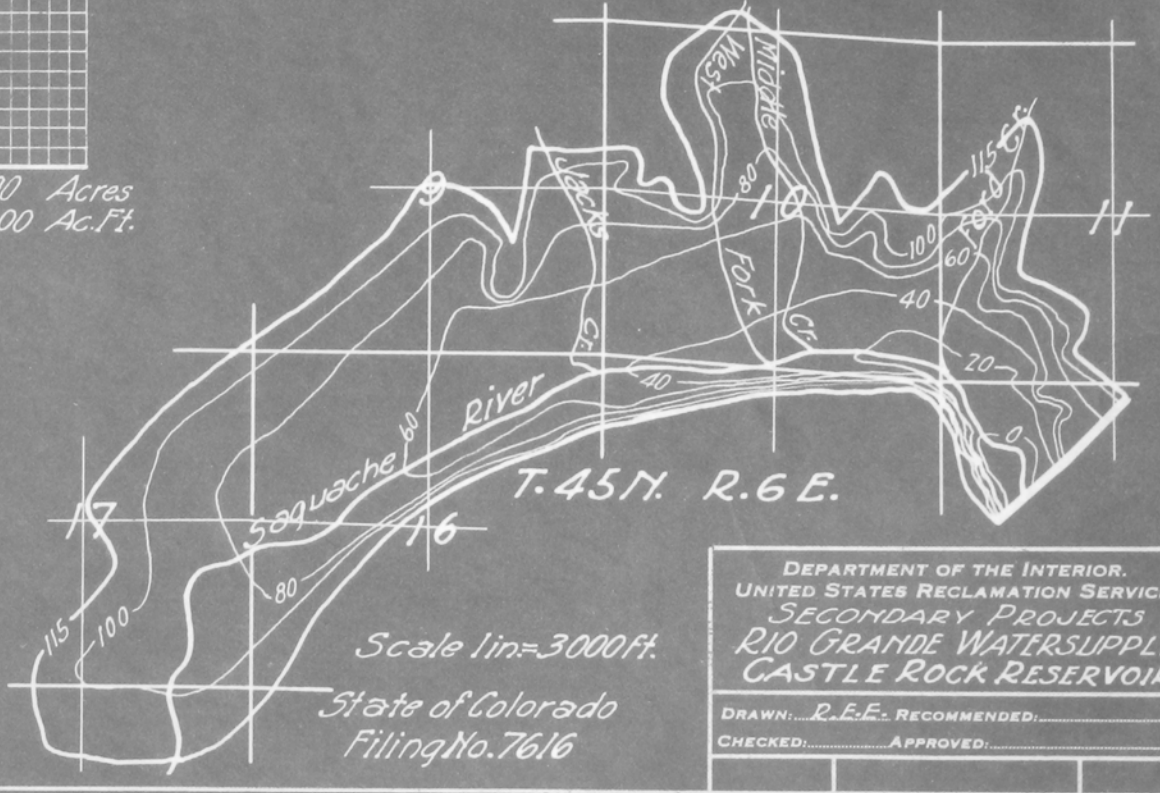
Scales: Hor. 1 in = 500 ft.
Vert. 1 in = 100 ft.



TRANSCONTINENTAL DIVERSION
from Cochetopa Creek



Scale 1 in = 20000 ft.



Scale 1 in = 3000 ft.

State of Colorado
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DEPARTMENT OF THE INTERIOR.
UNITED STATES RECLAMATION SERVICE.
SECONDARY PROJECTS
RIO GRANDE WATERSUPPLY
CASTLE ROCK RESERVOIR

DRAWN: R.E.E. RECOMMENDED:
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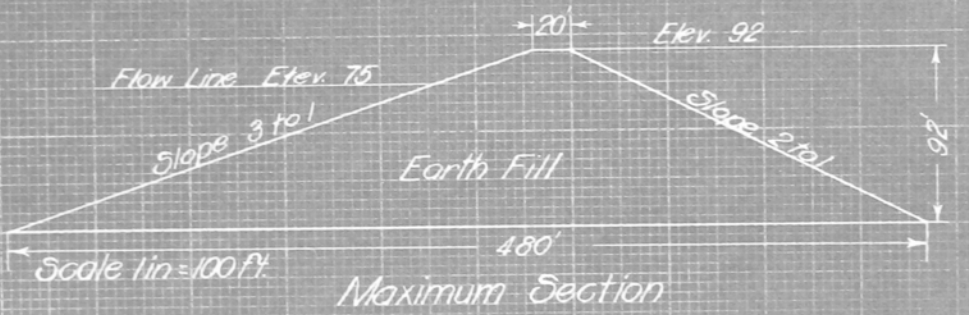
CASTLE ROCK RESERVOIR



Maximum Section

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CASTLE ROCK RESERVOIR

ON SAGUACHE CREEK

Earth dam, maximum height 92 feet - Capacity 20,000 acre feet at 75-foot water level

Right of way - 750 acres at $50				$	37,500
Dam -					
Cut-off trench, excavation	10,400	c.y. @	$1.	$ 10,400	
Stripping, 2 feet deep	23,500	" @	.75	17,600	
Puddle trench	10,400	" @	1.	10,400	
Embankment	490,000	" @	.75	367,500	
Riprap	16,900	" @	2.	33,800	
Sheet piling	10,000	l.f. @	1.	10,000	
					449,700
Spillway - 1000 sec.ft. (Base 30; d.w. 5.0; Q=1100)				15,000	15,000
Outlets 800 sec. ft.				12,000	12,000
				$	514,200
Add 35% overhead & contingencies					179,970
Total (20,000 acre feet at $34.70) - - - -				$	694,170

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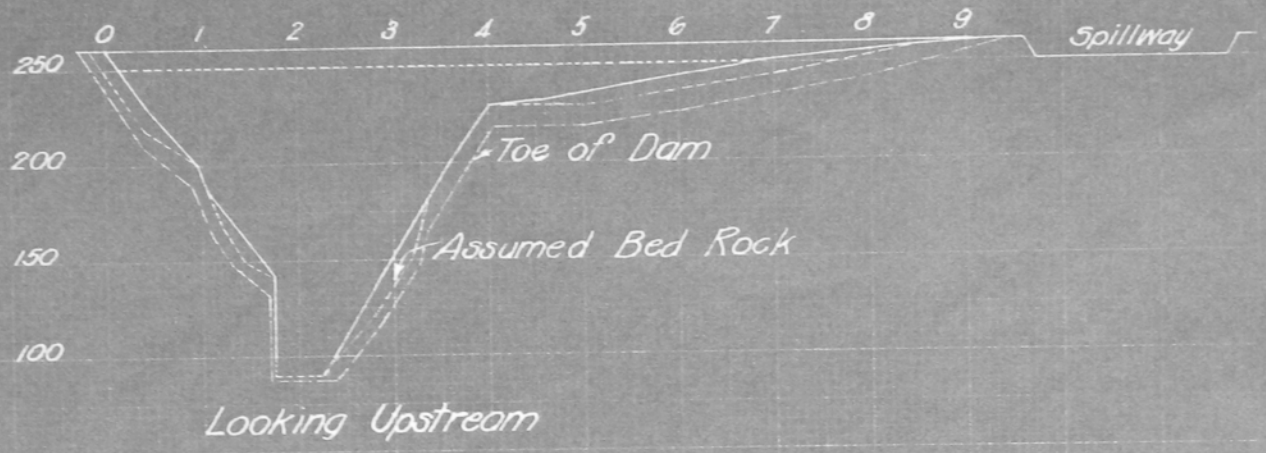
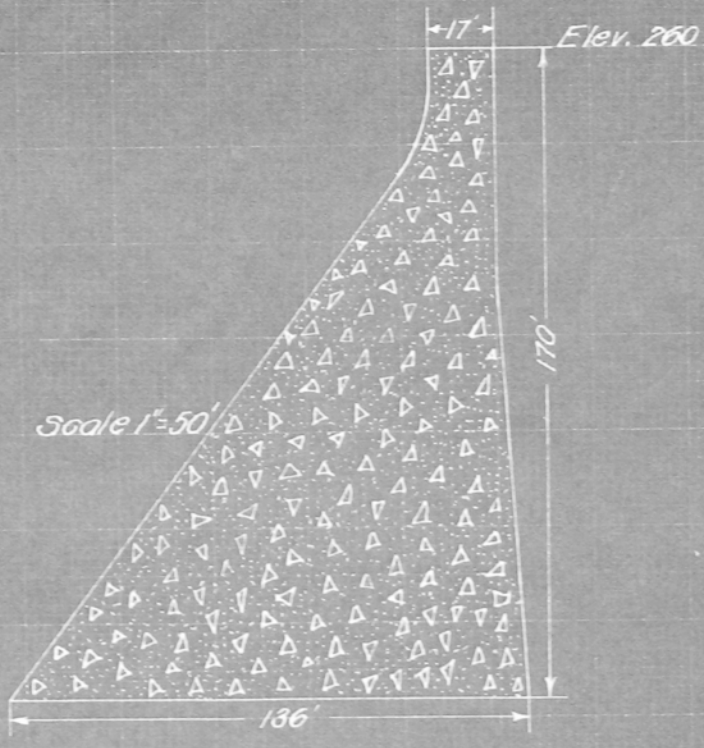
EL VADO DAM
Profile and Section



Looking Upstream



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EL VADO RESERVOIR

Capacity - 146,000 acre feet

Concrete dam - height 170 feet from stream bed.

Excavation -		
Rock 21,400 c.y. @ $4.00	$85,600.	$ 86,000.
Concrete -		
Class A (1-2-4 reinforced) 1,000 c.y.@$30	30,000.	
Class C(1-3-6 cyclopean)88,400 " " 10	884,000	914,000.
Outlet gates & machinery (2,000 sec.feet)		
2 Needle valves & operating mechanisms at $30,000	60,000	
272 lin.ft. 54" riveted steel pipe at $21.30	5,800	66,000.
Spillway - 12,000 sec.feet		20,000.
		1,086,000.
Overhead & Contingencies - 35%		380,000.
		1,466,000.
Right of way & moving saw mill		250,000.
Total (146,000 acre feet at $11.75) - - - - - -		1,716,000.

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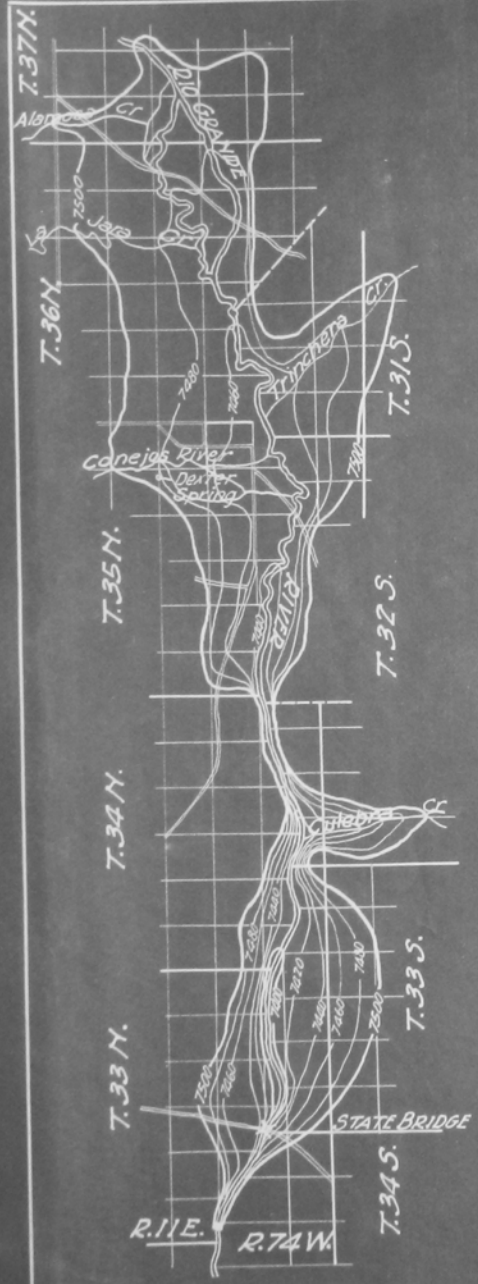
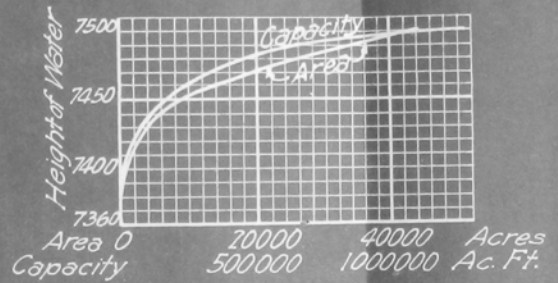
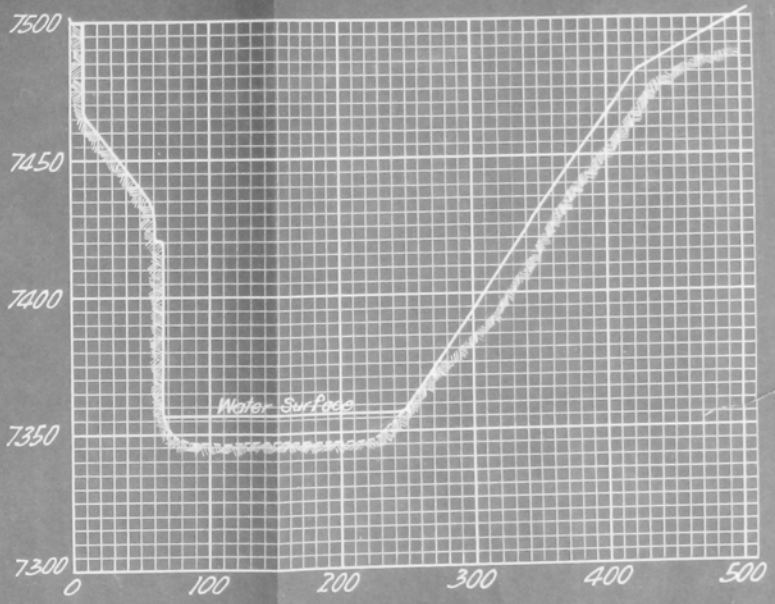


CAPACITY TABLE

Elev. of Water Level	Area of Water Surf. in Acres.	Increment of Capacity in Ac. Ft.	Total Capacity in Ac. Ft.
7360	0		0
7400	600.0	8000.0	8000.0
7420	2400.0	24000.0	32000.0
7440	5500.0	69000.0	101000.0
7460	14300.0	169000.0	270000.0
7480	26000.0	364000.0	634000.0
7500	44100.0	641000.0	1275000.0



PROFILE OF DAM SITE



Horizontal Scale, 1 in. = 100 ft.
Vertical Scale, 1 in. = 50 ft.

DEPARTMENT OF THE INTERIOR.
UNITED STATES RECLAMATION SERVICE.
SECONDARY PROJECTS
RIO GRANDE WATERSUPPLY
GIROUX RESERVOIR

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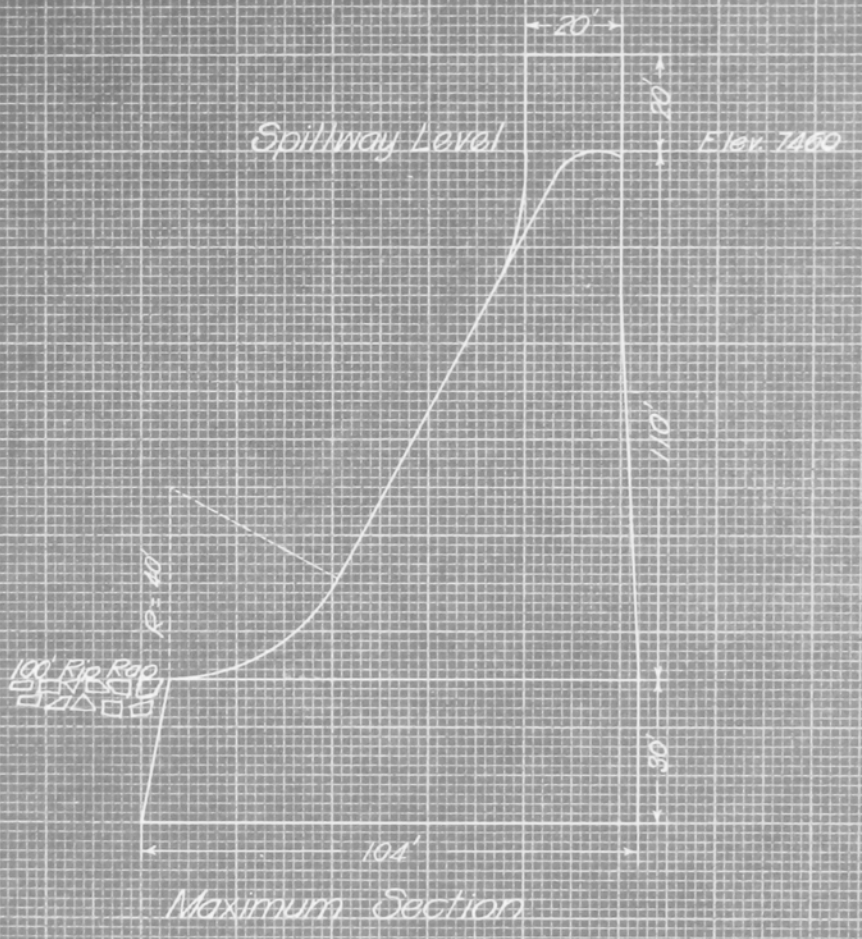
GIROUX RESERVOIR



Maximum Section

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GIRAUX RESERVOIR

ON

RIO GRANDE RIVER NEAR COLORADO-NEW MEXICO STATE LINE

Height of dam - 110 feet	Capacity 200,000 A.F.	
Concrete overflow dam		
Right of way - 12,000 acres at $20	$240,000	$240,000.
Excavation -		
Rock, below 7350- 18,900 c.y. @$6.00	113,400	
" above 7350- 6,400 " " 1.50	9,600	123,000.
Concrete -		
Class A(1-2-4) reinforced 1200 c.y.@$30.	36,000	
Class B(1-2½-5) plain 2800 " " 15.	42,000	
Class C(1-3 -6) cyclopean 61800 " " 10.	618,000	696,000.
Bridge -		
Concrete reinforced 1170 c.y. at $18.00	21,000	
" " 780 " " 13.50	10,500	31,500.
Gates & Mechanisms, 2,000 sec.ft. -		
2 needle valves & operating mechanisms at $30,000	60,000	
160 lin.ft. 54" riveted steel pipe at $21.30	3,400	63,400.
		$ 1,153,900.
Add 35% Overhead & Contingencies		403,900
Total (200,000 acre feet at $7.79) - - - - - -		$ 1,557,800.

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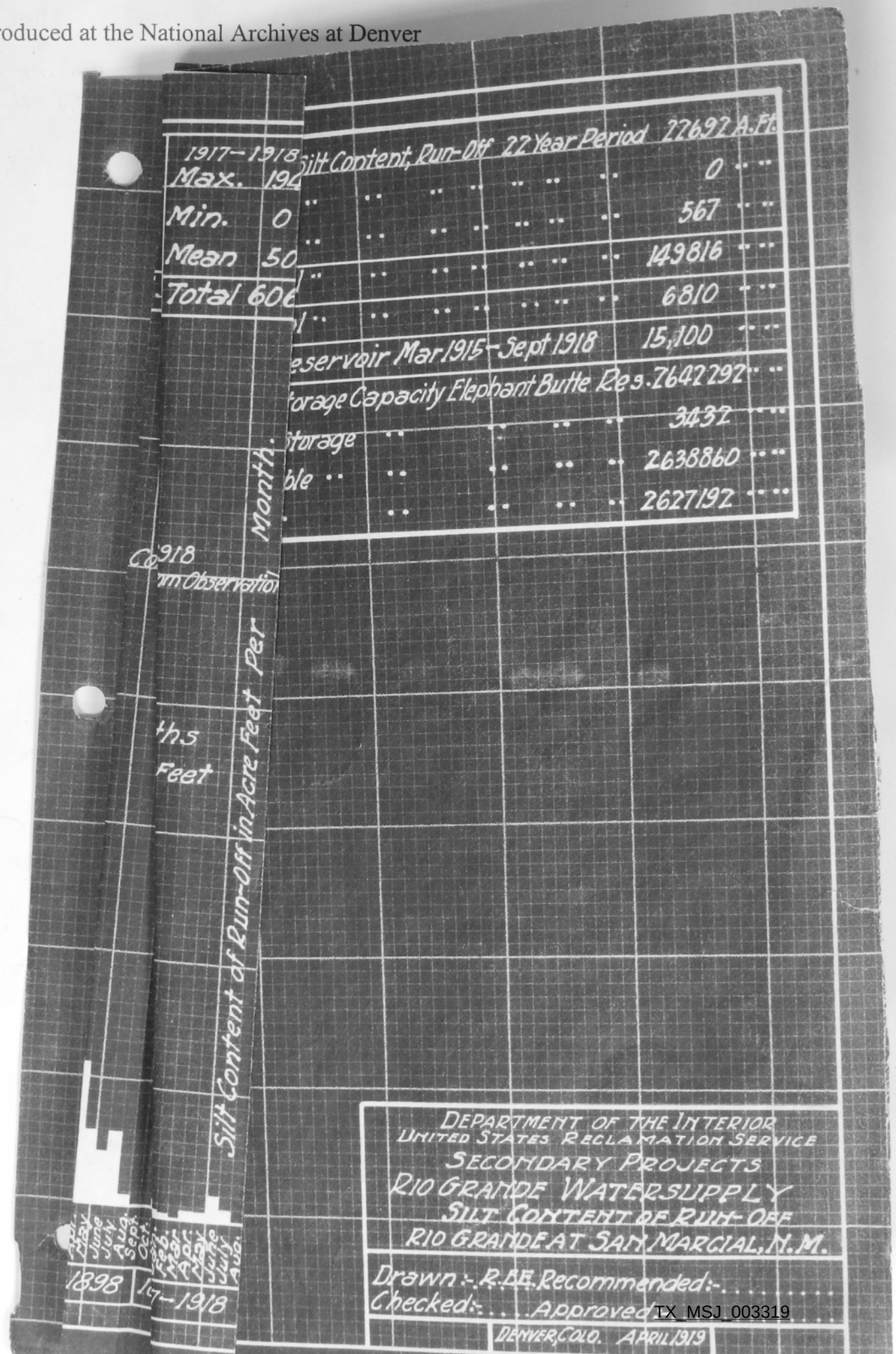

1917–1918
Max. 192
Min. 0
Mean 50
Total 60

Silt Content, Run-Off 22 Year Period 72692 A.Ft.
0
567
149816
6810
eservoir Mar 1915–Sept 1918 15,100
torage Capacity Elephant Butte Res. 2642292
Storage 3437
ble 2638860
2627192

Co. 918
rm Observation
Month.
ths
Feet
Silt Content of Run-Off in Acre Feet Per

May June July Aug. Sept. Oct. Feb. Mar. Apr. June July Aug.
1898 17–1918

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE
SECONDARY PROJECTS
RIO GRANDE WATERSUPPLY
SILT CONTENT OF RUN-OFF
RIO GRANDE AT SAN MARCIAL, N.M.
Drawn:- R.E.E. Recommended:-
Checked:- Approved
DENVER, COLO. APRIL 1919

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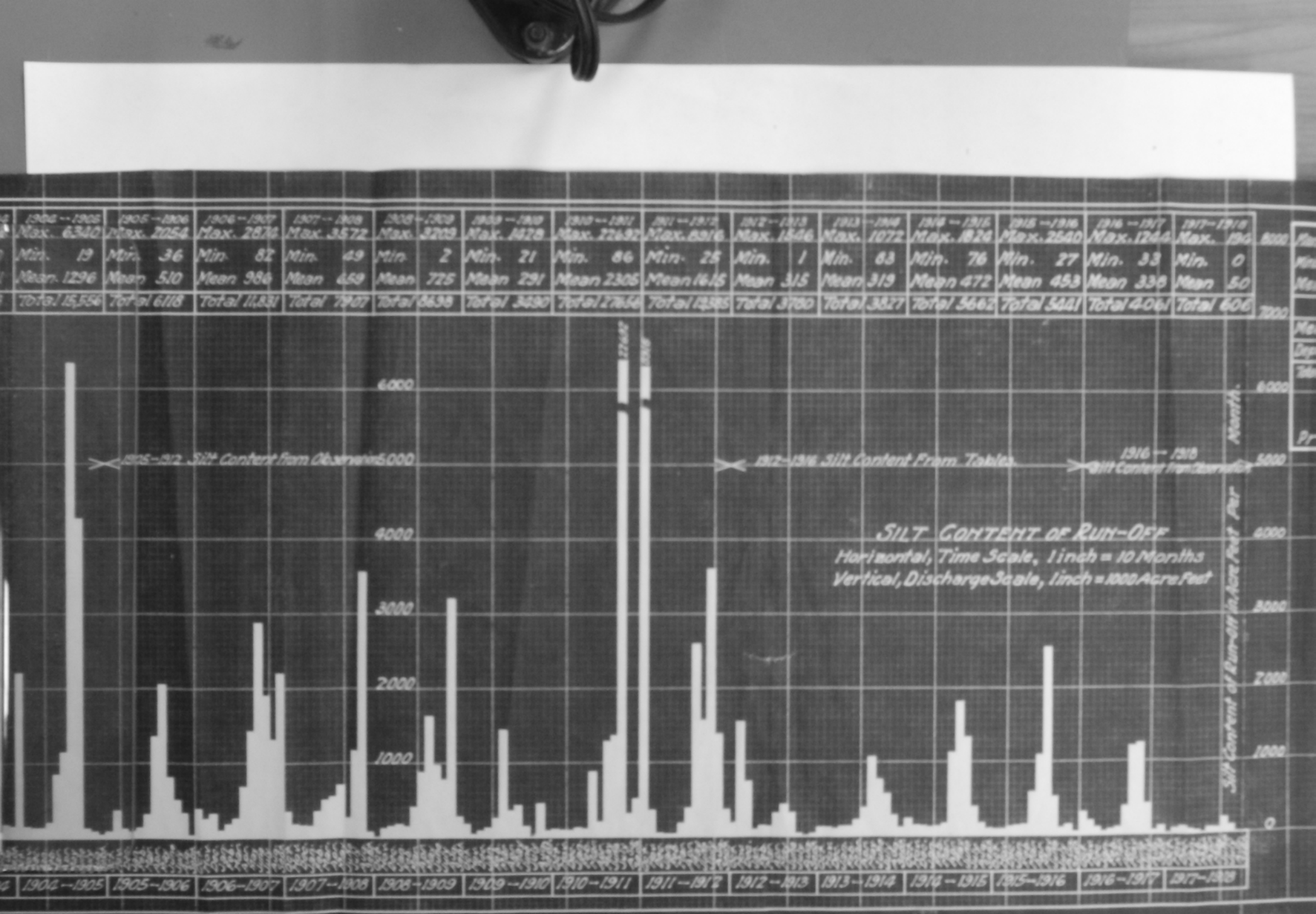

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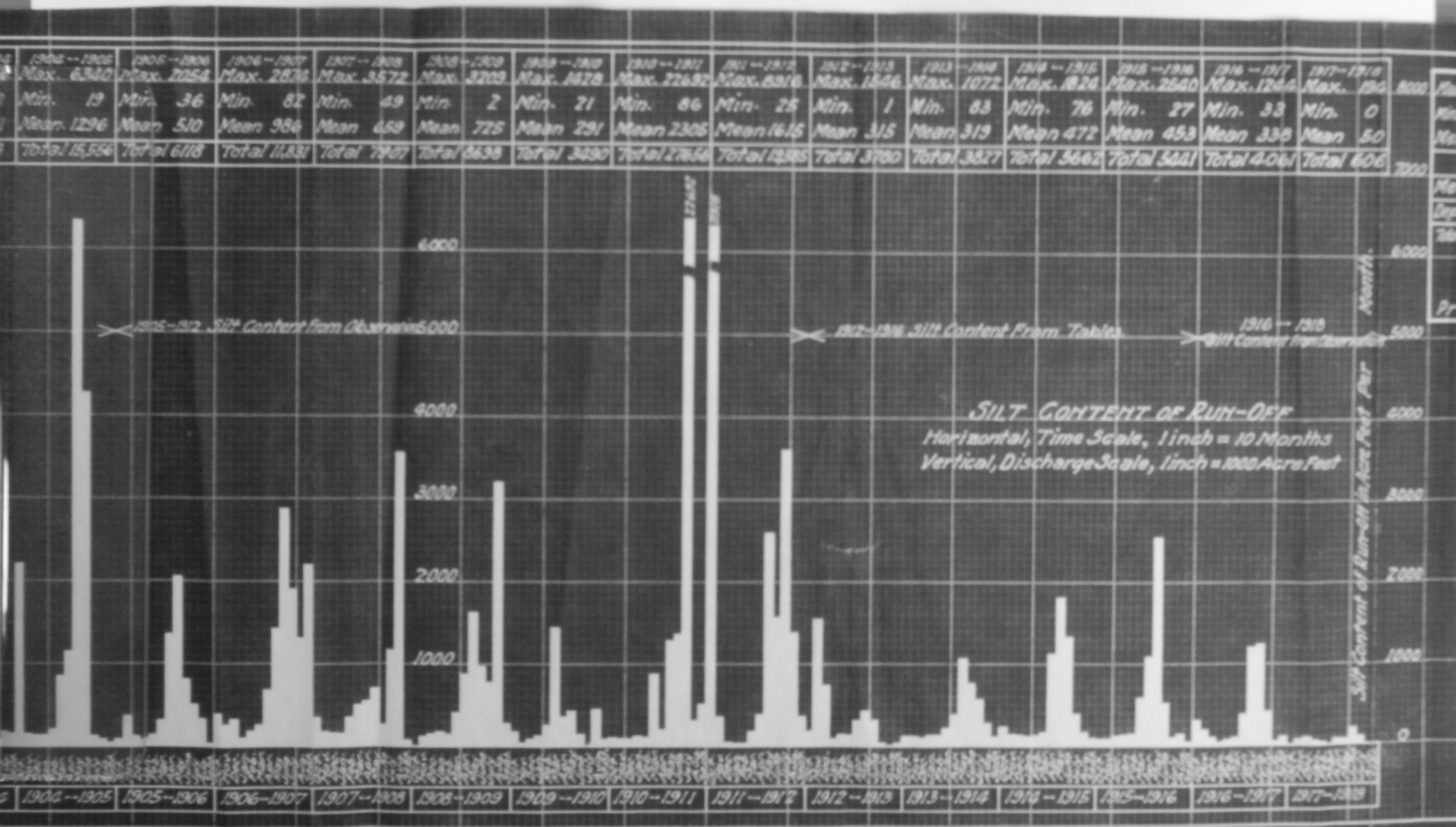

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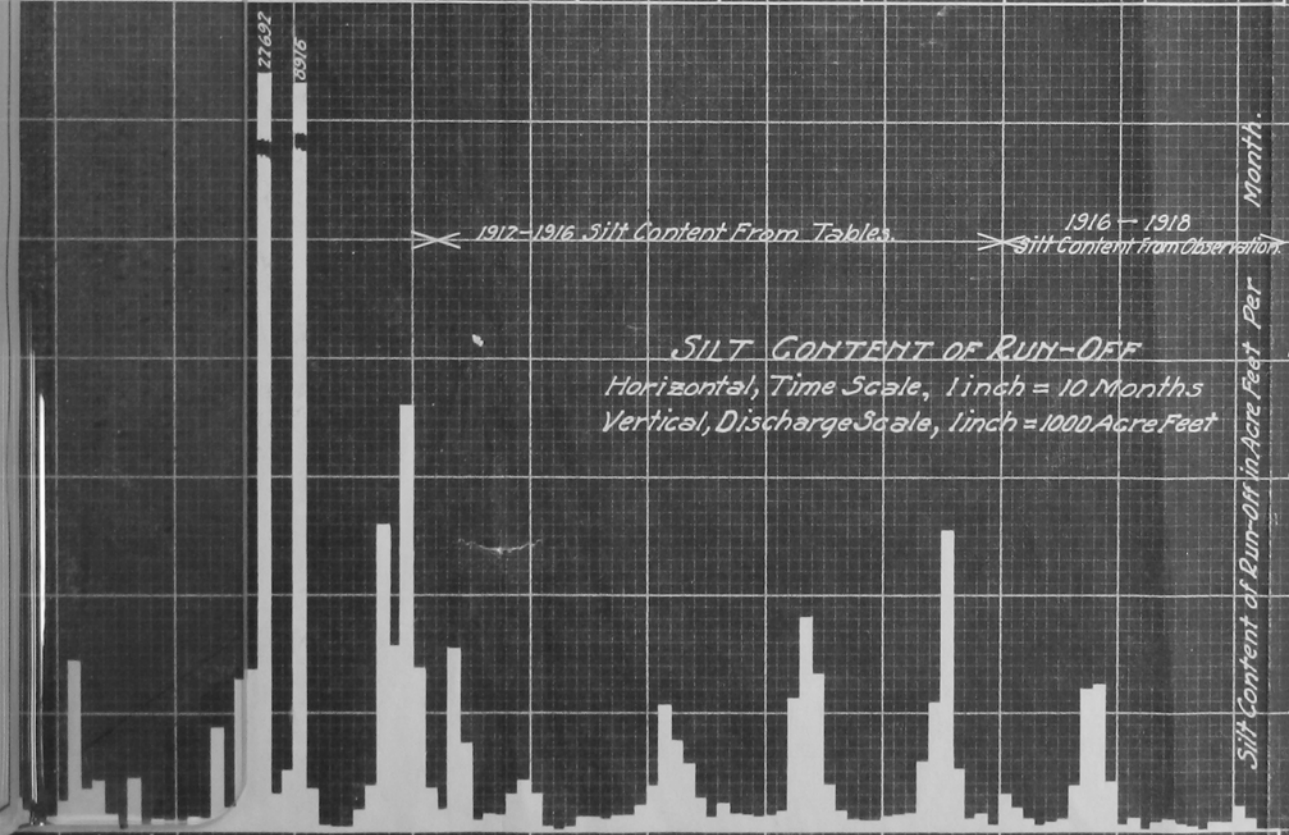
1909 – 1910	1910 – 1911	1911 – 1912	1912 – 1913	1913 – 1914	1914 – 1915	1915 – 1916	1916 – 1917	1917 – 1918
Max. 1428	Max. 27692	Max. 8916	Max. 1546	Max. 1072	Max. 1824	Max. 2540	Max. 1244	Max. 194
Min. 21	Min. 86	Min. 25	Min. 1	Min. 83	Min. 76	Min. 27	Min. 33	Min. 0
Mean 291	Mean 2305	Mean 1615	Mean 315	Mean 319	Mean 472	Mean 453	Mean 338	Mean 50
Total 3490	Total 27656	Total 19385	Total 3780	Total 3827	Total 5662	Total 5441	Total 4061	Total 606

Maximum Monthly Silt Content, Run-Off 22 Year Period	27692 A.Ft.
Minimum	0
Mean	567
Total	149816
Mean Annual	6810
Deposited in Reservoir Mar 1915 – Sept 1918	15,100
Total Original Storage Capacity Elephant Butte Res.	2642292
Sub-Storage	3432
Available	2638860
Present	2627192



1909 – 1910	1910 – 1911	1911 – 1912	1912 – 1913	1913 – 1914	1914 – 1915	1915 – 1916	1916 – 1917	1917 – 1918

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE
SECONDARY PROJECTS
RIO GRANDE WATER SUPPLY
SILT CONTENT OF RUN-OFF
RIO GRANDE AT SAN MARCIAL, N.M.

Drawn:- R.E.E. Recommended:-
Checked:- Approved:-
DENVER COLO. APRIL 1919

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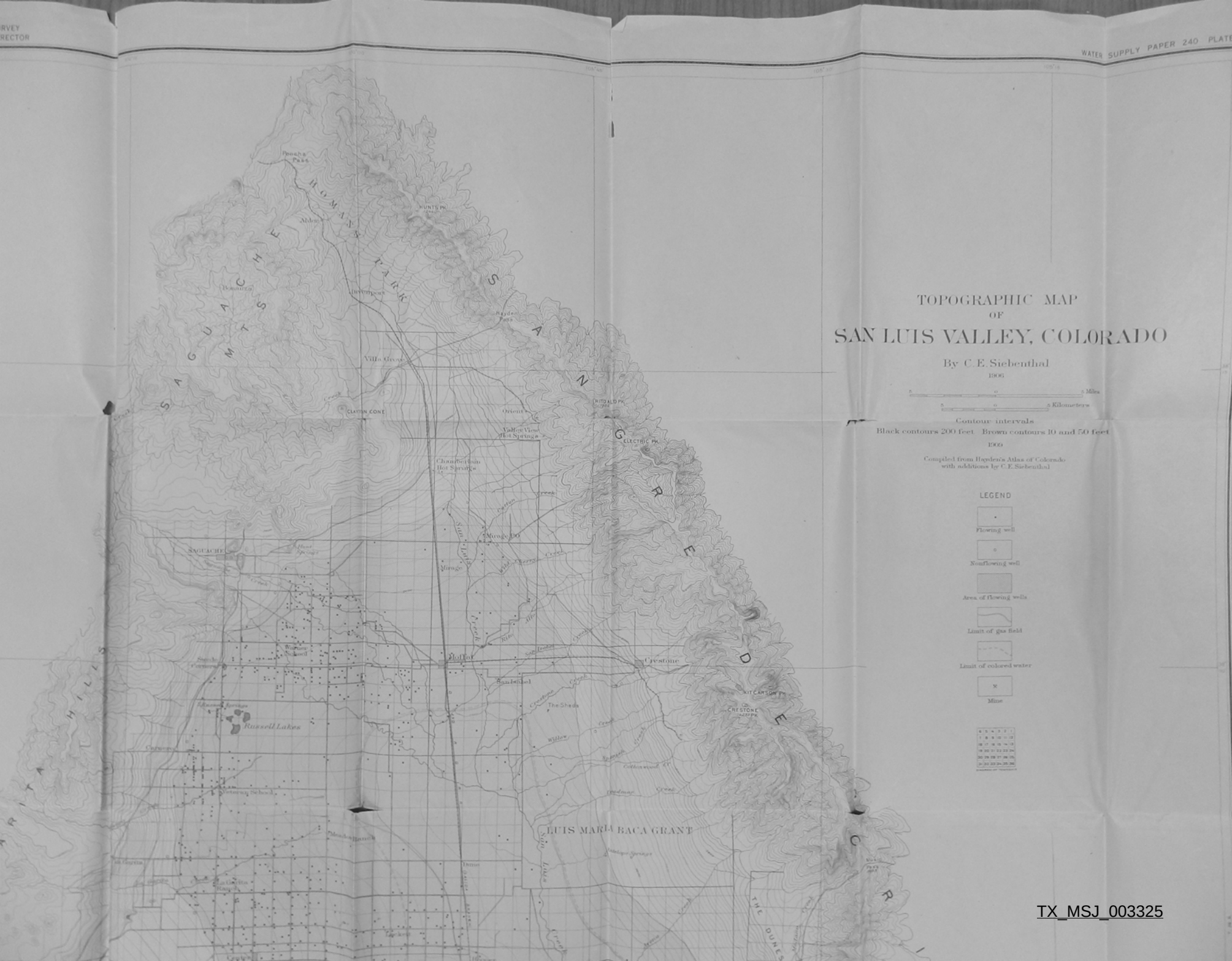

TOPOGRAPHIC MAP OF SAN LUIS VALLEY, COLORADO

By C. E. Siebenthal

1906

5 0 5 Miles

5 0 5 Kilometers

Contour intervals

Black contours 200 feet. Brown contours 10 and 50 feet

1909

Compiled from Hayden's Atlas of Colorado with additions by C. E. Siebenthal

LEGEND

- Flowing well
- Nonflowing well
- Area of flowing wells
- Limit of gas field
- Limit of colored water
- Mine

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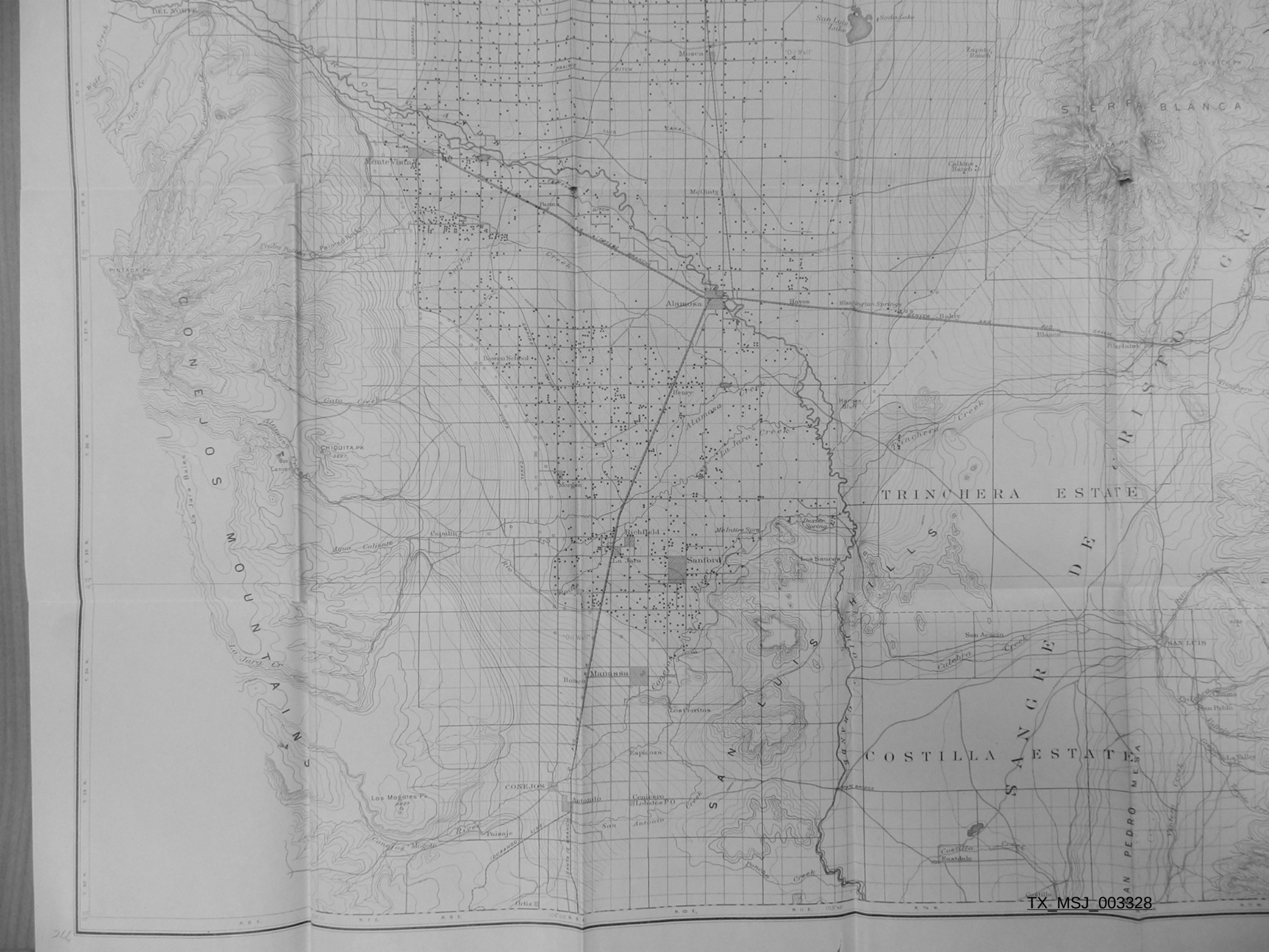

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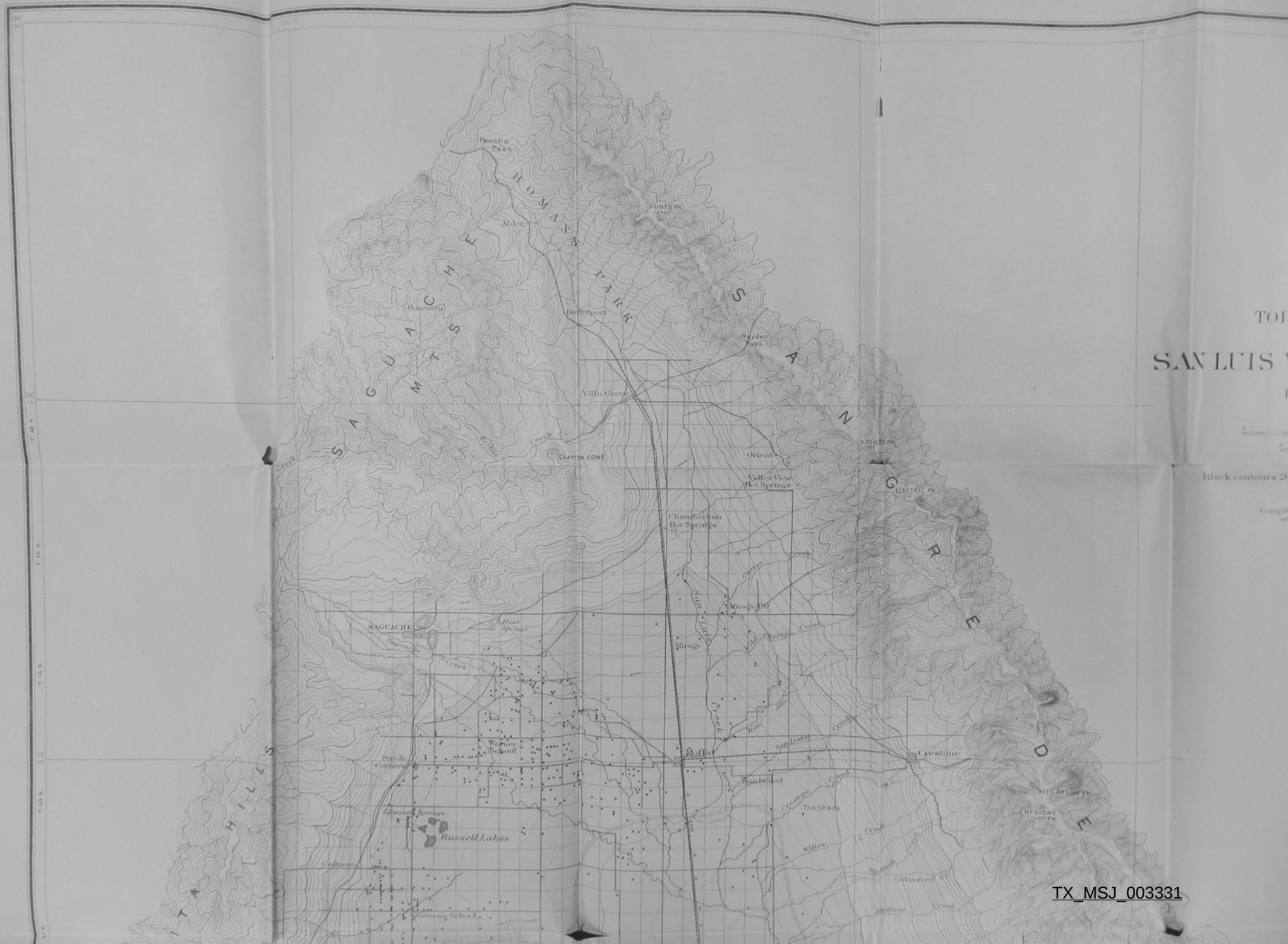
U. S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR



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RG 115 RECORDS OF THE BUREAU OF RECLAMATION

General Administrative and Project Records, 1919-1945

General Files, 1919-1929

302.28--302.31 A

NV - NM

Entry 7

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302.31 New Mexico Surveys & Investigations Thru 1929 2 of 2

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DEPARTMENT OF THE INTERIOR

UNITED STATES RECLAMATION SERVICE

Denver, Colorado, June 18, 1919.

From Engineer Harold Conkling,

To Chief of Construction.

Subject: Water Supply - Rio Grande River.

1. Herewith report on water supply for the San Luis Valley, Middle Rio Grande and Rio Grande Project, together with study of effect of development of the first two areas on the recorded supply for the last. This report is made in accordance with your instructions.

2. Although the records on the Rio Grande are very complete and the primary gaging stations have been maintained in some cases for thirty years, yet the various conditions entering into the study have made necessary a large number of assumptions. While it is believed that all the assumptions made are fair ones, yet in the absence of definite data, their reasonableness must be largely a matter of opinion. It is believed, however, that any engineer going over the same ground and taking up the facts and possibilities step by step, will reach the conclusion that any phase of development will tend to affect the water supply in the direction of the assumption made, although the unit quantities which he may use may be different from those used in the report.

3. The uncertainty is caused by the fact that all the additional acreage which can be irrigated along the Rio Grande must first be drained. Drainage will discharge water to the

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stream, which is now lost by evaporation from the seeped area. Drainage will be succeeded by irrigation of the land formerly seeped and this will consume a part or all of the water released by drainage. In the San Luis Valley there seems to be no reason why consumption under irrigation may not even exceed the present evaporation.

4. While data are sufficient to make fair estimates of the water now lost, yet the question of what percentage of any area will actually be drained if a system is constructed and the efficiency of the drains in the part which is drained cannot be definitely stated in advance. There is also a paucity of data on consumption of irrigation water. The basis of the entire report is the consumption of water. Not only does the supply for the Rio Grande Project depend on the consumption in the Middle Rio Grande and the San Luis Valley but on each project conditions are favorable for re-use of return flow by the acreage on the lower end. The Rio Grande and the Middle Rio Grande are both 150 miles long, very narrow and are irrigated by a succession of ditches heading in the river, while in the San Luis Valley, the drainage water can be largely diverted to the land.

5. Although there is a lack of extensive data concerning consumptive use in field conditions, yet such as do exist point to a much greater uniformity for this than for diversions. That is, consumptive use with any ordinary economical

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method of irrigation appears to be independent of diversion. Above a certain amount, sufficient to supply consumption, each acre foot diverted will, if drainage is perfect and water does not stand on the surface, cause an additional acre foot of return flow.

6. The dependable data at hand on consumptive use are as follows:

	Acres investigated	Years covered	Acre foot per acre: Water diverted	Precipitation	Total water	Return flow	Consumptive use
Boise Project	13,550	2	4.08	0.94	5.02	2.89	2.13
Cache la Poudre	234,000	9	1.25	1.26	2.51	0.35	2.16

The unit consumptions used in the report are as follows:

	Acre feet per acre: Plant transpiration	Incidental evaporation	Precipitation	Total beneficial consumption	Evaporation because of inefficient drainage	Total consumptive use
San Luis Valley	1.00	0.25	0.60	1.85	0.25	2.10
Middle Rio Grande	1.00	1.00	0.75	2.75	0.31	3.06
Rio Grande Project	1.00	1.50	0.80	3.30	0.35	3.65

As records deal with stream discharge only, the quantities assumed in the report are those which consume diverted water and are:

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	Beneficial consumption	Evaporation because of inefficient drainage	Total	Diversion duty
San Luis Valley	1.25	0.25	1.50	2.50
Middle Rio Grande	2.00	0.31	2.31	3.81
Rio Grande Project	2.50	0.35	2.85	4.35

7. When the studies preliminary to the report were started, it was believed that the method of study should be to determine how much water is needed for the Rio Grande Project, with reasonable shortage in low years. That is, with the recorded supply, to determine the safe yield of Elephant Butte reservoir and then to estimate as closely as possible the effect on the supply, of development of the Middle Rio Grande and San Luis Valley with the idea that the maximum development of these areas which could be made without depleting the supply for the Lower Rio Grande should be delimited.

8. It was also the idea that possibly these developments were of such magnitude that they could be successfully handled only by the Reclamation Service and therefore that the limitations found necessary by the study of the water supply, if the conclusions of the study were acceptable, would be imposed by the Reclamation Service, all water rights protected, and an orderly and safe development of the river ultimately consummated under the direction of the Service.

9. With greater knowledge of physical conditions comes the conviction that construction of these other projects is

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neither so complicated nor so expensive that their ultimate construction depends on government aid. It is believed, insofar as the engineering features are concerned, that these projects will be constructed at some time whether included in the Reclamation program or not, albeit piecemeal private development will not be so effective nor so efficient as government construction.

10. The next question was, then, what are the probable limits of development from an engineering standpoint, and if such limit will seriously encroach on the water supply for the Rio Grande, what legal limit may be imposed? This last was submitted to the legal department.

11. It appears that court decisions up to the present time give no definite basis for saying that development above may be limited by legal methods to prevent encroachment on supply for the Rio Grande Project. This is partially due to conflict of state's rights and partially to the peculiar conditions summarized below.

12. San Luis Valley. A large body of water rights exist totaling more than the discharge of the streams. These rights have been used in succession on various tracts in the valley. Irrigation ceased on any particular area because of rising ground water so that it would be difficult to show abandonment. The rights are merely quiescent. Duty of water is such that irrigation of these areas, if drained,

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will exhaust the stream flow. Additional area must be irrigated from drainage return or pumping from ground water. The courts have held that movement of ground water is so obscure no restrain can be placed on its use before it reaches the stream.

13. Middle Rio Grande. The burden of proof of depletion of supply may rest on the Reclamation Service. This may be impossible to prove because the contention will be made that drainage releases more than enough water to compensate for the consumption through irrigation of the same area. This matter, in the absence of convincing data, would be the subject of expert testimony which might, with any two men, be diametrically opposite.

14. The conclusions of the last paragraph also apply to the San Luis Valley, but more forcibly to the Middle Rio Grande, where a reservoir must be built, while for the San Luis Valley no new reservoirs are absolutely necessary. It undoubtedly can be successfully urged that any new reservoir right is junior to the Elephant Butte right but this is not true as to direct flow rights.

15. If the foregoing paragraphs are true as to engineering and legal phases of the situation, then it is evident that limitation of development on either of the projects under discussion may be difficult of imposition from without and the local physical conditions should be used in estimat-

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ing. In the San Luis Valley, this limitation will be due to a combination of water supply and topography, and in the Middle Rio Grande probably to topography alone.

16. The questions which it was desired to answer by the report were:

(1) Is there a water supply for the San Luis Valley sufficient to justify the Reclamation Service undertaking an extensive development in the valley and are conditions in the valley favorable for a government project.

(2) The same question for the Middle Rio Grande?

(3) How will such development affect the water supply for the Rio Grande Project?

(4) Is the water supply sufficient now or will it be sufficient after such development for extensions to the present Rio Grande Project?

17. San Luis Valley. The subject is too voluminous to present in any detail in this letter but the following conclusions may be presented:

(1) The present non-beneficial loss of water is about 580,000 acre feet or 0.65 depth per acre average on the 850,000 acres of seeped land.

(2) The consumptive use for irrigation may be as much as 1.50 acre feet and about 770,000 acres is the probable ultimate irrigated acreage if the valley is drained plus 40,000 acres now irrigated in mountain valleys - a total of 810,000 acres.

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(3) Surface water supply is not sufficient for this and reservoirs, if built, will not give a satisfactory water supply.

NOTE: See graph following. This graph is based on an ideal duty of 2.5 acre feet per acre at diversion which is not realized in present practice. Present practice in diversions, if continued for future enlarged acreage, would generally use the entire summer flow and leave only winter flow for reservoirs. The graph is presented merely to show what could be accomplished were all ditches under one control with a 2.5 acre foot diversion, the approximate sufficiency of the supply in the last half of the period of record for the estimated ultimate acreage, and the disastrous shortages in the first half of the period. It is believed that private development would be such as to approximately utilize the latter period.

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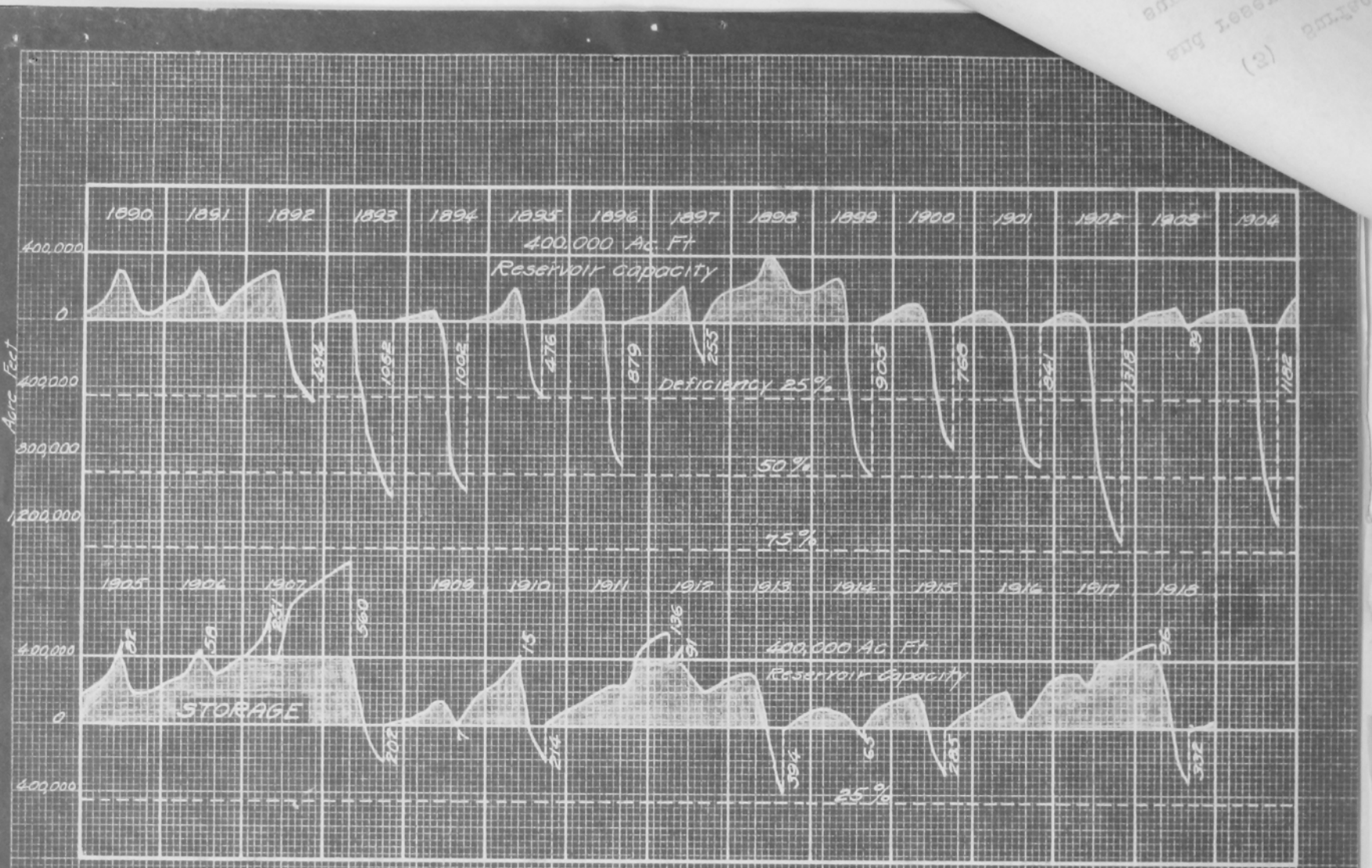

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Pumping from ground water should not be prohibitively expensive. It has already been tried in the valley and such development seems probable. With this, water supply will be sufficient.

(4) Drainage will not develop increased water at the valley outlet because the water so developed will be re-used in the valley. In fact, drainage will cause a reduction in outflow because with the probable irrigated acreage the consumptive use will be larger than present evaporation.

(5) Trans-mountain diversions from the Gunnison and San Juan Rivers, while not examined in the field, are believed infeasible. Two possibilities exist: from the first to the Saguache; from the second to the south fork of the Rio Grande. This is based on examination of topography sheets.

19. At the present time there are in the valley several small drainage projects and it is understood that the construction of two more is about to be financed. One great bar to extensive development is the expense of outlet drains and this particularly applies to the dead area which embraces the northern half of the valley. As stated, nothing was found to indicate that this construction is so difficult that it will not be done eventually if left to private development, but it is also true that it is and

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will be difficult to secure the necessary cooperation among private interests. It is probable that no very serious effort has yet been made in that direction.

20. It is the common belief in the valley that so much water will be saved by construction of a main drain to the area that the government can undertake it free to the valley for the development of projects below.

21. This would remove the difficulties incident to cooperative work on the part of the valley and be a desirable development for all parties in interest, if true.

22. The conclusion of this report is directly the opposite. It is found that the net result of drainage will be the diversion of more water on the average from the streams and its consumption in the valley than will be regained by drainage. This applies both to the dead and the live areas.

23. Such being the case, there is no reason for construction of any part of the drainage system free to the valley.

24. The valley presents no inviting field for extensive development by the government. The present monopoly of water supply by private interests renders it practically certain that no such supply can be stored in the reservoirs as shown in the graph. The fact that canals have already been built to almost the whole west side of the valley leaves

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the field of irrigation out of consideration.

25. It is believed that the only field for government work lies in the construction of the main drain to the dead area provided the benefitted lands wish to bind themselves to repay the cost but without doubt such proposition will meet with much opposition.

26. Construction of a drainage system should not, it is believed, go further than this or possibly main drains south of the Rio Grande, although this depends largely on sentiment in the valley. Undoubtedly for the valley a better system of drainage can be laid out and built by the Reclamation Service but it is also true that fairly satisfactory drainage can be done piecemeal. While it is believed possible to furnish a water supply by pumping, yet such development must come about very gradually. A complete drainage construction would be far in advance of recognition of lack of surface supply and during the years of gradual change much hardship would be incurred.

27. The foregoing does not consider the desirability of entering the valley in accordance with the Soldier-Settlement Act. This would involve acquiring by purchase some part and perhaps a large percentage of the area considered - over a million acres gross in the west side of the valley. If a part is purchased, an old water right must be purchased with it or recourse must be had to pumping at some future

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date, or a drainage water right secured. If all but the present well developed lands are purchased, it must be with the intention of pumping on a good share of the land. While such development is believed so probable in private hands that the residual water from such development is the basis of water supply studies for projects below, yet it can hardly be recommended as a desirable undertaking to embark on wholesale in view of the many uncertainties of the situation.

28. It is perhaps possible to work out some way of making soldier-settlement apply to some part of the valley. Such proposition should be the subject of specific investigation when the subject comes up but it is impossible to handle it in this report. It is probable that acquisition of water rights in the valley for new lands means the acquisition also of a series of lawsuits.

29. Middle Rio Grande. In the Middle Rio Grande, the situation, while somewhat similar, works out to entirely different results. The irrigable land considered is in the river bottoms and is definitely limited by the steep bluffs on either side. The probable total area which it is feasible to drain and irrigate is 134,000 acres gross, or 116,000 net.

30. Only half of the tributaries between Buckman at the upper end and San Marcial at the lower end have been

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measured. The recorded loss between these stations is not the true loss because of the tributary inflow. When to the measured inflow (discharge at Buckman plus measured tributaries) is added the estimated inflow from tributaries, the loss through the Middle Rio Grande averages 508,000 acre feet annually. It is probable that the loss from the seeped bottom is about 2.5 feet in depth including the approximately 49,000 acres now irrigated. Based on the consumptive use of 2.0 acre feet estimated in this report, the development of the Middle Rio Grande will increase the discharge at San Marcial 94,000 acre feet annually, but when the effect of the assumed decreased discharge from San Luis Valley in reducing present loss thru the Middle Rio Grande is considered, the proportion of reduced loss ascribed to irrigation in the Middle Rio Grande is changed to 70,000 acre feet in the final analysis. This varies with different cycles and for the critical period 1898-1902 it is estimated that a loss of 21,000 acre feet annually will be caused by irrigation in the Middle Rio Grande instead of a gain of 70,000 acre feet.

31. The difference in estimated results from drainage of the San Luis Valley and the Middle Rio Grande are due partly to the difference in soil. The coarse soil of San Luis Valley is not evaporating any large quantity of water while the finer Middle Rio Grande is. It is also partly due to the circumscribed area of the Middle Rio Grande which does not permit expansion.

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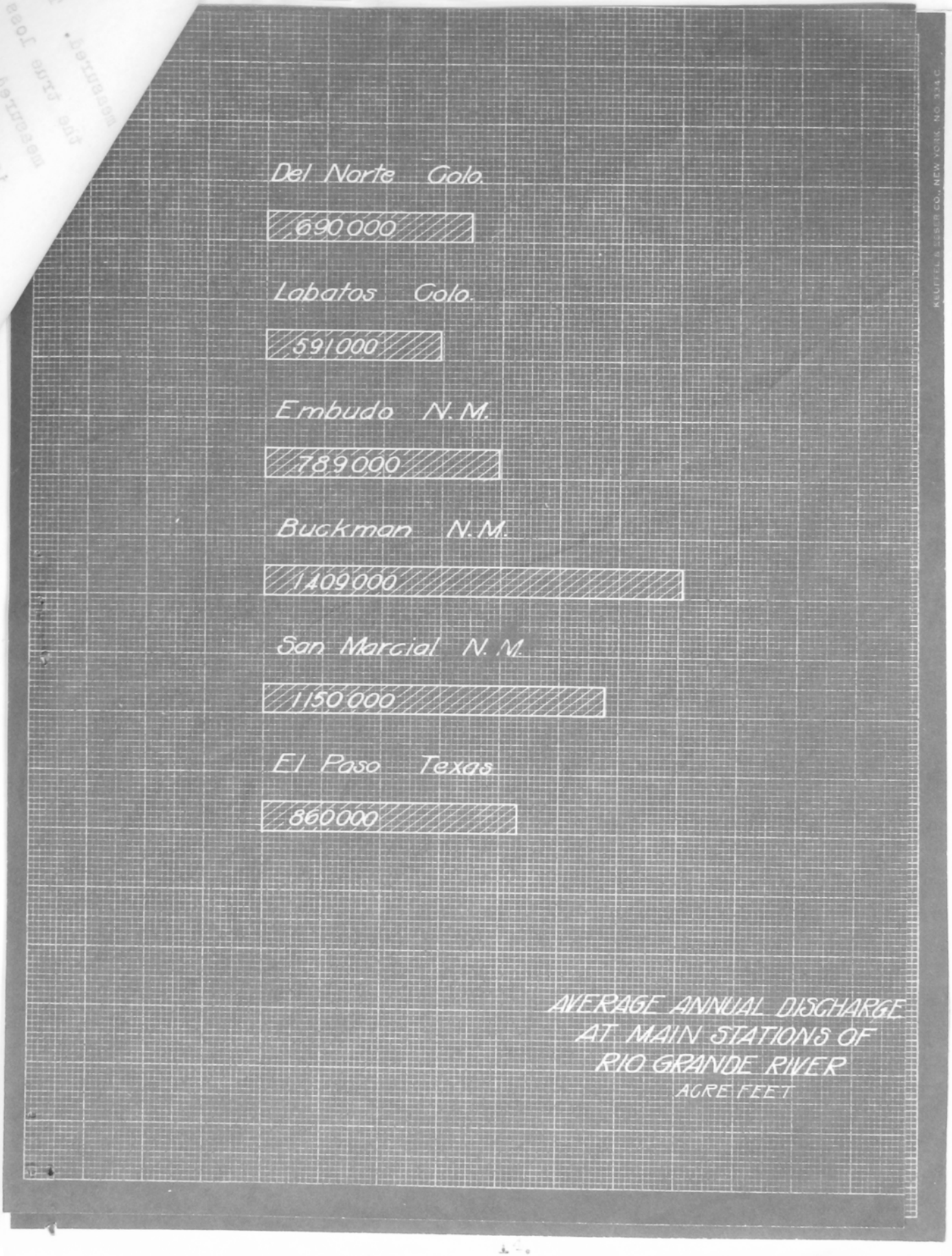

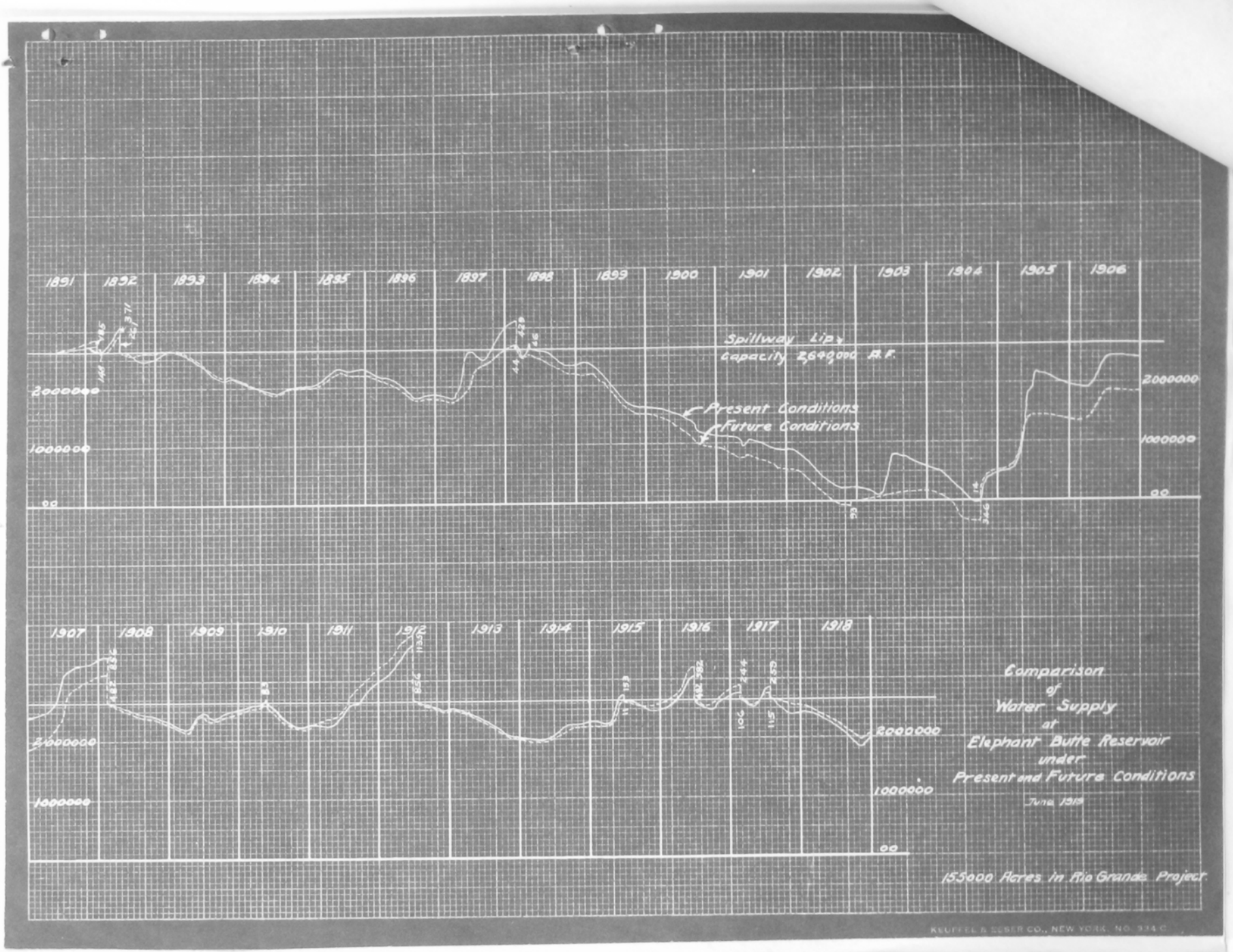

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32. The complete cutting off of outflow from the San Luis Valley does not greatly affect the water supply for the Middle Rio Grande. The average recorded gain between the Colorado-New Mexico State line and Buckman, at the head of the Middle Rio Grande, is 818,000 acre feet and this is all available to the Middle Rio Grande independent of the San Luis Valley. In occasional short years, however, the gain is not sufficient for full supply.

33. A reservoir is necessary for the Middle Rio Grande for a late season supply. Good sites exist at the Giroux just above the State line on the Rio Grande and at El Vada on the Chama. The Giroux site, because of depletion of discharge from San Luis Valley, will not answer the purpose since little water would be available for filling it in low years. Data are not sufficient to determine the exact size needed since the discharge at El Vada has been recorded for only three years, but approximately 150,000 acre feet seems sufficient. The estimated cost of the El Vada site is less than $12.00 per acre foot.

34. A reconnaissance was made of a possible transmountain diversion from the Navajo, a tributary of the San Juan to the Chama, but it is not feasible.

35. Here, as in the San Luis, development will take place with or without government aid. Government aid will furnish the cheapest and more comprehensive construction because private development will be piecemeal and the last portions developed may have to furnish the entire storage, the cost

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would, under government construction, be distributed over the entire acreage.

36. The conclusion in the report is that 94,000 acre feet annually will be saved. This rests on two estimates - first, of tributary inflow and, second, of consumptive use. That these estimates are accurate would be too much to expect but certainly there is room for considerable of margin of error.

37. With the above provisos in mind as to the accuracy of the data on which the conclusions are based, it is believed that the margin of allowable error is sufficient to say:

(1) That construction of the Middle Rio Grande will probably increase the supply for the Rio Grande Project on the average, but that a probable decrease will be caused in the critical period 1898-1902. This is not necessarily an argument against government construction because less efficient private drainage may cause a greater decrease. This decrease could be obviated if no reservoir were constructed but a reservoir is believed necessary if drainage works are built. The foregoing conclusion as to decrease is made, of course, on the assumption that at present no sure means of limiting development is apparent.

(2) That water supply for the Middle Rio Grande is independent of development in the San Luis except in the occasional short year which should come to every project where the land area exceeds water supply.

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(3) That if the residents of the valley can be brought together the project of draining the bottom lands and building a reservoir is a desirable government enterprise.

(4) That aside from the probable excessive cost of irrigating the mesa lands east and south of Albuquerque, water supply as determined here is not sufficient to warrant formulating any plan for this area.

(5) That a reservoir of approximately 150,000 acre feet must be constructed and that a desirable site with sufficient water supply exists at El Vada on the Chama River.

(6) That greater irrigation in the Middle Rio Grande will tend to reduce silt deposits in Elephant Butte Reservoir because silty water will be spread to greater degree than now and will be replaced by clear drainage water. The cost may be as follows:

Drainage	$25.00	per acre
Storage	15.00	" "
Canal revision . . .	25.00	" "
	65.00	" "

38. Rio Grande Project. The water supply depends on the residue after demands above are satisfied.

39. Following is a graph showing curve of reservoir operations for two conditions.

(1) Recorded supply at San Marcial reduced by the estimated decrease in discharge from San Luis Valley during periods of records.

(2) Estimated supply after complete development above as outlined.

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40. Some deficiency in supply is evident in the last condition:

	A.F.	Per Cent
1902	93,000	14
1904	346,000	51

Yet the average spill, excepting the six years from 1899 to 1904, is 140,000 acre feet. In 1896, Follett made an extensive inquiry at various points in the Rio Grande Valley as to run-off in previous years. Information was gained as far back as 1861 and no protracted period of run-off similar to 1899-1904 was found so that it is possible that the only extended series of low years in a cycle of fifty-eight years is embraced in the period of record. His data, together with records at El Paso, which bear a fairly constant relation to those at San Marcial, make it very certain that the large flood of 1891 would have more than completely filled the reservoir and maintained it full until August 1 at which time the graph starts.

41. The diversion duty is assumed at 4.35 acre feet per acre. As the irrigation season is ten months, almost all of the return flow may be utilized on the project if this duty can be obtained. Therefore, the actual diversion duty is immaterial so long as the return flow does not exceed the capacity of the drains. If it does exceed capacity of drains, either new drains must be constructed until a balance is reached or the same result be reached by reduction of diversion.

42. The acreage assumed is 155,000 as estimated by the project office. This does not include the Fort Hancock Unit.

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Actual acreage is problematical and depends on the efficiency of drainage in reducing the water table under the lower lying lands. It should be borne in mind that increased land prices may make possible some day the irrigation by more efficient drainage, of more of the 184,000 acres now under canal or to which extensions are planned.

43. Evaporation from the reservoir is taken at 7.15 feet annually. The estimated annual evaporation with the second scheme is 226,000 acre feet. Silt deposits in the reservoir will decrease its capacity and therefore, in some future cycle of years similar to the past, shortage will be more severe. Tending to relieve this is a possible item of 160,000 acre feet bank storage not considered in computations.

44. While reduction in diversion in a period of shortage would produce no result if the consumptive use remains the same, yet it is believed that the evaporation incidental to irrigation can be reduced by careful irrigation. If this is true, a reduction in diversion when the reservoir approaches 1,500,000 acre feet in contents may decrease the draft sufficiently to considerably alleviate the shortage shown.

45. Extension of the project will increase the shortages noted in paragraph 40. This extension may take place privately by pumping from ground water under assumed unirrigable acreage of 29,000 acres. An additional draft of 70,000 acre feet annually would increase the shortages shown to the following:(approximately)

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1902	549,000 acre feet	80%
1904	459,000 " "	68%

without adverse effect in other years. As stated, it may be possible to distribute this shortage.

46. Accepting the truth of deductions as to measured diversion above, although not necessarily true, question of expansion rests on attitude of the government toward the question of allowing such possible shortages.

General Discussion

47. One thing that is empahsized by this report is the necessity for knowledge on the part of the Reclamation Service of the consumptive use of water and evaporation from ground water at different depths.

48. When isolated projects were taken up, this was a matter of minor importance, but now when future development must correlate all the possible projects on a considerable part of a drainage basin, this knowledge is absolutely essential.

49. Several projects of the Service are suitable to some such experimental and hydrographic work. On the Rio Grande, in particular, conditions are favorable and the need great.

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FIRST MEETING

RIO GRANDE RIVER COMPACT COMMISSION

- - - -

Broadmoor Hotel, Colorado Springs, Colo.,

Sunday, October 26, 1924.

PRESENT:

Honorable Herbert Hoover, Secretary of Commerce.

J. O. Seth, Esq., Santa Fe, New Mexico.

R. F. Burges, Esq., Texas.

Joseph W. Taylor, Esq., Las Cruces, New Mexico.

Delph Carpenter, Esq., Colorado.

R. I. Meeker, Esq., Special Deputy, State of Colorado.

George Neel, Esq., Deputy State Engineer, Santa Fe, New Mexico.

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SECRETARY HOOVER: Gentlemen, I presume we had better call this meeting to order and entitle it as the first meeting.

It has seemed to me to be desirable to have this conference in order to determine the breadth of our problem, for one thing, and another thing to determine what our actual problem is to be. Of course, the entry of Texas into the matter necessarily broadens thingsto a considerable degree. My understanding of the original idea is that there was an agreement solely between Colorado and New Mexico. My understanding now is that both these states welcome the entry of Texas into the question, as being a contribution to a settlement, and a relief from the old problem of litigation in water rights. But the inclusion of Texas into the problem certainly broadens it mater-

ially, and to such an extent that I think we ought to have a preliminary discussion of the affair in order that we may not get beyond our depth. If Major Burges could tell us something about what the attitude of Texas is, I think it would help us in making up our minds what we want to do.

MR. CARPENTER: May I interrupt you, Mr. Secretary, I think it would be well at this time to elect a chairman of this Commission, and I move that Mr. Hoover be made the Chairman of this Commission.

MR. SETH: I second the motion.

(The motion being put to a vote was carried, and Secretary Hoover declared to be the Chairman of the Commission).

SECRETARY HOOVER: I presume we had better elect someone as Secretary of the Commission.

MR. SETH: I move that Mr. J. Howard Carpenter act as Secretary.

MR. CARPENTER: At least, temporarily, or until further provision is made.

(The motion being regularly seconded and put to a vote was carried.)

SECRETARY HOOVER: Both Mr. Seth and Mr. Carpenter have been duly appointed by the Governors of the States of Colorado and New Mexico, respectively, and I understan d there is legislation directly and indirectly bearing upon this problem.

MR. SETH: Directly authorizing it.

SECRETARY HOOVER: Of course, there is no Federal Legis-

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lation authorizing the Compact; and I understand there is no legislation in Texas.

MAJOR BURGES: I have not the honor, so far, of representing the State of Texas, and am largely in the position of a "butter-in", if I may use the common slang expression of the day, to this extent, that I thought the attention of the Commission ought to be called to the importance of Texas being a party to it. And I will state that I have written to the Governor of Texas to that effect on behalf of the people in the upper Rio Grande Valley. I at that time anticipated from what I had heard that a meeting would be held in Washington, a preliminary meeting, and I suggested to the Governor of Texas, having seen in the paper that the Attorney General of the State was going to be in Washington, that it would be well to have the Attorney General present at the preliminary meeting, in order to suggest at least the desirability of participation on the part of the State of Texas. I had been advised by the Governor, and I believe all of the members of the Commission had been, that he thought it was desirable that Texas should be a party to the hearing, and that if given the opportunity he would lay the matter before the Legislature of Texas as soon as it convened. I have heard nothing from the Governor, which I attribute partly to the fact that he has been participating somewhat in the political campaign in Texas, and I think perhaps has not been at his office, or if he has been at his office, it has been just for brief periods, coming in and going out, and not attending to any correspondence that did not demand his immediate attention. Although I have heard nothing from him, I still deemed it advisable to come up here in order that the Commission might understand the point of view of some of us in the State of Texas on the matter, and at this time, or at such other time as you may de-

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sire, I would be glad to state our position, because I think it would be interesting to the Commission.

SECRETARY HOOVER: I think the whole question of organizing the work of the Commission depends on a thorough understanding of what the position of Texas is, and what steps we should take in that connection, so I think it will be a good idea for us to hear Major Burges.

MAJOR BURGES: I will be glad to do that.

The problem of the Rio Grande, as it affects the state of Texas, presents, I think, what I may say is, in my opinion, two distinct problems. It is the view of the people at El Paso, and in the El Paso Valley, which includes the irrigable lands in El Paso County and Hudspeth County, that that portion of the Rio Grande lying north of Fort Quitman presents a separate problem. I suppose every member of the Commission knows that under the treaty between the United States and Mexico, which resulted in the building of the Elephant Butte Reservoir, that the Republic of Mexico waives the presence of any water in the Rio Grande between the point at which it becomes a boundary stream, that is, the south boundary line of New Mexico and Fort Quitman, Texas, in consideration of the agreement on the part of the United States, to perpetually supply to Mexico, for the use of the Juarez Valley, sixty thousand acre feet of water per year. It is a matter of fact, and it can be established to the satisfaction of any fair minded person, that the use of water of the Rio Grande above Fort Quitman does not at least materially affect the interests of the people below Del Rio, Texas, as there is no irrigation that is of any consequence, and I think no possible irrigation of any importance between Fort Quitman and Del Rio, Texas. The Rio Grande flows for hundreds of miles through a deep canon, and

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its waters are not important for either farming or stock raising, while it is passing through this canon country, and through the canon country the Rio Grande receives such an inflow of water from the tirbutaries in Texas to some extent, and even to a larger extent in Mexico, that the river below Del Rio is a much larger river than it is above Fort Quitman, but it is not at all dependent, in my opinion, from what I have been able to learn, upon the waters that pass Fort Quitman, and if no water passed there it would not be material to the people below there - that is my belief. There is, however, some difference of opinion on that point. I believe that to be due to want of information on the part of those people as to where their water comes from, and that is not merely my individual opinion, but it is based upon considerable research and measurement and investigation that has been made by the International Boundary Commission, and through Governmental Agencies; so that I apprehend that in the long run everyone will be convinced that the use of the water above Fort Quitman is in no way injurious to the people in the lower Rio Grande Valley.

SECRETARY HOOVER: Have you a map with you?

MAJOR BURGES: I have not a map with me. It would have been more thoughtful upon my part to have brought it.

SECRETARY HOOVER: How far is Fort Quitman below El Paso?

MAJOR BURGES: Fort Quitman is perhaps 80 miles below El Paso, and about 80 miles below Fort Hancock, and just below Fort Quitman, or practically at Fort Quitman, the Rio Grande passes out of the Valley into the Canon and flows for hundreds of miles.

SECRETARY HOOVER: What is it, five or six hundred miles down to Del Rio?

MAJOR BURGES: It is over six hundred miles from there to

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Del Rio, by the windings of the river.

SECRETARY HOOVER: How far below Del Rio to the boundary line?

MAJOR BURGESS: That is another six hundred miles -- nearly twelve hundred miles in there. The people in the upper Rio Grande Valley feel that they have an interest that is very nearly identical, if not entirely identical, with the people of New Mexico and the people of Colorado in the contention that the waters of the upper Rio Grande are not valuable to the people of the lower Rio Grande, that the water supply comes to them from tributary streams, and that they are not dependent upon the flow that passes through. It is my own belief that the State of Texas should be represented on the Commission by some man who does not reside in either the upper or lower Rio Grande Valley. I have no idea what the Governor does think about that. I know that he regards the matter as important to the State of Texas, both from what he has written and from what he has said to me. But it is my belief that the State of Texas should be represented on the Commission by some man who has no local interest. I think that it is extremely probable--in fact, I feel very little doubt -- that if someone is appointed to represent the State of Texas who has no personal bias, or local point of view, that he will be convinced that the lower Rio Grande proble, is absolutely separate from that of the upper Rio Grande. And with that representation on his part, backed by the support which will be given from the upper Rio Grande Valley, I think it will be convincing to the Legislature of Texas that the interests of the State have not suffered by an agreement which fixes the upper Rio Grande problem as separate from the lower one. I may say -- it may not be relevant, and I think it is not -- that we are working at this very moment upon a compact for the division of the waters of the Pecos River, and we are confronted with a

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similar situation. It is the present belief of the people in Texas who are most interested, and I am attorney for the Texas people on the Pecos River, that we can cut the Pecos in two, so to speak, at or near Fort Sumner, New Mexico, and say in the compact that it places no limitation or restriction upon the use of the waters of the Pecos River above Fort Sumner, and that the compact regulates the use of the waters below that point, and if that can be done we believe that the compact will be ratified in both states. Without that done, there might be a grave difficulty in getting it ratified in New Mexico. Now, the problem in Texas is somewhat similar. I believe if we convince such a representative as I hope the Governor will appoint that the two problems are separate and distinct, and he comes before the Legislature of Texas with the statement of his conviction, and his reasons for it, that we will be able to ratify the compact in the Texas Legislature; and I take it that all of these compacts between the states must derive whatever value they have at least from the ratification of the state legislatures. The river goes out at what is called Great Bend, and down here some six hundred miles comes into the Del Rio Valley. The Del Rio Valley does not use the Rio Grande water for irrigation; it has an abundant supply of its own, and from that point the Rio Grande of the United States flows down southeasterly into the Gulf of Mexico about six hundred miles below, and in that course it received the waters of the Pecos and Devils Rivers in Texas, besides minor streams, and a number of important streams in Mexico.

MR. CARPENTER: Mr. Chairman: The matter of participation by Texas, of which Mr. Burges has spoken, the people of the State of Colorado look with favor upon it. In fact, the Act of our Legislature under which I was appointed, authorizing me to sit in a Commission between New Mexico and Colorado, and

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the United State, or between Texas, New Mexico and Colorado and the United States, so indicates. I do not regard these acts of the legislature as a positive prerequisite to participation by any state. A compact agreed upon by this Commission is at best but an officer, a suggestion to the legislatures of the interested states. that such a compact be entered into between the states. A compact really is entered into by the acts of the legislatures, and by congress, in approving and ratifying the work of the Commission. In view of this legal status, it has occurred to us working on rivers further to the north, that it is unnecessary for a Commission to act, or the Governor to proceed under a prior legislative act, except as a matter of policy of convenience, but not of necessity. In view of that common opinion, in 1921, the Governor of Nebraska appointed a Commissioner for that State to sit upon the South Platte River Commission without prior legislative authority. That Commissioner proceeded to the conclusion of these negotiations, and signed the compact for his state, merely under executive appointment without prior act of the legislature. In a more recent development than that, on the North Platte, the matters came to a focal point, as it were, after all legislatures had adjourned. The Governor of Colorado appointed me, the Governor of Nebraska appointed Mr. Willis, and without legislative authority. In this instance, the President of the United States has appointed Mr. Hoover, without prior act of congress. And with respect to the North Platte River, the President has appointed Mr. Davis, of New Mexico, as Federal Representative, without prior act of congress. These Federal Representatives probably do not carry the same degree of authority that they might have carried under congressional sanction, but it is sufficient with all of us to give us our place at the table, and our place "in the sun", as

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it were, in the matter of working out the problem, and in the end accomplishes as much, probably, as though there was a prior legislative act, and it carries with it another feature. Two acts of the legislature frequently are more convenient. They do not tend to more conflict than the one act. The only advantage of the prior act, and the principal advantage of the previous act, is expressing the policy of the legislature; the secondary features are providing the necessary finances with which the Commission may function, etc. The Governor of Colorado received from Governor Neff, of Texas, a request that Texas be extended the courtesy of participation in the work of this Commission, and wrote as though under the impression at that time that he could not proceed without an act of his legislature. The precedents that I have mentioned were then called to the attention of Governor Neff. Governor Neff did not reply, because of engagements, and on October 20, 1924, his private secretary replied advising me, in reply to the letter that I had sent to the Governor for the Governor of Colorado, that Governor Neff was absent from the State, but that he, the secretary, had been authorized to say "That it is his intention to name a representative for Texas to serve on this Rio Grande Commission, subject to the later approval of our State Legislature. Just as soon as Governor Neff appoints someone to represent this State, he will write you further." This communication was very agreeable to the Governor of Colorado, and to the Commissioner for that State, and we earnestly hope that Governor Neff will appoint a representative in person and residence to suit the people of Texas, of course at an early a date as possible, in order that we may have his aid and the benefit of his counsel in this proceeding.

Mr. Chairman, while I am on that, I heartily agree with Major Burges' statement of his impression of the River. It

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has veen the understanding of all of us to the north of the head waters of the River, that from time immemorial, in low periods of low flow, the Rio Grande was a broken stream, so much so, that in some years, along in the forties, 1846, or shortly thereafter, 1850, the channel of the stream was used as a roadway because of the fact that there was no water then flowing in it from Fort Quitman to El Paso. The treaty between the Republic of Mexico and the United States bears out that common understanding, and has been the basis also for our conclusions in that respect, and I earnestly hope that if Texas does enter upon this Commission the Commissioner from that State will concur with us in our views in this regard. The area from Fort Quitman to El Paso is legitimately a part of the upper country. The area from Fort Quitman to the Gulf is another territory, as it were, with other supplies.

MR. SETH: The Act of the Legislature under which the New Mexico Commission acts makes no reference whatever to Texas.

MAJOR BURGES: May I interrupt just a moment? Isn't that also true of yourselves? The article that I have, which I took to be a correct copy, gives an alternative, that is, the Governor may appoint a Commissioner to confer with the Commissioner from New Mexico and a representative of the United States, or, in the alternative, with a representative of New Mexico without a representative of the United States; but it did not mention the State of Texas.

MR. CARPENTER: Yes, I am certain it did.

Major Burges: They did?

MR. CARPENTER: Three alternatives, one between the two states.

MR. SETH: Have you a copy of your Act?

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MR. CARPENTER: No, I have not.

MR. NEEL: I have checked Mr. Carpenter on that, because I looked it up specifically with some reclamation engineers. It does include Texas.

MAJOR BURGES: I have what pruports to be a copy of that Act with me.

MR. SETH: The New Mexico Act certainly omits Texas, presumably, I think, on the theory that all the area above Fort Quitman, which is scarcely entirely true, but on the theory, nevertheless, that the Reclamation Service represented practically all of the area. I believe it did not practically represent all of it. Personally, I would have no objection to sitting with any duly authorized representative of the State of Texas, but I rather question the appointment of Commissioners without prior legislative authority, because any compact that may be entered into has no effect until approved and any Commissioner on behalf of the state, without prior legislative authority, is handicapped. He has not the means of procuring the necessary engineering and other advice, and has no authority, strictly speaking, to call upon any state official to furnish it. I don't know what the situation might be in Texas in that regard, but I understand that New Mexico has had some legislation. If there was a duly qualified appointed commissioner of Texas, I certainly would go ahead. Personally, I think, that proper representation of Texas is very important, as I have wired Mr. Hoover on several occasions. I recently have had a meeting with the various interests in New Mexico, and the portion of the Rio Grande project in New Mexico, and all are most heartily in favor of the compact. They have a water compact that would settle everything, including Texas. Our

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situation is this: Mr. Taylor is President of the Elephant Butte Irrigation District. The Rio Grande Project is divided into two parts, partly in New Mexico and partly in Texas. Mr. Taylor is President of that portion in New Mexico. They are both served by the Elephant Butte Reservoir. Mr. Taylor's irrigation district has expended a large sum on money in preparing its case in connection with this Commission. The El Paso portion has done nothing. There is grave danger of any compact that may be arrived at causing possibly some shortage of water in the future, and unless Texas were bound by the compact it would place the New Mexico end of the project in a most embarrassing position. It is my opinion that the importance of completely cleaning up the job while we are at it is sufficient to warrant the delay, if necessary, to get Texas properly in and have the whole thing out; and certainly that is the feeling of the interests along the Rio Grande in New Mexico.

SECRETARY HOOVER: When does the authority under your two constituting Acts expire?

MR. SETH: Mine has no limit, but it would expire at the next legislature. I will have to report at the next legislature.

MR. CARPENTER: I am supposed to report at the next legislature, on the first of January.

MR. SETH: I don't believe there is any danger of delay in the matter; that is, I don't know of any development that is being held up in New Mexico. The financial situation is such that there could not be any development.

SECRETARY HOOVER: I have an impression about these problems that time is a requisite. I think our problem in Col-

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orado has not progressed with as much rapidity as we possibly could have, owing to the fact that one has to carry a vast amount of public education in his mind.

MR. SETH: That is particularly true in New Mexico. When we first started in, I think there was a great division of opinion. The compact was fought by representatives in Sierra County, as practically all of the Elephant Butte Irrigation District is embraced in that county. Now, I think after meetings with the various interests, and getting together, there is not the slightest opposition to the compact in that State, and I think the same is true of Texas.

MAJOR BURGES: The El Paso people are absolutely converted to the theory; and if I may be allowed to say it, I have followed with close interest and attention what was done on the Colorado River. Taking a cue from the Colorado case, I went to the legislature of Texas myself with the proposal, and I drafted a bill for the Pecos River Commission. At that time I took up the matter with Mr. A. P. Davis, head of the Reclamation Service, and he approved of the idea heartily, and at that time said to me, "What would be your attitude of a similar Commission on the Rio Grande, because", he said, "I apprehend that sooner or later we are going to have to face identically the same problem". I said, "Well, Mr. Davis, my personal view is that it is desirable to have a Commission draft a compact on the Rio Grande just as it is on the Pecos." Now, it may not be irrelevant to say that at the time the work was commenced on the Pecos -- and that was only a year ago -- parties both in Texas and New Mexico seemed utterly incredulous to any result being accomplished, but today I have reason to believe that the prevailing opinion in both states is that the compact will be agreed upon and it is probable that it will be ratified; at least, it looks probable. Now,

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as Mr. Seth has said, the El Paso people are completely converted to the theory of a compact, being so educated now for some months, if I may say it, by myself and others, as I represented as attorney both the El Paso and the Hudspeth County Districts since their inception. The people on the lower Rio Grande, are not yet, I think, convinced, but that is because there has been no campaign of education, that our problem is not their problem and their problem is not ours. I have had that matter up with some of them, and Mr. John Garner, whom I have known intimately well for many years, and who represents the lower Rio Grande District in congress, as you gentlemen know, I think is pretty thoroughly alive to the fact that the lower problem does not involve the upper waters of the River; but that is not true of a good many of their people. They are somewhat alarmed at our assumption that we own the Rio Grande above Fort Quitman. I think they will be convinced that whatever we do with the Rio Grande above Fort Quitman will not be in the slightest way injurious to their interests, just as I am inclined to believe, and hope it will be found, that the use of the waters of the Pecos above Fort Sumner is not injurious to the people below Fort Sumner in New Mexico and Texas. I believe we will convince them of that fact, but I think in order to do that it is absolutely essential that the State of Texas should be represented by someone who does not bring to the question a local bias. I believe I am broad-minded enough to see it from their standpoint as well as ours, but I would not expect them to believe that I see it as fairly from their standpoint as ours. They might very well be pardoned for thinking otherwise, because I have lived all my life, practically, at El Paso. The other problem, and it is important, I think, even if the Governor should designate a representative at this time, comes to his desk without any funds whatsoever. The leg-

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islatures of Colorado and New Mexico each made an appropriation to cover this. The Legislature of Texas did on the Pecos, just as the New Mexico Legislature did; but if the Governor should appoint someone -- and I am frank to say that I have had in mind an appointment -- that at least our people would recommend, and we are going to try to get the lower Rio Grande people to join us intthe recommendation, if they will, the appointment of the President of the Texas Conservation Association, a man of eminent ability and fine character, who resides hundreds of miles from both of us, and of no local bias whatsoever in the matter. But, of course, he would then need some engineering assistance; he would perhaps need legal assistance, since he is not a lawyer. And he would be very seriously handicapped in that respect, even if the Governor should appoint him without legislative authority since there would be no funds available for him to use in obtaining either legal or engineering assistance. That, however, is a matter that addresses itself more to the Governor than myself, and it is possible, even, that the Governor might find the means of meeting that difficulty. Our State Legislatures -- I don't know that the rest of you have that -- but our State Legislature is very jealous of appointments by the Governor not authorized by itself, and since I have had the honor to represent Texas in nearly all sorts of conservation meetings in Washington and elsewhere since President Roosevelt called the conference in which I represented Governor Campbell, the Commission always informs us that this is an honorary appointment, without legislative authority, and that the State makes no provision for the expenses of its commissioner. That is not true in cases where it is authorized. They did this when its attention was called to such a Commission on the Pecos. I may say that being absent at the time the Rio Grande Commission was formed, I was not called upon

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until after it was practically a fact accomplished, as the French say, or I might have done something at that time toward having that matter taken up, but I was absent and when I got back the legislation, I believe, had passed the Colorado Legislature, and was on its last lap in the New Mexico Legislature, if it had not finally passed, and the Texas Legislature was on the eve of adjournment, so it was practically impossible to do anything with it. However, as we understood it, and I am somewhat astonished to learn that that information is not correct, the legislation in neither Colorado nor New Mexico authorized participation by Texas, as we read the bills, or we may have had an imperfect copy.

MR. NEEL: Would there by any question in your mind about the Texas Legislature authorizing a representative on this Commission?

MAJOR BURGES: Not the least. I am sure, and I have the assurance of Governor Neff, and I have no objection to adding further that I went to Austin recently to talk to Governor Neff about that situation at the instance of the El Paso water users, and he told me at that time that he would in his message to the Legislature recommend that the Legislature authorize the participation of the State of Texas in the deliberations of this Commission, but he was inclined to think that the legislation of the other two states should be so amended as to include the State of Texas. I think that is important too, because otherwise I believe it would be a rather embarrassing situation, for the legislature of the states to authorize a certain state to participate, and then for another one to be participating without that recognition.

MR. NEEL: I think there is no doubt in the world that

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all the Rio Grande interests will unite, no matter which way the election goes, and that the New Mexico Legislature will do whatever they are asked to in the way of amending the law and continuing the Commission. I am certain of that.

SECRETARY HOOVER: I believe it would have a much better influence on public opinion if this Commission were authorized to act by legislative authority all the way around.

MAJOR BURGES: I think our battle would be half won if we were so constituted.

SECRETARY HOOVER: I do not know how difficult it would be for Congress to authorize a Federal Representative, but it would certainly carry more weight with it than purely an informal Commission.

MAJOR BURGES: Did not Congress authorize the appointment in the Colorado River Act?

SECRETARY HOOVER: Yes.

MAJOR BURGES: We wanted it in the Pecos River case, but Mr. Davis told me that he thought, and was so informed by others, that the prospect of getting any such action in the closing weeks of Congress was very difficult, if not impossible, and that he apprehended the President would designate somebody, as he did. He designated Mr. Peters, of the Reclamation Service; but undoubtedly it would aid in the ratification of the treaty if it were constituted formally by Act of the Legislatures and of Congress, although I presume that if the State Legislatures have acted, and the President has made an appointment, that probably the Presidential appointment carriesweight enough. Of course, it is not an unusual thing for the President of the

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United States to designate someone to represent the United States in official matters of this kind, without an Act of Congress, but at least in our state it is not so, and as I say, they write that very broadly across the face of our Commissions with the admonition I just quoted a moment ago.

MR. CARPENTER: It has not been the custom in any of the Western States, because there has never been any necessity for it; but in facing this problem in Wyoming, Nebraska and Colorado, the Governors have acted, as I say, without legislative acts, although their action was unusual.

SECRETARY HOOVER: I do not know what actual intrinsic difference it would make. I assume the legislatures all meet in January.

MAJOR BURGESS: The second Tuesday in January.

SECRETARY HOOVER: The differnce would not be very great in the progress of the work of the Commission.

MR. TAYLOR: I would like to itensify the importance of that psychological feature that you have referred to. In my District, the one warning I get from the water users, in going ahead with this procedure, is the possibility that our interests at sometime may be different from the interests of the El Paso Valley, and that unless we are very careful, that we proceed with the full acquiescence of the people in the lower valley, there may be questions of water supply which may at some time limit the project, and which might be interpreted by our friends below as being a limitation which would affect New Mexico's interests only. We have the City water supply of El Paso that may come up, and out people are a little bit doubtful of the propriety of going ahead unless Texas is fully and legally represented in

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every respect.

SECRETARY HOOVER: On the Federal side, any formal representative here has this difficulty, that the Reclamation Service is now practically the dictator of the water divisions up and down the upper Rio Grande. Isn't that so?

MAJOR BURGES: I think so.

SECRETARY HOOVER: Looking at it broadly, and from the point of view of right and wrong, I have had the feeling that if Congress authorized a representative here it would be a little more effective. At the present time, the present Directors of the Reclamation Service are in agreement that the Service has for many years gone outside of its authority and function in all these relationships; but there is a large fraction of people who support the notion that the Reclamation Service should arrogate this control, and it might tend to strengthen the position of the whole Commission, and the whole compact, if the thing was set up legislatively from a Federal point of view as well. It is a very thin line; it does not carry one very far in practical results, except for the influence and weight which the Federal situation might carry.

MR. SETH: Mr. Hoover, in the present instance, the Reclamation Service has done nothing. If you had had an Act of Congress with the direction which our New Mexico Legislature carries. that the State Engineer furnish all assistance available, if you had a similar provision with reference to the Reclamation Service, I would imagine at least that there would have been an earlier action in that respect by that Service in presenting the rights of the Rio Grande project.

SECRETARY HOOVER: There is one other phase to this

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Work, it strikes me. I have sat on two or three of these Commissions, and I have learned something of the Colorado one also, which I have applied with some success, and that is the desire to take the necessary time to go into the necessary engineering features. We had to waste a lot of time in the Colorado Commission in trying to arrive at the facts which should have been determined before we ever began to sit. In other words, up until the last day we were not in agreement as to what the flow of the Colorado River was at any one point.

MAJOR BURGESS: That could be repeated for the Pecos River Commission. You are talking about the Pecos right now.

SECRETARY HOOVER: Possibly the engineers never could entirely agree.

MR. CARPENTER: In the main, they could agree.

SECRETARY HOOVER: Yes, in the main, they could agree. It is infinitely easier for a Commission of this kind to proceed if it starts with certain accepted facts. If, on the other hand, we would start in tomorrow on this work, we have got to go to work and develop the engineering facts right straight through. Now, we have four agencies that are concerned, from the engineering point of view, three states and the Federal Government, and we have not before us the views of engineering staffs with regard to certain functions of that problem. They have not been considered together.

MR. CARPENTER: The engineers, collectively, have never conferred.

SECRETARY HOOVER: Now, just in the line of thought of proceeding to get this Commission effectually created: It would be of very great assistance if it were set up legislatively,

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and if there was that requirement of the four engineering staffs that their views should be at our disposal, we could then determine the primary facts before going to work.

MAJOR BURGESS: The Act of our Legislature, for instance, on the Pecos River, authorizes the Commissioner on behalf of the State of Texas to employ such engineering and other assistance as might be required. I am inclined to think that that was a mistake. I thought they had better have said that the State Board of Water Engineers should be at the disposal of the Texas Commissioner; but, however that may be, they had a perfectly competent engineer, probably more competent than any member of the State Board of Water Engineers; but in this case I apprehend that if the matter comes before the Texas Legislature, the State Board of Water Engineers will be directed to cooperate with the State Commissioner, and they, I am quite sure, if they take the view of the Rio Grande which we take, and which I am very confident we will convince them is correct, it will be a compelling factor with the legislatures in the ratifying of the compact.

MR. CARPENTER: Would it embarrass you if I asked what the situation would be with a change of administration?

MAJOR BURGESS: We do not anticipate any trouble. I have not admitted any change but one. We are facing the situation in Texas, frankly, that is a little unusual. It is true that Dr. Butte may be elected Governor of Texas. I am just judging the future by the past. I do not think that is highly probable, but it would be a bold man who would say that it might not happen. Now, Dr. Butte is a man of eminent qualifications and high character, and while he has never been in political life, having been only in public life as a professor, he is a man, as I say, of

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ability and character, and I have no doubt that he would take hold of this subject without bias, and in a broad gauge sense of way. I have contemplated the other change of administration, because, of course, that would arise in the natural course of events. Governor Neff goes out in January, and the supposition is that "Ma" goes in. She may, or she may not. If she does, there is nothing to apprehend in carrying out the policy that Governor Neff would carry out if he remained in office, and I have not the slightest reason to suppose that Dr. Butte would take any other view.

MR. CARPENTER: No one is more sensitive to the psychology of the situation than I believe the Commissioner of Colorado is. I fully appreciate the advantage of prior legislative authority. It lessens the work of the Commission. It removes a number of embarrassing details. It has a great educational advantage. I am urged by my people, however, to leave no stone unturned to keep the work of the Commission progressing. They have so long suffered what they consider an outrage, that they are restless; they feel that relief has been denied them for too long a period, and they are very unanimous in their urgings that we proceed this fall if possible. I do not wish to imply that these people are other than impatient. They simply feel that now that we have it started, we should keep going. I think I fully appreciate the advantage of having the "compulsory" if I may use that word, mandatory cooperation of engineering experts, and the advantage of being able to employ those necessary. The Acts of our Colorado Legislature provide, when read together, for state officials to aid, and then authorize the additional employment of such experts and assistants as may be necessary, it being the object of the legislature to equip the Commission with all necessary aid. I may say that the State of

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Colorado up to date has been very earnest in its efforts to forward the work of these Commissions. The legislatures have proceeded with unaminity in that respect. If the work is thought advisable to be delayed, you need expect no adverse action on their part, that is, the part of the Colorado Legislature. Of course, personally, I am willing to accede to the common view of the members of the Commission, and yet personally I am impatient to proceed because I probably have been giving more time and individual effort to this work than the other members, and naturally being ready myself, I am probably a little bit too insistent.

MR. SETH: While New Mexico can be ready without any question by next month, with such data as it will present, any procedure now without Texas being in I think will be an unwise step. I have no assurance of ratification. Isn't that true, Mr. Taylor?

SECRETARY HOOVER: Supposing we were going to devote ourselves to this problem from now on, would not two things happen; one that it would create a state of alarm in Texas that we are going ahead here without due consideration of her position, on the other that we are in fact going faster with the discussion than our engineering data warrants?

MAJOR BURGESS: I believe both of those facts are as stated. I believe that to proceed without laying the matter before the Texas Legislature jeopardizes our prospect of approval by the Legislature, and I think that it will be impossible for the case of the State of Texas to be laid before the Commission in such a way that the people of that state would feel that it had been adequately presented, and therefore that the compact should not be ratified. I do not want to take up too much time

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discussing it. But, for instance, let us suppose that the Governor of Texas should ask some distinguished man from the portion of the State in no wise interested in the Rio Grande to act as a Commissioner. I will assume that that man through patriotic motives would agree and would perhaps meet his own expenses, assuming that the Governor did not find expense money. He would not, however, feel warranted in personally employing engineering experts, and certainly not in obtaining legal advice, and if he had to state that that had been volunteered to him, and, for instance our people might be willing to volunteer both, that is, might be willing to give him the engineering advice and legal advice, too, would he not then go before the legislature handicapped with that very fact that his conclusions had been based upon the voluntary action of people who have a legal interest in the question, and not a state-wide interest in the question? I think it would be so embarrassing to him that the sort of a man we want on the Commission would hesitate to undertake it. He probably would say "I will be present at the discussions, but I do not feel that I ought to undertake this on the legal and engineering advice of volunteers from one or both sections of the Rio Grande valley."

SECRETARY HOOVER: He would be sort of an unofficial observer.

MR. CARPENTER: People of the San Luis Valley have been disturbed with the fear and apprehension that Texas would come forward and claim water for the irrigation of land near Brownsville, feeling that the burden of such a demand which they think would be unjust would naturaly fal l upon the source of supply, the major portion of which is in Colorado. The expression of views by you, Major Burgess, is quite assuring in that respect.

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If Texas could be persuaded to proceed upon the theory of adjusting river problems above Fort Quitman, I don't believe our people would object to the delay. Frankly, this is the way they feel. For years and years they have sought by every method within their command, and especially in the years when they had the finances to proceed, to have a reasonable removal of what is known as the Embargo Act on Development. Those efforts have been futile. The Reclamation Service, as a matter of ample caution, has held firmly to this position. It has caused a feeling that the whole lower end of the river is against the upper, and that what New Mexico and Texas want to do is to strangle future developments in the upper country. Now, naturally that has put them in a frame of mind that they look with apprehension upon the coming in of Texas, for fear of the Brownsville demands; be that as it may, we can proceed no faster than the whole Commission thinks advisable.

MR. SETH: Wouldn't it be more likely, Major, in your opinion, to arouse the Brownsville people for the Governor to appoint an informal, unofficial observer, as the Secretary has called him, than to have the Legislature act,

MAJOR BURGESS: I think it is of the utmost importance in Texas, and as I say, our interest is as a great in separating those two Rio Grande problems as yours is. As we see it, I think it is of the utmost importance that the Legislature of Texas should authorize the Governor to proceed, and I believe it is of the utmost importance that the Governor should appoing somebody who has not a local interest in either the upper or the lower Valley. It is the expectation to urge that rather strongly upon the Governor in making his appointment, that he do not tangle the question up with any local sentiment of either the upper or

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the lower valley, because I am rather confident that any capable and fair-minded man to whom the facts are presented will arrive at the same conclusion that we have arrived at, and without the suspicion that his interest or his wish is farther to his thought.

SECRETARY HOOVER: The engineering fact would probably bear upon that also, if the flow were developed to its maximum extent. The probable flow at Fort Quitman would be possibly greater than it is now. I don't know what the course of the river is.

MAJOR BURGESS: As a matter of fact, it has a negative flow now, and I think it will always be so. It is quite true that there are some flood waters that pass Fort Quitman, but they are not large; in fact, they are rather small, and they go for hundreds of miles then before there is any opportunity to use them. If it were not for the in-flow into the river, there would be no Rio Grande River at Del Rio, for instance. The water that passes Fort Quitman might run down, as it does, in a dry canon at times. There would not be any river. There would be a torrential stream; but there would be no river if there were not tributaries below Fort Quitman to keep it a perennial stream. Of course, as you gentlemen know, the Rio Grande below Del Rio is always a considerable river; it is very large at times, and moderate in size at times. But that is due to the tributaries that flow in it below Fort Quitman, and the water that it gets at Fort Quitman.

MR. CARPENTER: The river never goes dry at Fort Quitman now?

MAJOR BURGES: The river has not been dry in the El Paso Valley since the Elephant Butte Dam came into service. There has been no absolute cessation of flow. Of course, that

is due partly to the drainage canals.

MR. CARPENTER: Naturally, it is the result of irrigation, the drainage.

MAJOR BURGES: Yes.

MR. CARPENTER: That is the matter to which Mr. Hoover referred.

SECRETARY HOOVER: The whole effect would be to wipe out the whole flood flow, if there is any, and the return flow would possibly tend, as it has in other rivers, to create a better all around year flow at Fort Quitman than is now the case.

MAJOR BURGES: That is quite probable. The perennial flow of the rivers I have seen, and I believe I have been on nearly all the irrigation projects of the United States, the perennial flows of practically all streams were improved by the construction of reservoirs on those streams. They served the same purpose as natural lakes.

SECRETARY HOOVER: And irrigation has very much the same effect.

MAJOR BURGES: Undoubtedly it has. The fish, game and oyster commissioner appealed to the Governor in wild alarm, that I was about to destroy all the rivers of Texas by daming up all their waters, and the Governor sent for me and said he had this warning from the fish, game and oyster commissioner, and would like to know how about it. I asked him if he had been on the Medina River west of San Antonio since the irrigation plant there had been established, and he said he had. I said,"was it a better or a worse river?" And he said it

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was better. I said, "I think you will find that is true on all rivers." The perennial flow is improved by the construction of reservoirs and the irrigation of lands.

SECRETARY HOOVER: Before the construction of the Elephant Butte Dam, was there a heavy flood flow?

MAJOR BURGES: Yes, at times very disastrous floods; and then for weeks and weeks, when the river was perfectly dry, I went and opened its streams in the bed of the river.

SECRETARY HOOVER: The whole situation, as affected by the Elephant Butte Dam, would have to be considered in relation to the lower section of the Rio Grande, that their situation has been definitely improved.

MAJOR BURGES: At least, that is a matter that should be considered if they insist upon including this in the problem.

SECRETARY HOOVER: Convince them that they are not interested, and I believe that will be the final decision on their part. If, on the other hand, they insist on having an interest, having recognition in the flow, it practically makes any question of the upper flow of the river impossible for them having any participation.

MAJOR BURGES: It would very gravely complicate the matter.

MR. NEEL: It would necessarily bring in the Republic of Mexico. Below Del Rio, as I take it, the main supply, the large part of the supply comes from the Republic of Mexico.

MAJOR BURGES: That is correct. Their tributaries

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pour in more water than ours.

MR. CARPENTER: Mr. Neel, how much is the river increased.

MR. NEEL: Between two and three million acre feet. It is probably nearer three million.

MAJOR BURGES: Do you know the state of the Pierson Dam? Was it injured in the revolution?

MR. NEEL: No. The records I refer to were records prior to the construction of the reservoir, largely.

MAJOR BURGES: I have a little information myself, and I wanted some information as to the effect on the contribution of the Pierson Dam.

MR. NEEL: Five hundred million acre feet annually passing into the North.

SECRETARY HOOVER: It seems to me to be the proper thing to delay this proceeding until Texas is fully and competently represented.

Mr. Carpenter: Or until she has had reasonable opportunity.

SECRETARY HOOVER: Of course, if Texas does not want to be represented -

MAJOR BURGES: They acted on the Pecos matter as soon as it was called to their attention. The people are coming to realize that these water problems mean more in the upbuilding of the community than almost anything the legislature has to touch upon.

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SECRETARY HOOVER: There is also the question of the people of the San Luis Valley, that what this Commission is going to do is to regulate that. If nothing can be done which is beneficial, these questions must go into the courts, and we are then into clutches of two doctrines, one the equitable division of water, and the other the prior application to beneficial use, both of which ideas conflict; but in any event either one of them cannot be brought to a conclusion under eight or ten years of hard litigation.

MR. SETH: And very expensive.

MR. CARPENTER: We are fully cognizant of the expense.

MAJOR BURGES: That has been one of the considerations in the Pecos Case, the fact that there were years and years delay, probably not less than ten, and costly litigation, during which there would be no storage in either state. That has been a very powerful inducement to the people of that valley to get together in a spirit of sweet reasonableness, as I believe some philosopher once called it.

MR. SETH: In New Mexico, on the Rio Grande, there are thousands of native Mexicans with small holdings of irrigable acres, and in order for them to bear their proportion of any interstate litigation would mean almost confiscation, and that has been a very strong argument in our state for the compact idea; and I have not the slightest doubt that any reasonable compact that will bind everyone interested will be ratified.

MR. CARPENTER: Our people have no fear of the final outcome if we keep going. The only fear, as I say, with Texas is that by injecting the lower river country, they would bring

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about an impossible condition, and consequently a fear that it was the desire to provoke delay that was not necessary. Of course, we are naturally anxious to come to the aid of people long oppressed.

MAJOR BURGESS: Of course, as far as the state of Texas is concerned, I think no delay could be imputed to it. The legislation of these two states, as it reached us, and I am glad to be corrected if it is wrong, did not include the State of Texas — the Colorado Legislature — and if we had gone before the legislature in its closing days, I think we could have done nothing with it in view of legislation, as we understood it to read, and as it undoubtedly does in New Mexico, and the copy which I had did in Colorado, — the Governor, as soon as the matter was called to his attention expressed himself at once as willing to act in the matter as far as he could without legislative authority, but I think the more he considered it the more inclined he was to believe that he would not accomplish anything by having somebody listen in on the deliberations, and I think that he felt also that an attempt to authorize a man to do anything more than that might arouse the opposition of the legislature; and I believe that his apprehension in that regard is correct; I believe it would be dangerous.

SECRETARY HOOVER: The people of the San Luis Valley are the ones who are most anxious to have the situation cleared up. Assuming that a compact was arrived at between New Mexico and Colorado, it must come before Congress, and with the opposition of the State of Texas, if they were not a party to it, it would stand but little chance of passing. It would be very seriously jeopardized.

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MR. CARPENTER: There is no question but what the jeopardy would be increased with such a situation.

MR. NEEL: Texas would enlist the aid of the South on the question of State-Rights' proposition.

MAJOR BURGES: May I say that it would even be broader than that? I have given this matter quite a little bit of thought, and it seems to me it would not be sectional at all. If a compact which might on the face of it appear to vitally affect three or more states was brought before Congress for ratification by agreement between two of those states, would not the delegations from every other state rally to the state which had not been invited to participate, we will say, on the ground that the same thing might arise at any other time? This compact idea, I am disposed to believe, has a very large future in the United States. There are many questions that are going to come before the states for agreements as soon as this path is beat out, and an agreement between two of the states on a river that affects more than those two, in which the other one was not a participant, and in which there was even no provision for it to participate, I think would before doomed to failure in Congress, because every state would feel that this is too dangerous a precedent.

MR. CARPENTER: That would be true unless the compact left the lower section unimpaired.

MAJOR BURGES: Entirely. Of course, if there is a provision in there that this does not affect any interest in that state --

MR. SETH: But then we haven't accomplished anything.

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MR. CARPENTER: We have accomplished something, but not what we want.

MAJOR BURGES: I have no objection to saying here that we considered in a meeting of our own Board the question of whether our interests would be adversely affected by any sort of participation in the work of the Commission, and we arrived at the conclusion that any participation on our part -- and I say this in view of Judge Seth's remark, which is true, that the El Paso District has taken no steps yet whatever -- we reached the conclusion that if we participated in the work of this Commission, that anything we said might be taken to be a confession against interest as far as the rest of the State of Texas was concerned. They might say, "If you agreed to it, it binds you, but it does not bind us, and if we had any rights in the waters of the Rio Grande, and we think we did, when you agreed to limit the amount that the State of Texas got, you limited your right, and if it is ratified by the legislature it may limit the State of Texas right, but it still leaves us open to demand what we would have been entitled to if you had not conceded that we were not." It might prove highly detimental to us. It is exactly the same situation that has been suggested here by Mr. Taylor, the fear by the people in his Valley that if the State of Texas were not bound it might work to the detriment of the New Mexico end of the Rio Grande project, and we feel that if we participated in the work of the Commission in arriving at a conclusion it might be used against us subsequently by other interests in the State of Texas, whereas if we can bring them before the court, so to speak, we will preclude them by the judgment, we hope.

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MR. SETH: There is another feature of this river matter that seems to me makes Federal Legislation advisable, and that is the treaty with Mexico. The Federal Government must see that it is carried out. I would suggest, if we do postpone this, that we endeavor to get legislation by the three states in identical language, as far as it is possible, so that there will be no question.

MR. CARPENTER: The language would not be so important, but we should cover the same ground.

MR. SETH: Cover the same ground.

MR. CARPENTER: It might interest you to know, Major Burges, that Mr. Meeker, our expert, in all his studies of this river, and I think Mr. Neel considers it true of New Mexico, has at all times taken into consideration Texas as a party which should be included in our deliberations, whether bound, or not. In fact, we have proceeded on the theory that the ultimate result would be a settlement of the uses above Fort Quitman, and we were very keenly disappointed when we found there was no activity at El Paso, because we wished the benefit of counsel of these people, not that we cared to bind them one way or another, however; so it is very agreeable to us to have the participation of Texas, especially in view of the situation you have outlined; and if it comes down to a matter of delay, if we do not lose any ground, any benefit of our labors up to date, we have no serious objection to delay, if that delay is a progressive delay, one that is going to get us somewhere, but if the delay would mean the breaking up of the objective, then our people would never cease toregard the delay as a matter which should not have been consented to.

MAJOR BURGES: I don't think you have the slightest reason

to anticipate that the State of Texas will not act promptly, and in a spirit of friendly cooperation with the other states, and with the United States, in the matter.

MR. SETH: As far as New Mexico is concerned, the work done is just as available for future use as it would be now, and there is not the slightest doubt in my mind that the New Mexico Legislature will do whatever it is asked to do, no matter what the outcome of the future may be.

SECRETARY HOOVER: Well, in order to get some definite formulated idea upon this point, we ought to formulate some sort of a statement that we can put in as a sort of an Act of this preliminary conference.

MR. SETH: I think so.

SECRETARY HOOVER: Perhaps Colorado does not want to propose the delay, and I would suggest that perhaps Mr. Seth could properly make such a motion.

MR. SETH: I will make the motion, Mr. Chairman, that in view of the fact that the State of Texas is not represented, and has indicated a desire to be represented on this Commission; that her interests will be vitally affected by any action which this Commission might take; that there can be no complete determination of the problem without the participation of Texas, therefore this Commission proposes that the Governors and Legislatures of Colorado, New Mexico and Texas should have an opportunity to provide that the commission be composed of representatives from each of those states, together with the representative of the Federal Government, to arrive at an equitable and proper division of the waters of the Rio Grande by compact, for submis-

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sion to the Legislatures of the respective states and Congress. Should the State of Texas fail to take the necessary action, then the Commission proceed as originally outlined.

MR. CARPENTER: In view of the situation, particularly as explained by Major Burgess, and further in view of the desire of Colorado that Texas join with us in a progressive movement toward arriving at a compact affecting all the problems of the San Luis Valley, to the end that they may be permanently adjusted, I concur in the motion of Mr. Seth.

SECRETARY HOOVER: It appears to me that in order to arrive at a finality in all aspects of this problem, and thus to avoid costly and prolonged litigation over the interstate rights involved, we should impress upon each of the states that a settlement of part of the problems by two states without embracing those elements which concern also a third state, would not be a complete settlement. Despite the delay of two or three months that would be incurred, this delay will be infinitely valuable, if, as a result, we are able to set up a competent representation leading to a complete solution of all the problems of the upper Rio Grande. I therefore declare it to be the sense of the Commission that Mr. Seth's proposal be adopted.

I will add to my statement that the above is the sense of the meeting, and the Commission will adjourn until opportunity for action has been given to the State Legislatures.

MAJOR BURGESS: May I suggest that you use the expression "unofficially presented", instead of "unofficially represented." I don't want to be hypocritical, but I believe the word "represented" might raise some question, whereas if it is "unofficially presented", I certainly would have a right to do that.

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MR. CARPENTER: The minutes may be corrected in accordance with Major Burges' suggestion.

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DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY

CENTRAL CLASSIFIED FILE
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DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WASHINGTON

OFFICE OF THE COMMISSIONER

November 12, 1924.

DEP'T OF THE INTERIOR
RECEIVED
NOV 12 1924
SEOY'S OFFICE
APPTS., MAILS & FILES.

The Secretary of the

Interior.

My dear Mr. Secretary:

In compliance with your oral request, there is transmitted herewith a statement dated November 11, 1924, on "The Embargo on the Upper Rio Grande."

Respectfully yours,

Elwood Mead

Commissioner.

enc. 4645

8-3
Rio Grande.
Distribution of
Waters.
(Loose File)

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THE EMBARGO ON THE UPPER RIO GRANDE.

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THE EMBARGO ON THE UPPER RIO GRANDE

By Ottamar Hamele
Special Attorney Representing the Bureau of Reclamation
before the Rio Grande Commission.

First Settlements in Rio Grande Valley.

Spanish explorers under Coronado, moving easterly from the Pacific, reached the valley of the Rio Grande before the middle of the sixteenth century. They found the Pueblo Indians irrigating fields of wheat, corn, fruit and flowers from the waters of this river and its tributaries. The acequias then in use indicated great age, and suggested the existence of a prehistoric people of substantial population.

The Ysleta Church below El Paso and the Juarez Cathedral across the river, probably date back of the middle of the sixteenth century. The City of Juarez, Mexico (formerly called Paso del Norte) was an important town in the year 1600. Its diversion from the Rio Grande (Acequia Madre) quite likely was constructed more than 350 years ago.

The first attempts of the Spaniards to colonize the valley of the Rio Grande were carried on from Juarez as a base. Santa Fe was made the capital of New Mexico in 1605. Bernalillo was founded about the year 1700 and Albuquerque in 1706. Permanent settlement in the San Luis Valley in Colorado was not begun until after 1850. The town of Conejos was founded by Mexicans in 1855, and the Mormons established Manassa in 1878.

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Pioneer Irrigation Developments.

As already stated, the Acequia Madre at Juarez is probably 350 years of age. The rights under the Ysleta, San Elizario and Socorro ditches at El Paso are quite ancient. Each permanent white settlement in the Rio Grande Valley represents at least one diversion substantially as of the date of the settlement. In addition to these were the earlier irrigation rights of the Pueblo Indians.

The first half of the last century saw a considerable extension of irrigation in this region. The El Paso city ditch (formerly Ponce acequia) was built in 1827. In the Mesilla Valley, in New Mexico, the Dona Ana ditch was constructed in 1844, the Las Cruces ditch in 1849,and the Mesilla ditch in 1850. In the San Luis Valley in Colorado, the People's Canal on Culebra Creek has an appropriation dating from 1852.

Extent of Irrigation Prior to 1880.

Baron von Humboldt who visited Juarez in 1806 wrote as follows regarding that region:

> Travelers are in the habit of taking a short rest at Paso del Norte (Juarez) in order to lay in provisions so as to proceed on their way to Santa Fe. The country around El Paso included splendid fields comparable with the best in Andalusia. The land is sown with corn and wheat; the vines bear excellent grapes preferable even to those of New Biscay, and the gardens yield an abundance of European fruit such as peaches, apples and pears. As the soil is very dry, an irrigating canal brings water from the Rio Grande to El Paso. (Travels of Humboldt, Vol. IX, p. 265, German edition).

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Major William Emory of the U. S. Army, who explored the Rio Grande in 1852-1854, described Juarez and vicinity (the El Paso Valley) as a "continuous vineyard," and stated that an area extending for twenty miles on both sides of the river was in cultivation.

In 1880 this area consisted of approximately 25,000 acres on the Mexican side supporting a population of about 20,000, and approximately 15,000 acres on the American side with a population of about 10,000. It is estimated that 550 second-feet of water were diverted for this irrigation.

In the same year there were irrigated from the Rio Grande in the Territory of New Mexico, approximately 183,000 acres, demanding the use of about 5,600 second-feet of water, and there were irrigated from the Rio Grande in the State of Colorado, approximately 122,000 acres requiring about 3,700 second-feet of water. Of the area in New Mexico, about 10,000 acres were irrigated in the Rincon Valley, and about 31,000 in the Mesilla Valley, just north of El Paso.

Complaints from Mexico.

In the early eighties of the last century complaints began to be made on behalf of irrigators in Mexico, to the effect that irrigation in the United States had been increased to such an extent as seriously to deplete the water supply used for centuries on the lands in the vicinity of Juarez. The diversions

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particularly complained of were those in the San Luis Valley in Colorado. These complaints, voiced at first by individual landowners, later were taken up by the Government of Mexico with our State Department at Washington. It was contended by the Mexican authorities that the diversions in the United States were in violation of the treaty of Guadalupe Hidalgo of February 2, 1848 (9 Stat., 22), and that damages amounting to upwards of $35,000,000 had been sustained by the citizens of Mexico. It was suggested that a dam be constructed across the Rio Grande to provide the water to which the lands in Mexico were entitled.

General Stanley of the U. S. Army, commanding the Department of Texas, in his official report dated September 12, 1889, says on this subject:

> Our relations with our Mexican neighbors upon the long line of the Rio Grande have been kindly although they are a good deal excited over what they deem the violation of their riparian rights through our people taking all the water of the Rio Grande for the irrigation of the San Luis Valley, which leaves the Rio Grande a dry bed for 500 miles. The question is one that must be settled by the State Department, and thus far there has been no call for military force. The remedy for this water famine and consequent ruin to the inhabitants of the Rio Grande Valley must be found in storage reservoirs, so easy of construction, one in the canyon opposite Taos and the other in the canyon near and north of El Paso.

Concurrent Resolution of April 29, 1890.

There ensued several years filled with bickerings over this matter. Americans became interested from a financial

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standpoint in the proposed international dam, and bills to provide for its construction by the United States were introduced in Congress. A bill of this character (S. 1644-H.R. 3924) introduced in the 51st Congress(1889) provoked considable discussion. The agitation culminated in the passage on April 29, 1890, of a concurrent resolution authorizing the President to enter into negotiations with the Government of Mexico for the purpose of remedying the difficulties existing between the two countries on account of the depleted water supply in the Rio Grande. Under treaty of March 1, 1889 (26 Stat., 1512) there was created an International Boundary Commission to pass on matters affecting the common boundaries of the two countries on the Rio Grande and the Colorado, but this commission was not authorized to consider the question of the depleted water supply, as has been frequently erroneously stated. A copy of the concurrent resolution of April 29, 1890 marked Exhibit A is attached hereto.

The Rio Grande Dam & Irrigation Company.

For several years immediately following the passage of the concurrent resolution of April 29, 1890, little or nothing was done by our Government to carry out the purpose of the resolution. In the meantime, Sections 18, 19, 20 and 21 of the statute of March 3, 1891 (26 Stat., 1095), authorizing rights of way over the public lands for canals, ditches or reservoirs,

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was enacted into law, and on February 1, 1895, by approval of the Secretary of the Interior under said act, a private concern known as The Rio Grande Dam & Irrigation Company, secured a right of way over public lands to construct a large irrigation dam across the Rio Grande near Elephant Butte in New Mexico, about 120 miles above the city of El Paso. Sections 18, 19, 20, and 21 of the right of way act of March 3, 1891, are marked Exhibit B and attached hereto. The dealings of the Government with The Rio Grande Dam & Irrigation Company will be referred to later.

More Complaints from Mexico.

The activities of The Rio Grande Dam and Irrigation Company led to renewed efforts on the part of the Mexican authorities to secure action from this Government under the concurrent resolution of April 29, 1890. It was realized that those in control of a large private dam across the Rio Grande in New Mexico would be able still further to reduce the water supply available for the Mexican lands. Also it was assumed that if the proposed developments of The Rio Grande Dam and Irrigation Company were carried out it would be infeasible to construct the proposed international dam at El Paso. Under date of October 21, 1895 the Mexican Minister, M. Romero, sent a vigorous letter to Secretary of State Richard Olney, urging action under the concurrent resolution. A copy of this letter marked Exhibit C is attached hereto.

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Opinion of Attorney General Harmon.

By letter dated November 5, 1895, the Secretary of State transmitted to Attorney General Judson Harmon, a copy of the Mexican Minister's letter of October 21, 1895, referred to the concurrent resolution of April 29, 1890, and requested answers to the following questions:

(1) Are the provisions of article 7 of the treaty of February 2, 1848, known as the treaty of Guadalupe Hidalgo, still in force so far as the river Rio Grande is concerned, either because never annulled or because recognized and reaffirmed by article 5 of the convention between the United States and Mexico of November 12, 1884.

(2) By the principles of international law, independent of any special treaty or convention, may Mexico rightfully claim that the obstructions and diversions of the waters of the Rio Grande, in the Mexican minister's note referred to, are violations of its rights, which should not continue for the future, and on account of which, so far as the past is concerned, Mexico should be awarded adequate indemnity?

On December 12, 1895 the Attorney General rendered an opinion which is to be found in Volume 21 Ops. Atty. Gen'l. at page 274. The following is the syllabus or the decision as found in the report:

Article VII of the treaty of February 2, 1848, between Mexico and the United States, known as the treaty of Guadalupe Hidalgo, is still in force, so far as it affects the Rio Grande.

The taking of water for irrigation from the Rio Grande above the point where it ceases to be entirely within the United States and becomes the boundary between the United States and Mexico is not prohibited by said treaty.

Article VII is limited in terms to that part of the Rio Grande lying below the southern boundary of New Mexico, and applies to such works alone as either party might construct

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on its own side.

The only right the treaty professed to create or protect with respect to the Rio Grande was that of navigation. Claims against the United States by Mexico for indemnity for injuries to agriculture alone, caused by scarcity of water resulting from irrigation ditches wholly within the United States at places far above the head of navigation, find no support in the treaty.

The rules, principles, and precedents of international law impose no duty or obligation upon the United States of denying to its inhabitants the use of the water of that part of the Rio Grande lying entirely within the United States, although such use results in reducing the volume of water in the river below the point where it ceases to be entirely within the United States.

The fact that there is not enough water in the Rio Grande for the use of the inhabitants of both countries for irrigation purposes does not give Mexico the right to subject the United States to the burden of arresting its development and denying to its inhabitants the use of a provision which nature has supplied, entirely within its own territory. The recognition of such a right is entirely inconsistent with the soverignty of the United States over its national domain.

Agreement of May 6, 1896.

While the Attorney General's opinion of December 12, 1895, held that the complaints of the Mexican authorities were not justified either under treaty rights or under the rules of international law, the State Department apparently took the position that the United States was under a moral obligation to make good the depleted water supply of the Mexican lands.

On May 6, 1896 an agreement was made by Secretary of State Richard Olney, representing the United States, and the Mexican Minister, M. Romero, representing the Mexican Government, under which Col. Anson Mills and Señor Don F. Javier Osorno, members of the International Boundary Commission, provided by the treaty of March 1, 1889, were directed to investigate and report

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as soon as practicable upon the following three questions:

1. The amount of water of the Rio Grande taken by the irrigation canals constructed 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- the present year included.

3. The best and most feasible mode whether through a dam to be constructed across the Rio Grande near El Paso, Tex., or otherwise, 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.

Joint Commission Report of November 25, 1896.

Pursuant to the agreement of May 6, 1896, the joint commission therein named proceeded to consider and report upon the three questions set forth in that agreement. The commission's report bears dated November 25, 1896.

On question No. 1 relative to the amount of water taken from the Rio Grande by irrigation canals constructed in the United States the commission reported as follows:

From the very elaborate statistical report of Civil Engineer Follett the commission find that prior to 1880 there were in Colorado 511 canals taken from the Rio Grande and its tributaries, irrigating about 121,000 acres of land; that this number of canals and amount of land irrigated has kept increasing year by year, many of the canals being enlarged during the same period, so that the number of canals at this date has increased to 925, irrigating 318,000 acres of land; and that in New Mexico there were, prior to 1880, 563 canals taken from the Rio Grande and its tributaries, irrigating 183,000 acres of land, and at the present time there are 603 canals, irrigating 186,000 acres of land.

These results show an aggregate of 1,074 canals taken out in Colorado and New Mexico prior to 1880, and 1,528 taken from the river and its tributaries at this date, showing an increase of 454 canals and of 196,000 acres irrigated in the

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State of Colorado and Territory of New Mexico. This shows quite accurately the increase for the past sixteen years. There are no reliable records available showing the increase in the preceding years, but they were doubtless on a more rapidly increasing ratio.

It will also be observed that the greatest increase during these sixteen years was in the State of Colorado, the number of canals and acres irrigated remaining almost stationary in New Mexico for that period, but this is easily accounted for by the fact that the appropriation of water in Colorado has rendered such a scarcity in New Mexico that little further increase of canals and acreage was profitable.

It is evident to the commissioners that as the flow of water in the Rio Grande had not only become scarce at El Paso, but high up in New Mexico prior to 1888 or 1889, any increase of water used in Colorado would diminish materially the flow at El Paso during the irrigation season.

Relative to the second question, concerning the average amount of water in the Rio Grande year by year, the commission reported as follows:

There are no records or testimony available which will enable the commissioners to determine this question entire with any degree of accuracy. The first record of the flow of the river here at El Paso was taken in 1889, the driest year up to that date, the river being dry as far above as Albuquerque, N. Mex., and no water passing El Paso for four months during the year, embracing August, September, October, and November. There is no tradition of such scarcity of water prior to this date- 1889- the river only being dry once in about seven years, and then only for a short period in the latter part of the summer.

For the eleven months prior to March 31, 1890, the flow of the river at El Paso was 425,000 acre-feet. This includes the long drought of 1889, before mentioned. For the year ending March 31, 1891, the flow was 1,100,000 acre-feet. For the year 1892 the flow at El Paso was 1,850,000 acre-feet. For the year 1893 the flow was 875,000 acre-feet.

During a part of this time measurements at Embudo in the Rio Grande near the Colorado line showed that the flow at that point was greater than at El Paso, there being no increase in the flow from Embudo to El Paso. This fact is mentioned to show that the supply of water both in New Mexico and in the valley of El Paso depends, for the greater part, upon that of its

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head waters in Colorado.

An examination of the old canals in use in the El Paso Valley some thirty years ago convinces us that those on the Mexican side had a capacity of about 300 second-feet, and that those on the United States side had a capacity of about 250 second-feet.

Many of these for the past five years have been constantly dry, and all of them have been dry for a great part of the irrigating season three years out of the five past.

The foregoing is a condensed compendium of the large mass of information and statistics taken by our engineers, from which we form the following conclusions:

That the flow of the river at El Paso has now been decreased by the taking of water for irrigation by canals constructed in the United States of America about 1,000 second-feet for one hundred days annually, equal to 200,000 acre-feet of water.

It will be observed that this loss is distributed through the summer flow, which at best was not always sufficient before the diminution took place during dry seasons.

It should be understood that the great mass of these waters both before the construction of the canals and since consists of flood waters carried down the river unused, being utterly unavailable without large reservoirs to hold it for the season of irrigation, the maximum flow lasting but a few days, running as high as 16,000 second-feet, generally before the irrigation season fully sets in, and an average flood of about 5,000 second-feet during about forty or fifty days in April and May.

On the third question, respecting the most feasible mode of regulating the use of the waters of the Rio Grande, so as to secure to each country an equitable right to the use of the waters, the commission reported as follows:

The joint report of the engineers develops a feasible method of building a dam across the Rio Grande near El Paso about 3 miles above) and impounding a large mass of the flood waters in a lake some 15 miles long by about $3\frac{1}{2}$ miles wide, which it is believed by the commission will so regulate the use of the waters of said river as to secure to each country concerned and to its inhabitants their legal and equitable

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rights and interests in said waters, and neither they nor the commissioners have been able to discover any other feasible mode of consummating these ends.

The joint commission is of the opinion that the present flow of the river is sufficient to maintain the reservoir as projected, but insufficient to maintain it and at the same time maintain the projected reservoir 120 miles above El Paso, in New Mexico, known as the Elephant Buttesdam and reservoir. One of these projects, in the opinion of the commission, must give way to the other, or at least, if both are built, that at Elephant Buttes must in some way be restrained from using water already appropriated by the citizens of the El Paso Valley, both Mexicans and Americans, and a method provided in case they violate these restraining rules for a prompt and efficient legal remedy for the parties injured.

* * *

It is the opinion of the joint commission that Mexico has been wrongfully deprived for many years of a portion of her equitable rights in the flow of one-half of the waters of the Rio Grande at the time of the treaty of Guadalupe Hidalgo; and if there were no other evidence of that fact than the records and measurements above referred to, it is apparent to the eye of any visitor to the locality, where can be witnessed the dying fruit trees and vines, the abandoned fields and dry canals for the greatest portion that has heretofore been cultivated; and while we are considering the equitable rights of Mexico, this is also true of the United States side, where almost the same abandonment and destruction of former prosperous farms may be witnessed.

The joint commission is of the opinion that the impounding of this large body of the flood waters of the Rio Grande would not only effectually remedy the existing troubles regarding the equitable division of the waters of said river between the two countries, but would make it feasible to control the flow in the river so that it will be practically constant and uniform and prevent the erosions and avulsions which have heretofore rendered the boundary line between the two countries so uncertain, unstable, and vexatious. It is certain that this effect will result as far down the river as the mouth of the next important tributary, the Concho River, of Mexico, and that the restraint of the torrential flow will, in a great degree, remedy the erosions and avulsions below the mouth of the Concho to the Gulf.

The Commission recommended that the two Governments enter into a treaty to provide for a final settlement of all questions,

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past and future, regarding the distribution of the waters of the Rio Grande. It proposed that the United States defray all of the cost of the dam, estimated at $2,317,113.36; that an equitable distribution of the waters from the dam be made between the two countries, and that Mexico relinquish all claims for indemnity for the unlawful use of water in the past.

On the subject of interference with the water supply on the upper river, the commission recommended that the United States-

> in some way prevent the construction of any large reservoirs in the Rio Grande in the Territory of New Mexico, or in lieu thereof, if that be impracticable, restrain any such reservoirs hereafter constructed from the use of any waters to which the citizens of the El Paso Valley, either in Mexico or in the United States, have right by prior appropriation, and provide some legal and practicable remedy and redress, in case such waters should be used, to the citizens of both countries.

The complete text of the joint commission's report of November 25, 1896, with copies of other related papers, will be found in Senate Document No. 229, 55th Congress, 2nd Session, 1898. Copies of additional papers on the general subject appear in Senate Document No. 154, 57th Congress, 2nd Session, 1903.

State Department Requests Embargo.

On August 4, 1896, while the joint commission was considering the Mexican complaints in accordance with the concurrent

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resolution of April 29, 1890, and the agreement of May 6, 1896, the Mexican Minister again addressed the Secretary of State on the subject, forwarding a petition calling attention to the distressing situation on the Mexican side of the Rio Grande, and stating that the efforts of the two Governments to remedy the condition would be fruitless if, in addition to the forty dams in Colorado, the Rio Grande Irrigation and Land Company, Limited (successor to the Rio Grande Dam and Irrigation Company) should be permitted to construct a dam across the river at Elephant Butte, New Mexico. The communication from the Mexican Minister was referred to Col. Anson Mills of the joint commission, who reported thereon under date of November 17, 1896. This report was transmitted by the Secretary of State to the Secretary of the Interior by letter dated November 30, 1896. The latter communication suggested that an investigation be made of the rights of the Rio Grande Irrigation and Land Company, Limited, and that the Secretary of the Interior decline to grant additional rights of way over public lands for dams and reservoirs under the act of March 3, 1891. A copy of the letter of November 30, 1896 is marked Exhibit D and attached hereto.

Initial Embargo of December 5, 1896.

Following the suggestion of the Secretary of State made in letter of November 30, 1896, the Secretary of the Interior on December 5, 1896, addressed a letter of that date to the Commissioner of the General Land Office directing the suspension of action on all applications for rights of way for irrigation

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purposes over public lands in the Rio Grande basin in Colorado and New Mexico. By letter dated December 19, 1896, the Secretary of the Interior reported this action to the Secretary of State, and commented upon the rights of the Rio Grande Dam and Irrigation Company. A copy of the order of December 5, 1896, marked Exhibit E and a copy of the letter of December 19, 1896, marked Exhibit F are attached hereto. The order of December 5, 1896 has been modified five times as will hereafter appear.

First Modification of Embargo, January 13, 1897.

The Pecos River flowing through Eastern New Mexico is a tributary of the Rio Grande and was included in the blanket order of December 5, 1896. However, its waters reach the Rio Grande at a point below the irrigable area in the vicinity of Jaurez, and therefore could not affect the question under discussion. This fact was brought to the attention of the Secretary of the Interior by letter of January 11, 1897 from the Secretary of State, a copy of which letter marked Exhibit G is attached hereto. Accordingly on January 13, 1897, the order of December 5, 1896, was modified by the Secretary of the Interior so that it would not apply to the tributaries of the Rio Grande which empty into that river below the point where it becomes the international boundary. A copy of the order of January 13, 1897, marked Exhibit H is attached hereto.

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Negotiations for Treaty meet Difficulty.

In letters of December 19, 1896, December 29, 1896, and January 5, 1897, from the Mexican Minister M. Romero to Secretary of State Olney, the former expressed approval of the joint commission's report of November 25, 1896, and in letter dated January 30, 1897, the Mexican Minister transmitted to our State Department, a draft of proposed treaty following the recommendations of the report of the joint commission, which draft had been approved by the Mexican Government. The position of the United States was expressed in the following paragraph taken from letter of January 4, 1897 from Secretary Olney to the Mexican Minister:

> in preparing to enter into negotiations the Department has found the subject embarrassed by greatly perplexing complications arising out of reservoir dams, etc., either already built or authorized through the concurrent action of the Federal and State authorities. Just what legal validity is to be imputed to such grants of authority, or in what way structures completed or begun are to be dealt with, are questions under careful investigation and which must be disposed of before the United States will be in a condition to negotiate.

Navigability of the Rio Grande.

The letter of January 11, 1897 from the Secretary of State to the Secretary of the Interior (Exhibit G), in addition to suggesting that the embargo be lifted from the Pecos River, also suggested that the Rio Grande was a navigable river and that before approving rights of way for dams in the Rio Grande basin, the Secretary of the Interior should assure himself that the erection of such dams would

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not in any manner interfere with navigation. By letter dated January 13, 1897, the Secretary of State addressed the Secretary of War on the subject of the Rio Grande Dam and Irrigation Company, and suggested that the Secretary of War secure from the Attorney General an opinion as to whether the proposed dam of the company could be constructed without the sanction of the Secretary of War as directed by the river and harbor act of July 13, 1892 (27 Stat., 88, 100). A copy of the letter of January 13, 1897 marked Exhibit I is attached hereto. The Attorney General's opinion was requested by the Secretary of War on February 19, 1897 and again on April 8, 1897. Delay in the matter was caused by a change in National administration. On April 24, 1897 Attorney General Joseph McKenna approved an opinion of that date by Solicitor General Holmes Conrad. This opinion is reported in volume 21 Op. Atty. Gen'l. at page 518. The following is the syallabus from the report:

> The Secretary of the Interior had no power, under the act of March 3, 1891, providing for the location and selection of reservoir sites on the public lands of the United States and rights of way for irrigating ditches and canals, to grant a right to construct dams across the Rio Grande for the purpose of checking the flow of water and distributing it for irrigation purposes.
>
> The control and supervision of the navigable waters of the United States is vested in the Secretary of War.
>
> The remedy of the United States in case of the erection of a dam across navigable waters is by injunction, under section 10 of the act of September 19, 1890, and if the dam has been constructed, also by criminal prosecution.

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Litigation with Rio Grande Dam and Irrigation Company.

In accordance with the Attorney General's opinion of April 24, 1897, suit by the United States against the Rio Grande Dam and Irrigation Company was filed in the District Court of the territory of New Mexico, Third District, May 24, 1897. The purpose of the suit was to enjoin the defendant from obstructing the flow of the waters and interfering with the navigable capacity of the Rio Grande, a navigable river, in violations of acts of Congress and contrary to treaty with Mexico. The bill was dismissed by the trial court and this decision was affirmed by the Territorial Supreme Court (9 N.M.,392). The United States Supreme Court reversed the decree and remanded the cause with directions for "an inquiry into the question whether the intended acts of the defendants in the construction of a dam and in appropriating the waters of the Rio Grande will substantially diminish the navigability of that stream within the limits of present navigability, and if so, to enter a decree restraining those acts to the extent that they will so diminish." (See U. S. v, Rio Grande Dam and Irrigation Co. (1899) 174 U.S., 690).

Again in the trial court the cause came in for hearing, and again a decree against the Government was entered and later affirmed by the Territorial Supreme Court. Again the U. S. Supreme Court reversed the lower court, and remanded

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the case with "direction to grant leave to both sides to adduce further evidence." (See U. S. v. Rio Grande Dam & Irrigation Co. (1902) 184 U. S., 416).

For a third time the suit was placed on the docket of the New Mexico trial court. The Government amended its complaint, alleging that the statutory period of five years for construction required by the right of way act of March 3, 1891 had run, the requirement had not been met, and the rights, if any, the company had acquired were forfeited. Upon this new allegation, the trial court found for the Government, and its decree was thereafter affirmed by the Territorial Supreme Court (13 N.M., 386) and by the U. S. Supreme Court. (See Rio Grande Dam and Irrigation Company v. U. S. (1909) 215 U. S., 266). It will be noted that this litigation covered a period of over twelve years. Incidentally, the successors of the Rio Grande Dam and Irrigation Company (British interests) are now attempting to secure against the United States in an international tribunal an award of damages because they were prevented from carrying out their proposed irrigation enterprise.

Bills in Congress.

While the litigation between the United States and the Rio Grande Dam and Irrigation Company was in progress, various bills, providing for the construction of an international dam at El Paso and the distribution of the waters

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therefrom, were introduced in Congress. Typical of these was the bill (S 3894- H.R. 9710) introduced in 1900. A copy of this bill marked Exhibit J is attached hereto. On December 19, 1900 the Senate Committee on Foreign Relations reported this bill favorably and recommended that it be passed. (See Senate Report No. 1755, 56th Congress, 2nd Session). However, the bill was not enacted. New Mexico interests were strongly opposed to the plan for an international reservoir at El Paso, as such a reservoir would inundate a large irrigable area in the Mesilla Valley in New Mexico and prevent a much-desired further development of that region.

The National Irrigation Act.

On June 17, 1902 the National Irrigation Act became a law (32 Stat., 388). Under this act, the Secretary of the Interior was authorized to use certain moneys from public lands to construct and maintain irrigation works in sixteen designated States and Territories, of which the Territory of New Mexico was one. The State of Texas was not included in the list as there were no public lands in that State.

The new United States Reclamation Service in the Geological Survey, organized under said act, began investigations on the Rio Grande March 1, 1903, and the survey of a reservoir site in the vicinity of Elephant Butte was

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completed in August of that year. Borings for the foundations of the dam were begun in October 1903 and completed in February 1904. (See 2nd Annual Report U. S. Reclamation Service, p. 377; 3rd Annual Report, p. 95, 395). Under date of June 3, 1904, the Mexican Minister M. de Azpiroz, brought the claims of Mexico to the attention of the State Department again, urgently requesting the providing of a water supply or the payment of damages. In letter dated June 27, 1904 from Secretary of State John Hay to Secretary of the Interior Ethan Allen Hitchcock, reference is made to the letter of June 3 from the Mexican Minister, and it is suggested that the National Irrigation Act might be utilized to solve the difficulty. A copy of the letter of June 27, 1904 marked Exhibit K is annexed hereto.

Plans for a Reclamation Service Project.

On November 18, 1904, before the National Irrigation Congress held at El Paso, Engineer B. M. Hall of the Reclamation Service, presented a paper dealing with Government irrigation on the Rio Grande. He compared the plan for an international dam at El Paso as proposed in the joint commission's report of November 25, 1896, with the plan for a Federal dam at Elephant Butte in New Mexico. The following is taken from his paper:

> As mentioned above, Mr. Follett estimates that about 40,000 acres of land had prior rights under the old canals in El Paso valley and were deprived of irrigation by the act of American citizens on the headwaters; and that something more than one-half of this 40,000 acres lay on the Mexican side of the river.

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As the restoring of these ancient water rights is the primary object of the proposed expenditure of $2,317,113.36, the cost of 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 the Mesilla valley, which is just as near to El Paso, and just as valuable as any of the land that would be irrigated.

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 the commission had no alternative plan for consideration, and thought 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 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 Elephant Butte dam has the final advantage of being in New Mexico, and subject to the operations of the United States reclamation service. The project can be so planned that legislation by congress can allow New Mexico and Texas

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to participate. But the 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 El Paso valley in Texas and Mexico has laid claim by virtue of ancient prior appropriation and continuous use."

Congress Authorizes Construction of Dam.

By act of February 25, 1905 (33 Stat., 814) Congress extended the provisions of the National Irrigation Act "to the portion of the State of Texas bordering upon the Rio Grande which can be irrigated from a dam to be constructed near Engle, in the Territory of New Mexico, on the Rio Grande," and directed that "if there shall be ascertained to be sufficient land in New Mexico and in Texas which can be supplied with the stored water at a cost which shall render the project feasible and return to the reclamation fund the cost of the enterprise, then the Secretary of the Interior may proceed with the work of constructing a dam on the Rio Grande as part of the general system of irrigation, should all other conditions as regards feasibility be found satisfactory." By act of June 12, 1906 (34 Stat., 259) the provisions of the National Irrigation Act were "extended so as to include and apply to the State of Texas".

Treaty of May 21, 1906.

Although the third and final decision of the United States Supreme Court in the Rio Grande Dam and Irrigation

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Company case was not made until December 13, 1909, the third and final decision of the New Mexico trial court was rendered on May 21, 1903. Subsequent acts of the Federal Government apparently were based on the idea that the decision of May 21, 1903 would not be disturbed.

The negotiations which had been carried on between the United States and Mexico over a period of about a quarter of a century, culminated in the treaty of May 21, 1906 (34 Stat., 2953) between the two countries. Under this treaty the United States agreed to deliver to Mexico 60,000 acre-feet of water per annum, from the proposed Federal Elephant Butte reservoir, while Mexico waived all claims for damages, and all claims to any other water from the Rio Grande between the Acequia Madre at El Paso and Ft. Quitman, Texas. A copy of the treaty marked Exhibit L is attached hereto.

By act of March 4, 1907 (34 Stat., 1357) the sum of $1,000,000 was appropriated from the Treasury toward the construction of the dam required by the treaty, the remaining cost of the dam to be paid from the reclamation fund and collected from the landowners under the Rio Grande project.

While the construction of a division (Leasburg Unit) of the Rio Grande irrigation project was authorized by the Secretary of the Interior on December 2, 1905, the construction of the Elephant Butte reservoir was not authorized until

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May 23, 1910, and was not completed until May 13, 1916, ten years after the treaty was signed.

Federal Appropriations of Water from Rio Grande.

By instrument dated January 23, 1906, and filed in the office of the Territorial Engineer of New Mexico, on the same day, the United States gave notice of appropriation of 730,000 acre-feet of water per annum from the Rio Grande for the proposed Government project. A copy of this notice marked Exhibit M is attached hereto.

By instrument, dated April 1908, and filed in the office of the TerritorialEngineer of New Mexico on April 8, 1908, the United States gave notice of appropriation of all the unappropriated water of the Rio Grande for the said project. A copy of this notice marked Exhibit N is attached hereto.

Second Modification of Embargo, May 25, 1906.

By order dated May 25, 1906 the Secretary of the Interior modified the embargo on the Upper Rio Grande so as to permit approval of rights of way over public lands for irrigation purposes initiated by actual field surveys based upon notices of appropriation of water filed under the laws of Colorado prior to March 1, 1903. This action was not taken until it had been approved by the State Department in letters of March 7, 1906 and May 22, 1906 to the Secretary of

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May 23, 1910, and was not completed until May 13, 1916, ten years after the treaty was signed.

Federal Appropriations of Water from Rio Grande.

By instrument dated January 23, 1906, and filed in the office of the Territorial Engineer of New Mexico, on the same day, the United States gave notice of appropriation of 730,000 acre-feet of water per annum from the Rio Grande for the proposed Government project. A copy of this notice marked Exhibit M is attached hereto.

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the Interior. A copy of the order of May 25, 1906 marked Exhibit O is attached hereto.

Third Modification of Embargo, July 10, 1906.

On July 10, 1906 by le tter of that date to the Commissioner of the General Land Office, the embargo was modified by providing that in the future all applications for rights of way should be submitted to the Director of the Geological Survey, "to ascertain whether they will conflict with the obligations of the United States under the treaty with Mexico, recently ratified, or with the Rio Grande or any other project of the Reclamation Service." A copy of the order of July 10, 1906 marked Exhibit P is attached hereto.

Fourth Modification of Embargo, September 27, 1906.

On September 27, 1906 with the approval of the State Department, the Acting Secretary of the Interior issued an order revoking all prior orders affecting the embargo on the Upper Rio Grande in view of the settlement of the water right question between the United States and Mexico by treaty of May 21, 1906. It was further ordered that all applications involving the use of the waters of the Rio Grande in Colorado and New Mexico should be submitted for a determination by the Geological Survey to ascertain whether favorable action thereon would interfere with any project of the reclamation service or with the obligations of the United States under the treaty. A copy of this order marked Exhibit Q is attached hereto.

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Fifth Modification of Embargo, April 25, 1907.

The obligations of the United States under the treaty, the fulfilment of which depended upon the construction and utilization of the Elephant Butte reservoir, made it necessary for the Secretary of the Interior to determine a policy in dealing with applications for rights of way over the public lands for irrigation purposes,and on April 25, 1907 Secretary of the Interior J. R. Garfield approved a recommendation of the Reclamation Service providing that-

> until the development of irrigation on the upper Rio Grande, in the State of Colorado and the Territory of New Mexico, shall furnish sufficient data to determine the effect of the storage and diversion of water in that vicinity upon the water supply for the Engle Reservoir of the Rio Grande project, no further rights of way be approved which involve the storage or diversion of the waters of the upper Rio Grande and its tributaries, except applications of two kinds: First, those in connection with which there is a showing that the rights of the parties were initiated prior to the beginning of active operations by the Reclamation Service for the Rio Grande project, namely, March 1, 1903; second, applications which involve the diversion or storage of not exceeding 1,000 acre-feet of water per annum.
>
> When it becomes possible to determine the effect of the approved applications upon the water available for storage for the Rio Grande project, it may be possible to allow the use of rights of way to a greater extent than is now proposed.

A copy of the order of April 25, 1907 marked Exhibit R is attached hereto.

Sixth Modification of Embargo, March 2, 1923.

By letter dated March 2, 1923, the Director of the Reclamation Service reviewed the history of the embargo, and

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recommended that that Service be authorized to-

negotiate for the release of specific areas of public land for purposes of water storage under conditions that will best conserve and utilize the water resources and will protect vested rights in all parts of the Rio Grande basin- such negotiations to be subject to the approval of the Secretary of the Interior, and, prior to such approval, to be subject to the scrutiny of all interested parties.

This recommendation was approved by Secretary of the Interior Albert B. Fall on the date of the letter. A copy of this letter marked Exhibit S is attached hereto.

Rights of way in Colorado which have been approved.

While the embargo applies to New Mexico as well as to Colorado, there are few irrigation possibilities in the former State that could conflict with the embargo. From a compilation made from the records of the General Land Office in February, 1923, it appears that since the embargo went into effect, irrigation rights of way over public lands in the Rio Grande basin in Colorado have been approved by the Government as follows:

Applicant	Capacity, acre-feet.
Alta Lake reservoir	414
Balmon reservoir	40
Botefur reservoir	8
Bristol Head reservoir (2)	569
Clemmons & Bielser ditch	
Cole reservoir	19
Colton Creek Air Line ditch	
Colton Creek reservoir	76
Continental reservoir	38,196
Cove Lake reservoir	10,683
Davis Bros. ditch	
Deer Lake reservoir	203
Haton reservoir	95
Lost Lake reservoir	194

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Applicant	Capacity, acre-feet
Poage reservoir	260
Pond Lily reservoir	142
Regan reservoir	1,375
Rio Grande Reservoir & Ditch Co.	43,567
Road Canyon reservoir	915
San Antonia reservoir (see Alta Lake)	
San Isabel reservoir (2)	451
San Jose ditch No. 2	
San Luis Valley reservoir	3,283
Santa Maria reservoir (See Rio Grande)	
Short Creek reservoir	112
Sierra Blance reservoir	184
Swift Company reservoir	139
Tabor Ditch No. 1	
Tabor Ditch No. 2	
Taos Valley canal	
Terrace reservoir	13,000
Wild Cherry reservoir	684
Total	114,609

Objections to the Embargo.

Frequently since the embargo was made effective in 1896 protests have been filed against its continuance. These have come principally from landowners in the San Luis Valley in the State of Colorado, where the burden of the embargo is most keenly felt.

On the part of the complainants it has been urged (a) that the embargo is a restriction on the use of water, and is in conflict with the enabling act of March 3, 1875 (18 Stat., 474) under which Colorado was admitted to the Union, (b) that the right of way act of March 3, 1891 (26 Stat., 1095) makes a grant,and the Secretary of the Interior has no authority to withhold this grant as demanded by the embargo, and (c) that diversions in

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Colorado will not adversely affect the Government project.

On the other hand, the United States contends (a) that the enabling act of March 3, 1875 reserves to the Federal Government full authority over its public lands, (b) that the right of way act of March 3, 1891 gives the Secretary of the Interior a discretion to refuse to approve an application for a right of way when in his opinion it is contrary to the public interest to do so, and (c) that as a condition precedent to the approval of any application, it must appear clear that the Government project will not be injured thereby. The subject is discussed at some length by First Assistant Secretary Pierce in the Wagon Wheel Gap reservoir case (39 L. D., 104).

Rio Grande Commission.

Complaints against the embargo finally brought forth the suggestion that a commission should be named to make a study of the water supply and draft a form of compact between the States affected, under which an equitable allocation of the use of the waters of the Rio Grande would be made to each State. This would follow the precedent of the Colorado River Compact signed at Santa Fe, N. Mexico, November 24, 1922.

On March 12, 1923 the State of New Mexico enacted a law (N.Mexico Session Laws, 1923, p. 175) authorizing the appointment of a representative of such a commission. Under

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this act the Governor appointed Mr. J. O. Seth, an attorney at law, of Santa Fe, N. Mex. A copy of the statute marked Exhibit T is attached hereto.

On March 20, 1923, the State of Colorado enacted a Statute (Colorado Session Laws, 1923, p. 702) for a similar purpose, and under its authority the Governor appointed Mr. Delph E. Carpenter, an attorney at law, of Greeley, Colorado, to represent that State. A copy of the act marked Exhibit U is attached hereto.

In December, 1923, President Coolidge named Mr. Herbert Hoover as the representative of the United States on the Rio Grande Commission.

It is anticipated that at the January 1925 session of the Texas legislature, the Governor of that State will be authorized to name a representative on the Commission.

Dated November 11, 1924.

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EXHIBIT A.

(Copy of concurrent resolution of April 29, 1890).

Concurrent resolution concerning the irrigation of arid lands in the valley of the Rio Grande River, the construction of a dam across said river at or near El Paso, Tex., for the storage of its waste waters, and for other purposes.

WHEREAS the Rio Grande River is the boundary line between the United States and Mexico; and

WHEREAS by means of irrigating ditches and canals taking the water from said river and other causes the usual supply of water therefrom has been exhausted before it reaches the point where it divides the United States of America from the Republic of Mexico, thereby rendering the lands in its valley arid and unproductive, to the great detriment of the citizens of the two countries who live along its course; and

WHEREAS in former years annual floods in said river have been such as to change the channel thereof, producing serious avulsions and oftentimes and in many places leaving large tracts of land belonging to the people of the United States on the Mexican side of the river and Mexican lands on the American side, thus producing a confusion of boundary, a disturbance of private and public titles to lands, as well as provoking conflicts of jurisdiction between the two Governments, offering facilities for smuggling, promoting the evasion and preventing the collection of revenues by the respective countries; and

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WHEREAS these conditions are a standing menace to the harmony and prosperity of the citizens of said countries, and the amicable and orderly administration of their respective Governments: Therefore,

Resolved by the Senate (the House of Representatives concurring), That the President be requested, if in his opinion it is not incompatible with the public interests, to enter into negotiations with the Government of Mexico with a view to the remedy of all such difficulties as are mentioned in the preamble to this resolution, and such other matters connected therewith as may be better adjusted by agreement or convention between the two Governments. And the President is also requested to include in the negotiations with the Government of Mexico all other subjects of interest which may be deemed to affect the present or prospective relations of both Governments.

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EXHIBIT B

(Sections 18, 19, 20, and 21 of the act of March 3, 1891 (26 Stat. 1095), entitled "An Act to repeal timber-culture laws, and for other purposes," granting a right of way through the public lands and reservations of the United States for the use of canals, ditches, or reservoirs.)

Sec. 18. That the right of way through the public lands and reservations of the United States is hereby granted to any canal or ditch company formed for the purpose of irrigation, and duly organized under the laws of any State or Territory, which shall have filed or may hereafter file with the Secretary of the Interior a copy of its article of inoorporation and due proofs of its organization under the same to the extent of the ground occupied by the water of the reservoir and of the canal and its laterals, and fifty feet on each side of the marginal limits thereof; also the right to take from the public lands adjacent to the line of the canal or ditch, material, earth, and stone necessary for the construction of such canal or ditch; Provided, That no such right of way shall be so located as to interfere with the proper occupation by the Government of any such reservation, and all maps of location shall be subject to the approval of the department of the Government having jurisdiction of such reservation, and the privilege herein granted shall not be construed to interfere with the control of water for irrigation and other purposes under authority of the respective States or Territories.

Sec. 19. That any canal or ditch company desiring to secure

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the benefits of this act shall, within twelve months after the location of ten miles of its canal if the same be upon surveyed lands, and if upon unsurveyed lands within twelve months after the survey thereof by the United States, file with the register of the land office for the district where such land is located a map of its canal or ditch and reservoir; and upon the approval thereof by the Secretary of the Interior the same shall be noted upon the plats of said office, and thereafter all such lands over which such rights of way shall pass shall be disposed of subject to such right of way. Whenever any person or corporation in the construction of any canal, ditch, or reservoir injures or damages the possession of any settler on the public domain, the party committing such injury or damage shall be liable to the party injured for such injury or damage.

Sec. 20. That the provisions of this act shall apply to all canals, ditches, or reservoirs heretofore or hereafter constructed, whether constructed by corporations, individuals, or association of individuals on the filing of the certificates and maps herein provided for. If such ditch, canal, or reservoir has been or shall be constructed by an individual or association of individuals, it shall be sufficient for such individual or association of individuals to file with the Secretary of the Interior and with the register of the land office where said land is located a map of the line of such canal, ditch, or

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reservoir, as in case of a corporation, with the name of the individual owner or owners thereof, together with the articles of association, if any there be. Plats heretofore filed shall have the benefits of this act from the date of their filing, as though filed under it; Provided, That if any section of said canal or ditch shall not be completed within five years after the location of said section the rights herein granted shall be forfeited as to any uncompleted section of said canal, ditch, or reservoir, to the extent that the same is not completed at the date of the forfeiture.

Sec. 21. That nothing in this act shall authorize such canals or ditch company to occupy such right of way except for the purpose of said canal or ditch, and then only so far as may be necessary for the construction, maintenance, and care of said canal or ditch.

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EXHIBIT C

(Letter from the Mexican Minister, M. Romero, to Secretary of State, Richard Olney.)

Legation of Mexico,

Washington, October 21, 1895.

Mr. Secretary: I have addressed your Department on various occasions, communicating the instructions which I have received from my Government to endeavor to secure the adoption of an arrangement designed to remedy the evils which are suffered by the inhabitants of the Mexican bank of the Rio Grande from Paso del Norte to a distance of about 200 kilometers below.

Paso del Norte and the adjacent region down the river are situated in the center of the dry zone and consequently can not depend upon the rains for their agricultural operations, but are obliged to depend upon irrigation. From a report of the Weather Bureau at El Paso, Tex., dated August 25, 1894, a copy of which is herewith enclosed, it appears that the total rainfall registered from August 15, 1893, to August 14, 1894, was 4.97 inches, or next to nothing at all.

The city of Paso del Norte has been in existence for more than three hundred years, and during (almost) all that time its people have enjoyed the use of the water of the Rio Grande for the irrigation of their lands; and as that city and the districts within its jurisdiction did not need more than 20 cubic meters of water per second, which is almost

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an infinitesimal portion of the amount of water which flowed down the river, even in times of the severest drought, they had sufficient water for their crops until about ten years ago, when a great many trenches were dug in the State of Colorado (especially in the St. Louis Valley) and in the Territory of New Mexico, through which the Rio Grande and its affluents flow. The volume of water thus taken has so greatly diminished that which is brought by the river to Paso del Norte that, when the rains are not very abundant, there is a scarcity of water from the 15th of June of one year till the month of March of the next, which is the very time when water is most needed for the crops.

In the year 1894 the river became dried up entirely by the 15th of June, and only when it rained in New Mexico was there any water in it, and that lasted of course for but a short time. In that year the farmers were unable to raise any Indian corn, vegetables, or grapes, and the scarcity of water was such that even the fruit trees began to wither.

This state of things has naturally reduced the price of the land, which was good until that time, to an extremely low figure, and has diminished the population of that region very considerably. In 1875 there was at Paso del Norte, Zaragoza, Tres Jacales, Guadalupe, and San Ignacio, a population of about 20,000, which, in 1894, was reduced to half that number. Farms

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no longer produced enough to support their owners, and the situation of the people is wretched in the extreme, because, as they are unable to raise vegetables or other articles necessary to support life, they are obliged to send for them a distance of from 500 to 1,000 miles, their cost being thus increased while the people's means of paying for what they need are greatly diminished.

The United States Congress recognized the serious injury suffered by the Mexicans in a concurrent resolution approved April 29, 1890, whereby it recommended to the President of the United States to enter into negotiations with the Mexican Government with a view to deciding upon such means as might tend to remedy the difficulties occasioned by the scarcity of water in the Rio Grande from the point where it serves as the boundary between Mexico and the United States of America.

The Mexican Government, to which the United States minister in Mexico communicated the aforesaid resolution in pursuance of the instructions of his Government, authorized me to take steps here to secure the arrangement proposed in the resolution, and I so informed the Department of State in a note dated October 26, 1893. It has not, however, thus far been possible to make much progress in this matter.

The Government of Mexico thinks that according to Article VII of the treaty of Guadalupe Hidalgo of February 2, 1848, the inhabitants of one country can not, without the consent of the

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other build any works that obstruct or impede navigation in international rivers, and nothing could impede it more absolutely than works which wholly turn aside the water of those rivers. It is true that Article IV of the treaty of Mesilla of December 30, 1853, annulled Article VII of the treaty of Guadalupe Hidalgo, but at the same time it left its stipulations in force, as far as the Rio Grande is concerned, from the point where that river begins to be the boundary line between the two countries, and moreover, by Article V of the convention of November 12, 1884, the right of both countries to that river was again recognized, and it was again stipulated that one could not construct any works that obstructed navigation therein without the consent of the other.

From a report of the assistant quartermaster-general addressed to the general in chief of the U. S. Army, and dated Brazos de Santiago, Tex., September 5, 1850, it appears that Captain Lowe, U. S. Army, ascended it with a vessel, reaching a point several kilometers above Paso del Norte, which shows that it was navigable at that time.

Still, even supposing, without admitting it, that the Mexican Government's interpretation of the treaties were not well founded, and even if there were no stipulation on this subject between the two countries, the principles of international law would form a sufficient basis for the rights of the Mexican inhabitants of the bank of the Rio Grande. Their

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claim to the use of the water of that river is incontestable, being prior to that of the inhabitants of Colorado by hundreds of years, and, according to the principles of civil law, a prior claim takes precedence in case of dispute.

The circumstance that that river serves as the boundary between the two countries, and that it is consequently an international river, gives it a special character, which considerably restricts the freedom and rights of the inhabitants of both banks, and does not permit them to construct works that reduce the volume of water in the river to such an extent that it is no longer navigable, and even, at last, is dried up entirely.

I should fear to cast a reflection upon your knowledge of such matters if I were to quote the various doctrines laid down by writers on international law which are applicable to the present case and which support my asseverations..

These considerations, and the terrible situation in which the inhabitants of Paso del Norte and the neighboring districts now are, render the Government of Mexico exceedingly desirous to conclude an arrangement with that of the United States on this subject as speedily as may be possible; and I therefore repeat the request which I have verbally made on several occasions, viz, that the antecedents may be examined, and that the necessary steps may be taken to effect an arrangement with the Government of Mexico that will facilitate the fulfillment

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of international obligations and remedy existing evils as far as possible.

Be pleased to accept, etc.

M. Romero.

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EXHIBIT D

(Letter dated November 30, 1896 from Secretary of State Richard Olney to Secretary of the Interior D. R. Francis).

DEPARTMENT OF STATE
WASHINGTON.

November 30, 1896.

The Honorable

The Secretary of the Interior.

Sir:

I have the honor to invite your attention to the enclosed copy of a letter dated November 17, 1896, and accompanying papers from Colonel Anson Mills of the United States Army, who is a member of a joint commission appointed by the United States and the Republic of Mexico to report upon the best and most feasible mode- whether by a dam across the Rio Grande River near El Paso, Texas, or otherwise- of so regulating the use of the waters of the Rio Grande River as to secure to each country and its inhabitants their legal and equitable rights and interests in said waters for irrigation purposes.

This examining board was appointed in pursuance of a concurrent resolution of Congress, approved April 29, 1890, which recites the fact that by reason of the irrigating ditches and canals leading from the upper waters of the Rio Grande in the State of Colorado and Territory of New Mexico, an insufficient

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quantity of water remains in the river to irrigate the lands adjacent to the river after it leaves New Mexico, thereby rendering the lands arid and unproductive, to the great detriment of the citizens of both countries who live along the Rio Grande below the line of New Mexico. The resolution then authorizes the President to enter into negotiations with the Government of Mexico with a view to remedying this condition. I enclose a copy of the resolution.

The duty imposed upon this Board of Examiners was to ascertain:

(1) The amount of water taken from the Rio Grande by the irrigation canals constructed in the United States;

(2) The average amount of water in said river year by year before the construction of said irrigation canals and since their construction;

(3) The best and most practicable mode of regulating the use of the waters of the Rio Grande so as to secure to each country and to the border landowners on both sides of the river their legal and equitable rights and interests in said waters.

August 4th last, the Mexican Minister to the United States transmitted to this Department a copy of a petition forwarded by the inhabitants of the City of Paso del Norte, Mexico, calling attention to the distressing situation in the towns on the Mexican

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side of the Rio Grande caused by the immoderate use of the waters of the river for irrigation purposes by the adjacent owners in the United States above the boundary line. This petition states that the efforts of the two governments to remedy this condition will be fruitless if, in addition to the forty dams already existing in Colorado, the Rio Grande Irrigation and Land Company Limited should be permitted to construct, as it proposes, a dam across the Rio Grande at Elephant Butte, New Mexico. The Mexican Minister said that his government regarded this petition as well founded, and requested the United States to adopt such measures as may be in its power to put a stop to the works undertaken by the Rio Grande Irrigation and Land Company Limited until the effect of that company's proposed works upon the practicability of the international scheme could be considered by the examining board and determined upon to the satisfaction of the two governments. A copy of the Mexican petition was sent to Colonel Mills for his suggestions. The enclosed letter of November 17th, 1896, to which your attention is invited, is his reply.

Colonel Mills says that the proposed dam and reservoir of the Rio Grande Irrigation and Land Company Limited is located about one hundred and twenty five miles above El Paso, and that it will be useless at that distance to furnish

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water for irrigation in the vicinity of El Paso and below. He says furthermore, that he is informed that the same company has on file in the Interior Department applications for two additional dams and reservoirs, one at Rincon, New Mexico, about 100 miles above El Paso, and another at Fort Seldon, about 60 miles above; also that at the latter place a man named Ernest Dale Owen has applied for permission to erect a dam and reservoir.

It is understood that the Rio Grande Irrigation and Land Company Limited acquired its right to build the reservoir it is now constructing from a corporation existing under the laws of New Mexico under the name of the "Rio Grande Dam and Irrigation Company", to which company the right of way for the construction of the storage dam at Elephant Butte was granted by the Secretary of the Interior February 1, 1895, under the provisions of the Act of March 3, 1891.

Colonel Mills gives it as his opinion that the probable flow of water in the river will be sufficient to supply the proposed international reservoir after deducting for all the small reservoirs now in operation and likely to be constructed above, but that the flow will not be sufficient to supply the proposed international reservoir and allow for the supply of the proposed reservoir of the Rio Grande Irrigation and Land Company Limited at Elephant Butte or any other reservoirs upon the same scale, and that the scheme of building an

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international reservoir will have to be abandoned unless the completion of the works proposed by the Rio Grande Irrigation and Land Company Limited and by Owen is prevented. Colonel Mills' letter suggests that the rights obtained from the United States by the Rio Grande Irrigation and Land Company Limited may be subject to conditions in favor of the rights of those who live below, which on a proper showing might enable the Secretary of the Interior to cancel the grant made to that Company. The other applications for permission to build reservoirs for storage of the waters of the Rio Grande mentioned by Colonel Mills, have not, it is assumed, yet been finally acted upon.

The circumstances being as above stated, I desire to suggest the propriety of declining to grant any additional rights to build dams and reservoirs as applied for- certainly until the negotiations now pending between Mexico and the United States have reached a final conclusion. I desire also to suggest that an investigation may be made of the rights already granted to the Rio Grande Irrigation and Land Company Limited and of any acts or proceedings done by that company by virtue of such rights, with a view to ascertaining whether there is any legal power to cancel those rights, and, if the power exists, whether it can be exercised without injustice to the parties directly and indirectly interested in that enterprise.

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With a request for your earliest practicable attention to this matter,

I have the honor to be, Sir,

Your obedient servant,

Richard Olney.

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EXHIBIT E

(Order, dated December 5, 1896, of the Secretary of the Interior, placing the embargo on the Upper Rio Grande).

Department of the Interior,
Washington, December 5, 1896.

THE COMMISSIONER OF THE GENERAL LAND OFFICE.

Sir: Your office is hereby directed to suspend action on any and all applications for right of way through public lands for the purpose of irrigation by using the waters of the Rio Grande River or any of its tributaries in the State of Colorado or in the Territory of New Mexico until further instructed by this department.

Very respectfully,

D. R. Francis, Secretary.

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EXHIBIT F.

(Letter dated December 19, 1896, from the Secretary of the Interior to the Secretary of State).

Department of the Interior,
Washington, December 19, 1896.

The Honorable the Secretary of State,

Sir:

I have the honor to submit, in response to your communication of November 30, the enclosed paper, prepared under the direction of the Assistant Attorney General, which fully sets forth the claims and contentions of the Rio Grande Dam and Irrigation Company, and discusses at considerable length the laws of the State of Colorado and Territory of New Mexico relating to waters, and the acts of Congress and rulings of this Department relating to irrigation.

The application of the Rio Grande Dam and Irrigation Company was approved by my predecessor on the 1st day of February, 1895. In my opinion I have no right under the law, to revoke this approval. It has been decided by the Supreme Court of the United States in the case of Noble V. Union River Logging Railroad Company (147 U.S., 165) that the approval by the Secretary of the Interior of a right of way for railroad purposes over the public land can not be revoked by his successor, and upon the principle therein declared I deem it beyond my authority to revoke my predecessor's approval of the map filed by the Rio Grande Dam and Irrigation Company.

Assuming that I had such power, I submit to you whether

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or not the exercise of it would be proper in view of the opinion of the Attorney General of your Department under date of December 12, 1895. (21 Op. Att. Gen., p. 274.)

It is not the duty of this Department to protect the citizens of the United States against unlawful appropriation of the waters of the States and Territories by the inhabitants thereof, and if no treaty obligations of the Government are involved, I do not believe that I should assume to interfere.

Since the receipt of your communication complaints have been made to this Department by parties now having applications for irrigation privileges pending for the vacation of my order of December 6, upon the ground that the effect of such order is to imperil their rights by subordinating them to the claims of persons who may hereafter for lawful or nefarious purposes enter lands along the rights of way applied for. Very grave inconvenience would arise if such claims are filed and I therefore submit for your consideration whether or not there is further need for continuing the suspension heretofore declared.

Immediately upon receipt of your communication I addressed to the Commissioner of the General Land Office directions that he suspend all applications for right of way through the public lands for the purposes of irrigation by using the waters of the Rio Grande River or any of its

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tributaries in the State of Colorado or the Territory of New Mexico until further instructed by this Department. A copy of said order is hereto attached.

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EXHIBIT G

(Letter of January 11, 1897 from the Secretary of State to the Secretary of the Interior.)

DEPARTMENT OF STATE,

Washington, January 11, 1897.

Sir:

In your letter of December 19, 1896, relative to the reservoir which the Rio Grande Dam and Irrigation Company, or another corporation claiming the rights of that company, intends to build at Elephant Buttes, N. Mex., you informed me that you had, in compliance with my suggestion of November 30, 1896, directed the Commissioner of the General Land Office to suspend action on any and all applications for right of way through public lands for the purpose of irrigation by using the waters of the Rio Grande River or any of its tributaries in the State of Colorado or in the Territory of New Mexico until further instructions from you. The request of this Department upon which your order was based was made at the suggestion of Col. Anson Mills, a copy of whose letter, dated October 29, 1896, was transmitted to you October 31 of that year.

The attorneys of parties who have made application to your Department for the approval of rights of way to build dams and reservoirs on the Pecos River have made verbal complaint to this Department that the order has been applied by the General Land Office to the river Pecos, as well as to

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the tributaries of the Rio Grande which join that river above El Paso. Upon receipt of this complaint I made inquiry of Colonel Mills as to whether his request that action be suspended on all applications for permits to build additional dams across the Rio Grande or its tributaries was intended to apply to the Pecos, and whether the building of additional reservoirs on that river would affect the plan which this Department has under consideration of building an international reservoir at El Paso. He has replied under date of January 7, 1897, that he had not intended to stop the granting of permits for reservoirs on the Pecos or on any stream which empties into the Rio Grande below the proposed location of the international reservoir. He does not believe that further use of the waters of the Pecos for irrigation purposes will affect the international question pending between the United States and Mexico, as that river falls into the Rio Grande at a point where the diminution of its waters will have little if any perceptible effect upon the volume passing downward from that point.

I have the honor, therefore, to suggest that the order to the Commissioner of the General Land Office, referred to in your letter to me of December 19, 1896, be limited it its application to the tributaries of the Rio Grande which pour into that river above the point where it becomes the boundary between the United States and Mexico, and that it be no longer applied to applications for dams and reservoirs on the Pecos.

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There is another phase of this question which, it has occurred to me, may have an important bearing upon the rights of parties now applying for permission to erect dams across the Rio Grande, and also upon the international question involved. I have information which indicates that the Rio Grande River in some parts above the international boundary line is, and has been used as, a waterway for navigation between the United States and Mexico, and possibly between the State of Colorado and the Territory of New Mexico. If it be true that this stream in its natural condition is capable of use for the transportation of commerce between two States of the Union or between the United States and a foreign country, the river is a navigable water of the United States and as such subject to the laws of Congress enacted for the maintenance, protection, and preservation of the navigable waters of the United States. One of the principal matters of complaint by Mexico is that the diversion of the upper waters of the Rio Grande for irrigation purposes has affected the usefulness of that stream as a waterway for commerce.

The Attorney-General in his opinion of December 12, 1895 (21 Op.,274), held that the river was not navigable above the boundary in the sense of the treaty between the United States and Mexico; but the question here is whether it is navigable within the meaning of the laws of the United States. The conditions of navigability within the meaning of our statutes are

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well defined in the decisions of the Federal courts. Many of these are referred to in 20 Op. Att. Gen., 101.

If the Rio Grande River is in the part under consideration a navigable water of the United States, the question arises whether the erection of the proposed dams across it will not interfere with its navigability and bring those dams within the prohibition of the statutes enacted for the preservation of navigable waters. I refer particularly to the act of September 19, 1890, sections 7 and 10 (26 Stat. L., 426), and to the act of July 13, 1892, section 3 (27 Stat. L., 110). It is true that the enforcement of these statutes develops primarily upon the Secretary of War, and that at first view it may not appear to be a part of the duty of the Secretary of the Interior to take care of the navigability of the streams on the public lands; but in a case where the act of the Secretary of the Interior approving the right of way to build a dam across a river on the public lands may operate, as it must if the river is a navigable water of the United States, as a grant of executive sanction to a proceeding which is in violation of law, it would seem to be the duty and within the jurisdiction of the Secretary of the Interior to ascertain before sanctioning the erection of the dam whether it would constitute an obstruction to a navigable water of the United States and be within the prohibition of the statutes.

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As the erection of the dams under consideration is now the subject-matter of a complaint of the Government of Mexico, I feel it my duty to lay this question before you in order that you may determine, in the first place, whether you have the power, and in the second place whether it is a part of your duty to withhold approval of the pending applications for rights of way to build dams across the Rio Grande River and its tributaries above the boundary line, until the applicants have satisfied you that the river in the part affected by these dams is not a navigable water of the United States or that the dams will not interfere with the navigation of the river. It must be observed that the obstruction to navigation may result not only from the intervention of the dams across the course of the river, but also from the diversion of the waters, leaving an insufficient quantity below the dam for the purposes of navigation.

I have, etc.,

Richard Olney.

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EXHIBIT H

(Order, dated January 13, 1897, of the Secretary of the Interior, modifying the embargo on the Upper Rio Grande).

DEPARTMENT OF THE INTERIOR,
Washington, January 13, 1897.

The Commissioner of the General Land Office.

Sir: By departmental letter of December 5, 1896, you were directed to suspend action on all applications for right of way for irrigation purposes by the use of the waters of the Rio Grande or any of its tributaries in Colorado or New Mexico till further instructed.

I now hereby modify the above order by limiting its application, so far as the tributaries of the Rio Grande are involved, to those tributaries which empty into that river above the point where it becomes the boundary between the United States and Mexico.

Very respectfully,

D. R. Francis, Secretary.

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EXHIBIT I

(Letter dated January 13, 1897 from the Secretary of State to the Secretary of War).

DERARTMENT OF STATE,
Washington, January 13, 1897.

The Honorable the Secretary of War.

Sir:

August 4, 1896, the Mexican minister in Washington presented to this Department the enclosed petition from Mexican citizens in and about Paso del Norte, Mexico, protesting against the immoderate use of the waters of the Rio Grande River and its tributaries by residents of Colorado and New Mexico. The Mexican minister called attention to article 7 of the treaty of Guadalupe Hidalgo, of February 2, 1848; to article 1, last clause, of the treaty of December 30, 1853; to article 3 of the convention of November 12, 1884; and to article 5 of the convention of March 1, 1889, between the United States and Mexico, and, relying upon those treaty provisions, requested that the United States Government prevent the erection and operation of a dam by a company known to the complainants as the "Rio Grande Irrigation Company," at Elephant Butte, N. Mex., about 125 miles above Paso del Norte, designed to store all the surplus waters of the river and turn it into irrigating ditches and canals.

The complaint of Mexico was sent August 8, 1896, to Col. Anson Mills, of the United States Army, who was then

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engaged, under the direction of this Department, in an investigation of the volume of water in the Rio Grande and the feasibility of a plan under consideration by both governments of erecting an international reservoir. Col. Mills reported, November 17, 1896, the erection of the dam at Elephant Buttes and of other dams below there, which the same company contemplated building, would stop practically all the water coming into the Rio Grande above those points. The complaint and Colonel Mills's report were referred to the Secretary of the Interior November 30, 1896, with a view to ascertaining whether there was any legal power to cancel the rights claimed by the said irrigation company, and if the power to cancel existed, whether it could be exercised without injustice to the parties directly or indirectly interested in the enterprise. The Secretary of the Interior, had been previously requested to suspend temporarily all applications for rights of way to build dams across the river in all pending cases. December 5, 1896, he suspended the applications not already approved, but in a letter of December 19 said, with reference to the dam at Elephant Buttes to be built by the corporation referred to in the Mexican complaint,the proper name of which is "The Rio Grande Dam and Irrigation Company," that his predecessor had approved the application of that company for a dam and reservoir at Elephant Buttes, and that he had no power to

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revoke his predecessor's action. The law under which the Secretary of the Interior acts in approving rights of way and maps for dams and reservoirs on public lands is contained in sections 18 to 21 of the act of March 3, 1891. (26 Stat. L., 1095, 1101, and 1102.)

The Secretary of the Interior is, for the reason above given, powerless to intervene or inquire further into the lawfulness of the proposed dam across the Rio Grande at Elephant Buttes. The act of July 13, 1892 (27 Stat. L., 88-100) provides, however (in section 3, amending section 7 of the act of September 19, 1890):

> That it shall not be lawful to build any wharf, pier, dolphin, boom, dam, weir, breakwater, bulkhead, jetty, or structure of any kind outside established harbor lines, or in any navigable waters of the United States where no harbor lines are or may be established, without the permission of the Secretary of War. * * *

As the proposed erection of this dam across the Rio Grande at Elephant Butte has given rise to an important and international question, I have the honor to inquire whether the parties engaged in this enterprise, or others whose rights they enjoy, have obtained from you, as Secretary of War, the permission required by the act first above quoted. If your permission has not been obtained for the placing of this obstruction across the Rio Grande River, I have the honor to request that you will ascertain whether the river in the parts which will be affected by the dam and the diminution of the volume of water consequent upon its erection, is not a navigable water of the United States

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within the meaning of the statutes above quoted, so as to make your sanction a necessary prerequisite to the lawful erection of the dam. I have received information tending to show that the Rio Grande River is navigable for commercial purposes between the United States and Mexico, and possibly between the State of Colorado and the Territory of New Mexico. It probably will not float water craft of great size; but I understand that it has been used in the timber commerce of the country, and is, in its natural state, capable of regular, periodical, if not perennial, use as a waterway for commercial traffic between the two State of the Union or between the United States and a foreign country. If that be true, the river is a navigable stream of the United States, within the meaning of the laws for the protection of such waters.

In case it should be ascertained as a fact that the Rio Grande Dam and Irrigation Company, or persons exercising the rights obtained by that company, are without the permission required by the act of July 13, 1892, building or about to build a dam across a navigable river of the United States in a manner that will obstruct or impair the use of that river as a highway for commerce between the United States and a foreign country, or between States of the Union, I have the honor to request that you will adopt such measures as are most effective to open the river and keep it open to such navigation as it is naturally capable of affording for commercial traffic between the States or between any portion of

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the United States and Mexico.

Section 10 of the act of September 19, 1890, is a general provision enforcible in the courts under the direction of the Attorney General of the United States, and his aid would necessarily be invoked by you should you determine to put this provision of law in force against the Rio Grande Dam and Irrigation Company's obstruction of the river at Elephant Buttes. In this connection I desire to call your attention to an opinion of the Attorney-General delivered December 12, 1895 (20 Op. Att. Gen. 274), in which he holds that the Rio Grande is not a navigable river above a point 150 miles below Paso del Norte in so far as the treaty obligations of the United States with Mexico are concerned. He did not consider the question whether the river where it lies wholly in the United States is a navigable water of the United States within the meaning of the Federal Statutes. This latter question is, I believe, a new one, dependent upon facts not yet fully ascertained, facts which I have no doubt your Department can readily obtain and furnish to the Attorney General in case they, in your opinion, justify or require the intervention of his office.

To put you in a more complete possession of the facts relating to the dam at Elephant Buttes, I inclose copy of the letter of the Secretary of the Interior, dated December 19, 1896, referred to above, and of the accompanying report of

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the Assistant Attorney-General for the Interior Department. From these papers it appears that the Secretary of the Interior has acted upon the assumption that the Rio Grande River above the boundary line is not a navigable river of the United States, without requiring proof or otherwise ascertaining that it is not navigable.

I have the honor to be, sir, your obedient servant,

Richard Olney.

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EXHIBIT J

(Bill to provide for an international dam and distribution of waters of Rio Grande, introduced in Congress in 1900).

A bill to provide for the equitable distribution of the waters of the Rio Grande River between the United States of America and the United States of Mexico and for the purpose of building an international dam and reservoir on said river at El Paso, Texas.

WHEREAS the Republic of Mexico has made reclamation of the United States to the Secretary of State, through its legation in Washington, for a large indemnity for water alleged to have been taken and used by the citizens of the United States in Colorado and New Mexico, on the head waters of the Rio Grande to which citizens of Mexico had right by prior appropriation, in violation of the spirit of article seven of the treaty of peace of Guadalupe Hidalgo; and

WHEREAS an investigation directed jointly by the State Departments of the two Republics and carried out by the International Boundary Commission organized under the convention of March first, eighteen hundred and eighty-nine, discovered the fact that the flow of the river has gradually diminished for the past fifteen years in an increasing ratio, so that the ordinary summer's flow in the lower river is inadequate to supply the wants of irrigation, domestic, and other purposes, as has been supplied in previous years, and

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WHEREAS a remedy has been proposed by the two Governments for this deficiency by impounding in an international dam and reservoir near the boundary line between the two Republics, the annual flood waters of the spring season, which are greatly in excess of the wants of irrigation, domestic, and other purposes in those seasons, such waters to be equitably distributed between the two Republics; and

WHEREAS it was afterwards discovered that other like projects of large dams and reservoirs were contemplated above said proposed international dam and reservoir; and

WHEREAS the two Governments jointly directed the International Boundary Commission hereinbefore mentioned to investigate and report upon the feasibility of the project; and

WHEREAS said commission reported that, in their judgment, the project was feasible, but that the flow was insufficient for more than one reservoir; and

WHEREAS the two Governments were unable to agree upon the construction of said proposed international dam and reservoir until some method of restraining the building and use of other dams and reservoirs which would destroy the usefulness of said proposed international dam and reservoir has been devised; Now therefore,

BE IT ENACTED by the Senate and House of Representatives of the United States of America in Congress assembled, that nothing in the acts of March third, eighteen hundred and ninety-one,

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January twenty-first, eighteen hundred and ninety-five, February twenty-sixth, eighteen hundred and ninety-seven, and May eleventh, eighteen hundred and ninety-eight, shall be so construed as to authorize the appropriation and storage of the waters of the Rio Grande or its tributaries in the Territory of New Mexico, to which others have right by prior appropriation, and every person and every corporation which shall be guilty of thus unlawfully appropriating and storing said waters in this act mentioned shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine not exceeding five thousand dollars or by imprisonment (in the case of a natural person) not exceeding one year, or by both such punishments, in the discretion of the court. The unlawful appropriating and storing of water in this act mentioned may be prevented, and the dam, reservoir, or other means used for impounding the water may be removed by the injunction of any circuit court exercising jurisdiction in any district in which said water may be appropriated or stored, and proper proceedings in equity to this end may be instituted under the direction of the Attorney General of the United States.

Sec. 2. That the Secretary of State is hereby authorized to proceed with the consummation of the proposed treaty between the United States of America and the United States of Mexico, and if the United States of Mexico shall accept the construction of the proposed dam and reservoir, with the conditions

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that the flood water impounded by it shall be equally distributed between the two countries as liquidation of all past and future claims for water appropriated in the past or to be appropriated in the future by citizens of the United States otherwise than by impounding it in large dams and reservoirs in New Mexico, then the Secretary of State is further authorized to proceed with the construction of said dam and reservoir according to the plans and specifications submitted in the report of the International Boundary Commission, as published in Senate Document Numbered Two Hundred and twenty-nine, Fifty-fifth Congress, second session, and the sum of two million three hundred and seventeen thousand one hundred and thirteen dollars and thirty-six cents is hereby appropriated for that purpose.

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EXHIBIT K.

(Letter dated June 27, 1904 from the Secretary of State to the Secretary of the Interior).

Washington, D. C., June 27, 1904.

My dear Mr. Secretary:

I have this day sent you a copy of a note from the Mexican Ambassador in relation to the diversion of the waters of the Rio Grande River. It has been informally suggested that a practical solution of this question might be accomplished under the National Irrigation Act. I am informed that the engineers of the Hydrographic Bureau of the Geological Survey have already made some examination of the Rio Grande drainage basin with a view to devising some plan to provide a water supply for the irrigation of all the lands of the valley. I am also informed that the reservoir site known as Elephant Butte has been set aside as a reclamation project. It has been suggested that by establishing the main storage reservoir at Elephant Butte in New Mexico and a secondary reservoir near El Paso to catch the surplus flood waters and back up the overflow of the river, which is said to be heavy and perpetual, a sufficient supply of water can be obtained for irrigation in New Mexico,Texas and Mexico. It has occurred to me that you might be able, under the National Irrigation Act, to provide an ultimate solution

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EXHIBIT K.

(Letter dated June 27, 1904 from the Secretary of State to the Secretary of the Interior).

Washington, D. C., June 27, 1904.

My dear Mr. Secretary:

I have this day sent you a copy of a note from the Mexican Ambassador in relation to the diversion of the waters of the Rio Grande River. It has been informally suggested that a practical solution of this question might be accomplished under the National Irrigation Act. I am informed that the engineers of the Hydrographic Bureau of the Geological Survey have already made some examination of the Rio Grande drainage basin with a view to devising some plan to provide a water supply for the irrigation of all the lands of the valley. I am also informed that the reservoir site known as Elephant Butte has been set aside as a reclamation project. It has been suggested that by establishing the main storage reservoir at Elephant Butte in New Mexico and a secondary reservoir near El Paso to catch the surplus flood waters and back up the overflow of the river, which is said to be heavy and perpetual, a sufficient supply of water can be obtained for irrigation in New Mexico,Texas and Mexico. It has occurred to me that you might be able, under the National Irrigation Act, to provide an ultimate solution

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of the question presented by the Mexican Ambassador. If so I should be happy to cooperate in accomplishing that desirable object. I have accordingly transmitted to you a copy of the note of the Mexican Ambassador, and have asked for any suggestion which you may be pleased to make in order to aid the Department in making an answer to the Ambassador's note.

Sincerely yours,

John Hay

Honorable Ethan Allen Hitchcock,
Secretary of the Interior.

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EXHIBIT L

(Treaty between the United States of America and the United States of Mexico, dated May 21, 1906 (34 Stat., 2953) concerning irrigation from the Rio Grande).

The United States of America and the United States of Mexico being desirous to provide for the equitable distribution of the waters of the Rio Grande for irrigation purposes, and to remove all causes of controversy between them in respect thereto, and being moved by considerations of international comity, have resolved to conclude a convention for these purposes and have named as their prenipotentiaries:

The President of the United States of America, Elihu Root, Secretary of State of the United States; and

The President of the United States of Mexico, His Excellency Señor Don Joaquín D. Casasús, Ambassador Extraordinary and Plenipotentiary of the United States of Mexico at Washington;

Who, after having exhibited their respective full powers, which were found to be in good and due form, have agreed upon the following articles:

Article 1. After the completion of the proposed storage dam near Engle, New Mexico, and the distributing system auxiliary thereto, and as soon as water shall be available in said system for the purpose, the United States shall deliver to Mexico a total of 60,000 acre-feet of water annually, in the

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bed of the Rio Grande at the point where the head works of the Acequia Madre, known as the Old Mexican Canal, now exist above the city of Juarez, Mexico.

Art. 2. The delivery of the said amount of water shall be assured by the United States and shall be distributed through the year in the same proportions as the water supply proposed to be furnished from the said irrigation system to lands in the United States in the vicinity of El Paso, Texas, according to the following schedule, as nearly as may be possible:

	Acre feet per month.	Corresponding cubic feet of water.
January	0	0
February	1,090	47,480,400
March	5,460	237,837,600
April	12,000	522,720,000
May	12,000	522,720,000
June	12,000	522,720,000
July	8,180	356,320,800
August	4,370	190,357,200
September	3,270	142,441,200
October	1,090	47,480,400
November	540	23,522,400
December	0	0
Total for the year	60,000 acre-feet	2,613,600,000 cubic feet

In case, however, of extraordinary drought or serious accident to the irrigation system in the United States, the amount delivered to the Mexican Canal shall be diminished in the same proportion as the water delivered to lands under said irrigation system

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bed of the Rio Grande at the point where the head works of the Acequia Madre, known as the Old Mexican Canal, now exist above the city of Juarez, Mexico.

Art. 2. The delivery of the said amount of water shall be assured by the United States and shall be distributed through the year in the same proportions as the water supply proposed to be furnished from the said irrigation system to lands in the United States in the vicinity of El Paso, Texas, according to the following schedule, as nearly as may be possible:

	Acre feet per month.	Corresponding cubic feet of water.
January	0	0
February	1,090	47,480,400
March	5,460	237,837,600
April	12,000	522,720,000
May	12,000	522,720,000
June	12,000	522,720,000
July	8,180	356,320,800
August	4,370	190,357,200
September	3,270	142,441,200
October	1,090	47,480,400
November	540	23,522,400
December	0	0
Total for the year	60,000 acre-feet	2,613,600,000 cubic feet

In case, however, of extraordinary drought or serious accident to the irrigation system in the United States, the amount delivered to the Mexican Canal shall be diminished in the same proportion as the water delivered to lands under said irrigation system

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in the United States.

Art. 3. The said delivery shall be made without cost to Mexico, and the United States agrees to pay the whole cost of storing the said quantity of water to be delivered to Mexico, of conveying the same to the international line, of measuring the said water, and of delivering it in the river bed above the head of the Mexican Canal. It is understood that the United States assumes no obligation beyond the delivering of the water in the bed of the river above the head of the Mexican Canal.

Art. 4. The delivery of water as herein provided is not to be construed as a recognition by the United States of any claim on the part of Mexico to the said waters; and it is agreed that in consideration of such delivery of water Mexico waives any and all claims to the waters of the Rio Grande for any purpose whatever between the head of the present Mexican Canal and Fort Quitman, Tex., and also declares fully settled and disposed of, and hereby waives, all claims heretofore asserted or existing, or that may hereafter arise, or be asserted, against the United States on account of any damages alleged to have been sustained by the owners of land in Mexico by reason of the diversion by citizens of the United States of waters of the Rio Grande.

Art. 5. The United States in entering into this treaty does not thereby concede, expressly or by implication, any legal

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basis for any claims heretofore asserted or which may be hereafter asserted by reason of any losses incurred by the owners of land in Mexico due or alleged to be due to the diversion of the waters of the Rio Grande within the United States; nor does the United States in any way concede the establishment of any general principle or precedent by the concluding of this treaty. The understanding of both parties is that the arrangement contemplated by this treaty extends only to the portion of the Rio Grande which forms the international boundary, from the head of the Mexican Canal down to Fort Quitman, Texas, and in no other case.

Art. 6. The present convention shall be ratified by both contracting parties in accordance with their constitutional procedure, and the ratifications shall be exchanged at Washington as soon as possible.

In witness whereof, the respective Plenipotentiaries have signed the Convention both in the English and Spanish languages and have thereunto affixed their seals.

Done in duplicate at the City of Washington, this 21st day of May, one thousand nine hundred and six.

Elihu Root (Seal)
Joaquin D Casasus (Seal)

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EXHIBIT M

(Notice of appropriation of 730,000 acre-feet of water per annum from the Rio Grande, filed by the United States, in the office of the Territorial Engineer of New Mexico, on January 23, 1906).

DEPARTMENT OF THE INTERIOR

United States Reclamation Service.

Carlsbad, New Mexico, 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 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

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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 re-leased 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:

Storage dam about 9 miles west of Engle, New Mexico, with capacity for 2,000,000 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,

B.M. Hall

Supervising Engineer.

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EXHIBIT N

(Notice of appropriation of all the unappropriated water of the Rio Grande, filed by the United States in the office of the Territorial Engineer of New Mexico, on April 8, 1908).

DEPARTMENT OF THE INTERIOR

United States Reclamation Service,

Phoenix, Arizona, April 1908.

Mr. Vernon L. Sullivan,
Territorial Engineer,
Santa Fe, New Mexico.

Dear Sir:

Claiming and reserving all rights under our former notice of January 23, 1906, addressed to David L. White, Territorial 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

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distribution of the waters of New Mexico; to create the office of Territorial 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 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 of New Mexico 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 the 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 water, 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:

Storage dam about nine miles west of Engle, New Mexico, with capacity for two million (2,000,000) acre-feet, and diversion dams below in Palomas, Rincon, Mesilla and El Paso Valleys

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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,

Louis C. Hill

Supervising Engineer.

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EXHIBIT O

(Order, dated May 25, 1906, of the Secretary of the Interior, modifying the embargo on the Upper Rio Grande).

DEPARTMENT OF THE INTERIOR,
Washington, May 25, 1906.

The Commissioner of the General Land Office.

Sir: In a letter of January 25, 1906, to the department, Mr. F. C. Goudy, president of the Rio Grande Reservoir & Ditch Co., made complaint that the proposed construction of a reservoir by the company in Colorado for reclamation purposes and the procuring of a right of way therefor ie being prevented by the Government.

In a report of February 26, 1906, on this letter the Director of the Geological Survey recommended that-

"If there be no objection on the part of the State Department, at whose instance the order of December 5, 1896, was made, the same be modified to permit the approval of rights of way for irrigation purposes on the tributaries of the Rio Grande which were initiated by actual field surveys based upon notices of appropriation of water filed under the laws of Colorado prior to March 1, 1903."

The Acting Secretary of State, in a letter of March 7, 1906, to the department, stated that-

"The Department of State approves the recommendation of the Director of the Geological Survey modifying the order of suspension in accordance with the request of the Rio Grande Reservoir & Ditch Co."

In a letter of the 22d instant to the department the Acting Secretary of State has extended the approval covered by the letter of March 7, supra-

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"so as to include all companies or applicants whose rights of way for irrigation purposes on the tributaries of the Rio Grande * * * were initiated by actual field surveys based upon notices of appropriation of water filed under the laws of Colorado prior to March 1, 1903."

In view of the foregoing the departmental order of December 5, 1896, directing you to suspend action on all applications for right of way through the public lands for purposes of irrigation by using the waters of the Rio Grande or any of its tributaries in Colorado or New Mexico, and the order of January 13, 1897, modifying the original order so far as the tributaries of the Rio Grande are concerned by limiting its application to tributaries emptying into the Rio Grande above the point where it becomes the boundary between the United States and Mexico, are hereby modified so as to exclude from their operation all applications for right of way covered by the approval in the letter of the 22d instant from the Acting Secretary of State, quoted above.

The letter of Mr. Goudy is transmitted herewith.

Very respectfully,

E. A. Hitchcock, Secretary.

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EXHIBIT P

(Order, dated July 10, 1906, of the Acting Secretary of the Interior, modifying the embargo on the Upper Rio Grande).

DEPARTMENT OF THE INTERIOR,
Washington, July 10,1906

The Commissioner of the General Land Office.

Sir: In departmental letter of May 25, 1906, to you, departmental orders of December 5, 1896, and January 13, 1897, were modified so as to exclude from their operation all applications for rights of way through the public lands for purposes of irrigation by using the waters of the Rio Grande or any of its tributaries in Colorado and New Mexico initiated by actual field surveys based on notices of appropriation of water filed under the laws of Colorado prior to March 1, 1903, such modification being favored by the Acting Secretary of State in a letter of May 22, 1906, to the department.

In view of this modification of the orders mentioned you are directed that in acting on this class of applications, now on file or that may be filed hereafter in your office, to submit them to the Director of the Geological Survey to ascertain whether they will conflict with the obligations of the United States, under the treaty with Mexico, recently ratified, or with the Rio Grande or any other project of the Reclamation Service, and to transmit the reports of the director, with the applications when they are submitted for departmental action.

Very respectfully,

Thos. Ryan, Acting Secretary.

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EXHIBIT Q

(Order, dated September 27, 1906, of the Acting Secretary of the Interior, modifying the embargo on the Upper Rio Grande).

DEPARTMENT OF THE INTERIOR,
Washington, September 27, 1906.

The Commissioner of the General Land Office.

Sir: In a letter of the 24th instant to the department the Acting Secretary of State has stated, with respect to applications for right of way through public lands for purposes of irrigation by using the waters of the Rio Grande or any of its tributaries in Colorado and New Mexico, that the Department of State perceives no reason for the further suspension of action on any application of such character.

He has stated further that the intent of the original departmental order of suspension dated December 5, 1896, was to conserve the interests of the Mexican Government in the waters of the Rio Grande pending an agreement between the United States and Mexico on the question, and that such an agreement has been reached and is embodied in the treaty signed May 21 last, by which the United States obligates itself to deliver to the Mexican Government 60,000 acre-feet of water annually.

He has accordingly recommended that the order of December 5, 1896, and all modifying orders be rescinded, thus removing so far as the Department of State is concerned, all restrictions

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on the consideration of applications involving any enterprise of a character which, on investigation by the Reclamation Service, is found to be not prejudicial to the treaty interests of Mexico.

In view of this recommendation the departmental order of December 5, 1896, and the several modifying orders are hereby revoked, and it is hereby directed that before any applications involving the use of the waters mentioned in Colorado and New Mexico are submitted for final departmental action by you they be first submitted to the Director of the Geological Survey to ascertain whether favorable action thereon would interfere with any project of the Reclamation Service, or with the obligations of the United States under the treaty of May 21, 1906, with Mexico.

Very respectfully,

Thos. Ryan, Acting Secretary.

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EXHIBIT R

(Order, dated April 25, 1907, of the Secretary of the Interior, modifying the embargo on the Upper Rio Grande).

DEPARTMENT OF THE INTERIOR

United States Reclamation Service.

Washington, D. C.,

April 22, 1907.

The Honorable

The Secretary of the Interior.

Sir:

The situation on the Rio Grande requires careful consideration and determination of policy by the Secretary. Briefly stated the conditions are these:

The United States has entered into a treaty with Mexico, proclaimed by the President on January 16, 1907, by which it is agreed that the United States shall deliver to Mexico 60,000 acre-feet of water at the head of the Mexican canal near El Paso. In order to carry out this part of the treaty Congress has appropriated by Act approved March 4, 1907, the sum of $1,000,000 towards the construction of a dam on the Rio Grande, this being assumed to furnish water for 25,000 acres at $40 per acre. The total estimated cost of this project, including the dam, will be $7,200,000, of which amount $200,000 has been set aside and is now being used in the construction of subsidiary works, notably a diversion dam above Las Cruces, New Mexico. The remaining amount, $6,000,000

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must be obtained from the reclamation fund.

It is estimated that for this expenditure of $7,200,000 it will be possible to irrigate 180,000 acres at $40 per acre. Deducting the 25,000 acres in Mexico, this leaves 155,000 acres in New Mexico and Texas to refund the $6,200,000. By storing all the water of the Rio Grande, including storm floods, this acreage can be supplied. If the flow of the stream is notably diminished the area to be served will be correspondingly reduced and the cost per acre increased. This increase of cost will probably be at the expense of the lands in the United States as Congress has already made the appropriation for the building charge to comply with the terms of the treaty.

The headwaters of this river are in the State of Colorado, surrounding the San Luis Valley. For several years after December 5, 1896, the Department of the Interior refused to grant rights of way for reservoirs or canals on these headwaters because of the effect on the international problem below. The Departmental order was first modified May 25, 1906, to permit approval in cases where the applicants made a showing of priority over the United States. After the Senate had advised the ratification of the treaty on July 10, 1906, these orders of the Department were revoked and the Reclamation Service was required to pass upon each case as to conflict with the treaty or the Rio Grande Project. Most of

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the older cases have been reported on favorably by the Reclamation Service. In some of the cases, especially the later ones, the conditions involved some doubt as to the advisability of approval and the questions of policy to be considered by the Department were reported to the General Land Office for submission to the Department when the cases were presented for your consideration.

Recently a few exceptions have been made as to small reservoirs located high in the mountains where it appeared that the construction of works would not interfere notably with the supply of water which could be had in the lower reservoir. In view of the fact, however, that the treaty above mentioned has been concluded and an appropriation has been made by Congress for constructing the works in part, it appears probable that any considerable extension of the reservoir system at the headwaters may interfere with the plans of the Government.

Wide publicity has been given to the fact that the Department has in a few cases permitted the location of small reservoirs on the headwaters of the Rio Grande. As a result a considerable number of applications are being made for other reservoir sites. If it were practicable to lay down a general rule by which the smaller of these sites could be approved the results would probably be beneficial, but a practical difficulty arises in the possibility of defining

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the limits between the large and small projects. It is unquestionably true that if all of the large projects on the headwaters of the river which are planned by private parties could be actually constructed the water supply for the Government reservoir would be to a large extent cut off. It is important, therefore, to have a general rule which can be applied to all cases.

Recommendations.

I therefore recommend that the Department lay down the general policy that until the development of irrigation on the Upper Rio Grande in the State of Colorado and the Territory of New Mexico shall furnish sufficient data to determine the effect of the storage and diversion of water in that vicinity upon the water supply for the Engle Reservoir of the Rio Grande Project, no further rights of way be approved which involve the storage or diversion of the waters of the Upper Rio Grande and its tributaries, except applications of two kinds; first, those in connection with which there is a showing that the rights of the parties were initiated prior to the beginning of active operations by the Reclamation Service for the Rio Grande project, namely, March 1, 1903; second, applications which involve the diversion or storage of not exceeding 1,000 acre-feet of water per annum.

When it becomes possible to determine the effect of the approved applications upon the water available for storage

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for the Rio Grande project, it may be possible to allow the use of rights of way to a greater extent than is now proposed.

Very respectfully,

F. H. Newell

April 25, 1907

Approved:
J. R. Garfield
Secretary.

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EXHIBIT S

(Order, dated March 2, 1923, by the Secretary of the Interior, modifying the embargo on the Upper Rio Grande).

DEPARTMENT OF THE INTERIOR

United States Reclamation Service

Washington, D.C. March 2, 1923.

The Secretary

of the Interior.

My dear Mr. Secretary:

In the hearings on the problems of the Colorado River held in San Diego December 12, 1921, the Reclamation Service was criticized by the delegate from Colorado for the attitude of the United States concerning the reservation of public lands in Colorado for the protection of the water supply of the Rio Grande. In reply to his remarks you made the following rejoinder:

> "It may be that the Reclamation Service has been dilatory in not having ascertained and reported heretofore that there was sufficient water falling within that basin to fill the Elephant Butte reservoir and to enable us to perform our international obligations and our obligations to the prior users below that reservoir and yet to release certain of the waters in the State of Colorado- it may be that they have been dilatory, as I say, in the performance of that duty. I have suggested as much myself, and it shall be my pleasure to see that at an early date a report is made upon this proposition."

In response to your wishes thus expressed I have the honor to make the following report concerning this question:

The policy of the Department in regard to the approval of rights of way for the use of public lands in the Rio Grande

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drainage was initiated upon a request of the Department of State through the Department of Justice onDecember 5, 1896, in pursuance of which the Secretary of the Interior directed suspension of applications for rights of way upon public lands for irrigation purposes by the use of waters of the tributaries of the Rio Grande entering it above where it becomes the international boundary. Soon after the organization of the Reclamation Service a study of the situation was made which resulted in recommendation for the construction of Elephant Butte reservoir. The treaty with Mexico regarding the furnishing of 60,000 acre-feet for the Mexican lands was proclaimed January 16, 1907.

A letter from Director Newell to the Secretary of the Interior dated April 22, 1907 was closed with the following recommendations:

Recommendations

I therefore recommend that the Department lay down the general policy that until the development of irrigation on the Upper Rio Grande in the State of Colorado and the Territory of New Mexico shall furnish sufficient data to determine the effect of the storage and diversion of water in that vicinity upon the water supply for the Engle Reservoir of the Rio Grande project, no further rights of way be approved which involve the storage or diversion of the waters of the Upper Rio Grande and its tributaries, except applications of two kinds; first, those in connection with which there is a showing that the rights of the parties were initiated prior to the beginning of active operations by the Reclamation Service for the Rio Grande project, namely, March 1, 1903; second, applications which involve the diversion or storage of not exceeding 1,000 acre-feet of water per annum.

When it becomes possible to determine the effect of the approved applications upon the water available for storage for the Rio Grande project, it may be possible to allow the use of rights of way to a greater extent than is now proposed."

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These recommendations were approved by the Secretary of the Interior on April 25, 1907.

The recommendation and the accompanying letter indicate that the purpose of the reservation of the lands in Colorado was to protect the water supply of the Rio Grande project as a whole, including prior rights in the United States and Mexico and extension of irrigation as contemplated by the construction of the Elephant Butte reservoir.

The filings of the Reclamation Service upon the waters of the Rio Grande for storage and use in New Mexico, Texas, and Mexico were designed to cover all the waters of the river at that time unappropriated and to include of course such waters as had been appropriated by the lands included within the project. Information at that time indicated, and subsequent experience has confirmed, the fact that the Elephant Butte reservoir of the large capacity constructed is sufficient to control and store the flood waters of the Rio Grande in all years except a few extraordinary floods of rare occurrence which may be partially wasted; also that the amount of water that can thus be conserved and beneficially used is insufficient to supply all of the lands that might be reached with those waters. Or, in other words, that needs of the available lands exceed the water supply made available by the reservoir.

An important fact in this connection is that the dependable low water and ordinary flow of the river have long been

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appropriated and used for irrigation in Colorado and New Mexico above the Elephant Butte reservoir and nothing important remained for appropriation for the Elephant Butte project excepting freshets and floods which could not be intercepted and used commercially above this point without storage. Obviously such waters can not be made available except by large storage works.

The appropriation of these waters for the use of the Rio Grande project has been diligently followed by the expenditure of public funds in the construction of reservoir, diversion works, canal and distribution systems and the consequent drainage systems, with a total investment of over $10,600,000 therein by the United States. Probably an equal amount has been invested by the settlers in clearing, leveling and otherwise improving suitable for appropriate use the lands to utilize this water supply. So far as the formalities and the diligence of construction are concerned, the rights of the United States and of the settlers on the project have not been and can not be questioned.

The diversion and use of the dependable natural flow of the river and its tributaries has been so complete in Colorado and northern New Mexico that it may be stated broadly that any further feasible extension of such diversions can not materially cripple the water supply of the Rio Grande project unless accompanied by storage of the

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flood waters at or above such diversion.

The treaty with Mexico guarantees the delivery of 60,000 acre-feet of water annually at the diversion dam near El Paso for use in Mexico. The records indicate a dependable supply from the Elephant Butte reservoir of 720,000 acre-feet annually, or 12 times the amount required to fulfill the treaty. A general knowledge of the basin indicates that there is no practical possibility of so depleting the supply that the Elephant Butte reservoir could not receive and conserve sufficient of the flow of the river to fulfill the obligations of the treaty, if the entire shortage were imposed upon the American lands in the Rio Grande project. Any material decrease in the amount available for storage would react upon the project and cause a loss to the water users due tothe deficiency in the water supply.

In view of the above the question resolves itself about as follows:

Is it legal, and if legal, advisable, for the Secretary of the Interior to decline to approve the use of the public lands for storing and diverting for irrigation the waters of the Rio Grande, for the purpose of protecting the water supply of the lands developed under the Elephant Butte reservoir in New Mexico and Texas?

It may be physically possible in some cases to store and use the waters of the Upper Rio Grande without the use of

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public lands, but the opportunities for such development on exclusively private lands are believed to be few and meager and not seriously to affect the main question. It is possible to build storage reservoirs on the Upper Rio Grande and its tributaries that would intercept sufficient flow to deplete materially the supply of the Elephant Butte reservoir and that the waters thus stored could be used for irrigation below such storage and above Elephant Butte.

There are of course legal means, by injunction and otherwise, by which the valid rights of the irrigators under the Elephant Butte reservoir may be protected, but these are slow of operation and to depend upon them may be an injustice to possible investors in storage works who might undertake storage works in good faith, if such were approved by the Secretary of the Interior, and later find their investment wasted for lack of valid rights to the necessary water.

The above questions of law and of policy are of so fundamental a character that they demand consideration and decision directly by the Secretary of the Interior. It may, however, be in order for this office to venture a few suggestions.

It is believed that the best use of the waters for irrigation is the proper object of the policies and proceedings of this Service, and such use must be determined at any given time with full consideration of existing legal and physical conditions. Practically complete appropriation of the de-

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pendable flow of the river was accomplished many years before the construction of the Elephant Butte reservoir, and no material increase of the use of the river could be feasibly accomplished except by the provision of large storage works. Manifestly to be complete and make the best use of the water supply these works must be constructed at a point low enough to intercept practically all the drainage of the river which could not be otherwise conserved. The Elephant Butte site was selected as one which combined this advantage of location with the physical condition that at no other place in the basin could a reservoir of sufficient capacity be constructed to intercept the flow of all the unappropriated waters above the Mesilla Valley. Had the reservoir been built at such higher point as White Rock Canyon or above, many large and important tributaries such as the Galisteo, Puerco, and numerous other streams would have continued to waste large quantities of water which are intercepted and conserved at the Elephant Butte site.

In order to make such a large reservoir commercially feasible it is necessary that it receive the benefits of practically all of the unappropriated waters, and these were accordingly appropriated for such use.

Even though the wisdom of the construction of the Elephant Butte reservoir might be questioned by some, the situation now is that the investment has been made and is a physical success. The lands are served and are developed. To take

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away its water supply would not only violate existing moral and legal rights but would destroy large investments in proportion to the magnitude of the deprivation.

On the other hand it is manifestly wise and just to encourage any developments that may be carried out in the basin above that will not materially deplete the supply of the reservoir or otherwise jeopardize the interests it has built up. Extensive studies have been made by the Reclamation Service as well as by the Geological Survey, the State of New Mexico and other public and private agencies, and these have developed the fact that large areas now or formerly irrigated in Colorado and New Mexico have produced underground conditions where large bodies of land have been deprived of their fertility by the rise of ground water and hundreds of thousands of acres are for this reason now unavailable for cultivation from this cause, although most of the area is still available for grazing and some of it produces a low grade of coarse hay.

More than half a million acres of land in the San Luis Valley, Colorado, and various small valleys in New Mexico, require expensive drainage systems to bring back their fertility.

These waterlogged lands now discharge immense quantities of water into the air through evaporation, a part of which would be conserved by proper drainage systems and returned to the streams because with the lower ground water the natural

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evaporation from those lands would be decreased. If such drainage works were carried out in Colorado and the water returned to the stream and not used locally, it would follow down the stream, and unless diverted would increase the supply to the Elephant Butte reservoir. It would, however, pass by many small ditches which divert water from the river and during the irrigation season most of it could be diverted by these ditches and in dry times all of it. It would be extremely difficult to distinguish this from other waters of the river and to prevent its diversion by such ditches.

The valley lands in New Mexico which have been cultivated in the past are largely in need of drainage works also and the proper drainage of these lands would also conserve much water now lost and convey it into the river, where if not intercepted it would flow into the Elephant Butte reservoir. The drainage of practically all of the land in Colorado and New Mexico would be available as inflow to the Elephant Butte reservoir at all times outside of the irrigation season unless storage works so located as to intercept such waters were provided.

No Government authority has any right or power to interfere with the vested rights of the irrigators under the Elephant Butte reservoir or elsewhere. These rights, whatever they

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are, can be, and if necessary will be defended in the courts by the people most interested, that is, the farmers themselves. But it is believed that the Secretary of the Interior as the head of the Reclamation Service is in a position to assist in the full development and conservation of the water resources of this basin without local interest, bias or prejudice, and that much can be done in the way of encouraging such development and removing jeopardy from investments made for this purpose.

It is believed that under present conditions the Department would be justified, with the approval of the interests below, in assuring prospective investors in Colorado and northern New Mexico that they would be protected in the storage of waters in the same quantity that the construction of drainage works might deliver water into the river at a point low enough to insure its flow into the Elephant Butte reservoir. Each individual project should be worked out after careful study of the local physical and other conditions surrounding it. But the announcement of this general principle, it is believed, would remove some of the timidity of proposed investors, either public or private.

The effect of an approval by the Secretary of an application for irrigation right of way under the Act of March 3, 1891 (26 Stat., 1095) upon the interests of the United States under the Reclamation Law has not been decided

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by the Courts. The view has been expressed that, as the regulations require applications to be accompanied by evidence of ample water-right the Secretary's approval may commit the Government to a recognition of the validity of the water right claimed in connection with the application, with a possible estoppel of the United States to assert any water right in conflict therewith. Accordingly any approval of right of way as herein suggested should be carefully guarded by a reservation of all rights claimed by the United States for the Rio Grande project and for the Mexican lands under the treaty.

Recommendation.

It is recommended that this office be authorized to negotiate for the release of specific areas of public land for purposes of water storage under conditions that will best conserve and utilize the water resources and will protect vested rights in all partsof the Rio Grande basin- such negotiations to be subject to the approval of the Secretary of the Interior, and, prior to such approval, to be subject to the scrutiny of all interested parties.

Respectfully,

A. P. Davis

Director.

Approved:

Albert B. Fall
Secretary.

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EXHIBIT T.

(New Mexico Act of March 12, 1923, authorizing representation on Rio Grande Commission).

An Act Providing for the Appointment of a Commissioner on behalf of the State of New Mexico to Negotiate a Compact or agreement Respecting the Use, Control and Disposition of the Waters of the Rio Grande River and for Other Purposes.

S.B. No. 104 (As Amended); Approved March 12, 1923.

Be it Enacted by the Legislature of the State of New Mexico:

Section 1. The Governor of the State of New Mexico shall, with the advice and consent of the Senate, appoint a Commissioner who shall represent the State of New Mexico upon a Joint Commission, to be constituted as hereinafter provided for the purpose of negotiating and concluding a compact or agreement fixing and determining the rights of the signatories to the use, control and disposition of the waters of the Rio Grande River, and of the streams tributary thereto, excepting as to all waters appropriated to the use appurtenant and necessary to the full and complete operation of the Rio Grande Project in Southern New Mexico, being an irrigation project constructed by the United States Reclamation Service; provided, that settlers and land owners under said project shall not be put to any additional expense by reason of the passage of this Act.

Said Joint Commission shall include either:

(a) Commissioners for the States of Colorado and New

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Mexico, and a duly authorized representative of the United States of America; or

(b) Commissioners for the States of Colorado and New Mexico; provided, however, that any such compact or agreement shall not become operative and shall not bind any of the signatories thereto, unless and until the same shall have been ratified and approved by the Legislature of each of the signatory States and by the Congress of the United States.

Sec. 2. The Governor of the State of New Mexico shall notify the Governor of the State of Colorado of the appointment of the Commissioner for New Mexico pursuant to the provisions hereof. The Commissioner for New Mexico shall commence the performance of his duties upon receipt of notice by the Governor of New Mexico from the Governor of Colorado of the appointment of a Commissioner for said State, and unless the Governor of Colorado shall have officially communicated notice of such appointment to the Governor of New Mexico on or before October 1, 1924, the appointment of the Commissioner for New Mexico hereunder shall cease and determine without further act.

Sec. 3. When the Commissioner for New Mexico shall enter upon the performance of his duties he shall be furnished such engineering, legal, stenographic and other assistants as may be necessary or essential to the proper performance of his duties, and it shall be the duty of the State Engineer and his deputies to aid and assist the Commissioner for New

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Mexico whenever requested by him so to do.

Sec. 4. The compensation of the Commissioner for New Mexico,and of his assistants, shall be fixed by the Governor and Attorney General, and the State of New Mexico shall pay all necessary traveling and other expenses incurred in the performance of the duties of the Commissioner and his assistants both within and without the State of New Mexico, and also all other necessary costs, charges and expenses hereunder, including the payment of an equitable portion of the costs and expenses of any such Joint Commission. Such compensation and expenses shall be paid monthly, upon vouchers approved by the Governor and Attorney General, by warrants drawn by the State Auditor.

For the purpose of carrying out the provisions of this Act there is hereby appropriated but of the Water Reservoir for Irrigation Purposes Income Fund the sum of Five Thousand ($5,000.00) Dollars or so much thereof as may be necessary.

Sec. 5. The Commissioner for New Mexico shall have full authority to make any and all investigations of the Rio Grande River and the drainage area thereof, of the conditions obtaining upon said stream and of the present and future needs relative to the use, control and benefit of the waters of said stream, and to make such other investigations as my be necessary to the proper performance of his duties hereunder, and said Commissioner shall have the authority to administer oaths and to examine and require the attendance of witnesses.

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EXHIBIT U.

(Colorado Act of March 20, 1923, authorizing representation on the Rio Grande Commission).

AN ACT

Providing for the appointment of a Commissioner on behalf of the State of Colorado to Negotiate a Compact or Agreement Respecting the Use, Control and Disposition of the Waters of the Rio Grande River and for other Purposes.

Be it enacted by the General Assembly of the State of Colorado:

Section 1. The Governor of the State of Colorado shall appoint a Commissioner who shall represent the State of Colorado upon a Joint Commission, to be constituted as hereinafter provided, for the purpose of negotiating and concluding a compact or agreement fixing and determining the rights of the signatories to the use, control and disposition of the waters of the Rio Grande River, and of the streams tributary thereto. Said Joint Commission shall include either:

(a) Commissioners for the States of Colorado, New Mexico, and Texas, and a duly authorized representative of the United States of America; or

(b) Commissioners for the States of Colorado and New Mexico and a duly authorized representative of the United States of America; or

(c) Commissioners for the States of Colorado and New Mexico:

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Provided, However, that any such compact or agreement shall not become operative and shall not bind any of the signatories thereto, unless and until the same shall have been ratified and approved by the legislature of each of the signatory states and by the Congress of the United States.

Section 2. The Governor of Colorado shall notify the Governors of the States of New Mexico and Texas of the appointment of the Commissioner for Colorado pursuant to the provisions hereof. The Commissioner for Colorado shall commence the performance of his duties upon receipt of notice by the Governor of Colorado from the Governor of either of the States of New Mexico or Texas, of the appointment of a Commissioner for said State, and unless at least one of said States shall have named its Commissioner and shall have officially communicated notice of such appointment to the Governor of Colorado on or before October 1, 1924, the appointment of the Commissioner for Colorado hereunder shall cease and determine without further act.

Section 3. When the Commissioner for Colorado shall enter upon the performance of his duties, he shall be furnished such engineering, legal, stenographic, and other assistants as may be necessary or essential to the proper performance of his duties, and it shall be the duty of the State Engineer and his deputies, the Division Engineer of Irrigation Division No. 3 and the Water Commissioners whose districts are included within said Irrigation Division, to aid and assist the Commissioner for

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Colorado whenever requested by him so to do.

Section 4. The compensation of the Commissioner for Colorado, and of his assistants,shall be fixed by the Governor, and the State of Colorado shall pay all necessary traveling and other expenses incurred in the performance of the duties of the Commissioner and his assistants, both within and without the State of Colorado, and also all other necessary costs, charges and expenses hereunder, including the payment of an equitable portion of the costs and expenses of any such Joint Commission. Such compensation and expenses shall be paid monthly, upon vouchers approved by the Governor, by warrants drawn for the payment thereof upon the State Treasurer by the State Auditor in the ordinary manner,out of any funds appropriated under the provisions of an Act entitled "An Act to enable the State of Colorado to protect the waters of its natural streams and to maintain the right of appropriation and use of such waters for beneficial purposes within this State and making an appropriation therefor of the first class" or out of any appropriation of the first class made for the protection of the waters of the State.

Section 5. The Commissioner for Colorado shall have full authority to make any and all investigations of the Rio Grande River and the drainage area thereof, of the condition obtaining upon said stream and of the present

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and future needs relative to the use and benefit of the waters of said stream, and to make such other investigations as may be necessary to the proper performance of his duties hereunder, and said Commissioner shall have authority to administer oaths and to examine and require the attendance of witnesses.

Section 6. The General Assembly hereby finds, determines and declares that this Act is necessary for the immediate preservation of the public peace, health and safety.

Section 7. In the opinion of the General Assembly an emergency exists; therefor, this Act shall take effect and be in force from and after its passage.

Approved March 20, 1923.

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RG 115 RECORDS OF THE BUREAU OF RECLAMATION

General Administrative and Project Records, 1919-1945

Project Files, 1919-1929

Rio Grande Basin 023.--032.02

Entry 7

Box No. 924

TX_MSJ_003509

032.02 RIO GRANDE BASIN Water Rights; RIO GRANDE RIVER BASIN EMBARGO.
TRANSFER CASE THRU 1929

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TRANSFER CASE
032.D2
RIO GRANDE BASIN

(COPY)

THE SECRETARY OF THE INTERIOR

WASHINGTON

May 20, 1925.

Rio Grande Embargo

The Commissioner

of the General Land Office.

My dear Mr. Commissioner:

The original withdrawal was made December 5, 1896, pending consideration of treaty with Mexico as to claimed water rights of that country. The subsequent withdrawal of April 25, 1907, was made to prevent the building of dam, canals, etc., on the Upper Rio Grande in Colorado and New Mexico, pending construction of the Government Rio Grande reclamation project and the effect of storage and diversion of water upon that project.

The treaty with Mexico has been concluded, and Mexican rights defined and protected.

The Rio Grande project has been completed, water has been stored and is available for all the lands in the project. The Rio Grande in New Mexico and Colorado is not a navigable stream.

The approval of rights of way over public lands for dams and canals is pursuant to the act of Congress of March 3, 1891, which the Secretary of the Interior has no legal right to suspend or defeat. Grants under that act are not grants of water, but simply rights of way to use and occupy public lands. Water must be appropriated under State laws, and

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SDG

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under those laws priority in appropriation and use controls.

Present water users, including Mexico, the Government reclamation project, and others can not have their rights destroyed or defeated by the granting of mere rights of way on public lands or by the attempted subsequent appropriation of water and use of water by others.

The purpose of the withdrawal having been accomplished, there being no power in the Secretary to suspend laws of Congress, and the granting of water rights being vested in the States, the withdrawals or embargoex are hereby lifted, effective this date.

Very truly yours,

Hubert Work

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Penal Papers:

Governor Arthur T. Hannett
reports, penal papers
box 5

Dates 1925-1927

Serial Number **14153**

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14153

J. O. SETH
ATTORNEY AND COUNSELOR AT LAW
20-23 LAUGHLIN BUILDING
SANTA FE, NEW MEXICO

OFFICE OF THE GOVERNOR
STATE OF NEW MEXICO



JUN 2 1925
RECEIVED

June 1, 1925

Hon. A. T. Hannett,
Governor of New Mexico,
Santa Fe, New Mexico.

My dear Governor:

The 1923 Legislature by Chapter 112 of the Session Laws of 1923 authorized the participation by the State of New Mexico in a joint commission to attempt an amicable division of the waters of the Rio Grande between the States of New Mexico and Colorado. Such joint commission was composed of representatives of the United States, the State of Colorado and the State of New Mexico. Governor Hinkle appointed me as the representative for New Mexico on this Commission. This Commission did a great deal of work looking to the making of a treaty or compact between the states but decided that no effective agreement could be reached without the participation of the State of Texas. At a meeting of the joint commission, it was decided that effort should be made to have Texas participate and that matters affecting the Rio Grande should remain in their then status until the Legislatures affected had an opportunity to act.

The Legislature of Texas, at its recent session, provided for the participation of Texas in the joint Commission and the 1925 Legislature of New Mexico amended the 1923 Law to provide for the participation of Texas and continued the Commission. You reappointed me to represent the State of New Mexico.

The 1925 Legislature of New Mexico further provided by Senate Bill 120 that in the event this joint commission should be unable to reach an agreement, and the member representing New Mexico should so report to you, you should take such steps as were necessary in your judgment for the protection of the rights of this State to the waters of the Rio Grande.

Notwithstanding the agreement of the commission, the Secretary of the Interior has seen fit to take action in matters affecting the Rio Grande which have materially changed the status theretofore existing and which in my opinion, seriously affect the situation in this state, and particularly the water supply of the Middle Rio Grande Valley. The whole matter has been fully discussed in the public press and it seems unnecessary to go into it in detail here. Prior to the

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recent action of the Secretary of the Interior, there were grave doubts as to whether the depletion of the river in Colorado had not gone to the extent of making impossible any practical agreement that would adequately restore and protect the rights of this state and particularly the ancient rights of the Middle Rio Grande Valley. The recent action of the Interior Department allowing certain applications for rights of way in Colorado and removing all restrictions on the allowance of other applications, has permitted and will permit the acquisition of vested rights in Colorado which make impossible any agreement between the states, which can properly provide water for the rights in this state having priority over those in Colorado.

It is not my intention to enter into any controversy with the representative of Colorado, but in view of certain statements in the press that the holders of rights of way recently acquired in Colorado are willing to enter into an agreement that their rights shall be subject to any compact, I desire to call attention to the fact that any such agreement would be unenforceable and impracticable and that such parties are unwilling to take the only effective steps to restore the status quo, namely, the relinquishment of their rights so recently acquired.

The matter has been fully discussed with Mr. Grimshaw of the Department of Commerce, representing Secretary Hoover, with the Colorado Commissioner, with the State Engineer of New Mexico, and with representatives of the various rights in the Middle Rio Grande and Mesilla Valleys. The Governor of Texas has not yet appointed a representative on the Commission. I have suggested a meeting of the three members of the Commission to discuss the matter, but this seems impracticable at the present time.

Senate Bill No. 120 of the 1925 Legislature, above referred to, seems to place on me the responsibility of recommending to you the course to be followed by the state in this matter - whether to further attempt an agreement or to take other steps to enforce and protect the rights of the State. With a full realization of the seriousness of the matter, and after obtaining the best engineering and other advice obtainable, I unhesitatingly report that an agreement such as is contemplated by Chapter 112 of the Session Laws of 1923, which will adequately secure and protect the rights of this state to the use of the waters of the Rio Grande can not be reached under existing conditions. It is my opinion that the situation with regard to the waters of the Rio Grande in this state is such, particularly in the Middle Rio Grande Valley, that immediate action is necessary for the protection of existing rights and I recommend that you make the provisions of Senate

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Bill No. 120, Session Laws of 1925, immediately effective.

In view of my opinion in this matter, my continuance on the Commission seems scarcely necessary and I am tendering herewith my resignation.

Respectfully submitted,

Rio Grande Commissioner
for New Mexico.

JOS-rh

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RG 115 **FY 13**

Records of the Bureau of Reclamation
Washington, D.C.

GENERAL ADMINISTRATIVE AND PROJECT RECORDS

1919-1945
GENERAL FILES, 1919-1929
023.6- -032

Box 33 **Entry 7**

TX_MSJ_003518

030.1 General Correspondence re Return Flow, Waste & Seepage Waters Thru 1929

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030.1

Return Flow and Its Problems on Reclamation Projects

By E. B. Debler, Engineer, Bureau of Reclamation

WHEN water is applied to the earth's surface naturally through rains and snows or artificially by irrigation it is disposed of in a number of ways. A part passes away immediately or very soon as surface run-off or evaporation from the surface of the snow, ground, or from the exposed surfaces of plants which catch the moisture. Another part enters the ground and is in part returned to the surface by capillary action to replace water evaporated from the surface. Some is taken up through the roots of plants and evaporated in the growth processes of the plant or stored in the plant structure and hauled away as a plant product. The remainder passes beyond the limit of capillary action and joins the mass of water existing under the ground surface, there generally to form part of a moving stream seeking a lower level, and reappearing in the form of seepage, springs, or artesian flow, the particular name popularly applied being dependent on the concentration of flow and the pressure with which it reaches the surface. The reappearance of these waters may be but a few hundred feet from the source thereof, or it may be several hundred miles, depending entirely on the ground structure and topography.

In the arid regions the term "return flow" is more properly used in designating the increase therein due to the application of irrigation water. This includes waters lost by seepage from canals and reservoirs, as well as waters applied by the irrigator to his land. Such return flow is in these places particularly prominent, as the return flow from precipitation prior to irrigation development is usually so small that the stream in its passage through the region actually loses a part of the water it brings from its mountain sources, at times drying up completely. With irrigation development such conditions are materially changed and living streams often result therefrom.

The water lost by evaporation, including plant transpiration and water stored in the crops that are removed, is termed the "consumptive use" of water. It has been found generally that where sufficient water is applied to maintain the growth of plants at a near maximum rate the application of additional water results in a corresponding increase in return flow, as the consumptive use increases very little, such increase in use being due to slightly greater opportunity for evaporation. Consumptive use is not, however, uniform, as it is greatly affected by soil, crop, and climatic conditions. From the few investigations thereof, seldom sufficiently complete for well-grounded conclusions, consumptive use of water on cultivated lands is estimated to vary from 1 acre-foot per acre annually in high mountain valleys to 3 acre-feet in localities like Imperial Valley. Rice lands use much more water.

EFFECT OF IRRIGATION

The first result of the escape of unused irrigation water is to raise the underlying water table and thereby gradually increase the amount of pressure head available to force this water through the ground structures intervening between the point of application of such water and the natural stream channels which it seeks. In some localities the ground structure is so open through the existence of broken rock or coarse gravel delta formations that a very slight rise in ground water will provide all of the needed pressure head to carry away unused water, and drainage problems do not develop. In a great many localities and over large areas the ground structure is, however, such that the velocity of water flowing through it is very slow, with the result that the underground streams are incapable of carrying away the excess water applied and the water table is built up higher and higher until it reaches the top soils and affects plant growth or even reaches the surface and floods it. Artificial drainage is then necessary.

ANNUAL DISTRIBUTION AND AMOUNT

Where irrigated lands lie close to stream channels and the ground structures are open, return flow is heavily concentrated in the irrigation season, reaching a maximum shortly after irrigation diversions have reached a maximum and with winter flow but a small fraction of summer flow. With large irrigated areas underlain to great depths with permeable deposits, return flow continues throughout the year, in some instances at almost uniform rates. In this respect return flow acts just as do ordinary streams which in sand-hill and lava regions often show remarkably uniform flow, whereas streams in clay, shale, or impervious rock regions will fluctuate with the precipitation. The most common condition found is one where winter return flow is from one-third to one-half of the maximum rate in late summer.

The average irrigation system delivers, at the farm, about 60 per cent of waters diverted. With ordinary irrigating methods about one-third of the delivered water escapes beyond the reach of plants. Of the diverted waters, 60 per cent becomes return flow and reenters the streams for further use unless intercepted. In extreme cases with diversions as high as 15 acre-feet per acre, return flow may reach 90 per cent of diversions and on concrete-lined systems with favorable soils may fall as low as 25 per cent.

UTILIZATION

In every case return flow augments the irrigation water available in the late summer after the stream flow, due to melting snows, has declined to less than the irrigation requirements of lands dependent thereon, and in that way serves a similar purpose as do storage reservoirs, but with the advantage over ordinary reservoirs that there is no loss from evaporation. In practice the effect has been to materially improve water rights on the lower portions of stream systems due to irrigation development on the upper reaches. In some cases the irrigation systems that have produced such return flow have been able to benefit in that less water is thereafter necessary to be passed down the stream to care for prior rights.

In many localities streams leave their mountain sources with sufficient gradient to move large masses of sand, gravel, and cobbles whenever in flood. These materials are deposited in the traversed valleys or in characteristic delta cones where the stream enters a large valley or the plains. Ordinary stream flows usually sink in these formations to reappear at some distance, under favorable conditions. The natural outflow from these underground streams and reservoirs has, in many places, been artificially increased by means of artesian wells and pumping, often to the point of excessive depletion as evidenced by permanent lowering of the water table. In places it has been found possible to materially increase the yield of such underground streams and reservoirs by facilitating increased stream losses during floods by spreading the flood water over the heads of the valleys and deltas.

RETURN FLOW ON FEDERAL PROJECTS

On the Boise project, Idaho, the Notus division is entirely supplied by drainage waters from another portion of the project and is therefore entirely dependent on return flow, the division having no canal connection with natural streams. The return flow in this case takes the place of storage which is supplied to other project lands from the Arrowrock and Deer Flat Reservoirs.

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On the North Platte River in Wyoming and Nebraska, early irrigation and power development established rights to an amount of water materially exceeding the ordinary steam flow of the river in late summer. With the progress of irrigation under the canals of the North Platte government project, return flow has developed to such an extent that much less water must be by-passed at the Whalen Dam than formerly anticipated, with water supply for prior rights below the project limits much improved over conditions existing in earlier years. Return flow from lands under Government canals is supplied to a number of canals under Warren Act contracts in the vicinity of Scottsbluff and Bridgeport, Nebr., as part of a supplemental supply, in lieu of Pathfinder Reservoir storage water. Where the North Platte River, prior to the time of irrigation development, seldom discharged more than 500 or 600 second-feet during the winter at Bridgeport, the river now carries a stream of 1,600 to 2,000 second-feet throughout the winter, even though the natural flow of the river at Pathfinder Reservoir is entirely cut off.

On the Umatilla project in Oregon, the lands under the west extension division are almost entirely dependent on return flow from the Hermiston division and some smaller areas adjacent to Umatilla River in the immediate vicinity, with a large increase in this supply anticipated when the McKay Reservoir water is put to use on the lands south and west of Hermiston.

By an appropriate stipulation in the adjudication decree of Snake River, the Minidoka project in Idaho is credited with the net gain in Snake River from Neeley to Milner Dam, such gain being due to return flow from the project and amounting during the irrigation season to several hundred second-feet over and above reservoir evaporation losses through Lake Walcott. As the Minidoka project is underlain with lava formations of unknown depth and very open, a large part of its return flow returns to Snake River beyond Milner Dam and is not available for irrigation use.

On the Rio Grande project, New Mexico-Texas, the Hudspeth County water improvement district in Texas, comprising some 20,000 acres of high-class agricultural land, is entirely dependent on return flow and waste water from project lands, and largely so from the El Paso Valley lands in Texas alone, as the El Paso Valley in turn uses return flow from Mesilla Valley in New Mexico and Texas.

QUALITY OF RETURN FLOW

Precipitation reaches the earth in a comparatively pure state, but upon contact with or passage through the ground, products of mineral and organic decomposition are dissolved. It is only the inorganic or mineral salts that are of interest in this discussion. With ample precipitation, liberated soluble mineral salts are removed almost as fast as they become available without concentration in stream flows. In the arid regions, however, precipitation is usually insufficient to prevent highly mineralized soils and their effluent is often heavily charged with salts. The streams leave their mountain sources with notably pure water, which increases in mineral content in passing through the arid regions, due to influx of more highly charged water and concentration by evaporation of the stream itself. Upon applying such waters for irrigation, a negligible part of the salts carried to the lands are stored in the plants and removed. The water evaporated by the plants and soil leaves its salts and if these salts are of deleterious character they must be added to the salt content of the water passing away as return flow if irrigation is to continue indefinitely. The return flow in its slow percolation through the soil strata has further opportunity to become heavily charged with salts. In some cases the dissolved salts combine chemically with others found in place on the land to form insoluble precipitates that may be either beneficial or harmful. The suitability of return-flow water for irrigation purposes as indicated by the tolerance limit of crops, depends on the character and concentration of the dissolved salts in such water and in the soils on which it is to be used, the permeability of the soils and subsoil, provisions for drainage, crops to be grown, amount of water available for flushing purposes, and rainfall.

LEGAL STATUS

As stated, early irrigation development was largely confined to lands contiguous to streams from which they were served by short canal systems. The underlying soils were usually loose stream-washed materials which facilitated the quick return of unused waters to the stream without producing surface streams of material volume. Later developments of large areas, often at great distances from the source of water supply, resulted in many hitherto dry channels becoming living streams capable of supporting irrigation on material land areas. Artificial drainage to relieve alkali and seepage conditions also contributes large amounts of water. Increasing values of irrigation water and the exhaustion of water supply obtainable at moderate costs often furnished the incentive for recapture of return flow, including drainage waters, by the project producing it, and almost invariably resulted in litigation as other irrigators already using these waters were deprived thereof, although usually having made no expenditure to produce the water supply used by them. State irrigation laws having generally been framed before return flow became a recognized factor in irrigation supply are, on the whole, in a rather unsatisfactory shape. The decisions regarding return flow are therefore in conflict. The general tendency, however, is to regard return flow in all of its forms recoverable by the agent producing it until it enters a stream which in its natural condition supplied irrigation diversions, when it becomes a part of such stream and subject to appropriation therefrom as are other waters of the same stream. The result is a material aid to new projects which can be arranged to utilize their return flow by sale to other projects needing such supplemental supply or by project extension. At the same time such decisions do not strike at vested rights which have been built up from the use of return flow under earlier development when such return flow was rarely sufficiently concentrated in volume to become a bone of contention.

NEW PROJECTS

On new projects the consideration of the return flow becomes a very important factor. If materially impeded by flat topography or impervious strata, it must be supplemented by artificial drainage. The localities of appearance of return flow are most important. In general, irrigation was initiated along the streams in their lower courses with development spreading therefrom to adjacent higher lands and upstream valleys. With the irrigation of adjacent higher lands which in themselves are usually adequately provided with natural drainage, the limited underdrainage along the borders of the lower valleys becomes overloaded and seepage follows, requiring protective border drains to avoid destruction of valley property.

Project return flow, if of suitable quality and properly located, may be used to replace stream flow belonging to prior appropriations and which under such circumstances can then be diverted for the project. Or project return flow may be used to extend the project area, usually with material reduction in project acre construction costs. Where runoff is limited and arable lands are in excess of the available water supply, development plans should have in view the greatest practicable use for all return flow. The solution of these problems requires careful estimates of the quality, quantity, and seasonal distribution of return flow.

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RIO GRANDE COMPACT COMMISSION RECORDS, 1924-1941, 1970

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RIO GRANDE COMPACT COMMISSION RECORDS, 1924-1941, 1970 RICHARD F. BURGES PAPERS: Proceedings of Rio Grande Compact Conference Held Dec. 19-20-21, 1928 at Santa Fe, N.M. (Title page, 78 pp.)

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P R O C E E D I N G S

of

RIO GRANDE COMPACT CONFERENCE

Held

December 19-20-21, 1928

At

Santa Fe, New Mexico.

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P R O C E E D I N G S O F

RIO GRANDE COMPACT CONFERENCE

Held

December 19-20-21, 1928

At

Santa Fe, New Mexico

The Rio Grande Compact Conference met in the Senate Chamber of the State Capitol Building at Santa Fe, New Mexico, on December 19, 1928, at 11 A. M., with the following persons in attendance:

COLORADO

Delph E. Carpenter, Interstate Water Commissioner for Colorado.
George M. Corlett, Lieutenant Governor of Colorado.
Ralph L. Carr, Assistant Attorney General of Colorado.
Judge J. C. Wiley)
Albert L. Moses) Representing the San Luis Valley Water Users Asso-
W. W. Platt) ciation
F. Burris Gowdy, Pres. Rio Grande Canal Co.
C. D. Johnson, Division Engineer of D. & R. G. W. RR Co.
R. I. Meeker, Consulting Engineer for Colorado
M. C. Hinderlider, State Engineer of Colorado

TEXAS

T. H. McGregor, Interstate Water Commissioner for Texas.
Richard F. Burgess, Special Counsel for the Texas Commissioner

NEW MEXICO

Francis C. Wilson, Interstate Water Commissioner for New Mexico
D. C. Henny, Consulting Engineer for New Mexico and Texas Commissioners.
R. G. Hosea, Engineer for New Mexico and Texas
Roland Harwell, General Manager of the Water Improvement District No. 1, El Paso.
A. S. Robertson, Pres. Elephant Butte Irrigation District.
Edwin Mechem, Attorney for the Elephant Butte Irrigation District.
A. W. Newcomer, Representative of the Middle Rio Grande Conservancy District.
R. L. Burkholder, Chief Engineer, Middle Rio Grande Conservancy District.
Pearce Rodey, Attorney for the Middle Rio Grande Conservancy District.
H. F. Robinson, Supervising Engineer, Indian Irrigation Service.

William J. Donovan, Assistant United States Attorney General, Washington, D. C.

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SENATOR MCGREGOR: I move that Col. William J. Donovan be made Chairman of this Conference and take charge of the meeting. The motion was duly seconded and unanimously carried.

COL. DONOVAN: Gentlemen, I appreciate this expression of confidence. The fact that there is a representative of the Interior Department here is evidence of the interest that the President of the United States takes in the success of this conference. I hope that I will be of some aid to you in arriving at a satisfactory conclusion. What is the further pleasure of the meeting?

MR. CARR: I move that Mrs. M. C. Safford be made Secretary of the Conference. The motion was duly seconded and unanimously carried.

MR. WILSON: I move that we do now adjourn until 1:30 P. M., at which time the program can be simplified. The motion was duly seconded and carried, and the conference recessed until 1:30 P. M.

At 1:30 P.M., the meeting was called to order by Col. Donovan.

COL. DONOVAN: What is the pleasure of the meeting now?

MR. WILSON: We have thought that it would be an excellent plan from the standpoint of presentation of the different sides represented here in this matter, if Colorado would open with some preliminary statement of Colorado's position, and we would like to know the attitude of Colorado in that respect. Our thought is that in the light of the situation on the river, Colorado being rather high up on the stream, it might be enlightening to all of us to get their present attitude, which can then form the discussion for us, and perhaps, save time.

MR. CARR: As I informed Mr. Wilson at noon, it is not Senator Carpenter's idea that he should outline the plan at this time. We have come here to find out what is offered and claimed by the other states. Colorado is in the position of being upstream and might be in the position of a defendant, perhaps. We want to know what the lower states are claiming. There has been no opportunity for Governor Corlett and Senator Carpenter to have any conference since they started on this trip. Colorado will be ready to express its opinion largely through Governor Corlett who is not now ready to do it, and for that reason Colorado is going to have to ask your forbearance, and ask what New Mexico and Texas claim before we can make any answer.

MR. WILSON: Mr. Chairman, in response to that suggestion, as we view the matter, it is more a question of what Colorado expects to do in the way of making available supplies that now exist there and which are not utilized; we look upon the situation more in the light of Colorado being in the position of plaintiff in this case, and for that reason, if they could have the conference which they have not had, we will be glad if they could determine on the method of procedure. We wouldbe glad to give them that time necessary.

MR. CARR: We are in a position to ask for consideration and ask what you people require of us down stream. The conference is called here; Texas and New Mexico have been preparing plans; Colorado, it is true, has been going forward with plans to return water to the Rio Grande River through drainage, but before we can come to the issue - I dont think it is a matter of anybody trying to secure any advantage

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by delay; there isn't any technical advantage to be gained, and I see no reason why New Mexico cannot now start and why Texas cannot follow. Colorado is ready and anxious as soon as it can get together in conference to talk, but unless there is some good reason why New Mexico and Texas, who had a conference before lunch, should not state their position, I think they should start now.

COL. DONOVAN: Is there any objection, Mr. Wilson, to either New Mexico or Texas making a statement at this time?

MR. WILSON: We feel that much time will be saved if Colorado would make an opening statement - we would have the rebuttal right if they did - and define the position of Colorado at the present time and their future intentions, so that we can then state our side of it from the standpoint of requirements to preserve our present rights on the river. I think it would save a great deal of time if Governor Corlett would open the meeting with his statement of their position. I would be very glad if they would, because I think, I am almost sure, it will save a great deal of time. Texas and New Mexico have considered this particular point, and if Colorado could see their way clear to proceed, I am sure we can save time.

GOVERNOR CORLETT: Mr. Chairman, we feel that we are in this position - that as far as Colorado is concerned, we are asking for no extra terms of any kind. On the other hand, New Mexico and Texas are in that position and for that reason we feel - as I understand New Mexico and Texas do, and certainly if that is their position they should be first in naming what they are seeking at this conference.

MR. WILSON: May I briefly state the facts in that particular? All that New Mexico and Texas is striving to do is to preserve their present rights intact from further depletion by Colorado, threatened by the Vega-Sylvester Reservoir. We have no objection, nor would we interfere with any development in Colorado by that means or otherwise, provided Colorado will deliver at the state line such water as we think our rights entitle us to as a matter of law. That is the definite and specific position we take, and in view of the fact that Colorado proposes to extend its present usage by that means, we believe it is best for them to state their situation as they find it now.

MR. CORLETT: We are resisting the imposition of any servitude on Colorado, and I think that states our position. We are in the position of a defendant in this case.

MR. WILSON: Servitude of what kind?

GOVERNOR CORLETT: Of all that we claim. In any event, Mr. Wilson, we have the right to control our own resources as we see fit, and as I say, we are in the position of a defendant in this case.

MR. WILSON: May I ask, without regard to any rights on the river below your state line?

GOVERNOR CORLETT: Our own only; we ask for no consideration from New Mexico and Texas insofar as their s are concerned.

MR. CARR: May I suggest, Mr. Wilson, that since you are claiming on behalf of New Mexico and Texas, certain rights which you do not care to have Colorado encroach upon, that you define your rights, define what you claim and we can quickly get at issue.

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MR. WILSON: I dont know whether this is very regular or not.

COL. DONOVAN: I think the main thing is to get at the facts at the sacrifice, to some degree, of regularity.

MR. WILSON: In that way we would get atthe facts much quicker if Colorado would set forth its future and present intention of the use of the stream in Colorado. If we can get a discussion of that and the rights upon which they claim, on what they found their right to make future depletion, we can progress much faster from my view, and I think we are reasonable in asking that they set their idea forth or express their intentions and plans and the reasons for them, and the rights upon which they base their belief that they have a right to further deplete the stream, legally as well as a matter of engineering; we think that that would save time, and we see no occasion for any refusal on the part of Colorado to so proceed.

MR. CARR: As far as time is concerned, we see no distinction between the course of procedure as suggested.

MR. WILSON: Simply because there are many things which you may say in the course of your statement with which we can agree and which will save us the time of discussing entirely. There are certain well defined figures of an engineering character which we can admit, and which, in your statement, you will undoubtedly set forth, and in that case it will be unnecessary for us to discuss.

MR. CARR: Isn't it entirely possible if you wae to start and make your claim of rights that we would likewise be in a position to harmonize with you and save time?

MR. WILSON: In view of the fact that your uses are unquestionably planned to be extended, it looks to us as though you should have the first part in this proceeding. That is to say, you should set forth the reasons why you think you can go farther and dam the stream beyond the point where you have.

MR. CARR: Isn't it true that the states of New Mexico and Texas are likewise planning to use the water of the stream more than they have?

MR. WILSON: Not to any great extent for consumptive use.

MR. CARR: We dont so plan either as you will learn from upon exposition of our position.

MR. WILSON: If you will develop that fact and say it is the fact, perhaps it will be unnecessary to go into very much further discussion.

MR. CARR: I believe if the lower states will define the rights they claim it is entirely possible we will be able to get together quickly on a large portion of what is claimed, and when once those rights are defined we will be in a position to suggest what it is hoped to do under the upper stretches of the river. May I say at this time it is the idea of Colorado that in the sisterhood of states, other states in which a river may run have rights which we are ready and willing to respect, and we dont claim the right, of course, in an interstate river, to absolute control of the entire stream, but if Texas and New Mexico feel that their rights are being endangered, they would, in the natural course of events, be plaintiffs in an

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equity action and they would say wherein their rights are endangered, and I think logically that's the way to open this conference.

COL. DONOVAN: May I suggest - I wouldn't ask any sovereignty here to jeapardize its position. It seems to me there must be a middle ground and rather than call upon New Mexico and Texas to exactly recite its claim, isn't it possible, and I dont think this is begging the question, perhaps for Texas and New Mexico to define what they conceive to be the issue without any assertion of a claim, and in that way we can come to grips on this thing.

MR. WILSON: That will be satisfactory, Mr. Chairman. I assume if that is the case, we would have the right to close in the event that we open.

MR. CARR: May I suggest that the question of opening and closing is hardly the way to put it in a conference of this kind which is trying to reach a compact.

COL. DONOVAN: Why dont we let this develop? In the first round there is always a little sparring - wait until we get into the fight.

MR. WILSON: Mr. Chairman and gentlemen of the conference: In the first place, as coming from New Mexico and holding the conference here, I want to welcome you all to Santa Fe with the hope and trust that this conference will result in something very definite and specific for the benefit of all of those here and the states which they represent. In making an opening statement of this character, I feel that so far as New Mexico is concerned, we should make it extremely brief, because we think the high spots, so to speak, of the situation can be defined without going into a great deal of detail, and shortly on the historical subject. I think, perhaps, we should touch upon that phase of the situation in order to inform those who may not be as thoroughly informed as we are upon the subject of the origin of irrigation on the Rio Grande River. Long before Europeans came to this country there existed a civilization in the Rio Grande Valley based upon the bottom industry, so to speak, of agriculture and behind it was the use of water upon lands for the purpose of raising crops, with such stability that these crops could be guaranteed from year to year. I am referring to the Pueblo Indians and their civilization. There are very early records of these facts in the reports made by the various Spanish adventurers who came here and the priests who accompanied them. There undoubtedly was extensive irrigation on the Rio Grande at that time, taking 1540 as the first actual contract. It is not possible to estimate what the condition was, and therefore, all we can say is that the Pueblo Indians rights are xxx xxxy of very ancient origin and undoubtedly precede any rights which have come on since.

As soon as the Spanish Conquistadores came into the country and commenced to settle definitely in this section they adopted in large part the methods of agriculture which the Pueblo Indians were already employing, and as the result there grew up, superimposed upon the Indian civilization, a European civilization of agriculture by irrigation, and as the Europeans increased in number, naturally they increased their areas, with the result that by the time of the American acquisition of this country through the Treaty of Guadalupa Hidalgo in 1848, there were very large areas irrigated up and down the Rio Grande Valley, and those rights preceded anything which

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was done in Colorado, because practically the first use of water in Colorado of the Rio Grande in the San Luis Valley approximates the year 1850. By that time in fact it has been estimated that at least 125,000 acres in the middle Rio Grande down to El Paso was actually in cultivation. In other words, at that time, in 1850, there were priorities existing in the Rio Grande Valley to the extent at least of 125,000 acres, and possibly more. The usages in the San Luis Valley increased very rapidly after 1880. Up to that time there were perhaps ups and downs, desultory increases and decreases resulting from conditions, markets, etc. In part, perhaps, from the seepage of the land and ineffective drainage then in force. By 1880, however, there was in the San Luis Valley the commencement of a very great increase, and about the year 1890, by virtue of ~~xxxxx~~ demand made by the ~~xxxxxx~~ Mexican government to our State Department, the Federal government undertook an investigation of the conditions, the complaints being that through uses in Colorado and in upper New Mexico the stream had been so depleted that it could not be applied - there was no water to be applied commercially to land in Mexico, whereby failures of the crops had done very great damage there. The original claim for that damage was thirty-five million dollars. As a result of that complaint, in 1896 a man, an engineer named Follett was sent down to make an investigation and report upon the subject of uses of the Rio Grande, and as a picture of the situation then and the causes of the depletion which had brought about the damage which was complained of by Mexico, I think I shall read just that portion of his report which constitutes a summary of his investigations. His findings were as follows:

> "The fact of a decrease in the flow of the river at El Paso exists, as claimed, and dates back to 1888 or 1889. Before those years the river went dry at intervals of about ten years. Since 1888 it has been dry every year but two. The use of mater for irrigation has not materially increased in New Mexico since 1880, and hence is not the cause of this decreased flow. The use of water in the San Luis Valley of Colorado has very largely increased since 1880, and at the present stage of development it takes from the river, in excess of what was taken in 1880, an amount of water equivalent to a flow of 1,000 second feet, running for 100 days; at least this amount is taken, and possibly more. It is impossible to state specifically how much water was in the river prior to this increased use of water and since, as the records do not antedate this increased use, and as the flow since the records began varies within very wide limits. This flow of 1,000 second feet, if allowed to remain in the river, would do much toward preventing a dry river at El Paso. Hence, the Mexican and American citizens of the El Paso Valley have suffered in common with their neighbors of the Mesilla Valley and those still farther up the river by this Colorado increased use of water. The suffering has been greater in the El Paso Valley than elsewhere. All of the summer flow of the streams in the San Luis Valley, except their flood waters, are now appropriated, and therefore the use of water therein for direct irrigation is not likely to materially increase in the future."

That presents a picture of the situation in 1896. At that time it was shown by his report that uses in the San Luis Valley had more than doubled between 1880 and 1896, and that the uses in the middle

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Rio Grande section and in the El Paso section had, if anything, decreased; at least, no more than held their own. The result of this report was that on December 5, 1896, the Secretary of the Interior at the request of the Department of State and the Department of Justice, entered what is called the Embargo. The Commissioner of Lands of the United States refused to grant any more rights of way for reservoirs or ditch lines on the river until further order. In other words, since the United States owned practically, if not all, of the possible damsites and owned the lands through which diversion ditches must be run, it put a stop then and there to any great enlargements in the San Luis Valley by diversion. That order was in effect until 1905, if I remember rightly, when it was partially lifted to the extent that all those who had initiated rights prior to 1903 in Colorado, or on the river, and had followed that initiation by surveys, were exempted from the embargo and could continue the development. That brought about, or aided, at least, materially in considerable additional development in the San Luis Valley, and we find in the year 1906, or thereabouts, I think I am correcting in stating, that there was then approximately 450,000 acres as against 325,000 acres in 1896, actually irrigated in the San Luis Valley.

As a matter of fact, the government, however, being confronted with an international obligation, started in the year 1903 through the Reclamation Service, to develop the possibilities of the Elephant Butte site as a conservation reservoir for the purpose of satisfying such treaty obligations as might be entered into between Mexico and this country, and in addition to that to preserve the rights of those who had had, perhaps, a century and a half of rights below that dam in the Mesilla Valley and the El Paso neighborhood. The result of the 1903 investigation and those which followed year after year, crystallized in the construction finally - the authorization and construction finally of the Rio Grande project. The treaty itself was finally proclaimed in January, 1907, and the embargo temporarily lifted by request, really, from the State Department, to the effect that the agreement had been made and the embargo was no longer necessary because the United States would be in a position to deliver the water through the Elephant Butte dam, so it did not really result in the lifting of the embargo because the Secretary of the Interior immediately promulgated a new report, based upon a report of the then Director of the Reclamation Service, whereby the embargo was again in force, and with some few exceptions, such as development of storage not in excess of 1,000 acre feet, and the rights initiated prior to 1903, the embargo was continued. The construction of the Elephant Butte dam and the development of the Rio Grande Project followed after the authorized Act by Congress, and I think the Project was completed in 1914. The Project was constructed for two purposes, the first being to serve as the means by virtue of which the Treaty obligation could be carried out; that treaty obligation consisting of an agreement to deliver Mexico 60,000 acre feet annually in full satisfaction of all claims by Mexico against the United States. In other words, in order not to force the San Luis Valley users to forego the uses to which they had placed the water of the Rio Grande to the detriment of Mexican uses, the Government spent the money necessary to build the Elephant Butte dam, and as an incident to it, I take it that the dam was primarily built so that this guarantee could be kept. As an incident to it, it was a full-fledged reclamation project and had in contemplation the irrigation of 155,000 acres. At that time, in view of Mr. Follett's report andother reports which were made by the Reclamation Service,

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it appears that the entire normal flow and low flow of the Rio Grande was applied to beneficial use and probably, as the report indicates, more than that; so that, on that date, you had a situation where the river, to be utilized any further in Colorado or elsewhere, and in order to permit the international treaty obligation to be carried out, it became necessary to construct a dam which would conserve the flood flow and the winter flow - any other flow - which would not encroach upon the normal flow of the river. In other words, the project was constructed for the discharge of the treaty obligation and for the irrigation of 155,000 acres. It utilized all of the water of the river which otherwise could not be commercially applied for irrigation purposes, either in Colorado, or New Mexico, or in Texas. That is the picture presented at that time, and about that time, 1907.

The contention of the Reclamation Service and of the United States Government would be, I believe, that the commencement of investigation in 1903, followed out by the progressive development of the project until its completion, and until it was brought into use in 1914, was the initiation of the project, and the subsequent rights would relate back to 1903 and form a basis of the priority of the project. Today the project is fully developed to its proposed capacity of 155,000 acres, and the delivery to Mexico of the treaty amount. So much for the Elephant Butte and its position in 1914, and the priorities claimed for it. I take it that New Mexico's position in that respect does not differ materially from that of Texas, if at all.

As regards the Middle Rio Grande Conservancy District and its cause, I would like to say a few words. Depletions in Colorado unquestionably had something to do with the decrease in acreage in the middle Rio Grande section between the years 1850 and about 1910 or 1915, and I might say, to the present time. There were other causes admitted but the decrease in that section was in part undoubtedly caused by the depletion in the flow of the river at such times, during the irrigation season, as would prevent the useful use of the water for the purpose of irrigation, whereby crops failed and gradually the area diminished. May I submit at that point, that that area and that decrease, being in part, at least, caused by the depletion of the stream by uses in Colorado progressively increased, were certainly not subject to any abandonment idea. In other words, if those rights were lost by non-usage, they were lost by the overt acts in Colorado, and therefore, it could not be contended there was any legal abandonment, but was forced to the extent of the acreage thus abandoned. However, that decrease has taken place, and incidentally large areas became seeped in the middle Rio Grande Conservancy District unquestionably and in part caused by the low flow of the river brought about by depletions in Colorado, whereby the shifting of the river bed constantly raises the water table of the river causing seepages of areas which had previously been irrigated. Now, I would like to suggest to Colorado that the action which New Mexico is taking in that connection is something which perhaps Colorado could well emulate, and perhaps something which you intend to emulate in the near future. While this area is not a dead area such as you have in Colorado, nevertheless seepage of lands, increasing evaporation and increased losses, and our people in the middle Rio Grande Conservancy District, viewing that as a problem which should be solved, just as we view the fact that your problem should also be solved, in your dead area, proceeded a few years ago to undertake the financing and developing of the Conservancy District, partially for flood control, drainage and, of course, for irrigation. Under that project 120,000 acres, as the plan now stands, approximately

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will be brought into useful irrigation or improvement, so that their present status will make it far more efficient from an agricultural standpoint than has been the case in the past. They expect to spend in the neighborhood of ten or twelve million dollars for that project and the communities and farmers are financing themselves for that purpose. The water which will be necessary to irrigate the lands, which will be drained, we believe, will be in effect by the drainage system, drainage of the seeped areas back to the river and thus the project cannot be of any harm whatever to the El Paso district and may, in effect, be of benefit to it. I suggest that the seeped area and the dead area in Colorado should be handled in a similar manner and that thereby there is a possibility of a solution of some of your problems. At least the San Luis Valley, with 650,000 acres today irrigated, can well afford to spend the comparatively small sum which it would cost to bring that dead area into useful capacity, and perhaps afford a relief to the river which Colorado in turn may take advantage of above the state line. The embargo question, however, did not end where they left it. It did stop, to some extent at least, new diversion in Colorado. It did not stop development of new areas from your drainage water. Unquestionably those new areas which were irrigated are irrigated from your drainage waters and will continue to increase as the efficiency of your drainage ditches and system increase, and there would be naturally a less return to the river by the consumptive use of more and more water.

The situation which confronted New Mexico in 1925, however, and Texas, we can briefly state. Up to that time the embargo existed and prevented any large development, but by virtue of it new diversions could be brought about to the detriment of the stream below the state line. In 1925, Secretary Work lifted the embargo and, if I am properly informed, a license was issued to one of your corporations for the right to use the Vega-Sylvestre site and such rights of way as were necessary thereto. That meant the storage of over 200,000 acre feet of water which for the most part would be flood water. Now it may be stated that that could not injure the Middle Rio Grande Conservancy District which must be dependent upon the normal flow for its success. Outside of the reservoir which they propose to build at El Vado, morally, as a matter of assurance against very dry years, the Middle Rio Grande Conservancy District must expect its supply and the permanency of its investment from the normal flow of the river. Any conservation, however, of flood water naturally and inevitably will encroach upon the appropriation of the Elephant Butte Dam for the reason that the Elephant Butte dam must have behind it the flood flow of the river for the purpose for which it was constructed. In other words, the Rio Grande Project, through the Government, having had appropriated for its use all of the unappropriated waters of the river, which appropriation was applied for and granted in New Mexico in 1908, necessarily means that any depletion of that flood flow will be used in Colorado to the detriment of the project in New Mexico. Now I am not going into the question at this time of what that means. I can say this, that we can demonstrate, we believe, to the satisfaction of any advised body of men, that if you take three year periods, and take these three year periods and place them during the low water period from 1895 to 1904, and start with a dam say in 1898 for flow of water, and then take the depletion of the project amounting to about 950 to 60,000 acre feet, roughly, and take the inflow for 1898, 1899 and 1900, at the end of the period you will discover that one more dry year would leave the project practically without water. I have considered the methods by virtue of which the question of frequency

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of these dry cycles may occur, but I dont consider any such estimates as material. The question is will any depletion of the present project result in the destruction of the efficiency of that project for the purposes for which it was built, provided there is a possibility of the recurrence of such periods as I have mentioned, and you can take that figure and finally figure out - you can pick out three such periods between 1889 to the present time, which would make the possibility of such an recurrence, from the standpoint of frequency, 13 chances out of 100 that it may occur again. With these facts before us, Mr. Chairman, and without going into the engineering detail at this time, it is the contention of New Mexico that any further uses in the State of Colorado are bound to result to an impairment of the rights of the Rio Grande Project, and regardless of any contention that is demonstrated by past experience, provided those experiences recur, and we know out of our knowledge of this country that they are bound to occur. So far as the middle Rio Grande Conservancy District is concerned, it may be contended that we have built the El Vado dam, and that we have there a resource which would prevent any damage, even though there should be some increased depletions in Colorado. We submit that the El Vado dam is built, not to meet depletions in Colorado, but for the sole purpose of insurance to the middle Rio Grande Conservancy District, during the periods of very dry years when it will not be the fault of Colorado if the river run so low any insurance will have to be called into effect. Their use, in other words, in Colorado resulting in further depletions of the stream, must result necessarily in reducing that insurance to a point where finally it would not be insurance at all. Now, again, it is not my purpose to go into great detail at this time of these features, but we submit, and are willing to demonstrate it by much greater engineering detail than I can give you in the short time I have allotted to myself, figures which will indicate or show, and we believe demonstrate, that any further depletions in Colorado will impair the priorities of the middle Rio Grande Conservancy District; which must, according to our view of the law, at least, and the known date of the appropriation, impair the rights which they have by virtue of their ancient priorities, and must of necessity impair the Elephant Butte project. In that respect, the government has an interest - I have already stated the primary purpose of the construction of that project. Depletions of the Rio Grande which might in any year result in emptying that reservoir would thereby prevent the government from executing its treaty obligations and fulfilling them, and thereby, the government has a vital interest in seeing that there can be no such possibility arise, because the dam was built in the light of conditions existing in 1908, and it was built for a specific purpose - that at no time, at no season, and during no dry period, could the government fail in executing and in fulfilling its treaty obligation. The priorities, as I have suggested, of the Rio Grande project undoubtedly, in our view of the law, would date to 1903 under the Reclamation Act. The increase from that date to the present date of the areas in the San Luis Valley amount to over 200,000 acres, the rights for which, in our view of the law, would be subsequent to the initiation of the Elephant Butte project. Our priorities, in other words, on the river are far superior to those in Colorado for at least the period since 1903. Then, what is the problem? We dont want to encroach in any manner upon the possibilities of Colorado; nevertheless we cannot stand still and watch that development made at the cost of our rights and our priorities, believing as we do, that the Wyoming-Colorado case settled the question; that if we invoke the jurisdiction of the Supreme Court of the United States in this matter, our priorities would be recog-

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nized as paramount to those in Colorado, and as a result we would obtain a decree which would protect our rights against further depletions in Colorado. Under that case, believing that to be true, nevertheless if there is a method by virtue of which Colorado development can continue without danger to our rights, without danger to our projects, then we not only will be glad to see it accomplished, but we will be glad to cooperate with you. Briefly, our conception is in that connection is this: That the dead area - and I am not going to discuss it at great length - can be drained, and under the figures which we have obtained from your own engineering Department and from other sources, it would appear that the drainage possibilities in that dead area would amount to possibly 200,000 acre feet which would have to be returned at the state line, due to the drainage situation. Now, if Colorado, - the San Luis Valley - undertook that and could return 200,000 acre feet to the state line, Texas and New Mexico, assuming a status which would keep our rights as they were in 1908, by some such arrangement, as engineers and lawyers who have a joint purpose in view could arrange, if you can accomplish that, then we have no objection naturally to any use or anydevelopment in Colorado which will bring that result about. The Vega-Sylvestre, with its capacity of 200,000 acre feet and more, might well be constructed, provided that Colorado will deliver at the state line, during the irrigation season, as well as during the winter months, that which the river shows should be delivered there in average normal years, or average years during the period of 33 years during which we have measurements and can tell what our average is. As you know that average is around 600,000 acre feet. My suggestion, then, is to Colorado, that the problem is primarily yours, and that the salvation of your situation reposes in your own hands. That not only do we ~~xxxx~~ not want to interfere with your development, but that we will cooperate with you to bring it about. And here today, I am going to close my remarks with this statement, assuming that we will have the right for rebuttal, I would be glad to see Colorado come to this conference, and I hope you have, with a definite plan looking to that end and which we, New Mexico and Texas, can protect by Compact mutually not only to Colorado but to ourselves. If you have such a plan and can develop it, it means without further ~~fx~~ trouble the financing of the Vega-Sylvestre - and personally, I dont see how that development can occur with litigation pending, which we hope to avert by this meeting, or that a Compact which will allocate to Colorado a systematic and definite condition which will permit such a development. It is not my purpose to go any further into the facts at this time, but I will again express my hope that Colorado will have some such suggestion to make to us that we can agree upon. Thank you.

MR. BURGESS: Mr. Chairman, and Gentlemen: I am requested by the Texas Commissioner to make a brief statement as to the position of my state, that being predicated upon the fact that I am more familiar with the history of irrigation in the Rio Grande Valley than our Commissioner, who comes from the capital of our state. It has occurred to me that perhaps a word might advantageously be said in passing about that portion of the Rio Grande which forms the subject of our deliberations, the Act of the Legislature of Texas which authorized the appointment of a Commissioner, authorized him to confer with the representatives of New Mexico and Colorado with reference to the use of the waters of the Rio Grande and its tributaries above Fort Quitman, Texas. It is perhaps unnecessary to go at any length into the reason for stating that point, yet it may

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not be amiss to say that the Rio Grande for practical purposes is a different stream above Fort Quitman from the Rio Grande below that point. Below that point it is the source of the supply for great irrigation development in the Gulf country in Texas, and to some extent New Mexico, but that water is derived from tributaries pouring their water into it largely from Mexico, and in any event at the time when the federal government instituted its first investigations looking to a treaty with Mexico and the building of the Elephant Butte Reservoir, the condition which had then grown up upon the Rio Grande had practically severed it into two streams, and very little water except in floods, passed Fort Quitman, and therefore, we are dealing with the Rio Grande above that point and not below.

It is a matter of history that following the Pueblo irrigation in the Valley of the Rio Grande in New Mexico, which dates from an exceedingly early date about which archaeologists may differ, and with which we need not concern ourselves, that the use of the waters of the Rio Grande for irrigation was initiated by the Spaniards in the El Paso Valley on the Texas side of the River, and in the Juarez Valley on the Mexican side of the river, up through the Mesilla Valley in New Mexico, and at various points along the course of the Rio Grande throughout New Mexico. It was not an experimental thing and it was not a small development. W. H. Davis, who was appointed United States Attorney, and came to this territory shortly after the territory came under the jurisdiction of the United States, has given us a detailed description of the valley in El Paso County; also of the Juarez Valley and in the Mesilla Valley above that. Speaking specifically of the territory around El Paso, he speaks of the many thousands of acres that were covered by waving wheat fields, and he gives us the measurement of the annual production, all of which he conceived to be surprising, as well as interesting, information to the United States, and doubtless it was. He also described in glowing terms the vineyards in the valley, and states in his book, that the wines produced were not excelled by the vest vintages of France and Spain. I admit at this moment, in this year of Grace, One thousand Nine Hundred and Twenty-eight, to use the Scripture form - "How the mighty have fallen". However, that is the condition as it presented itself to an intelligent American observer at that time. Lieutenant Wise of the United States Navy, published a book about the same time, and his testimony is substantially the same. Not dating quite back to the time of Lt. Wise or Attorney Davis, I came to the El Paso Valley myself in 1889, and have resided there since 1892. When I came to El Paso, the Valley was in a high state of cultivation. The personal reports of the state to which I have recently had occasion to refer back to, shows that El Paso County exported large quantities of fruits - grapes, peaches and other fruits - to the interior of the state. I, myself, during the early '90's watched the progressive drying up of the Rio Grande and the destruction of those orchards and vineyards. They practically disappeared under this repeated drying up of the river. The river which had been dry at rare intervals and for short periods prior to 1890, went dry practically every year, with rare exceptions, after that date, and the development which had made such a garden of that valley as the authors I have mentioned to you described, reverted very largely to a barren condition.

A foreign country some times gets the ear of a government quicker, perhaps, than its own people, and the Republic of Mexico, in behalf of its citizens, registered not only an emphatic, but oft-re-

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iterated complaint of a depletion in the flow of the Rio Grande until, as Commissioner Wilson has told you, the United States commissioned W. W. Follett, consulting Engineer of the United States Boundary Commission, to investigate the conditions of the Rio Grande and to report to what this annual drying up of the river was due. The conclusions arrived at by that engineer, and he was a great authority, a man - I pause to pay that tribute to him because I knew him well through a great many years - he was a man who labored indefatigably in the cause of science and applied science to practical usage, suffering all the time from an acute disease - and there he did a great good, and I think did it well. He reported that the cause of the drying up of the river at El Paso and above that point pretty well up through the major part of New Mexico, was due to the vastly increased use of water during the irrigation season in the San Luis Valley in Colorado. Now we would not, except in self defense, lay a retarding hand upon the irrigation of every acre of irrigable land in that state, but it is a commonplace to the people of the arid west that those who first used and applied the water to beneficial use acquired a right to use it superior to any claim that may be made after that, and if that doctrine were not recognized throughout the arid west, as has been pointed out by the Supreme Court of the United States as well as all of the courts of our arid states, there would have been no successful irrigation, on any generous scale in the western states, and no successful placer mines. As a result of the report which was made by Mr. Follett, as Commissioner Wilson has told you, the authorities of the United States laid what was called an Embargo upon the building of reservoirs or the making of additional diversions, except small in quantity, on the upper Rio Grande, and that continued in force and effect and substance until 1925.

Now, the State of Texas claims an integral interest in the Rio Grande federal reclamation project located partly in the State of New Mexico, and partly in the State of Texas, and, deriving its waters from the Elephant Buttex Reservoir, it stands upon, and relies upon, the appropriation made by the United States as the basis of that project. It is not timely now to go into detail as to the history of that project, the ideas advanced by the authorities of Mexico and the ideas advanced with equal confidence by the Senators and Representatives of Texas, that they had prior rights in the flow of the Rio Grande which had been encroached upon by the diversions in the San Luis Valley. The government, through its engineers, conceived the idea that by the storing of the flood waters at Elephant Butte that they could restore and protect the water rights which the government in common recognized in Mexico, and of course, which, under the decision of the United States Supreme Court, recognized in Texas and New Mexico. To do that it was necessary to build a reservoir sufficient to hold in years of excessive run-off water to meet irrigation needs in years when the run-off was deficient. It is not necessary to go into figures on that matter at this time - it would serve no useful purpose at this stage of the presentation. The State of Texas is claiming, and relies upon, its rights under the federal Rio Grande Irrigation project. In addition to that, the State of Texas has under irrigation above Fort Quitman, and below the lower boundaries of the Rio Grande project, in round figures, 20,000 acres of land which is under successful cultivation today by irrigation. In addition to that the Commissioner for Texas has been requested by the municipal authorites at El Paso to lay before the commission the claims of the City of El Paso to a municipal water supply from the waters of the Rio Grande. I shall not go into detail about that at all

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at this time. I merely mention it as a claim which the Commissioner has been requested to present as the representative of his state.

Now, the position which we take, and I conceive it is the same position that is taken by the State of New Mexico, is that under all of the information that has been obtained by federal authorities charged with the investigation of the matter, the State of Colorado has already encroached upon the supply indispensable to the proper irrigation of those lands having vested rights in New Mexico and Texas above Fort Quitman. It is, of course, purely incidental, that that irrigation is vastly greater in the aggregate than the combined area in the other two states - a simple glance at the map will show how extensive the development is there, but has only this relevancy - it is far junior to the other development. It exceeds it three to one in volume, and that we do not begrudge until it reaches the point where it threatens the successful irrigation of the lands having a vested right in New Mexico and Texas. That we conceive it to be the status as it exists today, and therefore, we consider it is incumbent upon Colorado to propose, if she has one, a solution and to demonstrate the possibility of the solution which would enable them to make still ampler extension without destroying our rights.

Recess of 5 minutes taken.

MR. CARR: Mr. Chairman, as Colorado sees its position to be it is an advocate for the people who make claim for water in Colorado, and for that reason we are asking one of the representatives of the Colorado people who are claiming water to outline their position, with the understanding that this is not the statement of the Commissioner of Colorado.

GOVERNOR CORLETT: Mr. Chairman, and Gentlemen of the Session: I want to state at the outset that we from Colorado are coming down here with open minds and open hearts. We come with no intention of placing arbitrary conditions of consideration. We are frankly desirous of a satisfactory settlement if such can be arrived at. In order that we may state our position, as New Mexico and Texas have stated theirs, - and I will say, Mr. Chairman, it is with some fear and trembling that I start out in view of the apparent entente between those two great states of New Mexico and Texas on this proposition. I will have to go into the history in the manner that we view it in the San Luis Valley on this situation. It is very true, as Commissioner Wilson has stated here, that this whole territory both in Colorado and New Mexico was occupied by Indians in the early days, whom had their small patches of corn or maize, both in Colorado and New Mexico and that they were in all probability the original Americans and possibly had prior rights to either the people of New Mexico or Texas or Colorado. We likewise have to admit that there were Spanish settlements both in the San Luis Valley and in New Mexico and Texas which antedated the organization of our states and our territories, and that they too had possibly some vineyards and produced excellent wines as the gentleman from Texas says. Those uses, however, were very inconsiderable as compared with the uses attempted in the later day, and in the period commencing with, perhaps, 1872, or 1874, and from then on. In Colorado we have perhaps, one ninth of the drainage of the Rio Grande valley. We have a great deal more than half of the irrigable area of the Rio Grande Valley. We control, perhaps, one fifty-second, or one-fifty-first of the drainage area of the Rio Grande Valley. We water as much land at the present time with

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900,000 acre feet as are watered in Texas and New Mexico with, I should say, approximately four times that amount of water.

The great development in the San Luis Valley started, as Commissioner Wilson said, along in the '70's and '80's. The period between 1880 and 1890 was a period of great run-off in the Rio Grande, everyone had lots of water. There was some 600,000 acres ofland in cultivation in the San Luis Valley at that time. That period was followed immediately by a succession of very, verydry years. One of our large canals in the San Luis Valley, watering some 90,000 acres, had water in it three days during the season during that period. There was a condition of drouth along the entire Rio Grande, not only in Texas, not only in New Mexico, but in the San Luis Valley as well. During the same period, I dont doubt but what the people of New Mexico and Texas suffered some. During that period the acreage under cultivation in the San Luis Valley was depreciated about one half, from 600,000. to 300,000 acres. Now, I think, in order that you may understand our position, Mr. President, we have discussed it more or less between ourselves here, our people are ofthe opinion that the people of Texas and New Mexico took an advantage of this succession of very dry years and instituted, with the United States government and with some of the agencies of the government, a concerted program of development of the Rio Grande in Texas and New Mexico, and in old Mexico, if you please, whereby a strained relation was developed between Old Mexico and the United States, and which was settled by the conceding to Old Mexico, under the treaty of 1907, of 60,000 acre feet of water, against the highest legal opinion of United States Attorney General Harmon at that time, who said that Mexico had no rights whatever in the Rio Grande from an international standpoint and advised strenuously against the nation conceding those rights. But, referring back to the time of 1896 when this controversy started, the Embargo, as it has been mentioned here, came about at the request of the State Department of the United States xxxxxx to the Department of the Interior on the request of the people of New Mexico and Texas and on account of the Mexican situation as it haddeveloped at that time. That embargo was placed without any consideration as to rights but merely, as it was said, to maintain national amity.

The federal statute had guaranteed to every person settling on government lands, or occupying government lands, to right to construct ditches across public domain, the right to construct reservoirs on the public domain, upon compliance with the statutes of the federal government. We were denied that right by the embargo while the other peoples, more favored by the government, were permitted to exercise their rights. We were not permitted to go into the United States court, although we attempted to at that time, because we could not sue the government without the permission of the governmental agencies. We did not claim at that time and we do not claim at this time that the federal government did not have the right to take our rights away from us for any national purpose, but we did claim, and we do now claim that the government had no right to take those rights without providing for compensation, or providing for some relief. The result of that embargo was simply this: That while after having suffered five years of that dry period I mentioned, and you know about, from 1890 to 1896, we were in a position to build reservoirs in the San Luis Valley to scientifically regulate our irrigation flows and on account of the embargo we were prevented from doing that. We had the matter consistently before the Department until 1907, until the Treaty with Mexico was completed, and then a partial relief was given. We were permitted to build two small reservoirs, one of 46,000 acre feet

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capacity and one about 35,000 acre feet capacity on the upper Rio Grande, and several little reservoirs of 200 or 300, or 400, up to 1,000 acre feet. We were finally able to develop storage capacity of about 75,000 acre feet. Perhaps I had better correct that stoxrage capacity to the amount of 100,000 acre feet but deliverable capacity of about 75,000 acre feet. Now, the physical results in the San Luis Valley were these: There were large floods coming down the stream in the spring of the year. We had our immense canals there - -

COLONEL DONOVAN (interrupting): What period was that?

GOVERNOR CORLETT: That's from 1896 on - the embargo went on in 1896. These waters were diverted. We have some 5,000 second feet of decreed rights on the Rio Grande in District No. 20. These waters were then taken and applied in large quantities to the land in the spring when the waters were not specially needed for irrigation but in order to get ground stoxrage ~~xx~~ to carry the crops over ~~xxxxxxxxx~~ and possibly supply them to some extent during the dry season that was bound to come later. I want to say at this time, Mr. President, in my opinion, and you Commissioners will no doubt go into that, that if the San Luis Valley were permitted to scientifically regulate their flow of water that the consumptive use would not be as great if they were permitted to regulate it to the fullest extent possible, as it is at the present time. The actual results of this shortage ~~xxxxx~~ were that a great portion of the lands that were improved, that were cultivated, that had people living on them, became seeped and sour by the application of water in the springtime and people commenced moving further west to take up new land, build new improvements, and it was the cause of an untold number of heartaches and of the ruination of an untold number of lives. Senator Thomas made an estimate of the damage to the San Luis Valley in a speech in the United States Senate, about 10 or 12 years ago, in which he estimated the direct loss to people of the San Luis Valley on account of this embargo in the sum of 168 millions of dollars. I think, as a matter of fact, taking that up to the present day, that that is a very, very small estimate for the immense damage that has been occasioned. These lands upon which an excess of water was applied in the spring would some years produce a full crop if the season dried off later. If we had a little rain in connection with that, it became immediately too wet. The result being that over that period a great many thousand acres under cultivation there produced half or one fourth of a crop. Taking a very conservative estimate of the value of these crops at $20 an acre, you can readily estimate what an almost inconceivable loss was occasioned by that course of procedure. We continued to object, we continued to ask for relief from the Department of the Interior through the agencies of the lower Rio Grande; the Rio Grande was declared an inapplicable stream from its mouth to its source on the continental divide. It seems every possible stumbling block has been placed in our way, and I want to say at this time, that I think the Commission should take into consideration this fact: That while the lower Rio Grande has been, practically, the ward of the government during all of this strife and trouble - it was referred to some time since by some people as the Battle of the Rio Grande - the people of the San Luis Valley have never had a cent of government aid. In fact, they never asked for government aid in any of their developments. In 1925 the Secretary of the Interior, after considering the matter from every standpoint, entered an order allowing and approving the Vega-Sylvestre reservoir on the upper Rio Grande. Prior to that time we had a filing on the Wagon Wheel Gap reservoir of some 900,000 acre

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feet - that was filed in 1896. We found we would not have water available for that reservoir and changed to the Vega-Sylvestre. We cannot possibly control on the Rio Grande in excess of about 700 square miles of drainage area which is, as I said before, about one fifty-first part of the drainage area. I would like to call the President's attention to the map; you will see a little lobe running off to the left at the top of the map, and the maximum of storage area that we can control here is above these points.

COL. DONOVAN: You mean above and running to places called Creed to Hermit?

GOVERNOR CARLETT: Anyway that is on account of our physical conditions there, that is the maximum area we can control the run-~~ffs~~ off in storage works. The San Luis Valley from there flattens out and we have no ditch there at this time, but there is 1,300,000 acres; we have under actual cultivation about 600,000 acres, and the rest of that area is all seeped and wet, practically. I want to call the attention of everyone concerned at this time to the fact that up until the very dry period from 1890 to 1896, and another dry period in 1901 or 2, there was no question as to the supply of water, either in Colorado or New Mexico. That on account of that dry condition while Colorado's hands were tied with this embargo, a right was initiated in New Mexico and Texas for 2,700,000 acre feet of stoarge, and I just want to call your attention at this time to the statement made that if the Vega-sylvestre reservoir is constructed that 200,000 acre feet would be taken from the Rio Grande, and to say that that is no more true than the fact that the Elephant Butte reservoir would take 2,700,000 acre feet per anum from the Rio Grande. They have in addition to this storage which was designed to cover 140,000 acres of land taken in, as I understand it, from the retturn water from the projects there, the Hudspeth Irrigation District and from other large areas in Texas, that the return waters alone from the Elephant Butte dam would some three or four times supply all of the water that was conceded to Mexico. That the Rio Grande, since the construction of that project, notwithstanding the immense capacity of the Elephant Butte reservoir of 2,700,000 acre feet, has been in flood at El Paso numerous times, causing large amounts of damage. That New Mexico and Texas apparently, I will say New Mexico, now proposes, after receiving out of the Rio Grande while, as I say, our hands were tied, 2,700,000 acre feet of storage as compared with our 75,000 acre feet of storage, now proposes to initiate a new project in the middle Rio Grande and construct reservoirs on the Chama ~~and the~~ a tributary of the Rio Grande river, for the purpose of securing a sufficient amount of additional water to guarantee a perfect water right for their middle Rio Grande project, and then they say that Colorado has depleted the flow of the Rio Grande so as to seriously affect the rights in New Mexico. We say on the contrary that if we are permitted to store the flood waters of the spring in Colorado on this very inconsiderable area of some 700,square miles on the upper Rio Grande, constituting about one fifty-second of the drainage area of the Rio Grande, and store the waters that we are now using in excess applications, and that we have used since 1890 to secure ground storage, that we could adequately water the immense territory that we have in the San Luis Valley at this time. It is true, there is a large area of seeped land. It is true that a large amount of that could be returned, and will be returned, to New Mexico and Texas for use. We now have engineers in the field, and have had for some time past, securing the necessary data for the construction of a drainage canal from the San Luis Lakes to the Rio Grande River which

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would drain what they say is the sump area, and return something over 200,000 acre feet to the Rio Grande. I just call the President's attention to the fact that insofar as that return water is concerned, that it is physically impossible for the people in Colorado to utilize that water in Colorado so that there would be no possibility of that water ever being used by Colorado in the future. I dont know where Mr. Wilson gets 200,000 acres~~feet~~ of new land taken under the drain. We have drained some 125,000 acres of the Rio Grande, south of the Rio Grande, and constructed an immense outlet ~~its~~ into 100,000 acres north of the Rio Grande, but not a single acre of new land, so far as I am advised, has been taken under irrigation on account of this drainage. There is this thing that appeals to me, and seems to me must appeal to the Commission: We have heard of ancient rights; we heard of ancient rights in 1896 when the embargo was placed on and when the people of New Mexico and Texas, with the aid of the federal government, contributed an outright donation, as I understand, of one million dollars in consideration of the 60,000 acre feet which was given to Mexico which was, in practical operation, charged to the San Luis Valley, and it seems to us that this theory of ancient rights has been exhausted, at least in the 2,700,000 acre feet of storage in the Elephant Butte. They say that their middle Rio Grande project is seeped; they say it also had ancient rights, and yet certainly this land has not been depleted while remaining seep by Colorado, and as to the ancient rights, they must indeed be very ancient rights according to our records and information, if they ~~existed~~ at all.

Just before closing, I want to dwell, if possible, a little stronger, although I think I brought it out in my talk here, of that period between 1880 and 1890 when there was adequate water in the river for everybody, and on that period from 1890 to 1896 and from then on to 1900, in which the flow was very, very much depleted. In which, if you please, a condition of drouth existed upon the entire Rio Grande, because it was on the basis of the measurements during that period that the claim was made whereby they were permitted to go ahead with the construction of the Elephant Butte project, and it was on these figures that the embargo was initiated in the first instance. When, as a matter of fact, it was not the use of water in the San Luis Valley that caused the depletion, but it was caused by the reason that we did not have enough rain and snow in the mountains to provide any water to the people of the San Luis Valley, New Mexico or Texas either one. And when you look over the records the use of water in the San Luis Valley going from an infinitesimal figure to the delivery of water to the Elephant Butte Reservoir, for two different reasons; first, I think it is admitted by all eminent engineers that the most economical use of water can be had nearest the course. Any water which is applied in the San Luis Valley returns quickly to the river; the only outlet of that immense territory is the canyon of the Rio Grande leading down to Texas and New Mexico. A very small portion of that water applied is actually consumed by the plants - the great majority of it returns to the river and comes on down. In examining the reports at Embudo Station and at the state line from the period for which the reports are available, it is astonishing the very little difference that is noted in the years when large amounts were in cultivation, and the years when a small amount was in cultivation. If this regulation which I have spoken of were permitted, it would merely mean the storage of the water that is now applied in the spring in large amounts, and the holding of it to the proper time when it is actually needed for the production of crops and applying it in a

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scientific manner instead of a haphazard fashion as we have been compelled to do during the last 38 years on the Rio Grande on account of this embargo, which, when removed, the Secretary of the Interior said was illegally initiated in the first place. The second reason why the storage of water and the regulation of water on the Rio Grande could not possibly materially affect the people of New Mexico is the fact that the water from the state line has to be conveyed through 1100 miles of tortuous channel, through a dry, rocky and absorbent country, and any water actually turned loose at the Colorado line, at least during the summer time, would have a very, very small chance of ever reaching the head of the Elephant Butte reservoir. A third benefit that undoubtedly would result to at least northern New Mexico, including the middle Rio Grande project, and the great majority of this great state of New Mexico, would be the delivery of a larger amount of water during the irrigation season than could possibly be delivered under the old regime where it was a constant question of large freshets and dry channels, but when applied to the land, with the continuous return water from the land into the river, furnishes a stream for storage in New Mexico that would water a great many more acres of land in New Mexico than could possibly be watered without the construction of large storage works in New Mexico to regulate it.

Now, when the commission get into this matter and consider the needs, we have, as I said, more irrigable land in the San Luis Valley than both Texas and New Mexico combined, and we ask for a very infinitesimal portion of the drainage area to regulate the rights on that land. We can produce, with New Mexico or Texas, as valuable crops as consistently, and from any standpoint we cannot conceive of any reason why New Mexico and Texas should object to that regulation of our water rights in Colorado. We are willing to go ahead - we would be glad of the cooperation and support of New Mexico and Texas in the construction of this immense drainage canal that will undoubtedly be constructed. We have the promise of the support of the Reclamation Service and the Department of the Interior, and I am sure that Mr. Wilson will verify me in that statement as he and I were present when we discussed it with Dr. Mead and Secretary Work. And this all can be handled so that New Mexico will receive all of the benefits and more too that she is now receiving, if Colorado can be permitted to go ahead and develop and regulate her supply as she sees fit, and nobody will be injured in the least. Everybody will be benefitted to the utmost in this construction. But, we cannot do it by making threats of actions in the Supreme Court, and I just want to say at this time, Mr. Wilson, in regard to the suit in the Supreme Court, it seems to me that about a year and a half ago you wrote me that you expected at that time to bring suit in the Supreme Court, and I told you then, and I tell you now, that we have no fear of an action in the Supreme Court. We are anxious, willing and able to get together on a conference proposition, but we will not consider any possible threat of an action in the Supreme Court.

MR. WILSON: May I suggest, Governor, that we - Mr. Chairman - that that was not a threat - you misunderstood me.

COL. DONOVAN: We know that lawyers always like to talk about the Supreme Court anyway.

GOVERNOR CORLETT: We would be in a position - we will meet you at Philippi on that proposition. I think, Mr. President, that that statement

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fairly defines our position at this time. We are going ahead with our reservoir proposition, our right of way is approved; we have arranged to finance it and we are arranging to have the necessary instrumentalities provided by this session of the Legislature. We expect to go ahead with our drainage canal and provide that water for the Rio Grande River, not because we feel particularly that it is incumbent upon Colorado or the San Luis Valley to furnish additional water to New Mexico or Texas, but for the reason that we require an outlet in Colorado, and it will - and we are glad that it will - redound to the benefit of New Mexico and Texas.

MR. CARR: Unofficially and on behalf of the southern part of the San Luis Valley, I wish to merely suggest at this time that there is another project on the Conejos River, perhaps the largest tributary of the Rio Grande in the northern country, which is being fostered by the people of Conejos County and which stands side by side with the Vega-Sylvestre. I want to make that suggestion at this time so it may be considered throughout the meeting of the commission, and on behalf of the people of the south end of the San Luis Valley, permit me to say that it is our earnest hope, and has always been, that we might get together in a Compact because we think that is the way out, and as far as discussing any litigation is concerned, that is entirely beside the question. We are here around a conference table for the purpose of getting together on a peaceable basis which will return something to our farmers of the San Luis Valley and in New Mexico and Texas. We have never yet been able to find any method whereby our farmers can irrigate their lands by means of litigation. We want to secure from the people of Texas and New Mexico the assurance that we may store water on the upper rivers in the San Luis Valley, firmly believing, as Governor Corlett has said, that that will be a benefit to the people down stream because of the return water at a time when it is needed; because of the assurance that water is going to be available from those reservoirs if needed down stream at a time when it now causes difficulty in the San Marcial country every year when we have high waters on the Rio Grande. One more thing which Governor Corlett did not mention, the water in the summer, which is planned to be drained, has never reached the Rio Grande River; that xxx water has never been tributary to the Rio Grande and has never been used down here, and the engineers I think will agree if that drainage canal is constructed it will bring into use in New Mexico and Texas a supply of water which has never been enjoyed in the past by either of the states. In other words, we have discovered an inland ocean which may be turned into the river to be used down stream and has never been tributary to the Rio Grande.

GOVERNOR CORLETT: I want to say Mr. Carr's proposition is just as important as the Vega-Sylvestre deal. Mr. Wilson mentioned the Vega-Sylvestre, but we are just as much interested in the Conejos reservoir as we are in the Vega-Sylvestre, and in the proper regulation - - Mr. Chairman, if you will permit me just a second - we had a meeting here the other day in which the agriculturist up there was estimating the amount of acreage they say had an adequate supply for tuberous crops - such as potatoes and beets - he estimated out of this entire acreage 150,000 acres that did have a water right adequate for tuberous crops simply for the lack of one irrigation, and yet we have all of this immense area that is partially watered and overwatered - one of our great troubles there is not enough water but too much water, but they do it every time in order to get this ground storage to carry over this dry period where, if they just had a little scientific regulation, which is just like having a little money in the bank.

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We contemplate no new ditches; we are not expecting to take in any new territory. We are expecting to regulate the water that we are already using there, and I want to say we are using every available drop going down the RioGrande River now. Mr. Platte mentions that our duty of water there averages something like 2 acre feet to the acre, while under the Elephant Butte project in New Mexico and Texas, as I understand, it runs about 7 acre feet to the acre. Perhaps the engineers know more about that - I am not an authority on that.

COL. DONOVAN: Is there anyone else who would like to be heard at this time?

MR. WILSON: Of course, we rather hoped that Colorado would state their position a little fuller, but if the statement which has been made by Colorado is all that is intended to be made, I would like to have a few minutes with my colleagues to decide whether we care to make any further statement, or whether we can perhaps adjourn and attempt to sit around the table and arrive at some conclusion.

COL. DONOVAN: Let's take a recess then. (about 5 minutes taken.)

MR. WILSON: Mr. Chairman, we have heard from Governor Corlett and we are very glad to hear from him and very pleased at his attitude and the statement he made. However, as we understand it, he is here representing the San Luis Valley and he is not speaking for the State of Colorado, which will be the high contracting party with us, and we would like to have Commissioner Carpenter, through Mr. Carr, either make a statement for the State of Colorado or, on the alternative, state he affirms officially, and agrees, with the statement made by Governor Corlett.

MR. CARR: The Commissioner of Colorado says he approves of the statement as outlined by Governor Corlett.

MR. WILSON: And doesn't care to say anything further?

MR. CARR: Doesn't care to say anything further.

MR. WILSON: We assume then he is officially approving the statements made by Governor Corlett as Colorado's position.

MR. CARR: Yes.

MR. WILSON: And you accept it as such?

MR. CARR: Yes.

MR. WILSON: Mr. Chairman, New Mexico and Texas has nothing further to submit orally. We have thought it would be wise, perhaps, to endeavor to have an executive session, possibly this evening and see what we can accomplish in round table discussion, to meet some common basis upon which we can perhaps proceed further. If that is satisfactory to Colorado and the Chairman, we would be glad to proceed in that manner.

MR. CARR: It is alright with us, Judge Wilson.

MR. WILSON: Is it satisfactory to the Chairman?

COL. DONOVAN: It is to me. Do you want to decide upon the time now or later?

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MR. WILSON: We would like to resume on the basis which I have already stated at 7:30 this evening if that meets with the approval of the delegation from Colorado and the Chairman.

COL. DONOVAN: Where?

MR. WILSON: Right here. I think perhaps it would be better here if we could get a table. I will try to do that.

COL. DONOVAN: If there is no objection, we will take a recess until 7:30 this evening.

MR. CARR: No objection from us - we are anxious.

Recess taken until 8:30 P.M.

The meeting was called to order by the Chairman, Col. Donovan, at 8:30 P.M. at the De Vargas Hotel.

MR. WILSON: So there may be no delay, I want to state now that we feel from the statement of Colorado this afternoon that we see a way by virtue of which the possibilities of agreement are much closer. The statement made for Colorado this afternoon indicated that with certain methods or procedure of preserving or improving conditions in their basin water could be conserved and delivered at the state line which would, perhaps, more than make up for depletions which might result above the state line, from conservation or other methods of improving and regulating the river. We want to cooperate. To that end, we are willing to present, and will present now, a suggestion for a solution based upon engineering considerations which personally I am not competent to handle, and that it may be explained in such a manner that we may all understand it, I am going to ask Mr. Henny, the consulting engineer for New Mexico, in this matter, to make that explanation, and I will introduce him now for that purpose.

MR. HENNY: Mr. Chairman and Gentlemen: I might briefly state what has been my previous connection with this situation. I have been for years consulting engineer for the Reclamation Service, and I am now acting in that capacity now and then. For the last six years I have been consulting engineer for the Elephant Butte and the El Paso Irrigation districts, and have studied the situation from the standpoint of their particular interests. With the consent of these Districts, I was, about a year ago, permitted to accept also the appointment of Consulting Engineer of the Middle Rio Grande Conservancy District. These connections have given me a great deal of familiarity with the ground, and with the river, and I have made many studies of the river conditions and of the requirements below the Elephant Butte dam; also of the effect of the middle Rio Grande Conservancy District upon the Elephant Butte dam. In these studies, Mr. Chairman, we were early confronted with this fact; that we seemed to be up against a river which is discharging less and less water at the Colorado line. I say this advisedly, although the situation is not nearly as one might like to wish it in order to make positive and mathematical proof of that fact - that is by reason of the greatly varying rainfall and greatly varying run-off of the river. The fact of this depleting river can possibly be most simply explained by stating that if one makes a list of what may have been the outflow from the mountains in Colorado at the points where the various streams enter the valleys, that when the determination of this total run-off from the mountains is made and it is compared

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with the total that runs past the state line, there is a difference which we have called "Colorado Depletion". Now, this Colorado depletion is not a thing that keeps on increasing from year to year - it is evident that when there is very little water the depletion must be small ; that the larger the flow of water is the larger the means that exist in Colorado to cause depletion, so it is necessary to study this question of depletion from year to year in the light of constantly varying arithmetic. If one makes a tabulation of the estimated amounts that run from the streams of Colorado into their valleys and compares that with what flows out, consequently when one makes that list from year to year, this depletion varies, but if one takes arbitrarily two years of practically the same run-offm from the mountains one would expect to find practically the same outflow from the state, but that is not what is found. Just to give an example, I will read from a report I made 4 years ago to the district below the Elephant Butte Dam:

> "In the year 1906 the estimated total run-off from the mountains in Colorado, which is Red River, was 1,728,000 acre feet. In the year 1922, 16 years later, it also was 1,725,000 acre feet - a difference of 3,000 acre feet - less than a fraction of one percent difference. Now, in 1906 the depletion by Colorado was 886,000 acre feet, and in 1922 it was 1,050,000 acre feet, a difference of 164,000 acre feet."

If one found that merely for two arbitrary years that had similar rainfall it would not be very convincing, but if one studies other years it is persistently found there is depletion, so an effort has been made to find out what the real depletion is, what has been the trend and what is the tendency. The study was not made with any view to a Compact which had not been mentioned between states, but was made with a view to studying our supply of water in the Elephant Butte dam. It is apparent that if one base a water supply to the Elephant Butte dam on the past flow which reached it, one has a picture say of 30 years. During the first of these 30 years there was a certain depletion; later on this depletion increased, and now, when we are confronted with conditions as they are today, 1927, and we want to study now this supply to the Elephant Butte Reservoir, we cannot use the record as it stood of inflow because, under present conditions of greater consumption in Colorado, if the cycle of rainfall and run-off would otherwise repeat itself, the effect on the Elephant Butte would no longer be the same as in the course of years. It is necessary to amend this record in view of fast increasing depletion. This has been the study thathas been made in the first place by the Engineers of the Reclamation Service. It was made by me a few years later, in this report which was rendered, as I stated, 4 or 5 years ago, incidentally arriving at practically the same results so far as the depletion is concerned. The study made by me four years ago, and the study previously made by the Reclamation Service about two years earlier, was based on the records as were then available carried up to the date of these years. Recently these various studies have been taken up again and have been brought up to date, both by the Reclamation Service and by Mr. Hosea being employed in that behalf by the State of New Mexico. Now the result of this most recent work is set forth in certain diagrams or curves, which I believe are important, as I will explain later, as to why they gradually work up to possibilities of use that were not originally intended when these curves were constructed. Here is a diagram on which is plotted, on a horizontal scale, the years, beginning with 1900 and ending with 1928.

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On a vertical scale is plotted the Colorado depletion, estimated on the basis which I explained a short time ago; the difference between the mountain run-off and the amount that passes the state line. The diagram (New Mexico and Texas Exhibit A) from which I am speaking is entitled "Diagram showing Trend of Depletion of Rio Grande in the San Luis Valley, Colorado, April to September."

MR. MOSES: In estimating the run-off of the mountains, did you take only that tributary to the river or did you include all the basin of the San Luis Valley?

MR. HENNY: I stated, perhaps not emphatically, this is only what contributes to the flow of the river; it excludes what would go into the dead area.

GOVERNOR CORLETT: Does it include only the Rio Grande and its tributaries and it excludes all of the dead area?

MR. HENNY: As I stated before, both the inflow and outflow vary very greatly and the depletion consequently varies greatly. For instance, in 1900 the depletion was 500,000; in 1901, it was again practically 500,000; then comes a low year, 1902, the depletion is only 250,000, and so on through this diagram. The depletion varies. In order to smodh it out for practical use, and in showing trend, these high peaks and low valleys, a second line has been drawn, which is dotted, where each point represents the average of the year in which it is drawn, the year preceding and the year following it - a three year average. That line, of course, is not subject to such excessive fluctuations as may be seen from the results. In order to show trend there has been drawn, passing as nearly as possible through the middle of the irregular figure, a dotted line which is intended to show the trend so far as these figures are capable of showing it, and it will be clearly seen that the trend is upward and continues upward on a rather even grade until the year 1920 was reached, after which it has been proceeding at a slower rate, and is at the present time apparently increasing but slowly. Now, in explanation of this depletion, I may just for a moment hold up a diagram which is information which it has been possible for our engineers to get, which indicates the increase of irrigated area in the San Luis Valley.

MR. CARR: Have you a curve showing the annual depletion or only for the 6 months' period from April to September?

MR. HENNY: I come to that later - we have them for the winter season as well. This diagram (New Mexico and Texas Exhibit B) is entitled "Irrigated Area in the San Luis Valley, Colorado" is represented by a drawn line giving the actual record, and by a three year mean arrived at, so the 3 year mean of the first diagram checks by a dotted line. There is again apparent during the period covered by the previous diagram a rise, which is simply a broad confirmation of the increasing depletion which was found from the water studied below.

GOVERNOR CORLETT: What is that based on?

MR. HENNY: That is based on records obtained by our engineers; obtained largely, I think, by Mr. Yeo and Mr. Osgood, and I think compiled and checked by Mr. Hosea. I would like Mr. Yeao to state that.

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MR. HOSEA: It is based on data collected by engineers of the Reclamation Service, Debler & Elder.

GOVERNOR CORLETT: Personally collected?

MR. HOSEA: No, taken from published reports.

MR. HENRY: (continuing) We have a diagram here (New Mexico and Texas Exhibit C) entitled "Diagram showing Relation Between Inflow and Outflow San Luis Valley, Colorado, April to September". This diagram contains, in many respects, the same matter that was intended to be shown by Exhibit A, but it is somewhat differently presented. The horizontal base no longer refers to years but refers to quantities of inflow into the San Luis Valley from the mountains surrounding it, exclusive of the dead area. Whereas, on the vertical side of the diagram are marked quantities representing outflow across the state line. It is quite apparent that in case the outflow should be identical to the inflow, and the inflow should be 500,000 acre feet in a year and the outflow should be 500,000 acre feet a year, they would strike a point on a straight line inclined at x 45 degrees on this diagram, resulting from the fact that the scale of quantities representing inflow is the same as the scale representing outflow. It is, of course, also quite certain that the outflow is less than inflow as long as water is used in Colorado. Hence, if on the map for any given year the inflow, as, for instance, 1910, is estimated at 900,000 acres, and instead of finding 900,000 acres which we place back of this first mentioned line we find only 400,000 outflow, we obtain a point on the map and that point is marked 1910, representing the conditions of 1910. That is for all of the years, going clear back to 1892. As a result this diagram shows a number of spots scattered over the paper and if those spots be studied it is found that in the upper incline region covered by spots we strike all the early years. As we come down below that line we begin to strike the later years. In other words, during later years, was a given inflow into Colorado and we do no longer find the outflow found in earlier years but we find lesser amounts. It could not possibly be expected that these spots would go along mathematical lines to conditions which produce to outflow, because they are too varied, the method in which the rain falls and the amount of natural evaporation is a constant variation, so that the best that can be done is to study the various spots and the years they represent, and then find a group of years which may vary, between 1920 and 1928, and we find in these years generally, low down on the paper, it becomes possible to draw an approximate curved line connecting these spots. The same thing can be done for earlier periods. From the period representing 1920, it might take in years just preceding and just following, and so on for earlier and earlier periods. If that is done without bias and in the best manner that the information permits, the result will be these curves that are shown, or slightly different curves. Unquestionably individual engineers will not draw these curves in the same position, but from studies of similar curves in the past, all have that same trend and all cover just about the same area, so that the studies are confirmatory of each other.

Now these diagrams and this study was originally made for the purpose of being able to study the Elephant Butte water supply in the light of increased depletion so that the record of past inflow at Elephant Butte might be properly amended and represent future inflow before the cycle repeats itself, but since this Compact pro-

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blem came up these curves have suggested themselves as being fit for further use. Let us say that a Compact should tend in this way - we will accept 1908 as a condition where Colorado will agree that that is a fair measure by which the rights below Colorado can be measured. Then it would be possible to find each year what the inflow is at Del Norte and from that extending up into the curve is had how much water should cross the state line to satisfy lower rights. If 1908 is not the year, but 1900, or 1920 be agreed upon, the curves are here that might serve such a ~~proposition~~ purpose; some such an arrangement of estimating what the Colorado outflow should be in satisfaction of lower rights will, in my opinion, in any event be necessary no matter how arrived at. The river is constantly changing. It is not possible for Colorado to agree to deliver 600,000 acre feet because there are years like 1902 when it could not possibly be done. If it cannot be done, yet they would like to use water in a year like 1902, with a curve of this kind, with a small inflow coming from the mountains, only a small amount would be required to satisfy the lower rights - that is all they would have had under certain conditions of depletion as of a certain date. Such a curve is not so easy to apply; on the face of it it looks very easy. One can express it a curve or percentage. When 1,000 acre feet is the yield in Colorado, according to this map in 1908 there should flow across the line, if this line were to be adopted, 425,000, consequently 42½ percent. In case there was only 600,000 going in, and we turn again to the 1908 mean, the outflow would not be more than 110,000 which, in that case, would represent less than 20 percent, and so the percentage would be very low and gradually increase and would make it actually possible for Colorado to deliver. I should say, Mr. Chairman, that in supplement of this diagram which merely covers the months of April to September, another diagram was made (New Mexico and Texas Exhibit D) which is entitled "Diagram showing relation between Inflow and Outflow, San Luis Valley, October to March". This diagram covers that part of the year which is not included in the previous diagram. The reason why two diagrams were made is that one diagram falls during the irrigation season and the other during the non-irrigation season. Now, on this diagram again on the horizontal scale is shown the inflow to the San Luis Valley, and on a vertical scale the outflow across the state line. Were the two to be alike the points from year to year representing that fact would all fall, if united, at a line on a 45 degree angle.

MR. MOSES: To save the record, he says these diagrams shown inflow into the San Luis Valley without excluding any area, and I am wondering if he wants to exclude any.

MR. WILSON: It excludes all the area - I will ask him, - in all of these diagrams are you excluding any of the San Luis Valley, Mr. Henny, in all of these?

MR. HENNY: I am excluding all the dead area and all the mountains that discharge into the dead area.

COL. DONOVAN: In all of these diagrams?

MR. HENNY: Yes sir. From this map it would appear that instead, during the winter, of the outflow being less than the inflow, the trend is for it to be greater. There is a certain benefit derived from drainage conditions. Again, any one of these two lines can be utilized for the purpose of finding if it once be agreed upon as basis of

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a Compact what flow should cross the Colorado line for years of various inflow. As I say, this matter is not as easy as it looks - the inflow comes at odd years - it is a matter that has got to be studied; it xxxxxx is a matter that should go into water-masters and engineers' hands; it should be adjusted from month to month, bothduring non-irrigating and irrigating season, but it is presumed that if a Compact be reached that the tendency will be with the best knowledge and information that it will be carried out in good faith. That errors that are avoidable will be corrected as may be feasible and possible to correct. My study, Mr. Chairman, was directed to the last few months, and the question can there be worked out on a basis for a Compact with Colorado on one hand and New Mexico and Texas on the other, that would deal fairly with Colorado, permit further development there, and yet do no injury to the states below. It has had nothing to do with legal rights; merely with physical conditions. Now, if some Compact can be reached whereby for a given season, with a given measurable inflow, a certain outflow must be secured across the state line, but if the relationship can be based on the conditions as they have existed in the past, whether the year 1908 or some other year, then there is a basis where, so far as I can see, the States of New Mexico and Texas could agree without danger of serious injury. I believe that covers my part of the presentation.

MR. WILSON: We would like Colorado to realize at this time that what we are doing here is to submit a suggestion which has init principles which can be applied to our prospective situations. We do not expect Coloradto to accept dogmatically or literally what we have set down here, but we do expect, however, that Colorado will take the suggestion and either tell us whether it can be adapted to their ideas of the proper application of it, or tell us that it cannot be adapted, that there is no method of application and explanation here. I dont know that any cross examination of Mr. Henny will bring out anything, but of course we would be glad to have such cross examination if it will bring out any information that will be helpful, but at the present time all we are submitting is a principle upon which we think we can get together if we can agree on details. I interpose that so that no time will be wasted in questions which at this time may not help us at all.

COL. DONOVAN: I suppose you would have no objection to questions that define that position?

MR. WILSON: I would be very glad to have such questions.

GOVERNOR CORLETT: Might I ask a question - -

MR. WILSON: (interrupting) We are just presenting this as something for you at the present time to give consideration to; as a foundation, as a principle, generally, upon which possibly we can agree on the details, the year and all the other things that have made up what Mr. Henny has explained.

MR. CARR: We appreciate the spirit in which it is offered but presume there will be a few uestions we want to ask, not in the nature of cross examination, but I do want to make this suggestion - we got the Senator out of bed pretty early this morning and it is now 9:15; that's a long day for a fat young buck like I am, but it is altogether too long for the Senator, and I would like to suspend until 10 o'clock and if there are any questions that might arise if we might not ask Mr. Henny tomorrow. I move we adjourn until 10 o'clock tomorrow.

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COL. DONOVAN: The only suggestion I want to make is, would it be better for the Senator to meet here rather than in the Senate?

MR. CARR: If that's possible, we certainly would welcome it.

Recess taken until 10 A.M., December 20, 1928.

At 10:30 A.M., December 20, 1928, the meeting was called to order by the Chairman in the Senate Chamber.

MR. WILSON: Mr. Chairman, we present the following agreement:

> The States of Colorado, New Mexico and Texas by their respective Commissioners, do hereby stipulate and agree as follows:
>
> Whereas, the high contracting parties are now engaged in negotiations for a Compact between the States of Colorado, New Mexico and Texas concerning the waters of the Rio Grande and its tributaries above Fort Quitman, Texas, and
>
> Whereas, in their efforts to arrive at a compromise it has become necessary to adduce certain evidence, statements and exhibits;n
>
> NOW BE IT UNDERSTOOD AND AGREED: First, that the statements made and evidence adduced and all exhibits offered are so made, adduced and offered only for the uses and purpose of the conference now pending and for no other; Second, each of the parties hereto shall have the right in subsequent proceedings of any character or nature to offer such of the statements, evidence and exhibits here offered in the same manner as if they had not been submitted in this proceeding, subject, however, to the rules of evidence and procedure covering such subsequent proceedings; Third, no such statements, exhibits and evidence shall be used against any of the parties herein as an admission against interest in any proceeding or proceedings which may arise between the high contracting parties; Fourth, it is the further purpose and intent of the parties hereto that the record submitted in this proceeding shall not be accepted as prima facie evidence in any other proceeding.

COL. DONOVAN: Do you concur in that, Colonel?

MR. BURGESS: In view of the fact that in some of the litigation, citizens and corporations of the states appear as parties, does anybody deem it necessary to say "shall not be admissible against any of the parties herein or their citizens or corporations thereof". I dont think, perhaps, it is necessary; the only question is it says it is not admissible against any of the parties - the parties here are the States, but others might be in the proceedings, and would it be admissible against them?

GOVERNOR CORLETT: We have had that same matter under discussion, and I think it could be remedied by simply saying that "nothing affecting the matters in controversy here, or any matter affecting the controversy here."

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MR. BURGESS: I believe you have covered what is done here, but the question is shall it bind the citizens and corporations of the State in the same way? In other words, could it be said, for instance, that the council of one of your districts or the council of one of our districts, or any other person - I dont think it would be admissible. It just occurred to me that that question might arise.

MR. WILSON: It has been sugested to me that we should add a paragraph to the effect that this has been prepared at the request of the parties by the Chairman of this meeting. I think that probably is a very valuable suggestion, if the chairman doesnot object?

COL. DONOVAN: I have no objection. As I understand it, Major Burgess, you agree to this stipulation as it has gone in, and you (addressing Mr. Carr and Gov. Corlett) and Senator Carpenter? -a- All agree. What is our next step?

MR. WILSON: We now offer Mr. Henny for such questions as our Colorado brethren may like to ask him, those questions, of course, being confined to the elucidation of any statement he made last evening.

MR. CARR: We would like to have the right to cross examine Mr. Henny if we so determine.

MR. WILSON: We have no objection, except to say, Brother Carr, I wish you wouldn't use the words "cross examine".

MR. CARR: Well, question, then.

COL. DONOVAN: Further develop the information that Mr. Henny has.

MR. CARR: At this time Governor Corlett would like to make a supplementary statement of certain matters which were overlooked yesterday.

MR. WILSON: The governor is speaking now for the Commissioner?

MR. CARR: We will accept whatever he says.

GOVERNOR CORLETT: It will be very short, but there are certain things, possibly extraneous to the matter as it has developed so far, that it seemed to us the Commission should have inmind in the consideration of this question. The first is that from our position, and I think it is generally admitted by irrigation men, that there are really three essentials to irrigation. One is the diversion of the direct flow rights - that is, the diversion of the water from the stream by taking it in its natural course from the higher ground. The other is the construction of adequate drainage, which is a necessary complement to irrigation, and the third is the complementing of the direct flow rights by proper storage. In other words, the direct flow must necessarily, in order to serve as a complete water right, be lengthened, that a certainamount of direct flow may be called on at any time that the direct flow proves inadequate. In this connection we thought we should call to your attention the fact that, as shown by the evidence adduced here up to this time, the States of Colorado, New Mexico and Texas have appropriated all of the direct flow. It so happens that a great majority, I will say, of that direct flow has been appropriated in Colorado.

MR. WILSON: Do you object to my asking a question? Do you mean by direct flow, the normal flow?

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GOVERNOR CORLETT: Yes. That direct flow has been applied to the rights, and the use of that direct flow or normal flow, as the Commissioner says, are fixed and determined - they are vested rights at this time. Now, then, while we were restrained by this order, Texas and New Mexico went in and complemented and perfected their direct flow rights by the development of the Elephant Butte Reservoir, wherein not only the proportion of New Mexico and Texas was appropriated, but a large portion, taking into consideration the amount of direct flow rights and the needs of Colorado, a great portion of that water which should logically be utilized before complementing and completing the direct flow rights, and which, I think all will agree, are necessary to complementing and completing direct flow rights, have been appropriated by New Mexico. Now, as soon as that embargo is relieved, as soon as we are permitted to go ahead and complete our rights, we proceed, and New Mexico and Texas come in with a proposition that before we be permitted to logically utilize our portion of the flood waters which are an incident to the direct flow that cannot be used directly in irrigation, they are a complementing part of the direct flow rights, before we can do that, they expect to establish a perfect water right for their middle Rio Grande proposition. I think that will give the idea generally of our position on these flood rights; that as an incident to our application, to our proportion of the direct flow rights, in all logic we must have a sufficient part of the flood right to complement that by storage, or those rights which have been provided by our diligence become ineffective and incapable of producing satisfactory results. That is one proposition. Then this is probable - you might say this is a little far-fetched - that the reservoirs on the upper end of the river are of rocky base, there is no sediment, no filling up; that the reservoirs on the lower end of the Rio Grande are temporary structures - I think all engineers thinking the matter over seriously will agree with me in that statement, that any development that may be made such as the Elephant Butte is temporary in its nature; New Mexico may have reservoirs at the head of their rivers where clear water runs through and that doesn't affect us, that eventually this same country now being placed under cultivation must rely upon the return flows from the river above, having exhausted the capacity of their reservoir. That may be a long time in the future, but it is a matter of computation as far as engineers are concerned, and the effective use is in the establishment of a continuous flow for the lower section by the storage in the ground and the natural returning of the water to the river from the countries above. That is just merely a proposition that I think the Commission should take into consideration for the ultimate good of the nation.

Another thing, and this is the third thing, I would present, and that is this: That insofar as the developments we are ~~already~~ making now are concerned, they are extremely temporary; if the United States ever gets into the position of the British Empire in the Ponjab in India or the White Nile in Egypt, in the great development supervised by Sir William Wilcox, where it is not a question of the amount of money the lands will return, but is a matter of bushels of grain that will be returned for the support of the people, for the feeding of the peoples of the country, any Compact that you make here, or any distribution or any division, undoubtedly will be wiped aside. Now, there will be people who have vested rights who will be compensated for any loss, but it will be a question ultimately of wher the most pounds, or most tons, or most bushels of grain or foodstuffs can be produced for the support of the people of this nation. Now, to establish a thing here that it might take generations to change

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would be folly. Where we can by the utilization of this water at the headwaters of the stream provide a continually increasing permanent flow for the lands below, we would be overstepping our opportunities to provide for the permanent good for the Rio Grande Valley. These are three things that I thought ought to be presented for the consideration of the Commission; while not controlling they might be of some assistance. There is one other suggestion I wish to make; yesterday my statement here was very cursory and did not cover the matter as fully as it might have been covered. I made a statement here that is a matter of record in the Interior Department, and upon which the removal of the embargo was based. That can be had through the Secretary of the Interior, but I would be very glad to present that, being a matter of record, for the consideration of the Commission if they desire.

MR. WILSON: I have no intention of prolonging discussion, but, of course, New Mexico and Texas could not concede that there existed any legal right or moral right in the State of Colorado to the flood flow of the river or to excess flow over and above water which has been applied to beneficial use in that state. We would have to insist upon the principle of law which we believe to be settled, that the rights initiated for the Elephant Butte, the ancient rights of the Middle Rio Grande Conservancy District, dating from 1903 and prior thereto, are followed by actual application of the waters, the flood waters as well as excess waters of the stream, to beneficial use, and vest in these projects, or raise a vested right, which Colorado has no right to impair or destroy. I would like to make that statement in order that we may have it understood, that we will not concede, and could not do so, a principle such as I understand Governor Corlett has attempted to lay down for Colorado as controlling in this conference.

COL. DONOVAN: So I can be sure I understand correctly, last night, as I understood the statement made and these exhibits offered on behalf of New Mexico and Texas last night, were made not on the basis of any assertion of a legal right, or the yielding of a legal right, or any challenge of the legal right of Colorado, but was simply directed to the physical situation, to a principle of dealing with that - am I right?

MR. WILSON: That is exactly right.

COL. DONOVAN: What was submitted to Colorado was the question of dealing with these physical facts and whether or not they would be willing to meet those facts.

MR. WILSON: That is correct.

MR. CARR: At the proper time we will restate our position in regard to the statements of Mr. Wilson, but at this time we cannot concur in what he says. Do I understand New Mexico has nothing more to offer?

MR. WILSON: Simply for the reason we have offered something and we would like to know next as to whether Colorado can meet us upon the suggestion made last evening?

MR. CARR: The situation is, we feel, that as was said this morning " A swallow doesn't make the summer", and it was just a suggestion of one phase of the situation. We feel there are many other factors

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entering into the situation on which the Commission should be informed before we can submit a proposition or give an answer thereto.

MR. WILSON: I thought, Mr. Carr, in considering the proposition made last eve ing you could introduce into your position any other factors which you consider material as bearing upon the situation on the river. That proposition would not bar you from proceeding as far as you like into matters which you thought must enter into the consideration of your proposal.

MR. CARR: We are ready at this time offer some evidence.

MR. WILSON:Upon this proposal?

COL. DONOVAN: (addressing Mr. Wilson) You dont expect at this time a categorical answer to the proposition you submitted? As I understandyou, you are perfectly willing in preparation of their answer that they should present such further factors as they may think necessary in order to arrive at a determination of that.

MR. CARR: The situation, as we see it, is there has been no proposal made, and for that reason we are not attempting to make any offer on that.

MR. WILSON: We are proposing a principle, not a statement in regard to water or anything else.

MR. CARR: Let it lay that way - that you have proposed a principle, and we are now going to proceed to facts. We are not suggesting that you answer or that you receive it as a proposal. It's just facts.

MR. WILSON: We will presume that having made a suggestion of a principle that what you have to say would bear upon whether Colorado will or will not accept that principxle.

MR. CARR: Mr. Wilson, dont you think we are playing with words?

MR. WILSON: No, I dont.

COL. DONOVAN: Mr. Carr, you may not have heard the conversation between Mr. Wilson and me - I gather from what Mr. Wilson says that Colorado is not called upon to make any categorical answer, but Colorado, it is understood, is simply submitting certain elements and factors, believing these are necessary to arrive at a determination.

MR. CARR: Very well - the witness we will call is Ralph I. Meeker of Denver, Colorado, and those who know him best will, I think, admit his qualifications, so I am simply going to introduce him to the Commission.

MR. WILSON: We admit his qualifications.

COL. DONOVAN: This might come up some time in the future after we are gone, so we had better memorialize it now.

MR. CARR: He is consulting engineer for Colorado. He is an expert on matters concerning water supply, river flow, uses and waste of water, consumptive use and return flow water. He was the sole expert of the State of Wyoming in the case of Wyoming v. Colorado, whose figures were accepted by the Supreme Court of the United States in the

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determination of that case. He was expert for the State of Colorado with the Interstate River Commissioner on the Colorado River studies, which later resulted in the Colorado River Compact. He was the expert of Colorado on the La Plata River which was in controversy between Colorado and New Mexico and resulted in the La Plata River Compact. He is expert for the State of Colorado on the North Platte River studies with the Interstate River Commissioners from Colorado which are now about to be embodied in a three state compact. He was also expert on the Arkansas River studies from 1903 to 1906. He was engineer for the United States Geological Survey with headquarters at Denver, which duties are now being performed by Mr. Follansbee. He is now water supply expert on the Arkansas River, working with the Mississippi Board of Engineers, andhe has devoted his life to water and supply studies and is known for his careful and painstaking work and his conservative conclusions.

MR. MEEKER: As a preliminary to my discussion of the Rio Grande, I wish to state that my first work on the Rio Grande was in 1904-5-6; at that time I was in the Geological Survey and had measured the Rio Grande at various points in New Mexico and Colorado. Later, in 1914, I took up the study of this Rio Grande interstate problem under the direction of John E. Field, at that time State Engineer for Colorado. Some eight months were devoted to the study of the usesof water in the San Luis Vally, the middle Rio Grande Valley, and in Texas. Later on, while employed as special deputy state engineer of Colorado, I initiated the measurements of the drain in the San Luis Valley, realizing that before a settlement could be reached on the interstateproblem we must know something of the recoverable waters. Commencing at about 1923 I have devoted a large part of each year to the study of the Rio Grande uses from Fort Quitman to the head waters, involving trips, in 1920, to the Mesilla and El Paso Valleys, and again in 1923, and finally a three year study of the uses of water under the Elephant Butte Reservoir above Fort Quitman, Texas, which commenced in 1925 and was perminated in September of the present year.

Now, a few words in reference to water supply of the Rio Grande basin; I wish to bring out the fact that at the time of the treaty settlement xx with Mexico and the determination of the Elephant Butte Reservoir - or the establishment of the idea that they were going to construct a reservoir there - the records of water supply on the river at various stations were quite meager. The river basin had just passed through an extreme dry cycle commending about 1906 - about 1896, and ending about 1905, culminating in the year 1902, which was a very low year. The result was, ideas of water supply were quite limited at that time. Since that time we have some 20 years of records at various stations on the main stem of the river and many tributaries. I wish to point out 2 or 3 stations on the river, just for comparative purposes, to give some idea of what the annual flow was in the years of short run-off, and the later years. I will take Buckman, which is at the head of the Rio Grande Valley inNew Mexico, probably about 15 miles northwest of Santa Fe, just as an illustration station. At the time for the period of 1890 to 1902, the average mean flow, in acre feet, at Buckman, was 1,152,000 acre feet per year. For the period 1890 to 1906, 1,257,000 acre feet; for the period 1890 to 1915, 1,402,000 acre feet; and for the 38 year period, 1890 to 1927, 1,437,000 acre feet per year, showing a long time mean of about 280,000 acre feet per year. Over the short time record of 13 years, 1890 to 1902, I could cite some figures for the other stations on the main

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stem of the river, but will consider that a sufficient example. The study of the river has been an evolution. Water supply reports of 1907, 1908 and 1910 have long since become obsolete. In 1918-1919 the Reclamation Service made a very comprehensive study of the river, engineers Conklin & Debler being authors of the report, and even as recently as that there are a number of elements that we considered at that time that had been changed due to changing uses on the river; recovery of ~~xxxx~~ return flow by drainage canals, construction of reservoirs and additional phases of the use of water. Some of the conclusions drawn at that time ~~dix~~ do not obtain in full today, only ten years later. Some of the conclusion that were made at this time will have to be modified in 5 or 10 years, due to the change in conditions of the river. The point I wish to bring out is that where irrigation is practiced, conditions of use of water cause changed conditions of river flow, and engineering studies to meet that situation must be made frequently throughout the river basin. Now, nothing has been presented in reference to the Rio Grande Basin water supply, so I will give you a birdseye picture of the water supply of the Rio Grande Valley above Fort Quitman, Texas. In my discussions of the Rio Grande Basin I exclude the closed basin area at the north end of the San Luis Valley when I am discussing water supply. The reason for that is that the streams from the mountains that enter the closed basin discharge their waters into what we ordinarily call the sump, which includes the San Luis Lakes, a low lying area, and the portion of water that is not used for irrigation in the closed basin is lost by evaporation and does not reach the main channel of the Rio Grande so far as we know, and from records or ratherfrom the statements of pioneers of the valley, that water has never reached the Rio Grande since the settlement by whitemen. There has been some mention of the fact that water may come back in an underground way - it has never been demonstrated. From geological information, and I know of my own knowledge from soil borings in the vicinity of the low parts of the sump near the Rio Grande that there is a strain of clay in the bed of the Rio Grande for several miles with a blanket of sand and that ~~xxxxx~~ stratum dips towards the north end of the closed basin which makes it closed in fact. Now, from the records of stream flow, supplemented by some minor estimates of waters used and consumed in irrigation, the average yearly run- ff of the Rio Grande basin at Fort Quitman, Texas, is 2,662,000 acre feet. The estimated present consumption average per years is 2,295,000 acre feet, leaving a present basin surplus of 367,000 acre feet per year. The run-off may be subidivided as follows: average values in acre feet per year

Colorado	1,400,000 A.F.
New Mexico	1,262,000
Texas, negligible	- 0
Mexico	0

You will find that these figures total 2,662,000 acre feet. Now, I propose to subdivide the estimated present consumption by states:

Colorado	855,000 acre feet

and that is for a 38 year period

New Mexico	994,000 " "
Texas	280,000 " "
Mexico	166,000 " "

In that connection, I wish to mention the fact that the Treaty burden is 60,000 acre feet per annum. Large uses are now being made of the Rio Grande in Mexico due to the large water supply in the river below the Rio Grande project. Some seven outlaw canals, if I may use that term, divert water from the river below the Rio Grande project, irrigating, in round figures, some 25,000 acres of land in Mexico. Now, let me convert these figures by states into percents to give the rest

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of the picture. On water produced,

	Colorado	53 percent
	New Mexico	47 "
	Texas	0
	Mexico	0
On estimated present consumption,	Colorado	37 "
	New Mexico	43 "
	Texas	12
	Mexico	7

I should like to add still another table with the heading estimated present and future consumption. I shall subdivide this by states:

Colorado	855,000 acre feet
New Mexico	1,091,000 "
Texas	282,000 "
Mexico	66,000 "

On a percentage basis we have for estimated present and future consumption by states, the following figures:

Colorado	37 percent
New Mexico	48 "
Texas	12
Mexico	3

under the assumption that ultimately the surplus and waste waters of the El Paso Valley will be controlled so that they may be used in the United States.

COL. DONOVAN: Have you now reached a point where you could suspend for a recess - we must keep an engagement with the Governor?

MR. MEEKER: Yes.

Recess taken until 2 P.M., and upon reconvening at that time Mr. Meeker continued:

MR. MEEKER: Mr. Chairman and members of the Commission: To recapitulate for a moment on the state water supply in the Rio Grande basin, I wish to point out that Colorado produces 53 percent of the basin supply; and consumes 37 percent; New Mexico produces 47 percent and uses 43 percent, under present conditions. Now, in connection with my statement of this morning, I think I mentioned that the closed basin was excluded but I want to point out that the water taken from the main stem of the Rio Grande and used in the closed basin is included in my discussion.

MR. WILSON: Are you going to give us those figures, your measurement of that portion of the stream which goes into the closed or dead area?

MR. MEEKER: Yes sir, I will give you to you right now. The diversions on the Rio Grande to the closed basin average from 400,000 to 450,000 acre feet per year. Now the origin of the closed basin in the San Luis Valley, as you probably know, is an old lake bed, an ancient lake, and probably in geological times the closed basin wasnot a closed basin, if I may use that term, but ~~xxxxxx~~ with the erosion of waters and the deposition of silt, a narrow arm, a shallow arm was built up which made it conform to the Rio Grande drainage so that no surface water of the closed basin reaches the Rio Grande. Referring to Exhibit A of New Mexico and Texas, the diamgram showing trend of depletion of the Rio Grande in the San Luis Valley, Colorado, April to September, only, I wish to point out that this graph deals with what might be called an irrigation period in the San Luis Valley, and naturally the trend of water consumption would be magnified because of the diversions during that period. Diagram or Exhibit D

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of New Mexico and Texas, shows the relation between inflow and outflow of the San Luis Valley, October to March, or the Winter period, should be taken in conjunction with Exhibit A in order for you to consider the full year period at the state line, as Colorado has done in her studies. This diagram A shows an increased consumption which is synonymous with depletion. If the data on this diagram were applied on the depletion in this diagram, the yearly consumption at the state line would be reduced. I mention that because to one who doesn't understand these matters clearly this will magnify the condition of depletion; it does not represent the true condition during the yearly period at the state line. If I remember correctly, the division into these two periods was made by Engineer Debler of the Reclamation Service at least in one study for the special purpose of determining the storage that might have to be supplied to the middle Rio Grande project; that was one phase of it. I would like to make a distinction between the yearly consumption and yearly depletion of the river. Exhibit A shows the consumption of water, that is, the ~~xxx~~ difference of the inflow to the valley and the outflow, so that is properly consumption for the period shown. The depletion would be the rate of increased consumption over a given period of years. I mention that because another diagram does show the depletion purely and this one shows both consumption and depletion. There is one point in connection with depletion that I have not brough out, and that was during the period prior to 1900. These 2 graphs go to 1900 and I believe this one prior to 1900. In the '90's, the last decade of the century, there was a heavy canal construction commencing in the '80's in the San Luis Valley, and there was a contest or race for water among the large canals of the valley. With the result that after the construction of these canals in 1880 large quantities of water were diverted in excess of the needsof the land of that day, with the result that the burden placed on the river was as great in those years as it was in the following decade, due to the fact of the desire to perfect water rights. There was another element that entered ~~xx~~ into the water use of the valley, and that was that the canals were all constructed in a porous, gravelly soil~~x~~, the water table of which was anywhere from 10 to 15, or 40 or 50 - probably the average depth of the water table was around 50 or 60 feet, the result was when they made canal diversions they had heavy losses through those porous soils. Some times, - I recall on the upper ends of these canals they get cobblestones as well as gravel on the top of the Del Norte Cone - so between the losses of the canals, and some of these canals are very long, and the contest for speed to get water out on the lands and protect their water rights, there was an abnormal burden placed on the river in those early years. In connection with depletion that simply means this: the amount of depletion that might be thought to have occurred by irrigation engineers would be less than some of the diagrams which can be developed would show if these things were taken into account. I have a set-up in connection with depletion in Colorado, so I will remove these andpresent my set-up and this can be marked "Colorado's Exhibit No. 1" and I will give this to Mr. Henny. Colorado's Exhibit No. 1 is designated as Water Input and Output, San Luis Valley, Colorado, 1902 to 1927, inclusive, and the graph on the blackboard is a rough graph of exhibit No. 1. We dont go back of 1900 in this study for the reason that there are no records at the state line prior to 1900. Furthermore, there were no records on the Conejos River, a large tributary of the Rio Grande in Colorado, prior to 1902, so that is the starting point for the graph. The graph shows on the vertical base the SanLUis Valley inflow - values in 1,000 acre feet; the horizontal base, San Luis outflow, values in 1,000 acre feet, both being per year. In determining the

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depletion of the Colorado area four years have been used, 1902-3-4-6. Other years are shown on the photostat graph but they have been discarded on account of an analysis which shows that the best measurement of depletion is secured in what we call years of regular flow, and theyears of irregular flow have been excluded to make the analysis. The result is the curve; the heavy line shows theinflow at the state line and the outflow for that period, the first decade of this century or 25 years ago. I have then taken similar records for the years 1923-5-6-7 and worked out another curve which is the heavy dotted line; the difference in between is the depletion and is marked with the word "depletion" and an arrow going to it. That difference over a 30 year period averages 50,000 acre feet per year. Now, taking the graphs submitted by New Mexico, our analysis shows a depletion from that study of 100,000 acre feet per annum over a 30 year period at the state line. The result is a disagreement of 50,000 acre feet per annum. The present recorded flow at the Colorado line is about 600,000 acre feet per annum. If you correct for a 50,000 acre feet depletion it means an output of 550,000 acre feet per year. If you correct for 100,000 acre feet depletion it means 500,000 acre feet per year. Now, an explanation of that difference is dueto the fact that abnormal years have been used in working out depletion. By dividing the years into two periods it spreads the points wider than they would be on the yearly period, and the study of the graphs submitted by New Mexico shows that those lines might be placed at considerable variations with the actual lines on the graphs. Let me explain, for example, in the year 1905, which I havenot shown on the board but is on the graph, in the San Luis Valley, the annual precipitation is only about 8 inches per annum, a very low amount. The result is our stream guaging stations are located at the rim of the valley where our streams come out of the mountains. In ordinary years there is very little run-off from the valley floor; in abnormal years of precipitation or large snowfall or rains, the valley floor contributes a considerable flow of water, and in making an analytical study of the depletion it is proper not to use those years because it upsets the curves and gives an abnormal figure; that is why we have used this method of analysis to determine the Colorado depletion. I want to point out that studies prior to the one by New Mexico, that I recall, all have shown even greater depletions, and as indicated this morning, changing conditions on the river require changes in analysis and new rates every few years to meet those conditions. The study of depletion on the Rio Grande has been just as large an evolution as the other studies of water supply. In connection with stream flow records, I wish to point out the Colorado records are based upon automatic guages since the year 1911, 1912, 1913 and 1914. During that period of years automatic guages were put on all principal rivers in the valley so that we have accurate records of the inflows and outflows of the valley and various tributaries to the Rio Grande. Now, for the time being - no, before I leave the Colorado area, I want to point out the water supply that would be recovered by the proposed south drain. Our studies show the water recovery to be about 175,000 to 200,000 acre feet per annum, of which about 50 percent will be drainage recovery and 50 percent will be surplus waters of the closed basin which were never tributary to the main stem of the river. Let us change now and go to the lower end of the river in Texas. As I see it, any set-up or study of the water supply of the Rio Grande basin should not only take into consideration the headwaters, but should take into consideration the uses of the waters in the lower basin, especially in view of the fact that there are large wastes passing the lower end

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of the Rio Grande Project at Fort Quitman. I might explain Fort Quitman is 80 miles below El Paso and the end of the middle Rio Grande Project is about 45 miles below El Paso. The outflow at Fort Quitman is less than the outflow at the end of the Rio Grande Project for two reasons. The Hudspeth County Reclamation Conservancy District No. 1 lies below the Rio Grande Project, and there are seven Mexican outlaw canals, if I may use that term, taking out below the end of the Rio Grande Project which use water between the two points in question. Therefore, the flow at Fort Quitman is always less than the flow at the end of the Rio Grande Project, because of this intermediate use. I will give you a birdseye view, based upon a three year study of the lower valley and the water uses under the Elephant Butte reservoir - I will read some figures. The total supply available at the end of the Rio Grande Project for 1925 was 347,000 acre feet

1926 370,000
1927 386,000
1928 380,000

This latter figure is approximate, because the last three months of the year were not available, but I extended it on the basis of the previous year. Now, there is some of that water that is not usable because it occurs during the winter months when irrigation isn't practiced; some of it is arroyo inflow - they have during the summer time and fall an occasional storm in the Mesilla or El Paso Valleys, which is torrential in character and produces run-off into the main stream, and that water will be excluded along with this drain water during the winter months, and a certain amount of water allowed for lack of control and sand solution. Revising the table I have just given - I might amplify that right there - the channel of the Rio Grande is quite sandy and is very fine, and of course, the river picks it up and carries it along and they have diverted large quantities of water through the canal heading and waste some of it back through the solutions in order to keep some of the sand out of the canal. Revising the figures given to allow for the drain which goes in too low to be used by the Hudspety Canal, and for arroyo inflow and winter drain, waste for 1925, 173,000 acre feet;

1926 249,000
1927 245,000
1928, approximate figure with the three months extension based upon previous performance, 260,000 acre feet.

As pointed out this morning, Mexico is now using 100,000 acre feet in excess of the treaty burden. Under future development, the New Mexico area will impose an additional burden on the river if projects which are contemplated are constructed, and they have been allowed for in our set-up.

MR. WILSON: You might state those, please, and the amount of water to take care of their needs.

MR. MEEKER: You want it in detail? - The summation is 100,000, and the detail I can give you later.

MR. WILSON: Alright.

MR. MEEKER: The question was asked as to how we get the records of this waste. There is a station on the Rio Grande at Tornillo, which is near the endof the Rio Grand Project, maintained by the U. S. Reclamation Service. All water passing that station is not available to the Rio Grande Project.

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MR. BURGESS: May I ask whether the figures are measurements at Fort Quitman or at the lower end of the Rio Grande Project?

MR. MEEKER: They are.

MR. WILSON: Measurements by the Reclamation Service?

MR. MEEKER. I am going on that right now. While the question is answered directly, I will digress to say this: We have used the reclamation service records at Tornillo. We have, the State of Colorado, maintained automatic guages this year and last year at Tornillo, and taking those records and the records of the Reclamation Service, and taking the deliveries from the Tornillo Canal to the Rio Grande Project and the Hudspeth Canal, the wastage through the Mexican wier, at the end of the Hudspeth Canal and the waste of the few minor laterals we have arrived at these figures. A full three years' record was secured at Fort Quitman prior to the establishment of a station by Colorado. The Mexican government had maintained a station for several years at Fort Quitman. The Colorado station at Fort Quitman was established in January 1, 1926 and automatic guage records were secured at all of our stations.

MR. WILSON: How many stations have you?

MR. MEEKER: The station at Fort Quitman, 80 miles below El Paso, check records for portions of two years at Tornillo about 45 miles below El Paso, check records with automatic guages for short periods at Kershane, and Kershane is equivalent to El Paso; it is three miles from El Paso, and checked records during 1927 and 1928 at the outlet of the Elephant Butte reservoir. Now, in connection with this waste, I wish to bring out the point that excess waters have been discharged from the Elephant Butte reservoir above the needs of the Rio Grande project. The reservoir has been in operation about 14 years, and the average discharge from the reservoir during that period was, in round figures, about 900,000 acre feet, but at the time of the commencement of operation of the Elephant Butte reservoir the acreage under canal xx in that project, including all community ditches, was much less than it is today, so that a very large quantity of water has been discharged from the reservoir above the needs of the lands. During the last 5 years the outflow from the reservoir has averaged approximately 880,000 acre feet, and under that condition we find here excess supply of, in round figures, 230 or 240,000 acre feet, after making allowance for unavoidable waste. So you can readily see that even 100,000 or 150,000 acre feet of water per year xxxxxxxxxxx were retained in the reservoir; in ten years; that would be a million and a half acre feet.

MR. WILSON: Is there any inflow between the Elephant Butte and points at which you have taken your records?

MR. MEEKER: This arroyo inflow, a little underground inflow from the torrential rains that occur and which has been excluded because it is not xxxxxxx controlable, and also a small amount of underflow between the Elephant Butte Reservoir and Hatch. Hatch is a point on the Rio Grande approximately 35 or 40 miles below the reservoir. To go back to the point, if the excess waters which have been discharged from the reservoir were retained in the reservoir, the storage contents of the reservoir would be just about double, or more than double what they arenow, and I am not making that extreme if I take the 200,000 acre feet or 230,000 acre feet and apply it over a ten

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year period, it would equal the capacityof the reservoir. The main thing I want to bring to your attention is that large quantities of water have been wasted from the Elephant Butte reservoir since its operation, and the approximate storage contents of the reservoir is about a million acre feet. If that water which has been wasted had been held in the reservoir, the reservoir would have been practically full today. I think that that's an important point in any proposal concerning the discharge of the deficient quantity of water across the state line of Colorado. It should receive consideration because if water is retained in the reservoir it will immediately crowd water up stream, to use a common saying. The storage of the water of the reservoir, instead of wasting it will keep the reservoir full, or nearly full, and the irrigators under that project will see that their water supply is adequate, and when it gets down to a million acre feet they commence to worry in view of the fact that they turn out over 800,000 acre feet in a year, and with few exceptions they will begin to worry about the second year's water supply if they get a good year's rain. If the water waste on the lower end is used from the reservoir, then it will be clearly demonstrated to the farmers under the project, I think, that they have more than an adequate water supply because any upstream development will come slowly on the river and it would be a long time before a point would come - let me put it differently - the proper control and use under reasonable beneficicial use from the Elephant Butte reservoir will demonstrate the adequacy of the water supply of the Rio Grande Project and the Mexican burden, and the Hudspeth County Irrigation district which, as near as I can determine, was never contemplated in the original Rio Grande Project, and is junior in every respect, but I have always included that in my set-ups, and I think it fair to s include it. When I talk about surplus waters of the Rio Grande Basin that includes your Hudspeth County project, the Rio Grande project and the Mexican burden. Now, Commissioner Wilson asked a question - before I get to that, I wish to point out that the Elephant Butte reservoir has the capacity, or originally had a capacityof 2,638,000 acre feet, the largest reservori in the United States, and the average yearly flow at San Marcial, after depletion for uses of the basin above in a 30 year period is 1,130,000 acre feet; so you can see the reservoir stores over twice the average annual run-off of the Rio Grande at that point. To put it another way, the reservoir has a capacity sufficient, under reasonable beneficial use, to supply the project if full for three year periods. I want to stress this waste of water. I didn't get quite through and I will continue on that. I have taken, as I said, figures, values in acre feet per year. During our study of the lower Rio Grande we made a good many personal observations which confirm each other in values in acre feet per year. I will read just a few of these at random in order to give you some conception of how widespread it was throughout the year, and during several years. For example, on August 18, 1925, the total waste below the end of the Rio Grande project - and in this set-up I am including the water delivered to the Hudspeth County District because they have a contract, or did have, which stipulates - I am not sure they have this year, but they had a contract and received water from the Rio Grande project for $1 or $1.25 per acre foot. This includes that water. August ~~xx~~ 18, 1925, 484 second feet; August 21, 798 second feet. I am not going to pick out all the big ones but some of the low ones too. I will come to 1926, March 30, 1033 second feet;

April 19 550 "
May 24 600 "
June 12 449

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June 20 631 second feet
July 9 824
Sept. 16 741
Sept. 25 305
Oct. 27 235
1927, Feb. 10 492
Feb. 12 526
Mar. 2 243
Mar. 8 451
Apr. 12 605
Apr. 28 269
May 6 524
May 10 708
June 9 456
June 15 819
July 14 545
Aug. 12 569
Sept. 26 525
Sept. 30 555

I am omitting the high ones with large arroyo inflow unless in a cursory way I have overlooked it.

Oct. 21 280 Second feet
1928 Feb. 13 442
Feb. 22 402
Mar. 7 275
Mar. 19 371
Mar. 20 713
Apr. 15 988

To explain the difference beween a second foot and an acre foot, a second foot flowing for 24 hours is equal to 2 acre feet and so if we have, I will take 500 second feet - if we have some of these figures multiply that by two and it will give you acre feet waste during a day; if you want to get it for a month, multiply the second feet by 60 for ready conversion. For a further view point on that, 500 second feet continuously for a year, although that ins't the condition here, but just to give you an idea of what it amounts to - it would be about 360,000 acre feet. Continuing on the wastage of the Rio Grande project:

Mar. 19 713
Mar. 20 459
Mar. 21 390
Apr. 15 988
Apr. 18 678
May 5 1225

I cant recall offhand whether there was any rain at that time; I think not, though. If there were rain at that time that figure would be a little large.

May 25 804
June 4 624
June 14 403
June 25 558

Here is a large one, I suspect there is rain in it:

Aug. 14 1206
Sept. 4 677
Sept. 16 193

That table, those random figures I read, showing that we have our own observations on that three year study. I had an assistant hydrographer and engineer at El Paso and he covered the river from Elephant Butte to Fort Quitman, a distance of about 220 miles, and not only did he guage at these river stations that I indicated a while ago, the main

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stations, but he also measured the drains, diversion canals and made intermediate measurements from time to time so that we are not guessing at these figures. These figures are all personal observations by the State of Colorado.

MR. WILSON: May I ask you a question. I just want to get it clear about one point; take for instance, August 14 -

MR. MEEKER: What year?

MR. WILSON: 1928, you had the figure of 1,206 second feet. Did you give the measured flow at the Elephant Butte on that day, or a week previous or the week following?

MR. MEEKER: I can do that; it is over at the hotel and I can give you to you tomorrow; I have all of these details.

MR. WILSON: You will remember you made no comparison between those two figures.

MR. MEEKER: I dont know whether I did on that specific date, but I have on other dates.

MR. WILSON: Not on this day?

MR. MEEKER: I would have to check it up to be sure on that.

MR. WILSON: You couldn't get that this afternoon, have it sent over?

MR. MEEKER: I dont believe so, unless I went after it myself. I will make a note of it.

MR. WILSON: You could take Aug. 14, May 5, April 15, all in 1928.

MR. MEEKER: And you want the discharge of the reservoir on the same day; we will have to allow - -

MR. WILSON: The week before or the week after.

MR. MEEKER: We would have to allow a lag of ten days for that water.

MR. WILSON: I realize that, that's why I suggest you give us figures a week or ten days before if you have them.

Recess taken for 5 minutes.

MR. MEEKER: I dont wish to be understood as being critical because waters have been wasted down at the lower end of the Rio Grande project because you couldn't use it, but I do wish to stress the matter when you are complaining about the depletion, or threatened depletion, by Colorado. From that viewpoint I wish to stress it. Now, Commissioner Wilson asked a question that I have gotten to, about the lands that I allowed for that will be irrigated in the future in New Mexico. I will give them to you by sections of the river. I have allowed from the Colorado-New Mexico line to Embudo for 50,000 acres; that's land around Tres Piedras, Sunshine Valley, some around Taos, and on these tributaries from Embudo to Buckman, which would include the Chama, 25,000 acres; from Buckman to San Marcial, I have used 30,000 acres; of new land about 100,000 acres in the valley proper, making 130,000

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acres all told.

MR. WILSON: Is your figure based upon just the initiation of some possible project, or projects under way and completed recently?

MR. MEEKER: I am taking potentialities.

MR. WILSON: That is consumptive use?

MR. MEEKER: I have applied it to consumptive use to those and use it in my set-up so when I say the estimated future surplus on these 637,000 acres, it allows irrigation for all of these lands. About the number of measurements made by the State of Colorado, I will just give you a recapitulation during the three year period:

River measurements	423
Drainage canals	642
Irrigation canals	170
Total	1235

and the river measurements were but a small part of that investigation study.

MR. CARR: You said you included the Hudspeth district and also water for Mexico when you were discussing your set-up in connection with the water which you stated in your discussion, that the water which flows below the Rio Grande Project, that you included the Hudspeth District and also the water for old Mexico; did you mean the 60,000 acre feet which we were obligated to deliver to Mexico under the treaty, or did you take into consideration the 165,000 or 166,000 acre feet which is actually being used in Mexico?

MR. MEEKER: Does your question pertain to the statements I made about the waste at the end of the Rio Grande project?

MR. CARR: Yes.

MR. MEEKER: I took the actual total amount of the river wastage at the end of the Tornillo and the El Paso outlet, and between that point and Fort Quitman, the Hudspeth District takes out some 50,000 or 60,000, and the Mexican canals take out a large quota.

MR. CARR: When was this Hudspeth project commenced?

MR. MEEKER: I can't give you the exact date on that now; the project was approximately 10 years old and if I recall correctly, it had a few canals that were on the river at that time and had been using water for an indefinite period.

MR. CARR: This was commenced during the period when the embargo was still in effect on the Rio Grande, was it?

MR. MEEKER: That is true.

MR. CARR: You mentioned the year 1902 as being a dry year. In a year like 1902 would there be any water to store in the San Luis Valley in the Vega-Sylvestre and Conejos Reservoirs?

MR. MEEKER: There would not.

MR. CARR: Why?

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MR. MEEKER: Demands of prior rights and prior reservoirs would have the first claim and would not be supplied, so there would be no water for these projects.

MR. CARR: In your graph which is marked "Colorado's Exhibit No. 1" did you take into consideration the flow of the stream during the entire year or just for a portion of the year as was done in Mr. Kenny's case?

MR. MEEKER: The 12 months' period; using calendar years.

MR. CARR: What, according to your figures, is the depletion per year of the water at the state line in Colorado?

MR. MEEKER: 50,000 acre feet.

MR. CARR: What would be the amount of water turned into the river from your figures if the north country or sump country were to be drained?

MR. MEEKER: 175,000 to 200,000 acre feet per year.

MR. CARR: Now what do you figure is the amount of waste water which goes below the Rio Grande project?

MR. MEEKER: Unavoidable waste, the actual water that's available at the end of theproject is over 350,000 acre feet, or little better, per year.

MR. WILSON: What would be the unavoidable waste?

MR. MEEKER: In xrround figures about 100,000 acre feet.

MR. WILSON: ~~You~~ Would you also state, so as to make the record on one point, have you made any estimates of the cost of adequately draining the dead area?

MR. MEEKER: I have some figures on that.

MR. WILSON: Have you any estimate that you might put into the record as a tentative figure?

MR. MEEKER: The dead area in Colorado? - Somewhere between $500,000 and $700,000.

MR. WILSON: Which would produce the result you just mentioned?

MR.MEEKER: That's approximate, I might want to revise it later.

MR. CARR: To reach a total on the question I was asking, if the waste, actual waste below the Rio Grande Project were saved, and the drain were made in the north country in the San Luis Valley, you would have a total saving over present conditions of how much?

MR. MEEKER: ~~175~~ 175 plus 230 - 400,000 acre feet.

MR. CARR: That could be added to the flow of the river by those two things.

MR. MEEKER: That will be available for future uses.

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MR. CARR: Were there any other lands outside of the Hudspeth Project below El Paso which have been irrigated during the period that the embargo has been in effect?

MR. MECKER: I believe the Tornillo unit, about 9,000 acre unit of the Rio Grande project. If it came in on a strict basis, it would be a junior right, and then there are about 2,000 acres, or perhaps 3,000 acres on the American side between Fort. Quitman and the Hudspeth County line that are irrigated by pumps from the river by gasoline engines.

MR. CARR: Would it be reasonable for a project to always expect a 100% water supply in every year as was suggested yesterday in connection with the El Vado project?

MR. MECKER: In connection with the basin water supply, if some projects must insist on 100% water supply in dry years, that means that water will have to be wasted during years of plenty because development - if these projects will not permit development of that surplus during theyears of surplus it will have to go to waste, so that I dont feel, I dont think it is standard engineering by irrigation engineers that projects should have 100 percent water supply in any type of drouth year that can be taken. In fact, I would say that the projects that can stand a 30 or 35 percent loss occasionally without serious injury - when I say occasionally, I better say once in 15 years.

MR. CARR: On the plat offered by Mr. Henny showing the depletion from October to March, during the winter months, at the state line, the results would show that Colorado is now delivering a greater quantity to the state line during the winter months than it did formerly, if I understood you.

MR. MECKER: That is true.

MR. CARR: What is the relative value of winter flow as compared with summer flow as regards the Elephant Butte project?

MR. MECKER: It is much more valuable because winter flow has a chance to get through the channel to the reservoir;during the summer the channel of the Rio Grande is quite wide through the middle Rio Grande Valley and percolation losses are heavy and there is some evaporation losses, so that an acre foot of water turned loose at the state line in winter would perform a greater amount of work than during the summer months.

MR. CARR: You made a statement, Mr. Mecker, I wishyou would explain in connection with the original capacity of the Elephant Butt dame being 2,600,000 acre feet, and the flow of water past San Marcial being 1,300,000, and then you made a statement as to capacity, of the ability of the project to furnish water consumption below for how many years?

MR. MECKER: Three years.

MR. CARR: How do you explain that?

MR. MECKER: I take the set-up of the Reclamation engineers as to the demands of the project, 155,000 acres, plus the Mexican burden and include the Hudspeth project.

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MR. CARR: Does that include any inflow during those years?

MR. MEEKER: No, it doesn't. That just takes, assuming the reservoir is full at the commencement of the first year, the water supply is adequate to serve the lands for a 3 year period.

MR. CARR: Without adding any more water to the quantity with which you started?

MR. MEEKER: That's true.

MR. WILSON: This is not intended as cross examination, just a question for information. Assuming that depletion during the summer months, the irrigation season, which we show on our graph last evening and which you had here today, were to continue, would it not impair, and in time, seriously so, the irrigation of the middle Rio Grande Conservancy District?

MR. MEEKER: I couldn't catch all of that - please read it again.

MR. WILSON: Question repeated.

MR. MEEKER: If depletion should occur from the Colorado area it would probably require additional storage from that contemplated in the El Vado site because, as I understand it, the graphs that have been presented by Engineer Kenny were prepared on a co-operative study of the middle Rio Grande district, and the assumption on which they were based there were no equities in the upper river, they would take the river as is and correct it for depletion and place their surveys on that

MR. WILSON: Returning to my question - assuming that no further conservation is contemplated or should be contemplated, speaking from the standpoint of legal right, than that of the El Vado reservoir, would there not be an impairment of the middle Rio Grande right or uses of water if that depletion continued as shown by that graph?

MR. MEEKER: I prefer to answer that this way. There would be an impairment of the river flow if heavy depletion continued.

MR. WILSON: And if that river flow is now entirely taken up at an average normal basis by the middle Rio Grande District, would it not result in the impairment of the uses of water in that district?

MR. MEEKER: Quite true if they had the legal rights to that water.

MR. WILSON: I want to ask a question more or less of a general nature, but one which I would like to have you consider as connecting your statement, soto speak, with our principle which we submitted last evening; taking your statement then from an engineering standpoint and assuming for the purpose of this question that your statement is entirely in accord with the fact, and is correct, could Colorado reconcile your statement - assuming it is correct, as I said - with some such principle as I submitted to you for a settlement according to your theory of the difficulties on the river?

MR. MEEKER: I have my doubts about that solution because of the administration features involved, but I would prefer to make reply further on that as we go further into the matter.

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MR. WILSON: Assuming that the administration features could be disposed of, would you think it might be fitted in?

MR. MEEKER: I feel that it would be easier solved in some other way.

MR. WILSON: Very well, haveyou a suggestion on that other way?

MR. MEEKER: Not at this time.

MR. WILSON: You cannot at this time give us any indication of that suggestion

MR. MEEKER: We will get to it before we get through with the confer nce.

MR. WILSON: I thought you had finished your talk and that perhaps you might have some ideas.

MR. MEEKER: I have taken this position in my work on this - I have been trying to let things solve themselves as the session progresses. I came here with no pre-determined ideas only I had examined in a minor way the principle laid down to see how it might apply.

MR. WILSON: You wouldn't say at this time that it could not be applied - is that what you would like us to understand?

MR. MEEKER: No, I wouldn't say at this time it couldn't be applied.

MR. WILSON: We would like to know whether you are under the impression, in the light of your statement, that the middle Rio Grande district has a 100 percent water supply at this time, or in past years?

MR. MEEKER: No, I am not under the impression that they have been able to secure a 100 percent supply from the river from the canals that now constitute that area.

MR. WILSON: Then none of your remarks have been predicated on the theory that they have a 100 percent water supply.

MR. MEEKER: No, you have a lot of assumptions there.

MR. WILSON: Mr. Meeker, some of your figures which you gave upon the subject of waste were taken during the period of development and construction before the real completion of the Rio Grande Project weren't they?

MR. MEEKER: My figures embrace the years 1925-6-7 and 1928.

MR. WILSON: Were there not during those years unavoidable waste which resulted from adjustments in the project which could not be avoided during suchperiod?

MR. MEEKER: I know of none outside of those I took into account.

MR. WILSON: So that there would be no explanation from your viewpoint on the standpoint, at all, of the waste which you have described?

MR. MEEKER: That is obvious.

MR. WILSON: Mr. Chairman, so far as Mr. Meeker's statement is concerned, I think congratulation is due Colorado for the very clear way in which they have laid out the engineering problems and their ideas

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of the project. We, however, feel that there are some explanations of some of his statements which are proper engineering explanations, and we would like to have an opportunity to make those explanations, whether now or at some future time. We would like it understood we are prepared to make those statements. I dont want to interrupt the Colorado method of procedure at this time unless they xrsxrsxdx would rather have it done at this time.

COL. DONOVAN: Would you rather wait?

MR. WILSON: Have you anything further for Colorado?

MR. CARR: Not now. Mr. Meeker will probably offer more data tomorrow.

Recess taken.

MR. WILSON: I want to ask Mr. Meeker one more question. In arriving at your results on your depletion curve, I assume, Mr. Meeker, that you proceeded upon the same theory with a different application as the depletion curve as it was presented last night by Mr. Henny, am I correct?

MR. MEEKER: They are similar in some phases.

MR. WILSON: Similar in theory?

MR. MEEKER: Arrived at by the study of the inflow and outflow of the San Luis Valley.

MR. WILSON: Similar in theory and principle.

MR. MEEKER: Yours has some additional theory that mine hasn't.

MR. WILSON: But, in principle they are about the same.

MR. MEEKER: Yes.

MR. WILSON: That being true, would it not then be also a fact that our suggestion of last evening does apply a principle which might be a basis in arriving at a compact?

MR. MEEKER: It may be applied - it is possible it can be; it isn't absolutely a solution.

MR. WILSON: That's all, thank you. We want to expedite matters all we can and while we would prefer to have all the Colorado engineering facts in the record first, nevertheless, in view of Mr. Meeker's statement he isn't quite prepared to go this afternoon, we are prepared to present our viewpoint on the alleged wastage which he has so kindly given us this afternoon.

MR. CARR: Before you go into that, I would like to ask a few questions of Mr. Meeekr:

Q Have you any development of seepage or drainage waters on the project below the Elephant Butte dam?
A There are some 350 or 375 drain canals of the Rio Grande Project that can pay back to the river about 320,000 acre feet per year.
Q Is any ofthat wate recaptured and re-used?
A Portions of it are.

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Q Approximately how much?
A Not very much, but the surplus waters or waste waters coming out of the project.
Q Under the treaty with Mexico where is the United States bound to deliver the water which goes to that country?
A At El Paso, at the International Dam, at the Acequia Madre canal.
Q Of this seepage and drainage water which is developed on the project, how much reaches the river above El Paso?
A Practically two thirds, 200,000 acre feet.
Q Under the treaty, how much is the United States obliged to deliver to Mexico at that point?
A 60,000 acre feet per annum.
Q And from seepage and drainage water alone, without turning any water directly out of the Elephant Butte dam for that purpose, two thirds of the 320,000 acre feet of seepage and drainage water is now utilized to take care of the treaty obligations?
A That is correct.
Q What would be the effect of a re-use and recapture upon the upper river of the seepage and drainage water which is developed on the project?
A The use of that drain water will decrease the demand on the Elephant Butte Reservoir and build up a greater storage quantity.
Q And not only could the treaty obligations in Mexico be taken care of, but a large portion of the water necessary for the project itself could be furnished by a proper recapture of the drain water?
A That would be the proper use - under economic use.
Q What is the practice, if you know, in Colorado with respect to the re-use and recapture of seepage and drainage water?
A It is a common practice on all of the rivers in Colorado, especially on the South Platte River. I will cite that as a major example - from the seepage of 130 or 150 miles of the river some 200,000 acres of land are virtually supplied by the return waters which are stored during the winter time and then discharged for summer irrigation.
Q Is there any reason that you know of why a similar practice could not be practiced with respect to this water of the Rio Grande project?
A It will come in time, under pressure of need.

BY MR. WILSON:
Q That is the practice at the present time in the San Luis Valley?
A To use all the return water they can?
Q To file on drainage water and under your filing to appropriate it to beneficial use.
A They use it wherever they can.
Q Which results in a consumptive use of the drainage water, so to speak.
A That's it.
Q May I ask one more question - could you state in the record in the event the Vega-Sylvestre and the Conejos projects are built, whether they contemplate the storage of water for new acreage in addition to that now claimed to be irrigated?
A It would be for lands that have an inferior right, a deficient right.
Q You mean by that lands intermittently cultivated and irrigated because of a present deficiency?
A Yes sir.
Q In other words, they are to be used to complete now insufficient water rights?
A Yes sir.

MR. WILSON: Thank you. Resuming the situation that I endeavored to ex-

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press a few minutes ago in regard to the statement made by Mr. Meeker which should be explained and perhaps expounded a little bit by us, I would like to have Mr. Harwell, who is Manager of the portion of the Rio Grande project which lies in Texas, present some of the physical facts which surround the conditions bringing about what Mr. Meeker has termed - but which we do not admit - as wastage from that project, and following him I would like to have Mr. Henny make a statement also from his studies of the river. Mr. Harwell will be first.

MR. HARWELL: Mr. Chairman, Ladies and Gentlemen of the Conference: In view of Mr. Meeker's statements concerning the waste water at the lower end of the Rio Grande Project, I think it is very desirable that the Commission should have at this particular time a little bit more complete picture of the actual situation obtaining upon the Rio Grande project, and particularly upon the lower end of the Rio Grande project with reference to the status of construction work and its influence, perhaps, on the records which Mr. Meeker has introduced on waste water. The lower end of the Rio Grande Project, insofar as the handling of water is concerned, has not been completed during this period which Mr. Meeker cites in his records are waste. Above El Paso there are four major diversions, all built in a substantial manner by the Reclamation Service which control, with some exception, in a fairly desirable manner the diversion water for irrigation purposes. The distance between El Paso and the Elephant Butte Dam in a straight line approximates 120 miles - the distance in a straight line from El Paso to the lowest diversion within the Reclamation project proper is some 80 miles. Now, whereas these upper diversions have been put in fairly early in the history of the project and are operating fairly efficiently, the caring for the lower situation has waited, because prior to the inauguration of the program of the Reclamation Service, private community ditches had intakes on the river which permitted the irrigation of land and consequently did not require that these diversions should be put in in the first instance since the other improvement work was called for. So the process of completing diversions on the Rio Grande Project has been going on from the early history of the project and left these lower diversions in the non-efficient condition, until they could be reached with more effective work. I think anyone familiar with the Rio Grande project will bear me out in this statement, that this work of adequately diverting the waters of the Rio Grande below El Paso is not yet completed, but is in the process of being so completed. What influence has this lack of adequate diversion had on this so-called waste which Mr. Meeker mentions, and which he proposes to set up, so far as I can gather, for all time to come. That's the question which seems to me to be very appropriate to discuss at this moment. Below El Paso we have a heading at San Rosario on the Island, We have the Guadalupe and Hansen headings and a few years back, the Tornillo heading which have all served substantial areas. All of these headings were merely a projection of community, or rather were heads of community ditches which heretofore existed, and which were temporarily improved in the most effective manner possible, pending the time when they might be put in better condition by reason of construction work. At the Island heading, as well as the heading at Hansen and Guadalupe, it has always been necessary to run more water in the river than was required for our own diversions in order that the rixx water in the river channel might reach an elevation whereby the necessary quantities of water could be drawn by these ditches. That's a condition which has obtained throughout this period of

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record which Mr. Meeker has mentioned. The lands in the Rio Grande project have, in certain instances, been considerably ahead of the construction work; that is to say, settlers have located upon one area or another in instances served by these community ditches and old ditch headings, and we have given them, at the sacrifice of water, some sort of service to enable them to live and make crops during the interval that construction could more adequately take care of that. Now, to cite further what it has been necessary to do at these headings which I have just mentioned, namely those headings of old community ditches, during any low period of river flow such as might occur by reason of failure to adequately anticipate the needs of irrigation requirements, or other reasons, it has been the great problem to get water out of the river channel into these ditches; so much so that temporary wiers have been put across the river to the extent that would be permitted by the Mexican government, as a means of raising the water elevation and being able to get the water at the low flow of the river into these ditches. Now the Mexican government has never consented to anything permanent, or anything that could not be taken out in a hurry, and to be very frank these temporary wiers have been constructed by putting a cable across the stream fastening brush to it, and were not at all effective except that they contributed to a certain extent in getting the river flow into these canals. We had a further element of interference with respect to delivery of water down the river in that the Mexican people had a diversion canal, the San Rosario diversion and the diversions which I have mentioned, Guadalupe and Hansen, and since no one knew the quantities of their requirements of water, they very frequently, whenever the river would get down to a point where it was just about satisfying our own requirements, would make a heavy encroachment of water on the Mexican side, resulting in a shortage on the American side. To overcome that situation, over which we had no control, we would make a prompt release, but by the time the release became effective the Mexican demand might be satisfied, and in all events the surplus occasioned by such release was not needed. So these Mexican demands in the past have always been a source of great interference in the economic delivery of water to these various headings. Fortunately that situation is subject now to correction, or is reported to be, and likewise will this question of being required to run more water in the river than is required in order to raise the elevation to enable water to get in these canals will shortly be remedied by the process of constructing a riverside canal which is now in the course of construction, and which would be readily observed by anyone going over the project. It is sought to divert in an efficient manner all the water for the lower end of the project at the Island heading, namely a point approximately 12 miles in a straight line below El Paso. The first of the heading has been put in and the short stretch of the canal and diversion. The diversion was used last year for the first time and in using that diversion we find that it was easy to control a part of this difficulty which we heretofore had because of low water in the river, because we could divert water in the river through this new heading in a fairly efficient manner, so these fluctuations did not bother us much. Now, the extension of the riverside canal is in progress; it will be built from the heading to a point opposite the San Rosario Island in order to control all of the water of the RioGrande useful for irrigation purposes at this heading and avoid any and all possible Mexican encroachment by that means. Now, when the riverside canal functions, which it is now in part, it will not be necessary to raise the elevation of the water in order to supply these lower heads, consequently there will be no necessity of

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wasting water in order to get water to the property owners who heretofore have been served by these inefficient heads. I dont think for one moment anyone would claim, in view of the expenditures on the Rio Grande Proeject and the progress made, that there has not been diligence in carrying out those plans as promptly and as quickly as possible. Surely all agencies have lent themselves to that purpose and there has been no undue delay in that particular. If we are remedying these conditions, how can it be said that these so-called wastes, which have occurred in the past by reason of the incompleteness of the project, how can it be told that these wastes will continue? The project itself cannot afford to waste swaters in the manner it has in the past, and has no intention of doing so because its requirements will not permit that, because its land is increasing and this water must be utilized unless there is to be a general shortage upon the project as a whole. I have spoken briefly about the Mexican influence upon the project water supply by the unauthorized diversions. The future influence will be negligible, excepting at the heading of the Acequia Madre at El Paso. The points below, mentioned by Mr. Meeker, as outlaw canals, will only be able to draw on the flood waters or on the unavoidable waste, which is a means of conserving to the fullest possible extent all waters originating either at Elephant Butte or on the project. We have connected recently - within the last two months - the drainage system upon the Island with the drainagesystem of Tornillo so the drainage water may flow through the drainage canals of the Tornillo system and be available for future use. Now going a step further, I think it is very clear that the construction of the riverside canal will eliminate the Mexican problem of encroachment upon the water supply very effectively, excepting for their area tributary to the Acequia Madre, and the diversion for the Acequia Madre has been responsible to a certain extent for this question of waste again. The Mexican demand, aside from those lower diversions, has, of course, been an unknown quantity to the operators of the project, and a heavy encorachment by the Mexicans at the head of the Acequia Madre will create a shortagxe temporarily in the river, and likewise a sudden release on their part will create a surplus. Just a word or two about the Hudspeth County Irrigation District. By contractual relations, the Hudspeth District is entitled to no more water than the surplus waters which may exist at the Tornillo canal. If I remember correctly, I am reciting the language of the contract. That may be interpreted in another manner and merely say that the Hudspeth District was entitled to receive no more water from the project than this unavoidable waste which is bound to occur through this 150 miles of operation between the dam and the point of lowest delivery. When I speak of 150 miles, I mean a straight line, because the other line is much longer. If that be an unavoidable waste, and it is that which the Hudspeth District is to utilize, it will be further supplemented by their own pumping operations for drainage; They are putting to use water which would otherwise be put to use in the streambed by them or anyone else interested. It is desirable under those circumstances, since no one else could benefit by the use of such water, that the people on the American side should benefit by such use, and we have contributed our effort to that end. We have all the water turned loose down the stream bed subject to use by Mexico and Americans, and it seemed more reasonable to contract for its sale and let it benefit lands in the United States. To sum up the situation of this picture, the figures which have been presented on waste are those figures - which not admitting the correctness of the same - have been gathered during the period of construction and re-adjustment and during the time that every effort has been made to put the system

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into a more efficient condition. I think that statement can go unchallenged. If you get a picture of incomplete ditches, inefficient headings, trying to raise the elevation of the river - then if you take the riverside canal at an expenditure of $350,000 which will shortly be in operation; you get the furtherpicture of the Hudspeth District being in the future limited to the use of these waters which can be called legitimately unavoidable waste, I think you get an actual view of the situation which is perhaps somewhat different from the figures which Mr. Meeker presents as a situation which is calculated to obtain on the Rio Grande in the futurem where, as a matter of fact, all re-adjustments necessary to those corrections have virtually been made, and will be completed within the very near future, less than a year's time.

MR. WILSON: I would like to ask one question - if I correctly interpret your statement, you are explaining the waste on the ground of present and past inefficient works, whose inefficiency prevents complete service to the land which lies within the project.

MR. HARWELL: Yes, that's true.

MR. WILSON: May I ask you that in the event the efficienty is increased by the measures which you have described, will this waste all then be employed to the irrigation of land within the project now inefficiently irrigated?

MR. HARWELL: Yes, we will make every effort to that end and use only those waters which will flow down the Rio Grande below theproject which are gained by factors without the control of the operating board of the project.

MR. CARR: You heard Mr. Meeker state that his testimony was not offered for the purpose of criticizing you people because of the waste but merely for the purpose of drawing attention to a fact?

MR. HARWELL: I dont know whether I got that entirely, but if you say he said that - -

MR. CARR: If I say on his behalf that is his position, you will accept it as such?

MR. HARWELL: If that is true. However, I assumed from your presentation that you were setting up a waste which existed on the lower end of the Rio Grande project which you seek to put to beneficial use somewhere else, and I am telling you in the future there will be no such waste.

MR.CARR: You are telling me there will be no such waste, but in making that statement, you are admitting that there is at the present time and that there has been that waste?

MR. HARWELL: Not exactly that. I dont confirm his figures but I say there has been a waste - we recognized that all the time and regret it very much.

MR. CARR: How long ago was this project commenced.

MR. HARWELL: You mean commenced work on the project?

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MR. CARR: Yes.

MR. HARWELL: 1910, I think.

MR. CARR: Then the figures which Mr. Meeker presented commenced with the year 1925, didn't they?

MR. HARWELL: I think so.

MR. CARR: About 18 years after the work was commenced?

MR. HARWELL: Yes.

MR. CARR: It is your plan, as you outlined your answer to Mr. Wilson, to extend the acreage, or at least to extend the efficient consumption of water to the point that the water which you say now is wasted will still be permitted to flow from the reservoir.

MR. HARWELL: For use on land, yes, but pardon me, I didn't say extend the project because as you are probably aware the project has never been fully under irrigation. You have to at least irrigate all the land within the project before being subject to extension.

MR. CARR: Then the water which you admit has been waste ofer this period of years you propose to put to beneficial use on the project.

MR. HARWELL: We are required to do so, in order to have water for these lands which fall properly within the project and which are anticipated to be irrigated by the project.

MR. WILSON: And will ultimately, if not now, bear the cost of the project.

MR. HARWELL: All ~~xk~~ within the 155,000 acres, if that answers your question

MR. CARR: 155,000 acres - that figures covers just what?

MR. HARWELL: The lands, the irrigabel area and the anticipated irrigable area of the project proper.

BY MR. CARR:

Q How much has been irrigated?
A The maximum at any one time, 147,000 acres.
Q 147,000 have been irrigated?
A That's been the maximum area irrigated in any one year.
Q What year was that?
A I imagine close to that approximately this past year.
Q 1927 do you mean, or 1928?
A 1928.
Q These 147,000 acres were irrigated in 1928 out of a total of 155,000?
A Out of the gross total, a great deal more than that.
Q I understood you to say you had a total area of 155,000 acres.
A You are discussing a complicated subject. The gross area of our particular district, excluding the roads and rights of way, is something like 75,000 acres. That's gross area. We hope to reach an irrigable area of 67,000 acres out of that total and we have an irrigable area at the present time of something like 63,500, so you can see under the reclamation system, naturally those areas that can be benefitted are classed as irrigable. The areas that

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are not irrigated are classed as dorman, so when you are discussing irrigable area you are talking about something variable. The quantity depends on the effectiveness of the work.

Q Then what will be your answer to my question as to the total irrigable area in the project?

A The anticipated area - bear in mind all the work is not yet completed - the total anticipated area is 155,000 acres.

Q Now, we can start with that; then during the last year you had 147,000 of that total under irrigation.

A Not 147,000 of that total. We have 147,000 acres under irrigation which includes some suspended lands that are not included in this irrigable area. Not all of that 147,000 of the 155,000 acres was irrigated.

Q How much?

A It would be sheer guess on my part - I wouldn't attempt to say.

Q What is the suspended area which you mention?

A The difference between the gross area and the irrigable area.

Q Have you a copy of the contract which you mentioned there, which you said would be made between the district and theproject?

A If I didn't quote the contract correctly I failed to do so by lack of memory - I have read it.

Q I am not questioning your veracity as to that - I am asking have you a copy of it?

A No, I haven't.

Q Could you furnish us with a copy?

A I dont know at this particular time.

Q Within the near future?

BY MR. WILSON: We will furnish a copy and make it a part of the record.

By Mr. CARR:

Q We would like to have it. As I understand you, the plan is through the medium of this riverside canal or ditch, and other methods you spoke of, to keep the Mexican government from making these demands upon the river.

A At points below the heading of the riverside canal, yes sir.

Q By whom were those demands made.

A What demands?

Q Those Mexican demands to which youhave referred.

A ~~Demand~~ Demands nothing - they are simply taking the water.

Q By whom was this water taken?

A By the citizens of the Republic of Mexico.

Q This is water in addition to the water which is delivered at the Acequia Madre under the treaty?

A This is water which they take without reference to any treatyor anything else.

Q It is in addition to the water which we are bound to deliver under the treaty?

A I wouldn't answer that; I couldn't answer that yes or no, because I dont know to what extent they have diverted above. I imagine it would be in excess of the treaty requirements.

Q Has any effort ever been made by you people to see that the treaty was enfroced so that no additional water would be taken by the people of Mexico?

A Strenuous efforts.

BY MR. WILSON: I hardly think that's fair to ask this man a question of that kind. I will be glad to answer them.

BY MR. CARR: I will be glad to withdraw the question if you will show me where I am - -

BY MR. HARWELL: I can answer that. The most vigorous possible protest has been made in the first instance, and repeatedly for that matter,

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getting no results, and in the second place by putting the matter before the House Irrigation Committee and securing $350,000 to build works which would obviate a fair part of that encroachment.

BY MR. CARR:

Q Then it was your idea they were taking water in addition to the treaty obligations?

A Always said so, yes.

Q You have stated it is necessary to turn out this waste water from the Elephant Butte to meet the needs of the country below because of the lack of efficient construction.

A Yes sir.

Q Is that theonly reason?

A For turning out excess water?

Q Yes.

A Absolutely yes - you are confining your question to the period Mr. Meeker mentioned?

Q I am going back of that time. That of course was to take care of the necessary waste, plus this necessity for additional water in order to raise the river to the height of your headgates on the Guadalupe and Hansen.

A That's the chief requirement. We have had several near riots on the occasion of shortages and we have concentrated all efforts to get water to these people.

Q As a matter of information, we have heard rumors that water has been turned out of the Elephant Butte because of difficulties with people around San Marcial.

A You have heard rumors, you say?

Q There is no connection between those rumors and the truth?

A Not so far as I know; I have never even heard the rumors.

Q We have heard them, and I am asking for information. You do have difficulty with people around San Marcial from the flow of the river, dont you?

A No, the people around San Marcial have complained of the elevation of the reservoir at one time and did seek to settle some claims in that respect, but that never had any bearing on the flow of the river.

Q It has not been necessary to lower the water table in order to provide against fugure claims on their part?

A You mean to lower the lake in order to avoid claims?

Q Yes.

A No sir.

Q Isn't it true that Secretary Work ordered the headgates to be opened so that that condition might not obtain?

A If he did so, he transmitted his order in such a highly confidential manner I never heard of it.

Q You would have known of it had he not done it in strict confidence?

No answer

Q That's obvious.

MR. WILSON: It hink that probably Mr. Henny will fill in a good many things which you are undertaking to bring out. You may recall him if you like.

MR. HENNY: Mr. Chairman and Gentlemen: I understand that I am to say what little I know about the conditions which have contributed to what Mr. Meeker, I think originally calls excessive waste were the project fully completed. Mr. Harwell has very ably explained the inadequacy of the system below El Paso as it exists today. I would like to follow him broadly, but before doing so, I would like to point out

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one other fact which may have contributed to the waste which is in process of correction, but which is in New Mexico and does not fall within the immediate observation of Mr. Harwell who is General Manager of the El Paso County District. I refer to the present condition at the Leesburg dam, one of the diversions in New Mexico, constructed by the government. That diversion has been in some difficulty. It was probably owing to the fact that after the Elephan Butte Reservoir was constructed, the water released from the Elephant Butte was perfectly clear water - blue water ; previously the river system had adjusted itself to muddy water. Now it was suddenly called upon below the Elephant Butte outlet to carry blue water. The effect, as every hydrographic engineer knows, that clear water has a greater reducive power than dirty water. When water is surcharged with dirt it cannot pick up any more and it immediately deposits the excess lower down. The effect of running clear water was anticipated but it is very difficult to appreciate just what it will be. It did what we expected but it did it rather rapidly; it began to erode the river down below; began to pile up sand some distance from the Elephant Butte; that sand has been progressing down stream until it reached the Leesburg heading, carrying large quantities of sand into the canal and made proper diversion ~~xixff~~ difficult. Now, whenever you have a heading which is not acting properly you will find that it is impossible to release water from the reservoir in such a way as to insure the possibility of diversion without, at times, being compelled to let out excessive amounts of water. This condition is being amended. The canals are again being lowered, the dam, as I understand, is being raised and when this work is accomplished that source of lack of control will have been eliminated. As we come down to the International Dam we have this condition: On theone side the Reclamation Service takes out the Franklin Canal, which is a big canal serving the lands below El Paso, and on theother side, the Mexicans take out the Zanca Madre (sic). In order to supply the Franklin Canal with the large amount of water it needs, we have to release that from the reservoir and the total intended to be used at the International dam for the joint use of the Franklin and the Zanca Madre can be supplied with a reasonable degree of regulation, with a minimum of loss, if you have control over both canals. But, if the Mexicans at one time take, as they have done, larger quantities through their Zanca Madre canal than they are entitled to, than for the season they stated they would, then the Franklin canal would necessarily be short. That is a thing that cannot be controlled and therefore the unknown fluctuations of the diversion on the Mexican side causes trouble on the American side and again necessitates releases from the Elphant Butte reservoir in excess of what would otherwise be necessary. It has early been known by the Reclamation Service that there is only one way to cure this condition in case the State Department is unable to protect the rights of the Americans and enforce its treaty rights; that one way is to extend the Franklin Canal upward until it gets a heading on both sides of the river within American territory. It would become then a canal similar to what we have heard so much about in connection with the Imperial Valley, an All-American Canal. At that point it may be possible to divert all the water needed for the lands below El Paso. It should not only divert what is attempted to be diverted now at Franklin Canal but also the water which is now being diverted from the new Riverside canal mentioned by Mr. Harwell to the present Hansen and Guadalupe headings. This important work which would make the district independent of Mexican encorachment is not contemplated by the Reclamation Service. It is by reason of its enormous cost. That Franklin Canal

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passes through the City of El Paso; it would require additional right of way of great value; it would call for canal extension upward ina place where property is valuable and enlargement of the canal all the way down, a re-arrangement of the canal system to permit diversions now contemplated at the Island heading on the riverside canal to be made instead of at the head of the Franklin Canal. So long as this condition persists there will be unavoidable waste merely due to the fact that the State Department does not protect the American rights. The uncertainty of demands - or, I should say not demands, but the uncertainty of the amount which Mexico takes whether it has a right to them or not. The waste in the past through conditions below the International dam have been serious by reasons explained by Mr. Harwell; the necessity of maintaining three imperfect headings which always means a serious waste. That condition is being amended now. There are a number of other causes which are productive of waste which are more or less beyond the control of any human agency. It is well known if there is a heavy summer rain in the valley, the headgates are being closed temporarily, or at least lowered, while the water released some days previous from the Elephant Butte Reservoir is on its way down. The amount not needed on account of this rain cannot be put back in the reservoir and it makes its appearance days later at the end of the project. It is unavoidable waste. There are a number of other unavoidable wastes which I think have been given fair consider tion by Mr. Meeker; such as sand washing from canals; such as drainage from the Mesilla Valley during the winter season whenit cannot be used in El Paso; such as practically all drainage from the El Paso Valley insofar as it may not be used or picked up by the Hudspeth district. The result of this past waste has been that the Elephant Butte Reservoir at the present time does not hold water which it might reasonably have expected under a perfect condition of control. Now that condition of the contents of the Elephant Butte Reservoir is to the farmers below it a most serious consideration. Mr. Meeker has stated that a full reservoir will carry the project through for three years without any inflow from above. My figures do not confirm that statement. My figures show that during the period beginning with 1898 and ending with 1903, during the first three years, inspite of the inflow, assuming that the project below makes its irrigation demands, it will be found not merely empty but will have already a far insufficient amount for 100 percent supply. The shortages that must be suffered by the district were a condition to repeat itself as occurred at that time, would result in an enormous and almost intolerable shortage. To get that shortage down further by accepting the risk of entering upon such a period which may begin this year for all we know, with A RESERVOIR THAT IS NOT FULL; WHEN THE SHORTAGE WILL result even upon the supposition that the reservoir is full, is a serious matter for the irrigators and something they would do their best to avoid. Of course, it has been stated it is not the district directors themselves, or the managers, who release the water at the reservoir - it is the government itself, and so far as explaining past waste is concerned, I have tried to find the point of view of the engineers of the Reclamation Service, but, of course, the best explanation can only be furnished by the men who did it, and it had been my hopes that the Reclamation Service would have a representative here. The Reclamation Service is very seriously interested with its twelve million dollar investment, the return of which is entirely dependent upon the maintenance of the rights of the Elephant Butte dam and the proper operation of the Elephant Butte Reservoir. However, in the

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absence of any representative of the Reclamation Service, which by the way I personally requested of Dr. Mead only a month ago, we have been compelled to do the best we could to try to find what the cause of this waste may have been. If any representative of the Service familiar with the operation of the work were here he could undoubtedly materially supplement the statements Mr. Harwell has made.

GOVERNOR CORLETT: Who did you say that was?

MR. HENNY: Dr. Mead - they could undboutedly supplement the statements made by Mr. Harwell. The studies as to the deficiency of a supply for the projedt based on the Elephant Butte Reservoir have been made, so far as they were made, by me in a report which I made to the Districts in 1924, which I ref rred to last night and have with me here, and the reports made by the Reclamation Service itself, so far as I know, have all been based upon the elimination of this avoidable waste. Now on thatbasis it is found that during the dry cycle very serious shortages must be encountered. Mr. Meeker has stated that there was a short period of rather low years which extended, as I understand him, from the year 1890 to theyear, and inclusive of, 1903; hence a period of about 14 years. This then was a period of 14 years out of a total period of about 38 years up to date. It is during a period of 14 years then, let us say, in a cycle of 38, that the entire supply of the Elephant Butte is likely to be necessary, but that the supply to the Elephant Butte prior to such a period, must be hastened so it may be met at the beginning with a full reservoir, and it is quite apparent that any encroachment upon the rights to the Elephant Butte,whatever they may be, will simply contribute to make the shortages which must be encountered more distressing. It is, as I understand, for that reason that these districts employed me in the first place in assistance to find out what the situation is and in assisting in defining what their lawyers will argue are their legal rights. I think, Mr. Wilson, that is all I have to say.

MR. WILSON: Mr. Henny, would you state for the record your past experience in connection with irrigation projects and reclamation works, giving us thehigh points, please?

MR. HENNY: The only high point is that I have been engaged in practically exclusively irrigation work since 1905; that for 4 years I was supervising engineer for the Reclamation Service for the Pacific Division, and had there under my charge theconstruction of seven large projects which have since been completed. That since 1909, at the end of this 4 year period, I have been practicing my profession as consulting engineer and have spent a large proportion of my time as consulting engineer for the Reclamation Service. I have also, during the balance of the time, been connected with a large number of private or district irrigation enterprises, and am now.

MR. WILSON: Would you state some of the larger of such projects?

MR. HENNY: I have already referred to the fact that I am consulting engineer for the middle Rio Grande Project, which is a large project. I have been called upon by the States of Oregon and Washington to report upon irrigation projects in those two states. I have been consulting engineer for the Los Angeles Flood Control, which is partially tied up with irrigation in that it attempts to serve the purposes of conservation of water for irrigation as well as the distinct matter of flood control. I have been called to Porto Rico

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By that government, and to Cuba by the Cuban government to report on irrigation enterprises in those countries. I have been called to Mexico on a similar mission for the New York Bankers. I would have to carefully re-adjust my memory to include all of the list.

MR. WILSON: I think that's sufficient. In view of that experience, and based upon that experience, can you state whether or not in your opinion, the Rio Grande Project has been constructed, and measures employed, for the efficiency of the same with as much diligence as such a project could?

MR. HENNY: Broadly speaking, I would say Yes, Mr. Wilson. From very early after irrigation started, the necessity for drainage on a large scale was apparent. It had been realized vaguely but it had not been realized how early it would be necessary to spend money on that feature, and how much money might be involved. If there had been less need for expenditures for drainage, there might have been more money available for such work as is being carried out at this time, such as canal headings referred to. I myself have been connected with it as a consulting engineer on both phases of the construction, the dam itself and drainage to the river headings.

MR. WILSON: Your conclusion is, on the experience that you have had, your connection with these other projects, that all diligence possible has been employed in the fulfillment of the purposes of theproject, the irrigation of 155,000 acres and the furnishing to Mexico of its treaty water.

MR. HENNY: That would be my judgment. There is just one feature that I may touch upon. The project has been considered as of a scope in area by the Reclamation Service of 155,000 acres. As I understand, the exact limits are not definitely and finally defined, and I will say this: that the question came up whether, for instance, the Hudspeth project should be taken in, whether pumping should be permitted from the canals to higher lands so as to add to these areas. These questions have been put up to me by the directors of these two districts. My report in these cases has been universally that the project supply, during any dry cycle, is so precarious, and during a period of full river we could reasonably add many thousands of acres, it would so jeopardize the rights and privileges of the Elephant Butte Reservoir and of the people owning this 155,000 acres, that it did not seem to me advisable but it is a thing upon which the directors have their final say.

MR. WILSON: Mr. Henny, in connection with this alleged wastage to which Mr. Meeker has directed our attention, would you say from your experience and knowledge of the project that that wastage could be, if it exists, depended upon at any future time to be utilized in the sense Mr. Meeker has suggested it might be in the supper basin in Colorado?

MR. HENNY: No, that was rather a surprising statement to me, because, assuming the use of this project I find serious shortages would result at the present time - the reservoir may hold a million acre feet, but it should hold a great deal more, as Mr. Meeker says, for the safety of the project itself. If this waste can be stopped it should be for the purpose in the first place of building up the reservoir to give some satisfactory assurance that the large amount of money spent upon such a large reservoir may be of benefit, and a proper

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measure of benefit during the dry cycles that are certain to come.

MR. CARR: As I understood you to say, a surplus is permitted to flow out of the Elephant Butte for the purpose of taking care of the possibility that the Mexican people will take more water out of the Acequia Madre than they should, and in that way they threaten the supply to the Franklin Canal.

MR. HENNY: The direct object is not to furnish the Acequia Madre with more water; the direct object is to furnish the Franklin with sufficient water.

MR. CARR: Yes, you take care of the slack caused by the over appropriation used by the Mexican people and send down an additional amount so that the Franklin will be sure to have its supply.

MR. HENNY: To make up for our impossibility of control of the Acequia Madre Canal.

MR. CARR: You say that the only manner in which that problem may be solved would be an extension of the Franklin Canal so that it might be supplied without danger of being threatened by the Mexican diversions.

MR. HENNY: I didn't say the only solution; I said, the State Department might do something, but I said that might be only the physical solution in case the State Department would be unable to protect the rights of Americans.

MR. CARR: Isn't it true at the present time this question of over-appropriation at the Acequia Madre is under consideration of the Treaty Commission?

MR. HENNY: They are in conflict with it.

MR. CARR: Isn't there a Treaty Commission that is considering these matters at the present time?

MR. HENNY: There is, and we certainly hope they get a solution which will make unnecessary the expenditure of millions of dollars.

MR. CARR: And to make unnecessary, of course, the release of this quantity of water which is permitted to run down there to take care of their possible encroachment.

MR. HENNY: Yes.

MR. WILSON: I dont suppose you mean that exactly. Some of this water is not wasted; some of it is inflow between the dam and Fort Quitman.

MR. CARR: I am talking about the water Mr. Henny described was permitted to go from the Elephant Butte to take care of this situation. My question goes purely to the water taken directly from the reservoir to meet this need.

MR. WILSON: That's understood, yes.

MR. CARR: Now, you said that you were surprised at a statement of Mr. Meeker's regarding the waste water which is permitted to leave the

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Elephant Butte headgate being possibleof use above. Just why were you surprised at that statement - in what manner is it surprising?

MR. HENNY: It is surprising in this respect; that this water is absolutely necessary for the proper irrigation, so far as it is possible under the circumstances, of the two districts. We are operating under an appropriation for the Elephant Butte Dam by the government which claims this water.

MR. CARR: Well, assuming, as Mr. Meeker did, and as you admit, I take it that this water is now wasted; is it not true if it were not wasted at the present time that it would be available up the river for use.

MR. HENNY: No, because it should have stayed in the Elephant Butte dam to hold up the reservoir where it belongs, and the reservoir now, as Mr. Meeker stated, is capable of holding twice that and we may be confronted with a low cycle.

MR. CARR: Then there isn't any possibility that the saving of this waste and the retention of it in the reservoir would work to the benefit of the people up stream under any condition?

MR. HENNY: It would operate distinctly to the disadvantage of the Elephant Butte people, and they are more anxious to recover it than anybody could be, so it could not be used, fairly at least, as I understand rights, anywhere else.

MR. CARR: You heard Mr. Meeker's figures; dont you agree as to there being an average - I believe he made the statement that during the last year about 327,000 acre feet.

MR. HENNY: I heard the figures Mr. Meeker stated; I dont know about the correctness of them.

MR. CARR: You spoke of this avoidable waste. How much of that waste would you say is avoidable?

MR. HENNY: In the first place I dont know that there was that much waste, but assuming there was, then I would say the difference between that gross amount and the amount of waste unavoidable; whatever that may be.

MR. CARR: Do I understand you to say there is no waste? You said assuming there is that waste - do I understand you to mean there is no waste?

MR. HENNY: I meant assuming that figure to be correct.

MR. CARR: Now, mentioning this waste at the Acequia Madre, would it be picked up by the Mesilla diversion?

MR. HENNY: It would be held back of the Elephant Butte dam.

MR. CARR: What is the capacity of the Acequia Madre?

MR. HENNY: I couldn't answer that question definitely. You understand, of course that the 60,000 acre feet to which the Acequia Madre is entitled, which, by the way, under the treaty, should come from the Elephant Butte dam, and not from drainage, is divertible at different rates according to their own desire, so that an average flow during the irrigation season which would total 60,000 acre feet

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would give us the size of the ditch, which is far smaller than it is. Possibly some one else can answer that.

MR. CARR: You say this 60,000 acre feet should come from the Elephant Butte rather than from drainage?

MR. HENNY: Yes.

MR. CARR: Why doyou say that?

MR. HENNY: Because it is only true.

MR. CARR: Then, regardless, I assume of the amount of seepage water and drainage water which might be re-used and recaptured on the river it would be necessary to turn out, in addition to that, so that it might come from the Elephant Butte dam, in order to meet our treaty obligation, 60,000 acre feet.

MR. HENNY: The actual fact isentirely different because at the same point where the Acequia Madre diverts there is a far larger government canal which diverts at the same time. The water of the Elephant Butte and the water of the drains above the international dam must of necessity mingle, and there is consequently a mixed water whichboth the Franklin and the Acequia Madre must take. The total amount of drainage water in comparison with Elephant Butte water is, I think, small enough so that there is injury to Mexico to receive that in lieu of water from the Elephant Butte reservoir, pure and simple, which it would be impossible to deliver, but if the question came up to supply the water required under the Mexican treaty solely, then I concede that the Mexicans would have a valid reason for complaint.

MR. CARR: You are assuming, of course, there is some water in the stream in addition to this drainage water?

MR. HENNY: That assumption is correct, for most of the time but during a dry cycle it might well happen, and according to our records it would happen, that there is no more water in the Elephant Butte Reservoir right in the midst of an irrigation season. Not all the water that goes into the International dam is drainage water.

MR. CARR: What is the yearly project demand from the Elephant Butte dam?

MR. HENNY: I would prefer, Mr. Carr, that another witness can handle that better. I have studies here which would answer that question but they are of date 1924. These studies have now been brought up to date and that can be answered bysome one lse.

MR. WILSON: May I suggest that on questions of that character, I would like to present Mr. Hosea.

MR. CARR: I will not press the question. I might possibly be permitted to state that a report by Mr. Hosea has had my study for the last few months. That I agree with its general conclusions but that I am not as familiar/with it as the man who wrote it and he is available.
and cannot be as familiar

MR. WILSON: That completes our presentation on the question of waste at the Rio Grande project.

COL. DONOVAN: Yes. So the situation is that at the moment you are not prepared to go onwith Mr. Meeker. Mr. Wilson said they would make some explanation of the wastage and he says they have completed that.

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MR. CARR: I think as was suggested by the last witness that Mr. Hosea has some matters to be presented. We might take that up at this time or when we resume tomorrow.

MR. WILSON: Have you any questions you would like to ask of the character you asked Mr. Henny; if so, I will present Mr. Hosea, but if you have no such questions - -

MR. CARR: I will not pursue that at this time.

MR. WILSON: We have given you the study that we have made of the whole situation and that will disclose the figures which you have asked for unless you want them again. We may desire to place in the record some portion of this report, but at this time I dont think it is necessary. So, if you want to proceed - -

MR. CARR: I dont know that it is incumbent upon us to proceed, but surely you have something more to present.

MR. WILSON: Nothing except excerpts from the report of which you have a copy. I understood you were going to present some more figures through Mr. Meeker.

MR. CARR: Mr. Meeker has some further studies he wants to make tonight, but it is entirely possible that Mr. Meeker has completed. I think, however, he will want to put on some more stuff.

MR. WILSON: The ~~xxxxxxxxxx~~ purpose of our trying to get at this point and the suggestion we made last night is to clear up all matters which might precede it as far as Colorado is concerned and then ask you if you would not give us reasons why you could join with us in that principle or why you could not. We are very glad to have anything Mr. Meeker can offer, but at this time we would like to urge some definite principle upon which we can work with the idea of a Compact. Either our own idea or some other idea which Mr. Meeker intimated he might present.

MR. CARR: Might I not say frankly, as I have tried to do several times, we do not think you have made any proposal which we can understand.

MR. WILSON: Mr. Meeker stated he thought the principle was possible; we would like it considered.

MR. CARR: As a fact, but even if it might furnish one of the phases as Mr. Meeker said he was not prepared to answer; he said it might be; that is not, as I understand it, binding upon the Commission as yet and we dont think frankly that you have presented any proposal.

MR. WILSON: Of course, Mr. Carr, until you show us why we have not presented any proposal, we cannot go any further.

COL. DONOVAN: May I suggest something. As I recall everything that has gone on today, it comes to this: Judge Wilson pressed the question as to whether or not you would accept the principle that he said he laid down last night. Now Colorado said it was not prepared to do anything in regard to that; that Colorado wanted to develop the processes of fact before arriving at any conclusion. That was my understanding, and that one of the elements in that process was the statement by Mr. Meeker. Am I correct as to the net result of today?

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MR. WILSON: I think so.

COL. DONOVAN: Colorado may have something further to present. I think that we are getting at a time when we are apt to get to wrangling, so I think it is a good time to adjourn.

MR. CARR: I move we adjourn until 10 o'clock tomorrow, which motion was duly seconded and carried.

At 10:30 A. M. December 21, 1928, the meeting was called to order by the Chairman.

COL. DONOVAN: Gentlemen, on behalf of the Commission, I should like to submit something to this conference, and this statement is made without any obligation on the part of any state concerned, and it is submitted only as a basis of discussion. This is what is submitted by the Commission:

> Without a commitment of either party to the discussion, the following proposals are suggested for discussion at the next meeting of the Commission at which time they will be explored and discussed freely as possible bases for an Interstate Compact:
>
> 1. The proposal of Engineer D. C. Henny which, it is requested, shall be put in concrete form in writing in order that it may be correctly understood by all parties;
>
> 2. Specific amounts of water to be annually delivered by Colorado at the Colorado-New Mexico line;
>
> 3. Agreement by Colorado to refrain from impounding water of the Rio Grande and its tributaries in any reservoir hereafter constructed in Colorado in years when the annual runoff shall fall below a given percentage of the average annual runoff, except that Colorado shall have the right to impound in such reservoirs an amount equivalent to the avoidable waste from the lower end of the Rio Grande Project as now constituted; *
>
> 4. Colorado to agree that she will not store in all reservoirs hereafter constructed in that state in any year water in excess of the ascertainable aggregate quantity of seepage, drain and return waters (including all ~~xxx~~ water from the sump drains) delivered at the interstate line plus an amount equivalent to the avoidable waste at the lower end of the Rio Grande Project as now constituted; * of
>
> 5. Each of the states of Colorado and New Mexico to be entitled to divert and to consume in any year a fixed percentage of the water originating and flowing in that state during that year.
>
> (* In propositions numbered 3 and 4 Colorado agrees to release any water improperly stored on or before the first day of September in the year such storage occurs, and waives objection to further construction of new Reservoirs by New Mexico above the Elephant Butte Reservoir

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which would tend to interfere with the water supply which otherwise would flow into the Elephant Butte Reservoir.)

In any case Texas and New Mexico to lend their good offices and support to appropriate measures by the Congress of the United States for the construction of the Sump Drain in Colorado.

GOVERNOR CORLETT: There is one suggestion it seems to me, as long as this is coming from the chairs, those places where it says "Colorado agrees" it should read "Colorado to agree" in order that a false impression may not go out to the people generally that this is a proposition of agreement in case they should meet it partially.

COL. DONOVAN: I think that's a good suggestion and unless there is objection that will be adopted.

MR. WILSON: In view of the suggestion made in the first numbered paragraph, I would like to have a few minutes to discuss the matter with my engineering staff and associates from Texas.

COL. DONOVAN: Is there anything further that we could do; that we could submit?

MR. CARR: As suggested yesterday, Mr. Meeker has made further study and has some matters to present.

(As the New Mexico and Texas delegations are about to leave for conference,)

COL. DONOVAN: Couldn't you leave some of your group here to listen to Mr. Meeker?

MR. WILSON: Yes, I will leave Mr. Harwell and three engineers who will take notes on Mr. Meeker's statement, and Mr. Harwell may want to ask some questions in my absence.

MR. MEEKER: Mr. Chairman and Members of the Commission: Yesterday I gave some observations on daily waste at the lower end of the Rio Grande Project, and Commissioner Wilson asked for the quantity of water being discharged from the Elephant Butte Reservoir either seven days prior to that or ten days, due to lag, in the flow of the river - it takes from 7 to 10 days for the water to reach the end of theproject. These dates, the first one is April 15. I find I dont have the second fee discharge of the reservoir for the two days that would fit in with April 15, so I shall go to May 5, on which date - -

MR. HARWELL (interrupting) What year?

MR. MEEKER: 1928. On May 5, I stated that the waste at the end of the project was 1225 second feet. Now if we go back 10 days to the reservoir on April 25, the discharge as measured by Colorado with an automatic guage, was 2173 second feet. That allows for 10 days lag; if we only allow a 7 day lag, taking April 28th, the discharge was 2055 second feet at the Elephant Butte Reservoir. Then going to the next reported discharge, namely, August 24, --

MR. HARWELL: (interrupting) May I interrupt just a moment. In this first

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instant, do the records show any case of runoff, arroyo flow, rainfall or anything of that sort?

MR. MEEKER: I haven't looked that up as yet.

MR. HARWELL: You dont know whether there was any runoff at that particular time?

MR. MEEKER: I can determine that later.

MR. CARR: That wasn't asked for or we would have tried to have it.

MR. MEEKER: I tried to avoid taking periods where there was an arroyo flow. On August 24, I reported a waste of ~~45~~ 1206 second feet; going back 10 days or August 14, the discharge at the Elephant Butte Reservoir as taken from the Colorado records was 1832 second feet, and taking the date of Autust 17, a 7 day lag, thed ischarge was 1426 second feet. That supplies the information requested. Now, we will go up to the Colorado area for a while and discuss storage in the San Luis Valley. The present developed storage capacity of the San Luis Valley is approximately 300,000 acre feet, but I wish to point out that that 300,000 adre feet is not stored every year, or any year, because some of these reservoirs are located to one side of the main channel and are fed by feeder canals;for example, the Santa Rita Reservoir is x fed by a feeder canal. That's a reservoir of 35,000 acre feet.

MR. MECHEM: What did you state was the present capacity?

MR. MEEKER: The total present capacity is 300,000 acre feet. Going to the largest reservoir, the Sanchez, is on a tributary of the Culebra; that is largely supplied by a feeder canal from the Culebra, so that when these reservoirs are all summed up on total capacity and then the average yearly storage is summed up over a period of years, the actual amount that is delivered from these reservoirs is 160,000 acre feet per annum, or just about 50 percent - it checks out 53%, but the round figure is close enough. That's a pertinent point in reference to the proposed Vega-Sylvestre Reservoir and the proposed Conejos Reservoir. The capacity of the proposed Vega-Sylvestre is 238,~~000~~ acre feet, and the Conejos site 140,000 acre feet, a total of 378,000 acre feet. Engineering studies have been made of the probable yield from these reservoirs, and the Vega-Sylvestre, year in and year out, with only full supply eight years out of ten - we allow 2 years when there wouldn't be sufficient supply for theland. That being a channel reservoir site, it would yield 69 percent of its capacity. On the Conejos, that is also a channel site, the yield would be 110,000 acre feet, or about 77 percent. Combining these two we get a total capacity of 378,000 acre feet, and the average yearly yield, eight out of ten years, is 270,000 acre feet or 70 percent. I would like to call your attention to the fact that this 270,000 acre feet annual yield is approximately the water supply available at the end of the Rio Grande Project during the period of 1925 to 1928, inclusive. So that the waste water which has been discharged from the Rio Grande project, eliminating the avoidable waste, would supply the storage needed in the San Luis Valley. May I correct that? The unavoidable waste - eliminating the unavoidable waste. Now we will go to the drains of the San Luis Valley at the present time. There are 15 drain systems in the San Luis Valley which have been constructed by private capital in districts at a cost of $1,500,000. These drainage systems take care of an area of 165,000

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acres of which 90,000 acres are in the sump or closed basin area, and 75,000 are tributary to the Rio Grande. The output of these drains in the live area is, in round figures, 70,000 acre feet per annum, of which approximately 20 percent or 12,000 acre feet are re-used on lands below, leaving a net inflow to the river of 58,000 acre feet. That covers the period from 1923 to 1927, inclusive. Now, in the live portion of the San Luis Valley, there are two large springs which furnish return flow from irrigation. The Diamond Springs over on the La Jara Creek basin and a spring in the Rock Creek basin. These springs discharge 30,000 acre feet per annum, of which approximately 50 percent, or 15,000 acre feet, are re-used in the valley, leaving a net inflow to the river of 15,000 acre feet, or making a total recovery of 73,000 acre feet for the river under present conditions. Then, if we add the 27,000 acre feet of the drainage return flow of the given areas, we have a total production in the live area of 100,000 acre feet per annum. Now, we will go over to the dead area, the closed area or sump. There are three drainage systems constructed in that area which produce 30,000 acre feet, of which approximately 10,000 acre feet are re-used, leaving 20,000 acre feet discharged into the San Luis Lakes and the sump proper. In connection with this drainage water I wish to point out that approximately 50 percent of it occurs during the non-irrigation season, and of the 50 percent occurring during the irrigation season, in round figures, one half, will not be used, cannot be re-used in Colorado due to the flat country in which the drains are located, and the impossibility of getting that water out on lands, so that under present conditions, and under future conditions, always 75 percent, in round figures, of the drainage recovery will be fed back to the Rio Grande. Now, at the present time the two largest drains, the Rio Grande Drainage District and the San Luis Valley Irrigation and Drainage District, use, respectively, 6,000 and 7,000 acre feet per annum. I mention this specifically because of the question raised by Commissioner Wilson yesterday as to how much drain water we were using. At that time we stated we were using all we could, but I didn't go into it in detail because I expected to make this presentation now. That Rio Grande drain produces 30,000 acre feet per annum, so that the re-use of 6,000 acre feet, that's over a 6 or 7 year period, is 20 percent, and the other drain, it's an annually constructed drain, and my figures are rougher on that, checks out 25 percent.

MR. HARWELL: Speaking of a drain from which you give a figure of 20 percent, over an average of several years - can you state what percentage of the water of that drain was used in 1927 or 1928?

MR. MEEKER: It would not vary very much from that figure.

MR. HARWELL: Not greatly in excess of over 20 percent?

MR. MEEKER: I think so.

MR. HARWELL: You think it would be greatly in excess?

MR. MEEKER: I think it would be close to 20 percent because I have a detailed record of that here, and some times it has been much less than that, and I am taking the outside limit. Now, in connection with the use of drain waters, I wish to point out there is a Colorado statute in reference to drainage districts which permit them to re-use this water on the lands within their boundaries, and the San

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Luis Valley Irrigation District, that's the new large drain in the sump area, draining at the present time about 40,000 acres, is a skeleton system for something like 83,000 acres. That is an irrigation district and has a drainage canal as a part of the system, and that water is being re-used under the Colorado statute . Now, we come to the probable discharge from the sump drain. I yesterday gave the round figure of 200,000 acre feet per year. I prefer to correct that figure and say that from 175,000 to 200,000 acre feet per year will be the probable discharge, and here is the pertinent point in connection with that. The water consumption, as near as we can forecast it by engineering analysis of the Vega-Sylvestre and Conejos reservoirs, after constructed, will be, in round figures, 180,000 acre feet or practically an offset, so that the increased use under these two reservoirs will be offset by the recovery from the sump drain when constructed, and that means practically no additional burden will be put on the river. In fact, I will give you the figures as they work out. The estimated present outflow at the Colorado-New Mexico line, a 38 year average, corrected for depletion, 550,000 acre feet per annum. Estimated sump recovery, 185,000 acre feet, that's the mean figure, giving a total outflow of 735,000 acre feet at the state line. Then if the two reservoirs are constructed and use the water contemplated, we will have a deduction of 180,000 acre feet, due to consumptive uses, which leaves a net outflow at the state line under future conditions of drainage and reservoir control of 555,000 acre feet, or practically the samefigure that it is discharging today. I didn't give anything yesterday on the basin irrigated acreage which I now wish to do. The present total irrigated acreage in the Rio Grande basin, excluding the closed basin in the San Luis Valley, is 752,000 acres, segregated as follows:

Colorado,	410,000 acres
New Mexico	234,000 acres
Texas	68,000 "
Mexico	40,000 "
Total	752,000 "

Then, if we combine the New Mexico and Texas acreage, we have a total of 302,000 acres, and if we add to that figure the 40,000 acres irrigated in New Mexico at the present time, there are 342,000 acres irrigated in the Rio Grande basin below the Colorado-New Mexico line, and those are all gross figures. I gave the forecast yesterday of what the ultimate consumption, and what the present, would be in the Rio Grande basin.

MR. MECHEM: You said the total is 752,000 acres, exclusive of the sump area - what do you mean?

MR. MENKER: Well, there is a closed basin area of about 2500 square miles on the north end of the San Luis Valley.

MR. MECHEM: I understand that, but do you mean that you are excluding land of the sump area irrigated from sources other than the Rio Grande?

MR. MENKER: Yes, 67,000 acres, but all of that land in the sump irrigated from the Rio Grande is included in that 410,000. Under future conditions the forecast indicates a total of 1,158,000 acres ultimately irrigated when waters are recovered by drainage systems in the Rio Grande Valley and the San Luis Valley and reservoir control is obtained on the river and its tributaries. That means an increase of 400,000 acres, in round figures, over existing area. That figure may be segregated into round figures, 200,000 in Colorado, 100,000

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in the middle Rio Grande Valley, these areas both being seep and consuming approximately as much water under re-reclamation, and then an additional 100,000 acres on tributaries in New Mexico, with a small acreage in Texas. I believe that's all I now have.

COL. DONOVAN: Were there some questions you would like to ask?

GOVERNOR CORLETT: I made a statement here that there was 100,000 acres of storage capacity on the Rio Grande and about 75,000 storage; that should be limited to water District No. 20, which is the water used from the Rio Grande proper. Those figures do not correspond with Mr. Meeker's. (addressing Mr. Meeker) You take in the entire valley.

MR. MEEKER: Except the sump. (referring to Gov. Corlett) He takes just a portion of the main stem of the river.

COL. DONOVAN: That statement you makenow is the definition of your own statement, Governor.

GOVERNOR CORLETT: Yes.

MR. MEEKER: As most of you know, the middle Rio Grande Conservancy District is a badly water-logged seep area, with heavy consumption during the year by evaporation from these saturated areas.. The waters recovered in that proposed project which is now in formation, or has been formed for 2 or 3 years, under engineering studies made, by that district, in conjunction, I believe, with the Reclamation engineers, the water recovery will be sufficient to offset the consumption under reclamation, so that that project will impose no additional burden on the river. The same condition obtains in the San Luis Valley when we get the drainage that is necessary; that means the sump outlet as well as other drains to connect with the waters recovered; they will offset the increased consumption from the proposed reservoirs. Going back to the reservoirs - the reservoirs are necessary in both the San Luis Valley and the middle Rio Grande Valley to control the flood water and hold it over for the late summer irrigation or from a wet year to a dry year, and thereby assure crops year in and year out. I overlooked one matter and that is a comparison, roughly, of the acreage irrigated in New Mexico and Texas from 1902 to 1927, the thought being to get a comparative figure showing the increase between the time of the establishment of the embargo in 1896 and present conditions, but not having a precise figure available for some of these areas in 1896, I took the census figures of 1902 and then the figures I have xxxxx derived from engineering studies from the last year. That shows in 1902, which by the way was a dry year, 97,000 acres irrigated from the Rio Grande in New Mexico; 15,000 acres in Texas and in 1927 and 1928, 240,000 acres in New Mexico and 70,000 acres, in round figures, in Texas, indicating an increaseof 143,000 acres in New Mexico and 55,000 acres in Texas, or a total of 198,000 acres increase from 1902 to 1927. In reference to Mexico in that period I can only state that I dont have the figure for 1896 or 1902 and am unable to give the increased acreage in Mexico, although I know it has been very heavy since the construction of the Elephant Butte reservoir, because prior to that time the river was not regulated and the Mexican ditches outsideof the Acequia Madre and one or two other old ones, have all been constructed since the Rio Grande project commenced to function, and the large amount of waters were released from the Elephant Butte Reservoir.

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MR. HARWELL: Have you any corresponding figures for that period for irrigation plans in Colorado.

MR. MEEKER: Yes, I think I can give them to you.

MR. HARWELL: Would you mind, please?

MR. MECHEM: (interrupts) This 1902 figure you say you took that from the census?

MR. MEEKER: Yes sir, U. S. Census.

MR. MECHEM: And not from surveys?

MR. MEEKER: That was all the available information gleaned from all sources, Reclamation Service in various states and by some reconnaisance surveys. I find I left my census reports, but I am willing to take the figures off the graph prepared by New Mexico and Texas, Exhibit B. Referring to Exhibit B, New Mexico and Texas graph showing irrigated area in San Luis Valley, Colorado, and which I understand excludes the closed basin, although an inspection leads me to believe perhaps it does not. The U.S. Census figure for 1902 for the Colorado area, that's the comparable date, is 300,000 acres, and our present figure which I gave a few minutes ago, is 410,000 in Colorado, excluding the closed basin; if you wish to include the closed area, it is 67,000 additional.

MR. HARWELL: How many acres irrigated by waters tributary to the Rio Grande originating on the Rio Grande in the closed basin?

MR. MEEKER: 67,000 acres of the closed basin is irrigated from the closed basin water supply, and there is 140,000 from the Rio Grande on the closed basin; that figurex is included in the 410,000 which I have given for the live area.

MR. HARWELL: I am just trying to segregate those two figures on the closed basin.

MR. MEEKER: 142,000 irrigated from the Rio Grande and 67,000 from the closed basin streams.

MR. CARR: Is that 142,000 from the Rio Grande a development since 1902?

MR. MEEKER: I dont have the figures right now but I can give the acreage irrigated from the Rio Grande under these canals in 1902, but from my knowledge of the valley and long time work there, I would say there was undoubtkedly 100,000 acres at least irrigated in the closed basin from the Rio Grande about 1902.

MR. CARR: So the increase would be approximately 42,000?

MR. MEEKER: That's only round figure; I would like to reserve the right to correct that if it becomes pertinent, because I am giving rough figures.

MR. CARR: You stated, Mr. Meeker, that the waste water at the lower end of the Rio Grande project just about equals the amount of water which could be stored on the Vega-Sylvestre and Conejos sites in Colorado?

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MR. MC KEE: The yield of these reservoirs; the amount of waste at the end of the Rio Grande project is equivalent to the yield these reservoirs would furnish, their capacity being much greater.

BY MR. CARR:

Q In that figure as to the waste at the lower end of the Rio Grande project, did you take into consideration any of that seepage or drainage water which you said yesterday would be developed?

A I do take it into account - no, let me correct myself there, I am making an offset on the waste there against the future reservoir yield regardless of any other matter.

Q Then the water which is developed by seepage and drainage on the Rio Grande project is in addition to that, isn't taken into consideration in this offset? I mean the seepage and drainage in the Rio Grande project?

A That is automatically taken into account in the 270,000 acre feet; that's already in there, you cant put it in again.

Q Now you mentioned 15 projects in the San Luis Valley; do these drains the entire valley with the anticipated drainage from the sump area or is there any additional area in the San Luis Valley which will necessarily be drained in the future?

A In the live area there is at least 50,000 acres that will have to be drained under pressure of need in the southern part of the valley. In using the figure on what would be recovered through the sump drain I have included all land in the sump that will be drained in the future but not now drained.

Q Have you taken into consideration the additional drainage in the live area in your figures for the sump area?

A No, I have not.

Q Have you made any estimates on the amount of return flow to the Rio Grande which will be developed by this anticipated drain in the live area?

A I believe I offset that on the increased consumption by the Conejos Reservoir; I think that was used to reduce the figure on consumption by the new reservoir on the Conejos.

Recess for a few minutes.

Q Mr. McKee, you I asked you about giving additional land in the live area of the San Luis Valey in addition to the 15 projects which you mentioned and the proposed sump land, as to the acreage which it was anticipated might be drained in the future and which would furnish return water which might be reused or which would further add to the flow of the river.

A I stated there would be 50,000 acres in the southwest part of the valley, live area, ultimately to be drained but that the amounts for the recovery have been taken into account in connection with the consumption of the Conejos Resefvoir.

Q Is there anything additional in the valley?

A Yes, I overlooked one item; it is a potential item; the Costilla project on the east side of the San Luis Valley irrigated from Culebra under the reservoir of 100,000 acres feet capacity, and a forecast of the return flow from that project is, roughly, over 30,000 or from 30,000 to 35,000 acre feet. That forecast is based upon an examination of some of the wells there which are quite deep. During the present year, from the knowledge of conditions of these wells 10 or 15 years ago, a recent examination shows that the water table of these wells has risen from 15 to 25 feet in the last 10 years, so that the water table is gradually building up slowly for this reason. There is only about 15,000 acres now irrigated

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in that project and there are large areasof adjacent lands to which no water is being applied, so that the water table is being built up under those lands as wellas the project lands, and that of course, gives a much lower increase in height of the water table than it would if the geology is such that those underground waters would not spread. Eventually, I cannot forecast the exact time, but probably in 15 or 20 years, the return flows will be evidenced on that project and then increase, to a round figure, of about 30,000 acre feet. That figure I have not added in to the outflow at the state line in my previous compilation.

MR. MECHEM: Can you, or did you, state how many thousand acre feet of water annually is diverted from the Rio Grande basin into this dead area?

MR. MEEKER: I believe I gave you that as ~~xxx,xxxxxxxxxx~~ 400,000 acre feet on that 142,000 acres.

MR. MECHEM: That wasnot all diverted from the Rio Grande? Part of that is inflow from tributary drainage isn't it?

MR. MEEKER: No, that's all from the Rio Grande.

MR. HARWELL: I would like to ask whether or not you have made a study of the large water supply for the Rio Grande Federal Irrigation Project?

MR. MEEKER: I have some information on that but it isn't accurate at this time.

MR. HARWELL: Have you ever figured as to the average annual release required from the Elephant Butte Reservoir for the actual irrigation of lands under the Federal Rio Grande Project?

MR. MEEKER: That's the information I am just talking about.

MR. CARR: May I interpose; that is the last question which I asked Mr. Henny for last night and which it was suggested Mr. Hosea would give to us at some future time.

MR. HARWELL: At the same time he may have some information on that matter himself.

MR. CARR: He may have an opinion; what we want is the exact figure.

MR. MEEKER: I haven't touched on that stuff because I am not prepared at this stage of the game, and naturally I dont like to be questioned on it if I am not prepared.

MR. CARR: We ask that no further questions be asked along that line.

MR. HARWELL: I would like to ask one further question.

MR. CARR: Well, as far as he knows.

MR. HARWELL: I want to bring out one point in connection with the water supply of the Rio Grande Project; is this avoidable waste which you set up in addition to the saved water supply for the Rio Grande project

MR. MEEKER: That's my conception of it.

BY MR. HARWELL: Then, in order to arrive at that figure, you must know

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what the state water requirement is?

MR. MESSER: I have made some studies on that, yes sir, but I am not prepared to submit that at this time. I wish to submit that later.

BY MR. HARWELL: The distinction I wanted to make at this time is whether or not your claim that that avoidable waste would be further utilized on the ground it is simply waste with reference to the requirements of the project, it being conceivable that the project could need such water or whether or not that amount of water was in excess of the project requirements?

A That's my conception, it is in excessof the requirements as the project now functions. The Rio Grande project is 95 percent completed and that's what my figures are based on. I think I have some mathematical studies not finished that will sustain the other viewpoint.

Q This set up concerning this avoidable waste is of relatively short duration?

A I am taking information commencing with 1925 when I commenced my field studies; that's why I am taking those particular studies.

Q Then, in order to assume that that avoidable waste is a constant proposition you must also assume that the ~~studiesxofxwater~~ status of watersupply for the Elephant Butte reservoir is a constant proposition during that same period.

A The reservoir analysis of the water supply was for all phasesof theproject; it is practically a constant supply through the elevation of the Elephant Butte reservoir. If that waste, avoidable waste of some 200,000 acre feet is not released from the reservoir then the storage of the reservoir will build up and you will have a reservoir full a big part of the time.

Q That phaseof it is a matter of engineering opinion isn't it?

A I think we are getting beyond the intent of your question as originally stated.

Q The point I wanted to state is that you now regard that avoidable waste, that water you regard as avoidable waste as being in excess of reasonable project requirements.

A That's true and it is based in part on mystudies of this incomplete stuff for the last 3 or 4 years, and there are quite a number of elements to sustain or confirm the viewpoint of that being waste.

Q The proposition then is simply this: That you claim ~~x~~that this 300,000 acre feet which you name as your conception of the avoidable waste is in reality a surplus water supply, is that it?

A You might consider it unnecessary release from the reservoir under reasonable use.

Q Unnecessary release?

A Yes sir.

Q Under reasonable use, and therefore, in excessof theproject requirements?

A Yes, that's it.

MR. ROBINSON: In order to lead up to and clear up the record, you made an estimate a while ago on the areaof land that is now under cultivation or under irrigation in New Mexico, and also what might be in the future irrigated in our discussions and all statements, it seems to me, they have only spoken of the New Mexico irrigable land as those in the Rio Grandeproject and those that will come in the Rio Grande Conservancy District. There is an area that lies north of this district in the

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Espanola Valley, and I wish to ask if you included that in your estimates of irrigable area; that diverts water directly from the Rio Grande.

MR. MEKNR: Yes, if you will recall, Commissioner Wilson inquired about the location of projects or irrigable lands that I included, and I started up at the Colorado-New Mexico line and came down through the Sunshine Valley, Tres Piedras, into Taos with 50,000 acres in that area; 25,000 acres above Buckman in the Espanola Valley and tributary to the Chama, and then not only that in the middle Rio Grande Valley, but I allowed for some lands in there included in the Bluewater project on the Puerco, so I think I have included all the potential projects set up in New Mexico.

MR. ROBINSON: Might I also add I am in this conference representing the United States Bureau of Indian Affairs in connection with Indian lands that draw water from the Rio Grande. I understand that Commissioner Wilson will introduce a schedule later, but I make thestatement that the lands of the Indians, that the government is claiming for the Indians, that draw water directly from the Rio Grande is about 23,000 acres, of which 2200 acres lies north of the Conservancy District.

Recess taken for a few minutes.

MR. WILSON: ~~New Mexico and Texas desire~~ With reference to the definition requested by the Commission as regards the proposal made by Mr. Henny in behalf of Texas and New Mexico, we submit the following; as an effort to accurately define that proposal:

> As a basis of a Compact we beliefe that in following out the proposed plan that we may agree between the states that future delivery of water at the state line by Colorado shall be made in an amount annually, distributed during the non-irrigation season by months and during the irrigation season by weeks, equivalent to the water delivered at that point, durin some series of years during which some records exist, the selection of which is to be agreed upon; said equivalent, however, to be determined by inflow to and outflow from the San Luis Valley, exclusive of the dead area, as established by an agreed curve which shall represent the ratio of inflow and outflow which prevailed during said accepted series of years.

MR. CARR: Just one other matter in connection with what I was starting to say about the interpretation placed upon the proposal of the Commission as to the ~~text~~ dignity of the various proposals. It is the understanding of Colorado that each of the five proposals is of equal rank with all of the others and that there is to be given no priority in the matter of discussion or time because of the numbering of the proposals in the document.

COL. DONOVAN: It is my understanding there is no degree of rank and no regulations on any proposal there.

MR. CARR: Just this one thing. The statement as originally presented, as I understand, is withdrawn and what goes in the record is what you just stated. That was not contained in your written statement as to the position of the proposals, and it was for that reason I suggested that - because that was not contained in your written proposal but in your oral proposal.

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COL. DONOVAN: As I understand Mr. Wilson, his original statement as read was purged from the record; that there stands now only his last statement. As to the other statem nts in regard to rank, it is my impression that it might be just as well for clarification to have it remain because it is clear from this discussion that all agree there is no precedence by reason of the fact of thenumbering of any of the proposals.

MR. CARRL: Colorado agrees to that statement.

MR. WILSON: So does New Mexico and Texas.

SENATOR MCGREGOR: I want to make a motion and a few paradoxical observations, and the motion I am going to make is not debateable and what I am going to say is not binding on me and need not necessarily be binding on anyone else. I am going to ask permission for myself and others similarly situated, if I may make that motion and defer action on it until I have made the observations that I may afterwards have in mind. I move that when we adjourn, if we do so, that we adjourn to reconvene in this city on Monday morning, at 10 o'clock on January 21. The observation ~~x~~ I had in mind is that I regret I have studied the uses of water so late in life; that had I been e rlier enlightened ~~xxx~~ I realize I might have suffered a different character of headache than heretofore, but I know I would never have had as much fun. Since I began the study of the uses and values of water I find great pleasure in the fact that I was initiated in the San Luis Valley by the delightful citizenship of that modern paradise. I could not help but think a s I looked at the mountains there that when God finished he made that valley and left it to cherish his smile, but that memory was weakened a little by the fact that, like Humpty-Dumpty and Governor Corlett, it has seen a great fall. And so, independently of the historical relation that once existed between Texas and Colorado and the relatinn born of the comity of states, I shall always cherish a multitudinous source of many pleasures on my visit to Colorado. Then I found that the regret of having to leave Colorado was minimized by the fact that I came to New Mexico. I always like thehistory of New Mexico and love her traditions, especially the antiquities of Santa Fe, but I have learned that this is the home of art and an artist colony, and I have been particularly pleased about the antiquity of the artists I have seen. At the same time much pleasure has also sprung to witness the fall of the Governor of Colorado and the fall of my own mishap, and I console myself with the thought of "How the Mighty have fallen". Of course, I find a peculiar regret in the fact that in the course of these negotiations we lost the original chairman of this commission. That regret does not spring from the fact that the commission lost anything,because I think theinflow was as great as the outflow (applause), but my regret springs from the fact when the chairman left here and laid aside the duties of this commission that he romped "On the Sidewalks of New York". It is quite a job that some of us in Texas had cherished for another. Now, if later on the Republican party wants another candidate for the President, and will make her selection from the same source she did this year, that the majority recently given in Texas, I am satisfied will be increased by two.

COL. DONOVAN: In view ofthe agreement of this conference, that will not be considered a commitment.

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SENATOR MCGREGOR (Continues): What I stated, Mr. Chairman, in the beginning was not a predicate for the statement I just made because, like the Irishman - of course you dont know anything about them - when the Scotchman said were he not a Scotchman he would be an Englishman, and the Englishman said if he were not an Englishman he would be a Scotchman, and the Irishman said if he was not an Irishmen, he would be ashamed of himself. I find a pleasure in the fact that I believe we are going to get together and have water enough for everybody. I think nature dealt abundantly with these valley people by giving them a citizenship that can, and will, solve its problems, and out of that is generated the further regret that Texas, in a generous mood should have ever given to this Union Colorado and New Mexico; it should have kept them for herself. If we reach a conclusion in our negotistions which are to take place hereafter, I extnnd here and now an invit tion to this commission and its employes to visit Texas and we will take you across the river and show you where Juarez and Mexico gets that 60,000 acre feet; that you may see it as you go so you will not miss having seen it. (Applause.)

MR. BURGESS: If you will indulge me for one moment, the successor of Mark Twain, Irving Cobb, in his facetious articles after his return from France, said that he had discovered what the French did with water - theydidn't drink it but they put gold fish init. I find that by observation I can nowtell him we discovered another use for water; we make Compacts about it. Alluding just for a moment to that most unhappy of all land sales by which Texas parted with New Mexico and Colorado, I want to say this, that Texas is very proud of both daughters. We regard New Mexico and Colorado as both daughts of Texas; we are proud of the fact, and we have, so far, in our mingling with the people of both states, we have felt for their citizens, individually and collectively, the sentiment we have just expressed, and we certainly hope when our deliberations are resumed here that we will be able to compose our differences as members of a family should. Now, just one other thought; it would give us the greatest possible pleasure if at this time or any later time, this Commissionxx and its entourage would see fit to hold a session with us in El Paso. It extends a cordial welcome to come at any time and stay as long as you can, and we will try to make you enjoy every moment of the time you are there. (Applause)

GOVERNOR CONLETT: Mr. Chairman and Gentlemen: I wish I had the ability to respond in kind with the illustrious Commissioner from the State of Texas and Major Burgess. I am afraid, however, it would be a sad failure if I should attempt to imitate their excellent deliver and pleasant personality. There is just one thing we would hate very much to do in all of our deliberations here, and that would be to take away from these gentlemen any portion of the water that would be necessary for the protection of these vineyards down there so graphically described here yesterday and the day before, but, seriously speaking, Mr. President and Gentlemen, we agreciate very xxxx very deeply the many courtesies that have been extended to the delegation from Colorado both by the New Mexico delegation and the delegation from Texas. We appreciate fully that our ideas cannot run along the same channel, and we also appreciate the apparent fairness of everyone concerned in this attempt to make an amicable and friendly settlement of a very much aggravated question. One that has possibly contributed more misunderstanding than any otherxone item between these great states. I feel sure that our deliberations, taking into consideration the conscientious and fair consideration that the dele-

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gates from all sections have given to this question, will result in an absolute understanding that will pave the way for future relations that will be of great benefit to all of the states and parties concerned. We will be very glad to ~~xxxx~~ accept the most kind invitation of Major Burgess any time it is convenient - I know we should be royally entertained and have the wonderful time that you describe. On the other hand, we would be very glad to extend to you gentlemen the invitation to return to Colorado and we would like to have the Chairman go over the San Luis Valley as well. We are very much in hopes that some time or other we may meet on our ground and may offer our hospitality in return for the wonderful hospitality that you extended to us. I second the motion of the illustrious Commissioner from Texas.

MR. WILSON: I couldn't add anything to the remarks already made. I would remind the Major that while we may be daughters of Texas, at this time and at this age we, all of us who are fathers of daughters, have learned that they bring us up instead ofus bringing them up. I want everyone here to feel that our great game in this whole proposition is to make it possible to avoid all future friction between the states on the subject of the future of the Rio Grande, and New Mexico believes that that is going to be arrived at, especially in view of the fact that we have the guidance and aid of our Chairman whose ability has already been demonstrated so ably to us. As far as the location is concerned, I would like to suggest to you all that Santa Fe has seen many historical events. It is not necessary to remind you of them, but I might bring to mind at this time that the Colorado River Compact which had its inception in themind and heart also of your distinguished Commissioner, was signed here and that today, most fittingly, the President of the United States has signed the Boulder Canyon Dam legislation, which I believe will result in making that Compact effective. So I would like to see Santa Fe again the center of a similar historical event, and I trust in our next meeting that hope will be realized. (Applause)

COL. DONOVAN: I would like to say just one thing. I have been greatly impressed here with the fine spirit of all of those who have come to this conference. I think this subject challenges the intelligence and the intellectual power and development of everyone concerned, and I think what has been evidenced is a high knowledge of statesmanship shown by you gentlemen having the dignity of your respective states, to be realistic enough to know it has to be dealt with in a practical way, and with that knowledge, I am sure the hope of Mr. Wilson will be fulfilled. If there is no objection, we will adjourn to this place on January 21st at 10 o'clock.

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RG 115 RECORDS OF THE BUREAU OF RECLAMATION

General Administrative and Project Records, 1919-1945

Project Files, 1919-1929

Rio Grande Basin 023.--032.02

Entry 7

Box No. 924

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032.1 RIO GRANDE BASIN WATER RIGHTS: RIO GRANDE COMPACT THRU 1929
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TRANSFER CASE
032.1
RIO GRANDE BASIN
2/12/29

Rio Grande Compact

Report of Commissioner for
New Mexico

and

Memorandum of Law on Interstate
Compacts on Interstate Streams

Submitted by
FRANCIS C. WILSON
Rio Grande Compact Commissioner

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Rio Grande Compact

Report of Commissioner for
New Mexico

and

Memorandum of Law on Interstate
Compacts on Interstate Streams

Submitted by
FRANCIS C. WILSON
Rio Grande Compact Commissioner

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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, 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—Delph E. Carpenter

For the State of New Mexico—Francis C. Wilson

For the State of Texas—T. H. McGregor

who, after negotiations participated in by William J. Donovan, 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 term "Rio Grande Basin" means all of the territory drained by the Rio Grande and its tributaries in Colorado, New Mexico and Texas, above Fort Quitman, Texas.

(c) The term "tributary" means any water course, the waters of which naturally flow into the channel of the Rio Grande.

(d) The "Closed Basin" means that part of the San Luis Valley in Colorado where the streams and waters naturally flow and drain into the San Luis Lakes and adjacent territory, and the waters of which are not tributary to the Rio Grande.

(e) "Domestic" use of water has the significance which attaches to the word "domestic" in that sense at common law. "Municipal" use means the use of water by or through water works serving the public. "Agricultural" use means the use of water for the irrigation of land.

(f) The term "power" as applied to the use of water means all uses of water, direct or indirect, for the generation of energy.

(g) "Spill" or waste of water at a reservoir means the flowing of water over the spillway, or the release of water through outlet structures other than for domestic, municipal or agricultural uses, and losses incident thereto.

The provisions hereof binding each signatory State shall include

and bind its citizens, agents and corporations, and all others engaged in, or interested in, the diversion, storage or use of water of the Rio Grande in Colorado or New Mexico, or in Texas above Fort Quitman.

ARTICLE II.

The States of Colorado, New Mexico and Texas hereby declare:

(a) That they recognize the paramount right and duty of the United States, in the interests of international peace and harmony, to determine and settle international controversies and claims by treaty and that when those purposes are accomplished by that means, the treaty becomes the supreme law of the Nation;

(b) That since the benefits which flow from the wise exercise of that authority and the just performance of that duty accrue to all the people, it follows as a corollary that the Nation should defray the cost of the discharge of any obligation thus assumed;

(c) That with respect to the Rio Grande, the United States, without obligation imposed by international law and "being moved by considerations of international comity," entered into a treaty dated May 21st, 1906, (24 Stat. 2953) with the United States of Mexico which obligated the United States of America to deliver from the Rio Grande to the United States of Mexico, 60,000 acre-feet of water annually and forever, whereby in order to fulfill that promise the United States of America, in effect, drew upon the States of Colorado, New Mexico and Texas a draft worth to them many millions of dollars, and thereby there was cast upon them an obligation which should be borne by the Nation;

(d) That for the economic development and conservation of the waters of the Rio Grande Basin and for the fullest realization of the purposes recited in the preamble to this Compact, it is of primary importance that the area in Colorado known as the Closed Basin, be drained, and the water thus recovered be added to the flow of the river, and that a reservoir be constructed in Colorado upon the river, at or near the site generally described as the State line reservoir site. The installation of the drain will materially augment the flow of the river, and the construction of the reservoir will so regulate the flow as to remove forever the principal causes of the difficulties between the States signatory hereto;

(e) That in alleviation of the heavy burden so placed upon them, it is the earnest conviction of these States that, without cost to them, the United States should construct the Closed Basin Drain and the State Line Reservoir described in (d).

The signatory States agree that approval by Congress of this

Compact shall not be construed as constituting an acceptance or approval, directly, indirectly or impliedly, of any statement or conclusion appearing in this Article.

ARTICLE III.

(a) Colorado, under the direction and administration of its State Engineer, shall cause to be maintained and operated an automatic recording stream gauging station at each of the following points, to-wit:

(1) On the Rio Grande near Del Norte at the station now maintained, known and designated herein as the Del Norte Gauging Station, (the water records from this station to include the flow diverted into the canal of the Del Norte Irrigation System);

(2) On the Rio Conejos near Mogote, a station known and designated herein as the Mogote Gauging Station;

(3) On the Rio Grande at or near the Colorado-New Mexico Interstate line, a station known and designated herein as the Interstate Gauging Station;

(4) Such other station or stations as may be necessary to comply with the provisions of this Compact.

(b) New Mexico, under the direction and administration of its State Engineer, shall cause to be maintained and operated, an automatic stream gauging station at each of the following points, to-wit:

(1) On the Rio Grande at the station known as Buckman;

(2) On the Rio Grande at San Marcial;

(3) On the Rio Grande at the Elephant Butte Reservoir outlet;

(4) Such other station or stations as may be necessary to comply with the provisions of this Compact.

(c) Texas, under the direction and administration of its duly constituted official, shall cause to be maintained and operated an automatic stream gauging station at each of the following points, to-wit:

(1) On the Rio Grande at Courchesne;

(2) On the Rio Grande at Tornillo;

(3) On the Rio Grande at Fort Quitman.

(d) New Mexico and Texas shall establish and maintain such other gauging station or stations as may be necessary for ascertaining and recording the release, flow, distribution, waste and other disposition of water at all points between the Elephant Butte Reservoir and the lower end of the Rio Grande Project, both inclusive. Provided, however, that when the United States shall maintain and operate, through any of its agencies, an automatic gauging station at any of the points herein designated, it shall not be necessary for the State within

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which said station is located to maintain a duplicate gauging station at such point, whenever the records of such Government stations are available to the authorities of the several States.

(e) The officials in charge of all of the gauging stations herein provided for shall exchange records and data obtained at such stations for monthly periods through the operation thereof, or at such other intervals as they may jointly determine, and said officials shall provide for check ratings and such other hydrographic work at the designated stations as may be necessary for the accuracy of the records obtained at such stations and to that end may establish rules and regulations from time to time.

ARTICLE IV.

The State Engineer of Colorado, the State Engineer of New Mexico and such officer of Texas as the Governor thereof may designate shall constitute a Committee which may employ such engineering and clerical aid as may be authorized by the respective State Legislatures, and the jurisdiction of the Committee shall extend only to the ascertainment of the flow of the river, and to the prevention of waste of water, and to findings of fact reached only by unanimous agreement. It shall communicate its findings of fact to the officers of the respective states charged with the performance of duties under this Compact. Its findings of fact shall not be conclusive in any court or other tribunal which may be called upon to interpret or enforce this Compact. Annual reports compiled for each calendar year shall be made by the Committee and transmitted to the Governors of the signatory States on or before February 1st following the year covered by such report.

ARTICLE V.

It is agreed that to and until the construction of the closed basin drain and the State Line reservoir herein described but not subsequent to June 1, 1935, or such other date as the signatory States may hereafter fix by acts of their respective State Legislatures, Colorado will not cause or suffer the water supply at the Interstate Gauging Station to be impaired by new or increased diversions or storage within the limits of Colorado unless and until such depletion is offset by increase of drainage return.

ARTICLE VI.

To the end that the maximum use of the waters of the Rio Grande may be made, it is agreed that at such times as the State Engineer of New Mexico under the supervision and control of the Committee shall

find that spill at Elephant Butte Dam is anticipated he shall forthwith give notice to Colorado and New Mexico of the estimated amount of such spill, and of the time at which water may be impounded or diverted above San Marcial, and thereupon Colorado and New Mexico may use in equal portions the amount of such estimated spill so found by the State Engineer of New Mexico, and on notice from the said State Engineer of New Mexico that the period of said spill, or estimated spill, is terminated, Colorado and New Mexico shall desist from such increased use.

ARTICLE VII.

(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.

(b) 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 this Compact and no advantage or right shall accrue or be asserted by reason of construction of works, reclamation of land or other change in conditions or in use of water within the Rio Grande Basin or the Closed Basin during the time intervening between the signing of this Compact and the concluding of such subsequent Compact to the end that the rights and equities of each State may be preserved unimpaired. Provided, however, that Colorado shall not be denied the right to divert, store, and/or use water in additional amounts equivalent to the flow into the river from the drain from the Closed Basin.

(c) Any Compact concluded by said Commission shall be of no force or effect until ratified by the legislature of each of the signatory States and approved by the Congress of the United States.

ARTICLE VIII.

(a) Subject to the provisions of this Article, Colorado consents to the construction and use of a Reservoir by the United States and/or New Mexico, and/or Texas, as the case may be, by the erection of a dam across the channel of the Rio Grande at a suitable point in the Canyon below the lower state bridge, and grants to the United States

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and/or to said States or to either thereof, the right to acquire by purchase, prescription or the exercise of eminent domain such rights of way, easements and/or lands as may be necessary or convenient for the construction, maintenance and operation of said Reservoir and the storage and release of waters.

(b) Said Reservoir shall be so constructed and operated that the storage and release of waters therefrom and the flowage of water over the spillway shall not impede or interfere with the operation, maintenance and uninterrupted use of drainage works in the San Luis Valley in Colorado or with the flow and discharge of waters therefrom.

(c) The construction and/or operation of said Reservoir and the storage and regulation of flow of waters thereby for beneficial uses or otherwise shall not become the basis or hereafter give rise to any claim or appropriation of waters or of any prior, preferred or superior right to the use of any such waters. The purpose of said Reservoir shall be to store and regulate the flow of the river.

(d) The United States, or the signatory States, as the case may be, shall control the storage and release of water from said Reservoir and the management and operation thereof, subject to a Compact between the signatory States.

(e) Colorado reserves jurisdiction and control over said Reservoir for game, fish, and all other purposes not herein relinquished.

(f) Colorado waives rights of taxation of said Reservoir and appurtenant structures and all lands by it occupied.

ARTICLE IX.

Nothing in this Compact shall be construed as affecting the obligations of the United States of America to the United States of Mexico, or to the Indian Tribes, or as impairing the rights of the Indian Tribes.

ARTICLE X.

It is declared by the States signatory hereto to be the policy of all parties hereto to avoid waste of waters, and to that end the officials charged with the performance of duties hereunder shall use their utmost efforts to prevent wastage of waters.

ARTICLE XI.

Subject to the provisions of this Compact, water of the Rio Grande or any of its tributaries, may be impounded and used for the generation of power, but such impounding and use shall always be subservient to the use and consumption of such waters for domestic, municipal and

agricultural purposes. Water shall not be stored, detained nor discharged so as to prevent or impair use for such dominant purposes.

ARTICLE XII.

New Mexico agrees with Texas, with the understanding that prior vested rights above and below Elephant Butte Reservoir shall never be impaired hereby, that she 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.

ARTICLE XIII.

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 provision herein contained establishes any general principle or precedent applicable to other interstate streams.

ARTICLE XIV.

This Compact may be terminated, or extended, at any time by the unanimous legislative action of all of the signatory States, and in that event all rights established under it shall remain and continue unimpaired.

ARTICLE XV.

Nothing herein contained shall prevent the adjustment or settlement of any claim or controversy between these States by direct legislative action of the interested States, nor shall anything herein contained be construed to limit the right of any State to invoke the jurisdiction of any court of competent jurisdiction for the protection of any right secured to such State by the provisions of this Compact, or to enforce any provision thereof.

ARTICLE XVI.

Nothing in this Compact shall be considered or construed as recognizing, establishing or fixing any status of the river or the accuracy of any data or records or the rights or equities of any of the signatories or as a recognition, acceptance or acknowledgment of any plan or principle or of any claim or assertion made or advanced by either of the signatories or hereafter construed as in any manner establishing any principle or precedent as regards future equitable apportionment of the water of the Rio Grande. The signatories agree that the plan herein

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adopted for administration of the water of the Rio Grande is merely a temporary expedient to be applied during the period of time in this Compact specified, is a compromise temporary in nature and shall have no other force or interpretation, and that the plan adopted as a basis therefor is not to be construed as in any manner establishing, acknowledging or defining any status, condition or principle at this or any other time.

ARTICLE XVII.

The signatories consent and agree to the extension of time for construction of reservoirs on sites covered by approved applications during the time of this Compact and for a reasonable time thereafter.

ARTICLE XVIII.

This Compact shall become operative when approved by the legislature of each of the signatory States and by the Congress of the United States. Notice of approval 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 its approval by 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 12th day of February, in the year of our Lord, One Thousand Nine Hundred and Twenty-nine.

DELPH E. CARPENTER
FRANCIS C. WILSON
T. H. MCGREGOR

Approved:
WILLIAM J. DONOVAN

RIO GRANDE COMPACT

REPORT

OF

FRANCIS C. WILSON
COMMISSIONER FOR NEW MEXICO

Hon. Richard C. Dillon,
Governor of the State of New Mexico,
Santa Fe, New Mexico.

Sir:

I have the honor to report that a Compact on the Rio Grande above Fort Quitman, Texas, was signed by Commissioners for the States of Colorado, New Mexico, and Texas, at Santa Fe, New Mexico, on February 12th, 1929, which in effect provides for a truce between the States interested, to June 1st, 1935, during which period of time Colorado agrees not to impair the flow of the river by new or increased diversions or storage within the limits of Colorado, unless and until such depletion is offset by increase of drainage return. The Compact was executed by me as Commissioner for the State of New Mexico, acting under authority of Section 1, Chapter 112, of the Session Laws of 1923, and Chapter 114 of the Session Laws of 1925, supplemented by the provisions of Chapter 120 of the Session Laws of 1927, by Hon. Delph E. Carpenter, Commissioner for the State of Colorado, and by Hon. T. H. McGregor, Commissioner for the State of Texas. Col. William J. Donovan, Assistant to the Attorney General of the United States was appointed by the President as the representative of the United States of America to participate in the meetings. Col. Donovan has approved the Compact in behalf of the United States. The instrument has been executed in quadruplicate originals, one of which will be deposited in the archives of the Secretary of State for the United States at Washington, and one with the Secretary of State of each of the signatory States. The Compact will become effective when ratified by the Legislature of each of the signatory States and approved by the Congress of the United States.

I am handing you herewith, the original signed draft which is to be deposited in the archives of the Secretary of State of the State of New Mexico.

Generally speaking, the Compact settles for a period of six years, to-wit, until June 1st, 1935, the controversy which has been in existence

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for a great many years concerning the continuing depletion of the water supply of the Rio Grande in Colorado by the constantly increased uses in that State in the San Luis Valley area. The interests of New Mexico and Texas being practically the same in this connection, the necessity of a Compact was essentially of equal importance to both. However, New Mexico, had at stake not only the Rio Grande project consisting of the Elephant Butte dam and the district below, but also the Middle Rio Grande Conservancy District and all users above that district to the Colorado line, which involve direct diversions from the main channel of the river. The first meeting of the present conference was held in December, 1928, and then adjourned until January 22nd, and from that date until the signing of the Compact, negotiations have been continuous and without material interruption. We have had the benefit of the aid, cooperation and tactful leadership of Colonel Donovan who has acted as the Chairman of the conference. A brief explanation of the provisions of the Compact follows.

ARTICLE I, contains a definition of the various terms employed in the Compact, descriptive of conditions upon the river and the use of water.

ARTICLE II, contains a declaration by the signatory States concernnig the treaty between the United States of America and the United States of Mexico entered into on May 21, 1906, (34 Stat. 2953), by virtue of which the United States of America became and is obligated to deliver from the Rio Grande to the United States of Mexico, sixty thousand acre-feet of water annually and forever. After setting out the facts concerning the Treaty, it is alleged that the sixty thousand acre-feet thus taken from the river constituted in effect a draft upon the States of Colorado, New Mexico, and Texas worth to them many millions of dollars whereby they were and are called upon to meet an obligation out of their resources which should fall upon and be borne by the Nation as a whole for the benefit of which the Treaty was entered into. It is then recited that to discharge this obligation to the three States upon whom it has been imposed by the Treaty, Congress should authorize the construction of a drain into the Closed Basin in Colorado to drain the waters now wasted in that Basin, into the river, and of a reservoir at the Colorado-New Mexico State line for the regulation of the flow of the river so that the flow of the river could be equated to the benefit of New Mexico and so that the uses in Colorado could be increased without injury to the river below. By this means, at a cost much below the value of the water given to Mexico by virtue of the Treaty, some return would be made by the United States to the people of the three States in compensation for the serious depletion of their resources occasioned by the Treaty. The closing paragraph of this Articles recites: "The signatory States agree that approval by Congress of this Compact shall not be construed as constituting an acceptance or approval, directly, indirectly or impliedly, of any statement or conclusion appearing in this Article."

ARTICLE III provides that Colorado shall maintain and operate automatic stream gauging stations at each of the following points, to-wit: (1) On the Rio Grande near Del Norte at the station now maintained, known and designated herein as the Del Norte Gauging Station, (the water records from this station to include the flow diverted into the canal of the Del Norte Irrigation System); (2) On the Rio Conejos near Mogote, a station known and designated herein as the Mogote Gauging Station; (3) On the Rio Grande at or near the Colorado-New Mexico Interstate line, a station known and designated herein as the Interstate Gauging Station; (4) Such other station or stations as may be necessary to comply with the provisions of this Compact; New Mexico shall maintain and operate automatic stream gauging stations at: (1) On the Rio Grande at the station known as Buckman; (2) On the Rio Grande at San Marcial; (3) On the Rio Grande at the Elephant Butte Reservoir outlet; (4) Such other station or stations as may be necessary to comply with the provisions of this Compact; Texas shall maintain and operate automatic stream gauging stations at: (1) On the Rio Grande at Courchesne; (2) On the Rio Grande at Tornillo; (3) On the Rio Grande at Fort Quitman. This article also provides that there shall be complete cooperation between the officials of the respective States whereby records and data obtained from the stations mentioned shall be exchanged and checked.

ARTICLE IV provides for a Committee to consist of the State Engineer of Colorado, the State Engineer of New Mexico and any officer of Texas designated by the Governor of that State, the jurisdiction of which shall extend, (1) to the ascertainment of the flow of the river, (2) to prevent waste of water anywhere in the Basin above Fort Quitman, and (3) to make findings of fact upon conditions which may exist upon the river, and to communicate them to the officers of the respective States charged with the performance of duties under the Compact.

ARTICLE V contains the agreement which from the standpoint of New Mexico and Texas is the principal consideration for this Compact, to-wit, that until the construction of the Closed Basin Drain and the State Line Reservoir, but not subsequent to June 1st, 1935, Colorado will not cause the water supply in the river as measured at the interstate gauging station to be impaired by new or increased diversion,

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or storage within the limits of Colorado unless and until such depletion is offset by increase of drainage return to the river. In effect this agreement is a solemn pledge that Colorado will not further impair or deplete the flow of the river at the interstate gauging station during the period from the date of the Compact to June 1st, 1935.

ARTICLE VI provides that the State Engineer of New Mexico acting under the supervision and control of the Committee described in Article IV, shall notify the States of Colorado and New Mexico of the estimated amount of any anticipated spill or actual spill at the Elephant Butte dam so that such excess water at that point may serve as a signal to water users in Colorado and New Mexico above the Elephant Butte Project which will enable them in equal portions to impound or divert water of the river above San Marcial until notice is served upon them by the State Engineer of New Mexico that the period of said spill has terminated, when both Colorado and New Mexico above the point mentioned, shall cease from making any increased use or diversion of the flow of the river. This provision is to make possible above San Marcial additional uses of the water of the river which would otherwise go to waste by being spilled at Elephant Butte Dam, and to permit the use of such excess or surplus waters for beneficial purposes over and above what is now possible in New Mexico and Colorado above San Marcial.

ARTICLE VII provides that upon the completion of the Closed Basin Drain and the State Line Reservoir, but in any event not later than June 1st, 1935, a Compact Commission 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 to the end that there may be an equitable apportionment of the use of the waters of the Rio Grande amongst the said States. It is further provided in effect, that when the Commission undertakes its labors it shall do so upon the basis of conditions as they existed at the time when this Compact was signed and ratified so that the rights and equities of each State may be preserved during the six years covered by this Compact, and so that they may enter into a new Compact without being affected by any changes which have transpired upon the river as regards additional uses during that period. The only condition attached is that Colorado can divert, store and use water, in addition to its present uses and storage equivalent to the flow into the river from the drain from the Closed Basin, which of course, is based upon the assumption that the Closed Basin Drain will be built during the intervening time.

ARTICLE VIII contains a grant from Colorado to the United States, or to New Mexico, or to Texas, or to all three as the case may

be, for the erection of a dam at the State line site, giving and granting to them or to any one of them, the right to acquire rights of ways, easements and land which may be required therefor. The purpose of the reservoir is to store and regulate the flow of the river and the grantees or grantee, as the case may be, are given the right to store and release water from the said reservoir and to manage and operate the same subject only to the Compact contemplated after June 1st, 1935. Colorado waives any right of taxation of the said reservoir and appurtenant structures and of the lands which may be occupied by the same.

ARTICLE IX contains a provision to the effect that the Compact shall not be construed as affecting the obligations of the United States of America to the United States of Mexico, or to Indian Tribes, or as impairing the rights of Indian Tribes.

ARTICLE X pledges the respective states to avoid waste of waters, and charges the officials thereof with the duty of exerting every effort possible to prevent wastage of water within their respective territory.

ARTICLE XI sets forth an agreement that the waters of the Rio Grande and its tributaries may be impounded and used for the generation of power, but that such impounding and use shall always be subservient to the use and consumption of water for domestic, municipal and agricultural purposes, and declares those purposes to be dominant.

In ARTICLE XII, New Mexico agrees with Texas, with the reservation that prior vested rights above and below Elephant Butte Reservoir shall never be impaired, that she will not cause any depletion of the flow of water for the Elephant Butte Reservoir by increased diversion or storage within New Mexico, unless and until such depletion is offset by increased drainage return.

ARTICLE XIII contains the declaration that the Compact was entered into by the signatory States because of the peculiar conditions existing in the territory drained and served by the Rio Grande, and that the Compact does not establish any general principle or precedent applicable to any other interstate streams.

ARTICLE XIV provides that the Compact may be terminated or extended at any time by unanimous legislative action of the signatory States, and that in either event all rights established under the Compact shall remain and continue unimpaired.

ARTICLE XV reserves in the signatory States the right to adjust or settle any claim or controversy by direct legislative action of the interested States and reserves the right to each state to invoke the jurisdiction of any court of competent jurisdiction for the protection of any

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right secured to such State by the provisions of the Compact, or to enforce any provision thereof.

ARTICLE XVI in general establishes the status quo on the river as the primary consideration of the Compact and leaves the future agreement, if such should be made, wholly unaffected by the provisions of this Compact, which are described as amounting to a compromise of a temporary nature.

ARTICLE XVII provides that the signatory States may consent and agree to the extension of time during the period of this Compact for the construction of reservoirs on sites covered by approved applications, and for a reasonable time thereafter.

ARTICLE XVIII provides for the machinery of ratification by the signatory States and approval by Congress.

GENERAL DISCUSSION

The origin of the controversy for the solution of which this Compact contributes a plan not only for the present, but possibly for the future, may be said to relate back to the period of great development in the San Luis Valley in Colorado commencing about the year 1880. Just prior to that year, and during the decade thereafter, great canals were built in the San Luis Valley, and large areas of land were placed in cultivation and the flow of the Rio Grande at the Colorado-New Mexico line became greatly depleted. In the Mesilla Valley and El Paso sections of the river much damage resulted. For centuries there had been appropriations of water of the Rio Grande in Mexico across the river in the El Paso district, which use also suffered greatly from the depletion mentioned. The latter condition was brought forcibly to the attention of the Government of the United States by claims advanced by Mexico for damage done to the users of water in Mexico in an amount in excess of thirty million dollars. The United States instituted an investigation of the situation and in a report made in 1896, the Government Engineer attributed the damage to the depletions in Colorado already described. As a result of this report the State Department insisted upon the imposition of an embargo upon the river to prevent further depletion of the stream. Accordingly, the order was issued and thus development upon the river was halted.

From the period 1896 to 1903, intensive investigations were made by the United States for the determination of the best method to meet the situation, and it was finally decided to build a great project upon the river to be located at the Elephant Butte Dam site which would serve to conserve and impound the flood flow of the river so that it could be employed to meet shortages and deficiencies below that point

caused by the depletions in Colorado, and to fulfill any treaty obligation which the United States might assume to satisfy the claims of the United States of Mexico. In 1906, the Treaty with Mexico was concluded (34 Stat. 2953) and it was approved and confirmed by the Senate in January, 1907. It was conceded that since the water originated entirely in the United States, which had been used in Mexico in the El Paso District, that the United States of America were under no obligation imposed by international law to pay the claims or to provide for the continuation of irrigation of lands in Mexico out of the flow of the Rio Grande, but the State Department desiring to avoid friction with Mexico and "being moved by considerations of international comity" agreed in the Treaty to deliver to the United States of Mexico, sixty thousand acre-feet of water annually and forever, with certain conditions attached, depending upon whether there was a universal drought upon the river or not. To discharge this international obligation thus voluntarily assumed by the United States, and to create a great reclamation project in this country, the Rio Grande Project was undertaken, and the Elephant Butte Dam constructed and completed during the period from 1907 to 1914. Thus, there was created at that point in the river a mighty catch-basin which conserved all of the water of the river not applied to beneficial use above San Marcial and there was imposed upon the resources of the river above that point a burden of sixty thousand acre-feet, which the United States were obligated to deliver to Mexico. It is true that this project has greatly benefited the section between the dam in New Mexico and Fort Quitman in Texas, but above San Marcial the burden of the obligation to Mexico operates as a direct drain during dry cycles upon the resources of the stream in the basin above San Marcial. The embargo mentioned was continued until it was lifted by Secretary Work in 1925, and all development upon the river of any extensive character has been thereby prevented. The figures presented by the Engineers retained for the States of New Mexico and Texas show that nothwithstanding this embargo there was, has been, and is an increasing consumptive use of water in Colorado which has resulted in depletion of the flow of the river at the New Mexico-Colorado State line. The Middle Rio Grande Conservancy District has been organized and is now being financed for the purpose of repairing the damage which in part, at least, has been caused by this depletion with respect to the flow of the river. The future of this district and that of all of the users of the water of the Rio Grande above the district to the Colorado State line will be in jeopardy so long as these depletions continue, and there is no water returned to the river to take the place of the water consumptively used in Colorado in the San Luis Valley.

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The problem before New Mexico, and before Texas, as well, to the extent that the water supply conserved by the Elephant Butte Dam is also threatened by these depletions, has been for many years that of finding some instrumentality by virtue of which the destruction of rights in New Mexico and in Texas by these increasing depletions and consumptive uses in Colorado, could be stopped. The reasonable and propert method of approach is by Compact between the States, each of which has a common interest in the highest and most efficient uses of the flow of the river. Litigation should be looked upon as the last resort and the costs incident thereto, as well as the frequently unsatisfactory results of this method, has justified the exhaustion of every possible friendly approach before entering into the expensive and unsatisfactory solution by litigation.

Both New Mexico and Colorado are prior appropriation States, and each has a system of water law which recognizes that the first in time is the first in right with respect to the use of water. The Supreme Court of the United States in the Wyoming-Colorado case, 259 U. S. 419, 66 L. ed. 999, has decided as between States having this system of law that on interstate streams the same doctrine would be applied regardless of state lines. Litigation between the two States would result in interminable evidence upon the question of priorities and the outcome of such litigation could not be foretold with any degree of reasonable accuracy, and in fact, would unquestionably result in disappointments to both sides. Kansas and Colorado have been litigating for nearly thirty years their respective rights on the Arkansas River, and today after spending considerably over one-half million dollars, they have reached no satisfactory result. The Wyoming-Colorado case was in reality an attempt at a judicial compromise which has not been wholly satisfactory to either of the litigant States. The cost of this litigation and the carrying out of the decree has amounted to large sums of money. Out of this experience has grown the idea of Compacts and even though there may be some unsatisfactory features to this method, they are comparatively small compared with the disadvantages of litigation.

Some explanation should be given of the Closed Basin situation in Colorado and the necessity for a State Line Reservoir. The Closed Basin means that part of the San Luis Valley in Colorado where the streams and waters and the drainage from the irrigated area naturally flow and drain into the San Luis Lakes and adjacent valley, the water of which never reaches the Rio Grande. The construction of the drain into this territory from the Rio Grande so that drainage will be set up and the waters now lost by evaporation and otherwise, will be returned

to the River, is a feasible project. During the hearings closed by the agreement embodied in this Compact, the Colorado Engineers estimated that the increase to the flow of the river by this means would amount to one hundred seventy-five thousand acre-feet per annum, and while this estimate may be high, there seems to be no question but that there will be a very large increase to the river flow by means of this drain. Furthermore, the drain will return to the river a steady and equated flow throughout the year. To the extent that this return will increase the normal flow of the river at the State line, the uses equivalent thereto above that point in Colorado could be multiplied without damage to New Mexico and Texas. Thus, the construction of the drain will benefit Colorado greatly and also New Mexico.

As regards the State Line Reservoir, the effect would be to regulate the river so that Colorado could deliver at the State line a quantity of water equivalent to the present flow annually at times in the year outside of the irrigation season, or during flood periods when such contribution to the river would not damage her development and would permit the increase of that development. In other words, instead of delivering the present normal flow during all seasons of the year, Colorado could deliver in a few months water equivalent to the present annual supply without regard to seasons which could be conserved in the reservoir and let down the river at a time when it would be important and useful to those below who divert water from the channel of the river for irrigation. Thus, the State Line Reservoir would be particularly of value to the Middle Rio Grande Conservancy District and it would serve to bring about the most efficient use of the waters of the river both in Colorado and in New Mexico.

It is estimated that the cost of both the drain and the State Line Reservoir would be in the neighborhood of two million and a half dollars. Upon a conservative basis the sixty million acre-feet which the United States, to preserve friendly relations with Mexico, has agreed to deliver to the citizens of that nation, is worth nine million dollars, and since in the final analysis this draft upon the river must be made by the sections of New Mexico and Colorado above San Marcial, it is equitable and just that the Government should compensate them to the extent of this comparatively small expenditure.

If there is any surplus in the river caused by spill and alleged waste at the Elephant Butte, it can be used under the Compact in New Mexico and Colorado equally without danger of damage to the users of water in New Mexico and under the Rio Grande Project.

From the foregoing I recommend to your favorable consideration the following benefits to New Mexico obtained by virtue of the Com-

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pact transmitted herewith:

(1) It brings about cooperation between the signatory States to the end that all of the resources contained in the section of the Rio Grande above Fort Quitman to the headwaters in Colorado, shall be utilized to the fullest extent and with the greatest efficiency possible.

(2) It preserves the flow of the river at the State line for six years without impairment by new uses in Colorado.

(3) It averts the necessity of the doubtful remedy of litigation which had become imminent prior to the time of this agreement, which would involve all the uncertainties, not to mention the great cost, of such procedure.

(4) It should lead to the drainage of the Closed Basin whereby an equated flow of a large quantity of water will be added to the flow of the river above the State line, the equivalent of which can be used in Colorado and which will be available for use in New Mexico at seasons when it will be most needed.

(5) It should lead to the construction of the State Line Reservoir which will solve the problem of Colorado of the delivery of water at the State line without interfering with new development in the San Luis Valley, and will greatly improve and stabilize conditions in New Mexico by equating the flow of the river so that during the irrigation season a dependable quantity of water will be always present in the main channel of the river.

(6) At the end of the period provided for in the Compact, to-wit, after June 1st, 1935, a permanent Compact may be entered into at a time when conditions on the river will be more settled and more easily determined by engineering information, particularly as to the prevention of waste, and the utilization of surplus waters ,and therefrom a just and equitable settlement of the water resources of the river will be more easily arrived at than is possible at present between the three States.

I believe that the Compact should be ratified by the Legislature, and I so recommend.

I would be ungrateful indeed not to mention the aid that I have received and the benefit which has accrued to the State of New Mexico through the services of D. C. Henny, our Consulting Engineer, of Herbert Yeo, our State Engineer, of Mr. J. L. Burkholder, Chief Engineer of the Middle Rio Grande Conservancy District, and his Assistant, Mr. R. G. Hosea, all of whom have been not only essential to our cause but always loyal in their service. From a legal standpoint, I have had the benefit of Judge Edwin Mechem, whose sane advice has been

of great help to me in critical periods of a trying undertaking, and of Mr. Pearce C. Rodey, Attorney for the Middle Rio Grande Conservancy District. Maj. Richard F. Burges of El Paso, Attorney for the Commissioner of Texas, Hon. T. H. McGregor, has been at my side throughout the negotiations, and with Senator McGregor, has been always helpful in the common cause.

The three States have been fortunate in our Chairman, Col. William J. Donovan, whom President Coolidge appointed to represent the Federal Government in our negotiations. Without his sympathetic and always diplomatic approach to every angle of the problem, I believe it is not too much to say that the agreement finally reached would not have been possible.

Respectfully submitted,

FRANCIS C. WILSON,
Interstate River Commissioner
for the State of New Mexico.

MEMORANDUM OF LAW—INTERSTATE COMPACTS.

The Constitution of the United States of America provides that "No State shall, without consent of Congress, * * * * enter into any agreement or Compact with another State". (Art. 1, Sec. 10, Par. 3.)

It is not material as to time when the "consent of Congress" is given,—it may be given before or after the Compact or agreement is concluded between the States. Furthermore, any approval by Congress of proceedings taken under the agreement by the signatory States indicates consent and would be sufficient. Story on Const., 4th ed., Vol. 2, Chap. 35; Virginia v. Tennessee 148 U. S. 521, 37 L. ed. 537; Wharton v. Wise, 153 U. S. 173, 38 L. ed. 669; Virginia v. West Virginia, 11 Wall. 59, 20 L. ed. 67; Green v. Biddle, 8 Wheat. 85, 5 L. ed. 547. A formal act is not required. The consent may be manifested by resolution, State v. Cunningham, 102 Miss. 237, 59 So. 76, Amer. Cas. 1914-D, 182.

Such compacts are inviolable under the Constitution, and it is deemed no objection to its binding character that its effect is to restrict, in some directions, the legislative power of the State entering into it. Green v. Biddle, supra, see also Hawkins v. Barney's Lessee, 5 Pet. 457. When Congress consents, the States are restored to that extent to their original sovereignty and their compacts become of binding force, operating with the same effect as a treaty between sovereign powers and the agreement is thus conclusive upon all the citizens of the signatory States and binds their rights. Rhode Island v. Massachusetts, 12 Pet. 724, 9 L. ed. 1233.

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The construction of such compacts when made effective by the consent of Congress is a judicial question, Rhode Island v. Massachusetts, supra. The prohibition against making such agreements between States without the "consent of Congress' extends only to subject matters which are in their nature political. Union Branch R. Co. v. East Tennessee etc. R. Co., 14 Ga. 327. Virginia v. Tennessee, supra.

Such compacts regulate the rights and remedies of all who are affected by it, Fleeger v. Poole, 1 McLean 191, Aff. 11 Pet. [U. S.] 185, 9 L. ed. 680 and cases supra, first paragraph.

Principles above defined are applicable to interstate streams, Kansas v. Colorado, 185 U. S. 125, 206 U. S. 46, and "the rule of decision is not to be collected from the decisions of either State, but is one * * * * of an international character," Marlett v. Silk, 11 Pet. 1, 23, 9 L. ed. 609.

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THE

STATUTES AT LARGE

OF THE

UNITED STATES OF AMERICA

FROM

DECEMBER 1931 to MARCH 1933

CONCURRENT RESOLUTIONS
RECENT TREATIES, EXECUTIVE PROCLAMATIONS AND AGREEMENTS
PROPOSED AMENDMENTS TO THE CONSTITUTION AND
TWENTIETH AMENDMENT TO THE CONSTITUTION

EDITED, PRINTED, AND PUBLISHED BY AUTHORITY OF CONGRESS
UNDER THE DIRECTION OF THE SECRETARY OF STATE

VOL. XLVII

IN TWO PARTS

PART 1—Public Acts and Resolutions, and Proposed Amendments to the Constitution.

PART 2—Private Acts and Resolutions, Concurrent Resolutions Treaties, Executive Proclamations and Agreements and Twentieth Amendment to the Constitution.

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UNITED STATES
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OF THE

UNITED STATES OF AMERICA

PASSED BY THE

SEVENTY-SECOND CONGRESS

1931 – 1933

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may be desired by the Wichita and affiliated bands of Indians for cemetery purposes: *And provided further*, That there shall be reserved to the Indian owners all coal, oil, gas, or other mineral deposits found at any time in the land.

Reservation of mineral rights.

Approved, March 28, 1932.

[CHAPTER 94.]

AN ACT

Granting certain public lands to the State of New Mexico for the use and benefit of the Eastern New Mexico Normal School, and for other purposes.

March 31, 1932.
[S. 1590.]
[Public, No. 69.]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby granted and confirmed to the State of New Mexico seventy-six thousand six hundred and sixty-seven acres of surveyed, non-mineral, unappropriated, and unreserved public lands of the United States in the State of New Mexico, for the use and benefit of the Eastern New Mexico Normal School, at Portales, Roosevelt County, New Mexico, to be used solely for normal-school purposes. Such lands shall be in addition to the lands granted to the State of New Mexico for normal-school purposes under the provisions of the Act entitled "An Act to enable the people of New Mexico to form a constitution and State government and be admitted into the Union on an equal footing with the original States; and to enable the people of Arizona to form a constitution and State government and be admitted into the Union on an equal footing with the original States," approved June 20, 1910, as amended, and the grant of such lands shall be subject to the same terms and conditions as are imposed upon the grants made by such Act of June 20, 1910, as amended.

New Mexico.
Grant of land to, for Eastern New Mexico Normal School.

To be additional.

Vol. 36, p. 557.

Terms and conditions.

Approved, March 31, 1932.

[CHAPTER 95.]

AN ACT

For the temporary relief of water users on irrigation projects constructed and operated under the reclamation law.

April 1, 1932.
[S. 3706.]
[Public, No. 70.]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That any irrigation district, water-users' association, or other water-users' organization under contract with the United States for payment of construction charges under the Act of June 17, 1902 (32 Stat. 388), or Acts amendatory thereof or supplementary thereto, including the Act of February 21, 1911 (36 Stat. 923) (upon acceptance of this Act by resolution of its board of directors or corresponding body), shall be required to make no payment on the regular construction charge for the calendar year 1931, and in lieu of the regular installment of construction charge provided for under existing contracts, may pay for the calendar year 1932 on the basis of 50 per centum of the amount which, but for this Act, would be payable under said contracts, such amount to be computed and determined for that year in the manner provided in said contracts and the law applicable thereto. Interest and penalty as now provided by law and contracts for nonpayments when due shall apply on all charges for 1932 adjusted as herein authorized; and otherwise the deferred payments herein authorized shall bear interest until paid at such rate, and

Irrigation on reclamation projects.
Payments of construction charges deferred.
Vol. 32, p. 388.
Vol. 36, p. 925.
Post, pp. 776, 1427.

Calendar year 1931.

1932.

Application of interest and penalty provisions.

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shall be paid at such times, as the Secretary of the Interior shall determine: *Provided*, That in determining the rate for the sale of power during the irrigation season of 1931 to irrigation districts from any power plant operated by the Bureau of Reclamation, interest on the cost of the power system shall not be included as an element, but interest at the rate of 2½ per centum per annum shall be included as an element of such rate for the sale of power to such districts during the irrigation season of 1932: *And provided further*, That the payments for construction charges and interest payments on the cost of the power systems referred to in this Act shall not be deemed waived, but only deferred, and shall be paid as provided in this Act.

Provisos.
Interest as element in determination of power rate.

Construction charges and interest payments not waived.

Benefits to apply to individual water-right applicants.

SEC. 2. On projects or divisions of projects where no irrigation district, water-users' association, or other water-users' organization has assumed joint obligation for payment of construction charges individual water-right applicants or entrymen upon acceptance of this Act in a manner satisfactory to the Secretary of the Interior, shall be required to make no payment on the regular construction charge for the calendar year 1931, and in lieu of the installments payable under existing contracts, may pay their regular installments of construction charges for the calendar year 1932 on the same basis as that authorized in section 1 hereof for districts, associations, and other water-users' organizations.

Uncompahgre reclamation project, Colo.
Vol. 46, p. 1974.

SEC. 3. The Act of Congress approved January 31, 1931, entitled "An Act for the relief of the Uncompahgre reclamation project, Colorado" (Private, Numbered 300, Seventy-first Congress), is hereby amended to extend for one year from and after January 1, 1932, the time for beginning construction of drainage system upon the Uncompahgre project, and any and all construction charges accruing upon or for said project for or during the year 1932, shall be deferred and included in and made payable as a part of the project supplemental construction charge provided for in said Act of January 31, 1931; and in order to afford opportunity to complete the construction authorized by the Act of Congress approved February 21, 1931 (Public, Numbered 708), relating to the Grand Valley reclamation project, Colorado, any and all construction charges accruing upon or for said project for or during the year 1932 shall be deferred and shall be included in and made payable as project supplemental construction charges under the terms as provided in this Act.

Construction of drainage systems on, deferred. Payment.

Grand Valley reclamation project, Colo.
Vol. 46, p. 1202.
Construction charges deferred.

Resumption of payments of charges under existing contracts.

SEC. 4. At the expiration of the period for which deferment of charges is made under this Act, all districts, water-users' associations, or other water-users' organizations, and all individuals accepting the provisions hereof shall resume payment of charges on the basis of and in accordance with existing contracts and shall continue payments thereafter until the entire indebtedness of said districts, water-users' associations, or other water-users' organizations, and individuals to the United States shall have been fully paid. In the case of a district, water-users' association or other water-users' organization, or individual having contracts executed pursuant to the Act of February 21, 1911 (36 Stat. 925), the Act of August 13, 1914 (38 Stat. 686), or the Act of May 25, 1926 (444 Stat. 636)[1], or any special Act the deferred construction installment or installments for the calendar year 1931, and that portion of the 1932 installment or installments deferred, together with the installment or installments of deferred construction and/or operation and maintenance

When deferred construction installments due.

Vol. 36, p. 925; Vol. 38, p. 686; Vol. 44, p. 636.

[1] So in original.

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for 1931 and 50 per centum of the installment and/or installments of such deferred charges for 1932, shall be paid as an additional installment to be due and payable one year after the date the last installment under existing contracts shall become due, except in those cases in which the Secretary of the Interior, whose decision shall be final, shall find necessary additional installments, which he is hereby authorized to fix. In the case of any district, water-users' association, or other water-users' organization, or individual under contract for payment of construction charge pursuant to subsection F, section 4, Act of December 5, 1924 (43 Stat. 702), construction payments shall be continued on the basis of existing contracts until the entire indebtedness to the United States, including all charges deferred pursuant to this Act, shall have been fully paid. Installments so carried over shall be subjected to the reductions provided for in section 8 hereof.

Exception.

Additional installments authorized.

When construction payments to continue under existing contracts.
Vol. 43, p. 702.
Reductions.

SEC. 5. The Secretary of the Interior, in his discretion, and upon acceptance of the provisions of this section by the water users affected, in the manner provided in sections 1 and 2 hereof, may permit adjustment of construction and/or operation and maintenance charges heretofore deferred by contracts made pursuant to existing law to be made for the years 1931 and 1932 on the basis authorized in sections 1 and 2 hereof or on such other basis as the Secretary may find to be required in each case.

Adjustment of construction, operation, and maintenance charges.
Ante, pp. 75, 76.

SEC. 6. The Secretary of the Interior, in his discretion, is further authorized to defer the payment to the United States from any water-users' organization, as defined in section 1 hereof and from any individual water-right applicant or entryman of construction charges and installments of deferred construction and/or deferred operation and maintenance charges for the calendar year 1930 and prior thereto. Such deferred charges, together with penalty or interest to December 31, 1931, under existing laws and contracts shall be paid in such annual installments as the Secretary of the Interior may fix.

Payment of construction, etc., charges, for 1930, etc., deferred.

Annual installments.

SEC. 7. Any irrigation district, water-users' association, or other water-users' organization which has contracted to pay construction charges and which is not in arrears for more than one calendar year in the payment of any construction, operation, and maintenance, or other charge due by it to the United States may, at its option, deliver or authorize the delivery of water during the years 1932 and 1933 to water users who may be more than one year in arrears in the payment of charges or asessments due from such landowner or water user to the district or association.

Delivery of water to delinquent individual user.

SEC. 8. In the case of any irrigation district, water-users' organization, or individual, receiving credits on account of power profits or other revenues under the provisions of subsections I and/or J, section 4, Act of December 5, 1924 (43 Stat. 703), or any other Act of Congress, when any extension is granted as provided in section 1, 2, or 4 the amount of such credits shall be deducted from the amount of any payment so extended: *Provided*, That the provisions of this section shall not apply to power profits or other revenues derived from works not constructed at the expense of the United States. The credits, if any, in excess of the payment so extended shall be applied as now provided by law and contract. Acceptance of the provisions of this Act shall operate as a waiver of any law and/or contract providing for application of credits different from that in this section prescribed.

Power sale profits to be deducted from payments.
Vol. 43, p. 703.
Ante, pp. 75, 76.

Proviso.
Not applicable unless Federal construction.

Credits in excess of payment.
Effect of acceptance hereof.

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Crediting payments of construction charges for 1931.

SEC. 9. Collections of construction charges for the calendar year 1931 (which charges are subject to adjustment and are adjusted under sections 1, 2, and 4 of this Act) and penalties and interest, if any, from water-users' organizations and individual water-right applications or landowners, heretofore made under existing contracts, shall be credited upon the succeeding payments as they become due, including operation and maintenance charges.

Deferment of the repayment of moneys advanced to reclamation fund.
Vol. 36, p. 835.
Vol. 46, p. 1507.

SEC. 10. That the Act of June 25, 1910, entitled "An Act to authorize advances to the reclamation fund, and for the issue and disposal of certificates of indebtedness in reimbursement therefor, and for other purposes," as amended, and the Act of March 3, 1931 (46 Stat. 1507), are hereby amended so as to provide that payments in reimbursement of moneys so advanced under these Acts and not heretofore repaid shall be made by transfer annually from the reclamation fund to the general funds of the Treasury beginning July 1, 1934.

Approved, April 1, 1932.

[CHAPTER 96.]

April 8, 1932.
[S. 3836.]
[Public, No. 71.]

AN ACT

To authorize the construction of a temporary railroad bridge across Pearl River at a point in or near the northeast quarter section 11, township 10 north, range 8 east, Leake County, Mississippi.

Pearl River.
Construction of temporary railroad bridge across, authorized.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Pearl River Valley Lumber Company is hereby authorized to construct a temporary railroad bridge connecting its timber holdings and its lands and timber across Pearl River at a point in or near the northeast quarter section 11, township 10 north, range 8 east, Leake County, Mississippi, in accordance with the provisions of the Act entitled "An Act to regulate the construction of bridges over navigable waters," approved March 23, 1906.

Construction.
Vol. 34, p. 84.

Amendment.

SEC. 2. The right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, April 8, 1932.

[CHAPTER 97.]

April 8, 1932.
[S. J. Res., 47.]
[Pub. Res., No. 15.]

JOINT RESOLUTION

For the improvement of Chevy Chase Circle with a fountain and appropriate landscape treatment.

District of Columbia.
Erection of memorial fountain at Chevy Chase Circle, authorized.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Director of Public Buildings and Public Parks of the National Capital is authorized (1) to provide for the erection of a memorial fountain of simple design at Chevy Chase Circle in the District of Columbia and for appropriate landscaping in connection therewith, and (2) to accept, on behalf of the United States, donations for such purposes except that the work herein authorized shall not be commenced until there shall have been received donations equal in the aggregate to the estimated cost of such work and unless such work can be completed within a period of three years from the date of enactment of this Act. The United States shall be put to no expense in connection with such work. The plans and designs for such fountain and landscaping shall be approved by the National Commission of Fine Arts.

Acceptance of donations.

No Federal expense.

Approval of plans.

Approved, April 8, 1932.

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FROM

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OF THE

UNITED STATES OF AMERICA

PASSED BY THE

SEVENTY-SECOND CONGRESS

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SEC. 4. That nothing in this Act shall prevent the carriage, storage, or handling of property free or at reduced rates, for the United States, State, or municipal Governments, or for charitable purposes. Special rates to Government, etc.

SEC. 5. That the provisions of the Shipping Act, 1916, and as amended prior to this Act, shall in all respects, except as amended by this Act, continue to be applicable to common carriers by water in intercoastal commerce. Existing laws applicable. Vol. 39, p. 729; Vol. 40, p. 900; Vol. 44, p. 1083.

SEC. 6. That this Act may be cited as the Intercoastal Shipping Act, 1933. Title.

Approved, March 3, 1933.

[CHAPTER 200.]

AN ACT

March 3, 1933. [S. 5417.] [Public, No. 416.]

To extend the operation of the Act entitled "An Act for the temporary relief of water users on irrigation projects constructed and operated under the reclamation law," approved April 1, 1932.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in the administration of the Act entitled "An Act for the temporary relief of water users on irrigation projects constructed and operated under the reclamation law," approved April 1, 1932, the Secretary of the Interior is authorized and directed to extend the provisions of such Act relating to certain charges coming due for 1931 and to one-half of certain charges due for 1932, in like manner to the remaining one-half of such charges coming due for 1932 and to all of similar charges to become due for 1933, and to extend the provisions of section 3 of such Act, (1) so far as they relate to the extension of time for beginning construction of a drainage system upon the Uncompahgre reclamation project, to one year from and after January 1, 1933, and (2) so far as they relate to certain charges upon or for the Uncompahgre and Grand Valley reclamation projects in the State of Colorado due and payable for the year 1932, in like manner to all similar charges due and payable for the year 1933: *Provided*, That the deferred charges shall bear interest at the rate of 3 per centum per annum for the years specified in the Act approved April 1, 1932, and as amended herein, which interest shall be paid at the same time the principal deferred herein is paid.

Water users on irrigation projects. Extension, for 1932 and 1933 charges, authorized. *Ante*, p. 75, amended.

Uncompahgre drainage construction.

Construction charges, Uncompahgre and Grand Valley projects, deferred.

Proviso. Interest, deferred charges.

SEC. 2. That the last line of section 10 of said Act is amended by substituting "1936" for "1934."

Reimbursing advances to begin July 1, 1936.

Approved, March 3, 1933.

[CHAPTER 201.]

AN ACT

March 3, 1933. [S. 5525.] [Public, No. 417.]

To extend temporary relief to water users on irrigation projects on Indian reservations, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Interior is authorized and directed to extend to water users on Indian irrigation projects like relief to that provided in an Act approved April 1, 1932, applying to water users under the reclamation law for the remaining half of such charges due for the calendar year 1932 and for all similar charges to become due for the calendar year 1933, the said Secretary to issue appropriate regulations for the carrying out of the provisions of this Act.

Indian irrigation projects. Relief provisions to water users on, extended. *Ante*, p. 75.

Approved, March 3, 1933.

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Compliments of NGH

P R O C E E D I N G S

of the

RIO GRANDE COMPACT CONFERENCE

held

at

Santa Fe, New Mexico,

December

10

11

1934.

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INFORMAL MEETING

An informal meeting of the Commissioners, and their legal advisors was called by Mr. S. O. Harper, representative of the United States Government at 8 P. M., December 10, 1934, in Room 102, La Fonda Hotel, with the following persons present:

S. O. Harper and E. B. Debler representing the United States
M. C. Hinderlider and S. P. Howell representing Colorado
Thomas M. McClure and Frank H. Patton representing New Mexico
Senator T. H. McGregor and Major Richard F. Burges representing Texas.

MR. HARPER: I want to read you this telegram which I received Saturday: "S. O. Harper, Bureau of Reclamation, U. S. Custom House, Denver, Colorado. 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."

The delegation to me of the responsibility of presiding at this meeting was, to say the least, entirely unexpected, and I had no idea I was to be assigned these duties until I received this telegram. My contact with this situation, as most of you know, has been rather long range. When someone talked with Dr. Mead and expressed surprise that I had been assigned this duty, I am told he smiled and said: "It's probably just as well he hasn't had previous contact with it." As I understand my duties I will act largely in the capacity of an observer and referee, or any other term you may call it, and I propose to represent the interests of the government only so far as they are affected by the Treaty with Mexico of 1906, and the investment which the government has in the Rio Grande project in New Mexico and Texas.

Now to refresh your memory, I might quote from Article 7 of the Compact dated February 12, 1929, which says: "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."

I think that is the substance of what this Commission is called together to attempt to accomplish - to conclude a compact. The purpose of this preliminary meeting is to outline a course of procedure and a program for our formal meetings to be started tomorrow morning at 10 o'clock - at least tentative arrangements have so been made. I believe it will be in order to have expressions from the official representatives of each state, and any suggestions that you may have to offer as to what shall be covered in the meetings tomorrow, the procedure which will be followed, and time limitations, if any, which will be placed on the presentation of each of the representatives of the several states, and I will call on Mr. Hinderlider first to express his views on behalf of Colorado.

MR. HINDERLIDER: You have just read into the record the telegram from the Secretary of the Interior authorizing you to act on behalf of the Federal Government. May I make this observation - it is my understanding that the representative of the Federal Government on these Commissions has the same power and authority that the representatives from any of the states have, and it has been customary, upon the meeting of such Commissions, for the delegates, or Commissioners, of the respective states, to elect the Federal Representative as Chairman of the conference, and hence I would like to offer at this time a motion that Mr. Harper, who represents the United States Government on this Commission, be designated as Chairman of our further deliberations.

Seconded by Senator McGregor and unanimously carried.

SENATOR McGREGOR: To be sure we understand this, for instance if the three states agree on a compact, I don't think his (Harper's) negation would destroy that compact. I don't think he has a vote on it, in other words.

MR. CARR: I don't think so; he is presiding officer without vote.

MR. HARPER: I think that can be answered by referring to the Compact of 1929 which the three Commissioners signed, and at one side it was approved by the representative of the government. Even though that were not the rule, as a matter of policy the representative of the government will act as Referee, for want of a better word, or umpire, and will only express his opinions when he considers that the interests of the government, as represented by these two contacts which I just mentioned, are affected.

MR. HINDERLIDER: Do you want the designation of the official Commissioners?

MR. HARPER: Yes, I believe that would be in order.

MR. HINDERLIDER: By authority from Governor Edwin C. Johnson of Colorado, M. C. Hinderlider has been designated as the Commissioner representing the State of Colorado in these deliberations. I am also Interstate River Commissioner for the State of Colorado. My official legal adviser here is Hon. Schrader P. Howell, Asst. Attorney General of the State of Colorado, with the additional advisers Hon. George M. Corlett, Attorney at Law, of Monte Vista, Colorado; Hon. Ralph L. Carr, Attorney at Law of Denver, who represent a majority of the canal systems in the San Luis Valley, and Royce J. Tipton as Engineering adviser. I may add, Mr. Chairman, that in the hurry of leaving my office Sunday evening I neglected to bring the letter of appointment or executive order, of Governor Johnson with me, but I assume that can be furnished later for the record.

MR. HARPER: That may be furnished later. Mr. McClure, will you state the representatives of New Mexico.

MR. McCLURE: I will ask Mr. Patton to speak for New Mexico.

MR. PATTON: Mr. Chairman, I am Frank H. Patton, Assistant Attorney General

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of the State of New Mexico. This state has what is known as an Interstate River Commissioner. The Interstate River Commissioner is at present absent from the state and we, believing that he as such official would possibly have no power to act at this meeting, the Governor of this state, A. W. Hockenhull, has designated Hon. Thomas M. McClure as Commissioner to act at this meeting under Article 7, Paragraph (a) of the Tri-State Compact. Under the law of the State of New Mexico, the Attorney General and his assistants are the legal advisers of all the State departments, bureaus, boards and commissions. It is for that reason that I am present as the legal adviser of Mr. McClure and as Asst. Attorney General of the State of New Mexico, under the law, with all the powers and duties possessed by the Attorney General. We are requesting as our assistants and adviser, the Hon. Pearce C. Rodey of Albuquerque, N. M.; Hon. Edwin Mechem, Attorney at Law, Las Cruces, N. M. and Hon. C. H. Howell, as engineering advisers. We are also calling in Mr. John Bliss of the State Engineer's office of this state.

SENATOR McGREGOR: The State of Texas is represented by its duly commissioned Commissioner T. H. McGregor of Austin, Texas, who has associated with him, Hon. Richard F. Burges of El Paso, Texas, as lawyer and counsel.

MR. HARPER: Mr. E. B. Debler, Hydraulic Engineer of the Bureau of Reclamation will attend the conference as engineering adviser for the representative of the Government. Mr. DeVries, our district counsel, who would have been here as legal adviser, was called to Washington and will not, therefore, be able to be present at this meeting.

Would you care at this time Mr. Hinderlider to give us your views as to the scope of this conference, the limitations, if any, which we will place on various speakers, and the program to be followed?

MR. HINDERLIDER: In response to your inquiry, Mr. Chairman, I may say that following the procedure of our last conference in Santa Fe leading up to the present Rio Grande Compact, it is my understanding that each state presented the general views of that state, and I presume that that procedure would be entirely satisfactory to Colorado. As to the time limit to be placed upon each State, I do not think that we should contemplate any particular limit of time because it is my feeling we are all here with the desire to reach an understanding, if at all possible, with respect to the waters of the Rio Grande. If such procedure is acceptable to all the states, I doubt if it would be feasible to place a time limit upon what they may have to say, but I should be glad to hear from the commissioners of the other states before expressing our final opinion in that regard.

MR. HARPER: My thought in mentioning the word 'time limit' was that possibly if we do not exercise some control we may cover a good deal of the same ground which was covered five years ago, it being now the purpose of this conference to go on from here and conclude the work which was started and not completed five years ago. May we hear from the representative from New Mexico?

MR. McCLURE: I really think that we should more or less place some kind of a limit on discussions in regard to this or we might have too lengthy orations. We are all very short for time and I feel possibly there might be some repetition and if we can confine those repetitions to one discussion, it would probably save time.

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MAJOR BURGES: I think it would be a little difficult to indicate in the beginning - of course, as those who were present on the former occasion know, when we actually came to drafting the Compact it was done in a short while. We took lots of time in preliminary discussions, but the actual work of drafting the Compact was very quickly done. Of course, I seriously question whether any debate in the ordinary sense of debate will be worth while, although I do not have any desire to preclude anybody from saying what they want to. I doubt, however, if a debate would facilitate any agreement.

MR. HARPER: As I understand it, in the 1929 conference, open meetings were held for 2 or 3 days - until everyone had a say - and then the conference went into executive session to work out the details of the compact.

MR. HINDERLIDER: It would seem to me that in a matter of such grave importance, that all the necessary matter in the hands of the states should be presented preliminary to attempting to draft a compact. I may say further that some of the Commissioners, at least two of them - Mr. McClure and myself - were not present at the former hearing leading up to the present compact, and neither was Mr. Howell of the Attorney General's office of Colorado, so I feel that each state should have sufficient time to present any matters that may seem pertinent to it to present. It is my thought personally that the meeting tomorrow will probably not involve the presentation of any detailed data - its more in the nature of presenting a broad view, as I understand it, of the position of each state, after which, probably, it would be desirable for all of us to recess and return at a later date after we have had time to digest the matter presented. That's my own thought and I would be glad to hear from the other commissioners.

MR. HARPER: Could you make an estimate of how long it would take your representatives to present their case at this time?

MR. CARR: At the previous conference, I don't believe all three states took over an hour and a half.

MR. HARPER: Is it the sense of the meeting that each state, beginning at the regular session tomorrow, shall be called upon to make an opening statement broadly outlining the position of that state, each state in turn - just in what order perhaps is immaterial - making this general statement through its chosen representative or legal adviser, and then following such statements, that each state be given an opportunity to present through other representatives who are here any special matters which these particular representatives or advisers wish to submit to the meeting?

MR. HINDERLIDER: That is Colorado's viewpoint, Mr. Chairman.

SENATOR McGREGOR: Mr. Hinderlider made the suggestion that we might recess to a later date. Under the terms of Sec. 7 of this compact, this new Commission is to create a new compact. This Commission can do that now by reenacting the existing compact, if they saw fit and unanimously did so, and it would not require any further time. If they decline to do that tomorrow, then Mr. Hinderlider's suggestion is timely. There ought to be a recess say of 30 or 60 days, so that the differences between these states, being

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clearly defined in order to know the points of issue, so when they come back they can approach the subject intelligently. Another reason for that, Mr. Chairman, is that the Texas legislature did not - it don't make any difference to you New Mexico or Colorado follows - but the Texas legislature will have met in the meantime and can furnish its commissioner with a little state money and railroad fare. There is no appropriation now at all to take care of what happens here, but our legislature meets in January and that can be taken care of and ought to be. So I think the first question we ought to approach is as to whether the three signatory states are satisfied with the present compact. If you are, we can report it to our respective states, have the legislature re-enact it into statute and have the federal congress approve it. I am not saying that you do that - I am just telling you the procedure. If you don't want the existing compact, say what you want in this new compact and let these commissioners go home and come back about February 15th and come to an agreement.

MR. HINDERLIDER: With respect to Senator McGregor's first statement, I believe after the presentation of the basis of each state tomorrow it will immediately develop whether or not any state is satisfied with the present compact.

SENATOR McGREGOR: You know now, individually and personally, whether the existing compact will be renewed, so it doesn't require any proof on that. You represent and speak for Colorado. I know now - and Major Burges soon will know it - whether or not Texas will stand for the same compact and we don't need any proof, so if Colorado would come here and say we are unwilling to continue this compact, then this compact passes out.

MR. HINDERLIDER: Don't you think it would be absolutely necessary to have this meeting tomorrow and it will develop immediately. Then as to the other matter, which I consider of considerable importance, the legislatures of all three states will convene in January. The period of the session of our legislative assembly is from 90 to 100 days. We all realize that if we can agree on a compact it should be done so that the matter may be laid before our respective legislatures for ratification before the adjournment thereof, and also the compact may then be laid before the Congress of the United States by the president for confirmation before it adjourns, so, in my opinion, we will have to work toward those ends as the limit of the time we could give to the matter at this particular time. I believe, however, that after the matters are presented tomorrow and the opinion of the Commissioners had, that a temporary adjournment should be taken; that it would be profitable for everyone concerned to return to Santa Fe at a later date to continue our negotiations.

MR. HARPER: How about the views of New Mexico on this matter?

MR. McCLURE: Mr. Chairman, the views of New Mexico at the present time in regard to what we would want are a little indefinite at this time. I have no statement to make at present in regard to that. I think Mr. Hinderlider is right in trying to get our action before our respective legislatures before the termination of the compact in June, 1935, and also have it ratified by Congress. If possible, in this term of Congress.

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MR. PATTON: The legislature of New Mexico will meet on the second Tuesday of January. We only have a 60 day session - 30 days less of madhouse than you have in Colorado - and I believe we might say we are in this position at this time. We have nothing definite to present so far as data is concerned regarding a new compact. Possibly we will have to take that position at this meeting tomorrow. The matter of limiting debate for that reason, insofar as New Mexico is concerned, does not interest us very much because, in all probability, we will have very little to say.

MR. HINDERLIDER: Likewise, we may have very little to say.

MR. HARPER: As I sense the feeling of the delegates, we are agreed that the meeting should start off tomorrow with an opening statement by the delegate or representative from each state in turn. Such opening statements might take an hour, or an hour and a half. Perhaps New Mexico, as Mr. Patton has just said, may not care to take much time. I would suggest that some one place before us a motion, if that is the sense of the meeting, and as to fixing the order of presentation by each of the states, if you wish to leave that to the Chair you may incorporate it in the motion; if not, state otherwise.

SENATOR McGREGOR: I move that when we adjourn, we adjourn until 10 o'clock tomorrow morning, at which time the various states tersely state their attitude towards the existing compact and such changes therein as they desire, the states speaking in alphabetical order.

MR. McCLURE: I might add that the meeting will be held in the Supreme Court Chambers at the State Capitol Building.

Seconded by Mr. Hinderlider and unanimously carried.

SENATOR McGREGOR: I move that Mrs. Ethel F. Stevenson be designated the official reporter of this Commission.

MR. HINDERLIDER: I'll add the amendment that the states pay for her services on a pro rata basis, and if there are no federal funds available for the pro rata share of the government, that the three states absorb it.

Seconded and unanimously carried.

MR. HINDERLIDER: I believe the proceedings should be fully reported tomorrow, except for discussion off the record, so each of the commissioners may have a full copy of the record later on.

MR. McCLURE: Should the expense be confined to one copy for each state? I think there should be some limit for some states might want 8 or 9 copies.

SENATOR McGREGOR: An original and three copies; then if additional copies are wanted they shall be paid for by anyone who wants them.

MR. HARPER: If there is nothing more to come before us at this time, the meeting will stand adjourned until 10 o'clock tomorrow morning.

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PROCEEDINGS

of the

RIO GRANDE COMPACT CONFERENCE.

The Rio Grande Compact Conference met in the Supreme Court room of the State Capitol Building at Santa Fe, New Mexico, December 11, 1934, at 10 A.M., Mr. S. O. Harper presiding, with the following official representatives in attendance:

S. O. Harper, Asst. Chief Engineer, Bureau of Reclamation, representative of the President.
E. B. Debler, Hydraulic Engineer, Bureau of Reclamation, engineering adviser.
Representing the United States Government

M. C. Hinderlider, State Engineer, and Interstate River Commissioner
Schrader P. Howell, Asst. Attorney General
George M. Corlett, adviser
Ralph Carr, adviser
Royce J. Tipton, Engineering adviser
Representing the State of Colorado

Thomas M. McClure, State Engineer and Commissioner
Frank H. Patton, Asst. Attorney General
Pearce C. Rodey, legal adviser
Edwin Mechem, Engineering adviser
John Bliss, Engineering adviser
C. H. Howell, Engineering adviser
Representing the State of New Mexico

T. H. McGregor, River Commissioner
Richard F. Burges, Legal adviser
Representing the State of Texas.

INFORMAL PROCEEDINGS

MR. S. P. HOWELL: It just occurred to me that a motion should be adopted providing for the presentation of credentials, and I think, in order to have the record straight, which I am confident the Commissioners will agree is proper, that should be preceded by the call of the Governors and correspondence relating to this particular meeting which is in conformity with Section 7.

MR. HINDERLIDER: I would like to offer the motion that there be included in the record the invitation of Governor Edwin C. Johnson to Governor Hockenhull of New Mexico and Governor Miriam Ferguson of Texas to meet at Santa Fe, New Mexico, for the purpose of negotiating a new compact concerning the waters of the Rio Grande; also a copy of the correspondence passing between the three Governors relating to this matter; also the request of the Governor of Colorado, and I believe also by the Governor of New Mexico, to the President of the United States to appoint a representative of the federal government to sit with the commissioners of the three states in question. Also the presentation of credentials to show the accredited representatives here on this Commission

by virtue of the authority from our repsective Governors (copies of all of which are attached hereto.)

Seconded by Mr. McGregor and Unanimously carried.

SENATOR McGREGOR: Before you proceed with the regular business this morning, I would like to make a privileged motion, to show an appreciative record for the services of a public servant which adds a charm to public life. I miss here on this occasion the great character that dug out of the federal constitution the right of the states to form a compact. I met him in the beginning of the first conference that was had on the original compact; a man of transcendent ability and of marvelous patriotism, with a superb patience, never losing sight of the great state of Colorado. I have been close to, and in public life, practically all of my life, and I have never met a man that I thought was more devoted to his duties and sense of duty, more loyal to his state than Delph Carpenter. Realizing conditions as they exist now relative to him, I think it would be highly appropriate for this Commission to send him at least a courtesy telegram, and with that thought in mind this morning I drafted what I thought was appropriate. Then I mentioned the matter to Major Burges and found that he had had the same thought and he handed me his draft and I have made a composite of the two which I will read to the Commission and move that the reporter be instructed to send it to Senator Carpenter and give it to the press of the great state of Colorado: "Hon. Delph Carpenter, Greeley Colorado. The Commissioners, legal advisers, engineers and all other attaches of the conference having under consideration the Tri-State Compact concerning the waters of the Rio Grande, extend to you their heartiest felicitations and express their sincerest regrets that you are not able to be present and continue in the great work which you inaugurated and to which you have contributed so much. T. H. McGregor, Thomas M. McClure, M. C. Hinderlider, S. O. Harper."

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

MR. HINDERLIDER: Mr. Chairman, as Commissioner for the State of Colorado, and on behalf of my state and my associates at this meeting, I want to express my very sincere appreciation of the attitude of Senator McGregor, the Commissioner for Texas, and our colleagues in this matter. I am sure that Senator Carpenter will very greatly appreciate this tribute of esteem, regard, respect and affection.

FORMAL PROCEEDINGS

MR. HARPER: The meeting will now formally come to order. Five years ago, early in 1929, a meeting was held in this city between representatives of the three states, Colorado, New Mexico and Texas, participated in by a representative of the federal government, which led to the adoption of a compact signed by the commissioners under date of February 12, 1929; later ratified by the legislatures of the three states and was approved by Congress on June 17, 1930. Article 7 of this compact reads as follows: "On or before completion of the closed basin drain and state line reservoir, and in any event not later than June 1, 1935, a Commission of three members shall be constituted to which 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 said states. The Governors of said states shall request the President of the United States to name a representative to sit in said Commission."

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Pursuant to this Article, the Governors of the States, as just recited by Mr. Hinderlider, took action to have this meeting convene at Santa Fe on December 10th. A telegram was received by me from Secretary of the Interior, Harold L. Ickes on December 8th reading as follows: "S. O. Harper, Bureau of Reclamation, U. S. Custom House, Denver, Colo. 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."

Last evening an informal meeting of the Commissioners and their legal representatives was held with a view to agreeing upon a form of procedure and other matters relating to organization. For the benefit of those who were not present at that meeting I will briefly review the action taken. Credentials were submitted orally to be confirmed later by filing written credentials with the official reporter. It was agreed as to procedure that each state should be called upon to submit, through its commissioner or other representative, a preliminary statement broadly outlining its position, the states to be called upon in alphabetical order. The functions of the federal representative on this Commission are principally of an advisory nature, in addition to acting as Chairman of the meeting. As I understand it, he is to assume the position of umpire or referee, will have no vote but will furnish any advice, or answer any questions, if called upon. Mr. Debler, as engineering adviser, will be available to furnish information or facts to any of the members of the Commission upon request. In the formal proceedings it will be necessary for the chair to limit recognition to the members of the Commission, as this is a meeting solely of the official commissioners. The legal advisers or other advisers will secure recognition through the authorized members of the Commission. The Commissioner will introduce the adviser he desires to speak.

SENATOR McGREGOR: Suppose I would be asked some legal question affecting the priority rights under your water rights law with which I am not familiar. Wouldn't I have the right to ask my counsel to answer it? In other words, I can appear here by counsel.

MR. HARPER: It will be proper to ask, informally, any question you desire.

SENATOR McGREGOR: What I am driving at, I have the right to appear here by counsel?

MR. HARPER: You must designate and introduce your counsel before he begins to speak. This is only in the interest of orderly procedure. I believe, with this introductory statement, we are now ready to call on the Commissioner from Colorado, Mr. Hinderlider, to submit his statement, either through himself or his duly authorized representative.

MR. HINDERLIDER: Mr. Chairman and gentlemen of the conference: I wish to preface my preliminary remarks with the statement that I will be followed in making these remarks by Mr. George M. Corlett, who will present the major phases of Colorado's position. Once again we are met together in this historic city in a forum where states having common interests in the greatest natural resource within their borders, have debated what they have conceived to be their rights and equities in the waters of two of our greatest rivers and in

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one of lesser importance. As a result, such discussions, have wholly or in part, succeeded in adjusting their conflicting claims on the basis of fairness, comity and good will. While the Supreme Court of the United States has held, in theory at least, that as between themselves each state is possessed of all the elements of a sovereignty, and that no state may impose its will upon another, nevertheless all stand upon the common basis of equality, and that tribunal has uniformly applied this underlying principle in disposing of disputes which have arisen between the different states with respect to common resources, such as the waters of an interstate stream. In keeping with this principle, the legislatures of the states of Colorado, New Mexico and Texas, and the Congress of the United States in ratifying and approving the present Rio Grande Compact, provided that any new compact shall be predicated upon an equitable division between the states of the waters of this great interstate stream. Equitable division we do not conceive to necessarily mean that each state does, or shall have, an equal share of the common resource, but rather that the same measure shall be accorded to each state to secure to such state the fullest enjoyment of the use of its share of the waters upon whatever basis determined; whether it be that of priority of use, relative contributions, necessities and opportunities for use, or a combination of these, and possibly other reasons. Colorado feels that all causes for disagreement between these states with respect to the waters of the Rio Grande should be forever removed by a permanent compact between the states, which will provide the citizens of each state with the same degree of security, and that nothing short of such understanding would conform to the spirit and intent of the mandate of the present compact. Colorado feels that this is a solumn obligation resting with equal force upon all three of the states. Colorado welcomes the opportunity to present her views, claims and reasons therefor, in a spirit of friendliness and good will for the citizens of her sister states, with the hope that they may constitute the formula by which this solution of our mutual problem may be achieved. Mr. Chairman, as I have already stated, Hon. George M. Corlett, who represents a major number of the water-users in the San Luis Valley in Colorado, will now present to the conference Colorado's general views and position with respect to this interstate problem.

MR. CORLETT: Mr. Chairman and members of the Commission; lady reporter and gentlemen: I appreciate more than I can say this new exhibition of the universal courtesy and consideration of Senator McGregor and Major Burges in sending this kindly message to Delph Carpenter, whose advice and keen insight we will all miss; not only the people of Colorado but the people of New Mexico and Texas as well, I am sure. It brings strongly to my mind the fact that in this matter in which we are all interested, that we come and go. In digging out my files the other day, when my secretary placed them on my desk, I found that I started my first file in this matter in 1904. Our family settled in the San Luis Valley on the Rio Grande in 1888. In looking about over the assemblage here, I think perhaps Major Burges is the single individual that I can remember - there are probably a number here - who has been connected with this matter from its inception besides myself. We have discussed the matter privately; we have discussed it publicly; we have discussed it through the newspapers, which have, I think, probably contributed more in the way of a brake upon a final amicable termination than in a helpful way - not intentionally, but because, perhaps, they jumped at conclusions and were misadvised. All of us here, I think I can say without any question, are interested in the Rio Grande river and the Rio Grande Valley. We have our individual

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rights to protect, we have our individual ambitions and desires, but I think I can say without any question of doubt that we all are anxious, willing and ready to do everything we possibly can to promote the best interests of the Rio Grande Valley from its mouth to its source, and especially that portion which we are interested in above Fort Whitman.

I cannot help but think, in starting out on these discussions, that any set of individuals can meet, can enter into bickerings, can by possibly excess personal regard for their own interests, eliminate the possibility of united action, but it takes real statesmanship to work out a problem such as this, where the interests conflict, where there must be a crystallization of the benefits and of the ideas - the benefits that will attach, and the ideas that shall prevail, as it is applied to the entire district. We are here, gentlemen, as I understand it, for a dual purpose. In the first place we are here because we want a permanent compact. We entered into a compact as the Chairman has said, in 1929 and that is about to expire. We would like, if possible, to finally settle and determine our rights in the Rio Grande so that we may go ahead in the future with certainty; so that we may have our program outlined for years to come and know upon what we may rely. There is another matter that we are to consider at this time, and I think it possibly is the most pressing matter before this Commission, and that is that growing out of the old compact and growing out of the deliberations that lead up to that compact. The Public Works Administration has made an appropriation of $900,000 to construct a drain from the closed in basin in Colorado to the Rio Grande, which would make tributary to the Rio Grande a drainage area at least equal in size to the present area draining into the Rio Grande in Colorado, and which would divert the water which is developed, whatever that may be, from this closed in basin, commonly referred to as the sump area, into the Rio Grande for the use of New Mexico and Texas, with, as we must insist upon, a commensurate adjustment insofar as Colorado is concerned for this water to be delivered. That appropriation must be accepted or rejected soon.

I think, gentlemen, that perhaps it might not be amiss for me at this time to go into a little bit of the history of that outlet drain proposition which has not yet appeared in the records of this compact matter. I think it was along about 1925, I was in a conference with Secretary Hubert Work, who was then Secretary of the Interior, discussing our problems on the Rio Grande in Washington. He suggested that we ought, if possible, to get together, especially New Mexico and Colorado. At that time the principle difference was more acute between New Mexico and Colorado. In fact, he said "Corlett, Francis Wilson from New Mexico is here in Washington, and I would like for you two gentlemen to get together and agree on just one thing - I don't care what it is, just agree on something and then I would like to have you come up and talk it over." Senator Phipps placed at our disposal one of his rooms in the Senate Building and we spent three days in chewing over this difference of opinion as to the waters of the Rio Grande and we were unable to make any progress. Finally, I suggested to Mr. Wilson that we were running around in circles; that if we had any sense between us we would get together and build an outlet drain which would replace more water in the Rio Grande than could possibly be controlled in Colorado if we utilized our reservoir possibilities to the fullest. I offered to go into the records prepared by the Reclamation Service with him, some of which I believe Mr. Dobler participated in. I may be in error, but isn't that true? - - We finally went up

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to Dr. Mead's who got out three reports of the Reclamation Service. We went over these at length, and it developed that the Reclamation Engineers had determined there would be a return from this drainage area of a minimum of 16,000 acre feet per annum, and a maximum of 600,000 acre feet - I don't think you ever found the 600,000 acre feet.

We both agreed that if this were true, that this would undoubtedly automatically settle all matters of difference between the states of Colorado, New Mexico and Texas. We went up to Secretary Work to report, and he took us back in that little cubby-hole back of the secretary's desk, took off his coat and we all sat down. He sent for Dr. Mead to participate in the meeting. He asked us if we had arrived at any conclusion. We told him we had; that if these reports of the Reclamation Service were correct, that it would settle all matters of difference if we could dig this drain. Dr. Mead immediately became excersised over the Reclamation Fund, and when the Secretary asked him whether he thought this was feasible and should be carried out, he said "Well, Mr. Secretary, it looks to me like a raid on the Reclamation Fund". The Secretary said: "No, we have thirty million dollars worth of claims proposed by the Republic of Mexico that is a charge upon the entire United States of America. We have ceded 60,000 acre feet to Mexico in satisfaction of these claims; no three states should be required to pay the cost of providing that 60,000 acre feet and no three states should be charged with a national obligation. This whole Rio Grande matter has been held up in order to preserve comity between the nations of Mexico and the United States and this obligation is an obligation of the nation and not on the three states involved, and the United States ought to provide the necessary funds for the construction of this outlet drain which would replace in the river, at least the amount of water that was ceded to Mexico." Dr. Mead said "With that understanding, I think that you are right; I think undoubtedly Colorado is entitled to consideration as well as the other two states. I will be glad personally to do anything I can to help work out this situation." Mr. Wilson came back to New Mexico and I came back to Colorado.

Through our efforts this original compact meeting was arranged with the idea in mind of promoting the construction of this outlet drain to replace this water in the river in order that we might satisfy the claims of all people concerned. The Compact, if you have read it, or if you will refer to it, makes its primary objective, in its pre-amble and all through its entire body, the construction of this outlet drain for the purpose of putting water in the river that is not perpetual, in order to give us a cushion upon which a fair adjustment could be made. We think our efforts here in the former compact have borne fruit. We have accomplished, at least partially, the objectives we started out to accomplish. Immediately after the compact was entered into we prepared bills to the Congress of the United States. We passed these bills twice in the U. S. Senate carrying an appropriation of $800,000 at two different sessions for the construction of the drain and $10,000 for the survey of the state line reservoir. It is true that the compact provided for the construction of the outlet drain and the state line reservoir, the reservoir to be used as regulatory work in order to maintain parity of flow to the Elephant Butte. When we presented these matters to Congress we could not see in Colorado any possibility of promoting the construction of the state line reservoir until compensating storage was provided

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for in the San Luis Valley. We talked this matter over, I am sure with Major Burges and I know with Francis Wilson, and we finally agreed, in view of the fact we had all made surveys of our Vega-Sylvester site and were ready to commence construction, we would provide in that bill a fund of $10,000 for the survey of the state line reservoir, with the idea in mind that if we could secure the allocation of funds adequate to construct the outlet drain, then we would start on the parity as to reservoir construction. Unfortunately, in both sessions of Congress in which this matter was passed, on account of the press - as they thought of more important matters - we were never able to get the bills up for consideration in the House itself, but in this last session of Congress we were able to secure an amendment in the Public Works Act which provided for the allocation of funds to adjust losses occasioned to any state which arose from international adjustments to the detriment of states of the Union. While New Mexico, Texas and Colorado are not specifically mentioned, this is the only case extant that I know of in which that condition prevailed. In any event this particular amendment was designed and was prepared for the specific purpose of meeting this situation. As soon as the large appropriations were made and the Public Works Administration money had been placed for allocation, we presented applications for construction of not only the outlet drain but the state line reservoir and the Vega-Sylvester reservoir.

The Public Works Administration allowed, as I have said before, an allocation of $900,000 for the drain, but did not make any appropriation for either reservoir, and we today would like, in conjunction with you people, to work out some feasible plan whereby our right to regulation of the Rio Grande in Colorado may be protected, and that we can accept this allocation to construct this outlet drain, whereby whatever waters are available from this immense acreage in Colorado would become available and supplement the water rights in Texas and New Mexico. Now, gentlemen, the Chairman last evening intimated, I thought very plainly, that he wished us, insofar as possible, to limit ourselves to matters subsequent to the former compact. However, Mr. Chairman, while I am going to endeavor to do that just as much as I possibly can, on account of the fact that we have made more intensive studies of the situation and are better advised at this time than we were at the time of the former compact, it may be necessary for me to go back of that to some extent.

I just want to, if I may, leading up to a definite statement of what our requirements are in Colorado and the objectives that we would like to arrive at, I would just like to set up for the Commission and you other gentlemen, all of whom I know are interested, a picture of present conditions as I see them. With all of the information that I have been able to glean during this period of almost 40 years of observation - I want to say here, gentlemen, and perhaps I had better put in the record, that I represent as general counsel and - I presume that is the reason Mr. Hinderlider asked me to talk here, not because I am particularly equipped as an orator to do so - but I represent as general counsel the Rio Grande Canal Waterusers Association, which waters 125,000 acres, the largest single project on the Rio Grande; the San Luis Valley Irrigation District, which waters 65,000 acres; the San Luis Valley Canal Company, which waters 32,000 acres; the Monte Vista water-users Association, which waters 30,000 acres; and various other smaller canals and ditch companies; the Santa Maria Reservoir Company

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which furnishes supplemental water, partial supply, to perhaps 150,000 acres, and in addition to that, I represent the Rio Grande water-users Association which represents about 4/5ths of all of the water in the Rio Grande in Colorado.

The condition of the Rio Grande that I wanted to mention prior to the Compact leads us to about this picture as we see it. Before the construction of the Elephant Butte Dam there were possibly 50,000 to 60,000 acres of land along the Rio Grande in New Mexico and Texas above Fort Whitman under irrigation. Along in the 1880's our immense development commenced in the San Luis Valley and by 1890 we had about 600,000 acres under cultivation. A portion of that was probably senior in right to rights in the Rio Grande Valley in New Mexico and Texas. Undoubtedly there were priorities senior to any priorities in Colorado in New Mexico and Texas prior to the construction of the Elephant Butte Dam and prior to our construction of this large enterprise. Just what the respective acreage would be, as considered under the light of the Wyoming decision on the question of priority, I am unable to state. In the event this matter should ever come to the consideration of the courts it would undoubtedly be determined on that matter of priorities as between these 30, 40 or 60,000 acres, whatever it may have been, in the Rio Grande Valley in New Mexico and Texas, and the early rights commenced to be initiated in the San Luis Valley in the 1850's; but, in any event, we have priorities in the San Luis Valley, of prior development and seniority over an area developed of at least 600,000 acres, prior to the Elephant Butte Dam, prior to any of the subsequent improvements; priorities that were all adjudicated April 1, 1896, aggregating something over 5,600 cubic feet of water per second of time.

Early in the 1890's we ran into the dry spell, something similar to the present drouth condition along the Rio Grande. We started out then to regulate our water rights by reservoir construction. We filed on the Great Wagon Wheel Gap site - if you haven't been in the San Luis Valley you don't know of that - with an aggregate capacity of 900,000 acre feet. We filed on a number of other reservoirs, and then this embargo came along which prevented us, on account of international misunderstandings with Mexico, from the completion of our projects which had been initiated up to that time. During the next several years, and during the period that we were held up on account of this misunderstanding, some 250,000 acres were lost. Those of us who lived there during that time, gentlemen, know what that loss meant to Colorado. You can go over that territory now - I took Col. Donovan, your predecessor, over that country in 1929 - and you can see the old ditches that were there; you can see the foundations of the old homesteads; you can see the rusted wire lying around that once constituted fences; you can see the remains and ghosts of old mills and elevators; you can see broken hearts and ruined lives, blasted ambitions, that grew out of that 250,000 acres which we were compelled to release on account of this iniquitous embargo that was imposed on the Rio Grande in 1896. I want to say to you at this time, I don't want to raise any controversial issues here, but for every acre brought into cultivation by the Elephant Butte construction, two acres were lost to Colorado, with the heart-breaks, and ruined lives that follow such a loss.

We have grown old in attempting, in Colorado, to cut our pattern according to our cloth. We have suffered, bled and died in that country.

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You folks - this isn't in a spirit of criticism, but with the idea of helpfulness - you folks in New Mexico, I prophesy, can well look carefully into the experiences of Colorado before you commence a mistake based upon possibly too optimistic engineering data that we did in Colorado, and you can save yourselves a great many heartaches, and your people a great many heartaches, that you otherwise will be bound to get into with the present course that you are pursuing in New Mexico in the development of new land. Land isn't a question in this western country - it's water. We have three acres in the San Luis Valley for every acre we have water for. Its good farm land that could be developed, and you here are going - eventually whether you want to or not - be compelled to cut your cloth according to your pattern in New Mexico and Texas.

You know, the older I become, the more I become convinced of the possible futility of our continual attempts to improve more, to expand more, to invite more people in. Honestly, I have come to this conclusion, that eventually the waters of the Rio Grande are going to be applied upon the lands that will produce the most bushels of grain for the consumption of the people of the United States, and it don't much matter whether that land is located in New Mexico, Texas or Colorado. Just as it has been on the Blue and White Nile by the British Government in Egypt and on the Punjab in India. As I say, we have grown old in experience in the San Luis Valley - you can well profit by our experience.

Now, our objective at this meeting, gentlemen, is, if possible, to arrive at some means whereby we can serve the needs of New Mexico to the greatest possible extent; we can serve the needs of Texas to the greatest possible extent; we can serve the needs of Colorado to the greatest possible extent, with the least injury to all concerned, and we want to do that, if possible, without resort to the courts in an exact determination of priorities as they did in the Wyoming case. We don't want to have to go into court and say that possibly New Mexico has priorities over Colorado for some nominal amount; then Colorado comes in with this immense diversion in the 1880's; then the rights of the Elephant Butte attach; then your Middle Rio Grande follows, and so on, and have our water apportioned according to the priority of application and the seniority of development. That's what we are heading for unless we can get together on some reasonable basis. Now I want to say at this time, gentlemen, that insofar as Colorado is concerned, we have no ambitions as to increase of acreage; we have no ambition as to new development; we are satisfied that we won't be able to develop any more land than we operate at the present time with the water that is available to Colorado. Our only hope, as it should be with you gentlemen down here, - don't get yourself spread out too thin, because if you spread your water too thin, its just like rock - if it has a certain amount of gold its mineral pay dirt; you reduce it, possibly by a hair, and its common country rock. That's what happens to your water if you spread it too thin. What we expect, and want to do, is to utilize our water to the best advantage and to regulate it in such a way as will do the people of the state of Colorado the most good, and that should be your endeavor here.

Now, while our hands were tied through the activities of the Federal Government, which we resent and always have resented as unfair and unjust, New Mexico and Texas were permitted to store 2,700,000 acre feet for the delivery

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of 60,000 acre feet to Mexico for which they received a million dollars, and the watering of an additional 140,000 acres which is junior to all of our development up there, and the watering of this acreage, which was actually diverted water at the time we started our development. The area in the San Luis Valley aggregates considerably more than twice the amount of all the land watered in New Mexico and Texas. The one district which I represent, that I told you about, the Rio Grande Canal Water-users Association, actually waters today almost as much land as all the new land brought in under the Elephant Butte construction, and yet up to the present time we have reservoir capacity of about 100,000 acre feet as compared with 2,700,000 acre feet. We need, to place us on a parity with New Mexico and Texas on the regulation of our water rights at the present time 1,300,000 acre feet of storage in the San Luis Valley. We can secure that storage and secure that regulation without interfering with the present set-up on the Rio Grande to any appreciable extent. That immense amount of storage is made necessary by reason of the very condition which we will show to you gentlemen if we are able, if the Commission is able here to determine upon the points upon which they want to have further conferences and consideration. We can demonstrate to you just exactly what that will mean.

Our demand is now, and is going to be, that we be placed upon a parity with New Mexico and Texas insofar as our present requirements are concerned. I think I have again summed up the entire proposition insofar as Colorado is concerned. Gentlemen, we are up against one of two propositions in Colorado, and you can see it the minute I point it out to you; we must follow one of two trails: We can cut our pattern according to our cloth; we can store the water that we are now applying in the springtime to get storage to carry us over the dry season which comes later when we fall short, and we don't have an immense reservoir such as you have, and we can limit our acreage to the amount of water that is available to us with the proper regulation - or, we can continue to do as we are doing today, we can water such acreage for intensive cultivation as the very early rights covered, such as tuberous crops, garden peas and things of that kind, and we will be able to cover a certain other area with such crops as grain, peas and things of that kind, and we will take the balance of our 5,600 cubic feet per second and place it on pasture lands that we can water intermittently and periodically, and our actual productiveness will be materially curtailed. You people will receive no benefit and the Nation as a whole will suffer.

We want, if you please, parity with New Mexico and Texas and that's our theme; we want nothing better and we want nothing worse. We are willing to let bye-gones be bye-gones in case an agreement can be arrived at. We are willing that the Great Elephant Butte proposition shall go ahead, and your Middle Rio Grande; that you people make the best possible use you can of the waters of the Rio Grande that are available, but we are going to insist upon parity - we will have to, in defense, insist upon the rights which are adjudicated to us up there and which are absolutely senior to any of the rights under your Elephant Butte or under your Middle Rio Grande. I like to put the cards out on the table and look them over, and I want you to do it too. I am not here making a threat at this time; we are not here with the idea of stirring up a fight of any kind, but we might as well look these things fairly in

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the face and then see if there are any statesmen enough around this state and in this audience, in these advisers, to work out some plan whereby we can work out some plan so that Colorado may properly regulate her supply of water in Colorado without let or hindrance in New Mexico, that New Mexico and Texas may likewise do the same thing. And get out of your minds the idea that we are trying to increase. What I said about newspapers a while ago is absolutely true. You will see, and I have seen, articles in the Denver Post that if we construct this outlet drain there will be 200,000 acres of new land come in - there isn't anything to that. There isn't an acre in that whole drain that you could raise hell on - there isn't an acre that will come in on account of the construction of that drain.

SENATOR McGREGOR: I didn't know there was any of that kind of land in Colorado.

MR. CORLETT: Well, there is, just as you have lots of it in Texas, but there won't be a new acre come in for almost 20 years now. I have consistently refused to accept a retainer, or to serve as counsel in any respect, for any organization which attempted to take in new land in the San Luis Valley, simply because there is no possibility of increasing our present requirements there. Those old people have been wiped out of the picture; there is no chance at this time of making any restitution. Some of them felt at that time that they were being drawn and quartered; some of them felt at that time, I imagine, a good deal like those fellows that were staked out on the plains over an ant-hill, with that continual eating into their sustenance. We have sat there and watched those people and their sustenance waste away: we watched them after that wither and pass out of the picture and they are gone. There is no chance to help those people. What we want to do at the present time is to regulate our own that we have there now; those people who have hung on notwithstanding the fact that during this period from 1896 to 1925 they were tied by the federal government, and the action of the government in refusing the right to the people of the state of Colorado guaranteed to every citizen of the United States to utilize public domain for the construction of reservoirs and ditches, was unfair and unjust. And the Secretary of the Interior, when he wiped off that iniquitous embargo, found it was illegally initiated in the first place, and yet we suffered. I feel very strongly on this proposition - I have been saturated with it, as I have told you, for a great many years. I have followed it from boyhood up to the present time - I know these things, but I still have every faith in human nature, and I still have faith that if we enter into the adjustment of this matter as statesmen, as men who have at heart the objective of arriving at the best solution for everybody concerned, with fairness to all, we will be able to arrive at a program which will give Colorado parity with New Mexico and Texas, and that's all we ask.

SENATOR McGREGOR: May I ask you a question - what do you mean by parity?

MR. CORLETT: It will take 1,300,000 acre feet of storage capacity to furnish - I am glad you asked me that question - equalize the flow of the river to give us approximately 2 acre feet per acre for the lands which are now actually being cultivated in the San Luis Valley, and which we have diverted, as we

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will be able to show, substantially every year for - I think we have records - I couldn't tell you just how many, but on an average we are diverting that amount at the present time, and have been diverting substantially that amount for all of these years, and will continue to divert that amount.

SENATOR McGREGOR: If you take 1,300,000 acre feet for Colorado, what does New Mexico get?

MR. CORLETT: New Mexico has 2,700,000 acre feet. You are over in the middle of the state and probably don't know much about it, but - -

SENATOR McGREGOR (interrupting): You are wrong; we are building a dam just above Austin - that's far away, but some times a fellow living off may know something about somewhere else. You discussed the Punjab and the Blue and White Nile and you never saw either one of them, so it may be I may know something about water rights here. That down here is storage flow, but what you propose is annual flow. I am just trying to arrive at what you mean by parity. What do you base this parity on - priorities?

MR. CORLETT: No, if the priorities were concerned - -

SENATOR McGREGOR: Well, what do you base it on?

MR. CORLETT: On the present acreage now under cultivation.

SENATOR McGREGOR: Which is based on priority.

MR. CORLETT: We water twice as much land in the San Luis Valley with about 800,000 acre feet than they do in Texas with the same amount of water.

SENATOR McGREGOR: But you base your parity on the present amount under cultivation?

MR. CORLETT: Yes sir.

SENATOR McGREGOR: And you base that on its priorities?

MR. CORLETT: If it were a matter of priorities, we would have all the priorities there were on the river, except - -

SENATOR McGREGOR: What do you base it on if you don't base it on that?

MR. CORLETT: Just on a parity of requirement, parity of necessity.

SENATOR McGREGOR: Which requirement is based on the land in question which rests on the fact it was put in cultivation, which is a question of priority.

MR. CORLETT: In other words, we would be willing at this time to limit ourselves with New Mexico and Texas on acreage, if they want to do it that way; we would be willing to limit ourselves, Senator, on the question of diversions that we have used.

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SENATOR McGREGOR: I am not trying to dispute you; I am just trying to understand your terms. My question hasn't been answered yet. I don't get what you mean by parity - equality, which must be established and rest on something which will take us back to the question of priorities.

MR. CORLETT: Present requirements, then.

SENATOR McGREGOR: Which comes back to, and rests on, anterior development.

MR. CORLETT: Yes sir.

MR. HARPER: It is my understanding that these preliminary statements would be completed without very much questioning, unless you wish to ask questions regarding facts.

MR. CORLETT: We don't so understand that. Until we get the questions we couldn't discuss them.

MR. HARPER: The questions should be limited to questions necessary to develop facts and should not run into arguments. Are there any further questions that the other commissioners wish to ask Mr. Hinderlider or Mr. Corlett? If there are we will be glad to hear them.

MR. McCLURE: I relinquish my right to the Texas commissioner.

MAJOR BURGES: Mr. Corlett, I would like to ask you a few questions. You stated in the very interesting beginning of your statement, that it was agreed between you and Mr. Francis Wilson and Secretary Work that the solution of your difficulty could be arrived at by contributing to the flow of the Rio Grande the water which is now lost in the undrained basin, or sump basin.

MR. CORLETT: Providing the figures as at that time compiled by the Reclamation Service were correct.

MAJOR BURGES: Are you now more doubtful about those figures than you were at that time?

MR. CORLETT: Yes sir, we are doubtful to some extent. Of course, this is a very difficult time to measure return flow because the underground waters have been so depleted that any correct estimate could not be made in a time like this, Major. You would have to have an observation, in my opinion, over a number of years to determine that. It is probable, from the investigation of our engineers, that this amount would be somewhat reduced, even from the low figure as fixed by the Reclamation Service at that time, but in any event it would aggregate, in our opinion, more water than could possibly be consumed if Colorado developed to the fullest extent that she possibly could.

MAJOR BURGES: If that be true, and you at that time reached the conclusion - in which I have always most heartily concurred - that the expense of providing that drainage should be met by the United States Treasury, and not by your state or all three of the states, and you are now tendered the use of that

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money, do you not think it is the part of wisdom and prudence to proceed with the utilization of that $900,000 before it will be withdrawn? It will not remain available indefinitely.

MR. CORLETT: I think that we should have some clear understanding of the compensating benefits that Colorado will receive before we turn this impounded water, which is impounded in an underground reservoir, into the Rio Grande for the use of New Mexico and Texas.

MAJOR BURGES: Isn't it true, under the compact, you have the right to every gallon of the water that is contributed to the Rio Grande in that way?

MR. CORLETT: That right has been questioned. Not only that, but under the compact we are also entitled to an equitable proportion of the waters of the Rio Grande, and that is what we are here to determine. Now, then, we are not, as I said before, expecting to in any way increase our requirements. We are expecting to regulate our flow, and as long as you gentlemen play - as we look at it - dog in the manger upon our reservoir construction, and every time we attempt to finance it there are objections from - I don't know that I ever had any from you, but I have from others here, and the agencies with which we have been dealing have had objections to construction in Colorado.

MAJOR BURGES: We necessarily have that objection.

MR. CORLETT: If we don't use any more water, why should you?

MAJOR BURGES: Because it isn't in human nature. I have, perhaps, some confidence, as you have, but it isn't in human nature for the man on the lower end of the ditch or river to agree to give the man above the absolute control of the water. In other words, I am not going to debate with you the question of priority. I do feel, however, that it is due ourselves. The people of both New Mexico and Texas, and I think it is due to many distinguished officials of the United States Government, who passed on it, to say that we are totally at variance with you over the idea of the embargo being unjust or unwise. I will not be one of those persons who, by silence, admit something I do not believe. We do not admit for one instant that you have any priorities in the use of the flood waters which are stored at Elephant Butte. I realize it is difference of opinion that makes horse trades and law suits, but I do confidently believe, in error though I may be, that the law is that when the United States on behalf of the Elephant Butte project filed on the unappropriated flood waters of the Rio Grande, it did not deprive you of one acre foot of water which was being impounded anywhere above that, and that the priority of that appropriation dates from that appropriation; but I do not care to debate that question. I think if we once get into that we re-open an interminable dispute which, I am quite sure, you and I could never agree about; it's a difference of opinion which we could not reconcile.

MR. CORLETT: Have you read the record of the Kansas-Colorado case?

MAJOR BURGES: I have.

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MR. CORLETT: Wasn't that based upon the proposition of priority of development as to requirement?

MAJOR BURGES: Don't you think it would be a waste of the time of this conference for you and I to go into the decision of the Kansas-Colorado and Wyoming cases? I don't think it would be a profitable discussion. I only register our dissent on two views for fear silence might imply our acceptance of your statements. We can simply brush that aside as not being assented to by us.

MR. CORLETT: We take it for granted that you are contrary-minded.

MAJOR BURGES: Yes, but the questions I do want to ask you, however, are these: I don't believe I got an answer to that last one. As I understand the matter, $900,000 for the sub-drain has been allotted by PWA, which is available now.

MR. CORLETT: Yes sir.

MAJOR BURGES: It will not continue available indefinitely?

MR. CORLETT: That's true.

MAJOR BURGES: If it were constructed, I believe I am right in the assumption that you would augment the flow of the Rio Grande - I do not undertake to say how much - and under the compact the entire amount by which the flow is augmented is allotted to the state of Colorado, or its equivalent for future development. That's true, isn't it?

MR. CORLETT: That's true, but we can only use it, Major, by reservoir construction.

MAJOR BURGES: After it is there, there will be, I apprehend, not the slightest divergence of opinion between you and me as to any means by which it was made available. What you must realize, however, is that we cannot take on faith a wholly untested thing as to the increased flow of the Rio Grande, for we will never know that until the sub-drain is constructed. Now, the money is available from a federal source to build it. It will not continue to be available; if it is not used, it will lapse. Now, why should you not permit the government to go ahead and make that expenditure and develop that supply?

MR. CORLETT: New Mexico has constructed 2,700,000 acre feet of reservoir storage; she is now constructing another on the Chama - -

MAJOR BURGES (interrupting): Which does not, in either case, take from you an acre foot of water you were using.

MR. CORLETT: I don't think it can, but while we have permitted you to go ahead and make this development without objection, you have consistently objected to our reservoir construction and the regulation of our flow up there in the San Luis Valley, and we need a perfect water right just the same as

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you need down here, and unless, and until, we can come to some understanding on this proposition that would permit us to proceed with our regulation there - all we want is regulation and equitable apportionment.

MAJOR BURGES: I ask you if the compact does not expressly authorize such additional storage use or diversion in Colorado as shall be equivalent to theflow by which the Rio Grande is augmented - you get it, by reservoir or any other means?

MR. CORLETT: We are not going to build up a wash tub of storage when we need 1,300,000 acre feet in order to regulate that river, without injury to you.

MAJOR BURGES: On the last question you said you had not objected to our building storage reservoirs but that there has been very strenuous objection to your doing so. I think that would be a fruitless discussion. Can you see no difference between the man above that gets all the water before the man below, and the man above building a reservoir to intercept what reaches him? Isn't there a difference?

MR. CORLETT: Is there a difference in human nature, whereby Colorado should be satisfied with an inadequate and unregulated supply, and the people of New Mexico should have a perfect and regulated supply?

MAJOR BURGES: Do you think we have an adequate supply? We face with terror the situation that lies ahead of us the next 12 months.

MR. CORLETT: Because you have over-expanded.

MAJOR BURGES: We are conservatively within the figures which all engineers say we should be able to water except at intervals, and we face one of those intervals now, but that is beside the issue. The question I asked you is this: Every acre foot of water by which the flow of the Rio Grande will be augmented is now allotted to you in the existing temporary compact if you choose to use it for that purpose by either storage, diversion or other use. Isn't that true?

MR. CORLETT: I am glad to hear you say so. I think it is.

MAJOR BURGES: We think so, too, so there is no issue between us there. We conceive the compact is written in plain unambiguous language, and if it isn't I have never been able to point out wherein it was ambiguous. We expressly say in the compact, all three states, that Colorado may augment her use by storage, diversion or otherwise use just so much as the flow of the Rio Grande is augmented by return flow.

MR. CORLETT: It says that our right to the re-use of this drainage water shall not be denied, but we are to have our equitable apportionment of the waters of the Rio Grande, and what could nearer accomplish that than parity between us?

MAJOR BURGES: You and I would never, in a thousand years, agree on what is parity. I don't wish to re-hash the old stuff, but we were using water of the Rio Grande adequately and sufficiently for our needs until you dried it up.

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When you dried it up the United States came to our rescue and provided a storage reservoir to conserve flood waters then going to waste.

MR. CORLETT: Not only adequate for that, but 140,000 acres additional.

MAJOR BURGES: I challenge the correctness of that statement, but it would be unprofitable for us to discuss it.

MR. CORLETT: I don't want my statements to be taken here by this Commission as being technically exact.

SENATOR McGREGOR: May I ask both you a question. First, do you wish to extend the existing compact? If you do we can do it here; if you don't we can't do it here so that passes out of the picture. Let's get to the issues - we are wasting time. I am trying to expedite matters. If we don't want to extend it, then we are through with the existing compact. Then the next question arises - do we wish to undertake to negotiate a new compact? You have stated you wanted a permanent compact, we say so too, so we evidently do. We all know you can't do that today, so the next move for this Commission would be to discuss as to when we would meet again with that in mind and when you can have all your data.

MR. CORLETT: If I may say a word here - I am sorry we have gotten into this discussion. I just want to make this explanation; my statements here are not intended to be technically correct, or with the engineering exactitude that you would probably finally want to get. I was in hopes that after we had presented our phase of the matter - I didn't expect Major Burges to agree with me wholly, but I know he is a gentleman who is very fair; I have served with him before and have a high regard for his ability and for his fairness, and while we don't agree on all of these things - and don't expect him to in the future - it seemed to me if the Commission here, after hearing what I had to say, which I am honest in, and what Major Burges will say, which I know he will be honest in, you feel that there are common grounds which would merit further discussion, which would merit further investigation on behalf of the Commission - and I believe there are - that then having presented these matters we would all go home, assemble the data in condition where we could present it in the most exact, concise and most acceptable form to the Commission at a subsequent date. I think that's really the purpose of this meeting, to give each side a sort of birds-eye view of how the other feels, then see if there are common meeting grounds upon which understanding - they may not agree on many questions - we could get together; one giving, another giving, and finally arrive at a satisfactory adjustment. That was my idea.

SENATOR McGREGOR: You are not willing to just simply extend this old compact as of today?

MR. CORLETT: That would be up to Mr. Hinderlider.

SENATOR McGREGOR: I am satisfied that none of you are. You might later on but I don't believe you would right now.

MR. HARPER: If the Chair may make a suggestion, I believe we are running into a debate. After New Mexico and Texas have made their opening statements,

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then we can come back to these matters and discuss them in more detail.

MAJOR BURGES: It seems essential that we should have an answer to the question which the Texas Commissioner has just asked - whether it is the desire to extend the operation of the compact, at least until the sub-drain can be constructed before that money is forever lost. It is available today under a public program that may not exist in the future. If it is not availed of now, it perhaps is gone forever, and the question is, does Colorado at this time want to avail itself of the federal appropriation for augmenting the flow of the Rio Grande?

MR. HARPER: Perhaps the Colorado representatives could answer that question more intelligently after the other states have made their opening statements. That would be my suggestion, that we come back to that question at that time. Before leaving this subject under discussion, Mr. Corlett mentioned some figures on the yield of the closed basin drain being furnished by the Reclamation Bureau. Those figures sound very very large to me and I do not recognize them as any figures furnished by the Reclamation Bureau. I would like Mr. Debler to state just what our latest and best estimates are on the possible yield of this closed basin drain.

MR. HINDERLIDER: The figures quoted by Mr. Corlett pertain to those original investigations of early date, and I believe the question propounded ought to be restricted to a like date.

SENATOR McGREGOR: Colorado doesn't claim strict accuracy.

MR. CORLETT: The Chairman is bringing up a question not brought up by me.

MR. HARPER: It's a question of making it clear for the record that the Reclamation Bureau does not necessarily agree with the figures that you have quoted as coming from the Bureau.

MR. CORLETT: That is probably true at the present time.

MR. HARPER: That will be sufficient for present purposes.

MAJOR BURGES: Our idea is the figures given are not very important at this stage of the proceeding, because, just as I was saying, if the temporary compact was signed in the hope and expectation that the sump drain would be built at federal expense - and that was the very identical reason for signing the compact in 1929 - we are now tendered the construction of that drain by the United States, and it seems to me that that is the first and essential question to be answered. It seems to me it is in order to answer whether they will utilize that provision or not. That was the very purpose of the temporary compact.

MR. HINDERLIDER: May I suggest it is my understanding that the allocation by the Public Works Administration for the construction of the drain, that it is a grant outright by the federal government, but the Secretary of the Interior, in a letter to the Chief Engineer of the Reclamation Bureau, copy of which was furnished me some time ago, imposed certain restrictions upon that allocation,

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namely, that the people of the San Luis Valley who might be benefited as a result of the construction of the proposed drain would organize a drainage district, and through such drainage district obligate themselves forever to maintain the proposed drain for the delivery of water into the Rio Grande, and also to provide, without cost to the federal government, the necessary rights of way required for its maintenance and operation. Those were the two restrictions placed upon this allocation of money, which it is my understanding is purely in the nature of a federal grant. We, of course, do not know upon what grounds the Public Works Administration made that grant, but it is presumed to be upon the assumption of the federal government of the moral, and possibly legal, obligation to the three states in question to recompense such states for the water the federal government ceded to the Republic of Mexico. If I am not correct in that view, I would be very glad to be corrected.

MAJOR BURGES: I so understood it. The point, as we see it, is every gallon of that increase is allotted to the state of Colorado. If it were divided between the states - for instance, if it was provided that the state of Colorado should increase its storage, diversion or use by one-third of the augmented flow of the Rio Grande, and New Mexico by one-third and Texas by one-third, then, of course, we would have one problem, but under the compact, which is binding upon us, Colorado gets the whole of it whatever it may be. Therefore, it seems to me Colorado must answer whether she will make use of that federal gift. If she does not, then an entirely different situation faces all of us. But the compact was entered into in order to obtain that gift. The states wanted to convince the United States that it should, and fortunately, we succeeded in convincing somebody that it should do it. Now, of course, the provision of the government as to preserving the work after the government had done it - we have no desire to enter into a discussion of that. If, as a matter of fact, we were sharing it we would be willing to enter that discussion, but we don't share it. I apprehend if New Mexico shared it she would be willing to enter into that, but they don't share it. Under the compact it is allotted exclusively to Colorado. The request was formal, and with all the force that we could summon, embodied in the compact. It was an appeal to the Government for justice, they saw it and granted it. The State of Colorado is confronted with the necessity of deciding, having asked for that, whether she wants it or not. If the United States has attached to it conditions which she is not willing to meet, the answer would have to be in the negative. In other words, we have been tendered what we signed the compact to get; it was part of the consideration, and until that question is answered, I do not see how we can answer any other one.

MR. CORLETT: If we are placed in a position where we can have compensating storage - -

MAJOR BURGES: The compact gives it to you.

MR. HARPER: Mr. Debler, do you agree as to the facts stated by Mr. Hinderlider, that this allotment for the Closed Basin Drain has no condition as to repayment of construction costs but only as to maintenance and rights of way?

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MR. DEBLER: My understanding is there were no conditions of any kind attached to the allotment at the time it was made. However, on request by the Chief Engineer for information regarding that allotment, the answer we got was there was no requirement for repayment, but there would be a requirement for maintenance of the drain after it was constructed. That, however, is subsequent information, in the nature of a ruling; it was not attached to the original allotment.

MR. HARPER: The Secretary of the Interior as Public Works Administrator has supreme authority over determining the conditions of these grants, and it does not mean he had over-stepped his authority in placing these conditions on the grant.

MR. HINDERLIDER: Colorado suggests that the next state present her views.

MR. HARPER: The Chair will now recognize the Commissioner from New Mexico, Mr. McClure, who will present the case for New Mexico.

MR. McCLURE: Mr. Chairman and gentlemen of the assembly: I will request that Mr. Patton, Asst. Attorney General, speak for New Mexico.

MR. PATTON: Mr. Chairman and Gentlemen: It is now 15 minutes to noon. At this time it would be impossible to make any definite presentation on behalf of New Mexico due to the fact that it is so near noon, so on behalf of the New Mexico Commissioner, I would move that we recess until 2:30 and that the States of New Mexico and Texas be given an opportunity to hold a little caucus, and at that time we will be in a position to state whether or not we have any statement to make, or state to the commission and the chairman such procedure as we have decided on in the interim.

SENATOR McGREGOR: I reluctantly disagree with our host, New Mexico. The atmosphere is delightful and the scenery beautiful, but we've got something else to look at. I move we keep on plowing - let's get through. Let's hear from New Mexico and then from Texas and then decide. You are all busy men and you got something else to do. I hate to differ with you.

MR. PATTON: We would not object to that, but we do desire an opportunity to caucus for a few minutes. If it is the pleasure of the Commission and of the Chairman that we continue throughout the noon hour, then it is the pleasure of New Mexico. We are at your service, but we do desire a few minutes for causus.

SENATOR McGREGOR: I move that they be allowed a few minutes for caucus. (Seconded by Major Burges.)

MR. CORLETT: I believe this is very important and if they want time to talk over this thing until 1 o'clock, I think they should have the time. We want, if possible, to arrive at some basis if there is any possible way.

MR. HINDERLIDER: Mr. Chairman, Colorado feels that the dignity of this occasion justifies that each and everyone of these states be permitted to have all the time necessary in their opinion in which to present their case.

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SENATOR McGREGOR: I'll withdraw my motion.

MR. PATTON: And I will amend my motion, to recess until 2 o'clock.

Seconded by Senator McGregor and unanimously carried.

MR. HARPER: We will now recess until 2 o'clock this afternoon.

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MR. HARPER: The meeting will please come to order. At the time of adjournment, the Commissioner of New Mexico had the floor, and he will resume his presentation at this time.

MR. PATTON: Mr. Chairman and Gentlemen of the Commission: Through the courtesy of the Chairman and the Commission, just before the noon hour the States of New Mexico and Texas were permitted the opportunity to go into caucus to determine their future procedure in this hearing. Since that time the States of New Mexico and Texas have been in caucus both separately and jointly, and we have concluded that there are two questions which must be propounded to the State of Colorado, and the answers to those two questions will, in all probability, in our opinion, determine the consequences. The first question which these states desire to ask the state of Colorado is this - does the State of Colorado intend to build the sump drain and utilize the money provided for that purpose. The second question - do you favor a continuance of the present compact? If we can obtain an answer to those two questions at this time, or possibly after the State of Colorado has had an opportunity to caucus and determine their answer, then Texas and New Mexico will be ready to inform the Commission and the Chairman as to their future course in this matter. I believe that the statement made by Major Burges this morning, during the course of his interrogation, at least by inference, states the position of the states of New Mexico and Texas.

MAJOR BURGES: The statement just made by the Attorney General of the State of New Mexico states Texas' position also.

MR. CORLETT: May we ask if there is any further statement or showing that New Mexico and Texas desire to make, or is this all?

MR. PATTON: New Mexico and Texas have no other statement to make at this time in the way of presentation whatever.

MR. HARPER: What is the pleasure of the Commissioner from Colorado?

MR. HINDERLIDER: Mr. Chairman and Members, Mr. Ralph Carr, legal adviser for the Commissioner of Colorado, will reply to the interrogatories propounded by the Commissioners from New Mexico and Texas.

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MR. CARR: Mr. Chairman and Members of the Commission: Before I answer the questions which I will answer, I think satisfactorily and briefly, I want personally to extend my appreciation for the kind things said this morning about our friend, Delph Carpenter. Most of you know the very intimate relationship which existed between Mr. Carpenter and me from the time I was just a youngster, and you know with what pleasure I went through the last conference as his assistant, and it seems too bad that we cannot have the benefit of his wonderful counsel and sympathy in working out these problems we have now. I am here at this time in an unofficial capacity with the very deepest respect for the ability and broadmindedness of the men who make up this Commission and its advisers. I don't think there is any reason for us to fear that we are going to reach a compact for a minute. We had situations which were really tense many times during those weeks five years ago, and we were able to reach something which I think was a great step forward as the result of our determination to try to serve our people, and so now I think that with that as our example we can approach the questions which have been presented, and consider just why we are here and what our position should be.

Now if we consider only the two questions which have been propounded by the Attorney General of New Mexico on behalf of the two lower states, we would be losing sight of the main reason for our being here. It is true in the other compact we said, we believe, and committed ourselves to the proposition that if the sump drain were to be constructed the problem confronting these states might then be worked out, and now we have a way to work out that particular problem, but the compact provided that at some time prior to June 1, 1935, these commissioners should meet for the purpose of making an equitable division of the waters of the Rio Grande. Now, that is our problem and that is our task - to make an equitable division of the waters of the Rio Grande. The problem of the sump drain is simply one of the factors to be worked out in making the big solution of equitably dividing the waters of that stream. In answer to the first question, does Colorado intend to build the sump drain and utilize the money allocated, I think that is, in substance, Mr. Patton's question - our answer is this: Insofar as Colorado is able so to do, Colorado is anxious to make use of that money and to construct that drain canal. There are certain questions involved before that can be taken care of, however, and we see, under the terms of the compact, some obligation on the parts of the states of New Mexico and Texas in respect thereto, but Colorado is saying, insofar as it lies within her power she wants that drain to be constructed. In the event obstacles arise which should be worked out by the other two states, then we say, we ask New Mexico and Texas to cooperate with us in seeing to it that that sump drain is constructed. That, I think, is our answer to your first question.

The second is - do you favor continuance of the present compact? I don't see, personally, why that question is asked. The present compact, by its terms, provides that the equitable division of the water of the Rio Grande must be made by the Commission prior to June 1, 1935. After many, many weeks of arduous striving, we reached that compact which is, in effect, except as to some of its provisions, temporary in its character because, again, I say our task is to equitably divide the waters of the Rio Grande and that's why we are here now, and we want to continue those provisions of the present compact

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which are beneficial and
which are permanent, and which should be retained, and then go on to this other task and equitably divide the waters of the river. It is not for us at this time to say that we wish to discontinue it - we couldn't say that, as I understand it - it's in force until June 1, 1935, and the idea is that we shall add something to it and arrive at a permanent compact between now and the end of that period. Colorado wishes to retain everything that is good for Colorado, New Mexico and all other parties interested in the compact as it stands, and to incorporate those in a final compact which will equitably divide the water of the river. As the Colonel suggests, Colorado has had five years to gather further information. Many things have happened since we were here before. We are all better advised. Colorado comes down here now and is ready to return at any time which is agreeable to the remainder of the members of this Commission, to present the results of these studies and deliberations in an effort to carry out the terms of the compact, to equitably divide the water of the river. Those are Colorado's answers to your two questions. If you want me to develop them further, I will be glad to do so.

MR. PATTON: Mr. Chairman, New Mexico, through its Commissioner, would like to yield at this time to the legal adviser to the Commissioner of Texas, Major Burges.

MAJOR BURGES: Mr. Chairman and Gentlemen of the Commission: I think everyone realizes that when we were in session five years ago, the temporary compact resulted from the conclusion, then unanimously arrived at, that there could be no permanent settlement of the allocation of the waters of the Rio Grande until we knew what waters were available for allocation. For that purpose, it became necessary, if it could be brought about, to have the sump drain constructed and its results demonstrated. It was in view of that that the temporary compact was agreed to. Now we conceive that that situation is exactly the same; it was at that hour, and it is today, impossible to agree upon the final allocation of the waters of the Rio Grande until we know what waters there are to be allocated. Our position then was - without seeking to revive all the debates we went through then - that Texas and New Mexico were not agreeable to the diminution of the flow of the water which they were then obtaining. We have had no reason to change since; in fact, natural conditions have enforced the necessity and wisdom of that decision - the drouth today demonstrates that.

Our position is this: It is impossible to make an allocation of the waters of the Rio Grande until we know what waters there are. That cannot be known until the sump drain is constructed and its result manifested. That being true, we cannot conceive that we could, even if we wanted to, arrive at any permanent settlement of the matter. We don't know what we are distributing. We did, at that time, go so far as to state - and if the figures first given this morning were still relied upon - what would have been a too liberal offer on the part of the two lower states, because, of course, if the annual return flow was to be at a minimum of 160,000 acre feet and a maximum of 600,000 acre feet, it is perfectly obvious that Colorado should not have all of it. But frankly, we were not optimistic about it then, nor are we now, but whatever the return was, why we did definitely agree that Colorado might have it, and as a basis for proceeding with the sump drain, she could store, divert and use a quantity of water equivalent to the entire return to the river from

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the drain, and that is still the position we are willing to stand by. Our second question was predicated upon this idea: If Colorado is going ahead with the drain - and we are constrained to believe it would be very unwise not to use that appropriation - then there should be such a temporary extension. You gentlemen all recall the compact expressly provides for that temporary extension as would permit the realization of that plan, and when that has been done we would then face the situation which we faced, as we thought five years ago, and that is, it would not be possible to arrive at a permanent allocation until we know what there is to allocate, and we cannot know that until this intermediate step is taken. That was the definite position of Colorado at that time, and it was ours, and I don't see that that position has been changed, except we do know we can get that drain at federal cost. At that time some of you were not very optimistic about it. Col. Donovan, who was presiding on behalf of the United States, interrupted me when stating the reasons which are set forth in the pre-amble. He said "I think I can make that stand before the committees of either house." I don't know whether he could or not, but the PWA has brought a new phase into the financial situation, and fortunately we are now confronted with the offer of the money, but we cannot permanently allocate the waters of the Rio Grande until we know what they are, and we cannot know that until the drain is constructed and its return indicated.

MR. CORLETT: Major, what difference does it make as to the amount that will be developed by the drain as long as Colorado is to be the recipient of the entire amount as covered by the compact? What effect will that have in any event upon our final determination of an equitable distribution?

MAJOR BURGES: Because until you know what water there is to distribute, you can't distribute it.

MR. CORLETT: It's Colorado's.

MAJOR BURGES: Yes, but then, of course, if you are going back to whether we are ready to relinquish part of what we have, our answer will be the same as it was then - no, we are not willing to diminish the flow across the state line, but we were willing and anxious that Colorado should have the benefit of whatever could be added to the volume of the stream; we were willing to throw the power of all three states behind the effort, and we believe it has been effective - we know it has, as far as federal action is concerned.

MR. CORLETT: I can't for the life of me see why this question of the amount to be developed by the drain has any effect upon our deliberations in this matter. We, of Colorado, are down here with open minds; we are anxious, willing and ready to go ahead with these deliberations to attempt to carry out the very purpose of the compact that was adopted in the matter of an equitable division of the waters of the Rio Grande. I have already said in our opening statement that we did not expect to increase our requirements. We have said that we want regulation commensurate, or that will be in parity with the regulation now enjoyed by the States of New Mexico and Texas. I think I can say without any question that we are willing to be measured by the same yardstick that New Mexico and Texas is, and that we would be willing

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to be limited to the same extent that they are limited. In other words, we are willing to go at this, as I said, with open minds, if possible, to arrive at a just and equitable determination; one that will result in the greatest benefit to all and the least possible injury to anyone. We stand ready to do that and if New Mexico and Texas are willing to come in on that basis, I think with this information that we have garnered during this period of five years, with the information that was opened up to us by the people of New Mexico and Texas during the former compact hearing, and with the information which Texas and New Mexico people will be able to bring forward at this time on account of their subsequent studies of this situation, that we might be able, at least, to make progress in this matter of an amicable determination between these great sovereignties. We, of Colorado, are of that mind and in that position, and we think that the Commission could very reasonably arrange for some adjournment whereby we could assemble these facts in such form as would make them most easy and most understandable to present to the Commission, and then the Commission could submit to us major propositions which might change our minds, which might satisfy us in certain particulars. Now, we could both stand up here and say "I won't slide down your cellar door, and you can't slide down mine", but that isn't the way that such adjustments are made between states to arrive at an amicable solution. We are not attempting to dictate to you; we are not attempting to question your honesty in these things, but we think you are reasonable men and we claim to be reasonable. I don't think I should take the position, or that you should take the position at this time that I say thus and so and I won't be convinced.

MAJOR BURGES: You are entirely overlooking the purpose of this. You started upon the assumption that the return from the sump drain would be sufficient to enable the states to settle that difficulty. We certainly hope that that is true. It was in the hope that that was true that we all three agreed to put a united front behind the effort to get it. We haven't gotten it, but it is offered; it is available. There is, in the first place, no necessity for an attempt to make a permanent allocation until we know what we have, and in the second place it would be impossible, even if it were desirable. The position which you take, with all due courtesy, as I see it, is this: That you want, first, all that you can get from the sump drain, and then before we find out what that is, you want something else. When you get that something else, you are taking it from us as, according to your own view, if the return from the sump drain is what you are anticipating it will be, it will give you all you need; therefore, we certainly should not agree at this time to give something more. We will, from our own insufficient supply, under your present supply, have to give you something additional, although you, yourself anticipate if the return should be what you think it will be, that you will get all you need.

MR. CORLETT: Major, here's the proposition I don't think you give due consideration to. We are using all the water we can at the present time and have been doing it, and, of course, we will continue to do that. We cannot utilize

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this drainage water under any physical condition unless we can arrange for compensating storage. If it should be determined - I think there is an error, I don't think this 160,000 or 600,000 acre feet ever came directly before this Commission before, - but if it should be determined that there was as much as 160,000 acre feet, Colorado could develop to the maximum extent possible in reservoir construction without in any way affecting the amount to come across the state line - it's a physical impossibility. We can't control it in the San Luis Valley over about ten percent of our drainage area. We spread out in a low valley and the return from that country comes so far down the river there is no possible reservoir site we could utilize to handle that water. The contour of the country and physical possibilities limit us to such an extent that we have got to have this immense amount of storage there in order to put us on a parity with New Mexico.

MAJOR BURGES: Why don't you develop this store, and then - as a matter of fact you did have the right to do that - you could build that tomorrow if you constructed the sump drain to demonstrate the return.

MR. CORLETT: I think that it's principally on account of suggestions from governmental agencies that possibly our right to store would be contested that makes it almost impossible for us to finance there.

MAJOR BURGES: It's in the compact just as plain; you are entitled to increase storage to the extent of that return; you are entitled to increased diversion to the extent of that return and increased use to the extent of that return.

MR. CORLETT: In order to take advantage of that amount of water it would be necessary for us to have a storage plant of at least 500,000 acre feet.

MAJOR BURGES: That's quite possible; I can conceive that might be true, but then, there is nothing in the compact that interferes with that.

MR. CORLETT: I think really we are straining at a gnat. If we get this information that we have assembled during this period together, we would get some place; we could make progress.

MAJOR BURGES: We cannot settle it; we cannot agree to give up more water until you have produced it.

MR. CORLETT: At this time we are not asking you to give up any water.

MAJOR BURGES: If we now authorize the storage of the flood waters, when you are using practically all of the normal flow, you are getting additional water.

MR. CORLETT: If we can't control it, we have to store out of our water that we are now diverting in order to have it there, because, as I explained to you, the physical conditions make it absolutely impossible to increase to any considerable extent our diversions there at this time.

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MAJOR BURGESS: After all of our long deliberations, we signed the temporary compact to see how much could be developed. We haven't moved one inch from that position. We all united to get it, and we got it; now we aren't using it.

MR. CORLETT: We have moved.

MAJOR BURGES: We have not moved one inch.

MR. CARR: May I say in answer to the last suggestion from Major Burges as to the fact that we are standing still, as was stated by Mr. Debler this morning the allocation of the $900,000 for the construction of the drain canal was made without conditions or reservations and some time subsequent thereto, when the San Luis Valley in Colorado as a unit was moving in every way it could to take advantage of the allocation of that amount of money, there came from the Department of the Interior conditions and reservations which were not contained in the law which gave us the money, which made it necessary for us to find a way under the Colorado statutes, if such there were, to organize a drainage district which should undertake the maintenance of the drain and to acquire rights of way for its construction. That was something not contemplated at any time when you had the matter under consideration.

MAJOR BURGES: I always had anticipated you would have to maintain the drain. I didn't think the government would enter into any agreement to maintain it.

MR. CARR: We were agreed 5 or 6 years ago, and today by your statements, everyone of us from the three states at least, that there was an obligation on the part of the United States of America to repay what we claimed was an injury to these states in taking the water and placing the embargo on the use of the water by the construction of reservoirs on the upper Rio Grande. Now, we seem to be agreed on that. We say this, and I think, Major, if you will consider it you will agree with me, that when the United States recognized its obligation to construct that drain, as corollary to that obligation, it recognized the further obligation to maintain it.

MAJOR BURGES: They didn't do it with us.

MR. CARR: Under the circumstances here, the Government took the water - we'll say of Texas, Colorado and New Mexico for the purpose of argument - and entered into an international obligation and in order to carry out the terms of that obligation, the United States government spent enormous quantities of money downstream and took the water of the upper states. Now, 25 or 30 years later, the United States Government comes in and says "Yes, we do owe you an obligation, we recognize that obligation; we are going to build you a drain canal", but Congress never said there is a condition, there is a reservation, there is an "if" clause here, dependent upon the proposition that the people of the lower San Luis Valley who own land which is of no value, comparatively, must enter into a drainage district and agree to permanently maintain this canal. I say to you, Major, that the conditions and reservations which emanated from the Department of the Interior did not happen to be any part of the

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intention of Congress, and I am saying to you men, as representatives of the other states, that if you will join with Colorado and show the members of Congress, the Secretary of the Interior, the Director of the Reclamation Bureau who may have it in charge, the injustice of this thing, that they will agree that the Secretary of the Interior should not have put those reservations on there and our chances of constructing the drain will be immeasurably hastened.

MAJOR BURGES: It will be a disastrous answer to you, as it was to us. We have fought for 20 years for that identical thing and we haven't gotten 5 cents. For 20 years farmers have paid for the delivery of 60,000 acre feet to Mexico every year, and they face today the certainty of paying for it through untold generations to come, and not one five cents has the United States ever advanced to them and you can't get one moment's consideration from Congress. They say you ought to be very glad to maintain your project which you got at government expense, and we don't get it at government expense, but there is no use going into a discussion of that. We have fought to a finish over the question that the United States should pay its proportionate share of the water to Mexico and they won't consider it. If you propose it today in the Bureau of Reclamation to the head of the Bureau of Reclamation, he looks at you and says "You better go home and forget it."

MR. CARR: I was one of those who questioned 6 years ago ever getting the money from Congress to build the drain. This is no more impossible if we will go to them with a concerted front and say that the Department of the Interior had no right to place that reservation on there; Congress didn't do it, so why did you?

MAJOR BURGES: I don't believe you will ever get the Government to accept the permanent and continuing responsibility for cost of upkeep - I don't believe it.

MR. CARR: Let's say we are unable to do that, then.

SENATOR McGREGOR: To give you a vantage point - a subordinate agency of the Government has no right to tie conditions on an appropriation, but if it's your purpose to get that off, then in order that you might have time to do that, you will be confronted with the proposition that you will have to continue the present compact.

MR. CARR: I don't agree with that. May I say this, if the attitude taken by the legal adviser from Texas is true and we are unable to get the Government to withdraw that condition, then it should be up to those of us along the river to agree to maintain that canal; then I say the states of New Mexico and Texas, insofar as they may have an interest there - they deny they have an interest, but I say you have a great interest - then we could see what is necessary to be done. There are those of us who question whether, under the existing laws of Colorado, we have the machinery to organize a drainage district of that character. If that happens to be true and we are going to be required to do that - and God save the mark - then we must have our legislature pass necessary statutes to enable us to do that. We are not going to be

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slothful in this; we are going forward as fast as possible. Now, Major, may I add this further answer to your suggestion about the closed drain: That, as I said before, is not the issue before this Commission. It's one of the factors in the solution of the great problem of an equitable division of the water.

MAJOR BURGES: Which cannot be done until we know what there is to divide.

MR. CARR: By the compact here you have set aside as one of the factors which was solved and which didn't need to be considered further, this proposition of whether that drain canal develops 10 or 10,000 or 600,000 acre feet, Colorado may take, use and store so much water above as is turned into the river down there.

MAJOR BURGES: May I ask you, did Colorado agree in return expressly that pending the doing of this that Colorado would not cause nor suffer the water supply passing the station at the state line to be decreased?

MR. CARR: I think that's in the compact. I say to you Colorado has not violated the compact.

MAJOR BURGES: You want us now to do that.

MR. CARR: What Colorado is saying to you, is that this one factor out of ten which are to be considered relative to equitable division has been solved. Let's put that on one side; then let's come before this Commission, and with the assistance of our engineers, let's present the data which is needed to arrive at a solution of these other matters, an equitable apportionment of the water.

MAJOR BURGES: Then when that has been solved, we will meet you in a friendly manner at the counsel table and do it, but that has not been solved. When that is done, we will meet you and reach a permanent compact.

MR. CARR: Why do we have to hold that out as the one thing which must be determined, when we have already determined it.

MAJOR BURGES: You asked me that before; let me answer it. That is because it will give you some water which you can use and which you don't have to take away from the thirsty individual that now hasn't enough. You are now asking to take it from that thirsty individual and still looking forward to getting this other.

MR. CARR: We are not asking to take a single drop from any thirsty individual, or any other kind of individual. We are saying to you here in language which was taken from the language of the decisions of the United States Supreme Court as the basis of division of the waters of interstate streams, that it could be equitably apportioned when we determine one factor that was on one side, and by agreeing that Colorado might have a commensurate amount of water, we didn't waive any right that Colorado had at the time of the signing of that

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compact to an equitable apportionment of the remainder of the stream, and we are not asking for a drop of water to which we are not equitably entitled. If there is some thirsty individual who is taking our water to which he is not entitled under the terms of equitable apportionment, then that's Colorado's water and we can arrive at it.

MAJOR BURGES: You agreed five years ago that it could not be done until the drain was built and the flow tested. That is wholly true as we see it.

MR. CARR: We did not make that as a last and final statement.

MAJOR BURGES: It couldn't be done then and it can't be done now.

MR. CARR: What difference does it make, whether it's ten or thirty thousand acre feet, its ours. Then we have the rest of the river to consider on an equitable division. We don't say "give us the water you have"; we say "give us the water to which we are entitled under all conditions."

MAJOR BURGES: You said five years ago it couldn't be done until the drain was built.

MR. CARR: We said when the drain was built that would remove the causes of controversy.

MAJOR BURGES: And we say that you now have the chance to build it, and if you go ahead and build it, then we will go ahead and meet and see if that has solved it. Why do we discuss it before it is solved when we have the solution of it in our hands? At that time we were only doubtful, now it is absolutely tendered. All we have to do is get together and do the thing, whether in a few months or a year or two. The second question was addressed to this thought inasmuch as the compact would run out on June 1st, it was probably necessary to extend it, which the articles provide for, until that work could be done.

MR. CARR: Colorado's position is this, as outlined by Governor Corlett this morning: We think we have arrived at a suggestion which was not made at any time during the other conference in Santa Fe, the proposition of allocating the water on a division which will place all people along the stream in parity with all others; not placing Colorado only necessarily, but placing the Middle Rio Grande and the people under the Elephant Butte on the Rio Grande project in parity.

SENATOR McGREGOR: This compact, adopted 5 years ago, apportioned the waters didn't it during the life of it?

MR. CARR: No.

SENATOR McGREGOR: In the provision that the State of Colorado could not further depreciate the flow at the state line? In other words, what it had been taking, it could continue to take. That was a temporary apportionment of the water.

MR. CARR: It was an armistice.

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SENATOR McGREGOR: It was a temporary apportionment of the waters of the Rio Grande.

MR. CARR: It was simply an agreement that we would not further deplete the waters.

SENATOR McGREGOR: It was a concession by two states that the other state could take as much as it had been and no more. We had an agreement expressed in that compact that the State of Colorado would not further depreciate the flow of the Rio Grande river at the state line?

MR. CARR: Yes sir.

SENATOR McGREGOR: Now, the actual effect of that agreement was an apportionment of the waters as of that date, wasn't it?

MR. CARR: I don't think so.

SENATOR McGREGOR: It was a division of the water at that time; you take so much and we take so much.

MR. CARR: No, I don't think so.

SENATOR McGREGOR: The effect of it was that Colorado took an amount equal to what she had been taking up to that time?

MR. CARR: But we would not further deplete it.

SENATOR McGREGOR: That was the effect of that agreement. Now, that was the result of fact-finding wasn't it?

MR. CARR: Yes sir.

SENATOR McGREGOR: The natural condition in Colorado and on the Rio Grande is identical today as it was then - the natural condition?

MR. CARR: Hardly. The clouds that were wont to gather don't gather any more.

SENATOR McGREGOR: The natural condition is the same. Now you want us to review the question as to whether Colorado shall further reduce that flow or not, isn't it?

MR. CARR: Our position is that during the period of the compact we would not further deplete the flow at the state line.

SENATOR McGREGOR: But you want this new Commission to review that finding, don't you?

MR. CARR: I don't think this new Commission is concerned with that finding, because the new Commission is burdened with the necessity of equitably apportioning the stream.

SENATOR McGREGOR: But to do that you want them to go behind that finding?

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MR. CARR: Of course, certainly; this Commission can't equitably apportion the stream without doing that.

SENATOR McGREGOR: Let's get down to the meat of this. What you want, the point of the controversy is - who gets the water?

MR. CARR: Yes sir.

SENATOR McGREGOR: To reach that conclusion you want to review the whole transaction, both prior and subsequent to the findings?

MR. CARR: Absolutely.

SENATOR McGREGOR: That's really the point of contention, isn't it?

MR. CARR: Absolutely, because we say that this Commission - -

SENATOR McGREGOR (Interrupting): If Texas and New Mexico are unwilling to go behind that, and you are unwilling to compact unless you do go behind it, then we are confronted with an impasse, aren't we?

MR. CARR: I don't think any man on either side of this controversy would permit an impasse to come.

SENATOR McGREGOR: I didn't ask you that. I asked you if that condition exists you won't get anywhere?

MR. CARR: I am afraid so.

SENATOR McGREGOR: If New Mexico and Texas would adhere to the proposition that you should not further reduce the flow, and Colorado would adhere to her proposition she wanted to go behind it for the purpose of reducing it, you couldn't get anywhere, could you?

MR. CARR: I will not grant you that for this reason: When we are discussing the proposition of parity, instead of including within that, as you would have us interpret it - -

SENATOR McGREGOR: (Interrupting): You are in fear yourselves if that condition exists you couldn't get anywhere.

MR. CARR: Let me finish my statement. You are including within your suggestion the implication that Colorado by asking that the water be equitably apportioned is coming here to ask that it be permitted to further deplete the stream, and that isn't our position.

SENATOR McGREGOR: Now, then, do you mean you will sign another compact with that provision in it, that you will not further deplete the stream?

MR. CARR: We are saying, as a court, a tribunal, a Commission of reasonable men, we expect the Commission to take up the question of what is equitable apportionment of the waters of that stream and then determine it.

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SENATOR McGREGOR: And in doing that go behind the other finding.

MR. CARR: May I suggest this, you say this compact was arrived at after considering facts. You know, and I know, and everyone there knows, that this compact is nothing more nor less than an armistice, a truce, declared because we were unable to do the thing we were there to do, equitably and permanently apportion that water.

SENATOR McGREGOR: Suppose it was all of that - cast out the question of a truce - I want you to say, do you propose to go behind that finding?

MR. CARR: Absolutely.

MAJOR BURGES: What was the purpose of that armistice - to build the sump drain.

MR. CARR: Yes sir, and to enable us to gather further information.

MAJOR BURGES: That was not our purpose for we have not tried to do it. It seems we are wasting time because after weeks and weeks of deliberations we reached the agreement we couldn't do anything until the drain was constructed. We still think that its perfectly idle to waste time discussing it until that fact is established, and it is not possible to establish it.

MR.CORLETT: Do you take the position that you people don't want to further discuss this matter with us?

MAJOR BURGES: Not until the sump drain is finished.

MR. CORLETT: We are ready and willing with open hearts and minds to come down and meet you.

MAJOR BURGES: And get further concessions which we said five years ago, and we say now, we won't give you.

MR. CORLETT: We are going to convince you we are entitled to parity. We are taking the chance that with New Mexico and Texas calling a caucus and we being down here by ourselves, we are taking a chance upon the fairness of Mr. Harper, who is interested to some extent in your Reclamation projects, that we will be able to convince you gentlemen that parity is the thing we are entitled to and you won't be damaged.

MAJOR BURGES: Why didn't you do it five years ago?

MR. CORLETT: We didn't have the information then.

MAJOR BURGES: And we haven't a bit more now.

MR. CORLETT: We will have to abide by your decision. But we are willing to come and we will do our best to convince you.

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MAJOR BURGES: It seems to me every word of the compact looks to the construction of the sump drain as a preliminary to the permanent settlement. Article 14 provides: "This Compact may be terminated, or extended, at any time by the unanimous legislative action of all of the signatory states, and in that event all rights established under it shall remain and continue unimpaired." Why was it to be extended by unanimous consent? For, as was brought out fully at the discussion, if we hadn't succeeded in getting the sump drain built, Colorado insisted at that time she couldn't do anything until she found out about the sump drain, but now, fortunately, we have the power to make that drain and make it at federal expense. So far as the upkeep is concerned, I don't think you will ever get the government to maintain it. We have fought over and over again and can't get it. I use this illustration and I think it's true - the story of the old woman who got on the train to go to San Antonio without a ticket. The conductor told her she would have to get off the train at the next stop, and she says "You've got to run this train anyhow, what difference does it make to you if I sit on here?" That's the position of the United States. They state very plainly - you have to operate the project anyhow, so what difference does it make if you have to deliver 60,000 acre feet to Mexico? You have to operate it anyhow, so why charge us anything?

MR. CORLETT: Did you ever play poker?

MAJOR BURGES: Not being a candidate for any office, I will state that I have (laughter).

MR. CORLETT: This is possibly out of line, but aren't you asking us to turn our ace in the hole over? Isn't that the substance of it?

MAJOR BURGES: We have no aces, but you have the opportunity to do the very identical thing the temporary compact was made to do. Let's do it and when that is done, we will meet you in a permanent compact.

SENATOR McGREGOR: Mr. Chairman and Gentlemen of the Commission: I don't know where we are exactly, but I think it would be a mistake to terminate this conference in a state of uncertainty, without some idea of getting one more chance of it. We have a good line on what each one wants, and without making a motion on it, my personal judgment is we ought to recess until some time about February 1st for another hearing. Texas and New Mexico know pretty well what Colorado's position is and Colorado knows what our position is. It would be a mistake to break up in a row and all go home. We ought to take another crack at it some time somewhere. I would like to hear from Major Burges, Mr. Patton and these other gentlemen about whether they want to just adjourn and have another meeting in early February. I can make this suggestion because I know I am not coming back - the Texas legislature will have to make an emergency appropriation for somebody to come out here and you ought to let it run until about February 1st to get that appropriation. I don't think we ought to walk off and quit and say we can't get anywhere. This is an exceedingly vital proposition, not only to these three states, but to the country at large, and the position these gentlemen hold is one of great

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importance. We went round and round for several weeks and we had good luck in getting this compact and I think you can get another one. I don't think you will get anywhere today, except just to continue the hearing to a later date.

MR. S. P. HOWELL: I just want to interpose that I concur entirely with Senator McGregor. These commissioners are here representing great soverign states, representing interests that touch into the very lives of the people of each of their states, and merely because there appears at this time to be a difference, such as apparently cannot be reconciled now, I don't think we can afford, I don't think you gentlemen can afford to let that be a conclusion of this matter. By taking a little time for further consideration - you considering what Colorado offers and we considering what our neighbors, Texas and New Mexico, have suggested, with a desire to work out some plan that's equitable and just, that some sort of an arrangement can finally be made. There is too much at stake to let the matter rest and the conference adjourn without delay. I appeal to you gentlemen and commissioners, that you can well afford to perhaps stretch a little on what appears to be a possible result and take a recess and let's come back again and see if there cannot be something evolved that will be for the best interests of the states whom we represent. I want to concur heartily with the suggestion of Senator McGregor. I don't think under the circumstandes that there is any reasonable justification for abandoning an effort to get together on some basis, even though the question raised by Major Burges, the question as to whether the compact in its present form should be continued, even that matter involves so many questions that I think our Commissioner would not be prepared to take a definite stand upon that today. I think in fairness to all, time should be given for all of us to carefully consider this matter further and adjourn to some time at the convenience of the commissioners, the latter part of January or early part of February, it seems to me would be a happy way to conclude our deliberations here today.

MR. PATTON: Mr. Chairman and Gentlemen: I call attention to the fact that the legislature of New Mexico meets on the second Tuesday of January. Article 14 of the compact itself provides that this compact may be terminated, or extended, at any time by the unanimous legislative action of all of the signatory states, and in that event all rights established under it shall remain and continue unimpaired. I think New Mexico and Texas have no objection to a continuance of this conference. We have no desire to abruptly terminate it. We are willing to take a recess to some time toward - I would suggest the middle or latter part of January. It's possible at that time we might be able to arrive at some decision and conclusion, but I think it only fair to state to the gentlemen from Colorado that New Mexico's position, to repeat, once more, is that we feel we are not in a position to further treat until the drain has been completed and until we know where we are. I believe Texas will join me in that conclusion. I would suggest that this meeting recess until possibly the latter part of January, the last Monday in January, and at that time possibly all the states may be in a position to more adequately discuss the matter. But again stating, I think our position must be understood,

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that until we can know what waters will be produced, I think I can civilly say we are not in a position to treat toward a permanent compact.

SENATOR McGREGOR: I move we recess until the last Monday in January, which is January 28, 1935, in Santa Fe.

MAJOR BURGES: Unless some other date would be mutually agreed upon.

MR. PATTON: Might I also call attention to the fact that New Mexico only has a 60 day session and the incoming administration is doing everything possible at the present time to limit that session to 30 days. I doubt if that will be accomplished, but nevertheless plans are being made to that end.

MR. CORLETT: Are you required to introduce your bills in a specified time?

MR. PATTON: That is usually made by rule of the legislature.

MR. CORLETT: It might be advisable then, within the appropriate time for the introduction of bills that each of the three states - I presume you can introduce a bill by title? It might be advisable for each state to introduce a bill by title for the possible ratification of the compact.

SENATOR McGREGOR: We couldn't do that in Texas, you have to state everything in the body of the bill.

MAJOR BURGES: I would like to make this suggestion - either at this time or in the very near future, if they saw fit, to indicate what changes they thought ought to be made in the compact, it would be helpful in considering the question. You gentlemen know wherein it's unsatisfactory to you. If you would indicate with some definiteness, either now or at an early date, what changes you propose to make, it would facilitate deliberations.

MR. PATTON: Shouldn't those changes be submitted in tentative form to the Commission?

MR. CORLETT: I don't know that we would want to say now that we would suggest a formal compact, but I think we ought to be ready, at least on the convening of this meeting, to have for suggestions such changes as we think ought to be made.

MAJOR BURGES: Our position is, as I see it, we don't see that any change is necessary in the compact until the drain is constructed; therefore, we have no changes to suggest. If, indeed, changes are to be suggested, they ought to be submitted in time for consideration.

MR. CARR: Can't we bring them when we come?

MAJOR BURGES: We will have lost a lot of time considering them.

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MR. CARR: We may be able to supply it.

MR. HINDERLIDER: Speaking for Colorado, insofar as I am able to determine, that date will meet with my convenience and my advisers.

MAJOR BURGES: It might be worth your consideration, the Rio Grande Compact Committee has to meet along some time and it will probably be my last appearance at that time, but I expect to attend that meeting in January.

MR. CORLETT: We honestly hope that you and Senator McGregor will both be back.

Mr. Hinderlider seconded the motion for adjournment until January 28, 1935, which was unanimously carried.

SENATOR McGREGOR: Gentlemen, I am through - I am going home and resign, but I want to say to you boys from Colorado and New Mexico that I have enjoyed being up here and helping divide up your water. I don't know much about water, except to put sugar and ice with it. If you ever come to Texas, come and see me, but don't come like Corlett did. He blew in one morning in a duck hunting outfit and asked me - don't you know me? I said - hell, no, so when you come down, come in your natural clothes so I will know you. Sorry I can't go on with you in the future, but I can't, but you have an important matter here so try to get together. Don't fall out and let some court 8 or 10 years from now handle it - it's good picking for the lawyers, but tough on the people.

MR. CORLETT: I would like to offer a motion on behalf of the multitude that we tender to Senator McGregor our very highest regards for his cooperation here in these meetings, for his kindly spirit and particularly for his diplomatic presentation, for his stepping into breaches many times when it looked almost as if the thing might fall. Senator, I am sure we all appreciate more than I can say the kindly way in which you have treated us and the courteous way through all of these deliberations, and if you don't come back we want you to take our appreciation with you.

MR. HARPER: I would like to express my appreciation to every delegate here for the courteous manner in which you have helped the chairman to conduct this very difficult meeting. I hope and believe that when we meet again that we are going to be able to get together on a basis that is fair and equitable to all three states. I don't feel exactly like Will Rogers did when, 2 or 3 weeks ago - perhaps some of you read his article in the Sunday papers - after his visit to Boulder Dam, he said: "I've heard a great deal about this controversy over the water that is going to be impounded: I would advise you boys that the best way to claim your water is to grab it and use it before it leaves your state; but anyway it may be all right to carry on this controversy; it makes good jobs for some lawyers." I don't feel that way about our problem. I know we are going to get together when we meet here again.

MR. HINDERLIDER: I think I am expressing the sentiment of the three commissioners representing the 3 states here today in expressing to you our

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appreciation for the very admirable way you have presided over this conference. The degree of fairness you have exhibited, and your further statement that you are satisfied that the conference can be re-convened upon the date designated and that we will ultimately reach a satisfactory conclusion in respect to these negotiations.

The meeting thereupon adjourned until January 28, 1935, at Santa Fe, New Mexico.

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(Copy of correspondence between Governors and
Washington leading up to this meeting.)

November 20, 1934.

Hon. A. W. Hockenhull
Governor of New Mexico
Capitol Building
Santa Fe, New Mexico

Hon. Miriam A. Ferguson
Governor of Texas
Capitol Building
Austin, Texas

My dear Governor _____:

Pursuant to provisions of Article VII of the Rio Grande Compact between the States of Colorado, New Mexico and Texas, which, by its own terms expires June 1, 1935, it is incumbent upon the Governors of each of the signatory states to appoint one Commissioner for the purpose of concluding a new compact, and also for the Governors to request the President of the United States to name a representative to sit with the Commission.

Having been advised by you some time ago that you had designated representatives of your state for the purpose of negotiating a new compact with respect to the waters of the Rio Grande, we suggest to you the advisability of a meeting of the representatives of the three interested states at the State Capitol at Santa Fe, New Mexico, at 10 o'clock, December 3rd, for the purposes above mentioned. We also suggest that you join us in making such request to the President as soon as we have agreed on the date for the Santa Fe meeting.

In connection with the proposed conference at Santa Fe, it is my understanding that each state will be represented by one commissioner designated by the Governor, together with such number of advisers as may appear to you to be desirable.

Awaiting your early reply, I am

Very cordially yours,
Edwin C. Johnson
Governor of Colorado.

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STATE OF NEW MEXICO
SANTA FE
November 23, 1934.

Honorable Ed C Johnson
Governor of Colorado
Denver, Colorado.

My dear Governor:

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I have your esteemed favor of the 21st inst. suggesting that I join you in suggesting to the President that representatives of our respective States meet at Santa Fe on December 3rd next for the purpose of negotiating a new compact relating to the waters of the Rio Grande.

I would be glad if you would proceed with this negotiation and arrange for the meeting at Santa Fe as suggested.

Assuring you of my esteem, I am

Yours most sincerely,
A. W. Hockenhull
Governor.

- - - - - - - - - - -

(Telegram) Denver, Colo., Nov. 30, 1934

His Excellency A. W. Hockenhull
Governor of New Mexico
Santa Fe, New Mexico

We have this date wired the President requesting the appointment of a representative of the government to sit with the commissioners of Colorado, New Mexico and Texas at Santa Fe December tenth for the negotiation of a new compact stop Pursuant to provisions of Article Eight of the present Rio Grande Compact we suggest that you wire at once a similar request to the President.

Edwin C. Johnson
Governor of Colorado

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(Telegram) Denver, Colo., Nov. 30, 1934
The President, Washington, D. C.
The States of Colorado, New Mexico and Texas have appointed commissioners to confer at Santa Fe, New Mexico, December tenth for the purpose of negotiating a new interstate compact covering the waters of the Rio Grande to replace the temporary compact to which the United States is a party stop In conformity with provisions of present compact Article seven A Chapter five hundred six Act of Congress June seventeen nineteen thirty it is necessary that you be represented upon such commission of which it is customary for the President's representative to act as chairman stop In order that the deliberations of the commission may proceed in regular form I respectfully request that you designate a representative to sit with the commission on December ten and that I be advised as soon as may be.

Edwin C. Johnson
Governor of Colorado.

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(Telegram) Santa Fe, New Mexico, Dec. 1, 1934.

Honorable Ed. C. Johnson
Governor of Colorado
Denver.

I am today wiring the President asking him to appoint representative to meet with representatives of New Mexico, Texas and Colorado at Santa Fe December tenth to negotiate new Rio Grande Compact stop With kind regards.

A.W.HOCKENHULL GOVERNOR OF NEW MEXICO. 2.

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November 27th, 1934.

Honorable Ed C. Johnson,
Governor of Colorado,
Denver, Colorado.

My dear Governor:

Referring again to your suggestion that a conference be held in Santa Fe, New Mexico early in December, between representatives of Colorado, New Mexico and Texas, for the purpose of concluding a new Rio Grande River Compact between these States and the Federal Government, I have conferred with our water Commissioners and find that the most suitable date for New Mexico and Texas would be on December 10th next. If this is agreeable to you, please go ahead and call the conference and add my name to your proposal. If there is anything further I can do in this matter, please advise me.

With kindest personal regards, I am

Yours most sincerely,

A. W. Hockenhull,
Governor of New Mexico.

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(Telegram) Santa Fe, New Mexico, December 1, 1934.

To the President
The White House
Washington, D.C.

I desire to join with the Governors of the States of Colorado and Texas in asking you to appoint a representative of the federal government to meet with commissioners of Colorado, New Mexico and Texas at Santa Fe on December tenth next for the purpose of negotiating a new Rio Grande Compact relating to the waters of the Rio Grande Stop With assurances of high esteem.

A. W. Hockenhull
Governor of New Mexico

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(Telegram) Santa Fe, New Mexico, December 8, 1934

To the Secretary of the President
The White House
Washington, D. C.

On December first I wired the president asking for the appointment of federal representative to meet with commissioners of Colorado, New Mexico and Texas at Santa Fe December tenth to negotiate a new Rio Grande Compact stop We are most anxious to know if federal representative has been named and if he will be in Santa Fe on that date. Please wire me.

A. W. Hockenhull, Governor.

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(Telegram) Washington, D. C., December 8, 1934.

Hon. A. W. Hockenhull,
Governor of New Mexico

The President has directed S. O. Harper Bureau of Reclamation at Denver to be his representative at Rio Grande Compact Commission meeting at Santa Fe, December ten.

Ickes, Secretary.

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(Copy of Credentials of Commissioners)

EXECUTIVE ORDER
STATE WATER COMMISSIONER

Pursuant to the power conferred upon me by Section 1651 Compiled Laws of Colorado of 1921 and Chapters 189, 190, 191 and 192 of the Session Laws of Colorado of 1923, it is hereby

ORDERED: That Mr. M. C. Hinderlider of the City and County of Denver, State of Colorado, be and he hereby is appointed COMMISSIONER, to serve without salary, to represent the State of Colorado upon any and all JOINT COMMISSIONS to be composed of COMMISSIONERS representing other States, for the purpose of negotiating interstate compacts, and at any and all conferences in relation thereto, particularly having to do with the waters of the Laramie, Colorado, La Plata, South Platte, Arkansas, Rio Grande and North Platte rivers.

GIVEN under my hand and the Executive Seal this twenty-fourth day of January, A. D. 1933.

(SEAL) (Signed) Ed C. Johnson, Governor

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EXECUTIVE ORDER
INTERSTATE WATER COMMISSIONER

Pursuant to the power conferred upon me by Section (a), Article VII of the Rio Grande Compact, approved by the Legislature April 9, 1929, it is hereby

ORDERED: That M. C. Hinderlider, of the City and County of Denver, State of Colorado, be and he hereby is appointed Commissioner, to serve without salary, to represent the State of Colorado upon a joint commission to be composed of Commissioners representing the States of Colorado, New Mexico and Texas, for the purpose of negotiating an Interstate Compact with respect to the use of the waters of the Rio Grande, and at any and all conferences in relation thereto.

GIVEN under my hand and the executive seal this third day of December, A. D. 1934.

(SEAL) (Signed) Ed C. Johnson, Governor.

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IN THE NAME AND BY THE AUTHORITY OF
THE STATE OF TEXAS

TO ALL TO WHOM THESE PRESENTS SHALL COME - GREETING:

KNOW YE, that I hereby constitute T. H. McGregor a Commissioner for the purpose of considering a compact providing for the equitable apportionment of the use of the waters of the Rio Grande River among the States of Texas, Colorado and New Mexico, as provided in Article VII of the compact entered into among said states and heretofore ratified by the Legislature of the State of Texas and approved by the Congress of the United States, and to carry out the provisions of said Article VII.

IN TESTIMONY WHEREOF, I have hereunto signed my name and caused the Seal of the State to be affixed at the City of Austin, this the third day of December, A. D. 1934.

(SEAL) (Signed) Miriam A. Ferguson,
Governor of Texas

BY THE GOVERNOR:

(Signed) W. W. Heath
Secretary of State.

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APPOINTMENT OF COMPACT COMMISSIONER

WHEREAS, in the City of Santa Fe, State of New Mexico, on the 12th day of February, 1929, the States of Colorado, Texas and New Mexico entered into a Compact for the purpose of removing causes of present and future controversy between said states in regard to the waters of the Rio Grande, and with respect to the use of the waters of the Rio Grande above Fort Quitman, Texas, and said states being moved by considerations of interstate comity, and

WHEREAS, said Compact by its terms was to expire on the first day of June, 1935, and,

WHEREAS, Paragraph a of Article 7 of said Compact reads as follows:

> "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 signature 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."

and,

WHEREAS, the Honorable E. K. Neumann, Attorney General of New Mexico, has heretofore been appointed Interstate River Commissioner of the State of New Mexico, and,

WHEREAS, said Interstate River Commissioner is now absent from the State of New Mexico,

NOW, THEREFORE, I, Andrew W. Hockenhull, Governor of New Mexico, pursuant to the above Paragraph a, Article 7, do hereby name and appoint Thomas M. McClure, State Engineer of the State of New Mexico, as Commissioner for the

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purpose set forth in said Paragraph a, Article 7 and for the further purpose of acting for the said absent Interstate River Commissioner.

Done this the 10th day of December, 1934.

(Signed) A. W. Hockenhull
Governor of New Mexico

(SEAL)

ATTEST:
Mrs. Marguerite P. Baca
Secretary of State

- - - - - - - - - -

STATE OF NEW MEXICO
Executive Office

To all whom these present shall come - Greeting:

KNOW YE, That reposing special trust and confidence in the prudence, integrity and ability of Thomas M. McClure of Santa Fe, New Mex. I do hereby appoint and commission him a delegate for the

STATE OF NEW MEXICO

to the Interstate River Commission under Paragraph a of Article 7 of said Compact.

The said Thomas M. McClure is therefore carefully and diligently to discharge the duties of said office by doing and performing all manner of things thereto pertaining in compliance with law.

IN TESTIMONY WHEREOF, I have hereunto set my hand and caused to be affixed the Great Seal of the State of New Mexico.

Done at Santa Fe, New Mexico, this tenth day of December, in the year of our Lord One Thousand Nine Hundred and Thirty-four.

(SEAL)

(Signed) A. W. Hockenhull
Governor of New Mexico

ATTEST:
Mrs. Marguerite P. Baca,
Secretary of State.

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ff. 1 Proceedings of the Rio Grande Compact Conference held at Santa Fe, New Mexico. 1934-1935.

Box 62

Series 7: Publications and reports, 1856-1992 and undated

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Papers of Delph E. Carpenter and Family

Water Resources Archive, Colorado State University, Fort Collins

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TX_MSJ_003683

TEXAS' BRIEFS

A. G. 51-238

STATE OF TEXAS

v.

STATE OF NEW MEXICO, ET AL

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AC 51-238

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1935

No. — Original

STATE OF TEXAS,

Complainant,

vs.

STATE OF NEW MEXICO, ET AL.

MOTION FOR LEAVE TO FILE BILL OF COMPLAINT AND BILL OF COMPLAINT.

WILLIAM MCCRAW,
Attorney General of the State of Texas.
H. GRADY CHANDLER,
Assistant Attorney General,
Counsel for Complainant.

RICHARD F. BURGES,
WALTER S. HOWE,
EDWIN MECHEM,
Of Counsel.

U.S. appropriation 1935

REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

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REPRODUCED FROM THE HOLDINGS OF THE TEXAS STATE ARCHIVES

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SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1935

No. — Original

STATE OF TEXAS,

Complainant,

vs.

STATE OF NEW MEXICO, ET AL.

MOTION FOR LEAVE TO FILE BILL OF COMPLAINT.

To the Honorable, the Chief Justice and the Associate Justices of the Supreme Court of the United States:

Now comes the State of Texas, by its Attorney General, William McCraw (Richard F. Burges, of counsel), and moves the Court for leave to file the bill of complaint herewith exhibited, in the above entitled cause, in a controversy which has arisen between the said State of Texas and State of New Mexico, the Middle Rio Grande Conservancy District, a quasi-municipal corporation, organized under the laws of New Mexico, and against Robert Dietz, who is President of said Middle Rio Grande Conservancy District, and M. R. Buchanan, T. J. Seneker, George Cook and Constancio Hendron, directors of said district, growing out of the action of said State of New Mexico and of said Mid-

FROM THE TEXAS STATE ARCHIVES

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dle Rio Grande Conservancy District, its president and directors, in storing, diverting and using the waters of the Rio Grande in contravention of the vested rights of plaintiff and its citizens, and in contravention of the Rio Grande Compact, between said States, and other acts alleged in said bill, and arising under the constitution and laws of the United States for the purpose of restraining said State and the citizens thereof, and particularly the Middle Rio Grande Conservancy District, and the president and directors thereof, their engineers and agents, from causing or permitting any new or increased diversion or storage of the waters of the Rio Grande or its tributaries within the limits of New Mexico which will impair the water supply of the Elephant Butte Reservoir, and for other relief prayed for in said bill; and that proper process may issue thereon, notifying the defendants of the filing of said bill, and requiring that they appear and answer thereto and defend the same.

Dated October 24, 1935.

STATE OF TEXAS,
By WM. MCCRAW,
Its Attorney General.
H. GRADY CHANDLER,
Assistant Attorney General.
RICHARD F. BURGES,
WALTER S. HOWE,
EDWIN MECHEM,
Of Counsel.
By RICHARD F. BURGES.

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1935

No. —, Original

THE STATE OF TEXAS,
Complainant,

vs.

THE STATE OF NEW MEXICO, ET AL.

BILL OF COMPLAINT.

To the Honorable the Chief Justice and Associate Justices of the Supreme Court of the United States:

The State of Texas, by William McCraw, its Attorney General, brings this, its Bill of Complaint, against the State of New Mexico, and against the Middle Rio Grande Conservancy District, a quasi-municipal corporation, organized under the laws of New Mexico, and against Robert Dietz, who is President of said Middle Rio Grande Conservancy District, and M. R. Buchanan, T. J. Seneker, George Cook and Constancio Hendron, who are the duly appointed and acting Directors of said Middle Rio Grande Conservancy District, and respectfully complaining, shows unto this honorable court that the ground, upon which the court's jurisdiction of the matters hereinafter set forth depends, is that this bill of complaint sets out a controversy

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between the said two States of which this court has original jurisdiction.

I.

Your orator further shows that the residents and occupants of lands within the Valley of the Rio Grande above Fort Quitman and now within the limits of the State of Texas, from the earliest date of the colonization and settlement thereof, and ever since the year 1681, have been accustomed to divert, and have diverted the waters of the Rio Grande for the purpose of the irrigation and cultivation of their lands situated within said valley; that these lands 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 protection of crops thereon. That ever since the date last above mentioned the occupants and residents of the Rio Grande Valley within the present limits of the State of Texas above Fort Quitman have diverted and used the waters of the Rio Grande for irrigation purposes.

II.

That during the latter half of the nineteenth century, and more particularly after about 1875, the occupants of that portion of the Rio Grande Valley lying North of the present limits of the State of Texas, diverted and used for the irrigation of their lands, ever-increasing quantities of the waters of the Rio Grande, until the Rio Grande, and particularly that part of it between the South boundary line of New Mexico and Fort Quitman, Texas, (which had been, from time immemorial and until about 1875, a perennial stream affording sufficient water for the irrigation of lands within the present limits of the State of Texas above Fort Quitman), became in large degree a torrential stream; that

so becoming a torrential stream, by reason of the greatly increased diversion of its waters above the Texas boundary line, that portion of the Rio Grande between the Southern boundary line of New Mexico and Fort Quitman, Texas, became entirely or nearly dry during a great portion of the summer irrigation season, thereby making unprofitable and impracticable successful farming within that portion of the Rio Grande Valley last above referred to; and that as a result of such reduction and exhaustion of the flow during the irrigation season, vineyards and orchards in that portion of the valley perished for want of water, and lands which had long been fruitful and productive were rendered arid and unproductive.

III.

Your orator further shows that as a result of the increased diversion and consumption of water above complained of, that portion of the Rio Grande Valley within the State of Chihuahua, Republic of Mexico, known as the Juarez Valley, which lies opposite to the El Paso Valley in Texas, was likewise deprived of water for irrigation, and the Juarez Valley, which from a very early date had reached a very high state of cultivation, was likewise injured. That as a result of the injury thus inflicted upon the lands lying within the Juarez Valley in Mexico, the Government of that Republic lodged with the Government of the United States serious complaints, and made demands upon the Government of the United States for reparation for the injury so inflicted, amounting in the aggregate, after the lapse of years and of repeated complaints, to many millions of dollars.

IV.

That as a result of the complaints lodged with the Government of the United States by the Republic of Mexico,

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and also as a result of complaints in behalf of citizens and residents of Texas, presented by its senators and representatives in Congress, the Government of the United States entered into negotiations with the Republic of Mexico for the construction of an international dam and reservoir, at or near the City of El Paso.

V.

That upon the passage in 1902, by the Congress of the United States, of what is known as the Federal Reclamation Act, and the organization of the United States Reclamation Service, the Department of the Interior of the Government of the United States caused studies and surveys to be made upon the Rio Grande to determine the most effective and economical plan for conserving the waters of the Rio Grande for the irrigation of lands, both in Texas, above Fort Quitman, and in the Juarez Valley in Mexico.

VI.

Your orator further shows that as a result of such studies and surveys a plan was evolved for the construction of a storage dam at Elephant Butte, on the Rio Grande near Engle, New Mexico; and that this dam was planned to be of sufficient height to create a reservoir of large enough capacity to control all of the flood and unappropriated waters of the Rio Grande, to the end that ample water would be restored to the lands below said reservoir without depriving lands in cultivation above said reservoir of water from the normal flow of the Rio Grande necessary for the irrigation of such lands, whether having contemporaneous water rights with those below or rights junior thereto.

VII.

That such plan thus evolved contemplated the supplying of water for irrigation to lands theretofore deprived

thereof in that portion of the Rio Grande Valley in New Mexico lying South of the proposed reservoir, as well as of the lands in the Juarez Valley and the El Paso Valley; and, in addition thereto, it was proposed and contemplated that such reservoir should afford water, from the storage and conservation of flood waters hitherto unappropriated and going to waste, to irrigate additional lands in the Rio Grande Valley in New Mexico below said reservoir, and in the Rio Grande Valley in Texas, above Fort Quitman, sufficient to make the construction and operation of such reservoir and the works appurtenant thereto economically feasible, notwithstanding the enormous cost thereof.

VIII.

Your orator would further show that the flow of the Rio Grande is extremely variable; that during the years that measurements have been made at or near the head of the Elephant Butte Reservoir, the total annual discharge has been as little as 200,700 acre feet, whereas, the maximum discharge in one year has been 2,422,000 acre feet; that the known variability of the flow necessitated a reservoir sufficient to impound in years of major flow, water for use in years when the flow would be deficient. That the cost of constructing a reservoir of sufficient capacity to enable the United States to meet its treaty obligation, and to supply water for the lands entitled thereto in New Mexico and Texas, necessitated bringing under irrigation such an amount of land as would render the construction of the proposed reservoir economically feasible.

IX.

Your orator further shows that under date of the 21st day of May, A. D. 1906, the United States of America entered into a treaty with the Republic of Mexico, in which

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the United States obligated themselves to construct a storage dam near Engle, New Mexico, and to deliver to Mexico annually a stipulated amount of water for the irrigation of lands in the Juarez Valley, and in consideration therefor, Mexico waived and relinquished all claims against the United States for damages above referred to; all of which more fully appears from a copy of said treaty which is hereto attached, marked Exhibit "A", and made a part of this Bill of Complaint.

X.

That for the purpose of carrying out the obligations by said treaty imposed, and for the purpose of protecting and restoring vested water rights, and to carry out the plan formulated by the United States Reclamation Service, and in conformity with the laws of the then Territory of New Mexico, the Government of the United States, under date of January 23, 1906, filed in the office of the Territorial Engineer of New Mexico its filing upon the waters of the Rio Grande near Engle, New Mexico, in the amount of 730,000 acre feet annually. All of which will more fully appear from copy of the Record of such Filing hereto attached, marked Exhibit "B", and made a part of this Bill of Complaint.

XI.

That, further, to secure and effectuate the purposes above outlined, the Government of the United States did, on or about April 8, 1908, file in the office of said Territorial Engineer of New Mexico a further filing and appropriation of all of the unappropriated waters of the Rio Grande near Engle, New Mexico. All of which will more fully appear from a copy of said application and filing attached hereto, marked Exhibit "C", and made a part of this Bill of Complaint.

XII.

That the Government of the United States did not, at any time subsequent to January 23, 1906, notify the Territorial Engineer of New Mexico that said Government released any of the waters appropriated on January 23, 1906; and the Government of the United States did not, at any time subsequent to April 8, 1908, notify the Territorial Engineer of New Mexico that said Government released any of the waters appropriated on April 8, 1908; and, further that the Government of the United States has taken no other action in conformity with the laws of the State of New Mexico limiting the water rights acquired under the laws of the then Territory of New Mexico, as set out in Exhibit "B" and Exhibit "C" of this Bill of Complaint.

XIII.

That in pursuance of the filings and appropriations set forth in Exhibits "B" and "C" hereto attached, the United States Reclamation Service proceeded promptly and diligently to construct said storage dam and other irrigation works; that such reservoir was constructed in accordance with the plan above described; and, that since 1915 all of the flow of the Rio Grande has been stored in the reservoir so created, and released from said reservoir for the irrigation of lands in New Mexico and Texas below said reservoir, and for the delivery of water to Mexico in accordance with the Treaty of 1906 (Exhibit "A" hereof).

XIV.

Your orator further shows that pursuant to the plan proposed by the Department of the Interior of the United States for the construction of said storage dam and the diversion dams and canals, necessary for the use of the

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waters stored in said reservoir, and other works appurtenant thereto, the holders of title to irrigable lands lying under said proposed reservoir and constituting the Rio Grande Project entered into a contract with the Government of the United States, whereby they obligated themselves and mortgaged their lands to repay to the United States Government the cost of such reservoir and works appurtenant thereto, with the exception of a portion of said total cost, amounting to the sum of One Million Dollars, which the United States agreed to pay for the portion of the waters allotted to Mexico, under the terms of said treaty embraced in Exhibit "A", and the Congress of the United States appropriated the sum of One Million Dollars therefor. That the portion of the cost of said reservoir and appurtenant works which the land-owners in New Mexico and Texas agreed to pay, and which they are, and for some years have been engaged in repaying, was the sum of approximately Fourteen Million Dollars, in addition to the annual cost of operation and maintenance of said reservoir and appurtenant works.

XV.

That the owners and occupants of the lands in said Rio Grande Project in New Mexico and Texas have paid annually into the treasury of the United States the cost of operation and maintenance of said reservoir and appurtenant works and such proportion of the cost of construction thereof as has been required by the Government of the United States, and they are obligated to continue such payments until the Government of the United States is reimbursed, under the terms of the contract entered into between them and the Government of the United States.

XVI.

Your orator would further show that all of the waters of the Rio Grande filed upon and appropriated as hereinabove set out, have been and are now applied to beneficial use in the State of Texas above Fort Quitman, and in that portion of the Rio Grande Valley in New Mexico lying south of the Elephant Butte Reservoir, and in the Juarez Valley in Mexico in accordance with the treaty with the United States set forth in Exhibit "A", and that at no time since its completion in 1916, has the reservoir ever been filled to its capacity.

XVII.

That as a result of the construction of Elephant Butte Dam and of irrigation works constructed in connection therewith, residents and land-owners within the State of Texas above Fort Quitman and in the State of New Mexico below said Elephant Butte Reservoir, have been enabled to apply and use the waters of the Rio Grande, and have applied and used the waters stored in said reservoir for irrigation of their lands having an aggregate area of approximately 180,000 acres, of which approximately 85,000 acres are in the State of Texas.

XVIII.

That all of the waters of said reservoir are indispensable to the successful irrigation and cultivation of said lands; and that should the owners thereof be deprived of any of such water, the remaining supply thereof will be insufficient for proper irrigation of said lands, and the value of such lands, upon which large sums of money have been expended by the owners thereof in placing said lands in suitable condition for irrigation farming, and the value of the homes and other permanent improvements thereon, will greatly be reduced.

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XIX.

That the maintenance of at least the accustomed quality of water in said reservoir is indispensable to the successful irrigation and cultivation of said lands; and that should this supply of water be impaired by reduction in the quality of said waters, said lands will become sterile and unproductive, and the value of such lands, upon which large sums of money have been expended by the owners thereof, in placing said lands in suitable condition for irrigation farming, and the value of the homes and other permanent improvements thereon will greatly be reduced.

XX.

Your orator further shows that, if the supply of water from said reservoir is reduced in quantity or in quality, in addition to the damage and injury inflicted upon its citizens and landowners through any such impairment of said waters for irrigation purposes, the State of Texas, and the counties and municipalities thereof, will be deprived of the revenue arising from the taxation of such lands and improvements, which your orator shows amount to a material and substantial sum to the State, and a large and indispensable revenue to the counties and municipalities thereof, to the great and irreparable injury of your orator.

XXI.

Your orator would further show that the rights of the State of Texas in and to the use of the waters impounded in the Elephant Butte Reservoir have been recognized and acknowledged by the State of New Mexico in that certain interstate compact commonly known as the "Rio Grande Compact", executed at Santa Fe, in the State of New Mexico, on February 12, 1929, copy of which Compact is

hereto attached, marked Exhibit "D" and made a part of this Bill of Complaint.

XXII.

That said Compact was duly ratified by the Legislature of the State of Colorado on the 29th day of April, 1929; by the Legislature of the State of New Mexico on the 9th day of March, 1929; and by the Legislature of the State of Texas on the 22nd day of May, 1929, and that the Congress of the United States gave its consent thereto by Act of Congress approved the 17th day of June, 1930.

That the Rio Grande Compact was formally extended by Act of the Legislature of the respective States on the following dates, to-wit: By the State of Colorado, on the 13th day of April, 1935; by the State of New Mexico, on the 25th day of February, 1935; and by the State of Texas, on the 18th day of April, 1935, and that the Congress of the United States gave its consent to such extension of the Compact by Act of Congress approved the 5th day of June, 1935. That said Compact is now in full force and effect. That by the terms of Article XII of said Compact it is provided:

"New Mexico agrees with Texas, with the understanding that prior vested rights above and below Elephant Butte Reservoir shall never be impaired hereby, that she 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."

XXIII.

Your orator would further show that for several years last past the flow in the Rio Grande has been below the average and below normal, and during the years 1934 and

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1935 the storage at the Elephant Butte Reservoir has been so depleted as to deprive irrigators entitled to water therefrom of sufficient water for the suitable irrigation of all of their lands, and has necessitated the curtailment of beneficial uses of water and the elimination from cultivation of certain lands for want of sufficient water for the proper irrigation thereof.

XXIV.

Your orator would further show that prior to February 12, 1929, the date of the Rio Grande Compact set forth in Exhibit "D", there was practically no storage of the waters of the Rio Grande or its tributaries in the State of New Mexico above the Elephant Butte Reservoir, and particularly that there was no storage of waters upon the Rio Grande or any of its tributaries by or for the use of the Middle Rio Grande Conservancy District. That at the date such Compact became effective, and for more than four years next preceding such date, the maximum amount of land under irrigation within the present boundaries of the Middle Rio Grande Conservancy District did not exceed 87,000 acres. That the waters of the Rio Grande and its tributaries were diverted for use on said lands by means of temporary diversion dams, which were, from time to time, washed out or destroyed when the river was in flood. That since such Compact became effective, the Middle Rio Grande Conservancy District has constructed within the State of New Mexico various permanent diversion dams by which it has been enabled to make, and has made, new and increased diversions from the flow of the Rio Grande, and said District has constructed other irrigation and drainage works, by which it has been enabled to and has delivered water so diverted to an increased area of land, and your orator is informed and believes, and therefore alleges upon

information and belief, that the Middle Rio Grande Conservancy District contemplates and intends to divert and use the waters of the Rio Grande and its tributaries for the irrigation of approximately 122,000 acres of land, and will divert additional waters for such increased area unless restrained and enjoined from so doing.

XXV.

Your orator would further show that subsequent to the ratification of said Compact, and in disregard of the terms thereof, and of the right to the use of the waters of the Rio Grande and its tributaries acquired under the filings and appropriations set forth in Exhibits "B" and "C", the Middle Rio Grande Conservancy District constructed, or caused to be constructed, within the State of New Mexico, upon the Rio Chama, one of the principal tributaries of the Rio Grande, a reservoir with a storage capacity of approximately 200,000 acre feet, known as El Vado Reservoir, which was practically completed and ready for use before the beginning of the irrigation season of 1935; that in this reservoir the Middle Rio Grande Conservancy District has this season stored in excess of 170,000 acre feet of water, derived principally from melting snow, and is now storing approximately 135,000 acre feet of such water, practically all of which water would and should have reached the Elephant Butte Reservoir, had El Vado Reservoir not been constructed and in use, and to all of which water the owners of land within the Rio Grande Project are and were entitled by virtue of the appropriations set forth in Exhibits "B" and "C", and by virtue of the terms of the Compact, set forth in Exhibit "D".

XXVI.

Your orator would show that the water supply of Elephant Butte Reservoir has been depleted as to quantity by

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such new and increased diversions, and by such storage within the limits of New Mexico which have not been offset by increase in drainage return reaching Elephant Butte Reservoir; the extent of said depletion was in excess of 70,000 acre feet in 1934, and in 1935 has been more than 250,000 acre feet.

XXVII.

That the water supply of Elephant Butte Reservoir has been impaired as to quality by such new and increased diversions and by such storage within the limits of New Mexico which have not been offset by increase in drainage return; and said reduction in quality will not have been offset unless and until there shall have been an increase in the aggregate amount of drainage return reaching Elephant Butte Reservoir materially in excess of the aggregate of all new and increased diversions and storage of water above Elephant Butte Reservoir.

XXVIII.

Your orator would further show that such storage and such increased diversion and use of the waters of the Rio Grande and its tributaries has been done over, and contrary to, the protests of the State of Texas, made on its behalf by the Rio Grande Compact Commissioner, the officer of the State of Texas authorized and empowered to make such protest.

XXIX.

Your orator further shows that under Article III of the Rio Grande Compact (Exhibit "D"), it is the duty of the State of New Mexico to establish and maintain such gauging stations as may be necessary to comply with the provisions of said Compact; that in order to comply with the provision that New Mexico would 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, it was and is essential that the increased diversions and use hereinabove complained of should be accurately measured at gauging stations suitably placed and properly operated for such purpose, and that drainage waters should be similarly gauged and measured, but your orator is informed and believes, and therefore alleges upon information and belief, that neither the State of New Mexico nor the Middle Rio Grande Conservancy District has installed or caused to be installed gauging stations sufficient to effect the measurements in this paragraph referred to, and of the absence of which complaint is herein made.

XXX.

Your orator further shows that in order to comply with Article III of the Rio Grande Compact, and in order to ascertain that the water supply of Elephant Butte Reservoir has not been or will not be impaired by new or increased diversions or storage within the limits of New Mexico unless and until such depletion is offset by increase of drainage return, it will be necessary that many more gauging stations, with proper measuring devices, be installed and operated than are now being operated in the Rio Grande Basin above Elephant Butte; that your orator is informed and believes that gauging stations, equipped with automatic recording devices and other proper equipment, are and will be necessary at each and all of the following points:

(a) On the Rio Grande at or within a short distance of Cochiti diversion dam.

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(b) On the Rio Grande at or within a short distance of Angostura diversion dam.

(c) On the Rio Grande at or within a short distance of Isleta diversion dam.

(d) On the Rio Grande at or within a short distance of San Acacia diversion dam.

(e) At or within a short distance of all other works of a permanent nature designed for the diversion of water from the Rio Grande or any tributary thereof within the State of New Mexico.

(f) On and near the head of each canal diverting from the Rio Grande at Cochiti diversion dam, at Angostura diversion dam, at Isleta diversion dam, at San Acacia diversion dam, and on and near the head of each canal diverting water from the Rio Grande or any tributary thereof at other works of a permanent nature within the State of New Mexico.

(g) On the Rio Chama a short distance above the flow line of El Vado Reservoir.

(h) On the Rio Chama at or a short distance below the El Vado Reservoir outlet.

(i) On the Rio Grande or any tributary thereof within the State of New Mexico at a point immediately above and at a point immediately below any other reservoir designed for the storage of water.

(j) On and near the mouth of each drain discharging into the Rio Grande or any tributary thereof within the Middle Rio Grande Conservancy District, and at such other points and on such other drains as may be necessary to fix the amount of drainage return referred to in Article XII of the Rio Grande Compact.

XXXI.

Your orator further shows that the acts and omissions of the State of New Mexico and of the Middle Rio Grande Conservancy District and of the President and Directors thereof, above set out, are contrary to equity and good conscience and tend to the manifest wrong, injury, and oppression of your orator and of its citizens and owners of land within its boundaries.

Wherefore, being without remedy except by an original proceeding in this honorable court, where matters of this nature are, under the Constitution of the United States, properly cognizable and relievable, and to the end that the State of New Mexico, the Middle Rio Grande Conservancy District, and the President and Directors thereof, may make full, true, and perfect answer to all and singular the matters aforesaid, (but not under oath, answer under oath being hereby expressly waived), as fully and particularly as if same were here repeated and the defendant distinctly interrogated thereto; and that the State of New Mexico, the Middle Rio Grande Conservancy District, the President and Directors thereof, their engineers, agents, and representatives, be enjoined and restrained from causing or permitting any new or increased diversion or storage of the waters of the Rio Grande or its tributaries within the limits of New Mexico, which shall have been originated, initiated, or effected since the filing of the notices and appropriations set forth in Exhibits "B" and "C", and particularly any increased diversion or storage within the limits of New Mexico subsequent to the date the Rio Grande Compact became effective, which will impair the water supply of the Elephant Butte Reservoir, unless and until such depletion is offset by increase of drainage return; that the State of New Mexico, and the Middle Rio Grande Conservancy District, and the President and Directors thereof be

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required to install, maintain, and operate gauging stations and measuring devices at each and all of the points set forth above. That upon a final hearing of this cause, the court appoint a Water Master, whose duty it shall be to enforce the provisions of the decree of this Court.

May it please the Court to grant unto your orator such process issuing out of and under the seal of this honorable court as may be appropriate to require the said defendants, the State of New Mexico, the Middle Rio Grande Conservancy District, and its officers and directors to be and appear before this Court, then and there to answer the said premises and to abide by and perform such order and decree as the Court shall deem meet and proper.

THE STATE OF TEXAS,
By WM. MCCRAW,
Its Attorney General.
H. GRADY CHANDLER,
Assistant Attorney General.
RICHARD F. BURGES,
WALTER S. HOWE,
EDWIN MECHEM,
Of Counsel,
By RICHARD F. BURGES.

EXHIBIT "A".

Treaty with Mexico Regarding the Rio Grande.

Convention between the United States and Mexico, Providing for the Equitable Distribution of the Waters of the Rio Grande for Irrigation Purposes.

(Signed at Washington, May 21, 1906; ratification advised by the Senate, June 26, 1906; ratified by the President, December 26, 1906; ratified by Mexico, January 5, 1907; proclaimed January 16, 1907; 34 Stat. 2953).

By the President of the United States of America,
A Proclamation.

Whereas a convention between the United States of America and the United States of Mexico, providing for the equitable distribution of the waters of the Rio Grande for irrigation purposes, and to remove all causes of controversy between them in respect thereto, was concluded and signed by their respective plenipotentiaries at Washington on the 21st day of May, 1906, the original of which convention, being in the English and Spanish languages, is word for word as follows:

The United States of America and the United States of Mexico being desirous to provide for the equitable distribution of the waters of the Rio Grande for irrigation purposes, and to remove all causes of controversy between them in respect thereto, and being moved by considerations of international comity, have resolved to conclude a convention for these purposes and have named as their plenipotentiaries:

The President of the United States of America, Elihu Root, Secretary of State of the United States; and

The President of the United States of Mexico, His Excellency Senor Don Joaquin D. Casasus, ambassador extraordinary and plenipotentiary of the United States of Mexico at Washington,

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Delph E. Carpenter. Esq.
Greeley - Colo

P R O C E E D I N G S

of the

RIO GRANDE COMPACT COMMISSION

held

at

Santa Fe, New Mexico,

January 28th

to

January 30th

1935.

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PROCEEDINGS

of the

RIO GRANDE COMPACT COMMISSION

held at

Santa Fe, New Mexico,

January 28th

to

January 30th

1935.

The Rio Grande Compact Commission met in the Federal Court Building at Santa Fe, New Mexico, at 3 P.M., January 28, 1935, whereupon the following proceedings were had:

MR. S. O. HARPER, CHAIRMAN: This meeting is called pursuant to a Resolution of adjournment at the meeting which was held in this city on December 11, 1934, which Resolution provided for adjournment to January 28th at this place. I will ask that each Commissioner or Representative of each of the states, beginning with Mr. Hinderlider, state who his official representatives are at this meeting.

MR. HINDERLIDER: Mr. Chairman, and Members of the Commission: By executive authority, M. C. Hinderlider, Interstate River Commissioner for the State of Colorado, has been designated by Governor Johnson to act in the capacity of Interstate River Commissioner and as a member of the Rio Grande Compact Commission. Hon. George M. Corlett, of Monte Vista, Colorado: Hon. John I. Palmer, Judge of the 12th District Court of the State of Colorado, of Saguache; Hon. Ralph L. Carr, of Antonito, Colorado, are designated as advisers to Colorado's Interstate River Commissioner in these proceedings; also F. B. Goudy, Esq., in a like capacity, of Omaha, Nebraska: Hon. S. P. Howell, Assistant Attorney General of the State, as legal adviser to the Interstate River Commissioner for Colorado: R. J. Tipton, as Engineering Adviser to the Interstate River Commissioner, all of these gentlemen being present.

MR. McCLURE: Mr. Chairman: Under authority of ex-Governor Hockenhull, and approved by the present Governor, Clyde Tingley, my commission is carried on to act as Commissioner for New Mexico on the Rio Grande Compact Commission (Thomas M. McClure). Mr. Frank Patton, Attorney General, legal adviser; E. K. Neumann, Interstate River Commissioner, in an advisory capacity; Hon. Edwin Mechem, legal adviser; John H. Bliss, engineering adviser: C. H. Howell, Chief Engineer, Middle Rio Grande Conservancy District, engineering adviser; H. C. Neufer, Chief Engineering Supervisor of the Indian Service, engineering adviser; William A. Brophy, Attorney for the Indian Service, legal adviser.

MR. RICHARD F. BURGES: Mr. Chairman: I am sorry to report that since the last meeting, although it was anticipated - Senator McGregor who had served on this Commission, has resigned, and the newly elected Governor of Texas has not designated a successor. I, myself, am Commissioner for Texas on the Rio Grande Compact Commission, and here in attendance on that meeting, but acting, I am rather constrained to say, without real official authority except to report back action. With me is Mr. C. A. Mebus and Mr. Idus Gillett, Directors of El Paso County Water Improvement District No. 1, who are present as other representatives from the State of Texas.

MR. HARPER: I take it, Major Burges, that any action you may take here will be subject to confirmation by the Governor.

MR. BURGES: Yes sir.

MR. HARPER: What is the pleasure of the Commission now as to procedure?

MR. NEUMANN: Our Governor, Clyde Tingley, is exceedingly sorry he was unable to be here this afternoon and greet the Commission and their representatives. As you know, the Governor is now in the midst of a legislative session, and is exceedingly busy. He has asked me to convey to the delegation his best wishes for a very harmonious meeting and he trusts that something good will come out of it for all of the states involved. He also wishes me to express that you each have his personal welcome and he trusts that your stay in New Mexico will be enjoyable as well as profitable.

MR. HARPER: On behalf of the Commission, I wish you would express our appreciation to the Governor for his kindly message, and tell him we fully appreciate his expressions of good will. For the record, I will say that the representatives of the Government here are myself, as representative of the President; Mr. E. B. Debler as engineering adviser, and H. J.S. DeVries of El Paso, legal adviser.

MR. HINDERLIDER: Mr. Chairman and Gentlemen of the Commission: At the recessing of the last hearing on December 11th, it was my understanding that at the convening of this present meeting, Colorado would be afforded the opportunity of presenting to the Commission and its advisers a plan whereby an equitable division of the waters of the Rio Grande River may be arrived at. It was my understanding at that time that the Commissioners for New Mexico and Texas had nothing further to offer, and with that understanding of the matter, I suggest and request that the advisers of the State of Colorado be permitted at this time to offer for the consideration of the Commission a proposed plan, based upon what Colorado considers to be an equitable division of the waters of the Rio Grande.

MR. HARPER: Is there any objection on the part of the other Commissioners? - - - (None).

MR. HINDERLIDER: Pursuant to that understanding, I would like at this time to call upon Mr. George M. Corlett to present Colorado's present views and position.

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MR. CORLETT: Mr. Chairman and Members of the Commission, Ladies and Gentlemen: I wish to apologize for reading this statement - it's something I have never done before, before this Commission, but it was our desire to make our statement as definite as possible, and for that reason, I ask you to bear with me. The statement is addressed to the Gentlemen of the Commission: At the last meeting in Santa Fe, in December, 1934, certain questions were asked in regard to Colorado's position on the building of the drain from the Closed Basin, and it was stated that further negotiations looking to an equitable apportionment of the waters of the Rio Grande River would not be considered by the signatory states of Texas and New Mexico until the Closed Drain was completed and the amount of the return water from the Closed Basin established, so as to determine facts upon which to base such an apportionment.

Colorado's position at this time will be stated. Colorado desires to support the Compact and to do its full share in that regard: but the Compact contemplates equity and Colorado believes that its sister states of New Mexico and Texas should do their full shares, and, asking equity, should do equity. On January 21, 1929, Colorado suggested the question of the Outlet Drain for the discussion of the Compact Commission. This was the first presentation to the Compact Commission of the question of the advisability of the construction of the Outlet Drain and the basis from which later developed the present compact, having as its primary object the equitable apportionment of the waters of the Rio Grande between the States.

At that time it was believed that the construction of this drain would ultimately solve all of the differences between Colorado, New Mexico and Texas, by contributing to the river certain amounts of water from the Closed Basin in Colorado. It was thought that this water, together with that developed by the control of avoidable waste, which was at that time apparent below the Elephant Butte projects, would produce an amount of water sufficient to equalize any additional burden which might be placed upon the Rio Grande by full reservoir development in the Rio Grande Valley in Colorado, or rather in the San Luis Valley, on the Rio Grande and its tributaries. Notwithstanding the fact that engineers seem to disagree as to the amount of return flow from the Outlet Drain, it is believed that the engineers of Colorado, New Mexico, Texas and the Reclamation Service have the necessary data at the present time to demonstrate that a quantity of water will be recaptured by the drain which, in conjunction with the saving of avoidable waste from the Elephant Butte Projects, will more than take up the additional burden, if any, placed upon the Rio Grande by full reservoir development in Colorado.

It has been demonstrated conclusively that this avoidable waste can be controlled, and during the first year after the hearing in 1929, it was controlled. Since that time, apparently, avoidable waste has again crept into the operations of these projects, so that the releases at the Elephant Butte have now come back to approximately what they were before the hearing in 1929, when we presented to the Commission the evidence of this large amount of avoidable waste. There is no doubt that this waste can be controlled by those in charge of the operations of the Elephant Butte projects.

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This outlet proposition was submitted on the basis that this drainage construction, which would undoubtedly be further supplemented by increased return from irrigated lands having a uniform supply in the San Luis Valley, and the control of the avoidable waste, would permit Colorado to go ahead with its reservoir development as it might see fit and as the physical conditions of the country would permit. We are now convinced that it is possible to furnish an annual uniform supply of water to the lands of Colorado on a parity with the supply now furnished to lands in New Mexico and Texas.

The conditions in the San Luis Valley in Colorado, at the present time, are intolerable. We have consumed as much as 1,000,000 acre feet in one year. Last year there was available less than 580,000 acre feet. Under the present unscientific and unregulated supply of water the amount of the irrigated area continually rises and falls. During wet periods the acreage increases; during dry periods the acreage decreases. Profits during wet periods are quickly absorbed by losses in succeeding dry periods. In adjustments between wet periods and dry periods, wet years and dry years, great numbers of individuals are financially injured. We, of Colorado, have as our objective, the regulation and adjustment of our water supply so that we may cut our cloth according to our pattern, utilize whatever amount of water may be available for the uses of our people in an orderly and scientific manner, adjust our water rights so that the supply will be as certain as may be. To say that Colorado cannot be trusted with reservoirs, is unreasonable. The statement was probably not well considered or it would not have been made.

To say that Colorado must guarantee a certain flow of water to New Mexico and Texas, irrespective of what the water supply may be, or that the Great State of Colorado should be impressed as a servient holder with a dominant right on the part of the States of New Mexico and Texas, is unjustified. If the states of New Mexico and Texas adopt the policy that, unless such a guarantee is given, they will, by threatened litigation and the advancement of visionary claims, prevent us, by beclouding our titles, from financing our projects, such a position, we maintain, is inequitable and unjust.

It was intimated at the last hearing that New Mexico and Texas would not discuss the matter of reservoir construction in Colorado until after the Outlet Drain has been constructed. We respectfully call your attention to Article VII of the Rio Grande Compact, which reads:

> "(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.

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"(b) 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 this Compact and no advantage or right shall accrue or be asserted by reason of construction of works, reclamation of land or other change in conditions or in use of water within the Rio Grande Basin or the Closed Basin during the time intervening between the signing of this Compact and the concluding of such subsequent Compact to the end that the rights and equities of each State may be preserved unimpaired. Provided, however, that Colorado shall not be denied the right to divert, store, and/or use water in additional amounts equivalent to the flow into the river from the drain from the Closed Basin."

Also the Fourth Annual Report of the Rio Grande Compact Committee, page three, reads:

"The object of all of the signatory states is to permit the maximum use and future development of the water of the Rio Grande consistent with the rights of the respective states. Accurate information as to water supply, requirements and uses thereof, in the basin of the Rio Grande above Fort Quitman, Texas, and its correlation, is necessary to the maximum beneficial use of the waters, and indispensable in the formulation of the final compact to which the present Compact looks."

Also, on page four, of the Second Annual Report of this Committee, addressed to the several Governors, under date of February 12, 1932, attention was called to the extremely variable annual flow of the Rio Grande and its tributaries above Fort Quitman, Texas, which fact is of primary importance in providing storage facilities looking to the maximum beneficial use of the waters of the Rio Grande:

"The Committee deems it advisable again to emphasize the extreme variability in the flow of the Rio Grande from year to year, since that variability is a prime factor in arriving at an equitable division of the waters, and because it demonstrates, as perhaps nothing else can do, the necessity for storage works so distributed upon the river and its tributaries as will permit the maximum beneficial use of the waters by the citizens of the three States, and at the same time meet the requirements of the United States under its treaty obligations with the Republic of Mexico."

And on page 7 of this Report, it says:

"The necessity for the construction of the Closed Basin Drain, in Colorado, and the State Line Reservoir, at the Colorado-New Mexico State Line, will be appreciated by reference to the language of Article II of the Rio Grande Compact, to which we respectfully invite your attention. The pertinent language of Article II is as follows:
'Article II. The States of Colorado, New Mexico and Texas hereby declare:
(a) That they recognize the paramount right and duty of the United States, in the interests of international peace and harmony, to determine and settle international controversies and claims by treaty

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and that when those purposes are accomplished by that means, the treaty becomes the supreme law of the Nation;
(b) That since the benefits which flow from the wise exercise of that authority and the just performance of that duty accrue to all the people, it follows as a corollary that the Nation should defray the cost of the discharge of any obligation thus assumed;
(c) That with respect to the Rio Grande, the United States, without obligation imposed by international law and "being moved by considerations of international comity", entered into a treaty dated May 21st, 1906, (24 Stat. 2953) with the United States of Mexico which obligated the United States of America to deliver from the Rio Grande to the United States of Mexico, 60,000 acre feet of water annually and forever, whereby in order to fulfill that promise the United States of America, in effect, drew upon the states of Colorado, New Mexico and Texas a draft worth to them many millions of dollars, and thereby there was cast upon them an obligation which should be borne by the Nation;
(d) That for the economic development and conservation of the waters of the Rio Grande Basin and for the fullest realization of the purposes recited in the preamble to this Compact, it is of primary importance that the area in Colorado known as the Closed Basin, be drained, and the water thus recovered be added to the flow of the river, and that a reservoir be constructed in Colorado upon the river, at or near the site generally described as the State Line reservoir site. The installation of the drain will materially augment the flow of the river, and the construction of the reservoir will so regulate the flow as to remove forever the principal causes of the difficulties between the States signatory hereto;
(e) That in alleviation of the heavy burden so placed upon them, it is the earnest conviction of these States that, without cost to them, the United States should construct the Closed Basin Drain and the State Line Reservoir described in (d).'"

There is now available the sum of $900,000.00 for the construction of the Outlet Drain, but nothing for the State Line Reservoir, and the grant for a drain is imposed upon conditions which Colorado may, or may not, be able to comply with. It entails the enactment of new laws to accomplish that purpose, which later must be voted upon by the residents of the proposed district in Colorado.

Let me digress at this time to say, as an evidence of our good faith in Colorado, that we have introduced a bill in the State Legislature of Colorado which would provide for the organization of such a district as could undertake the performance of the conditions, if necessary, imposed by the Secretary of the Interior. This burden upon the citizens of Colorado was not contemplated by the authors of the present compact.

The Compact provided for a commission to equitably apportion the waters of the Rio Grande River as of conditions obtaining in the river and within the Rio Grande Basin at the time of the signing of the Compact, February 12, 1929. Colorado must insist upon such equitable apportionment and not upon an apportionment to be determined after the completion of the drain from the Closed Basin.

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If, in furtherance of such equitable apportionment, New Mexico and Texas wish and desire to enter into a discussion of the amount of the possible increased consumption of water from the Rio Grande in Colorado under full development, and will attempt to work out a program whereby Colorado can go ahead with her development, as contemplated by the Compact, the Outlet Drain can be built. Necessary steps can be taken for control of the avoidable waste from the New Mexico and Texas projects so as to permit the full development and scientific regulation of all the waters of the Rio Grande, with the least injury to every one concerned and the most effective use of the waters available, and the accomplishment of the proposed apportionments on an equitable basis to the signatory states of Texas, New Mexico and Colorado can be attained. We are ready, anxious and willing to meet and discuss these matters, and as stated in 1929, we feel confident that, with the information we have, we can fully demonstrate that New Mexico and Texas will not be damaged but will be benefited by this additional regulation; and Colorado may go ahead in its development unhindered, and peace and quiet may prevail on the Rio Grande.

The water users on the Rio Grande in Colorado receive a daily report of the amount of water stored by each reservoir and the amount of water diverted to each canal. This report is completed before six o'clock in the morning and a copy is furnished to each ditch company. As soon as this light was thrown upon the screen of public opinion, so that each water user by referring to his table of decrees can determine whether he is receiving the water to which he is entitled, misunderstandings and bickerings faded out of the picture, and good will now prevails in place of recriminations. These three states are represented by men equally as reasonable as the water users on the Rio Grande in Colorado, and if we can cast the searchlight of reason upon the picture available from the accumulated engineering data of the three states and the Reclamation Service, we confidently believe that our matters of difference can be solved.

There is no reason why, with all of the excellent accumulated engineering data and advice, the states cannot determine, with reasonable certainty, from past records which are available, the effect of reservoir construction in Colorado, and evolve ways and means of solving our difficulties. For one or another to stand back and say: "I have made up my mind and will not discuss this or that phase of the matter," is mere boy's play. To say that Colorado cannot build reservoirs without investigation is unreasonable: to say that Colorado cannot build reservoirs to regulate her water supply, over a period of years, for fear that the flow would be decreased below an equitable amount for some reason which has not been disclosed, or for some reason that fantasy may dictate, might later develop, although not apparent now, is unfair and unjust.

We, of Colorado, propose to regulate our water supply. We believe we have the right to construct the necessary reservoirs to accomplish this result. We would like to do this without injury to any one concerned. We believe we have the great majority of prior rights on the Rio Grande and that we have the right to utilize them. We would like to work in amity with our sister states of New Mexico and Texas. Colorado does not expect these sister states to prevent her, arbitrarily, from the equitable, reasonable and adequate regulation and use of her water supply. We expect those states to evidence a spirit of cooperation in working out these problems.

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Colorado stands ready and offers to present to the Commission, whose duty it is to consider the equitable apportionment of the waters of the Rio Grande River, its idea of such equitable apportionment and a plan for its accomplishment. We submit such offer with the feeling that an equitable apportionment can be reached at this time, satisfactory to all the states, that the Outlet Drain can be constructed, and that the spirit and the intent of the present Compact can be fulfilled completely. Colorado, at this time, respectfully requests the privilege of presenting this plan.

MR. HARPER: Does the Commissioner from Colorado have others to present?

MR. HINDERLIDER: Mr. Chairman and Gentlemen of the Commission: I now would like to have Mr. Tipton, engineering adviser to the Commissioner, present this general plan which we have conceived as a basis for an equitable adjustment of this problem. I suggest that as Mr. Tipton has a number of exhibits that we take a recess until he can place them on the wall. (10 minute recess).

MR. R. J. TIPTON: Mr. Chairman, Members of the Commission and Gentlemen: Since the last Compact negotiations in 1929, we have carried on a series of studies clear beyond what was developed at that time. The results of these studies I will attempt to present this afternoon. The conclusions arrived at in some instances are based upon assumptions that I, myself, have made. I am responsible for a good many of the details of the study; the conclusions based upon these studies are my own and not necessarily the conclusions of the State of Colorado, nor the conclusions of the water users of the San Luis Valley. In presenting this, on account of the limitation of time, I will merely give the methods of the study and, in general, the conclusions, and the assumptions upon which those conclusions are based, and the details can be gone into later with any representatives of the other states who might want to go into those details. In presenting the picture also, it will be necessary to probably repeat some of the things that have been gone into before - some of the things that most of you are intimately familiar with. Some of you, however, are not, and in order that those of you who are not familiar with these features can become familiar with them, we can briefly go into them. It will be necessary to get the big picture before us at this time in order that we shall have a better understanding of what Colorado believes to be an equitable share of the water of the Rio Grande, and the way that can be arrived at.

This map is a map of the Rio Grande Basin above Fort Quitman, Texas, that being the portion of the Rio Grande Basin we are interested in here. As you all know, the Rio Grande Basin extends for many miles below Fort Quitman, but the total water supply produced above Fort Quitman is consumed, except about 14 percent which escapes from the basin: a large portion of the 14 percent is made up of unusable water. First, this line represents the Colorado-New Mexico state line, the small area extending north from that line being the San Luis Valley, or that portion of the Rio Grande Basin lying in the State of Colorado. The long shoe-string area, extending from the state line to El Paso, represents the portion of the basin which lies in New Mexico. The small area below El Paso represents that portion of the basin lying in Texas. Of the total water produced in the basin, over 50 percent of it is produced from the small area of mountains in the San Luis Valley in Colorado. Upon this map have been placed

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areas which are cross-hatched to represent the irrigation development in the three respective states. This large block of area in Colorado represents the present irrigation development of that region. The shoe-string areas extending along the stream in New Mexico represents irrigation development in that state, and also in Texas. At this point on the map is represented the Elephant Butte Reservoir which conserves the water that is used to irrigate the lands of the Rio Grande Project lying below the Elephant Butte Reservoir in New Mexico and Texas, and also used to regulate the flow of the stream in such a way that the 60,000 acre feet ceded to the Republic of Mexico can be delivered.

The development in the San Luis Valley, represented by the hatched area, was initiated largely in the decade from 1880 to 1890. Some of the development in the San Luis Valley was initiated in the 1850's; many small ditches were initiated at that time, but the large development was all made between 1880 and 1890. Since 1890 there has been no increased development in the San Luis Valley, except the construction of one or two small projects which irrigate, in the aggregate less than 50,000 acres, and some of this has been the consolidation of several little ditches in order that a more efficient application of water could be made. The reason no development has been made since that time was that the development initiated between 1880 and 1890 used all the available water supply of the Rio Grande produced in Colorado. No additional water was available for the development of additional projects which might have taken place during the irrigation boom from 1904 to 1911. The major portion of the development in Texas and New Mexico below the Elephant Butte Reservoir no doubt took place after the construction of the Elephant Butte Reservoir.

The Middle Rio Grande Conservancy District, which will be completed in a few weeks, is delineated on the map by the long shoe-string area from White Rock Canyon down to San Marcial. You are all familiar with that district and with the reservoir being constructed for the project. Before leaving this map, in order that you will have a general picture of the water supply that is available for these three major developments, I will indicate what that water supply is. There is a gaging station on the main stem of the Rio Grande at Buckman, which is a short distance above the first diversion works of the Middle Rio Grande Conservancy District. The mean annual flow at that point is some 1,300,000 acre feet. It is contemplated that there will be irrigated under the Middle Rio Grande Conservancy District some 123,000 or 124,000 acres of land. There is available for that irrigation this 1,300,000 acre feet of water at the head of the area. I will go into the distribution of the water supply later on.

There is flowing into the Elephant Butte Reservoir at San Marcial something like 1,200,000 acre feet of water, which is regulated and used for the irrigation of the lands lying below the reservoir which probably aggregate 200,000 acres, including that land which is irrigated in Mexico by the 60,000 acre feet delivered to Mexico. In Colorado, for the irrigation of the lands on the main stem of the Rio Grande, there are available 708,000 acre feet of water measured at Del Norte, which is the head of the irrigated area. There are available on the Conejos proper about 265,000 acre feet of water per annum, and including the whole Conejos area about 400,000 or 404,000 acre feet of water. Those are the two principal areas

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in the San Luis Valley that enter into this picture, as I will explain later on. This other map is a map of the San Luis Valley or the Rio Grande area in Colorado. In other words, this is an enlargement of this small area which appears on the first map. The boundary of the San Luis Valley is delineated by this heavy line which extends around the basin. On the west is represented the Continental Divide; on the east, the divide between the Rio Grande and Arkansas River systems. There is shown on the map three contours in order to indicate in general the topography of the valley itself. This heavy contour is 8000 feet, which defines in general the limits of the valley floor. In order to indicate the uniform topography the 7600 foot contour is shown, and the 7525 foot contour, which latter contour defines in general the so-called trough or sump area of the San Luis Valley.

The area lying above the 8000 foot contour consists of foot-hills and mountains, and it is that area which produces the run-off of the Rio Grande and its tributaries. There is an area delineated on the map and outlined by a heavy red line on the north side of the San Luis Valley: that area constitutes about 2900 square miles, while the total area of the valley is about 9000 square miles. The area delineated by the heavy red line represents the so-called Closed Basin which is not tributary to the Rio Grande and never was a tributary within the history of the white man; the area being cut off from the Rio Grande proper by a low ridge that runs along its southerly boundary. Of the 2900 square miles which represents the Closed Basin, only a small portion is irrigated by waters of the Rio Grande. An additional area within the Closed Basin is irrigated by the natural water production within that basin. The natural water production within the Closed Basin is estimated to be about 240,000 acre feet per year, which water never did reach the Rio Grande. In addition to the water that is naturally produced in the Basin, there is an amount of water which is diverted from the Rio Grande itself into the Closed Basin to irrigate lands within that basin. The low portion of the Closed Basin is called the sump area; it lies considerably east of the center of the Closed Basin. A portion of the so-called sump area consists of a series of surface lakes, swamp areas and alkali flats. A portion of the water which is produced within the Closed Basin and a portion of that which is diverted into the Closed Basin reaches the sump and is dissipated by evaporation, the water surface maintaining itself at such a point that the evaporation is sufficient to equal the inflow.

Directly to the east of the sump area is a portion of the Sangre de Cristo Range, no portion of which is below 13,000 feet in elevation. The distance from the sump area to the top of the Sangre de Cristo Range is small, and all of the water produced by the snow on the Sangre de Cristo Range within that vicinity reaches the sump and is dissipated by evaporation, there being practically no use made of that water. In addition, a limited amount of water reaches the sump from the north and some from the west from the present irrigated lands in that vicinity. In the interstate problem concerning the waters of the Rio Grande, there are only two areas of the San Luis Valley which enter into the picture at all, except the Closed Basin enters it insofar as the water that now is lost to the Closed Basin can be made tributary to the Rio Grande. The two areas that enter the picture are the areas on the main stem of the Rio Grande above Alamosa, and the Conejos area. The southeast area of the San Luis Valley consists of the Trinchera and Culebra drainage basins which are completely out of the picture because

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no water is contributed to the river by these streams and has not been for many years. Those areas are fully developed and are really over-developed. Reservoirs have been constructed on both streams beyond the ability of the streams to fill, so we can forget those areas so far as this problem is concerned. As I say, there is no problem in the valley in connection with those areas because they are over-developed and have been for some time. On account of the stream bed conditions, probably very little water ever reached the Rio Grande proper from those streams.

The other two remaining stream systems in the live area of the San Luis Valley, in addition to the Rio Grande and Conejos, are the Alamosa and La Jara Creek areas. Those streams are fully developed. Reservoirs exist on the two streams of sufficient size to control the flow. No further development will be made on those streams as practically all of the lands susceptible of development have been developed. A portion of these lands have been drained. The big problem so far as the San Luis Valley is concerned, is the regulation of the water which is now being used by the development on the Rio Grande proper which was made in the decade from 1880 to 1890, and for the control of the water which is now being used on the Conejos, which development was made in the decade from 1880 to 1890. The ditch systems on these two streams, as delineated on this map, are the ditch systems that exist at present, and those ditch systems can be found on a map of the 1890 census just as they are shown here.

The problem of regulation of the water supply of the Rio Grande and the Conejos is not a new problem; it was just as acute, or more so, in the late 1880's and early 1890's as now. The necessity for reservoir construction on these streams is mentioned in report after report, both in the State Engineer's office in Colorado, the reports of the U. S. Bureau of Census and other government reports. So the problem is not new. But, on account of the international difficulties between the United States and the Republic of Mexico over uses of water of the Rio Grande, which difficulties culminated, or were brought to a head, by the occurrence of a low cycle of run-off in the 1890's, and as a result of that bringing to a head of the difficulties, there was an embargo placed upon the stream in 1896 which prevented reservoir construction on the river, both in New Mexico and Colorado. That embargo was maintained until 1925, as a result of the international difficulties, and, as you all know, in 1907 a treaty was entered into by the United States and the Republic of Mexico whereby there was ceded to Mexico 60,000 acre feet of water. Then, with the stated purpose of placing the United States in a position to deliver that water, the Elephant Butte Reservoir was constructed, and completed in 1915. After the construction of that reservoir, or along with it, there was developed a Bureau of Reclamation project, the Rio Grande project, to use the waters stored in the reservoir. As a result of that reservoir, there has been afforded to the lands under the Elephant Butte virtually a perfect water supply by virtue of the construction of that reservoir. There will be afforded to the Middle Rio Grande Conservancy District virtually a perfect water supply on account of the volume of water which enters the project and the construction of the El Vado Reservoir; while on the other hand, ever since the development started in the San Luis Valley that development has had to depend upon the flow of the stream year after year to take care of the demand, as a result of which there is universally a seasonal shortage: and year after year an annual shortage of water supply to adequately

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irrigate the lands which were commenced in 1880 to 1890. To indicate the need for reservoir development in the San Luis Valley, I will refer to two other exhibits.

A large portion of the area that was irrigated from the Rio Grande in the Conejos in Colorado consists of land which is made up of a very shallow top soil in which the plants grow. The soil in general is not over 2 or 3 feet deep and is underlain by a coarse gravel sub-soil. In order to properly irrigate that type of soil would require very frequent applications of relatively small amounts of water. This is a sketch to illustrate the point. In most regions where irrigation is carried on, where good depth of soil obtains, in one application of water for irrigation purposes, there is an amount of water that is stored in the soil to a depth of 8 or 10 feet which is available for plant use. That reservoir of water which is held there for plant use might be sufficient to maintain plant growth adequately for a period of a month or more. In the San Luis Valley, the soil itself being only 2 or 3 feet deep, the amount of water stored up in that shallow depth is very limited. The amount is not only limited by the shallow depth, but by the texture of the soil. We have gone into the matter very thoroughly and can demonstrate later, by going into details, that the amount of water that would be held by the soil for plant use, would be less upon the one application than it is on ordinary soil 28 days after the application of water. In order to irrigate that type of soil properly, the water must be on tap when needed and must be applied in relatively small quantities frequently. Due to the fact reservoirs were not permitted in the San Luis Valley, that type of irrigation could not be carried on, so a sub-system of irrigation sprung up. Large volumes of water are diverted from the stream in April, May and June, when the water is available in the stream. The water is applied to the land, not by flooding methods, but through ditches 8 rods apart. The water builds up the ground water table in the coarse sub-soil and is continually applied until that water table is built up to a point where it makes contact with the lower surface of the soil, and from then on during the irrigating season, only sufficient water is run through the ditches to maintain that contact, so the water in July, August and September, when the stream flow is deficient, is supplied to the plants by this underground reservoir. As a result of that type of irrigation that had to be practiced, the lower lands in the San Luis Valley began to seep, this being the area first irrigated by the large development in the valley.

To illustrate further the non-parallelism between the stream flow and the demand, I will refer to this diagram. The upper line or this large solid line represents the average seasonal flow on the Rio Grande proper at Del Norte from 1890 to 1929. If we brought it to date, it would be somewhat less. The April, May, June, July, August, September and October flows are indicated. There is shown by the heavy broken line the average diversions that are made from the Rio Grande between Del Norte and Alamosa to irrigate the lands watered by the Rio Grande proper. There are shown by the dot and dash line the seasonal distribution of diversions as they should be. This ideal distribution of diversion was determined by an analysis of 65 different projects from which we could obtain data as to the use of water, and on which projects, the water was controlled. To indicate the

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measure of the distortion of use in the San Luis Valley I will show how the use of the water there compares with the use on these 65 various projects. In the San Luis Valley the combined April and May diversions are about 1.85 times the July and August diversions. In every other region, the July and August diversions are greater than the April and May diversions combined, being from two to 23 times those diversions. In absolutely no other region could we find such a condition as exists in the San Luis Valley.

This indicated ideal distribution of demand was also further fixed by comparing it with the application of water made by the only system in the San Luis Valley which has as its major water supply, reservoir water. This system applies water to its lands more or less in conformity with this indicated ideal demand so far as seasonal distribution is concerned. The yellow area between the actual diversions made in April, May and June, and the assumed ideal demand in April, May and June represents the over-diversions that are made during that period, diversions made to build up the ground water, store the water in the ground to supply deficiencies later on, which deficiencies are represented by the red area. Instead of storing water in the hills and reservoirs to make this water available, we make these over-diversions in the spring to meet deficiencies in the latter portion of the season; the water is stored in the ground and that building up of the ground water, and the seeping of the lands, of course, probably makes for an increased consumption of water in that region. There isn't only a grave need for reservoirs to correct this situation - in other words, to make the seasonal flow parallel to the seasonal demand, - but there is a grave need for storage to carry over the water from high years to supply deficiencies which would otherwise occur, and do occur, during years of low water supply.

There are shown here two hydrographs, the lower one representing releases on a daily basis from the Elephant Butte from 1915 to 1934 for the irrigation of land lying below that reservoir and for the delivery of 60,000 acre feet to Mexico. By virtue of the fact that reservoir exists on the stream, the stream is under full control and these lands have been able to obtain a perfect water supply year after year. Upon a critical analysis of all past stream flow records, various engineers have determined that throughout the whole series of years there probably would have been only two years when shortage would have existed - 1902 and 1904. Others insist that in those years no shortage would have existed. The upper hydrographs represent daily diversions between Alamosa and Del Norte for the irrigation of the lands which were irrigated in 1880 to 1890, these hydrographs being for 1928 to 1934, there being no record of diversions prior to that time. You will readily note first, the distorted use that was made of the water, and upon closer inspection of these hydrographs you will note that for the period July to September, in almost all cases, the total water is being diverted. In some cases, in June, when there are peak floods, the total of these floods are not diverted. So the use is very distorted each year, high diversions being made in April, May and June, all the water of April and May being diverted and a large portion of it in June, and in almost all cases every drop being diverted from July to September. In addition to that seasonal distortion, in such years as 1931, 1930 and 1934, the total use has been very, very small. In 1934, the water that was actually available was 50 percent of that which was required and 50 percent of that which

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had been diverted for many years. Compare these hydrographs, which represent the use of water on an old area, with those hydrographs which represent the use of water on an area, the irrigation of which commenced a good many years after the irrigation of this area. The perfect water supply, represented by the lower hydrographs, is due to the fact that a large reservoir exists at the head of the area. To make a further and little more general comparison, I will indicate how the mean annual flow at the head of each of these areas compares with the demand under those areas. Take first the area under the Elephant Butte Reservoir, take the natural water supply entering that area at San Marcial over a long period of years, and take the average use under the reservoir since 1929; apply that average use by months to that natural water supply uncontrolled, and you will find a mean annual shortage. This shortage will be a measure of the non-parallelism between natural occurrence of the water and demand, that will be about 130,000 acre feet. On the Middle Rio Grande Conservancy District, take the water entering that area on a mean annual basis at Buckman and we compare that with the monthly demand as determined by the engineers of the Middle Rio Grande Conservancy District and we find the mean annual shortage, or lack of parallelism between natural flow and demand, of 26,000 acre feet. If we take the demand of the land in Colorado on the main stem of the Rio Grande and the mean annual flow, we find the lack of parallelism between water supply and demand, is 126,000 acre feet. In other words, we are in the very condition now, and have been since 1890, that the Elephant Butte project would be if you had no reservoir to control your water supply.

The situation on the Conejos is even worse than it is on the Rio Grande proper in Colorado. That is due to the fact that the flow of the Conejos culminates earlier than that of the Rio Grande. Its flow in May and June is somewhat higher in proportion than the May and June flows of the Rio Grande, as a result of which the use of water on the Conejos is more distorted than on the Rio Grande, and this is further accentuated by the fact that absolutely no reservoir exists on the Conejos, while there is a nominal capacity on the Rio Grande. To determine the actual necessity of the San Luis Valley to cure this situation, we have attempted to determine the amount of reservoir capacity that would be required to regulate the flow on the stream to meet the demand of the lands that are now irrigated, and have been irrigated since the decade 1880 to 1890. We find that to regulate the supply to that demand so there would be absolutely no shortage from 1890 to 1934 - for which period stream flow has been kept - 1,500,000 acre feet reservoir capacity would be required. However, it probably would not be economically feasible to provide all of that capacity, so we took the sites that had been investigated, and determined what would happen if some of these reservoirs were constructed. As one set-up we considered the possibility of the construction of the Wagon Wheel Gap Reservoir, shown on our map. That reservoir site lies below most of the main tributary to the Rio Grande, except the South Fork. It is an excellent site and has a potential capacity of about one million acre feet. In addition to such potential capacity there are about 150,000 acre feet of capacity on the stream at the present time. We took the combined capacity

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of the proposed Wagon Wheel Gap Reservoir, and the present capacity, and analyzed the stream flow records from 1890 to 1934 against the demand of the lands irrigated between Alamosa and Del Norte to determine the adequacy of the combination of storage capacity to supply that demand. Our demand is based on 600,000 acre feet per annum for these lands. Diversions in that amount are made, and diversions in an amount considerably greater than that are made when the water is available. In 1929, the diversions aggregated 640,000 acre feet, and in 1932, a year following the very low year of 1931, there was probably over 700,000 acre feet of water diverted between Alamosa and Del Norte, but I consider 600,000 acre feet an adequate water supply for the lands to be irrigated between Alamosa and Del Norte if that water is made available year after year by proper control works and is available on demand. We assumed then as a demand, 600,000 acre feet with the distribution that I have gone into from the graph on the blackboard.

We started our study in 1904 and carried it on until 1934, and took the contents of the reservoir as of that date for 1890 and completed the study. This exhibit shows the result of our study. The upper part of the exhibit shows the inflow into the proposed reservoir and the outflow by months and years from 1890 to 1934. The stepped line up and down each year represents the inflow into the reservoir. The other line outlining the blue area represents the required outflow from the reservoir to maintain 600,000 acre feet year after year. The hatched portion of the blue area represents the deficiencies in the water supply as it existed in each one of these years to take care of the assumed demand of 600,000 acre feet. Looking over the various years, you will notice in general the water supply was greatly deficient to take care of this assumed demand. This deficiency at times reached 300,000 or 400,000 acre feet, just as it would under the Elephant Butte, or Middle Rio Grande Conservancy District if reservoirs were not there. The lower portion of the exhibit indicates what the contents of the reservoir would have been month by month from 1890 to 1934. You will note we start off with the contents in 1890 of some 560,000 acre feet. We build up very rapidly to a content of 1,500,000 acre feet in 1892; the supply of the reservoir is rapidly depleted in 1896; then a small increase occurs up to 1898 and then a rapid drawing down until the reservoir would be empty in 1902 and there would be a shortage in that year. There would be another shortage in 1904. From that point on the reservoir contents increase rapidly and the reservoir would fill by 1908 and remain practically full with spills almost every year until 1930, when it would begin to be drawn down again on account of the shortage of water supply which occurred in the last few years, and if we would have a repetition of the years from 1890 to date, the reservoir would be empty again.

That represents what we consider equity or parity so far as the Rio Grande proper is concerned in Colorado. The same picture applies to the Conejos. This provides a water supply for lands irrigated in Colorado comparable to the water supply provided for the Elephant Butte project by virtue of the Elephant Butte Reservoir, and comparable to the supply which will be afforded to the Middle Rio Grande Conservancy District by construction of the El Vado reservoir and by virtue of the inflow into the area. This would cure the situation in Colorado; it would not permit of any expansion but would stabilize the development which was started between 1880 and 1890. The question is, how would this development affect the water supply of the Middle Rio Grande Conservancy District and the lands under the Elephant Butte

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Reservoir? We went into that very thoroughly on a monthly basis and as a starting point we took the operation of the Elephant Butte Reservoir as estimated by E. B. Debler of the Reclamation Bureau, his study extending from 1895, as I remember, to 1922. While there are some features of that study we do not necessarily subscribe to, I completed the study from 1922 to 1934 and found his figures very close to the average of the releases on the Elephant Butte which have been made from 1929 to date. If this 600,000 acre feet of water were available for application to the lands along the main stem of the Rio Grande in Colorado, year after year, and the sump drain were constructed, there would be no question there would be a material return flow developed from that so we made an assumption as to return flow. That assumption is mine - I assumed that under this set-up the sump drain would produce not less than 50,000 acre feet of water per year. That seems reasonable on the basis of our studies to determine the possible production of the sump drain, and when we consider the material flow into the sump from other sources than the Rio Grande itself. I assumed that there would be an additional 50,000 acre feet of return flow come back to the river immediately between Alamosa and Del Norte. That happens at present with diversions of 600,000 acre feet or more.

My conclusions are made on the basis of these assumptions. I found that with this 100,000 acre feet return flow to the stream, and the constant application of 600,000 acre feet year after year, that the water supply of the Elephant Butte would not be adversely affected, but would be benefitted if the return flow resulted. I found that the combined shortages of 1902 and 1904 that Mr. Debler found would be reduced - would not be eliminated, but would be reduced. I carried Mr. Debler's study on to 1934 and when I carried the study on on this set-up I found between 200,000 and 300,000 acre feet more water in the Elephant Butte than there would be under present conditions. The whole thing hinges upon the question of return flow; the balance of it is a mere matter of calculation and I will be glad to go into detail with those interested. The effect on the Middle Rio Grande can be explained very briefly and clearly. The effect of this proposed reservoir development in the San Luis Valley is, of course, to store the peak flows: make these peak flows available for application to lands later on in the season or in years of low water supply. Every drop of water that's available for diversion in low years is at present diverted between Alamosa and Del Norte. During the low years in the San Luis Valley, the diversions being limited to the available water supply, the return flow would naturally increase. If, instead of having the very short water supply available for diversion in low years, there was this 600,000 acre feet available, the normal return flow can be expected. So, instead of drying up the river, if the 600,000 acre feet were available in these years, the 100,000 acre feet would result, or whatever the figure might be, and the river would be enriched by that amount during those low years or low periods. That necessarily follows. In the study made by the engineers of the Middle Rio Grande Conservancy District as to their water supply, and the adequacy of the water supply to take care of the demand, they found during a long series of years, during April, May and June the water as it naturally occurred was considerably in excess of the demands as they set them up. On the other hand, in most years the July, August and September supply that naturally occurs is usually less than

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the demand. Whenever there is a surplus water supply in April, May and June at the head of the Middle Rio Grande Conservancy District that water supply will be depleted by this process of storage in the San Luis Valley, but could not be depleted beyond the amount of water which at present passes at Alamosa. You cannot extend the use in Colorado beyond the drying up of the river at Alamosa. If you did that, even drying up the water at Alamosa, you would only deplete the flow 230,000 acre feet, most of that depletion resulting in April, May and June, but that cannot be done. It is not feasibly possible, unless enormous reservoirs were constructed. If you have this constant application of water in the San Luis Valley, it is bound to result in this return flow, so by analyzing it on a monthly basis, which you can go into, we found that in no instance when the water was being stored in the San Luis Valley could the supply at Buckman drop below the indicated demand; as a matter of fact, it was well above the indicated demand.

On the other hand, we found that when the water supply at Buckman was indicated to be short, there would be more water in the stream by virtue of releases from reservoirs than at present, and if this return flow developed, the flow during July, August and September at Buckman would be enriched. We have gone into that on a monthly basis and can go into it in detail. We indicate that that is true based upon my assumption of return flow. What I have said in connection with the Rio Grande applies to the Conejos. We found the consumption of water on the Conejos is unusually high if the consumption is all charged to the lands irrigated by the waters of the Conejos. When I say unusually high, I mean by what we determined to be the actual consumption by irrigated crops in the San Luis Valley by lands adequately drained. That is due to the distorted use which must be made of the water available, and possibly due to the type of crops raised there. So reservoir development on the Conejos would probably result in a net gain of the stream. Beyond a question of doubt there is considerably more water consumed on the Conejos itself than would be consumed if the water were adequately controlled by reservoir. So that is the picture. We have attempted to show what the requirements of the San Luis Valley are; what we consider to be equity; what we consider to be parity, and have attempted to show how we consider that would affect the users in New Mexico and Texas. If you care to go into the details, we are ready to go into them.

MR. HARPER: Does Colorado have anything further?

MR. HINDERLIDER: We feel, in view of the fact it is now quarter of five, and that there will probably be of necessity a desire to propound a number of questions as a result of Mr. Tipton's presentation, it would be well to recess the meeting until some proper hour tomorrow morning, to be decided by the Chairman.

MR. HARPER: What is the pleasure of the other two commissioners? What hour would you suggest? Ten?

MR. HINDERLIDER: Ten is satisfactory to us.

MR. HARPER: We will recess until ten o'clock tomorrow morning.

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JANUARY 29, 1935.

10:15 A.M.

MR. HARPER: The meeting will please come to order. At adjournment yesterday, I believe Mr. Tipton had just completed his presentation of engineering data. I will ask Mr. Hinderlider if he has anything further to present at this time?

MR. HINDERLIDER: Mr. Chairman, Colorado has nothing further to present at this time.

MAJOR BURGES: I would like to question Mr. Tipton along the lines of his statement yesterday.

MR. HINDERLIDER: It will be agreeable to Colorado.

MAJOR BURGES: Mr. Tipton, in order to get the matter clear in our own minds, and for the record, will you tell us what steps, under the law of your state, a man takes in order to initiate a water right say, on the Rio Grande or any other stream?

MR. TIPTON: You are asking legal questions of me which I think could be more properly answered by one of the legal advisers. I do not believe I went into the matter of the initiation of water rights in the state.

MAJOR BURGES: I don't think you did yesterday. This was a preliminary inquiry.

MR. TIPTON: I can answer the question from my own idea.

MAJOR BURGES: I am asking you as a practical water engineer to outline to us the procedure that is followed in order to initiate a water right.

MR. TIPTON: I believe the answer could be made much better by one of the legal advisers. It is a matter of information that is for the record and it should be correct.

MAJOR BURGES: The very next question would reach an engineering question which I think the lawyer could not answer so well is the reason I asked you.

MR. TIPTON: I would suggest that you have one of the attorneys outline the procedure and then I can go on.

MAJOR BURGES: It will be very satisfactory if one of the attorneys would do that. That will lay the predicate for the other question.

MR. CORLETT: As I understand your question, the initiation of a water right - -

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MAJOR BURGES (Interrupting): What steps a man would take if he wanted to appropriate water from the Rio Grande or any other stream, how would he go about it.

MR. CORLETT: He would make a survey of his ditch or reservoir system, would have a map prepared and certified by a civil engineer, file that map in the State Engineer's office and in the county with the county clerk and recorder of the county affected, and from that time on he would proceed with his construction and to the right to the use of that water on final adjudication would relate back to the time of the commencement of the construction work, which is usually considered to be the date of the filing of a map, but not necessarily. It may go on back beyond that date. Does that answer the question?

MAJOR BURGES: As I understand you then, on the date of the filing of this application he has the right to proceed with his work and with his use of water pending the final adjudication of his right?

MR. CORLETT: The filing of the map has nothing to do with his right to proceed. He may proceed before that time; he may proceed after that time. The filing of the map has no definite effect upon the date of his final priority.

MAJOR BURGES: What does affect his priority if the filing doesn't?

MR. CORLETT: The initiation of construction work.

MAJOR BURGES: You mean then, that if a man diverts water from one of your rivers before taking any procedure at all, that if he subsequently follows it up, why his right to appropriate dates back to the time when he did take water out regardless of any filing in the State Engineer's office, or elsewhere?

MR. CORLETT: I think you are wrong in that.

MAJOR BURGES: I am not stating it, I thought you did.

MR. CORLETT: The first affirmative act, Major, may be by survey; it may be by the construction of a ditch; it may be by the construction of a dam, or, as I say, by survey; really, as Mr. Hinderlider suggests, the matter of intention enters into - enters very strongly into the date of fixing his appropriation.

MAJOR BURGES: But he acquires, as I understand you, his right by his own act, utterly regardless of any filing with the State Engineer or elsewhere?

MR. CORLETT: Yes sir.

MAJOR BURGES: If he never filed, he would still have the right to go ahead and divert water?

MR. CORLETT: In many instances, rights have been determined in Colorado by way of injunction where no filing had been made.

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MAJOR BURGES: Do you refer now to rights that were initiated before the adoption of your existing statutes or since the adoption of your existing statutes?

MR. CORLETT: I can say this, Major, that many rights have been initiated where no filings have been made and are utilized today in Colorado notwithstanding.

MAJOR BURGES: Since the adoption of your present statute?

MR. CORLETT: Yes sir.

MAJOR BURGES: In other words, a man can acquire the right to the use of your water under the statutes as they exist today anterior and independent of the application to the state for the water right?

MR. CORLETT: Major, you are making a number of assumptions.

MAJOR BURGES: I am questioning you; I am not assuming they are true; I want to get at that.

MR. CORLETT: The conditions would be different if a general application had been had than if a general adjudication had been had.

MAJOR BURGES: To a stream on which no general adjudication has been had. That is true of the Rio Grande isn't it?

MR. CORLETT: No, we have a general adjudication and a number of supplemental ones.

MAJOR BURGES: Then, if you have had a general adjudication, could a man today acquire a water right on the Rio Grande independent of any filing or action he took in the State Engineer's office, or other official?

MR. CORLETT: It would be junior to all adjudicated rights at this time, as Mr. Carr suggests in that classification.

MAJOR BURGES: What power of control then has the State of Colorado today over any man who seeks to divert water from the Rio Grande in that state?

MR. CORLETT: I would say in this regard that they have no more power to preclude a respective water user in Colorado from filing a claim to the use of water than the Departments of the United States have to refuse the utilization to citizens of the United States, wherever they may be, to the use of public lands for reservoir and canal construction.

MAJOR BURGES: Of course, I am not interrogating you now on the right of the United States to say whether you can utilize public domain, because that is another large question on which you and I would probably take opposing views. I do, however, think it is important under the Compact to arrive at what is the law of Colorado on the right to take water from the river, or a river, in that state today.

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MR. CORLETT: Major Burges, Mr. Goudy suggests that perhaps for your information, to clear up the steps that might be taken after initiation of the right in the way of adjudication, after claims have been filed or ditches have been constructed, the procedure is to file a petition with the proper district court, one of the district courts in the water district in which the water right is located, and every other water user on the stream is notified of the claim, and the court proceeds to hear evidence as to the relative dates of construction and use, and determines the priorities between the several water users concerned. Mr. Carr suggests that we also call attention to the fact that under our Constitution all the waters in Colorado are dedicated to the use of the citizens of the state, and the courts only consider the matter of priority of right to use as between the individual citizens.

MAJOR BURGES: Then, as I understand you, under your law, the State of Colorado has no power to grant or withhold a right to the use of water from one of your rivers.

MR. CORLETT: That's right.

MAJOR BURGES: The state has no such right?

MR. CORLETT: No sir.

The following questions are propounded by Major Burges and answered by Mr. Tipton:

Q. Since the 9th day of February, 1929, do you know accurately, or approximately, the number of applications that have been filed in the State Engineer's office for the use of waters of the Rio Grande or its tributaries in Colorado?

A. I do not, no sir.

Q. You don't even know approximately?

A. I do not.

Q. You have access to those records?

A. I do. I have absolutely no knowledge of any that have been filed.

MR. CORLETT: Do you mean for the entire state?

MAJOR BURGES: Filed on the Rio Grande or its tributaries in Colorado.

Q. You have no knowledge on that subject?

A. I do not.

Q. You say you have access to those records but you don't know what they show?

A. I have access the same as the general public.

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Q. You don't have any official access?

A. No sir.

Q. I will come down more directly to what you said yesterday. In the study which you presented yesterday, you took the position that if water-users in the State of Colorado were allowed to provide ample storage facilities that it would enable them to make more efficient use of the water of the Rio Grande and its tributaries.

A. Yes sir.

Q. Just in order to get the matter a little more specific - we were not clear as to what your official figures were on that - what is the increased volume of storage which you propose in order to bring about that increased efficiency?

A. The plan as I presented it yesterday was based on the provision of one million acre feet of additional storage capacity on the Rio Grande proper above Del Norte. I made no statement as to the required storage capacity on the Conejos, but made the statement that the situation on the Conejos was more or less comparable to that of the Rio Grande. It would require possibly 200,000 or 300,000 acre feet of storage capacity on the Conejos to bring about the same situation that would be brought about on the Rio Grande by provision of a million acre feet.

Q. Then the solution of the problem which you advocate would contemplate increased storage facilities on the Rio Grande and Conejos from 1,200,000 to 1,300,000 acre feet over existing storage?

A. That's correct.

Q. Now I would like for you if you will to make more explicit wherein your present use of the water is inefficient.

A. The term "inefficient" might not be the exact term to apply, but I will explain - -

Q. That was your term, I think.

A. I will explain the method of use and result of that method and then whatever term is applicable might be applied to it. On account of the lack of storage facilities on the streams diversions must be made under existing rights according to the way the water naturally occurs. The water does not occur parallel to the demand, as a result of which large diversions must be made in April, May and June; ground storage must be built up in order that that ground storage shall supply the deficiencies that otherwise would occur in July, August and September as a result of the small natural flow. That method of irrigation causes areas of land to go to seep in the San Luis Valley. That method of irrigation also naturally results in probably a poor production of crops, since the high water table does not permit of the proper aeriation of the roots, and the whole general set-up from an irrigation standpoint, is an undesirable set-up. Due to the lack of storage facilities not only is the use in an individual season distorted, but we might say the use

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from year to year is distorted. For example in the year 1932 very large diversions were made on account of the grave shortage that existed in 1931. Those large diversions were absolutely necessary to bring the water table back up to approximately normal, the water table having been very greatly depleted in 1931. Even with these large diversions the water table was not brought back up to normal. On the other hand, had sufficient storage capacity been available whereby diversions in 1931 could have been those that were necessary or normal, the diversions in 1932 would have been normal and there would have been no necessity to have made very large diversions. That is as clear as I can make it.

Q. As I understood you yesterday, what might be called the cultivable soil or surface soil in the San Luis Valley is underlaid by a very porous or gravelly sub-soil.

A. That is true over a considerable portion of the area, and in some portions that is not true.

Q. Approximately what percentage of the whole irrigable, or part that has been under irrigation at one time or another, approximately what proportion of it is underlain by this gravelly sub-soil and what proportion is not?

A. Of course, it is all underlaid by the coarse gravel sub-soil at varying depths. That portion that has a top soil depth of from two to three feet constitutes possibly two-fifths of the total area that's irrigated. That's a rough figure.

Q. Irrespective of any water that is diverted and put upon the land by irrigation ditches, what would be the water table under the cultivated land?

A. You mean - I might state it this way - what was the water table before irrigation commenced, would answer the question.

Q. Well, of course, I don't know it would be necessarily confined to that. Assuming the irrigation were indefinitely withheld, it might or might not be the same again. What I wanted to get at was irrespective of the water that is put on by diversion, can you approximate what would be the water table under the cultivated valley?

A. I think I prefer to answer it in the form that I stated it. Our investigations indicate that over the area where the soil is two to three feet deep, before irrigation commenced over that area, the water table was at depths of 60 to 100 feet. That was determined by the depth at which the water table stood in various surface wells that had been constructed at that time.

Q. 60 to 100 feet?

A. Over a portion of the area; it ranged in some portions up to 15 feet.

Q. Have you any accurate figures, or approximately accurate figures as to what is the general level of the water table today under the cultivated valley?

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A. As I stated yesterday, the system of irrigation is such that over a portion of the area, that portion where the soil depth is shallow, the water table is held to a depth from 2 to 3 feet below the surface of the land, and over some portions which are drained after the irrigation season is over, the water is drained out down to the depth of the drain, and then in very dry years, such as 1931, the water naturally drains down to a lower depth; the drains go dry.

Q. Will you explain how you think the water could be used more economically if you held it in storage and could apply it whenever you had need of it?

A. Over a portion of the area the use of the water will change that. The consumption of the water over a given area probably would be less if the water were stored in reservoirs in the hills rather than being stored in the ground, because the water table would not have to be maintained at such a high level. The water being applied to the soil as required at frequent intervals. And the incidental evaporation by that system would be less, not only over the areas actually irrigated, but over the lower areas that are at present seeped by virtue of the maintaining of high water table, which is absolutely necessary under present conditions on the river.

Q. Do you think it is feasible, when you put the water on the surface soil with a gravel sub-soil which you have described, to prevent the escape of a large proportion of that water into the gravelly sub-soil?

A. No, I do not. I think that it is very true there would be an escape of a portion of the water applied, an escape of more of the water that was applied than there would be if this gravel sub-soil did not exist, but that water which escapes to the gravel sub-soil would have to find an outlet through the drainage systems, and would find such outlet and would not be evaporated as it is at present by virtue of maintaining a high water level, so there would be a net gain to the river.

Q. Can you give us an estimate as to what portion of the water applied in irrigation is, in your judgment, consumed by plant growth, what portion is lost by evaporation and what portion is lost by seepage or percolation into the sub-soil - approximately?

A. I will start answering the items in the reverse order. There is no water lost by seepage and percolation. The only water lost is, of course, by evaporation and transpiration. That water which seeps and percolates eventually reaches the stream system and is not lost to the stream system. We estimate that on efficiently well drained lands in the San Luis Valley, even under the present methods of applying water, that the amount of water consumed by plant growth, and also the incidental evaporation that takes place under those conditions, is about 1.2 acre feet per acre.

Q. The part consumed by plant growth?

A. Yes and incidental evaporation from a well drained area.

Q. What portion of it is lost - when you say that none of it is lost by

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seepage or percolation, you are for the moment disregarding the loss of water into the sump area?

A. You place losses in three categories - evaporation, seepage and plant growth, so the seepage and percolation, if it's lost at all, is by evaporation, and the - - -

Q. (Interrupting) Perhaps I did not make myself clear. I mean loss the stream suffers from which it is diverted.

A. I can answer that by giving some general figures in connection with the valley as a whole. We estimate that the total production of water in the San Luis Valley in the live area is between 1,300,000 to 1,400,000 acre feet.

Q. Total production?

A. Total production in the live area; in the dead area it's about 240,000 acre feet per year. There are 550,000 acres of land, approximately, irrigated in the San Luis Valley. There has been beneficially consumed, therefore, 1.2 times 550,000 acres of land, and our estimates indicate that for a period such as 1890 to 1934, the mean annual flow across the state line would be 470,000 acre feet. From those figures can be determined what we estimate to be the water lost by evaporation, a portion of which is recoverable by drainage construction through the sump or otherwise.

Q. Now, then, taking your figures at the proposed storage and the proposed production, you propose then the storage of the total production of the water of the San Luis Valley?

A. No, that would not be economically feasible. I think if you will remember in my explanation of the graph showing our proposed reservoir operation that I showed on the graph that out of a 45 year period there were some 20 or 25 years when spills would have occurred over the spillway of the reservoirs and some spills would have been substantial.

Q. Only two years according to your graph?

A. No, I can give you that. I would suggest this, Major, in connection with that and other matters in connection with it. We have gone into this study in great detail, not only as to the requirements of the valley, but the possible effect on the stream flow of the lower basin. It would take considerable time here to develop that, and as I mentioned yesterday, we would be very glad to go into detail with the engineers or anyone else interested.

Q. Could you furnish each of the other states with a copy of that study?

A. That's up to Mr. Hinderlider.

MR. HINDERLIDER: I think so.

Q. Could we have that now? It might save a great deal of time if we had that. It would save transcribing a lot of figures of your study.

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A. Certain portions of this I would have to discuss with Mr. Hinderlider. However, I will complete the answer to this question - it is very short: In 1907 there would be an estimated spill of 15,000 acre feet.

1908	29,000
1909	220,000
1910	161,000
1911	271,000
1912	229,000
1913	18,000
1914	67,000
1915	52,000
1916	272,000
1917	282,000
1918	No spill
1919	67,000
1920	345,000
1921	383,000
1922	370,000
1923	145,000
1924	230,000
1925	No spill
1926	22,000
1927	318,000
1928	97,000
1929	228,000
1930 to 1934, inclusive,	No spill

And in addition to these indicated spills, there would be the inflow to the river below the reservoir during the non-irrigation season which would be non-storageable water - could not be stored. That's of course in addition to return flow.

MR. HINDERLIDER: May I make a suggestion? It is the purpose of Colorado to furnish all necessary information that you gentlemen may feel necessary to enable you to analyze and digest this proposal which we have set up, and in order not to encumber the record unduly, and to the interest of conservation of time, I suggest that this information may be furnished you so you may study it at your leisure.

MAJOR BURGES: It might save a good deal of time if we may have access to it now. The one which he epitomized yesterday in his address. That inspires a great many questions we want to ask. It is quite possible if we had this during the noon hour, it might save a great deal of time and a voluminous record.

MR. HINDERLIDER: In further answer to my last statement, we are handing you here the essential data pertaining to the major phase of reservoir development in the San Luis Valley, which we conceive to be necessary to regulate the present diversions in the San Luis Valley so as to make the same conform to the demand, and it consists of tabular data pertaining to this particular matter, of reservoir construction in the San Luis Valley as proposed by Colorado, and its effect upon the interests of the two lower states. We can furnish you only one copy.

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MAJOR BURGES: One copy would meet our present necessities,and now, without questioning your right to do so, I infer some portion of the studies which Mr. Tipton has made, you do not feel we are entitled to.

MR. CORLETT: We furnished you that portion you asked for. I think that there is no particular objection to furnishing you the rest of it, but we would want to go over that. It was merely commenced for the use of our water commissioners.

MAJOR BURGES: We have a high opinion of it and we hope to have the benefit of the whole study on it.

MR. HINDERLIDER: I think we can furnish you that if you care for it.

MAJOR BURGES: That will greatly facilitate the Commission.

MR. HINDERLIDER: We did not anticipate turning this over to you, but I think there is no objection to it.

The questioning of Mr. Tipton by Major Burges continues:

Q. Mr. Tipton, what is the average annual use of water per acre in the valley in Colorado?

A. You mean the amount diverted per acre or the amount consumed per acre?

Q. Both, the amount diverted per acre and the amount consumed per acre.

A. The amount diverted varies between wide limits. There is a lack of records over a portion of the valley of diversions, so I cannot answer that question definitely. We consider the proper water requirement to be an average of 2 feet per acre, or a little more. But, as I say - -

Q. (Interrupting): Diverted or consumed?

A. Diverted. As I say, it varies from that one way or the other. Where an efficient use can be made of the water there is a remarkably high diversion duty, and where it cannot be made, much more water is applied.

Q. As I understand today, you are diverting an average of 2 feet per acre per annum.

A. No, I didn't say that. We consider our requirements to be that, but as to what the average diversion is, I cannot answer. We have records on the main stem of the Rio Grande from Alamosa to Del Norte, fairly complete records from 1928 up to date, and these records indicate the diversions, total diversions, amounted from about 300,000 acre feet to something over 700,000 acre feet. The 300,000 acre feet was on account of the limitation of water supply.

Q. What do you contemplate would be the diversion per acre? It would be 2 feet per acre if you had this ideal situation which you propose.

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A. In answering your question, I will have to repeat what I stated yesterday. The answer I will give to this question is my own personal opinion and does not necessarily represent the opinion of the water users who would benefit from this development. It is my personal opinion that if the water were regulated as indicated yesterday, two acre feet per acre for diversion duty would be ample, and would perform much better service than some of the larger diversions that are made at the present time under the conditions that exist on the river.

Q. It is your personal opinion then, if your plan were carried out, there would, and should, be diverted 1,100,000 acre feet per annum on an average?

A. Yes sir, and this plan which was proposed yesterday, as I indicated very plainly, applies to only two of the stream systems of the valley, and when you quote this figure 1,100,000 acre feet, that is taking the diversions that are being made in the areas other than these two areas. Those diversions have been made a great many years. What they are, we do not know; we contemplate they would continue as they have been, and the 2 acre feet per acre which I am mentioning, applies only to the main stem of the Rio Grande between Alamosa and Del Norte that would get the benefit of the proposed reservoir development and applies to the Conejos area. I don't want to say that the two acre feet per acre is that which is, or will be, diverted to the lands other than these two areas, but whatever those diversions are, or will be, will not affect the water supply of the lower basin in any way. They have reached the limit and cannot go any farther.

Q. How many acres are there under the main stem diversions?

A. Approximately 300,000 acres.

Q. That is from the main Rio Grande and Conejos?

A. The main Rio Grande alone.

Q. What is the number on the Conejos?

A. Between 80,000 and 90,000 acres - lands actually irrigated. Not lands under ditch and having water rights.

Q. When you speak of 550,000 acres do you mean actually irrigated or under ditch?

A. Actually irrigated. There are some 750,000 acres under ditch.

Q. And on the Conejos 80,000 to 90,000 acres?

A. Yes Sir.

Q. Mr. Tipton, of the water that passes the Del Norte gaging station today what amount, in your opinion, passes the gaging station at Lobato?

A. For a period such as 1890 to 1934, 230,000 acre feet.

Q. 230,000 acre feet?

A. Yes sir.

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Q. At what season of the year principally does that pass?

A. There is some 30,000 to 40,000 acre feet of that that passes during the months of November to March. Almost 200,000 acre feet which passes during the months of April to October. There are a great many years when there would be virtually no water pass, and there would be some years when there would be considerable pass, so the average would be about, approximately, 200,000 acre feet.

Q. You mean during these years that have passed, there are a number of years when none of the water passing Del Norte ever reached Lobato?

A. Yes, except the winter flow and some return flow.

Q. What is the full diversion period in your valley?

A. It varies: diversions ordinarily start about April 15 and continue through September and a portion of October. Some years it extends to the first few days of November.

Q. You said yesterday - I don't know that you said it, but you are probably familiar with it - that legislation had been introduced - I believe Mr. Corlett said it - legislation had been introduced at the present session of your legislature which would enable you to take advantage of the PWA appropriation under the terms prescribed by the government if you should decide to do it.

A. I did not make that statement and do not wish to comment on it.

Q. I wonder if you yourself know, or have any opinion, as to what are the defects in your present law?

A. I have no opinion. (Recess.)

MR. HINDERLIDER: Mr. Chairman and Gentlemen of the Commission: While Colorado does not conceive it to be the right of the commissioners of the other two states to request the complete report of Mr. Tipton, engineering adviser to the Commissioner for Colorado, yet, in the interest of expediting our considerations of this matter and as an evidence of good faith and good will on the part of the State of Colorado, we have seen fit to release to the commissioners for New Mexico and Texas a complete report of Mr. Tipton, engineering adviser to the Commissioner for Colorado, with this understanding: That many of the things set forth in this report are Mr. Tipton's personal opinion and conclusions.

MR. TIPTON: This is a report I prepared for Mr. Hinderlider's information and use and is not an official report. He did not have time to prepare an official report.

MAJOR BURGES: We appreciate it, Mr. Hinderlider, I assure you, and I concede we do not demand it as a right. I believe I opened with that statement, saying we would appreciate it if we could have it. I do not want to be understood as asserting we had a right to demand it.

MR. HINDERLIDER: I think you are perfectly right in that statement.

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The questioning of Mr. Tipton by Major Burges continues:

Q. Mr. Tipton, for the record I would like to ask you this: What is the acreage under irrigation from diversions of the Rio Grande between Alamosa and Del Norte that will make a return flow to the Rio Grande, and what acreage from diversions between the same points that would drain to the sump?

A. I think I understand the question. Understand, Major, the figures that I am giving are approximate figures only. I think you realize what conditions are in the valley as to topography, etc. and in the absence of very accurate surveys it would be impossible to determine the exact acreage, so this answer is given with that understanding. There are irrigated from the Rio Grande, approximately 180,000 acres of land which lie in the dead area. The balance of the area which is irrigated from the Rio Grande lies either immediately contiguous to the stream or south of the river, the drainage return flow of which would reach the river if drainage systems were constructed, and a considerable portion of the southwest area is covered by constructed drainage systems. Qualifying that answer a little further, 30,000 acres of the 180,000 acres irrigated in the dead area, are at present drained to the Rio Grande by constructed drainage systems.

Q. Do you have any figures - I believe you have but I haven't got them in mind - what was the return to the river from that 30,000 acres last year?

A. I don't know. I imagine - I would say offhand, practically nothing. On account of the very short water supply last year and the lack of adequate diversions, it is my opinion that the drainage systems were practically dry. I saw the drainage systems in 1931 - I saw this particular one we are talking about, and it was dry. I didn't see it in 1934, but it being a year comparable to 1931, I would say it was practically dry that year.

Q. I believe you stated, in round figures, the amount of water that was now passing, the water diverted amounted to a mean annual of approximately 230,000 acre feet.

A. For a period such as from 1890 to 1934, 45 years; for a period such as we had from those dates.

Q. In your study yesterday, you indicated that if the sump drain were in operation it would return 50,000 acre feet of water.

A. I did not make that as a statement of fact. I said that my study was based on the assumption that it would.

Q. Have you any objection to stating whether in your opinion that is correct, more or less?

A. In my opinion, if 600,000 acre feet of diversions were assured year after year, there would be no question at all but that the sump drain would produce at least 50,000 acre feet. May I add an insert to that. 600,000 acre feet between Alamosa and Del Norte.

Q. I also understood you to say that in making this estimate, you are of the opinion that 50,000 acre feet would be returned to the Rio Grande annually from the drain other than the sump drain.

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A. Yes sir, that was my statement.

Q. Now, I will ask you first, why is that not available to the Rio Grande now?

A. The 50,000 acre feet? It is available to the Rio Grande when diversions amount to 600,000 acre feet or more, but it is not available to the Rio Grande under average conditions. I won't say it is not available in some years; it was by no means available in 1930, 1931 and 1934.

Q. Then I will ask you this: If the sump drain returns 50,000 acre feet of water, and the other drains 50,000 acre feet of water per annum, what other or additional sources would there be of supply to the Rio Grande?

A. The 50,000 acre feet through the sump drain, and the 50,000 acre feet directly to the river between Alamosa and Del Norte does not represent by any means the total amount of water that would be indicated as not beneficially consumed in the sump area itself. If we assume that 1.2 acre feet per acre is the consumptive use, there is an additional amount of water that would be available to either the sump drain or to the river itself between Alamosa and Del Norte if additional lands were drained from the north to these areas. This 100,000 acre feet estimate was predicated upon the assumption that no further drainage systems would be constructed in that area. If further drainage systems would be constructed, it would make an additional source of water.

Q. Assuming that the 50,000 acre feet would be returned from the sump drain, and 50,000 acre feet from the area that's not drained into the sump, how would the water users below be compensated for the difference between the 230,000 acre feet per annum, and the 100,000 acre feet per annum?

A. I don't quite get the question.

Q. You say today - -

A. (Interrupting): Yes, I do get it. You are making the assumption that the 100,000 acre feet return flow is the only water that would get to the stream, say at Alamosa or above the state line from the Rio Grande area.

Q. I asked you if you could point to any other supply other than those two?

A. I thought you meant potential supply.

Q. What other water?

A. I misunderstood your former question. The other supply that would be available would be the unstorageable water which occurs between November and March; that is the water which originates to the basin below the proposed Wagon Wheel Gap Reservoir.

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Q. Do you know what that is approximately?

A. About 30,000 to 40,000 acre feet. There would be in addition to that the spill which I gave a while ago, the unstorageable water in other words which occurs between the period April to October inclusive.

Q. It's your theory that the Wagon Wheel Gap would be habitually full of water.

A. No, if it were it would not be necessary to construct it. It would be full, as I indicated, some 25 year period out of 45 year period, just - -

Q. (Interrupting): It would be full 25 years of that period?

A. Just as the Elephant Butte Reservoir would be about 25 years out of a 45 year period under the use, the same sort of use, that you have had in the last 4 or 5 years.

Q. Of course, the Elephant Butte has never been quite full.

A. Because there has been enormous spills - not over the spillway but through the gates.

Q. Are you then, when you are figuring on spill, of course, you include what is discharged?

A. Anything that would be discharged on the yearly basis over 600,000 acre feet, whether over the spillway or through the gates we would determine spill.

Q. When you figured your spill for the years you gave us, have you allowed 600,000 acre feet first before you figured spill?

A. Yes sir.

Q. Then I will ask you if it is not true, Mr. Tipton, that in lieu of the 230,000 acre feet which the lower users get today, the return after you had stored this water, is necessarily problematical; that is, it is more or less of a speculation or estimate as to what it would be?

A. I think it is a conservative estimate. It is necessarily an estimate, no question about that. For example, 50,000 acre feet of estimated return flow from the sump drain, assuming we have diversions of 600,000 acre feet year after year, probably 400,000 or 360,000 acre feet of which would be to the sump or dead area, and conceding the fact that there is a high mountainous country lying directly east of the sump, while the drainage area is short, there is absolutely no use made of that water, and with some contributions from the north out of the 240,000 acre feet produced in that area, I think the 50,000 acre feet is conservative.

Q. There is no doubt in your mind but what the sump drain is worth while.

A. I think it is distinctly worth while; decidedly so, from the standpoint of all three states.

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Q. You have no doubt it would be beneficial to construct the sump drain.

A. It would be beneficial to the three states. The benefit to the Middle Rio Grande Conservancy District would be material, in that it would improve their late season water supply and reduce necessary releases from the El Vado Reservoir.

Q. Of course, if the diversion and use in Colorado were increased by the same amount, this first diversion, it would be advantageous to the San Luis Valley?

A. Even though the use in the San Luis Valley - when I say use I mean consumption - were increased an amount equal to that which would be returned by the sump drain, or, any other additional drains, even though the equivalent of that water were actually burned up so the mean annual flow at the state line remained the same, yet the fact remains that such areas as the Middle Rio Grande Conservancy District would be benefitted, because the regimen of the stream would be changed in such a way that the late summer flow, that now under their set-up they consider to be deficient, would be increased and it would make for a beneficial condition down there.

Q. Yesterday in your study you alluded to four minor areas, more or less, in the San Luis Valley, in which storage had been provided equal to, or in excess, of the requirements, in which the water was practically totally used, economically used and consumed.

A. That's true.

Q. Will you name them once more and tell the approximate number of acres in each one, if you will - in each of these areas?

A. The Trinchera area; the Culebra area. I think the approximate acreage of these two is some 35,000 acres. The other two areas are Alamosa and La Jara areas and right now I can't give the approximate acreage in these two areas. I would have to determine that.

Q. Before the storage was effected and diversion made in these areas, they were, of course, contributing factors to the Rio Grande. Is that not true?

A. Not to any greater extent than now. They are contributing factors, the Alamosa and La Jara areas now to the Rio Grande. Probably the Trinchera and Culebra were not. The water production in those areas is very limited, the stream channels are fairly long and it is altogether possible that the limited water supply produced by the basins did not reach the Rio Grande but was evaporated before it reached the Rio Grande. As I say, the Alamosa and La Jara areas probably contribute as much as they formerly did.

Q. Mr. Tipton, I want to ask you this: It is an engineering fact, is it not, that the appropriation by the United States at Elephant Butte to the construction of the reservoir at Elephant Butte, did not deprive any water user above that reservoir of a single acre foot of water which was being beneficially used at the time the appropriation was made, and construction made. Is that not a fact?

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A. I don't know how an engineering fact differs from any other fact, but the embargo that was placed upon the river prevented the water users in the San Luis Valley from making the most - we'll go back to the term "efficient" use of the water, by virtue of the fact they could not build the reservoirs required to make that use, and it prevented them from making the same type of use of the water that the construction of the Elephant Butte Reservoir provided for the lands under that reservoir.

Q. The fact remains that prior to the building of the Elephant Butte Reservoir twice as much land had been brought under irrigation in the San Luis Valley as is today under irrigation in both New Mexico and Texas above Fort Quitman from the natural flow of the river, is that not true?

A. Ditches were constructed for the area, attempts were made to irrigate the area with the natural flow, just as attempts are made at the present time; a great deal of agitation concerning the construction of reservoirs went on, and due to the low water supply which resulted along about that time, there was a natural temporary abandonment of irrigation, resumption of which did not take place until 2 or 3 years after the water supply went up around 1905. The records show that as to stream flow, and the historical records indicate that that is true.

Q. Nevertheless, 550,000 acres, which you yourself say is under irrigation, is more than twice as much as is under irrigation in both the other states today.

A. Not according to the U. S. Census. I don't know how correct the figures in the last statement are, but the U. S. Census last year, as I remember, gave 380,000 acres in New Mexico.

Q. On the Rio Grande?

A. I'll admit I think that's very excessive.

Q. I will ask you what, in your opinion, as an engineer, would be the difference between the continuous small flow from day to day which would result from the 50,000 acre feet from the sump as compared with the head, or quantity of water from the flood waters that now reach the gaging station at Buckman?

A. Major, if you dried the river at Alamosa and didn't contribute any more water to the river from that area at all - if you absolutely cut off the flow, you would still have over a million acre feet at Buckman; a flow at Buckman greater than the flow at Del Norte which is used to irrigate 300,000 acres and the Buckman flow is used to irrigate 123,000 acres, so if you cut the river clear off and didn't contribute this small daily flow, you would still have considerably over a million acre feet.

Q. If that is true, why is the Rio Grande useless below Fort Quitman?

A. Because the uses in New Mexico and Texas absolutely consume all the water, outside of this avoidable waste, that goes down past Buckman and San Marcial. You dry the river up, we don't.

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Q. You would dry the river if you could use it beneficially. Wouldn't any irrigator do that if he could?

A. Yes.

Q. You have land enough to use every gallon of water, have you not?

A. We have land enough to use it, but it would be physically impossible to do it. As I say, if we did do that, dried it at the state line, you would still have over 900,000 acre feet at Buckman and that's 200,000 more than we have at Del Norte.

Q. Irrespective of what views you may have as to the justice or injustice of the embargo, I want to get clear on this proposition: It is obvious that the appropriation of the United States, and making beneficial use of that appropriation did not deprive any water user of one acre foot that was being beneficially applied above that.

A. We can't dis-associate the two things.

Q. The point I want to get at, it was being applied to beneficial use at the time that appropriation was made, and it didn't deprive any water user of one acre foot?

A. I don't think it did, and this proposed construction on the other hand would not deprive the Elephant Butte Project of any beneficial use of the water they are making.

Q. Of course, that is where the man upstream has a comfortable feeling of confidence over the man downstream, that the man downstream is never able to share. There are such diametrically opposite views on the embargo that I have hesitated to bring that into the discussion. I think the embargo was absolutely legal and just. Of course, there is much more loss by evaporation from the small flow than there is from the flood run-off is there not?

A. Less. Evaporation is a function of the exposed water surface. During a flood there is more water exposed than during the regular flow, therefore there is more water lost.

Q. If 500,000 acre feet flowed in ten days, wouldn't there be less evaporation in passing than if we had the 500,000 acre feet over 365 days?

A. Yes.

Q. Then, as a matter of fact, there is less loss from evaporation from the sudden flood than there is from a slow daily flow, is there not?

A. If it was spread over the whole year in transit.

Q. That's what the drain would be, spread over the whole year, it wouldn't be very much greater then.

A. It would depend entirely on a good many factors - the season of the year which the flow occurred, etc. About 40 or 50 percent of the drainage return is in the winter months, during which months, of course, evaporation is very, very small, almost nothing.

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Q. Now is it not a fact, in your opinion, that for the 230,000 acre feet passing the Del Norte gaging station which now reaches the people below, that they would receive under your plan an estimated return of which you, yourself, figure only 100,000 acre feet as the probable return flow?

A. No, that does not follow at all. I think that some of these questions that you are asking could probably be much better cleared up in your own mind if you did read the report which you now have in your hands. The 100,000 acre feet of return flow, as you say I estimated as that which would return, I did not estimate that as that which would return, I merely used that as a conservative figure to use to determine what effect this development might have upon the lower stream, but that 100,000 acre feet is by no means the total amount of water that would reach the lower basin from the Rio Grande area proper.

Q. I am going to ask you another question. I think as an engineer you will approach this question scientifically anyhow. Would you suggest that the people below Fort Quitman could expect a better water supply today if they wanted to reclaim 100,000 acres of land down there, than they could have done if the Elephant Butte had not been built?

A. I don't know whether there are any records available at Fort Quitman on the flow prior to the construction of the Elephant Butte Reservoir or not.

Q. Assuming the Rio Grande was dry at Fort Quitman five years out of six before the building of the Elephant Butte Dam from the latter part of June until May of the next year.

A. I can suggest that you do one thing - that you can take - this has a scientific approach - I have taken the records at Elephant Butte and compared them with records at El Paso over a long period of years, and those records indicate there has been very little change in stream loss in these two areas, although there has been considerable increase in acreage. While there has been a material change in peak flow that did come and don't now, yet the natural stream flow losses were sufficiently great that the consumption by irrigated areas at present do not materially change conditions. I don't know what the conditions are at Fort Quitman.

Q. As far as Fort Quitman is concerned, the Rio Grande was a torrential stream from the time I went to El Paso in 1892 until the building of the Elephant Butte, and was dry during all of the summer after June.

A. That's the way I would consider it was.

Q. Of course, that was directly due to the diversions of the river above.

A. The total quantity passing El Paso has not materially changed; the regimen has changed, but not the total quantity.

Q. That might be, I wouldn't be disposed to dispute that. To what extent is the water in the drains of the San Luis Valley re-used today?

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A. To the maximum. What part they re-use I don't know, what the actual re-use is that is made of the drains. Most of the drainage systems - I won't say "most", but I would say possibly half of the drainage systems that have been constructed, and particularly those in recent years, have been constructed with diversion structures whereby a re-use can be made of the water and there is a maximum re-use made of it during the irrigating season.

Q. Is there any reason why that should not be reasonably applicable to future drainage?

A. None at all.

Q. Whether we got any from the drains would be purely optional?

A. It would be impossible to dry the drains.

Q. Except for the winter flow.

A. It would be absolutely impossible to altogether eliminate all of the small flow of the sump drain because under the assumption that I made the major portion of the summer flow would come from other sources than the Rio Grande. It would not be subject to re-use under irrigation.

Q. What proportion of it approximately?

A. Over half of it would come from other sources.

Q. Then as a matter of fact, assuming that the water was re-diverted here the estimated return from the sump drain would have to be diminished by something less than half of the estimate.

A. No, by no means.

Q. Why not?

A. I made the statement over half of the water could not be used in any way; something less than half might be re-used but not all consumed. There would still be some of that that would reach the sump.

Q. Under strictly economical use of water, what would be the percentage of return for the water diverted?

A. If 2 acre feet of water per acre is applied to the land with an efficient drainage system and there is no re-use of that water, around 8/10ths an acre foot per acre should return.

Q. If there was a re-use, then you estimate about half of that or 4/10ths would still escape?

A. There would be half of it that would escape, that you could not get; that would be winter water, and of the other 4/10ths that might be subject to re-use, there would, of course, be a portion of that that would escape. It couldn't all be burned up, assuming they were used on lands that were drained.

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Q. In view of the decided opinion you have as to the value of the sump drain, which I share, whether my opinion is worth anything or not, do you not think that it is highly advisable to construct it while the money is available?

A. That's a question of policy.

Q. As an engineer, wouldn't you recommend that if you were passing on it?

A. I cannot answer the question because there are so many factors involved other than engineering that I am not intimate with.

Q. What other factors besides engineering? Why wouldn't an engineer - Suppose water were greatly desirable and the only available source is the Closed Basin; you knew that a drain could be constructed from that basin that would return to the river, we'll say 50,000 acre feet per annum, and the cost of the drain would be so much; wouldn't it be distinctly an engineer's problem to recommend that it would, or would not be, economically sound, feasible proposition?

A. The benefits arising from that are, as we mentioned, two-fold; one benefit is to the lower basin, the other is to Colorado. Before Colorado could benefit one acre foot from that, the necessary reservoir construction would have to take place in order that that could be utilized. Whether that reservoir construction were permitted would depend the question whether or not that drain were a desirable feature, and the benefit proposed to be gotten could be gotten, so that is a question I cannot answer. For the benefit of the lower states, from an engineering standpoint, I would say it is decidedly desirable to construct the sump drain and take advantage of the money.

Q. Allright then, if you were advised of the existence of a Compact which gave those above the absolute right to store, divert and use an equivalent of that, why wouldn't that be desirable?

A. If that were a plain definite condition, with no other conditions attached, I would say it would be very desirable.

Q. Are there any other conditions?

A. Major, you are attempting to get me into an argument about the question of policy here, which has nothing to do with engineering and questions of legal matters which has nothing to do with engineering. The only thing I have done in connection with the problem is to determine, from an engineering standpoint, what is necessary in the San Luis Valley; if the works are constructed how those works will effect the lower basin, so these questions you are asking me, I cannot answer, and if I did answer, the answers would mean nothing because they would not be official.

Q. The whole case was tried - if I may use that expression, if we were in court - five years ago upon the position advanced by Colorado, and set forth with great force, and, to my mind, accuracy, in which the whole solution of

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this problem was predicated upon the idea that the sump drain would solve the dispute between these states, and we were rather not only persuaded, but convinced, of that, and went into an agreement based upon that. It was very strongly urged by Colorado that if we would get behind that proposition with them and bring about that achievement, that the disputes between us would be settled and that would be the end of the controversy. Naturally, we have attached a great deal of importance to it, and when the situation developed, fortunately - when I say fortunately, I am not speaking for the Nation - and we had advantage of the PWA appropriation, we achieved what we were all hopeful of, but only vaguely hopeful of before that, and of course, naturally, we think that jeopardizing it or losing it is somewhat tragic.

A. I personally think it would be very unfortunate. I think it's probably not the proper thing to do to ask me the question - the position of Colorado was stated yesterday. However, from an engineering standpoint, I would like to state when you go through the report that you have in your hands you will find that it probably sets forth exactly that which is contained in the Compact. In other words, the construction of the reservoir proposed will not result in the consumption of any more water than that which will return to the river through additional drainage construction, which is the very thing provided in the Compact. As a matter of fact, I don't think there is any difference at all between the set-up as explained yesterday, and the provisions of the Compact.

Q. If you could convince the Hudspeth District on the thesis, the El Paso District could afford to pay a handsome fee over the happiness that would result in our valley because the Hudspeth District is very bitter on the subject that it doesn't work out that way, although L. C. Hill and others point out it would.

A. The question of convincing is not my job.

Q. I don't believe I asked you if this plan which you favor were carried out, would you or not expect to increase the amount of land under cultivation in the San Luis Valley?

A. That, of course, has nothing to do with the plan, because the plan as I worked it out from an engineering standpoint was predicated upon a mean annual diversion of 600,000 acre feet. As to whether the people of the San Luis Valley would want to limit, or would agree to limit - I don't know - I can't answer.

BY MR. HINDERLIDER: That relates to diversions out of the main stem of the Rio Grande; there could be another 230,000 acre feet that had already been under ditch at one time or another.

A. There are 750,000 acres that are under ditch. If an increase in acreage were made under the 600,000 acre feet set-up on the main stem of the Rio Grande, I think it would probably be detrimental to the best interests of the valley because it would result in diversion shortage, but I can't answer the question as to whether it would take place.

(Recess taken until 2 P.M.)

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At 2 P.M., the meeting was called to order by the Chairman, Mr. Harper.

MAJOR BURGES: Mr. Tipton, I inferred from what you said this morning that you were optimistic of a larger return from the sump area than the 50,000 acre feet which you stated.

MR. TIPTON: Yes sir.

Q. You think it would probably be larger than that?

A. If the diversions from the river were a fairly universal constant quantity each year.

Q. If your plan were carried out, you figure that that would follow?

A. On the assumption that this reservoir contemplated would be constructed.

Q. Would you mind indicating how much you think that would be?

A. I would hesitate to say; I would like to give as to what I think the possibility of return is if the 600,000 acre feet of water were diverted and the acreage irrigated at the present time remains the same - there would be a potential return of 240,000 acre feet to the river from both sides, from the lands that are irrigated on the two sides of the river. There are about 180,000 acres of land irrigated in the dead area from the river, and there would be about 8/10ths of an acre foot per acre of water that would be subject to return from that 180,000 acres in the dead area. That would be 144,000 acre feet per annum from that source alone, in addition to the natural water from other sources that would go to the sump. That's the potentiality; as to the amount of that that would be developed by future drainage construction, I do not know.

Q. This estimated return has been the subject of investigation by a good many engineers over a series of years, hasn't it?

A. That's true.

Q. And there is a very wide divergence of opinion?

A. Yes, the estimates that have been made and put on record vary between wide limits.

Q. It's perfectly obvious that that return would be very largely influenced by the total amount actually put under cultivation.

A. That portion of the return which would come from the irrigated lands. That's, Major, why I hold the figure to a conservative one. I didn't mislead officials of the state or anyone else by any optimistic assumption as to what might be done. I felt that 50,000 acre feet potential recovery, which is far less than any estimate that has been made and put on record, was a safe figure to use. As you know, estimates have been made that run as high as 300,000 acre feet, but I think that's entirely too high.

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MR. CORLETT: One was as high as 600,000 acre feet.

MR. TIPTON: That's an impossibility; that could not be returned.

MR. HINDERLIDER: Mr. Chairman, I apprehend from the nature of the questions propounded by Major Burges to Mr. Tipton he was somewhat confused as to certain phases of this problem that we have propounded, and the probability of solving that problem so there will not be injury to the lower basin states, particularly with respect to the drainage recovered and the depletion of the flow across the state line, and the amount of flow, and I would like at this time for Mr. Tipton to elaborate further on his remarks and possibly clarify Colorado's position with respect to these particular matters.

MR. TIPTON: The point I would like to clear up was the apparent assumption that by this development the return to the river from the Rio Grande proper area would be limited to the 100,000 acre feet of return flow that it was assumed would reach the river. Under present conditions, for a period such as 1890 to 1934, we estimate there would be contributed to the river at Alamosa a mean annual amount of 230,000 acre feet of water, varying between wide limits many years and practically none some years, but the average being 230,000 acre feet. Under the plan that was described yesterday, and assuming that the 100,000 acre feet of return flow would return to the river, the mean annual flow at Alamosa, plus the return from the sump drain, for a period such as 1890 to 1934, the estimate would be 215,000 acre feet. That will be found in the report that was handed over this morning. The 215,000 acre feet would be more usable, both by the Middle Rio Grande Conservancy District and by the Elephant Butte Reservoir than the 230,000 acre feet because the flow in the very low years would be higher than it is at present, which during years of non-spill in the Elephant Butte would tend to build the contents up. The same effect would be felt by the Middle Rio Grande District in that the water supply of that district would be improved. The 15,000 acre feet of apparent additional depletion would largely be cut off of the high years and in effect reduce the spill that would occur at the Elephant Butte Reservoir. As I explained yesterday and this morning, the whole set-up was based upon the delivery of the 100,000 acre feet of return flow which, to my mind, was a conservative figure, and which, to my mind, could be done, and the potentialities, so far as the return flow is concerned, particularly if the acreage in the San Luis Valley remained as it is, more or less, at present, would be much greater than 100,000 acre feet, and the ultimate recovery might be more than that.

MR. HINDERLIDER: This morning you stated that there would be undoubtedly some re-use of water resulting from the building of drainage systems that would drain into the sump area. That was discussed this morning. Now, would there be any depletion whatsoever of the water accumulated by the proposed sump drain before it crossed the state line?

MR. TIPTON: No, there could be no re-use of the water from the sump drain itself, and of course, the 50,000 acre feet I assume to be recoverable from the sump drain, I had in mind the re-use would have been made - whatever was to be made - that would have been the residue and there was no possibility of the State of Colorado re-using that. The lands along the sump drain have never been irrigated and never will be irrigated because there isn't sufficient water for them and it's a poor grade of land, and there are no diversions from the main stem in Colorado below the point where the sump drain would reach the river.

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MR. CORLETT: Now, Mr. Tipton, as I understand you, there would be 50,000 acre feet recovered from the sump drain; that's right, isn't it?

A. I used that as a minimum figure.

MR. CORLETT: I am just trying to build up the picture; and 50,000 acre feet increased return?

A. That really isn't an assumption; that really happens now under diversions equal to 600,000 acre feet or more.

MR. CORLETT: Then you compute the spill to an amount of how much more? In other words, how do you compute this 215,000 acre feet?

A. 30,000 to 40,000 acre feet of non-storable winter flow; 100,000 acre feet of return flow. That's in addition to this winter flow which naturally occurs below the reservoir, and the balance would represent the mean annual spill; that would be about 100,000 acre feet of mean annual spill. The only assumption in this whole study, - as I mentioned before, it can all be gotten by critical analysis of the report, - is the assumption on the basis of the return flow if the diversions are limited to 600,000 acre feet, and the return flow 100,000 acre feet for a period such as 1890 to 1934, the performance would be exactly as set forth in the report. This winter non-storable flow is determined from actual records. The spill is an amount which we determined by actual records and computation, taking into consideration the 600,000 acre feet. The effect on the Elephant Butte and the Middle Rio Grande Conservancy District is worked out on a monthly basis and is purely a matter of calculation; the only assumption in the whole set-up being that the diversions shall be 600,000 acre feet, that there will be a return flow of 100,000 acre feet.

MR. CORLETT: Then the only assumption here is the amount of return from the sump drain.

A. That's practically the only assumption.

MR. HINDERLIDER: That, together with the accumulation of water below Alamosa from other sources would make the flow across the state line how much?

A. Instead of an average of 470,000 acre feet for a long period of years such as 1890 to 1934, it would average 455,000 acre feet.

MR. HINDERLIDER: 15,000 acre feet less?

A. But it would be more usable by the lower basin than the 470,000 acre feet, and that can be determined by a study of the details.

MR. McCLURE: Would storage on the Conejos have any effect on that?

A. The Conejos is a little bit more difficult to work out on account of lack of records of diversions, etc., but due to the fact that the consumption on the Conejos per acre is so large, it is my personal opinion, and so far as I am concerned, I would be willing to recommend that to the Conejos water users, and have done so, if they could control their supply by storage so they could make the proper application of water, the outflow from the Conejos Basin

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would not be depleted, and it's conceivable to me it might be more than it is now.

MR. McCLURE: That's based on the 80,000 or 90,000 acres there, or increased development?

A. The 80,000 or 90,000 acres that are there now; I don't say this consumption is a result of irrigation, but there is being consumed probably more than 2.7 acre feet per acre of land actually irrigated, if you charge all the consumption to the irrigated area. You have several channels running through the Conejos area, the loss from which is material during flood periods. The water spreads out considerably, which, of course, increases the natural loss. By means of reservoirs, of course, some of these floods would be ironed out, the natural loss would be decreased, and, as I said before, there is no question in my mind but what the loss from irrigated areas would be materially decreased under the present set-up. I am in a rather peculiar position here; I am making statements to the Commission that haven't been considered at all by the water users of Colorado, so I want you to realize that I am giving my opinion, as an engineer, to you before giving it to my own water users - without their first having an opinion on some of these matters.

MR. McCLURE: I have a proposition I would like to place before the Commissioners for their action; something might come from it - I don't know, we might get together on it. The proposition I have is that the Commissioners go into executive session and see what they can iron out in regard to the proposition that's been placed before us by Mr. Tipton yesterday and today.

MR. HINDERLIDER: I take it that that would carry with it the legal advisers and other advisers?

MR. McCLURE: I believe not.

MR. HINDERLIDER: If it is based upon the presentation of the picture by Mr. Tipton, I probably would not be able to answer as to figures, not having these figures in mind as he has. I will say at this time, Mr. Chairman, that in connection with what Mr. Tipton has already said, that this report that he has made was handed to me at the time I was leaving Denver and since I arrived in Santa Fe, so I have had no chance myself to study it, and the same thing applies to the water users of the San Luis Valley.

MR. HARPER: I think Mr. McClure's suggestion a very good one and since the principal object to be attained is to crystallize our ideas, it would seem to me that we should limit the meeting perhaps to one adviser for each commissioner subject to the privilege of calling in any of the other advisers from time to time as you want to develop particular information. Is that your idea, Mr. McClure?

MAJOR BURGES: I am inclined to think if we go into executive session, it should be solely the Commissioners. If they decide they need either legal or engineering advisers, they could do that. Otherwise, the preliminary discussion should be among the Commissioners alone.

MR. HINDERLIDER: That's agreeable to Colorado.

MR. HARPER: If that is the sense of the Commission, we will so proceed, and this meeting will stand adjourned subject to the call of the Chairman. We will proceed to executive session.

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JANUARY 30, 1935

2:45 P.M.

MR. HARPER: The meeting will now come to order. Yesterday at the close of the public meeting, the Commissioners went into Executive Session and carried on a discussion for several hours, and I think have reached an agreement. This public meeting is again called at this time to give each of the Commissioners an opportunity to summarize the position of his state for the record, and to make known to those who did not attend the executive session the action which has been taken. I will at this time call on Major Burges to briefly summarize the position of Texas.

MAJOR BURGES: Mr. Chairman and Gentlemen of the Commission and All Interested Parties: We have listened with interest to the views that have been presented to us and have made a partial study of the records that have been submitted. I stated when we first assembled that I was retiring in the very near future as Commissioner on behalf of the State of Texas, or rather, as counsel for the State of Texas, because, strictly speaking, no commissioner has been appointed since Senator McGregor resigned. However, it seemed to be agreeable to the Governor that I should attend this meeting and confer with the representatives of the other two states. I believe I stated that I had assumed certain other official duties in connection with certain work on the International Boundary Commission which would disqualify me for future service as Commissioner under the terms of our state constitution, and I have reason to believe that the Governor of Texas will, at a very early date, appoint a successor to myself on this Commission. I feel, as I believe all of the members of the Commission do, that it is a matter of so much importance to all three of these states that any proposition advanced by one of them should receive the earnest and respectful consideration of all of them, and that everyone should strive in the end for a just and fair settlement of our difficulties. Much interesting matter has been presented on the part of the State of Colorado and we have not had time - at least, I have not, and I believe the Commissioner from New Mexico would probably agree - we have not had time yet to thoroughly examine and digest it, and in connection with that my very early severance of any connection officially with the matter, makes it expedient that my successor, who will represent Texas in future deliberations, should have the opportunity to thoroughly analyze and study what has been said on behalf of the State of Colorado. I sincerely hope that the three states will be able to solve their problem in justice and fairness to all of them, and preserve the cordial good will which is so much to be desired between the States and all residents of the Rio Grande Valley. All I can suggest at this time is, Mr. Chairman, that if it is agreeable to the other two states to continue for the next two years in the effort to reach a complete and equitable adjustment of the differences between them over the use of the waters of the Rio Grande, that I have reason to believe that the State of Texas will cooperate with the two sister states to that end. I have communicated to the Governor of Texas my views on the matter, and hope, during the day, to have a definite and authoritative statement from him. If it should meet the views of the other two states to continue the existing compact for a period of two years from the date of its present expiration in order that the completed work, or what we hope will be the completed work of the Commission can be laid before their legislatures at the next regular biennial session. I have reason to expect and I believe that the Governor of

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the State of Texas will, during the course of the afternoon, authorize me to act in conjunction with the representatives of the other states to that end.

MR. HARPER: Thank you. Mr. McClure, will you state the views of New Mexico?

MR. McCLURE: I think New Mexico takes Major Burges' statement as being what we would like to do and what is necessary. I have gone hurriedly through that report but would like to spend a great deal more time on it, and I think that that is the only course at the present time that we could take. New Mexico is in accord with extending the Compact until June 1, 1937.

MR. HARPER: Mr. Hinderlider, are you prepared to state the views of Colorado?

MR. HINDERLIDER: Mr. Chairman and Members of the Commission and the Conference: For the reasons already assigned by the Commissioners for Texas and New Mexico, Colorado concurs in the suggestions that the Commissioners recommend to their respective Governors, and they, in turn, to the legislatures, the extension of the life of the present compact to June 1, 1937. It is suggested by Colorado that in the meantime diligent effort be directed by the Commissioners and their engineering advisers in connection with the Bureau of Reclamation in the analysis and digestion of the data available to the Commission for the purpose of reaching an equitable allocation of the waters of the Rio Grande. For the purpose of expediting such studies, I suggest that this conference be recessed until March 18, 1935, or subject to the call of the Chairman, for the consideration of a further detailed presentation by Colorado of any plan it has to propose looking to this end. I therefore, Mr. Chairman, put that suggestion in the form of a motion.

MR. HARPER: Do you include the two things in that motion?

MR. HINDERLIDER: I think they should have formal action separately, so I am advised by Mr. Howell. I, therefore, move, Mr. Chairman, that the members of this Commission recommend to the Governors of their respective states the extension of the life of the present Rio Grande Compact to June 1, 1937. (Seconded by Mr. McClure and unanimously carried.) I further move, Mr. Chairman, that this conference of the Commission be recessed, with the understanding that it will convene in the City of Santa Fe, New Mexico, March 18, 1935, or at the call of the Chairman, for the consideration of plans to be further submitted by the State of Colorado for the equitable division of the waters of the Rio Grande. Anticipating and hoping that in the meantime the Commissioners for Texas and New Mexico will have made a careful study and analysis of the plan presented by Colorado at this conference. (Seconded by Mr. McClure and unanimously carried.)

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ff. 1 Proceedings of the Rio Grande Compact Conference held at Santa Fe, New Mexico. 1934-1935.

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REPORT ON
Investigation of Invisible Gains and losses in the channel of the
RIO GRANDE
from Elephant Butte to El Paso .

Feb.1936

John H. Bliss

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Report on Investigation of Invisible Gains and Losses in the Channel of the Rio Grande from Elephant Butte to El Paso, Texas, February, 1936.

Santa Fe, New Mexico,
February 15, 1936.

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

Dear Mr. McClure:

The determination of invisible gains and losses in the bed of the Rio Grande is an important item in the study of the use and distribution of the waters of the river. Several such determinations have been made in the upper reaches of the river but few such data are available below Elephant Butte Reservoir.

Measurements were made in 1917 and 1918 by the Reclamation Service but the data were obtained prior to drainage construction and are not applicable to present day conditions. In 1928 a preliminary seepage determination was made between Elephant Butte Dam and Leasburg Dam by E. L. Barrows for the State Engineer's office, a report of which will be found in the Ninth Biennial Report of that office. It was intended at the time that this work would be followed shortly by a more accurate and thorough series of measurements. Nothing was done, however, until the fall of 1935 at which time L. R. Fleck, Superintendent of the Elephant Butte Project suggested the advisability of making such a study before the impending construction of the Caballo Dam should

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finally prevent such work in the canyon above Percha Dam. It was decided to delay the work until a period immediately prior to the release of water for the 1936 irrigation season to allow ground water and bank storage to reach a minimum.

The work was undertaken by the State Engineer's office in cooperation with the Geological Survey and the Bureau of Reclamation. Acknowledgments are also made to the International Boundary Commission for data on discharge of the river at their El Paso station. About 2 weeks before measurements were started the Bureau installed 2 temporary recording gages at Percha and Leasburg diversion dams. Regular stations are maintained at these two places during the irrigation season but which become inoperative when the sluice gates are opened in the fall. The operation station at Mesilla Dam was also put into condition during the investigation.

The procedure outlined was to make two complete series of measurements, the first party to start at Elephant Butte Dam on January 26th and the second party to follow the first party one day later. Engineers of the Bureau of Reclamation who were familiar with the project acted as guides to both parties throughout the work. River stations were selected at frequent intervals to localize channel gains and losses in order to determine their probable sources or causes. No diversions were being made in any of the canals during the period of the investigation. To speed the work, all drain flows were measured but once, which was felt to be sufficient as these discharges vary but slightly. The discharge through Elephant Butte Dam had been held quite steady for several weeks, practically the only variation in discharge being a change of not over 2 feet due to operation of pumps supplying the town of Elephant Butte with water. The effect of this operation, which usually lasted but a few hours per day, was

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not noticed very far downstream as the flow soon smoothed in the broad pools below the dam.

On the night of January 28th a general rain occurred throughout the area. It was rather heavy in the Rincon Valley but below Las Cruces was a slow rain which, it was felt, affected the river discharge but slightly. A drizzle continued throughout the day until late afternoon when a hard downpour occurred. It is impossible to say to what extent the rain affected the measurements but, as they were completed to El Paso before the heavy rain on the afternoon of the 29th, and as the two series of measurements correlated so closely, it is doubtful that the rain affected the results appreciably.

The original plan contemplated the continuation of the work to the end of the irrigated area at the canyon section below Fort Quitman, Texas. The rectification of the river channel by the International Boundary Commission, now in progress, has so changed channel conditions that any results obtained at the present time would be of little value. Because of this fact and also due to international complications, it was decided to stop the work at the Courchesne river station at El Paso.

Because of possible inaccuracies due to the rain and also on account of a small rise in the stream in the canyon below Elephant Butte Dam, encountered by the first party, it was decided to make a remeasurement of the entire river to El Paso. The third series was started on February 1st and ended at Leasburg Dam on the night of the 2nd. The last couple of measurements that evening presumably caught up with the higher water in the river and attempts were made to remeasure these the following day. A continuous high wind, however, caused considerable variation in the discharge and precluded any reliable additional

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measurements.

Mr. Cunningham, engineer at Leasburg Dam, made a couple of determinations in the river section between the dam and Leasburg Canal spillway No. 1, to check seepage in that reach where it was thought some increase would occur due to springs.

Photostatic copies of the river stage charts at the five stations, Elephant Butte, Percha, Leasburg, Mesilla and Courchesne, together with discharge measurements made by their hydrographers, were furnished by the Bureau of Reclamation, who also furnished an accurate river mileage table from which the station mileages have been derived.

The results of the three series have been tabulated in Table I and a summation made under a column titled "Average (computed)." The discharges in this latter column were determined by comparison of the three series, those apparently in error being discarded. A few measurements were corrected for change in river stage due to rain. All discharges over 100 second feet were corrected to the nearest 3 significant figures. The chart, Fig. 1, shows graphically the results obtained. The lower of the two lines represents invisible gains and losses in the various sections.

By comparison of average channel conditions with measured section velocities, it was estimated that the river averaged 0.27 mile per hour between Elephant Butte and Percha Dam and 0.70 mile per hour between Percha and Leasburg, or, in other words, that the water measured at Leasburg was released from Elephant Butte about 7 days previous, or about January 21st.

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TABLE I

MEASUREMENT	Miles below Dam	First Series Date & Hr.	First Series Dis.	Second Series Date & Hr.	Second Series Dis.	Third Series Date & Hr.	Third Series Dis.	Average (computed)* Dis.	Gain	Loss	REMARKS
											2/1 pumping, 12.3=Av. daily
R.G.-Elephant Butte Dam	0.0	1/26 7:50 A	12.1	1/27 8:00 A	11.5	2/1 4:30 P	13.3	11.1			dis. 1/26 & 1/27
R.G.-Mescal Canyon	2.0	" 8:50 A	11.9	" 9:15 A	12.0	" 5:35 P	11.7	10.7			0.3 (Progressive correction of
R.G.-above Hot Springs	5.7	" 10:10A	20.5	" 10:15A	17.1	2/2 7:40 A	21.1	18.5	7.8		(0.1 feet per day made in
-Springs Sewer, etc.											(first 12 measurements be-
Est.	7.0	" 10:40A	2.2	" -	-	-	-	2.2			(low Dam: i.e., 1.2 decrease
Sub-total								20.7			(at Dam and 0.0 change at
R.G.-below Hot Springs	9.9	" 11:30A	24.2	" 11:00A	25.1	" 8:25A	25.3	23.9	3.2		(Selden Can.)
R.G.-above Palomas Ck.	15.3	" 12:20P	26.1	" 11:45A	27.2	" -	-	25.7	1.8		
R.G.-below Palomas Ck.	16.4	" 1:30P	31.8	" 12:45P	30.8	" 9:15A	31.6	30.3	4.6		
R.G.-Caballo P. O.	24.4	" 2:30P	39.3	" 2:15P	36.0	" 10:20A	37.4	36.0	5.7		(A rise of
R.G.-Caballo Damsite	29.0	" 3:40P	43.4	" 3:00P	41.3	-	-	40.8	4.8		(about 3 ft.
R.G.-Percha Dam	31.3	" 4:30P	48.5	" 4:15P	44.8	" 11:30A	44.2	44.0	3.2		(occurred Jan. 26th.)
R.G.-Garfield Flume	36.5	" 5:30P	51.4	" 5:00P	48.8	-	-	48.4	4.4		(Passing rise on 26th)
R.G.-below County Line	42.4	1/27 9:30A	54.0	1/28 9:50A	54.6	" 12.40P	53.8	53.8	5.4		(A.M. 4.67)
R.G.-Hiway Bridge-Hatch	51.1	" 10:45A	46.0	" 10:50A	43.4	2:10P	46.5	46.2			7.6 (Av. of last 3)(2/3-9:40)
Garfield Drain	51.6	" 11:20A	9.7	-	-	1:30P	9.0	9.7			9.0 Jan. 30 - U.S.B.R.
Sub-total								55.9			
R.G.-above Hatch Dr.											
Outlet	56.9	" 1:15P	54.2	" 12:40P	55.1	-	-	54.5			1.4
Hatch Drain	57.0	" 12:45P	6.4	-	-	2/3 10:30A	6.8	6.6			6.6 - Jan. 30 - U.S.B.R.
Angostura Drain	61.5	" 2:05P	1.1	-	-	-	-	1.0			0.8 - Jan. 30 - U.S.B.R.
Rincon Drain	67.6	" 3:20P	10.0	-	-	-	-	10.0			7.5 - Jan. 30 - U.S.B.R.
Sub-total								72.1			
R.G.-head Selden Canyon	69.0	" 4:25P	61.5	" 1:50P	60.8	2/2 3:40P	66.0	61.2		10.9	(2/2 & 2/3-high water) 2/3
R.G.-Leasburg Dam	75.9	" 5:40P	61.7	" 3:00P	61.0		-	61.4	0.2		(11:30 A.M. - 67.3
R.G.-Leasburg Spillway	78.4	1/28 8:45A	67.3	" 4:15P	62.0		-	62.0	0.6		(U.S.B.R.m's'm'ts. Feb. 6
											(& 7 give 0.4 gain)
Selden Drain	82.6	" 9:40A	1.0	-	-			1.0			1.2 Jan 30 - U.S.B.R.
Sub-total								63.0			
R.G.-below Picacho Flume	87.4	" 10:20A	59.5	" 5:20P	63.8	2/3 2:50P	61.7	60.2		2.8	(About .05 rise measured (on Jan. 28th.)

*First 12 measurements corrected for change of stage, Jan. 21 to Jan. 26.

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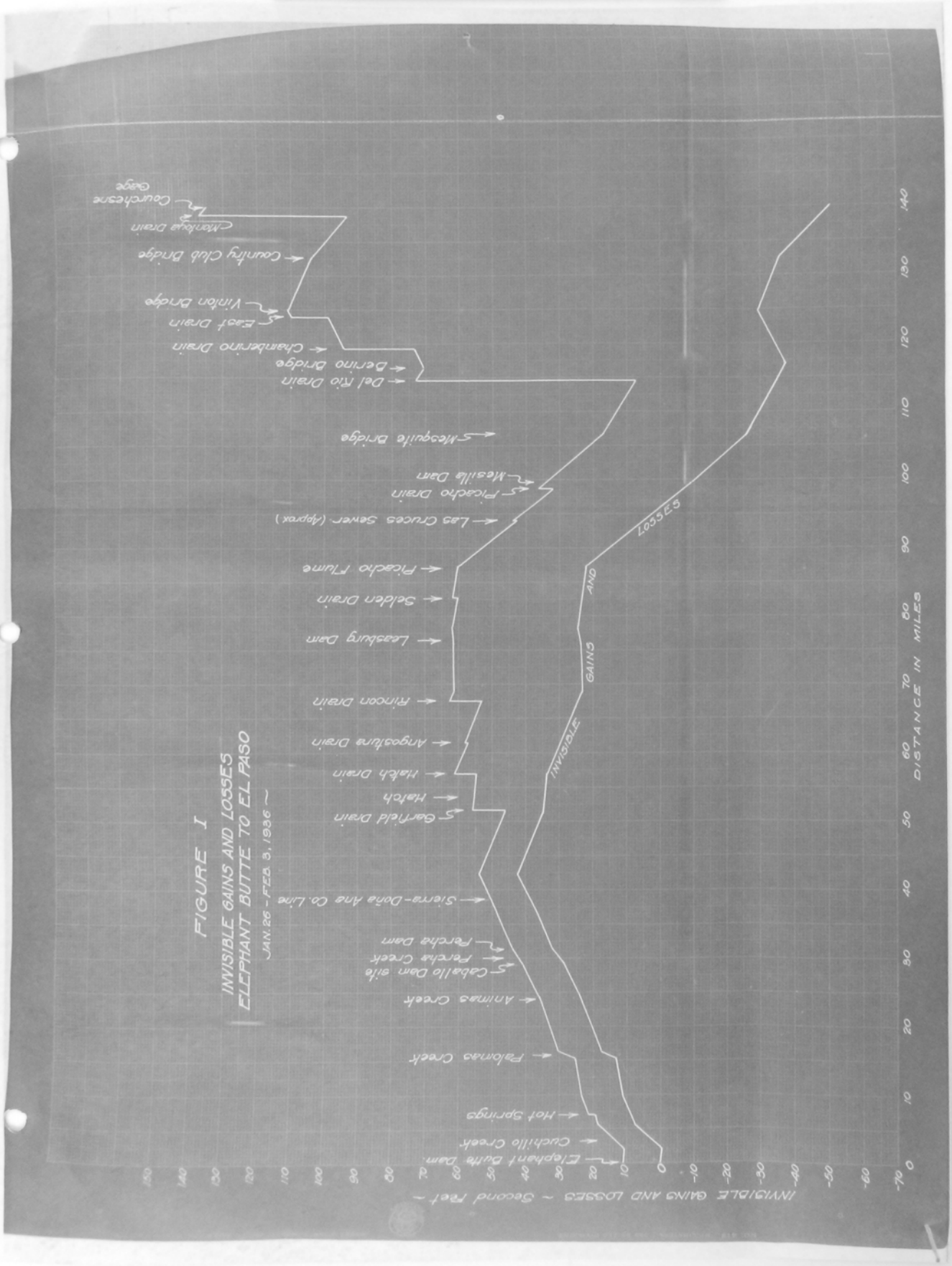

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The river below Elephant Butte was discharging about 11.1 second feet at that time as against 12.3 average discharge at the time of the investigation, a variation of 1.2 second feet due to a gradually increasing river stage below the dam. Although this variation is minor it was felt that its effect should be considered, and, accordingly, a progressive correction of 0.1 second foot has been made in the first 12 measuring sections. These corrections have been applied under the column "Average (computed)" in Table I.

Records obtained at Elephant Butte from the Weather Bureau land-pan indicate an average evaporation during the semi-cloudy period of the investigation was about 0.065 inch or 0.0054 foot per day. Records of previous years indicate that valley evaporation is approximately the same as that at Elephant Butte. Converting the average daily land-pan loss to water surface evaporation by the factor 66% and assuming the average effective water surface as 180 feet wide, the average daily loss per mile is 0.08 acre foot or 0.04 second foot.

This evaporation correction rate has been applied to the gains and losses in Table II. From these corrected gains and losses and the distance between the river stations the average seepages per mile have been computed.

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TABLE II

River Section	Station: Miles	Average Gain	Average Loss	Evaporation Corrections	Corrected Gain	Corrected Loss	Change Per Mile	
Elephant Butte Dam	0.0							
Mescal Canyon	2.0		0.3	0.1		0.2	-0.10	
Above Hot Springs	5.7	7.8		0.1	7.9		+2.14	
Below Hot Springs	9.9	3.2		0.2	3.4		+0.81	
Above Palomas Creek	15.5	1.8		0.2	2.0		+0.37	
Below Palomas Creek	16.4	4.6		0.0	4.6		+4.18	+1.00
Caballo Post Office	24.4	5.7		0.3	6.0		+0.75	
Caballo Damsite	29.0	4.8		0.2	5.0		+1.09	
Percha Dam	31.3	3.2		0.1	3.3		+1.43	
Garfield Flume	36.5	4.4		0.2	4.6		+0.88	
Below County Line	42.4	5.4		0.2	5.6		+0.95	
Hiway Bridge-Hatch	51.1		7.6	0.3		7.3	-0.84	
Above Hatch Drain	56.9		1.4	0.2		1.2	-0.21	-0.71
Selden Canyon	69.0		10.9	0.4		10.5	-0.87	
Leasburg Dam	75.9	0.2		0.4	0.6		+0.09	
Leasburg Spillway	78.4	0.6		0.1	0.7		+0.28	+0.14
Picacho Flume	87.4		2.8	0.4		2.4	-0.27	
Mesilla Dam	99.7		32.1	0.5		31.6	-2.57	
Mesquite Bridge	106.5		16.4	0.3		16.1	-2.37	-1.22
Berino Bridge	115.9		12.2	0.4		11.8	-1.26	
Vinton Bridge	124.9	8.0		0.3	8.3		+ .92	
Country Club Bridge	132.7		7.0	0.3		6.7	-0.86	
Courchesne	140.0		15.0	0.3		14.7	-2.01	

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The average seepage changes were as follows: (1) Canyon section below Elephant Butte, gain of 1.00 foot per mile; (2) Rincon Valley, loss of 0.71 foot per mile; (3) Selden Canyon, gain of 0.14 foot per mile; and (4) Mesilla Valley, loss of 1.22 feet per mile.

An analysis of the results shows, in general, the probable sources or causes of the gains and losses. A consistent increase in the canyon from the Dam to the Dona Ana-Sierra County line seems chargeable chiefly to underflow from the large intermittent streams entering from the west. A comparison of past records of inflow and outflow at the reservoir indicates some loss therefrom which cannot be accounted for by evaporation. It was thought that at least part of this loss would reappear in the river below, but this did not seem to be the case. In the first 6 miles the total gain, which includes the underflow of Cuchillo Creek, was but 7.5 second feet, making the increase chargeable to the reservoir almost negligible.

The water lost in the Rincon Valley feeds the ground water of the surrounding lands and is recovered largely by the drains. A small increase in Selden Canyon came chiefly from several short arroyos and from seeps in the vicinity of Radium Springs. In the Mesilla Valley the river channel loses a large amount of water, particularly in the section between Picacho Flume and Mesquite, through which the large Del Rio Drain parallels the river at a short distance. An increase was found in the section above Vinton bridge where the river enters a canalized section. This gain is possibly due to underflow in the old river channels on the west side of the valley entering the present channel above the bridge. It may also be that the cut, which traverses an apparently undisturbed deposit of caliche and heavy clay, is effective in bringing a con-

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siderable underflow to the surface in this section.

To determine the cause of some of the large channel losses, particularly in the Mesilla Valley, Table III was prepared, which shows the approximate pickup per mile in the various drains. Those drains which were chiefly "interior" gathered seepage at a rate of about 0.6 second foot per mile. A comparison of this rate with the 1.0 second foot unit increase in the Del Rio indicates that much of the flow of that drain is drawn directly from the river channel through underflow. This condition applies to a less extent to the Montoya Drain, and also to the Chamberino which drains the old river channels on the west side of the valley below Las Cruces.

TABLE III

Drain	Approximate Length-Miles	Discharge	Increase Per Mile	Drain	Approximate Length-Miles	Discharge	Increase Per Mile
Garfield	12.5	9.7	0.78	Picacho	7.4	5.1	0.69
Hatch	9.8	6.6	.67	Del Rio	65.2	65.4	1.00
Angostura	2.8	1.0	.36	Chamberino	22.7	21.0	.92
Rincon	13.5	10.0	.74	East	31.6	11.0	.35
Selden	4.5	1.0	.22	Montoya	58.1	44.4	.76

Figure II was prepared, which gives the comparison of various seepage determinations on the Rio Grande between Elephant Butte and El Paso. The October, 1913, measurements were made before any Reclamation development had been made and the results are not good. On page 686 of Water Supply Paper 358 the following statement appears: "It was found extremely difficult to draw conclusions from observations below Elephant Butte, and in view of the fact that the Elephant Butte dam will soon control the flow to the New Mexico-

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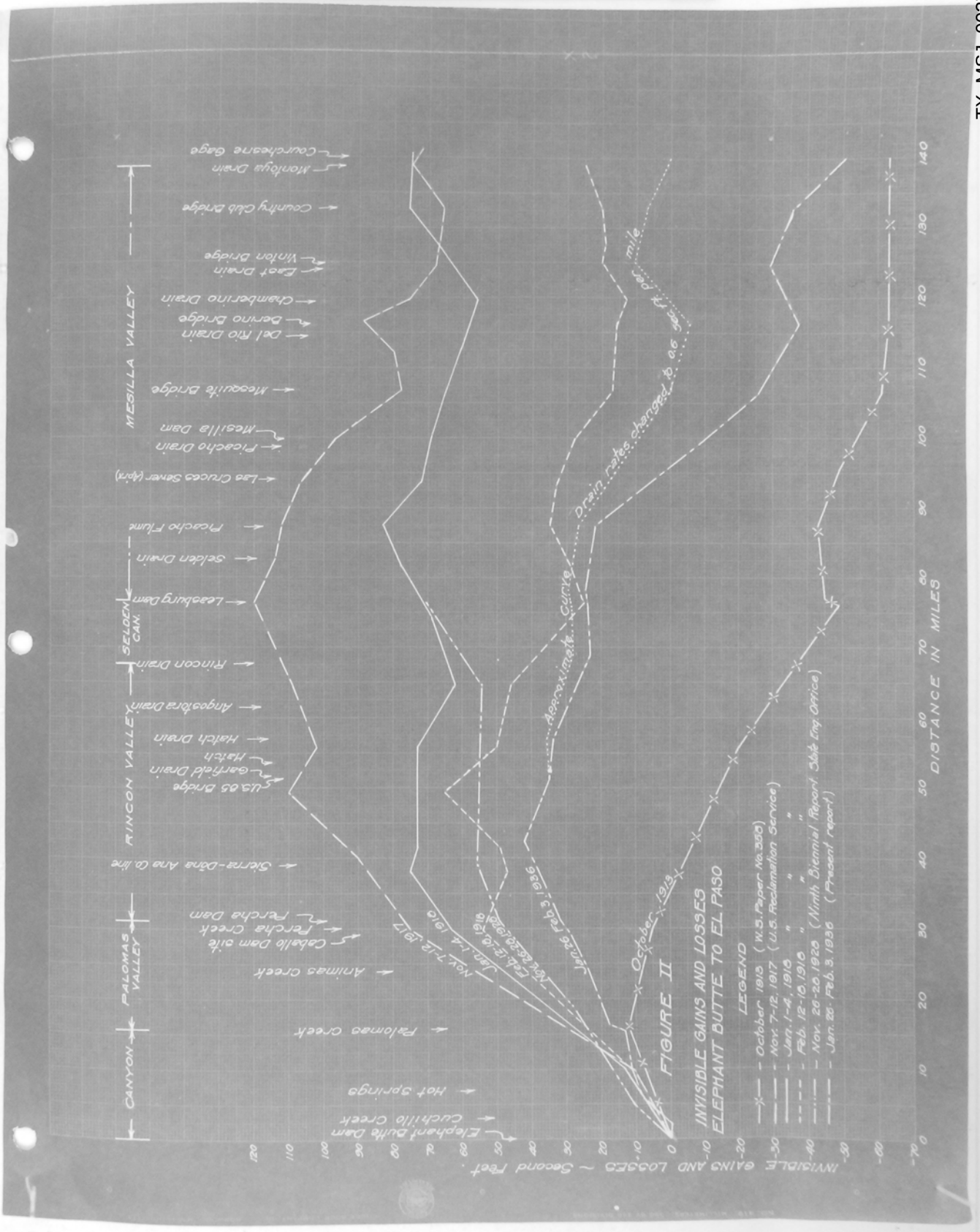

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Texas State line, more attention was given to that part of the stream above this point."

The three series in 1917 and 1918 were made by the Reclamation Service a year or so after the first use of the reservoir and before any drain construction in the valley. Although they do not agree well with the present work or even among themselves, they do show markedly the effect of irrigation on return flow. The November 7-12 series was begun one week after the gates at Elephant Butte were closed, at which time the seepage return was large. The curve exhibits the following properties: a large increase down to the Hatch bridge; practically no loss in the Rincon Valley; and a large loss in the Mesilla Valley as far down as Mesquite, after which the curve breaks upward and shows very little additional loss to El Paso. The January 1-4 series was started two weeks after the gates had been closed following a month's run in November and December. The curve shows considerably less return flow than did the November series. There was a consistent increase as far downstream as the Dona Ana-Sierra County line, below which the gains and losses largely compensated. The February 12-18 run was made six weeks following the January series, no water having been run from the dam in the meanwhile. It shows considerably less seepage increase than the other two, due to the lowering of the ground-water table, and, of the three, approaches most closely the results found in the present study.

The November 26-28 series made in 1928 was only completed to Leasburg Dam. It was started 5 days after a short release of water had been made from the reservoir. The curve lies between the January and February 1918 curves but varies from each.

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In order to make a better comparison of 1917-18 and present-day conditions, a second curve of the 1936 study was made by applying a pickup rate of 0.6 second foot per mile to all drains instead of using the measured discharges. This was done to reduce all drain returns to "interior" drain conditions. The curve has been plotted in Figure II and brings the various gains and losses much closer to the February 1918 seepage conditions. This curve is experimental and is not advanced as being accurate, at all.

It is impossible to account for the eccentricities of the curves prior to the present one, as little is known of the conditions of flow, irrigation, etc., at the time the measurements were made. They do show, however, that there is a direct relation of seepage to ground water and irrigation. It would be extremely interesting and instructive to compare seepage during the non-irrigation period against gains and losses found during the summer at a period when river and canal flows can be kept in a stable condition. It is hoped that such a determination may be made during the coming season.

Attached to this report is an Appendix which includes the following: (1) blue-line prints of the Elephant Butte project showing river and tributary streams (green), drains (red), diversion canals and laterals (blue), and roads (yellow), with all points of measurement, wasteways, diversions, drain returns, etc., marked in orange; (2) photostatic copies of gage-height charts at regular and temporary gaging stations; (3) discharge measurements and daily discharges at these stations; (4) a tabulation showing daily evaporation at Elephant Butte during the latter part of January. Note: (1) & (2) appear only in first copies.

Respectfully submitted
John H. Bliss
Engineer

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APPENDIX

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DISCHARGE MEASUREMENTS OF RIO GRANDE GAGING STATIONS
DURING PERIOD OF SEEPAGE INVESTIGATION, 1936.

	Date	Time	G.H.	Dis.	Hydrographer
Elephant Butte	1-26	7:50 A.M.	0.64	12.1	T. E. Yates
" "	1-27	8:00 A.M.	0.65	11.5	H. G. Neel
" "	1-29	9:00 A.M.	0.64	12.1	Geo. Shannon
" "	2-1	4:30 P.M.	0.65	13.3	T. E. Yates
" "	2-4	4:30 P.M.	0.66	15.6	Geo. Shannon
Percha Dam	1-25	5:30 P.M.	0.98	43.6	Jack Morris
" "	1-26	4:00 P.M.	1.00	48.5	T. E. Yates
" "	1-27	4:00 P.M.	0.98	44.8	H. G. Neel
" "	1-29	4:00 P.M.	0.99	46.6	Jack Morris
" "	2-1	8:10 A.M.	1.00	48.7	" "
" "	2-2	11:30 A.M.	0.98	44.2	T. E. Yates
" "	2-5	9:15 A.M.	0.98	42.7	Jack Morris
Leasburg Dam	1-27	8:00 A.M.	1.08	57.0	M. Cunningham
" "	1-27	5:40 P.M.	1.08	61.7	T. E. Yates
" "	1-28	3:00 P.M.	1.08	61.0	H. G. Neel
" "	1-28	4:30 P.M.	1.08	59.0	M. Cunningham
" "	1-29	8:00 A.M.	1.22	78.5	" "
" "	1-31	8:10 A.M.	1.20	77.6	" "
" "	2-1	8:00 A.M.	1.15	65.9	" "
" "	2-3	9:15 A.M.	1.08	56.2	" "
" "	2-4	8:00 A.M.	1.04	53.2	" "
" "	2-5	8:10 A.M.	1.03	51.4	" "
" "	2-6	1:00 P.M.	1.01	48.5	" "
" "	2-7	8:00 A.M.	1.03	50.1	" "
" "	2-7	2:30 P.M.	1.03	50.4	Resch-Cunningham
Below Leasburg Spillway	2-6	5:30 P.M.	-	47.3	M. Cunningham
" " "	2-7	10:30 A.M.	-	50.9	Resch-Cunningham
Mesilla Dam	1-26	8:00 A.M.	2.65	42.9	P. Treviz
" "	1-27	8:00 A.M.	2.65	45.8	" "
" "	1-28	7:40 A.M.	2.65	45.1	" "
" "	1-28	2:20 P.M.	2.65	54.0	T. E. Yates
" "	1-29	8:00 A.M.	2.71	42.4	P. Treviz
" "	1-29	10:30 A.M.	2.72	46.8	H. G. Neel
" "	1-30	7:40 A.M.	2.83	70.1	P. Treviz
" "	1-31	7:50 A.M.	2.86	81.4	" "
" "	2-1	8:00 A.M.	2.82	63.1	" "
" "	2-2	8:00 A.M.	2.85	42.0	" "

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(Discharge Measurements - Continued)

	Date	Time	G.H.	Dis.	Hydrographer
Mesilla Dam					
" "	2-3	8:00 A.M.	2.78	40.0	P. Treviz
" "	2-4	8:00 A.M.	2.77	34.9	" "
" "	2-5	8:00 A.M.	2.77	34.1	" "
" "	2-6	8:00 A.M.	2.76	34.0	" "
Courchesne (El Paso)	1-20	11:15 A.M.	1.14	125.	W. Bidwell
" " "	1-27	2:10 P.M.	1.16	134.	Joe Friedkin
" " "	1-29	2:40 P.M.	1.17	140.	T. E. Yates
" " "	1-31	8:40 A.M.	1.21	146.	W. Bidwell
" " "	2-3	2:10 P.M.	1.18	138.	" "
" " "	2-7	8:15 A.M.	1.14	125.	" "

Daily Discharges at Gaging Stations on Rio Grande

Elephant Butte -

Jan. 19	G.H.- 0.63	Dis.- 11.1	Jan. 25	0.64	11.7
20	.63	11.1	26	.65	12.3
21	.63	11.1	27	.65	12.3
22	.64	11.7	28	.66	12.9
23	.64	11.7	29	.66	12.9
24	.66	12.9	30	.66	12.9

Percha Dam -

Gage was not sensitive enough to record the river stages properly. No daily discharge estimates have been made.

Leasburg Dam -

Jan. 25	G.H.- 1.09	Dis.- 62.7	Jan. 30	1.27	95.7
26	1.09	62.7	31	1.19	79.3
27	1.08	61.3	Feb. 1	1.15	72.2
28	1.08	61.3	2	1.10	64.2
29	1.22	85.1	3	1.07	59.9

Mesilla Dam -

Jan. 27	G.H.- 2.65	Dis.- 34.0	Jan.30	2.85	81.5
28	2.65	34.0	31	2.84	78.4
29	2.72	46.9	Feb. 1	2.82	72.3

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Daily Discharges at Gaging Stations on Rio Grande (continued)

El Paso (Courchesne) -

Jan. 21	G.H. - 1.15	Dis. - 135.	Jan. 26	1.15	135.
22	1.15	135.	27	1.16	138.
23	1.15	135.	28	1.15	135.
24	1.15	135.	29	1.17	140.
25	1.15	135.	30	1.24	157.

Land Pan Evaporation - Elephant Butte

		Pan Reading	Rain	Evaporation (Ins.)
Jan. 23	Clear	4.213		
24	Clear	4.151		.062
25	Pt. cloudy	4.041		.110
26	" "	3.908		.133
27	Cloudy	3.807		.101
28	"	3.708		.099
29	"	3.842	0.19	.056
30	Pt. cloudy	3.978	.14	.004
31	Cloudy	3.944		.034

The January evaporation at Elephant Butte for 1934 and 1935 was 3.29 and 3.22 inches respectively as against 3.22 and 3.45 inches during the same periods at the State College.

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Folder 390 – Rio Grande Joint Investigation Purpose and Organization, 1935-1937.

Box 26

Frank Adams Collection

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390

REPORT OF RIO GRANDE BOARD OF REVIEW

WATER RESOURCES CENTER ARCHIVES
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA

1. A Situation Inimical to Public and Private Interests

The Board of Review appointed by the National Resources Committee to consider various projects and problems relating to the use and control of waters in the portion of the Rio Grande Basin above El Paso finds that a critical situation exists there which urgently demands immediate and constructive action.

(1) Relatively recent investments of the Reconstruction Finance Corporation in the bonds of the Middle Rio Grande Conservancy District help to jeopardize much earlier investments of Federal funds in the Elephant Butte Reservoir, built in accordance with the treaty of 1906 with Mexico. Federal investments should not be in conflict, one with another.

(2) Federal funds are being sought for new projects which would not only create additional "conflicts of Federal investments", but also would violate the Tri-State Compact, to which the United States, Colorado, New Mexico, and Texas are parties and which provides that further depletions of the waters of the Rio Grande shall not be made before June 1, 1937.

(3) The available water resources of the Rio Grande are fully appropriated. In proportion to their magnitude, new projects involving additional drafts upon these resources would damage the vested rights of thousands of citizens, and contribute to wastage of human effort. Life in the valley depends on water. Readjustments in its use, rather than new uses, are needed. Additions to the supply through trans-mountain diversion, if practicable, not overdrafts on the existing supply, should

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be promoted. It would be far better to do nothing than to destroy what now exists. To continue the uncoordinated "development" of the water resources of the valley could only intensify the existing conflict of interests, promote new discord, depress the standard of life in damaged areas, breed social insecurity and unrest, and perhaps preclude the adoption later of any effective and equitable plan for the conservation of water and the welfare of the region.

2. Recommendations Concerning Pending Applications for Rio Grande Projects.

The Board of Review recommends:

350,000 af

(1) Concerning N.E.C. 1329: That the application for the San Juan-Rio Chama Project submitted by the Bureau of Reclamation (total cost, $8,000,000; requested allotment, $1,000,000; approved by W.P.A. and filed with A.C.A.) be approved.

(2) Concerning N.E.C. 3609: That the allotment of $21,272 made to the Barr Bernardo Project (total cost and request, $47,272; approved by W.P.A., and by the Allotment Committee and the President for $21,272) be rescinded.

(3) Concerning N.E.C. 5163: That the application of the City of Albuquerque for $2,500,000 with which to increase the municipal water supply (approved by the Bureau of the Budget) be denied without prejudice for lack of data, indispensable to an affirmative decision.

(4) Concerning N.E.C. 3075: That favorable action upon the Taos Project submitted by the Bureau of Indian Affairs (total cost and amount requested, $245,000) be contingent on authoritative assurance that an adequate water right attaches to the Indian lands involved.

(5) That N.E.C. 3076, submitted by the Bureau of Indian Affairs (total cost, $1,712,000) be approved.

3. Considerations Underlying the Foregoing Recommendations

(1) N.E.C. 1329. The diversion of water from the Colorado Basin to the Rio Grande Basin for which this project provides is permissible under the Colorado River Compact and would not conflict with potential uses in the drainage area of the Colorado. It is reasonably certain that the proposed diversion would greatly facilitate a permanent compact between Colorado, New Mexico, and Texas with respect to the use of water from the Rio Grande. Indeed, it appears to be a dependable spearhead with which to attack this problem, which heretofore has withstood every assault. Water from outside is sorely needed in the Upper Rio Grande Basin to insure a reasonably good supply in years of subnormal precipitation and to increase in other years the volume available for carry-over storage. The project affords New Mexico one of the few opportunities possible to utilize its share of the water of the Colorado system under the Colorado River compact. It is understood that the diverted water would not be used on any land not now in cultivation. Partly because the water would be used only as a supplemental supply, the initial cost of development is believed to be well within economic limits.

(2) N.E.C. 3609. The Barr Bernardo Project would bring under irrigation mesa land for the cultivation of which there appears to be no justification. The cost of operation and maintenance would be so high, due to the necessity of pumping the water to the level of the

mesa, as to leave little or no margin of safety for the investment. The supply of water for which the project calls is deemed insufficient to support the intensive typeof farming without which the enterprise could not be self-liquidating. Destructive floods that may sweep from a side canyon over part of the area of the project constitute a serious hazard. The enterprise is in direct conflict with established uses and with the terms of the Tri-State Compact. All in all, it is undesirable and unsound.

(3) H.R.C. 5163. The object of this project is to add to the water supply of Albuquerque by storage of flood waters in mountains some seventy miles north of the city. It has not been proven by the applicants that an addition to the present supply is needed. The amount of water sought (27,000 acre feet) exceeds greatly the amount now required annually for municipal and domestic purposes or likely to be required, except, perhaps, in the relatively remote future. It is not known whether or not all or part of the supply would be used in fact for irrigation, whether the supply would be secured in exchange for existing rights or whether it would constitute an entirely new appropriation and use. If the project involves a new appropriation and use, as it appears to do, it is in conflict with existing rights in Rio Grande waters. Irrefutable evidence that the applicants would have a right to the water sought should be an indispensable prerequisite to favorable action on the application. In the absence of specific information on the points indicated, and on the engineering and financial aspects of the enterprise, Federal funds should not be allotted to the

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project.

(4) N.E.C. 3075. This irrigation project on Indian lands near Taos would involve an additional draft on Rio Grande waters of not less than 4,000 acre feet annually. In view of other rights and claims in the fully-appropriated waters of the river and in view also of the Tri-State Compact, it is the opinion of the Board of Review that Favorable action upon the project should not be taken except upon authoritative advice that water rights attach to the Indian lands involved, competent to sustain the proposed storage.

(No effort is made to express an opinion on the applicability of the principle involved in the case of Winters vs. the United States, 207 U.S. 564, where the decision permitted an expanding use of water on an Indian Reservation regardless of its relationship to earlier priorities in point of time. There appears to have been no judicial determination in the case of the Indian lands on the Rio Grande as to the right to create new storage.)

(5) N.E.C. 3076. The improvements contemplated by this project would not conflict with existing rights on the Rio Grande and they seem essential in connection with the irrigation of lands by the Indians.

4. Appraisal of Proposed Enterprises for which Applications are not Known to be Pending

(1) Conejos Project and Vega-Sylvestre Project. These two Colorado Projects may be considered together. Both involve the construction of dams for the storage of water to be used in irrigation. The proponents of both made applications to the Public Works Administration in 1933 for 100% grants. Both applications were rejected. It is understood unofficially that new applications for both are now being made or will be made immediately. It is therefore appropriate to comment on them in this report.

It is understood that the proposed Conejos reservoir on the Conejos River, a tributary of the Rio Grande, would have a storage capacity of some 99,000 acre feet and that it would cost approximately $1,600,000. The Vega-Sylvestre reservoir would have a capacity of 238,000 acre feet and would involve an expenditure of about $3,440,000. These large reservoirs, if constructed, will conflict with established uses to the extent that water stored in them is consumed in the production of crops. They would violate the terms of the Tri-State Compact. Except perhaps in years of abnormally high precipitation, they would conflict seriously with the interests, public and private, represented by the Rio Grande Reclamation Project by diminishing the volume of water available for storage in Elephant Butte Reservoir.

(2) The San Luis Valley Drainage Project. This project would provide a drain into the Rio Grande from a "closed basin" having no natural outlet for excess waters from neighboring mountains and adjoining irrigated lands. The drain would contribute to the Rio Grande a volume of water now estimated, on a maximum basis, at 40,000 acre feet annually.

It was contemplated under the provisions of the Tri-State Compact. The undertaking undoubtedly is feasible from an engineering standpoint.

The Mississippi Valley Committee recommended early in 1934 that this project, in behalf of which Colorado, with the support of New Mexico and Texas, had applied for a grant of $1,500,000, be not approved as a Federal undertaking under then existing policy, and the allotment of $900,000 later made by the Public Works Administration to the Bureau of Reclamation for construction of the drain was conditioned upon the assumption by an appropriate local agency of the costs of the requisite rights of way and of maintenance. This condition has not been met, and there appears to be little prospect that it will be met.

The Board of Review recommends that no further action be taken on this project until the exhaustive study of the entire drainage area of the Upper Rio Grande, recommended elsewhere herein, shall have disclosed the true relationships of the proposal to a final solution of the interstate and national questions involved.

(3) The State-Line Reservoir. This reservoir, the estimated cost of which is approximately $2,000,000 was proposed primarily to control and impound flood waters of the Rio Grande. It was contemplated under the provisions of the Tri-State Compact, and an application for its construction with funds of the Public Works Administration was made by Colorado, with the support of New Mexico and Texas. No allotment for the purpose was made.

If built, the State-Line Reservoir might bring about a serious conflict in water rights unless operated in conjunction with the Elephant Butte Reservoir. It would be shallow, and subject in consequence to relatively high loss of water by evaporation. Any holdover storage accordingly would be detrimental to other rights on the river. The development of power at the dam has been advocated, but all-year operation of a power plant there with stored water inevitably would conflict with other rights. The economic feasibility of any power development in connection with the enterprise is uncertain. Under all the circumstances, the Board of Review recommends, as in the case of the San Luis drainage project, that no further action be taken with respect to this project until the results of a study of the entire drainage area are in hand.

5. Safeguarding the Future.

The Board of Review urgently makes the following recommendations concerning future procedures and policies, to the end that conflicting interests in the drainage area may be composed and that the most efficient and equitable utilization of its waters, from the standpoint both of public and of private interest, may be promoted.

(1) A check on new proposals.- To minimize the possibility that ill-advised approval may inadvertently be given to new enterprises that would prove harmful to vested rights, both public and private, the Board of Review recommends that all appropriate representatives of Federal organizations in Colorado and New Mexico, as well as in Washington, be instructed 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 points of view.

Rapidity in handling requests for such opinions would be imperative. In order to act with the requisite speed, it may prove desirable to maintain in the area, for the short period of anticipated activity in promoting new projects, a representative of the National Resources Committee who would act as a contact agent. Furthermore, there should be available on call in Washington, a consultant from the panel of the National Resources Committee to review without delay each case as it arises.

(2) An opportunity and a challenge.- Whether the outlook through many years for life in the Upper Rio Grande drainage area is dark or bright depends fundamentally on the procedure followed in the immediate future with respect to its water problems. Two courses are open.

On the one hand, the water users of the region may be left to seek protection for their investments through court adjudication as victims of a competitive and cumulative over-appropriation of the limited water resources available. Judicial determination, too often based on distorted testimony and legal technicalities, would at best be relatively unsatisfactory to the community at large. Such adjudication of conflicting claims would require many years, due to the complex state, interstate, national, and international relationships involved, and would cost vast sums. Already the irrigation farmers, water users associations, local bankers, state authorities, and interested Federal agencies are apprehensive over the gloomy prospect. Greater and greater insecurity, unrest, and strife lie that way - the dark way.

On the other hand, it is possible to blaze a trail leading to collective security in the form of a permanent compact under which the rights and equities of the several states and their inhabitants in the life-giving waters of the valley would be firmly established through voluntary cooperation. The illuminating prospect of economic and social safety lies that way - the bright way.

Should the National Resources Committee elect to seize the opportunity and accept the challenge presented by the situation in the Upper Rio Grande Valley, the initial steps to be taken, in the opinion of the Board of Review, are the following:

(a) Basic information must be secured promptly, if a permanent compact is to be formulated before June 1, 1937, the date of expiration for the present temporary compact. Procurement of such information would involve an impartial inventory of present water rights and uses, the supply of water in the basin, the quantitative possibilities of increasing the supply through trans-mountain diversion, and the like - It is estimated that such an inventory would require about one year and cost $150,000.

(b) The investigation or inventory should be planned and directed cooperatively by the Rio Grande Compact Commission and the National Resources Committee. The Compact Commission, now inactive, is composed of one representative of Colorado, New Mexico, and Texas, respectively, and the assistant chief engineer of the Bureau of Reclamation, who was designated by the President as the representative of the United States and as chairman of the Commission.

(c) In the opinion of the Board of Review, it is absolutely essential to success that the three states shall participate largely

in the investigation, as suggested, and that they shall assume responsibility at the outset for an equitable part of the cost. It is therefore recommended that a Federal grant for the proposed investigation be made by or through the National Resources Committee, provided substantial contributions to the cost of the investigation are made by the three states.

(d) Finally, it is recommended that a conference be arranged at Santa Fe, or some other convenient place, between representatives of the National Resources Committee and the members of the Compact Commission, for discussion of the entire matter, submission of a provisional offer of Federal aid, and consideration of further proceduras. The time is ripe for constructive action.

Respectfully submitted,

N. J. S. Devries

W. W. McLaughlin

Harlan H. Barrows

Members, Board of Review

Folder 401 –Rio Grande Compact Commission Resolutions, 1935-1937.

Box 26

Frank Adams Collection

Water Resources Collections and Archives, University of California Riverside

Adams 401

WATER RESOURCES CENTER ARCHIVES
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA

RESOLUTION PASSED BY RIO GRANDE COMPACT COMMISSION AT SANTA FE, NEW MEXICO, DECEMBER 3, 1935.

WHEREAS, the Rio Grande Compact Commission was created for the purpose, among others, of making equitable division of the waters of the Rio Grande above Ft. Quitman, Texas, between the States of Colorado, New Mexico and Texas, and

WHEREAS, the National Resources Committee has expressed its willingness to cooperate, if practicable, with the Rio Grande Compact Commission in the collection of relevant basic data.

NOW THEREFORE BE IT RESOLVED that the National Resources Committee, through the Water Resources Committee, be requested, in consultation with the members of the Rio Grande Compact Commission, to arrange immediately for such investigation (1) of the water resources of the Rio Grande Basin above Fort Quitman, (2) of the past, present and prospective uses and consumption of water in such Basin in the United States, and (3) of opportunities for conserving and augmenting such water resources by all feasible means, as will assist the Rio Grande Compact Commission in reaching a satisfactory basis for the equitable apportionment of the waters of the Rio Grande Basin in the United States above Fort Quitman, as contemplated by such Rio Grande Compact.

In making this request the Rio Grande Compact Commission, and its individual members, declare it to be their desire to cooperate and assist in such investigation in all ways within their power, and it further declares that, through its individual members, it will seek

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to obtain the allotment of state funds, or services, or both, for the purposes of the investigation in such amounts as will equitably distribute the costs thereof between the Federal Government and the member states of Colorado, New Mexico and Texas.

It is understood that the cooperative investigation requested herein shall be limited to the collection, correlation and presentation of factual data, and shall not include recommendations, except upon request of the Rio Grande Compact Commission, based upon the unanimous agreement of its members.

It is further understood that the said investigation shall be in harmony with the spirit and intent of the Rio Grande Compact, and nothing herein contained shall be taken to be a modification or alteration of the terms thereof.

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RG 267 RECORDS OF THE SUPREME COURT OF THE UNITED STATES

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Brief

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SUPREME COURT OF THE UNITED STATES

OCTOBER TERM 1936

No. 12, Original 15/28

State of Texas

vs.

State of New Mexico, et al.

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SUPREME COURT OF THE UNITED STATES

OCTOBER TERM 1936

No. 12 Original

State of Texas

vs.

State of New Mexico, et al.

AD INTERIM REPORT OF THE

SPECIAL MASTER

On May 25, 1936, I was appointed Special Master in this case by this Honorable Court. On August 4, 1936, I held a conference in Washington with counsel, to agree on dates for hearings and on methods of procedure. Between November 6, 1936 and March 23, 1937, I held 38 hearings at Albuquerque, New Mexico, and at El Paso, Texas (including days spent in personal inspections of the drainage and irrigation systems involved, for a distance of about 400 miles up the Rio Grande River and 400 miles back). More than 3,000 pages of evidence by engineers, chemists, and other witnesses have been introduced as well as 267 documentary exhibits, graphs, maps and charts. All testimony for the complainant, as well as for the defendants, has been concluded, except rebuttal testimony by the complainant.

The progress of the suit has developed certain new situations, and certain conditions which I may term as floating factors, which, in my opinion, make it desirable that I should submit to this

Honorable Court an Ad Interim Report as Special Master.

Briefly stated, the suit arises out of the following circumstances.

The Rio Grande River rises in the southern part of the State of Colorado and flows easterly and then southerly in that State; it then flows south about 400 miles, through the entire length of New Mexico; from a point about fourteen miles north of the southern boundary of the United States, it forms the boundary line between the States of New Mexico and Texas (see New Mexico v. Texas (1927) 275 U. S. 279); thence it turns east at El Paso and becomes the boundary line between the United States and the Republic of Mexico. In Colorado, the Rio Grande with several tributaries flows through what is known as the San Luis Valley basin and adjoining territory, much of which is susceptible of cultivation under irrigation. In New Mexico, it flows through an open valley about two to six miles wide (except in the northern portion of the State, where it flows through rock canyons); and in New Mexico, there are not more than five tributaries of any size. Similarly, in Texas, it flows through valley lands as far as Fort Quitman (where the canyon country begins), which is located about 75 miles east of El Paso by land,(and about 130 miles by river prior to recent canalization of the river); and in this part of Texas, there are no tributaries other than arroyo washes. Most of the valley lands in both States are of value, only if properly irrigated and drained. Irrigation has been practiced around El Paso ever since the land in its vicinity was Spanish and Mexican territory. In New Mexico, the Pueblo Indians employed irrigation methods from a very early date, before the United States acquired it from the Republic of Mexico; and since 1880, American settlers in that Territory and State have

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employed similar methods. In Colorado, irrigation has been practiced by Americans chiefly since 1870.

The flow of the Rio Grande, like that of all great rivers in the semi-arid parts of the West, changes greatly, not only from month to month, but from year to year, largely owing to variations in winter snowfall and in summer and autumn torrential rains.

The water law of Colorado and the water law of New Mexico is that of prior-appropriation. The law of Texas is the old riparian-right law, combined with a law of prior-appropriation. State statutes and State Constitutions now regulate, to some extent, water rights in each of the three States.

In 1906 and in 1908, the United States, acting allegedly under the Federal Reclamation Act and under the laws of the Territory of New Mexico, and preparatory to entering upon a water storage project, filed notices of appropriation of unappropriated waters in New Mexico.

In 1915-1916, the United States, at large expense, completed the Elephant Butte Dam and Reservoir in the southern part of New Mexico, about 125 miles north of El Paso, Texas; its purpose was to store waters of the Rio Grande River which it assumed to have appropriated, to be used for two purposes, first to supply the Republic of Mexico with water under the Treaty of May 21, 1906; and second, to provide irrigation for lands in New Mexico and in Texas, south of the Elephant Butte Dam.

In the southern part of New Mexico, the water from the Elephant Butte Reservoir is conveyed to water users under contract between the United States and the Elephant Butte Irrigation District, and in the region of Texas north and east of El Paso under contract between the United States and the El Paso County Improvement District No. 1,

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and by contract between the United States and the Hudspeth County Conservation and Reclamation District No. 1.

Under the laws of New Mexico of 1923 and 1927, the Middle Rio Grande Conservancy District (a quasi-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. Construction of its irrigation, drainage, and levee systems began in April, 1930; and later, construction of a new dam and reservoir near the Colorado-New Mexico boundary line — the El Vado Dam — was begun in connection with the project. Water is conveyed to water users in the irrigable area embraced in the Conservancy District through the District organization and system.

On February 12, 1929, after several years of conference and controversy, the States of Colorado, New Mexico and Texas entered into a Compact to regulate the use of waters of the Rio Grande. This Compact, consented to by the Congress of the United States, was a temporary measure and was to expire on June 1, 1935, but has, by action of the States and of the Congress, been extended so as to expire on June 1, 1937. It 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."

On October 28, 1935, the State of Texas moved in this Honorable Court for leave to file a bill in equity (leave granted on November 11, 1935) 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 this Court and of water law in the southwest.

At the conclusion on March 20, 1937, of the hearings thus far held by me as Special Master, certain phases of the case have appeared which I am of opinion should be called to the attention of this Honorable Court, before the case shall be closed and before I hear arguments of counsel.

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 an international 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 difficult, if not 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.

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Second. New Mexico contends that the depletion of water supply alleged by Texas is also due to improvident or wasteful methods of operation of the Elephant Butte System by the United States Government.

It further 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.

If the challenge made by New Mexico to the legal validity of the appropriations of water made by the United States should be sustained, the amounts of water which the United States will be entitled to store in the Elephant Butte Reservoir and the amounts of water which will be legally available to New Mexico water users and to Texas water users, south of Elephant Butte Reservoir, may possibly be reduced. The United States would seem to be vitally concerned in this phase of the suit, since this contention by New Mexico, as well as its contention regarding the Republic of Mexico, appear directly to involve the interests of the United States; yet the United States is not a party to the suit. Furthermore, the United States has another interest in this suit, (and an interest possibly in conflict with the interest involved in its operation of the Elephant Butte project), inasmuch as the Reconstruction Finance Corporation has loaned to the Middle Rio Grande Conservancy District about $6,000,000 on bonds of the said District.

Third. New Mexico at the hearings has challenged the contention of Texas that the bill of complaint as filed contains allegations of facts, which, if proved, will entitle Texas to relief on general doctrines of law, apart and distinct from any rights which it may have under the Rio Grande Compact. Texas, on the other hand, maintains that its bill is based not only on violation of the Compact — but also on violation of rights of its water users in general; it refers to

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the allegations in its Bill and also to its allegation in paragraph three of its Answer to Motion to Dismiss, to the effect that: "Furthermore, the rights of the State of Texas, while crystallized and acknowledged in Article XII of the Rio Grande Compact, did not originate therein, but are predicated upon the facts set forth in the Bill of Complaint, and this cause of action would be equally maintainable if the Rio Grande Compact had never been signed."

If the Bill of Complaint filed by Texas does not set forth the facts as contended for in the hearings (as to which facts, voluminous evidence has been taken), the question is presented whether opportunity should not be afforded to Texas to move to amend its bill of complaint, if it shall see fit to make such motion.

Fourth. Texas contends, and New Mexico denies, that the operation of the Middle Rio Grande Conservancy District has depleted and will deplete 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 Conservancy District irrigation and drainage system, however, was not completely constructed until the year 1933-1934, and the effect on the water storage in the Elephant Butte Reservoir would not be fully shown until 1934.

Prior to the hearings, March 15-20, 1937, the chief evidence as to diversion of water and consumptive use of water due to the operations of the Conservancy District, consisted of estimates and expert opinion by engineers for the respective parties. These estimates based on figures comparing the flow of the Rio Grande at various points in the prior years with its flow for less than three years after the final construction of the Conservancy District's irrigation

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system, are an unsatisfactory basis for a present finding of facts by me. At the hearings in March, evidence as to diversions in the year 1936, based on actual measurements made by the United States Geological Survey, were for the first time available and introduced in evidence. It is highly desirable that similar measurements should be made during the water season of 1937.

Fifth. Texas contends, and New Mexico denies, that the operation of the drainage portion of the Middle Rio Grande Conservancy District has increased the salt contents of the water. (New Mexico further contends that the Rio Grande Compact properly construed contains no provision as to quality of water and only refers to quantity.)

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 1934 or possibly the year 1935. Actual salt tests of the waters in the drains of the District themselves were not made until late in 1935 and in the year 1936. Such limited amount of evidence as to salt contents is an unsatisfactory basis for a present finding, and it is highly desirable that similar salt tests be made in the water season of 1937.

Sixth. Texas contends, and New Mexico denies, that the construction and operation of the El Vado Dam by the Middle Rio Grande Conservancy District has still further depleted and will deplete 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.

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Seventh. Since December, 1935, the National Resources Committee on Public Works Planning, appointed by the President and headed by Harold L. Ickes, Secretary of the Interior, as Chairman and Frederic A. Delano, as Vice Chairman, through a Water Resources Committee, 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 securing and preparing material for a report, all through the year 1936. This report, it is understood, will be submitted in April, 1937. It is probable that this report will contain facts and suggestions of value as bearing on the issues in this case.

Eighth. Though this Honorable 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 contention of the State of Texas should be upheld in this suit, it would be very difficult (at least so far as concerns that contention which is based on the general rights of Texas water users as distinct from the rights of the State under the Compact) to frame a decree as to 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 possible future diversions or storages of water in that State; for while at this time, it is not appropriate for me to arrive at any conclusions of law, it is possible that, at the termination of the case, a decree, if in favor of Texas, might be based on

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the doctrine of equitable distribution laid down in recent cases in this Court, rather than on the strict prior-appropriation doctrine of Wyoming v. Colorado. Since the Rio Grande Compact to which Colorado is a party, expires on June 1, 1937, it is possible that increase of diversions or storages of water may in the future take place in Colorado, or, on the other hand, that increased amounts of water may be made available in Colorado through drainage projects. If either of these events should take place, any decree made by this Honorable Court now might have to be modified or adjusted to meet a new situation as to amounts of water available for either Texas or New Mexico.

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 might not result in an equitable adjustment of the situation. On the other hand, a postponement of findings and continuance of hearings by me until the end of the year 1937 might have the following results: (a) might practically eliminate the issue as to diversions by the Republic of Mexico; (b) might afford the State of Texas opportunity to move to amend its bill of complaint if it should see fit so to do; (c) might enable further data and measurements during the coming irrigation season of 1937 to be obtained by the parties to this suit, if they shall so see fit, as to the consumptive use and diversions of water by the Middle Rio Grande Conservancy District, and also might enable further tests to be made of the salt contents of the drains of the said District; (d) might furnish further evidence of the practical effect of the operation of the El Vado Dam; (e) might give all parties opportunity to consider carefully, and possibly act on, the forthcoming report of the National Water Resources Committee; (f) might afford the United States officials operating the Elephant Butte Reservoir and the officials operating the Middle Rio Grande

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Conservancy District time to consider whether any improvements in the methods of operation or economy in the use of water in their respective systems are practicable; (g) might afford an opportunity for the United States or the State of Colorado to seek to intervene in this suit, if either should see fit so to protect its interests.

In addition to the above considerations, the following situation arose during the hearings at El Paso, March 15-20, 1937.

On March 13, 1937, the Legislature of New Mexico, pursuant to a Message from the Governor, enacted into law Senate Bill No. 234 entitled, "An Act to extend the time of the Rio Grande Compact for a period of four months from and after June 1, 1937, by amending Article V and Paragraph (a) of Article VII of said Compact and declaring an emergency." By this Act, the Compact was extended, so as to continue in full force and extent from June 1, 1937 to October 1, 1937. The Act was to become operative "if and when the Legislatures of the States of Colorado and Texas, respectively, shall extend such Compact to October 1, 1937 and continue said Compact in full force and effect as so extended." Nothing is said in the Act as to approval of the extension of the Compact by the Congress of the United States; but it is assumed that such approval will also be necessary. The Act, however, was not to become binding upon the State of New Mexico unless a further condition should be complied with, namely,

> "that this act shall not be binding on the State of New Mexico, unless and until that certain suit now pending in the Supreme Court of the United States entitled "The State of Texas versus The State of New Mexico and Others" is dismissed, or unless and until a stipulation has been entered into between the attorneys for the State of Texas and the attorneys for the State of New Mexico in said suit and approved by the Supreme Court of the United States or the Special Master appointed by that Court to take the testimony, holding in abeyance any further proceedings in said suit until the first day of October, 1937."

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On March 26, 1937, I received from counsel for the State of Texas a stipulation signed by William McGraw, Attorney General of Texas; H. Grady Chandler, Assistant Attorney General of Texas; Richard F. Burges and Frank B. Clayton, Counsel for Complainants; and also signed by A. T. Hannett, Assistant Attorney General of New Mexico; and by Richard H. Hanna, Reginald S. Laughlin, William A. Brophy and Fred E. Wilson, Attorneys for Middle Rio Grande Conservancy District, copy of which stipulation is as follows:

> "Subject to the approval of the Supreme Court of the United States or of the Special Master, New Mexico, the Middle Rio Grande Conservancy District and the State of Texas, in conformity with S. B. 234 of the Legislature of the State of New Mexico, stipulate that any further proceedings in Original Cause No. 12, October Term 1936, be held in abeyance until the first day of October, 1937, without prejudice to the rights of any party."

This stipulation, so signed, I am filing with this Ad Interim Report.

One of the reasons which impelled the enactment of the New Mexico Act appears to have been the fact that the additional time until October 1, 1937 might afford to the representatives of the three States a further opportunity to conclude a permanent Compact to provide "for the equitable apportionment of the use of the waters of the Rio Grande" among said States of Colorado, New Mexico, and Texas under Article VII of the Compact as so extended. In my opinion, it is highly desirable that, if possible, such an equitable apportionment should be made by agreement rather than by litigation; and such appears to be the view of the Governor of New Mexico in his Message to the Legislature of March 10, 1937 (see Appendix A). Certainly, so far as the States of Texas and New Mexico are concerned, the evidence thus far presented in the present suit satisfies me that the irrigation and drainage projects above and below the Elephant Butte Dam and Reservoir ought, if practicably possible, to be considered and treated as a

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unit, and not as two separate projects only operable one at the expense of the other. If so considered, it is possible that by improved methods of operation, saving of water wastes, and increase of drainage flow, the water needs of both States may be equitably satisfied. I have the impression that if the engineer witnesses who have testified for the State of Texas and for the State of New Mexico respectively would devote to a consideration of the problem as a unitary one, the same signal ability and zeal which they have shown in presenting the phases of the problem as separate and distinct, and if they would treat it from the standpoint of the joint interests of the two States instead of from the standpoint of the separate rights of the two States, some solution may be found -- especially if they are given time to study, digest, and compare the voluminous and intricate data thus far comprised in 105 exhibits introduced by the State of Texas and in 162 exhibits introduced by the State of New Mexico, consisting largely of graphs, maps, estimates, tests, and statistics of a highly technical nature, testified to by engineers, chemists and other experts.

Accordingly, I respectfully recommend as follows:

(1) That this Honorable Court enter an order approving the stipulation herewith filed and that the Attorneys for the State of Texas be directed to transmit a copy of such order to the Governor of the State of New Mexico.

(2) That this Honorable Court further authorize me as Special Master to postpone hearings in this case, at my discretion, until such date after October 1, 1937 and prior to January 15, 1938 as I shall determine.

Respectfully submitted,

Charles Warren
Special Master.

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SUPREME COURT OF THE UNITED STATES

APPENDIX A.

Portions of the Message of Governor Clyde Tingley to the Legislature of New Mexico, March 10, 1937.

There is a joint investigation going on by the States of Colorado, Texas, and New Mexico, in cooperation with the United States Government, and upwards of $300,000 has been spent on this investigation which has as its objective a full development of the resources of the waters of the Rio Grande in the three States, and mong others the feasibility of the San Juan diversion.

Because of this investigation, I think it wise to extend until October 1 the Rio Grande Compact in order to give further opportunity for the respective States to negotiate for a permanent compact for the equitable distribution of the waters among the three States.

x x x I feel that the State of New Mexico should put forth every effort possible to agree upon an equitable allocation of the waters of the Rio Grande among the States of Colorado, New Mexico and Texas, and that the public interests can best be served by an agreement arrived at through a compact rather than through litigation. I also feel that New Mexico should exert every effort to cooperate to the fullest extent with the purpose and objects of the Joint Investigation being carried on for the purpose of arriving at a friendly solution between said states of the questions and problems which exist in reference to the Rio Grande. I shall insist that the Interstate Stream Commission, exercising the powers conferred on it by Chapter 25 of the Session Laws of 1935, make every effort to reach a permanent agreement with the States of Texas and Colorado relative to an allocation of the waters of the Rio Grande, whether the present compact is extended or not, and incidentally, this agency of the state, created by the Legislature of 1935, has full power and authority to continue such negotiations and to cooperate fully with the agencies of the Federal Government, even though the present compact should expire on June 1, 1937. In the event the present compact should expire and the Interstate Stream Commission should successfully negotiate a compact with Colorado and Texas, agreeing upon a permanent allocation of the waters of the Rio Grande among said states, in cooperation with the agencies of the Federal Government, I should deem such a matter of sufficient importance to call the Legislature into special session and ratify such an agreement in case one should be reached. I feel that it would be of sufficient importance to the other states involved to take like action should that become necessary. However, as stated before, I do not feel that I would be justified in recommending an extension of the present compact upon which the suit in the Supreme Court of the United States now pending is based, unless Texas will agree to either a dismissal or continuance of the case during the time the compact is extended.

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SUPREME COURT OF THE UNITED STATES

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The Supreme Court of the United States has said that the exercise of its jurisdiction in determining controversies between sovereign states is a substitute for war. I do not feel that it is consistent to deal with the State of Texas in an effort to settle our differences by peaceful means while Texas is resorting to the substitute for war in an effort to gain her ends. In other words, Texas should not come to us with a sword in one hand and an olive branch in the other.

Therefore I earnestly recommend the enactment of the Act herewith transmitted for your consideration.

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D - Direct Examination
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1125	1125	T-85	Executive Document H.R. #135, 34th Congress, 1st Session; Report of United States and Mexican Boundary survey..
1125	1125	T-86	Proceedings International Water Commission, Equitable Distribution of Waters of Rio Grande under Treaties 1884 and 1889.
1138	1138	T-87 T-88	Description by meets and bounds of El Paso County Water Improvement District No. 1.
1138	1138	T-89	No. 3 of Vol. 1, Beginnings of Settlement of El Paso District by Anne E. Hughes.
1160	1174	T-90	Differential mass diagrams, net usable supply and net draft, Elephant Butte reservoir.
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1177	1190	T-92	Differential mass diagrams, reported inflow net usable supply, safe yield, Elephant Butte Reservoir.

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1200		T-95	Annual gross consumptive use 1923 to 1935.
1254		T-96	By-laws of El Paso Valley Water Users Association.
1254		T-97	Amendments to Articles of Incorporation, El Paso Valley Water Users Association.
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CORRECTIONS

Page 122 or 1297, 7th line from bottom, strike 'kind' and insert 'mind'.

Page 123 or 1898, 4th line from top, strike 'salt' and insert 'small'.

Page 137 or 1312, first line, insert 'not' between 'is' and 'in'.

Page 180 or 1355, 14th line from top, insert 'didn't' between 'they' and 'release'.

Page 185 or 1360, last line, insert 'to' between 'order' and 'aid'.

Page 188 or 1363, 15th line from top, strike 'filas' and insert 'fails'.

Page 193 or 1368, 4th line from bottom, strike 'agriculture' and insert 'agricultural'.

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CORRECTIONS

Page 87 or 1233, 12th line from top, insert 'well' between 'valley' and 'below'.

Same page, last line, strike 'in' and insert 'entering' between 'sodium' and 'the valley'.

Page 84 or 1230, 5th line from bottom, insert 'under or' betwen 'occurring' and 'on',

Page 56 or 1202, 10th line from top, strike 'THE WITNESS' and insert 'THE SPECIAL MASTER".

Page 63 or 1209, 3rd line from top, strike 'nineth' and insert'ninety'

Page 32 or 1178, 10th line from top, strike 'nineth' and insert 'ninety'.

Page 18 or 1164, 11th line from top, strike 'fifth' and insert 'fifty'.

Page 67 or 1213, 8th line from bottom, strike 'spread more' and insert'superimposed'.

Page 68 or 1214, 14th line from top, strike 'identify' and insert 'identity'.

Page 89 or 1235, 7th line from bottom, strike 'at' and insert 'as'.

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ARTHUR L. BABCOCK

a witness called on behalf of the complainant, having been first duly sworn, was examined in chief by Mr. Clayton, and testified as follows, to-wit:

Q State your name, please.

A Arthur L. Babcock.

Q Where do you live?

A Riverside, California.

Q What is your occupation?

A Agricultural chemist.

Q What has been your education, Mr. Babcock?

A Graduate from the University of California in 1916.

Q In what school or college?

A College of agriculture.

Q Did you get a degree?

A Got a degree of Bachelor of Science.

Q And upon your graduation, what line of work did you pursue?

A The first four years, I was employed by a seed company in the production of various types of garden and field seeds.

Q What was your particular line of duty in that connection?

A I made contracts with farmers for the production of seed; arranged to deliver to the farmers what we called stock seed, which we selected from proven grounds, then I saw to it that the seed was planted at the proper time, in a proper manner, cared for in the growing season and properly harvested and cured.

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Q Did that involve irrigation?

A In many instances.

Q How long were you engaged in that line of work?

A About four years.

Q Then what line of work did you take up?

A I farmed for three years.

Q Where?

A In Sonoma County, North of San Francisco, between Healdsburg and Santa Rosa.

Q Does that involve irrigation where you did your farming?

A No; it didn't.

Q You were engaged in farming for three years?

A Yes, sir.

Q And then what did you do?

A Then I joined the co-partnership of Edward S. Babcock & Sons.

Q What kind of work does that co-partnership do?

A The co-partnership maintains a laboratory at Riverside, which does general analytical work. Approximately ninety percent of the laboratory work is [illegible] agricultural in nature.

Q Do you mean chemical analytical work?

A Yes, sir; and of that work a large portion is the analyses of soils and waters.

Q What is the purpose of the analyses of soils and water? What things do you look for?

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A In the case of soils, there are several certain nutritive conditions which we consider of importance. We make a great many analyses on that basis. In the case of--

Q Could you explain that a little more, what you mean by that?

A I would say there are several fertilizers, elements necessary to plant growth, three important ones, phosphorus, potassium and nitrogen. Of those three fertilizers, nitrogen is usually the one most likely to be deficient, and deficient in its available form, therefore we make a great many determinations of the soils to determine the amount of nitrates present.

(Discussion off the record):

Q You were going to tell us of other purposes of your chemical analysis soils.

A In addition to the analysis of soils to find out their fertilizing condition, we analyse soils to find out the salt content, and make certain tests to determine their physicial composition.

Q Well, now what is the purpose of that particular analysis.

A Physical analyses are made quite often to determine whether or not a soil probably will take water readily, be le ched readily, on the one hand, if it is a particularly heavy soil, on the other hand, we actually make physical determinations to see whether the sand and gravel soil may have sufficient clay, or clodial material to support life.

Q Also to determine the percentage of salt in the soil?

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A Yes, sir.

Q And what the particular elements are that go to make up the salt content of the soil?

A Yes, sir.

Q Generally speaking, Mr. Babcock, what are the salts that you look for particularly, in your salt analyses?

A Look for the salts of calcium, magnesium and sodium.

Q Are these variations of those salts?

A Yes, any one of the three cations, which I mentioned, the basic radicals, may be in combination with any one of three or more of the anions, or acid radicals.

Q What are the anions or acid radicals you speak of that these three elements most commonly unite with as found in the soil?

A That depends on the relative amounts of the cations present. Usually calcium will combine first with carbonate, and if there is calcium left over after all of the carbonate has combined with calcium, some of the remaining calcium will combine with sulphates. Those remaining, if all of the sulphates are u tilized, some of the remaining calcium will combine with chlorides.

Q Is there a particular affinity between the calcium and carbonate ion?

A It might so be stated.

Q Now, in your water analyses, Mr. Babcock, what is it you look for there? You have been discussing soils.

A Water analyses almost entirely are made for the purpose of

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determining the kinds and amounts of salts in solution, and the proportion of sodium to calcium and magnesium.

Q The percentage of sodium to calcium and magnesium?

A Yes, sir.

Q You do that on the assumption or belief that there is some significance about that relation, is that correct?

A Yes, sir.

Q Is your test, or your analysis of water samples similar to that of the soil samples?

A Yes, sir.

Q In so far as the presence of salt is concerned?

A Yes, sir.

Q Does the presence of salts of different compositions have any effect, first upon plant life itself, and secondly upon the soils?

A Yes, sir.

Q Let's take the plants first: Is it possible for you to state in general terms what the effect of applying saline water upon the land is for the purpose of irrigating crops?

A Yes, as the salinity is increased, crop plants will not grow to as large a size.

Q When you speak of salinity there, you speak of salinity as meaning the combination of salts you have just mentioned?

A Yes, sir.

Q And is there any particular point in the specific conductance

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or degree of concentration below which you say the water is all right, and beyond which you say the water is dangerous?

A No, there are no well defined limits.

Q Is it then a progressive matter, as the salinity increases in degree, the toxicity as far as the plant increases?

A I believe it is.

THE SPECIAL MASTER: Within what limits? You couldn't take every increase of salinity to be dangerous. There must be some limits one way or the other.

THE WITNESS: We believe that we could get a limiting factor with the first increases in salt content.

Q What do you mean by limiting factor, Mr. Babcock?

A That plant growth in most instances is retarded after the first increments of salts; in other words, if the solution in which the plant is being started carries more than traces of salts, some reduction in growth will occur. As that reduction continues, as the salinity increases, finally the salinity may become high enough to actually kill the plant.

Q Can you describe how that effect takes place, the stunting effect of alkaline water on the growth of plants? If you will, would it be helpful to use the blackboard?

A I think it would be, either now or shortly.

Q Now, using the blackboard, if you like, would you tell the Court how this effect on plants of alkaline water takes place?

A As far as the actual direct effect on the plant is concerned,

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we don't know with certainty just what the reactions are. We do know, however, that as the salinity is increased, the roots will withdraw less moisture. That use is a factor affecting the growth of the top of the plant. We also know that root development itself will be retarded as the salinity increases; and, we also know that in various horizons of the soil, the highest salinity is in the lower horizons; in other words, if we are irrigating a piece of soil and have water coming on at the top, going down through and wetting the soil and arriving at what might be called the water table, as would be the case in these valleys, water going out at this point, we might say, would have a certain conductance of a hundred, and water reaching this water table, which, we will say, is here at the bottom--

Q In speaking, make your remarks so it will reflect as near as possible the points you are trying to make, please.

A I am trying to illustrate that when irrigating the soil with saline water, the greater the concentration of the salinity, the greater the decrease in production either in growth or size of plant. I have stated that we get an apparent reduction in root development when the roots are subjected to a saline solution. At the present I wish to illustrate how that root development may affect the top development or crop production.

I think it will be easily seen that, as water is applied to the surface of the soil, it percolates through the same and reaches the water table, that the higher horizons of soil closest to the surface will have a lower concentration of salt than

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each succeeding horizon. The fact that increasing concentrations of salt in colution inhibit root growth, brings about the result if a plant is started on this soil there is a tendency to limit the root growth in the lower horizons, and confine most of the root growth in the upper horizons. When that is the case, we have a limited storage capacity from which the plant may debive its food cells and its moisture. That is probably the indirect method by which increased salinity affects crop production. Certain direct physiological effects upon plants from salts, which are not well defined, we simply know the results, the fact that certain salts when present in amounts of sufficient magnitude will produce certain symptoms in the plant, just why these salts produce those symptoms, we do not know. We also know that many or most of the common salts in the soil, those salts which occur in greatest quantity, which I mentioned a few minutes ago, the salts of calcium, magnesium and sodium, affect the plants often times without any visible symptoms; in other words we can have a decreased yield without visible symptoms. In many instances it is necessary, if the toxicity becomes very great, before any apparent visible symptoms are noticed,- In all probability the intake into the plant of these salts causes some type of derangement, whether it is a physical derangement of cells, or protoplasm in the cells, or whether it is a direct chemical derangement, investigations so far have not disclosed.

Q Do the plants themselves take up an appreciable quantity

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of the salts in the water?

A In relation to the salts in the soil, I would say no; however, the plants do remove some, or most, of the salts. There are instances in which, probably due to certain conditions, a plant may take in what we call a sudden inrush of salts. Of necessity often that large amount is negligible in comparison with the salts in the solution.

Q And you say this effect on the plants is a progressive sort of thing that increases as the proportion of salt in the water applied increases?

A That is correct. I might liken it to-- assuming that we are irrigating a piece of soil, and that, for some reason which might or might not be explained, at this end of the field we had what might be considered a normal crop for this soil, and the district in which it might be, and that we had increasing salinity as we approached the other end of the field; assuming that at the other end of the field the salinity were so high plant life could not be started, you would have a bare spot at this end of the field. In all probability, in general, we would get a crop from this normal down to no production atall; in other words, even the first increments or increase in salt concentration will have some effect on the production, although that may not be great in some instances, in some it will be very appreciable.

Q Does your firm have any function beside the analyses of

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waters and soil samples?

A Yes, a large part of our work today comprises the management either directly or indirectly of ranch properties, including citrus, as well as alfalfa, some deciduous crops and some grains.

Q Involving irrigation?

A Yes, sir.

Q And have you done some of that work yourself?

A I have.

Q Have you then had personal experience with the phenomena that you have just been discussing?

A Yes, sir.

Q Could you recall from your personal experience any immediate illustration, or illustrations, that would serve to emphasize this point?

A Yes, sir. I think the first time my attention was called to this phenomena was about eight or ten years ago. At that time the American Fruit Growers of Corona called my attention to the fact that at the lower end of their irrigation runs on certain blocks in their orchard property, the production was materially less than at the upper end of the irrigation runs, and I was asked to make an investigation and endeavor to determine the difference in yield between the upper ends of the runs and the lower. I might illustrate this example, if I may.

MR. CLAYTON: Is it all right to erase this, Governor, or do you want to use this for cross examination?

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MR. HANNETT: All right.

A It is customary in Southern California, that is in the Corona District, to irrigate orchards in furrows. The water starts at the upper end, usually from pipe lines or from a flume, and is carried to the lower portion of the field in these furrows. In so doing, considerable time is taken for the water to reach the lower end of the furrows. Water leaves the stand pipe at the upper end, passes by the trees, and finally reaches the lower end of the particular field. The length of those runs is usually determined largely by the character of the soil. On heavier soils, a long run may be used, for the reason that the water penetrates more slowly into the soil. In the particular instance that I have stated of the situation on the American Fruit Growers' property, the length of the run was, as I recall it, probably about four hundred or four hundred fifty feet.

Our first investigation was to determine whether or not the trees at the lower end of the run were getting sufficient water. From moisture samples taken and computed, and from observations in the field, we found that at the upper end of the run water penetrated very deeply, probably four or five times the depth of the root area, which we might roughly say was the area between this line--

Q The lower line.

A The lower line and the upper line, which represents the surface of the soil. The moisture investigation indicated that

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as I have stated, that the upper end of the irrigation run, water penetrated to several times the depth of the root area. At the lower end water penetrated on the average to about the depth of the root area, and in very few places slightly under, but not much.

Q What would the effect of that be with reference to the concentration of salts in the root zone from the beginning of the row to the end?

A At the upper end of the row, the dilution, theorecically, should be much greater in the upper horizons, and the concentration should increase as we progressively go to the lower horizons. At the lower end we have but one horizon, that being the root area, therefore the concentration of the salts at the lower end of the run, in the root area would be considerably higher than at the upper end of the run.

We endeavored to eliminate any other factors which might be responsible for decreased yield at the lower end of these irrigation runs, consequently, we made nitrate determinations from the soil near the upper ends of the runs, near the middle of the irrigation runs, and near the end of the irrigation runs. At the upper end of the irrigation runs, we found the soil within the root area to have several nitrates in our estimation for the use of the trees. Samples taken half way between the upper and lower ends of the runs, showed higher nitrates than we found at the upper ends of the runs. Samples taken at the

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lower end of the irrigation runs showed nitrates considerably higher than found either at the upper end of the runs or at the point approximately half way between the upper and lower ends of the runs.

Q So, from the stand point of salts alone, would you expect a higher or lower yield at the lower end of the run?

A With respect to the nitrates present, we would expect as high a yield at the lower end as at the upper. In this particular instance the nitrates were sufficiently high, with other factors being equal, and a maximum crop should be obtained with the lower concentration which was found at the upper ends of the runs.

Having eliminated the most probable two other limiting factors in production, aside from salinity, we made determinations to discover the concentration of the salts and type of salts present. The results of that investigation followed the-- I should say substantiated the theoretical assumption, which I have made that at the lower end of the irrigation runs the concentration of alkaline salts was several times as great as it was at the upper ends of the irrigation runs. The concentration at a point approximately half way between the upper and lower ends of the runs was less than the concentration at the lower end, but higher than the concentration at the upper end of the run.

An attempt was then made to rectify this condition in order

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to increase production at the lower ends of the orchards. Pipe lines were installed on blocks where those conditions were most apparent, in positions approximately half way between the original upper ends of the runs and the lower ends. By installing what we called intermediate pipe lines approximately half way between the upper and lower ends of the irrigations, we can get water from such pipe lines to the lower ends of the runs in a much shorter time, due to the shorter distance.

In practice there are many physical factors which have to be taken into consideration in the operation of properties. We might say that a longer run and larger head of water could have been used at the upper end in order to reach the lower end sooner, thereby allowing the water to percolate through the soil at the lower end; however, the physical manner of washing, in other words removing salt physically from the upper end, as well as other factors enter in, so if it becomes necessary to shorten the length of runs, it is usually advisable to put in intermediate pipe lines.

Q Then your conclusion, Mr. Babcock, from that investigation of this particular problem, was that the decrease in yield at the lower end of the run was due to the concentration of salts in the root zone, and that in turn was due to the failure to apply sufficient water to leach those salts out down beyond the root zone?

A That is correct.

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Q And the method you used to remove that was to apply more water at the lower end of the run in order to leach those salts out of the root zone?

A Yes, sir.

THE SPECIAL MASTER: Then if the salinity increases with the depth, the degree to which that increased salinity would affect crops would be according to the depth of the root of the crop, wouldn't it? That is, a crop with a short root would be less affected than a crop with a root that extended down to the concentrated salinity, is that so?

THE WITNESS: It is if we assume two assumptions, one that we are not using sufficient water to leach the bulk of the salts entirely below the root system.

THE SPECIAL MASTER: But irrespective of the amount of water you are using, I understand the lower you go the more concentrated salinity you have?

THE WITNESS: Yes, sir.

THE SPECIAL MASTER: So the degree to which a crop would be affected would be the degree to which the roots reached down to this point of concentrated salinity.

THE WITNESS: In substance, that is correct.

THE SPECIAL MASTER: I merely ask that because I can see that conditions might affect an orange grove that would not affect something else.

Q Would the same theory be true of any character of crop,

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provided, of course, you considered the root zone only of that crop?

A Provided we assume the-- provided we considered the root zone only, that is true of other crops. The degree to which the effect may reach is dependent upon the type of crop to some degree; in other words, it has been very definitely established that some crops are more resistant to alkali salts than others.

Q You used the term 'horizons' in speaking with reference to soils. Just what do you mean?

A By horizons, we mean any particular layer of soil which we might wish to describe regardless of whether one foot in depth, two feet, or whether we might in some cases be using inches; in other words we are referring to the layers or horizons of soil.

Q Without reference to any natural stratification?

A No, sir.

Q Now, what was the result of your change of application of water?

A The result in this instance was that we did obtain water at the lower end sufficiently soon to allow its percolation to a somewhat lower depth than was the case when we were irrigating the full length, and we did get a substantial increase in production following the installation of those intermediate pipe lines, and a partial leaching of salts from the soil in the root zone at the lower end of the irrigation run. We found, however,

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that we had again set up to a lesser degree the same situation which occurred before; in other words we found that the soil near the upper end of our new divisions, or blocks as they might be called, became leached more rapidly than at the lower end of the runs.

Q When you speak of leaching, do you actually mean the removal of an accumulation of salts in the soil, or do you mean simply the dilution of the salts in the root zone, or soil solution?

A I mean the actual leaching below the root zone, in this case, of the salts. At the beginning we found that sufficient water was being applied for irrigation purposes at the lower end of the land; in other words sufficient water was being applied to dilute the salts that were in the root zone at the lower end of the runs, but there was not enough water applied at the lower end of the runs to leach or push downward the salts from the root zone.

Q What I mean is this: What happened originally was that there was a sufficient dilution of the salts in the upper reaches of the run that the plants were not affected, whereas in the lower reaches of the run only enough was applied for the purpose of plant transpiration and evaporation, consequently there was not a dilution, but a concentration which resulted in the accumulation of salts. Is that stating it fairly?

A Yes, sir.

Q Would you draw as a conclusion from that, then--

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THE SPECIAL MASTER: Ask him what conclusion he would draw.

Q What conclusion would you draw, Mr. Babcock, from the illustration you have just given as to the necessity for the application of water of a saline content for irrigation purposes?

A We draw the conclusion that sufficient water would have to be applied to the surface to supply the demands of the trees, and to take care of losses from the surface due to evaporation; in other words, to supply on the one hand the losses due to transpiration and evaporation plus a sufficiently large additional amount of water to leach accumulated salts in the root area to some point below the root area.

Q To accomplish the later purpose, would it be necessary to vary the quantity of water applied in proportion to the concentration of salts in the water?

THE SPECIAL MASTER: As I understand, he is not talking about salts in the water when it is applied; he is talking about salts in the land which were to be leached down below the roots.

Q Is there any relation between the quantity of water which must be applied?

A Yes, there is.

Q What do you mean by that?

A I mean that if water is applied to the surface which contains a certain concentration of salts, let's say water applied has a conductance of a hundred, and we find that crops are materially reduced if the soil solution has the same

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concentration, and we know that the average concentration, or conductance,in that root zone to which the roots of the trees are exposed, will be determined by the amount of water applied times its conductance, and the amount of water that passes through the root zone times its conductance; in other words the average conductance of the solution in the horizon which contains the roots is the average conductance of the water applied and the water passing the horizon. If we assume that the water applied has a given conductance, and it is necessary to maintain a given conductance in the root area at the time of application, we can compute the conductance of the drainage from that root area, having thus our three factors, conductance of the water applied, average conductance of the water in the root area at the time of application, and conductance of the drainage water, and having further the factor of consumptive use of water; in other words, the amount of water that we must put into the root area for consumptive use. We can compute algebraically how many units of water will be necessary to be applied to the surface, provided that water is delivered with a certain conductance, and how many units of water it will be necessary to put through the root area and send into drainage.

Q We have used in our discussion the terms, soil solution, salts in the soil, and salts in the water applied to the land. Are there differences between those three terms?

A Restate the question.

Q Read it. (done).

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A Yes, sir.

Q Will you state what the differences are? Define the three terms.

A Soil solution is the moisture within the soil complex. I should say within the soil complex containing the various soluble constituents which may be there. When we speak of salts in the soil, we may be speaking either of dissolved salts in the soil solution, or we may be speaking of precipitated salts which may be found in the soil. In regard to salt in water, we are referring always to dissolved salts only.

Q What do you mean by soil complex?

A By soil complex, we mean particles of soil and the chemical composition of those particles, together with accumulations of precipitated salts which may be adhering to or lying between the soil particles.

Q Are you acquainted with Dr. Frank M. Eaton of Riverside, California?

A Yes, sir.

Q Does he occupy some official position with the Government?

A He does.

Q What official position?

A Dr. Eaton is in charge of the Rubidoux Laboratory of the U.S.Department of Agriculture.

Q Has Dr. Eaton made any experiments along the lines of which you have been speaking, the application of saline water for

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irrigation purposes and its effect on plants?

A Yes, sir; he has.

Q Have you witnessed those experiments?

A Yes, I have seen those experiments in progress.

(Thereupon at 12 noon a recess was had until 2 p. m. at which time the same parties as heretofore being present, the following proceedings, were had, to-wit):

MR. HANNA: If Your Honor please, before proceeding with the testimony, at this point and out of a spirit of fairness to Your Honor and to opposing counsel, we desire to advise the Court and counsel of the intention of counsel for the defendants to apply for a continuance in this case at the conclusion of the plaintiff's case, which we now anticipate will be within the next few days. We do not know just what counsel will require for additional time--

MR. BURGES: Probably not over three days.

MR. HANNA: We appreciate the fact that Your Honor has, with splendid frankness a desire no doubt very earnest to meet his responsibility in expediting this matter so far as that may be done, and to advise of that situation with regard to other matters which are of great importance--

THE SPECIAL MASTER: I have no matters which will interfere with this case.

MR. HANNA: However, we feel after a conference among ourselves, and after a discussion of our problems with our advising

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engineering staff, that the proper presentation of our case before Your Honor is necessarily going to call for additional time. I do not propose at this time to discuss the reasons generally for our conclusion in that respect, which we have been reluctant to come to. We will be prepared, however, at the time of the application, I believe, to justify our position as one not dilatory in character, and honestly predicated on the necessities of the case. We will be prepared to support that application, if Your Honor desires, by the evidence of our engineering assistants as to the problems that are confronting them in their preparation of our evidence for the defendants. I will not go further at this time, my purpose being simply, in the same spirit of fairness which has actuated Your Honor, to advise Your Honor that may eventuate at the close of plaintiff's case, and it will be our position at that time to seriously urge a substantial continuance, which we will discuss at that time measured by our needs under the circumstances.

MR. BURGES: I don't imagine we should be expected to make a reply until we have seen the grounds on which they will rely for a continuance. We think there ought to be no unnecessary loss of time, for reasons which are known, of course, to counsel and the Court; but, of course, when we have heard what they have to say, then we will be prepared to answer it.

THE SPECIAL MASTER: Of course, I shall not make any statement on the matter of a continuance until a formal motion is

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made, but I call attention of counsel for the State of New Mexico and for the Conservancy District, that there are several issues in this case which are not concerned atall with the scientific testimony. Those are issues which are raised by both sides, that is the priorities, much testimony as to the status of the Conservancy District itself, and other questions at issue, which are certainly a part of the case of New Mexico, and for which, I assume, due preparation must have been made before the proceedings in the Supreme Court itself, and certainly before I fixed the date of hearing; so that I should suppose that there was a certain portion of those issues involved on which the State of New Mexico should be prepared to go ahead with its case. Of course, I am not making any ruling now. As I said yesterday, I shall certainly not take any action which would interfere with the fullest presentation of the case by both sides; that is the attitude the Supreme Court itself takes; but, I simply divert to that matter that there are, it seems to me, in this case a number of issues that have nothing to do with the scientific testimony, and which were in the case of New Mexico itself and were not connected necessarily with the denial of the allegations of the bill.

MR. HANNETT: That is true, if the Court please; however, one of the primary objects of our asking for the continuance is for a further analysis of this mass of testimony and exhibits, and if we don't conclude our cross examination, we would be

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putting our case in out of order.

THE SPECIAL MASTER: We have been very lax in the matter of order, and we get further ahead in hearings of this kind if we are lax than if we have a witness available to testify on each section of the case as it is approached. The value of that has been shown right along when a witness could be recalled to testify to a certain portion and then taken off the stand and put on again; so that the question of order is a matter very much at my disposal. Certainly it was the understanding at the beginning that should be so. I will not rule now, but I would like to have you think over that side. It would seem to me from the allegations in the bill and affirmative-- not only denials but affirmative allegations in the answer, there is much evidence that could be put in on the part of the State of New Mexico and the Conservancy District, and if there was time needed for other portions of the case, we can consider that when the motion is made. I make no ruling at the present. I thank you, Judge Hanna, for bringing the matter to my attention.

(Thereupon the direct examination of the witness, Arthur L. Babcock, was resumed as follows, to-wit(:

Q I will ask you to refer again to the diagram which you have sketched on the blackboard, illustrating one experience you have had with the application of saline water on growing crops, in this particular respect, orange trees. Was the water you had reference to in your testimony of a saline content, or

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was the salt you had reference to in the soil itself?

A The water had a saline content.

Q The water had a saline content?

A Yes, sir.

Q And it was for that reason then that it was necessary to apply enough to the surface to prevent an accumulation of salts within the root zone?

A Yes. May I explain?

Q Yes.

A At the lower end of the furrows in this particular case, under the previous method of irrigation, only enough water was applied to wet the root zone. Wa ter was applied that was not particularly high in saline content; however, all of our waters have more or less salts. In this particular instance chlorides predominated. Of the water that reached the lower end of the furrows, a portion of it was taken away from that root zone by evaporation from the surface, and a portion left the root zone by way of the plants through transpiration, which left the bulk of the salts in the root zrea that were brought in by the water at the previous irrigation. That process continuing over and over again gradually built up the salt content in the root zone at that end of the orchard. While the concentration had not yet reached the point to which the trees would show apparent visible symptoms, still it had accumulated to the point where a sufficient decrease in yield was noted.

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Q Now, I believe you testified this morning that you had personally witnessed certain experiments that were carried out by Dr. Frank M. Eaton of the U. S. Department of Agriculture at the Rubidoux Laboratory in Riverside, California, having to do with the effect of the use of waters of saline content on plant growth, is that correct?

A Yes, sir.

Q Will you describe the nature of those experiments?

A May I illustrate how the experiment was set up by showing enlargment of the photograph by Dr. Eaton?

Q Yes. You only have one copy?

A I only have one copy.

Q I don't believe it will be necessary to pass that around; just hold them where they are visible.

A Dr. Eaton from experience in the field gained the idea that possibly small accumulations of salt had an effect on the growth and production of crop plants, and therefore he wanted to conduct a few preliminary experiments in order to determine whether his field observations were correct or not. He therefore set up a series of tanks with sand enough for soil. This sand buffer was properly leached. I should state that all soluble matters possible were leached from the sands, which were used to make up these sand beds. Then he established a series of tanks in which he could maintain solutions, nutrient solutions, that the plant values. In these tanks he planted various crops, using

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two tanks, as I recall, for each set of experiments, and having several plants of each variety in each experiment. The seed itself, in most instances, was planted in these tanks, and the nutrient solution pumped on to the surface of the sand in the tanks and allowed to drain off immediately to avoid evaporation and the concentration. This process of renewing and draining was repeated frequently every day. The operation was automatic, automatic pumps for putting it on with time clocks, so that as near as practicable he was maintaining in these tanks approximately a uniform condition with respect to the nutrients and salts in the solution to which the roots were exposed.

I had a copy of my notes and a leaflet by Dr. Eaton, which, evidently, was left at the hotel at noon.

Q Is this it, Mr. Babcock?

A That is it. These plants were grown in most instances to maturity, and at maturity the crops were harvested and the dry weights were measured, with the exception of lemon cuttings, in which case the determination was made as to the length of growth on the branches. In each instance an increase in the concentration of chlorides soil solution brought a decided decrease in yield. This was also true with regard to the first increase in concentration of sulphates. Further increases in concentration of both chlorides and sulphates further diminished the yield. In this particular set of experiments, the decreased yield resulting from a given increase in chlorides was approxi-

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mately twice as great on an average as the decrease in yield due to an equal concentration of sulphates.

In this set of experiments, the first increase unit was fifty milligram equivalents; the second increase was a hundred milligram equivalents; the third a hundred fifty milligram equivalents—correction, the second was a hundred fifty milligram equivalents and the third two hundred fifty. In this set of experiments the effect upon the plants was largely unapparent in the appearance of the plants; in other words, the color of the plants and their parts, and the general character of the growth was not altered greatly until the higher concentration of salts was reached. The apparent visual difference in the plants was in the size of the same. In this instance with plants growing adjacent to each other, this difference in size was very apparent.

Photographs were taken at the conclusion of the experiment, and I have here an enlargement of cotton plants hung up for photographic purposes. It can be seen that the general character of the plants is very similar; however, the similarity in color cannot be shown on this photograph. The cotton plants on the left hand side of this photograph, as you look at the same, which are smaller in size, were grown in a solution in which the concentration of sulphate was maintained, as nearly as possible, at two hundred fifty milligram equivalents per liter. The plants shown on the right hand of the photograph, as you look at it, were grown in the control tanks. The control tanks

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were supplied with a nutrient solution, which was in all respects identical with the solutions supplied to the other tanks with the exceptions that varying amounts of chlorides and sulphates were used in the other tanks.

THE SPECIAL MASTER: You stated the amount of sulphates used in the tanks where the left hand picture-- what was the amount of chlorides?

THE WITNESS: The experiments- the tanks which grew these cotton plants shown on the left hand side of this photograph, no chlorides were supplied.

THE SPECIAL MASTER: Is there any evidence of any substantial amount of sulphates in this valley?

MR. CLAYTON: Yes, sir; there is evidence that there has been an increase in the sulphates, chlorides and sodium salts generally.

THE SPECIAL MASTER: And this left hand picture shows simply the sulphates?

THE WITNESS: This picture illustrates the results obtained where sulphates only were used as toxic salts. In other words, in these tanks a uniform nutrient solution was used. Salts were added in given concentration and in certain other tanks chlorides were added in given concentrations. The only series of tanks which contained neither chlorides nor sulphates was used to show what the normal might be providing neither sulphates nor

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chlorides were present.

It should be stated, however, that in the control tanks a very small amount of sulphate was added, as I recall approximately three milligram equivalents, it having been generally thought that some sulphates were necessary for normal growth.

As an illustration of the reduction in yield, these experiments showed that in the tanks supplied with a nutrient solution plus fifty milligram equivalents of chloride, the yield in navy beans was reduced forty percent; the growth of lemon branches was reduced in growth forty-five percent; the reduced production of milo was sixty-three percent; the reduced yield in alfalfa from the three cuttings made was seventy-three percent; the reduced yield in cotton was seventy-five percent; the reduced yield in tomatoes was seventy-seven percent.

For comparative purposes, Dr. Eaton, interpolated the reduction in yield for sulphates to a basis of one hundred millogram equivalents. While he had no tank to experiment with this amount, the fact that there is an apparent ratio between the toxicity of chlorides and sulphates, makes it easier to show the percentage if the results for sulphates could be shown if the plants were grown in a solution with a concentration of one hundred milligram equivalents. The interpreted reductions based on percentage are as follows: Navy beans forty-five percent reduction; lemons sixty-five percent reduction; milo sixty-two percent reduction; alfalfa seventy-five percent reduction;

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cotton seventy-six percent reduction, and tomatoes seventy percent reduction. It will be seen that the reduction is approximately the same in most instances when we consider fifty milligram equivalent concentrations of chloride as against one hundred milligram equivalents of sulphate.

THE SPECIAL MASTER: In plain language what does that mean? Means that sulphates are less bad to the crops than chlorides?

THE WITNESS: Those experiments would tend to indicate the reduction in yield is about fifty percent. Let me put it this way: That we get approximately twice as much reduction in yield with chlorides as with sulphates at the same concentration. However in experiments that Dr. Eaton since those experiments were made--

THE SPECIAL MASTER: I don't believe we should go into any experiemnts--

Q In connection with the question that the Court asked you, Mr. Babcock, before you pass from that, I want to quote a sentence from a paper written by Dr. Eaton on June 5, 1935, entitled Salinity of--

MR. HANNETT: I object, it hasn't been identified.

THE SPECIAL MASTER: I want to find out the question first.

Q --entitled The Salinity of Irrigation Water and Injury to Crop Plants: "In colloquial language, waters containing much calcium or magnesium are known as hard waters. Waters with little calcium or magnesium are known as soft waters. In this

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language either a saline or non-saline water would be referred to as soft, providing the concentrations of calcium and magnesium were low. If your irrigation water is inclined to be saline, you can well afford to remember a statement by C. S. Scofield published in 1921 'Hard water makes soft land and soft water makes hard land'." Do you agree with that quotation, that statement?

THE SPECIAL MASTER: Do you agree with the facts stated in it?

THE WITNESS: Yes, I do.

Q Have you finished with your discussion of these experiments, Mr. Babcock?

A No.

Q All right, resume.

A Dr. Eaton felt perhaps this set of experiments started with too high an initial concentration of salts, so he made a few additional experiments which are not yet published, but which I have observed during their progress, and on which I have some notes.

One experiment that Dr. Eaton conducted was to see what effect the concentration of salts had upon the withdrawal of water by the plant and the development of roots by the plant. In this experiment, Dr. Eaton started a corn plant in a nutrient solution and allowed it to grow until a few inches of roots had been developed. He then removed the plant, covered the roots with lamp black, and divided the roots into four bundles as nearly equal as possible. He then placed the plant over four jars con-

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containing nutrient solution. The nutrients were the same in each of the four jars. Into each jar he put one bundle of roots. In one of the jars he added no chlorides; in another he hadded ten milligram equivalents of chlorides; in the third jar he added fifty milligram equivalents of chlorides; in the fourth jar he added two hundred fifty milligram equivalents of chlorides.

In the jar containing no chlorides, the fresh roots grown by the time the plant reached maturity weighed 8.8 grams. The transpiration which took place from the plant through the roots that were in this jar amounted to 908 cubic centimeters. In the jar containing ten milligram equivalents of chloride, the fresh weight of the new roots amounted to 5.1 grams; the loss of water from this jar due to transpiration by the plant amounted to 348 cubic centimeters. The weight of new growth of roots in the jar containing fifty milligram equivalents amounted to one-tenth of one gram. The loss of water from this jar due to transpiration by the plant amounted to 53 cubic centimeters. In the jar containing two hundred fifty milligram equivalents of chlorides, no new roots were grown, and the loss of water from this jar due to transpiration was 55 cubic centimeters.

This experiment indicates that the increased concentration of chlorides decreases root growth and transpiration of moisture by the plant; or, in other words, reduces the intake of water to the plant by the roots. It is my opinion that both of these results are factors influencing the growth of the plant above

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ground and the yield of the plant.

In order to demonstrate that the removal of moisture from the jars was not wholly dependent upon the amount of the new growth put on by the plant, Dr. Eaton conducted a further experiment. In this experiment the indidividual bundles of roots were apparently changed from one salt concentration to another. By so doing approximately equal root growth was obtained on all four bundles. However, the water removed from the various concentrations was approximately the same as the water removed in the other experiment. This would indicate that for some reason, even when the same number and type of roots are exposed to the various concentrations of chlorides that the intake of water is retarded by the higher concentrations of chloride. This is the picture.

Q In your judgment, Mr. Babcock, having witnessed these experiments, would you say that the experiments were typical of conditions that would be encountered in every day irrigation agriculture?

A Yes, sir.

THE SPECIAL MASTER: Well now, why? You take this last experiment, as I understand, these roots were exposed to the various degrees of concentrated chemicals. As I understand your previous testimony, you said that the chemicals coming down from the surface became more and more concentrated the lower they got, therefore such plants as had roots which did not reach those concentrated portions of the earth would not be affected as much

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as the plants which did reach the most concentrated portion of the earth.

THE WITNESS: That is quite true.

THE SPECIAL MASTER: That is an entirely different situation from a series of jars containing- all of those roots are in contact with the most concentrated chemicals.

THE WITNESS: You are quite right, Your Honor, except that it should be stated that all of our waters have alkali salts to a certain extent, even the very purest waters as they originate in the high altitudes carry some alkali salts, and these experiments that I have just concluded are by way of showing that as the concentration is increased the yield is decreased.

THE SPECIAL MASTER: I understand that perfectly, but I don't understand your answer when you state that these laboratory experiments reproduce conditions in the field. I can see that they might and also see that they might not.

THE WITNESS: May I put it this way, Your Honor; assuming that the concentrations in the soil do increase with depth, a plant growing with roots only near the surface would be exposed to a lower concentration of salts than a plant growing with roots in lower horizons.

THE SPECIAL MASTER: Therefore the operation of these facts that you have been testifying to, would depend somewhat on the type of crop grown?

THE WITNESS: It would.

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THE SPECIAL MASTER: And somewhat on the depth of the soil to which the concentrated chemicals reach?

THE WITNESS: That is right.

THE SPECIAL MASTER: And in that respect the conditions in the field would differ from your laboratory conditions?

THE WITNESS: Perhaps I could explain it in this way: The correlation--It has been testified, and is my opinion, that the solution in the upper horizons is less concentrated than in the lower. However, that applies to conditions where water of a given quality is applied in a given amount, and in field conditions the surface soil, to which surface rooted crops might be exposed, and in which surface rooted crops would grow, the concentration in this surface area may be greatly different in one section of a field from another, or one field from another, depending on the manner of cultivation-- irrigation, I mean the amount of water applied and depending on the concentration of the salts in the water applied; in other words, these various concentrations of salt used in the experiment represent conditions which do exist in the surface portion of soils in practical agriculture.

Q Assuming, Mr. Babcock, the same plant, the same crop, the same soil, and the same growing conditions, what conclusion would you deduce from these experiments as to a change in the salinity of the water applied to the crop?

A An increased concentration of the salts in the irrigating

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water applied, would result in an increased concentration of the salts in the solution in the soil to which the roots would be exposed, and a decreased concentration in the salts in the irrigating water would result in a decrease in the concentration of the salts in the soil, providing an equal amount of water was applied.

Q And could you overcome that effect, the effect of an increase in the salinity by any method?

A Yes, the condition of a-- I should say it could be overcome to a certain extent.

Q How?

A By the addition of more water in the event the concentration is increased.

Q I believe in reply to my question you stated what would be the affect of the increase in salinity on the soil solution. What would be the effect of that on the plant itself?

A In my opinion, increasing the salinity of the soil solution decreases the yield of the plants exposed to that increase.

Q Would you then, or not, agree with this further quotation from Dr. Eaton's paper, from which I just quoted: "Profitable and permanent irrigation agriculture therefore depends on the use of an additional portion of an irrigation water to remove salt residues from the rootzone by subsoil leaching. If the subsoil is not sufficiently permeable to permit leaching in this manner, the necessity for tile drains will be evident.

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If neither subsoil leaching nor tile drainage can be depended upon, then we can be well assured that the agriculture will be shortlived. This is not a theoretical consideration. Lands are currently going out of production from this cause just as they have gone out in the past".

THE SPECIAL MASTER: What is the question now?

MR. CLAYTON: I asked if in the light of these experiments he would agree with the facts stated in that quotation.

A Yes, sir; I would.

Q Mr. Babcock, is there any peculiarity, or particular significance, in the sodium percentage, that is the percentage of sodium salts and other salts in the water?

A Yes, sir; there is.

Q Will you explain what that significance is?

A The higher the percent of sodium in the water, the more likely we are to cause-- to bring about what we call puddling, or deflocculation of the soil.

Q Is that an effect on the plant, or more particularly related to the soil?

A Apparently it is related primarily to the soil, and secondly to the plant.

Q Explain what you mean by deflocculation or puddling of the soil. If you wish, use the board for illustration.

A For reasons which are not atall clear to any of us, certain physical conditions take place in soils containing particles of

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clay. Most of our soils have considerable amounts of clay. By clay we refer to very small particles of soil. These clays have the ability of-- have the characteristic of changing their physical arrangement in some way so that under certain conditions the soil becomes very hard and difficult to work, becomes more impervious to water, and becomes sufficiently hard to make it, in some instances, difficult for plant roots to penetrate. The factor which apparently brings this condition about is the chemical change in these particles of soil. The higher percentage of calcium or magnesium in these particles of soil, the more pliable the soil will be, in other words we have a condition of flocculation, as it is called. As the percentage of calcium and magnesium decreases in the soil particles, and the percentage of sodium increases, a greater deflocculation takes place, and the soil becomes more compact, more impervious to water, harder to work, and presents a great many problems in management. The soil in many instances may become so impervious it is practically impossible to leach salts through it. We do not know just why the percentage of sodium in these soil particles brings about this physical affect. There are several theories regarding it. One is that a soil particle expands more when wet, if it has a high sodium percentage, thus crowding the particles close together and making an impervious condition. Another theory is that with a low percentage of sodium, and a condition of flocculation, that the soil particles tend to group themselves into groups

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thus leaving larger spaces between groups than would be obtained between individual particles, and that as the percentage of sodium increases there is a tendency to break up these groups of particles, and produce what might be called a dispursion of particles. To illustrate the first theory, I might show soil particles roughly as these circles--

THE SPECIAL MASTER: Is it necessary to go into this? If we know there are two theories, and know the effects produced, is it necessary to go into the question of which theory is correct?

MR. CLAYTON: Perhaps not.

MR. HANNETT: We can see salt is bad.

MR. CLAYTON: It is perhaps not necessary to go into the theory. We wanted to go into the effect of sodium on the soil.

THE SPECIAL MASTER: I think you have gone far enough on that.

Q Do you agree with this statement from Dr. Eaton's pamphlet from which I just quoted with respect to the phenomena that you have just described: "When the percent sodium of a water is high the sodium replaces a part of the calcium and magnesium of the soil, resulting in a marked change in the structure of the soil. This exchange process is familiar to many of you who are acquainted with the action of certain water softeners. In some of these, a zeolitic material is first saturated with sodium by washing it with common salt, for instance sodium chlordie. When a hard water is then passed through the softener for subsequent use,

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calcium and magnesium are taken up from the water by the zeolite, and sodium is liberated to the water in their place. The result is the soft water so much desired for domestic or industrial use. It is important that you remember that sodium has been substituted for calcium and magnesium. The treated water has not been made less saline. You can be assured that these softened waters are not well suited to use on lawns and gardens. The adverse effects of sodium-induced impermeability are not wholly related to salt accumulation however. In our work we have observed lands to go out of production in comparatively short periods when irrigated with waters with high percentages of sodium. Examinations of some such soils have shown that they had not yet become sufficiently saline to account for the crop failure. As the total salinity of the water increases the percent sodium becomes increasingly more important." Now, do you agree with that?

MR. HANNETT: We admit that is true.

Q Now, Mr. Babcock, you have testified that as you increase the salinity of the water, the concentration of salts, it becomes necessary in order to give what I shall refer to as equivalent service, that is to leach the salts out of the root zone, and maintain the same character of plant growth, to add increasing quantities of water, is that correct?

A Yes, sir.

Q Now, have you prepared, or do you have, an exhibit showing the relation between the increase in salinity and the ~~increase~~

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in amount necessary to put on the land to overcome the effect of the salinity?

A Yes, sir.

MR. CLAYTON: Your Honor, we have several small copies of this exhibit, one of which we will introduce. We have a large one which we will use for purposes of illustration.

MR. HANNETT: There is no proof of increased salinity in the record so far.

MR. CLAYTON: There is a great deal of proof of increase in salinity.

THE SPECIAL MASTER: There is evidence on the subject.

MR. HANNETT: Yes, but no proof.

MR. CLAYTON: I will ask the reporter to mark for identification as exhibit T-77 an exhibit entitled Equivalent Irrigation Service with Waters of Different Concentration.

Q Now, Mr. Babcock, if you will refer to the large exhibit on the board, T-77 - you may come over here to do so. You have on this exhibit, Mr. Babcock, different examples, do you not?

A Yes, sir.

Q Two of which you have labeled Equivalent Service, and two of which you have labeled Service not Equivalent?

A Yes, sir.

Q Would you take those up one by one and explain the relation?

A Example A illustrates what would happen if a water of certain conductance were applied to the soil in a certain volume

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Assuming we had a given consumptive use of water, the amount of drainage water, and the conductance of the same, can be determined. As I stated in earlier testimony, the average of the conductance of the water in the rootzone, at the time of application of irrigating water, is the average between the concentration of the water applied and the concentration of the water removed. We will assume that the consumptive use of water is three acre feet, and we will assume that a given average concentration should be maintained in the root zone, and take for that figure a conductance of three hundred. That would mean that the conductance of the water draining from the root area would be five hundred. From computations, we show that in order to supply the three acre feet for consumptive purposes, and to maintain a conductance in the root area, at the time of application of irrigation water of three hundred, it would be necessary to apply 3.75 acre feet of water and pass to the drainage area or roots three quarters of an acre foot of water.

Now, if the water applied is of a higher conductance, we have, in example B, an example of what I term equivalent service; in other words, we wish to maintain the same average conductance of the water in the rootzone at the time of application that we had under this first service, and we want also to apply the same amount of water for consumptive use. In other words, equivalent service means that, regardless of change of character of water, the plant should be supplied with the same amount of water for

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consumptive use, and the concentration of the salts in the root zone, should be maintained constantly. In working out in example B, we find if the water applied has a conductance of a hundred fifty, instead of a hundred in example A, and assuming the same consumptive use of three acre feet, and maintaining the same average conductance of the water in the rootzone, we find it necessary to apply four and a half acre feet to the surface, and pass to the drainage below the rootzone one and a half acre feet of water, which would have a conductance of four hundred fifty.

I might call attention to the fact that an error was made in preparing this exhibit in which a figure, just quoted as a hundred fifty-- in which the figure just referred to as one and a half acre feet, appeared as one and a quarter acre feet; an arithmetical error.

THE SPECIAL MASTER: Let me see if I get that. If you increase your conductance, that is the salinity, fifty percent you say you have to increase the amount of water applied fifty percent, is that it?

THE WITNESS: It would be in percentage in all cases.

THE SPECIAL MASTER: In these two examples it is?

THE WITNESS: Yes, sir.

THE SPECIAL MASTER: You increase your conductance from one hundred to a hundred fifty, and you increase the necessity for water applied from three hundred to four fifty, which is fifty percent?

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MR. CLAYTON: Three seventy-five to four fifty.

THE SPECIAL MASTER: No, the consumptive use is three hundred, and you had to put on four fifty under example B, that is you only put on fifty percent more water.

THE WITNESS: I might explain it--

THE SPECIAL MASTER: You had fifty percent higher conductance and you put on fifty percent more water.

MR. CLAYTON: The water applied in example A was 3.75.

THE SPECIAL MASTER: No, we are starting out with a consumptive use of three hundred.

MR. CLAYTON: Three acre feet.

THE SPECIAL MASTER: Yes, three acre feet, and when you increase the conductance from one hundred to a hundred fifty, and the water from three hundred to four fifty--

MR. CLAYTON: No, in example A it is 3.75.

THE SPECIAL MASTER: I am talking about example B.

MR. CLAYTON: I thought you were drawing a comparison--

THE SPECIAL MASTER: I was drawing a comparison between the conductance, but the consumptive use is the same in both.

MR. CLAYTON: That is correct.

THE SPECIAL MASTER: And when you increase the conductance fifty percent in example B, you had to increase the amount of water applied fifty per cent; fifty percent over the consumptive use.

MR. CLAYTON: I believe I can clear that up with a question

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to the witness.

Q In example A what does the duty of the water have to be?

A The duty of water in example A is 3.75 acre feet to the acre.

Q And what is the consumptive use?

A The consumptive use is three acre feet.

THE SPECIAL MASTER: What do you mean by consumptive use there?

THE WITNESS: The consumptive use there includes two things: One the transpiration losses from the plant, and the other the evaporation from the soil.

THE SPECIAL MASTER: Now, if you say that the service is 3.75--

THE WITNESS: Yes, sir.

THE SPECIAL MASTER: In example A?

THE WITNESS: Yes, sir.

THE SPECIAL MASTER: Now, take the same service 3.75 and increase your conductance of the water, what happens then?

THE WITNESS: That would be what I call unequivalent service. That is illustrated in example C.

THE SPECIAL MASTER: I know, but how do you get the figure four fifty? How do you arrive at it?

THE WITNESS: In example B?

THE SPECIAL MASTER: Yes. You apparently start off with that figure. If you start off with that service, you are starting off with the figure four fifty, why do you do that? How do you

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arrive at that particular figure?

MR. CLAYTON: Do you wish me--

THE SPECIAL MASTER: No, I am asking the witness.

THE WITNESS: I am assuming that for the purpose of illustration, that the consumptive use might be three acre feet, and that we might have under certain irrigation systems a conductance, average conductance, in the rootzone of three hundred; that the amount of water necessary to produce that effect, in other words, to give us three acre feet for consumptive use and to maintain that average conductance in the root area, the amount of water necessary to be applied, when the applied water had a conductance of a hundred, would be three and three-quarter acre feet. That is arrived at by arithmetical-- algebraic equation from the fact, first that the average conductance in the rootzone, following the application of water, is equal to the average between the conductance of the water applied and the water withdrawn. By that method we first determine the conductance of the water removed. Now, we have as a constant, the consumptive use--

Q Mr. Babcock, may I interrupt. In each of these examples is the amount of salt that comes in with the applied water equal to the amount of water that is taken away?

A Yes, this represents a condition which will give a salt balance.

Q That is true in each of these examples?

A That is true in each example of equivalent service.

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Q Now, when you are speaking about the specific conductance of the soil solution, do you mean at the time of the application of water, or some subsequent time?

A Yes, that is the only practical way that we can base it, the time of application. This refers to the condition at the time of application, or, as you might say, at the completion of the irrigation.

Q Does that specific conductance increase between irrigations?

A Certainly.

Q Materially?

A Very materially. As the water is withdrawn from this root area, by evaporation from the surface, and by the large amount which transpires through the plant, the concentration of the soil solution is greatly increased, depending on the length of time between irrigation and amount withdrawn, that may vary from three to eight or ten times.

Would Your Honor like to have me explain the arithmetic or algebra by which this was--

THE SPECIAL MASTER: I would like to have it explained. It is clear as mud to me now.

THE WITNESS: Have I made it clear how I arrive at the conductance of the drain water?

THE SPECIAL MASTER: Understand, I am thinking of this thing out in the field. How do you go out there in the field and find the conductance of the drain water? How do you get samples of

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water and find the conductance of the water around those roots? Apparently you start with that figure.

THE WITNESS: We have to assume for the purpose of illustration that in this case we are using a plant which occupies the space-- the roots of which occupy the space between the surface of the soil and the water table.

THE SPECIAL MASTER: That is just it. Some crops may and some crops may not. You have varying conditions up and down the valley, and different parts. I don't see how, by a sample illustration, you can tell how much additional water is necessary to put upon the land in order to overcome additional salinity. It seems to me there are a dozen different factors may come in according to the crop, the locality, and many different conditions. I cannot see what the practical application of the example is.

THE WITNESS: If I may be allowed to use the board again, I shall endeavor to explain.

THE SPECIAL MASTER: I wish you would. I think it is a very important question, and highly important not only that I should understand it, but the record be such that the Court can understand it. Of course, what I am trying to get at is - undoubtedly there is an answer to it - what I am trying to get at is the practical application of the theory. Mr. Clayton can say whether there was a method by which increased salinity of the soil could be counteracted or overcome, but that is a

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practical question, it isn't a matter of applying some theory. It is a very important question.

THE WITNESS: I will draw a horizontal line on the board, which will represent the surface of the soil. Then I will draw another horizontal line a slight distance below the first, which I will assume will represent the depth to which cotton plants, for instance, might penetrate. Then, I will put, just for illustration, a cotton plant growing there. Now, if we apply water to the surface in a sufficient amount to wet only to the bottom of that root area, in other words to the second line which I drew there, the water-- the concentration of the water, as it went on-- Let me put it this way, the average concentration of the water in the rootzone, between the lower line and the upper line, will be equal to the average concentration between the water applied and the water found at the bottom of that root area. In other words, the average to which the roots are exposed is equal to the average between the conductance of the water applied and the water delivered at the lower elevation of the rootzone to be passed to drainage. That water going into the next horizon, which I will illustrate as another line some distance below, from-- if additional amounts of water are applied to the surface, this condition continues, and we may expect the same relationship to exist between the lower horizon of this root zone, in which we might have alfalfa growing, as existed in the first root zone illustrated.

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THE SPECIAL MASTER: According to your previous testimony, on your second horizon there, in which you have alfalfa growing, you would have increased salinity there?

THE WITNESS: Yes, sir.

THE SPECIAL MASTER: That is, the further down you get you would have more salinity. Suppose you had two adjacent fields, one of cotton and one of alfalfa, on this theory you would have to apply different amounts and additional water according to the depth of the root?

THE WITNESS: That is entirely correct.

THE SPECIAL MASTER: Is that practical over a whole valley of thousands of acres with every different kind of crop, to treat it in that fashion?

THE WITNESS: Yes, that is the practice in agriculture.

THE SPECIAL MASTER: Would it be practical in this valley? Are you familiar with conditions here?

THE WITNESS: I have just seen it during a two day trip.

THE SPECIAL MASTER: Is the irrigation in this valley in furrows?

THE WITNESS: Partially in furrows, and partially flooding.

THE SPECIAL MASTER: Which predominates?

THE WITNESS: From the evidence that I saw in the fields, I would say that furrow irrigation predominates with cotton and with alfalfa flood irrigation is entirely used.

THE SPECIAL MASTER: It is true that according to the crop and the location, there would have to be varying additional

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amounts of water under your theory?

THE WITNESS: Yes, sir; in the general practice of agriculture that is taken into consideration. It will be found, from a study of the ordinary duty of water on various crops, that some crops need and require additional water and they receive it.

THE SPECIAL MASTER: Do you know anything about the practice of the release of water at Elephant Butte?

THE WITN ESS: No, sir.

THE SPECIAL MASTER: Well, I understand so far, but I still don't understand, unless you make actual tests, how you arrive at the conductance of the water at the bottom of those roots.

THE WITNESS: I am in this instance deducing the conductance of the water, that goes to the drain, by logic, from the fact that the average concentration of the solution between the point at which the water is applied, and the point at which the water is taken off, will be equal to the average between the water applied and the water removed.

THE SPECIAL MASTER: That is assuming that you remove or drain there at the horizon of the roots. The drain may be much lower than that, and lower there may be an entirely different condition of the soil.

THE WITNESS: The water that reaches a certain horizon is the drainage water for the horizon above, may I put it that way, regardless of whether it is picked up and carried off. In

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