May 31, 2019

EXPERT REPORT OF ROBERT J. BRANDES

In the matter of:

No. 141, Original
In the Supreme Court of the United States
State of Texas v. State of New Mexico and State of Colorado

Prepared for:

Somach Simmons & Dunn
500 Capitol Mall, Suite 1000
Sacramento, CA 95814

Prepared by:

Robert J. Brandes, P.E., Ph.D.
Robert J. Brandes Consulting
6000 Maurys Trail
Austin, Texas 78730

MAY 31, 2019

that was conveyed through channel losses and seepage from the river channel and drainage ways to the groundwater system.

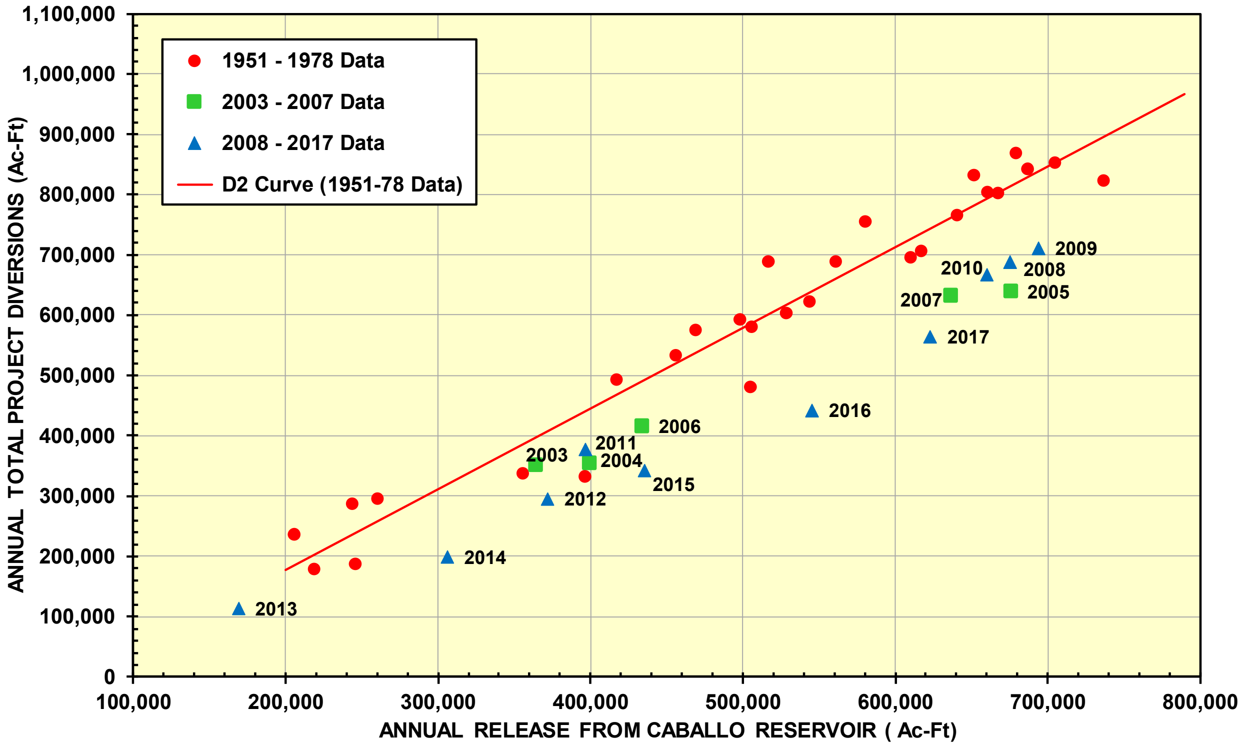
Finally, in a presentation in October 2008 at the 53rd Annual New Mexico Water Conference [9], Gary L. Esslinger, manager of the EBID, discussed the importance of the Operating Agreement for the Rio Grande Project ("Agreement") that had just been approved and adopted in August of 2008 by the USBR, the EBID and the EPCWID [3]. Preparation and adoption of a "detailed operational plan …….. setting forth procedures for water delivery and accounting ……" by USBR, the EBID and the EPCWID was a stipulation in earlier contracts [10, 11] between each of the Districts and the USBR under which each of the Districts assumed responsibility from the USBR for operation and maintenance of their respective canal and irrigation delivery systems. After many delays, the 2008 Agreement finally was intended to fulfill this requirement. As such, the 2008 Agreement prescribes procedures for determining annual allocations of Project water among EBID, EPCWID and Mexico, for releasing water from storage, for ordering and making deliveries of Project water, and for accounting and reporting. Maybe most importantly, the 2008 Agreement included provisions that were intended to address how groundwater pumping in New Mexico was to be recognized and accounted for, with certain concessions from EBID to the EPCWID regarding annual allocations of Project water.

Pursuant to this discussion, Esslinger explained how for specific annual releases of Project water from the reservoirs starting in 2003 when sustained dry conditions began and extending through the present (2007 at that time), the annual diversions of Project water from the Rio Grande at major canal headgates were considerably less than previous diversions corresponding to the same annual reservoir releases that were made during the 1951-1978 period. Esslinger illustrated this on a plot of annual diversions versus annual reservoir releases showing data for the 1951-1978 period and for the more recent years 2003 through 2007. A reconstruction of this plot is presented in Figure 4.6 below, except that the annual diversion and release data in this plot have been extended beyond Esslinger's 2007 data base and through the year 2017 [22,15].

As shown on the plot, practically all of the more recent data since 2003 (green squares and blue triangles) indicate reduced diversions relative to those for the 1951-1978 baseline data base for the same reservoir releases. The significance of the 1951-1978 period is that Project operations data from this period were used by the USBR around 1980 [12] to develop linear regression equations relating actual annual canal diversions to actual annual reservoir releases (referred to as the D2 Curve) and actual annual farm deliveries to actual annual reservoir releases (referred to as the D1 Curve). These relationships subsequently were used by the USBR for determining annual allocations of Rio Grande Project water for EBID, EPCWID and Mexico (see Subsection 6.3). Based on the fact that annual diversions have been reduced in recent years with respect to the D2 Curve for the same amount of annual releases from Caballo Reservoir as shown on the graph in Figure 4.6, Esslinger concluded that it was groundwater pumping and the lowering of groundwater levels in pumping areas and the associated depletions of surface water flows that caused the observed reductions in the annual volumes of Project water delivered and diverted during the 2003-2007 period (which now is further supported with the 2008-2017 data plotted on the graph).

With regard to the 2008 Agreement, Esslinger noted that a provision in the Agreement that required annual allocations of Project water to EPCWID and Mexico to be based on the 1951-1978 D1/D2 Curves tended to provide protection to these entities from subsequent impacts of groundwater pumping in New Mexico, and it allowed groundwater pumping in New Mexico to be grandfathered at the 1951-1978 levels that are embedded in the D1/D2 Curves. The fact that Project diversions since implementation of the 2008 Agreement still have remained well below the D2 Curve as shown on the graph in Figure 4.6 suggests that the effects of groundwater pumping in New Mexico on deliveries to Project users in the lower Mesilla basin and in the El Paso Valley of Texas still are not being adequately accounted for.

Figure 4.6 Annual Rio Grande Project Diversions versus Annual Releases from Caballo Reservoir



5.0 HISTORICAL TRENDS IN CHANGING FLOWS

As discussed above, examination of historical flows using various graphical and statistical methods applied to historical data can provide useful insight with regard to relationships, or changes in relationships, between different parameters of interest when trying to assess impacts of certain hydrologic phenomena. For example, if the historical groundwater pumping in the Rincon and Mesilla basins of New Mexico did, in fact, cause flows in the Rio Grande to be reduced and thereby be unavailable to Texas, these effects should be discernable in the historical data through the application of various graphical means.

Releases of Project water from Caballo Reservoir, and occasional spills of flood water, represent the principal source of water that influences the day-to-day magnitude of flows that occur downstream along the Rio Grande that ultimately reach Texas. While other factors such as canal diversions and arroyo inflows affect these river flows, it is the reservoir releases themselves that dominate the normal flow regime of the Rio Grande throughout the Project area. The historical

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Expert Report of John C. Carron and Steven T. Setzer

3rd Edition, Revised for September 15, 2020

In the matter of:

No. 141, Original

In the Supreme Court of the United States

State of Texas v. State of New Mexico and State of Colorado

Prepared for:

The State of New Mexico

Prepared by:

John C. Carron and Steven T. Setzer
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STATE OF TEXAS
STEVEN T. SETZER
114987
LICENSED
PROFESSIONAL ENGINEER

September 15, 2020

John C. Carron, Ph.D.

Steven T. Setzer, P.E.

TX v. NM # 141
New Mexico Exhibit
NM_EX-125

1.3.3 Hudspeth Reservoirs

Three reservoirs are modeled within HCCRD: Hudspeth Reservoir 1 (a generic name used in the model – Google Maps has this labeled "County Line Lakes"), Clayton Reservoir, and McKinney Reservoir. Historical data for these reservoirs is not available, so the model operates these reservoirs based on water available in the Hudspeth Canal and the crop requirements within the HCCRD irrigated areas. For example, if more water is available in the Hudspeth Canal than needed to meet the crop demands, the model will store the excess in the Hudspeth reservoirs provided storage space is available. If there is not enough water in the Hudspeth Canal to meet crop demands, water is released from the reservoirs to meet demands.

Together these three reservoirs have a storage capacity of approximately 4,200 acre-feet (AgriLife Research, 2009). Evaporation data for each of the reservoirs is based on reference ET data (Sullivan and Welsh, 2019).

1.4 River Network (reaches and headgates)

The RiverWare Model simulates the Rio Grande from the USGS gauges at San Marcial to Fort Quitman. Below Caballo Reservoir, river diversions take place at the following locations:

- Percha Diversion Dam
- Leasburg Diversion Dam
- Mesilla Diversion Dam (east side and west side)
- American Diversion Dam
- International Diversion Dam
- Riverside Diversion Dam (prior to 1999)
- Two unnamed diversion locations in Mexico below Riverside Diversion Dam
- Unnamed diversion location above Hudspeth feeder canal

In addition to the diversion locations listed above, the main channel of the Rio Grande in the RiverWare Model simulates the following processes:

- Return flows from wasteways
- Return flows from irrigation drains
- Surface water – groundwater interactions (gains/losses between river and alluvial aquifer)
- Losses due to open water evaporation
- Wastewater treatment plant returns

1.5 General Description of Service Areas and Surface Water Distribution Algorithms

Downstream from Elephant Butte and Caballo reservoirs, there are six service areas represented in the model: Rincon Valley (served by the Percha Diversion Dam), Leasburg Valley (served by the Leasburg diversion dam), Mesilla Valley (served by the Mesilla diversion dam), EPCWID downstream of El Paso (served by the American and Riverside diversion dams), HCCRD (served by drain flow and canal flow from EPCWID plus an unnamed diversion structure at the Hudspeth Feeder Canal), and the Juarez, Mexico region (served by Acequia Madre and two unnamed diversion dams).

In each of the service areas, there are water users which primarily use surface water when it is available, but may supplement their water supply via ground water pumping. There are also primary ground water users, who do not receive surface water deliveries, but whose pumping and return flows affect the aquifer and river.

Within the model, each service area served by a particular headgate is divided into irrigation sub-areas (Figure TM 1.1 shows one of five sub-areas in the Rincon Valley). The sub-areas were delineated so as to represent large-scale system features (e.g. a delivery canal and drain) and to divide the service area into roughly equal-sized segments (based on GIS coverage of current irrigated areas). The Rincon Valley is divided into five sub-areas, the Leasburg Valley into five sub-areas, the Mesilla Valley into thirteen sub-areas, the EPCWID region downstream of El Paso into five sub-areas, Hudspeth into three sub-areas, and Mexico into seven sub-areas.

The model simulates water diversions from the Rio Grande at one of the nine diversion dam structures. Diversion requests are either set to the historical diversion, when running the historical calibration simulation, or are set based on irrigation demands, limited to allocations, when simulating Project operations in the Historical Base Run or any of the alternative scenarios described in the main body of the report.

Once water has been diverted from the river into a canal, the total canal seepage for the service area (e.g. the Rincon Valley), is removed from the canal plus an additional 6% of the canal seepage volume for incidental loss (Sullivan and Welsh, 2019). The incidental loss leaves the system while the total canal seepage volume (which is imported from either the Rincon-Mesilla Model or Hueco Model), is then distributed to each sub-area to the RiverWare groundwater objects according to the volumes imported from the Rincon-Mesilla or Hueco Model. In other words, the Rincon-Mesilla Model and the Hueco Model provide the RiverWare Model with the canal seepage for each sub-area. Within the RiverWare Model, the total canal seepage for the service area (sum of the canal seepages for each sub-area within the service area) is computed and removed at the upstream end of the canal for the service area (plus the additional 6% incidental loss). Once removed from the canal, the seepage volume for each sub-area is added to the RiverWare groundwater object associated with that sub-area. There are exceptions to this process. For example, in the EPCWID service area below El Paso, the canal seepage is removed at various locations along the canal instead of the upstream end of the canal.

If the model is being simulated as the Historical Calibration Simulation, the remaining volume in the canal (after canal losses have been applied) is distributed to each farm headgate sub-area, *pro rata*, based on historical farm headgate delivery data and the percentage of irrigated acreage of each sub-area with respect to the total irrigated acreage in the service area. Any volume

May 31, 2019

EXPERT REPORT OF:
William R. Hutchison

In the matter of:

No. 141, Original
In the Supreme Court of the United States
State of Texas v. State of New Mexico and State of Colorado

Prepared for:

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5/31/2019

11.3 Alternative Consumptive Use Scenarios

133. As stated earlier, one of the components of the "1938 condition" is the irrigated acreage and consumptive use expressed as acre-foot per acre in 1938. Agricultural consumptive use has increased since 1938 as documented in Technical Memorandum 3 and previously shown in Figure 7.

134. The hypothetical simulations documented in Technical Memorandum 20 cover five scenarios where agricultural consumptive use is limited to that of 1938. The simulations were run from 1938 to 2016, but the modifications were applied only after 1950 to provide a means of comparison with other scenarios.

135. The agricultural pumping, agricultural deep infiltration, and surface water diversion components of the alternative consumptive use scenarios were developed by summing the consumptive use of 1938 (149,005 AF/yr) and the necessary component for canal losses and deep infiltration associated with irrigation. For each year, this sum was viewed as a demand and compared with the annual historic surface water diversions for agricultural use. If the historic surface water deliveries were higher than the new demand, the excess remained in the surface water system (i.e. surface flow was not diverted). If the historic surface water deliveries were less than the new demand, groundwater pumping for irrigation was set equal to the deficit.

136. Five alternative urban and domestic groundwater pumping scenarios were simulated. Scenario 1 assumed a limit of 10,000 AF/yr, Scenario 2 assumed a limit of 20,000 AF/yr, Scenario 3 assumed a limit of 30,000 AF/yr, Scenario 4 assumed a limit of 40,000 AF/yr, and Scenario 5 assumed a limit of 50,000 AF/yr.

137. Results of the simulations show that Rio Grande at El Paso flows are higher under

Rebuttal Expert Report
Gilbert R. Barth, Ph.D. and Steven P. Larson

State of Texas v. States of New Mexico and Colorado, No. 141, Original, U.S. Supreme Court

Prepared for:
State of New Mexico

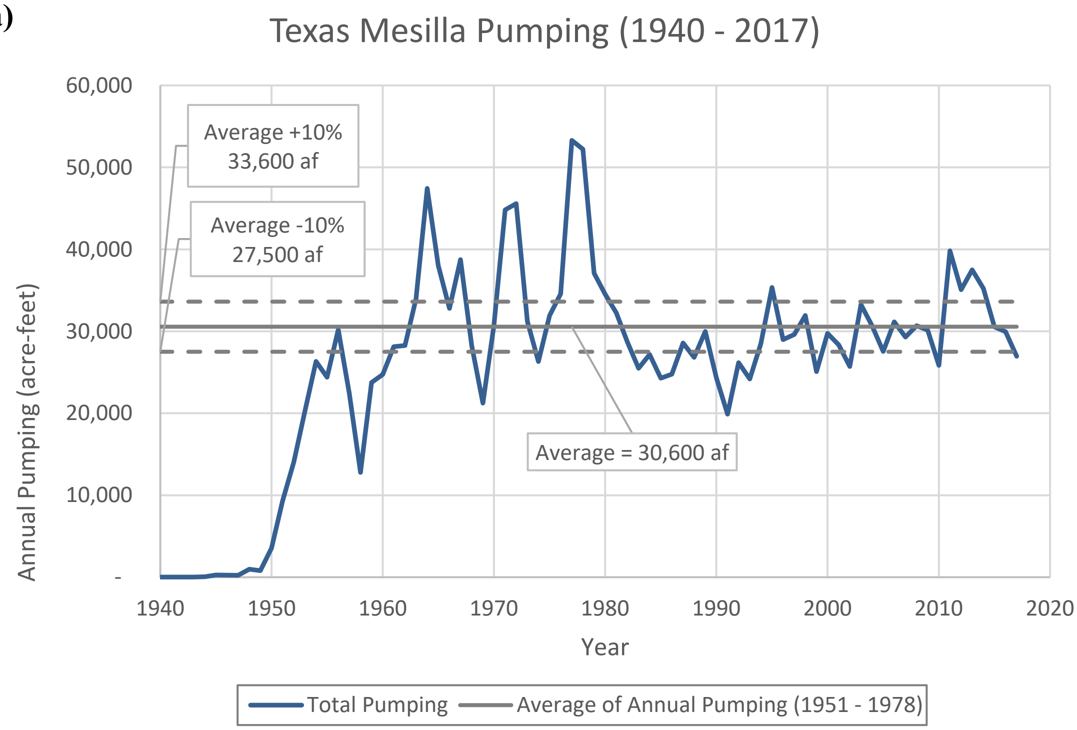
S.S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

1st Edition July 15, 2020
2nd Edition September 15, 2020

3100 Arapahoe Ave, Suite 203, Boulder, Colorado 80303-1050 • (303) 939-8880

TX v. NM # 141
New Mexico Exhibit
NM_EX-127

(a)



(b)

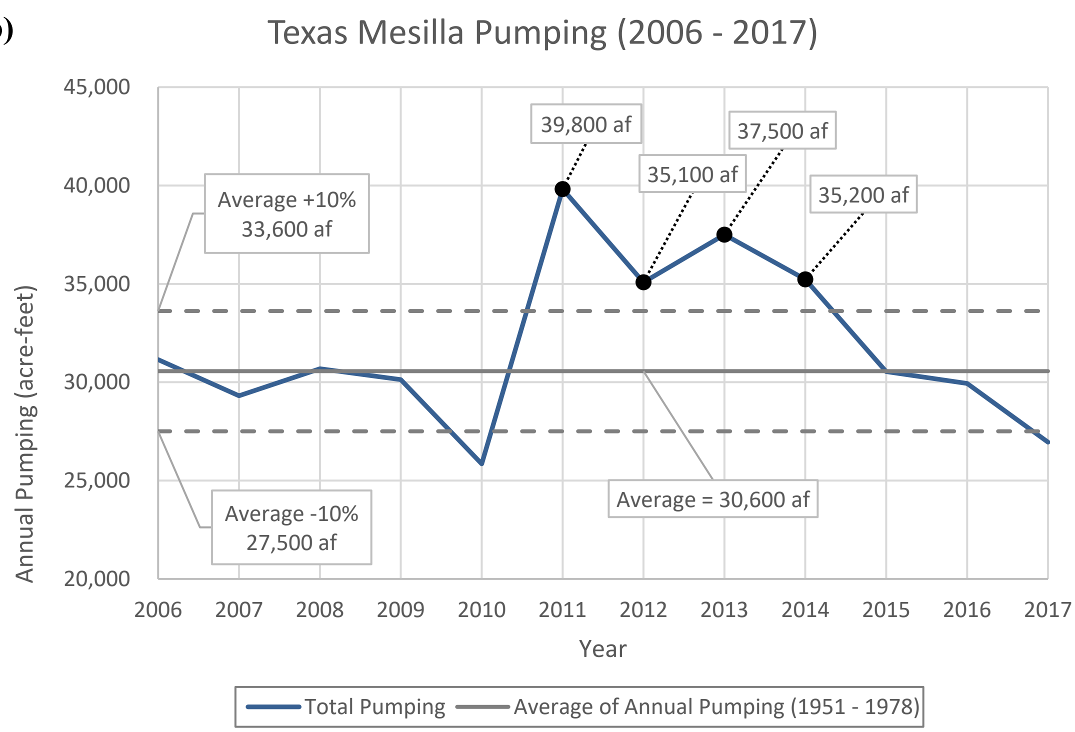


Figure 3-1. Annual Texas-Mesilla pumping, (a) simulation period and (b) period of operating agreement

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

****

REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
PEGGY BARROLL
OCTOBER 21, 2020

****

REMOTE ORAL AND VIDEOTAPED DEPOSITION of PEGGY BARROLL, produced as a witness at the instance of the United States, and duly sworn, was taken in the above-styled and numbered cause on October 21, 2020, from 1:02 p.m. to 3:29 p.m, before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-226

during the course of the year, but most often, people get, eventually divert too much, you know, exceed the limit. It usually happens late in the year. And we usually find out about it in the reconciliation that occurs after the first of the year when the water master compiles all of the meter data that's been obtained, compares it to the acreage and acre-feet per acre limits on those water rights, and then determines where discrepancies lie, where the diversions had exceeded the limits.

Q. And how does the -- how does -- I'm sorry. Go ahead.

A. That will occur in February or March.

Q. Okay. And how does the -- how does the enforcement or administration occur then after the fact?

A. At that time, in the early months of the following year, the water master will make calculations I have described. He will contact water right owners who have over diverted. I believe he has a -- a threshold of approximately 10 percent that exceeded their limit by 10 percent, that 10 percent being based on the general accuracy of the meters, and they -- we will work through the issue with agreeable water right owners, finding any errors in the data, which usually in the first pass, there are a few data points which were erroneous, meter entries, and then work with, again, the agreeable water right owners to come up with a repayment plan, which involves generally that water right diverting less in the year following the under diversion -- the over diversion. Noncooperative water right owners are their -- a packet that's set up to send up to the legal division of the state engineer's office and the enforcement action through the legal division is begun, and often that happening and getting a letter from a lawyer will cause water right owners to become more agreeable and work out a repayment plan for the water master. In general, there are approximately on the order of 200 over diversions in a given year, and they are dealt with by the water master through water master local enforcement, most of them, and then he will send recalcitrant ones up to the legal unit of the state engineer's office in Santa Fe, and that total number of enforcement actions that he requests from the legal division varies from 1 to 30 per year, and that would include over diversions and, say, violations -- other violations of the metering order.

Q. So if you've got, I think you said about 200 over diverters every year, that would have caused --

to take into account any delays as to when the water -- the water associated with curtailing groundwater rights would show up back in the river and would come up with -- he would be tasked with determining the administration date and water rights junior to that date would be curtailed.

Q. Any idea how long it would take to come up with that kind of an analysis and plan?

A. I don't know. But the tools we've developed as part of settlement talks and as part of our litigation have definitely made it within striking distance that we should be able to perform such an analysis expeditiously.

Q. What do you -- what do you define as expeditiously?

A. Within months rather than years.

Q. Do you recall Mr. Lopez's characterization of Texas' complaint in this action as a formal complaint for purposes of the Compact?

A. Yes.

Q. Okay. Do you agree?

A. Yes.

Q. Okay. What has New Mexico done since Texas has filed its complaint to address Texas' concerns?

A. Well, we have been investigating the validity

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December 04, 2020

James Dubois
U.S. DEPARTMENT OF JUSTICE
Environment & Natural Resources Division
999 18th St, # 370 South Terrace
Denver, CO 80202

Re: Deposition of **Peggy Barroll**
10/21/2020
141 ORIGINAL; State of Texas vs. State of New Mexico and State of Colorado

Dear Mr. Dubois:

Enclosed please find the **signed** original deposition of the witness named in the above-referenced matter for filing among your records. By copy of this letter, we are informing all parties shown herein of the **amendments** made to the deposition.

If you have any questions regarding this matter, please feel free to contact our office.

Sincerely,

Minnie Adame
Worldwide Court Reporters, Inc.

Job No. 65834

cc:
Samantha R. Barncastle
Chad M. Wallace
Maria O'Brien
Jeffrey J. Wechsler
Sarah A. Klahn

Corporate Headquarters
3000 Weslayan St. Suite 235 Houston TX 77027
713-572-2000 Fax 713-572-2009

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IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS)
)
Plaintiff,)
) Original Action Case
VS.) No. 220141
) (Original 141)
STATE OF NEW MEXICO,)
and STATE OF COLORADO,)
)
Defendants.)

THE STATE OF TEXAS :
COUNTY OF HARRIS :

I, HEATHER L. GARZA, a Certified Shorthand Reporter in and for the State of Texas, do hereby certify that the facts as stated by me in the caption hereto are true; that the above and foregoing answers of the witness, PEGGY BARROLL, to the interrogatories as indicated were made before me by the said witness after being first duly sworn to testify the truth, and same were reduced to typewriting under my direction; that the above and foregoing deposition as set forth in typewriting is a full, true, and correct transcript of the proceedings had at the time of taking of said deposition.

I further certify that I am not, in any capacity, a regular employee of the party in whose behalf this deposition is taken, nor in the regular employ of this attorney; and I certify that I am not interested in the cause, nor of kin or counsel to either of the parties.

That the amount of time used by each party at the deposition is as follows:

MR. DUBOIS - 01:16:41
MR. WECHSLER - 00:00:00
MS. KLAHN - 00:45:07
MR. HARTMAN - 00:00:00
MR. HICKS - 00:11:48
MS. BARNCASTLE - 00:00:00

GIVEN UNDER MY HAND AND SEAL OF OFFICE, this, the 31st day of October, 2020.

HEATHER L. GARZA, CSR, RPR, CRR
Certification No.: 8262
Expiration Date: 04-30-22

Worldwide Court Reporters, Inc.
Firm Registration No. 223
3000 Weslayan, Suite 235
Houston, TX 77027
800-745-1101

Barroll 30B6 Deposition 10/21/2020 Corrections

Page.line	Change From	Change to	Reason
13.10	Hotstef	Hohstadt	Transcript error
14.3-4	"which have been adopted and were succeeded in the constitution and in the New Mexico Supreme Court."	"which have been adopted and were upheld by the New Mexico Supreme Court."	Transcript error/ I misspoke
15.19-20	"New Mexico has the responsibility no to interfere with at or not to – or to ensure that that can occur to work in _"	"New Mexico has the responsibility to ensure its legal and regulatory framework allows Reclamation to deliver Project and Compact waters"	Clarification
15.24-16.1	"To work in concert with Reclamation when it comes to whatever is necessary surface water distribution of the project."	"To work in concert with Reclamation as necessary to assist in the delivery of surface water by the project."	Clarification
18.1-2	"it is, in fact, usable water or project supply."	"it is, in fact, project water, or project supply."	Clarification
24.9		Add to end: "Furthermore, the normal operations of the project, as understood by New Mexico, ensure that project users are delivered what they order. Reclamation adjusts Project releases to ensure the water that has been ordered is in fact delivered, regardless of contemporaneous gains or losses to the stream system."	My answer was incomplete
32.17-24	"A. Water users are -- water users in New Mexico cannot divert water that they're not entitled to and so that water users who do not have legal authority cannot divert surface water away from the Rio Grande project if groundwater use is impacting the Rio Grande project, then it would be necessary to, I believe, New Mexico would have to --sorry. Groundwater use depleting the project were alleged, it would have to be investigated and demonstrated. Groundwater depletions negatively impacting the project demonstrated the New Mexico remedied the priority administration, but this has not occurred."	"A. Water users in New Mexico cannot divert water that they are not entitled to. Water users who do not have legal authority cannot divert surface water away from the Rio Grande project. If it is alleged that groundwater use in New Mexico is impairing the project, then New Mexico would investigate it, and if necessary, remedy it."	Incomplete answer, transcript error
37.7	"information"	"investigation"	Transcript error

37.17-18	"And I say all water rights would be curtailed..."	"When I say water rights would be curtailed..."	Transcript error
39.7	"No."	"Some model runs that have be made in current studies can address this issue."	Incomplete answer
39.23		Add to end: " However, stream depletions calculated by a groundwater model alone cannot determine the actual change in the flows in the Rio Grande because the flow of the Rio Grande to Texas is controlled by Reclamation's operations of the Rio Grande project, which changes response to changes in gains and losses to the stream system."	Incomplete answer
46.15		Add "In part it would depend on the nature of the call. If it were a call based on instantaneous under-delivery of water to Texas, such that Texas was not receiving its Compact apportionment, New Mexico would evaluate the evidence, and rapidly work to resolve the under-delivery by whatever means necessary, ideally in cooperation with Reclamation. If it were a call based on deficits to Project performance or Project efficiency caused by New Mexico, then a more comprehensive evaluation would probably be necessary, but much of the work needed for such an evaluation has taken place as part of past and present hydrologic studies by New Mexico.	Incomplete answer
46.20	"That's right. The state engineer-- Q. And how long would -- go ahead. I'm sorry. A. The state engineer would make a determination as to what amount of curtailment was necessary, what volume of water, say, was necessary to address the call and probably involving use of groundwater models to take into account any delays as to when the water -- the water associated with curtailing groundwater rights would show up back in the river and would come up with -- he would be tasked with determining the administration date and water rights junior to that date would be curtailed."	"That's right. In the case of a call to address an immediate shortfall in delivery to Texas, New Mexico would take whatever steps were necessary to address that shortfall, which might involve other measures than curtailment of groundwater use, because of the delays inherent in groundwater impacts on surface water flows. In the case of a call based on impacts to Project performance or efficiency caused by New Mexico, the state engineer would made a determination as to what amount of curtailment of water use is necessary based on water rights data, and probably model results as well. Based on this analysis the state engineer would determine an administration date, and water rights junior to that date would be curtailed."	Unclear and incomplete answer.

Barroll 30B6 Deposition 10/21/2020 Corrections

47.9	"I don't know." But the tools we've developed as part of settlement talks and as part of our litigation have definitely made it within striking distance that we should be able to perform such an analysis expeditiously."	"Again, it depends on the type of priority call. In that case of a call made to alleviate an immediate shortfall of water to Texas, so that Texas is not receiving its Compact apportionment, New Mexico would act in a matter of days, to address this shortfall. The actions taken by New Mexico to address such a shortfall may or may not include curtailment of groundwater use, due to the inherent delayed impacts of groundwater pumping on surface water. For a call made by Reclamation to address deficits in project performance or efficiency caused by New Mexico, the more comprehensive analysis required would probably take a longer amount of time, but given the amount of work New Mexico has already done in this area, it should be achieved relatively expeditiously."	Unclear and incomplete answer.
61.5-6	"and it's also because of the current litigation and a lot of different causes that are all related to each other."	"The current litigation is related to the same issues: dropping groundwater conditions in the Mesilla basin."	I misspoke: my language was unclear.
80.13-14	"To provide you information about New Mexico's policies and the information required under Section C."	"The purpose of my testimony is to provide you information about New Mexico's policies and the information required under Section C."	Transcript error

Signature: Peggy Barroll 11/21/2020

SIGNATURE OF WITNESS

I, PEGGY BARROLL, solemnly swear or affirm under the pains and penalties of perjury that the foregoing pages contain a true and correct transcript of the testimony given by me at the time and place stated with the corrections, if any, and the reasons therefor noted on the foregoing correction page(s).

Peggy Barroll 11/21/2020
PEGGY BARROLL

Job No. 65834
10/21/2020 Deposition

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

****

ORAL AND VIDEOTAPED DEPOSITION OF
PEGGY BARROLL
FEBRUARY 5, 2020
VOLUME 1

****

ORAL AND VIDEOTAPED DEPOSITION of PEGGY BARROLL, produced as a witness at the instance of the Plaintiff, and duly sworn, was taken in the above-styled and numbered cause on February 5, 2020, from 9:39 a.m. to 5:29 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the DRURY PLAZA HOTEL - SANTA FE, 828 Paseo De Peralta, Santa Fe, New Mexico, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-227

Q. Okay. And you don't know when the OSE required the metering of municipalities? You don't know when there was a metering order issued?
A. I -- well, the metering order was not until 2004, when it really went into effect in 2008. The -- but entities like the City of Las Cruces, whenever they came before the state engineer office for anything, like a supplemental well application, for example, the state engineer would put as a -- as part of the conditions that you have to meter everything you do. That's typically how it worked for the M&I users is as soon as they had set foot in the state engineer's office for anything, they would then be required to meter all of their pumping.
Q. What's your recollection of the earliest OSE requirement of reporting from M&I use?
A. Well, the basin was declared by the state engineer in 1980, so I do not -- I'm not aware that any requirement would have been made before that date.
Q. What about domestic wells outside of M&I?
A. Domestic wells were exempt from the 2004 metering order -- or rather single-family domestic wells were exempt from that metering order, as were small stock and livestock wells. Multi-family domestic wells have required meters and do have

metering requirements associated with them.

Q. So was there pumping -- an annual pumping threshold, this multi-family requirement?

A. It's not a pumping threshold. It's just if a well is serving more than one household, it then requires a meter.

Q. So when was that put into effect, also in 1980?

A. I believe that the general requirement probably only came into -- I'm not sure. The metering order would have covered them, but, again, that would have been, like, 2004. Prior to that, I think some were metered because as they came into the office, they were required to get meters.

Q. When was this distinction between single- and multi-family wells made by the Office of State Engineer for the purposes of reporting?

A. I think it's been a longstanding distinction, but I don't know when it was made.

Q. "Longstanding" meaning, what, 1980s or earlier?

A. Yeah. And it would have been -- I think it's a distinction that's made throughout the state, not just in the lower Rio Grande.

Q. Okay. But you don't know exactly when that

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS, :
:
Plaintiff, :
:
VS. : Original Action Case
: No. 220141
STATE OF NEW MEXICO AND : (Original 141)
STATE OF COLORADO, :
:
Defendants. :

****

ORAL AND VIDEOTAPED 30(b)(6) DEPOSITION OF
UNITED STATES BUREAU OF RECLAMATION
BY AND THROUGH
FILIBERTO CORTEZ
AUGUST 20, 2020

****

ORAL AND VIDEOTAPED 30(b)(6) DEPOSITION OF UNITED STATES BUREAU OF RECLAMATION BY AND THROUGH FILIBERTO CORTEZ, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on August 20, 2020, from 10:02 a.m. MDT to 1:32 p.m. MDT, via Zoom videoconference, before PHYLLIS WALTZ, RMR, CRR, CRC, Texas CSR, TCRR, Louisiana CCR, in and for the State of Texas, recorded by machine shorthand, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed before any Notary Public.

TX v. NM # 141
New Mexico Exhibit
NM_EX-228

And the form that you're refusing to, is it the form that's shown on pdf Page 7, entitled Figure 1 "Internet-Based Order Forms"?

A. Yes.

Q. Has -- is it still the form, or has that been revised?

A. It has been revised somewhat, but it's pretty much the same.

Q. Contains the same general information?

A. Correct.

Q. Are -- are there records kept of any time when an order is not met?

MR. LEININGER: Objection; form.

A. Could you explain what you mean by "not met"? Because there is various delivery points, and each of those is metered to make sure that the water is delivered at the time, because it's not -- it doesn't all get to the same place at the same time. So there are, I guess, delays in delivering to the lowest points in the system as opposed to the highest points in the system getting an immediate delivery.

Q. (BY MR. WECHSLER) Understood. What I'm trying to get at is if there are times that, say, one of the districts orders water, but that water simply doesn't arrive, and I'm trying to get at the overall

issue of if that happens, how you address it. And so my first general question, I guess, is are there times where one of the districts orders water and it simply doesn't get there or it's short?

A. Yeah, that would happen only, really, with EP No. 1, since they are at the bottom of the system, because everybody else has already taken their water. So, and when it gets here to El Paso, now we make sure that the delivery in Mexico is met. So if there is a shortage as far as what EP No. 1 is expecting, that could happen for various reasons.

Q. What are those reasons?

A. It could be a break in the system somewhere, or it could be they underestimated the amount of loss that could -- is occurring in the system. And you can see that in the river boost on the order sheet. And, normally, we would -- we would expect extra water to be coming in, but these last drought years, we've been getting losses. So if those losses increase above what is being expected, there may be a -- not enough water when it gets down to the El Paso area.

Q. And so if you have that issue, how do you -- how do the districts and Reclamation address it?

A. As stated in the operation manual, I believe it states that half of the water that is short will be supplied back to the river by EBID and to make up for -- for the depletion excess. And then Reclamation will increase the release out of Caballo to make up for that loss.

Q. And if that occurs in a given irrigation season, are there records kept of that?

A. It hasn't happened in a while, but I believe so. There is an exchange of information given, and there may be a new order sheet put out to indicate the change in the -- the release from Caballo.

Q. Do you recall the last time it happened?

A. No, I do not.

Q. It sounds like it's something that does not occur very often; is that correct?

A. That's correct.

Q. Do you have any way of estimating how often it happened?

A. No, I don't.

Q. And where would those records reflecting that, if there are any, where would they be?

A. They would -- they would be filed along with the order sheets.

Q. Looking at Figure 1, I just want to make sure I understand the way the form works or what information goes into it. And let's start with the river boost that

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HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
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VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

****
REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
SHELDON DORMAN
JUNE 9, 2020
****

REMOTE ORAL AND VIDEOTAPED DEPOSITION of SHELDON DORMAN, produced as a witness at the instance of the Plaintiff State of Texas, and duly sworn, was taken in the above-styled and numbered cause on June 9, 2020, from 9:09 a.m. to 2:06 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-229

your earlier answer, it occurred prior to your becoming the water master?

A. Yes.

Q. So some time -- some time between 2001 and 2005, this move to a larger office came about, and this unit or this group of people working on the WATERS database became part of the office?

A. Yes.

Q. At some point, did you have duties that involved you to use the WATERS database?

A. In Roswell, it did.

Q. That's an absolutely awful question. Let me withdraw it and -- and see if I can do better.

Actually, let's approach it from a different direction. What was the process involved in becoming the -- becoming hired as the Lower Rio Grande Water Master?

A. The position became -- opened, became available, and I applied for it.

Q. What were the qualifications for the position?

A. I don't remember what those were.

Q. Did you go through an interview process?

A. Yes.

Q. At the time you went through that interview

A. It's kind of towards the beginning of my time as the water master, I was working closely with a couple of people from Interstate Stream Commission, and we were trying to figure out ways to do my job, and one of the attempts to do this was to create a -- an access database outside of WATERS to help me get, you know, through this process. That effort failed miserably, but at this time, we are still working on it.

Q. Okay. Let's look at the next-to-last paragraph that begins at the middle of the 2007 irrigation season. The last sentence of that paragraph, you say, and I quote, "Most of the wells that were not equipped with a meter were listed under the loan program and not listed as noncompliant." What are you referring to with regard to the term "loan program"?

A. Some of the people who we talked to about this metering order, they stated their problem they -- they had was they did not have enough money to pay for the metering for various reasons, and so the state engineer was able to somehow procure money and -- and allow farmers to -- or users to get low interest loans and give a person -- well, that's what it is, low interest loan program.

Q. Who administered that loan program?

A. I -- it was administered through the Interstate Stream Commission and EBID.

Q. What is the problem that you're talking about in the last paragraph on that page?

A. So in the Lower Rio Grande area, within EBID, there are a number of tracts of land that are the two acres or less, and a lot of those tracts are in areas that are not within municipal water supplies so they have drilled domestic wells, and we found out that a lot of those domestic wells were being used to supplement surface water on those tracts to irrigate something -- well, didn't matter what they irrigated. They were used -- they had supplement -- they had surface water rights with EBID, and domestic well is not supposed to be used for irrigation of anything over an acre, and they are definitely not to be used for supplementing surface water, so that's one of those categories of wells that we would require them to put a meter on, even though the owner said it was a domestic well and exempt from metering.

Q. How many of those situations did you discover?

A. I don't know the number of that either.

Q. Can you give me an estimate?

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HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
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VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

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REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
GARY ESSLINGER
AUGUST 17, 2020
VOLUME 1
****

REMOTE ORAL AND VIDEOTAPED DEPOSITION of GARY ESSLINGER, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on August 17, 2020, from 9:06 a.m. to 4:34 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-230

diversion where we then take out what EBID receives, and then it gets to Mesilla Dam, and that's where it gets a little complicated. But EP No. 1 follows the water down just like we do to ensure that their order is on the way.

Q. Why is it complicated at Mesilla Dam?

A. Because Mesilla Dam is the last diversion 44 miles north of El Paso, and there is 17,000 acres mas or menos or approximately -- sorry -- that are in the El Paso irrigation district, and so we -- when they place an order for that land, the water is split let's say 150 cubic feet per second goes in our west side system, and 40 feet goes into the east side system for lands that are in Texas. That right there, that subtraction is made, and we know then that the balance of 820 CFS is still headed down to El Paso in the river for the lower valley and for Mexico.

Q. Do you recall any instances where EP No. 1 did not receive the water that they ordered?

A. There -- there may have been in these times of shortages, especially when the Bureau was releasing the water that they weren't getting what they ordered and then they were calling on EBID to make up that water, and it was -- it was difficult at times, but that's when the Bureau was making the releases. I don't know of times since the two districts are telling the Bureau exactly what the release, that that has occurred.

Q. When did the two districts begin to tell the Bureau exactly how much to release?

A. In 2008.

Q. And that occurred with the operating agreement?

A. Yes, sir.

Q. Why did -- well, first, let me ask: Was it a frequent occurrence before 2008 for EP No. 1 to not receive the amount of water that it ordered?

A. That was one of the occurrences that could have taken place. There was many others. It was just the -- the manner in which the Bureau was operating and -- and the frustration that the two districts were --

THE VIDEOGRAPHER: I apologize. The court reporter was kicked off of the meeting.

THE REPORTER: I'm back on. I don't know why it -- it kicked me off and kicked me right back on so keep going.

THE VIDEOGRAPHER: Okay. Sorry about that.

Q. (BY MR. WECHSLER) Do you need me to ask the

IN THE SUPREME COURT OF THE UNITED STATES
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HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
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	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

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REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
ROBERT RIOS
AUGUST 26, 2020
****

REMOTE ORAL AND VIDEOTAPED DEPOSITION of ROBERT RIOS, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on August 26, 2020, from 9:01 a.m. to 11:59 a.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

exact number. Approximately how many lap recorders?
A. Some of them just doesn't ring a bell. Like, 36 --
Q. Are you talking about M36, Wasteway No. --
A. No. M34. M34, I don't think we have one there, and I don't think we have one at M42.
Q. Okay. Other than that, you have recorders at those locations?
A. I don't know about M37, because that's Wasteway 34A. I know we have one at M36, Wasteway 34.
Q. With those exceptions, do you have recorders at these locations?
A. Yes.
Q. Does EP No. 1 generally receive the water that it orders?
MS. O'BRIEN: Objection; form; lacks specificity in terms of time for one thing.
Q. (BY MR. WECHSLER) You can answer, Mr. Rios?
A. They were received -- ask the question -- repeat the question.
Q. Yeah. The question was do you generally -- does EP No. 1 generally receive the water that it orders?
A. I'm going to say yes.
Q. If you don't receive -- let's say you place

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STATE OF TEXAS)
)
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) (Original 141)
STATE OF NEW MEXICO,)
and STATE OF COLORADO,)
)
Defendants.)

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ORAL AND VIDEOTAPED DEPOSITION OF
RYAN SERRANO
FEBRUARY 26, 2019
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ORAL AND VIDEOTAPED DEPOSITION of RYAN SERRANO, produced as a witness at the instance of the Plaintiff State of Texas, and duly sworn, was taken in the above-styled and numbered cause on February 26, 2019, from 9:23 a.m. to 3:29 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the RAMADA HOTEL & CONFERENCE CENTER BY WYNDHAM LAS CRUCES, 201 East University Boulevard, Las Cruces, New Mexico, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-232

the well that's being replaced?
A. No, sir, not always.
Q. How frequently does that occur that the replacement well is going to have a larger capacity or be at a greater depth?
A. I think for the most part, what we see is greater depth, not necessarily larger capacity in terms of casing size or -- or pump size. Greater depth, individuals trying to achieve better quality water, from -- from what I've been told, from those well owners. But we also see where a well -- replacement well will be drilled, you know, sometimes would be smaller, smaller diameter, more depth.
Q. How frequent is that?
A. Probably more on the order of a third of the time.
Q. What is meant by measuring water usage?
MR. ROMAN: Object to form.
You can answer, if you can.
MR. GOLDSBERRY: Let me withdraw the question and rephrase it.
Q. (BY MR. GOLDSBERRY) I believe you testified that one of your duties was measuring and reporting water usage within the district. What's involved in reporting water usage?

A. Well, of course, through our -- through our metering program, we track the -- we quantify -- track and quantify the amount of water diverted in each of -- a number of different use categories, different uses such as irrigation, municipal, commercial, industrial, dairy, domestic.

Q. And -- and are all of those uses reported to the waters database?

A. Yes, sir, they are.

Q. Are municipal and industrial water uses recorded on the water -- waters database accessible to the public?

A. Yes, sir, it is.

Q. Is one of your duties the curtailing of how to priority diversions?

A. The -- the duties, as they're described in -- of a -- in statute, the duties of a water master, yes, sir. Have I ever conducted that activity in my time as the water master, no.

Q. Okay. Why not?

A. I've never had a priority call called in my district.

Q. Is one of your duties the -- some sort of coordination with the United States Bureau of Reclamation?

in the readings, and we usually -- we generally get a really good response to that, and it'll bump up our percentages up to 70 or 80 percent. And from there, if we still have some outstanding, what we do is we'll conduct what's called a meter blitz, and the purpose of the meter blitz is to acquire those meters that are outstanding for the purpose of completing our water master report and ensuring that we have a representative sample of all the wells reporting. So from there, after that point, it would be where we're at today. If those readings are outstanding, we'll send a second notice of noncompliance to those owners and begin a process where -- with our administrative litigation unit where we can try to seek penalties for them not complying with their requirements to report.

Q. When you took over the job as the water master, what was the compliance rate with regard to meter reporting?

A. It -- it was variable at times, more in the range of -- of 80 to 85 percent submittal rate.

Q. Okay. And that -- and that submittal rate is documented every year in your annual report?

A. Since -- since my time as the water master, yes, sir.

Q. Okay. Now, what type of wells have a monthly

reporting requirement?
A. That would be municipal, commercial, industrial.
Q. How many of those wells do you have currently in the district?
A. I can't say that I've ever broken out that particular category. What I would consider non-irrigation, which is inclusive of some of those types of uses is on the order of 400 to 450.
Q. So you get 400 to 450 wells that are non-irrigation, and that includes municipal, commercial, and industrial?
A. A portion, yes, sir.
Q. Okay. What else does it include?
A. It includes some metered domestic, some metered multiple domestic, some ag use -- what are considered ag use, which is non -- it's ag use that's non-irrigation. There would be some fish and game propagation, some utilities, some subdivision, some school use. There -- there's a long list of categories in the non-irrigation field.
Q. And where would I find that if I wanted to look for it?
A. You can find that -- we try to detail that in our annual water master report, but a more complete

list would be available in the water rights abstracting bureau, because we follow suit with their codes as they're entered into the water database.

Q. Okay.

MR. GOLDSBERRY: Let's break for lunch.

THE VIDEOGRAPHER: Off the record, 12:03.

(Break.)

THE VIDEOGRAPHER: On the record, 1:36, File 4.

Q. (BY MR. GOLDSBERRY) Just before lunch or shortly before lunch, you mentioned something about the administrative litigation unit collecting penalties for non -- noncompliance. Are you involved in the actual -- well, tell me the process. How -- how do they get to the -- to the penalty stage?

A. The penalties themselves are not collected by the administrative litigation unit. We -- through our compliance order and action process, we will -- we'll send an initial notice like we've talked about from the water master, then there's a certain period of time between a second notice will be sent from the administrative litigation unit if the issue hasn't been resolved, and if the issue continues to be unresolved then we will petition district court for

A. I was, yes, sir.

Q. And does this describe the situation you previously testified to about the problem in 2017?

A. It does. If I -- if I could, there's -- there appears to be an error here with regards to the date.

Q. That was going to be my next question.

A. I did not do this memorandum on July 29th of 2019. I imagine when it was opened, it automatically had the date repopulated. This was done in July of 2017. And to answer your question, yes, it was done in response to a situation that I previously described.

Q. Do you attend meetings of the Pecan Growers Association?

A. I do not.

Q. Let's talk about the owner management program. Would you describe that program for me, please?

A. The owner management program was derived from the Stream System Issue 101 settlement agreement. There's a specific provision within the agreement that allows for joint ownership in management of water amongst lands that are jointly owner managed. We -- we were -- once we received that order -- settlement agreement and final order from the adjudication court, and in turn, tried to take that to administer it, we had to look at each of those provisions and develop administrative strategies for handling those things, and the owner management program, as it exists today, is a result of that particular provision. What it does is it allows for the -- for the grouping of lands that are either owned or managed by an individual, and it allows for the averaging of the use of groundwater and surface water across all of those lines.

Q. Okay. What are the -- what are the qualifications for participation in the program?

A. There's a prescribed form that any particular individual has to use, and in order to participate, they have to list the water right file number, the hydrographic survey sub-file number, the amount of acres, whether or not there was a notice of intent on file for that particular water right, and there also has to be a owner signature for each individual water right allowing for those rights to be put in to this grouping. Other criteria before, when we're entertaining all that, we're looking at those groupings, we have to make sure that the water rights listed are recognized water rights within -- by the Office of the State Engineer, so we'll cross reference all that in our database, make sure that they're in good standing with our office and that they're recognized, the water rights that are listed. And then we'll go through with our WRAB bureau, and they'll proceed to group all those water rights together in our waters database under a unique identification number.

Q. Is the requirement of the program that all of the properties that are brought in to a given agreement be managed by a single individual?

A. That's not a specific requirement, but that is usually the case.

Q. So it's not a requirement?

A. No, sir.

Q. Is there a requirement that the owners on any one file have a written agreement with each other?

A. That's not a specific requirement, but, again, that is usually the case.

Q. So what gets filed -- let's take a hypothetical situation. We've got five owners that come together on -- and want to participate in this program. They fill out this form, provide the information, and file it with you?

A. They file it with the office with -- with me, yes, sir. Usually there's a lot of supporting documentation including lease agreements. We require maps of the lands that will be involved in the ownership management agreement, and any sort of other contractual things that they might have between the manager and the owner, they can provide that stuff, but it's not a requirement.

Q. Okay. If they do provide it, does it get included in the new file that's created?

A. Yes, sir.

Q. And does that information all get imaged on the waters database?

A. That information, with regard to ownership management, is not imaged. It's housed in paper files in the District 4 office.

Q. Why is it not imaged?

A. I do not have the answer to that question.

Q. So how does a member -- does the public have access to review those plans?

A. Absolutely. They can come in and see them at any point in time.

Q. So the only way you can see the plan is to come to your office and look at the paper file?

A. That's not necessarily true. There's -- you can look at the -- the particulars of the plan via the waters database. Like I said, it'll have a unique file number assigned to it. All of the lands that are included in that file, you can look at that in waters, the waters database, and it'll show the grouping, it'll show the total number of acres, total allowable diversion, how much groundwater they pumped for the year, how much surface water they've been allotted, the -- the total combined between surface diversions and groundwater diversions, percent diverted and how much is remaining, whether that -- there's a positive balance or negative balance there. That's all available in waters, available to the public.

Q. Do these plans get revised on an annual basis? Let me withdraw that question. That's not really what I want to ask you.

Are they required to resubmit the plans on an annual basis?

A. At this point in time, they are not. The plans will carry through in perpetuity until there's a change. So if there's an addition or subtraction, then they're required to notify us.

Q. And when that happens, does the owner management ship file -- owner management ship fill get -- does a new file get created?

A. No, sir. That -- it retains its number.

Q. Okay.

A. But a new transaction will be reflected in the database where there -- you'll see there was an amendment, either an addition or subtraction.

Q. What happens to the files that get combined in the waters database?

A. Those files remain intact. They're still there. For all intents and purposes, they're still active files, only -- only the diversions and acreages get removed from the removed from files into the into, which is the ownership management account, for accounting purposes. None of the essential elements of the water right are affected by -- by the ownership management plan.

Q. So the ownership management plan doesn't create a new right of any sort?

A. Absolutely not, no, sir.

Q. Is there an approval of -- of a plan required by your office?

A. When the plans are submitted, I review all of the plans for completeness, and on occasion, I'll assign some of them to my senior staff to review to make sure, as I stated earlier, that all the water rights that are being proposed to be included are recognized by the Office of State Engineer, and they're in good standing before we'll give final approval and allow for the entry of that plan in the database.

Q. What do you mean they're in good standing?

A. There may be, you know, an issue with a particular file, if there's outstanding issues in hearing or mediation or things of that nature. We don't want to affect those ongoing processes, so we won't allow them at that point in time to be included.

Q. Do you know if there is a similar program in any of the other New Mexico districts? And I'm talking about the OWMAN program.

A. From what I understand, I believe the OWMAN -- the OWMAN program, as it exists in the lower Rio Grande, is unique, and it does not exist anywhere else.

Q. Prior to that program being created as a result of this settlement agreement and decree was it possible to accomplish the same thing?

A. There was a similar process, administrative process, referred to as a combined and commingle.

Q. Tell me about that process.

A. Prior to 2011, the 101 settlement, an owner who wanted to move water in and amongst farms that he either owned or managed had to submit an application for a combined and commingle, and it would follow the

That is?

THE REPORTER: 69.

(Exhibit No. 69 was marked.)

Q. (BY MR. GOLDSBERRY) Have you had a chance to look at --

A. Yes, sir.

Q. -- the document that we marked as Exhibit 69? This is a copy of a document entitled, "Mesilla Valley Administrative Area Guidelines for Review of the Water Right Applications dated January 5th, 1999." Are you familiar with this document?

A. I've seen it, yes, sir.

Q. Is it still being used?

A. From my understanding, it is, yes, sir.

Q. Have there been any efforts to update this document?

MR. ROMAN: Foundation.

Q. (BY MR. GOLDSBERRY) Are you aware of any efforts to update this document?

A. I -- I am aware that there have been some efforts to update this document, yes, sir.

Q. And what -- what do those consist of?

A. From my understanding, there have been a few meetings. I don't know if there's been any drafts or anything like that.

Q. I take it you have not been personally involved with those efforts?
A. No, sir.
MR. GOLDSBERRY: Let's do it this way. Go ahead and mark that one 70.
(Exhibit No. 70 was marked.)
MR. ROMAN: Mac, can I grab one?
MR. GOLDSBERRY: Oh, I'm sorry. I got so carried away. Give me one.
MR. DUBOIS: Oh, all right.
MR. ROMAN: Thank you.
MR. GOLDSBERRY: There will be a day when you need to return the favor. They always come around.
Q. (BY MR. GOLDSBERRY) Okay. Are you -- let me -- let me make sure our record is clear. The document that I've just had, Exhibit -- marked as Exhibit 70 is also designated as NM 76889 through NM 76911. Have you had an opportunity to look at that document?
A. Yes, sir.
Q. And what is your understanding of what it represents?
A. These are the rules and regulations governing the appropriation and use of surface waters in the

State of New Mexico. These are rules that are promulgated in New Mexico Administrative Code.

Q. Okay. And have implementing rules within promulgated in District 4 on this topic?

A. These rules are statewide rules, and we do apply them in District 4.

Q. Okay. That wasn't my question. Are there District 4 specific rules that take these rules and regulations further and apply them specifically to that district?

A. Not that I'm aware of, no, sir.

Q. Okay. Are there similar rules and regulations related to groundwater?

A. There are, yes, sir.

Q. What are the current rules dated on groundwater?

A. There's -- there's a set of rules regarding the use of what are termed 72121 domestic wells, which would, of course, be groundwater wells. Those are promulgated. And there's some general rules for underground water administration that are -- have been promulgated. Nothing specific to the lower Rio Grande that I -- that I'm aware of.

Q. Okay.

(Exhibit No. 71 was marked.)

is -- wait a minute. I'm going to go back here. I see a column here, H, not sure we've seen that before, number of dials. These meters, I take it, have multiple dials?

A. Yes, sir. So Column H, the first row, you see there that it has six dials. That's the maximum number of digits for that particular meter.

Q. Does it actually have six dials or is it six digits?

A. Six -- six dials that are --

Q. I see what you're saying. In a particular -- in a particular meter. Do you have rules or regulations regarding the number of dials that a meter -- the minimum number of dials that a meter can have?

A. The lower Rio Grande metering order says that the meters shall be -- have sufficient digits to ensure that no more than one rollover occurs in a single accounting year.

Q. So what do we have in Column N?

A. Column N is the reading flag so when we confirm that it's a rollover, we enter that R designation, and the database will then accept the reading that's being entered.

Q. What do we see in Column P?

Q. What is included in the category of "other"?
A. Anything else that we might run into. Waste of water, maybe issues dealing with well drillers, well construction standards, things like that.
Q. Does it include over diversions?
A. No, sir.
Q. Excess diversions?
A. No, sir. We track those as a completely separate category.
Q. Okay. And is it -- is that referenced here somewhere on this document?
A. No, sir.
Q. Is there a document that tracks excess diversions?
A. That would be a separate -- a separate tracking spreadsheet and associated documents that were in the folders with the end-of-the-year data that we reviewed previously.
Q. So you analyze over diversion more than once a year?
A. No, sir. It's usually once a year.
Q. During your period -- during the period of time that you've acted as the water master, have any of the events or problems recorded in this document resulted in litigation?

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

****
ORAL DEPOSITION OF
CHERYL THACKER
APRIL 18, 2019
****

ORAL DEPOSITION of CHERYL THACKER, produced as a witness at the instance of the Plaintiff State of Texas, and duly sworn, was taken in the above-styled and numbered cause on April 18, 2019, from 11:04 a.m. to 3:38 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the HOTEL ENCANTO DE LAS CRUCES, 705 S. Telshor, Las Cruces, New Mexico, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-233

Q. Okay. So then how long were you a water resource specialist senior?
A. Right at seven years.
Q. Okay. And then in your current position since 2011?
A. Yes. I'm a water resource manager now.
Q. What's the difference between that and a water resource specialist senior?
A. A specialist senior doesn't supervise any employees, whereas I do supervise employees, and I deal with more complex applications and issues.
Q. Okay. So when an application for a change of water rights comes into the District 4 office, would it go to your desk?
A. At what point are you referring to? Immediately or --
Q. Yeah. So somebody walks in with a water rights application that they've just filled out to change a point of diversion or something, groundwater right, would that -- where would it -- where would they go first?
A. Oh, okay. First, we have what we call a buckslip, kind of passing the buck, and so it tells us where it needs to go, and sometimes I have to refer to it even now, okay, where's this go. So it's logged

into our mail log just to make sure it's been, you know, received, and then my supervisor, Andrea Mendoza, she's the manager of the District 4 office. It goes to her, and she assigns it.
Q. Okay. I see. So -- so Ms. Mendoza would be the one who would say this is complicated enough, I want you to handle it?
A. Correct.
Q. Okay. But you also supervise a staff?
A. I do.
Q. Okay. So is Ms. Mendoza also giving them assignments?
A. That's correct, actually. She gives the assignments to me as well as all the other water resource specialists who process applications.
Q. Okay. So in your -- in your role as a supervisor of the other water -- of the water resource specialists, what -- what kind of supervision do you provide?
A. They assign -- excuse me. The applications are assigned to them, and they write what we call a notice of publication, and that's what's to be published in the newspapers to alert the public. When they first start until I really feel like they're, you know, ready, I'll evaluate those and proofread them

and make sure everything is correct. Once they've gotten the hang of that and I feel like they're pretty good, all of them, they will write a report and make a recommendation whether the applications should be approved, partially approved, or denied, and what I do is proofread their reports and make sure their conclusions are correct and then I sign off on those and they go to the next on the buckslip.

Q. On the buckslip?

A. Yes.

Q. So what does the buckslip look like?

A. It's just a piece of paper, probably a third of an 8 by 11 -- 8-and-a-half by 11, and it just has the different steps of where the application should go after the successive step has been taken care of, if that makes sense. It's just kind of an instruction.

Q. So it -- it gets attached to the front of the application?

A. Correct. Yes. That's right.

Q. Okay. Okay. So the -- what are the steps on the buckslip?

A. First, there's the fact that it gets entered into our mail log in the database. What we have is a internal database that just keeps track of the applications and who they're assigned to and that sort of thing.

Q. So it doesn't get filed in the waters database right away?

A. Correct. Well, no.

Q. Okay.

A. Pardon me. After it goes to Ms. Mendoza, it goes to our waters database. What they do essentially is just index it and say, okay, we've got a placeholder for everything that's going to occur after that.

Q. Oh, I see. Okay. Okay.

A. So then it's assigned to the specific water resource specialist, and, you know, she makes her initials saying, okay, that's where it's going, then the specialist will look at it and write the notice of publication and they'll initial it saying, okay, this process has been done. Then once we get the affidavit of publication back from the newspaper proving that it's been published, then it'll go back to the water resource specialist, and they will write their review. So they -- they write on that new initial, okay, that's been done.

Q. Okay.

A. Goes to me, I review it. When it's all approved, I initial it, then it goes to waters, which

is the WRAB, water --
Q. Database?
A. Correct. And what they do is they input it. So we've got that placeholder that I mentioned this waters, just tells us, okay, that's the application. Then once we take our action, that information will be completed, entered into the waters database, and imaged so when you go on the waters database now, you can see the application, see the permit as aware of the conditions and all the evaluation that's been taken.
Q. So does the waters database entry happen in your office, too?
A. It's -- it is in our office. It's -- it's all one big building, but their office is kind of a suite down the --
Q. Okay.
A. -- down the hall.
Q. As a data entry staff?
A. That's correct. Yes.
Q. Okay. Does every district under the OSE have its own data entry staff for waters?
A. I don't know. The only thing I do know is there's a WRA B waters group in Albuquerque. Who they handle, I don't know.

Q. Okay.
A. Yeah.
Q. Okay. So you mentioned a step in the buckslip where the water resource specialist, I think you said will write -- write a review is the -- is the term you used. What do you mean by that? They write a review of what was asked -- what was requested by the applicant?
A. That's correct, actually. It's formally called a memorandum of recommendation, and so what they'll do is summarize what the applicant is requesting, all the elements of the water right, for instance, the point of diversion, the locations, if we're talking about an irrigation water right, the place of use, and so that's delineated, and then what's proposed, if it's a replacement well, for instance, and then through -- through the discussion in the -- the memorandum of recommendation, they establish whether there's a water right or the extent of the water rights. They talk about the hydrographic survey, and then eventually, they make a recommendation saying, yes, the water right is valid, I recommend that this point of diversion be -- or application to change location of well, for instance, be approved, and then there's the conditions of

approval that are attached to that recommending the point of diversion, the place of use that's approved, and all other conditions attached to that, and that attached to the application makes it a permit.

Q. I see. Okay.

MS. KLAHN: Could we have Exhibit 69?

THE REPORTER: Uh-huh.

Q. (BY MS. KLAHN) So this is Exhibit 69, which was marked in Mr. Serrano's first day of his deposition. It's Mesilla Valley Administrative Area Guidelines For Review of Water Right Applications. Have you seen these guidelines before?

A. Uh-huh.

Q. I figured you had. Just take a look at it and make sure it's complete. I believe it is, but just take a look and make sure.

A. It looks like it, and the weight of the document seems to confirm that.

Q. Okay. So generally -- I have some questions about these guidelines, but so generally, can you describe -- let's stick with the hypothetical example we were talking about in change of place of diversion for a well. How did these guidelines play into your evaluation of an application? Let's say Ms. Mendoza has referred it to you because it's more complicated.

How does this play into your evaluation?
A. These set the guidelines for local impairment, and -- as well as surface water depletion impairment and the parameters that we can use whether to approve or deny an application.
Q. Okay. So do you find yourself consulting these frequently?
A. I do.
Q. Okay. Well, I want to ask you some questions about how you use them. So let's turn first to Page 2. There's a Paragraph A1. In the first sentence of Paragraph A1 starts, "The Rio Grande stream system is fully allocated and existing rights may not be impaired by proposed appropriations." In your work as -- in your work when you're evaluating a permit application, what does that phrase "fully allocated" mean to you?
A. There's no available water for someone to file a new appropriation for -- that hasn't occurred historically.
Q. Okay. So no -- no -- no new water would be -- no water would be available for a new appropriation?
A. Correct.
Q. Okay. So is that one of the things you look

at is to be sure that a permit to change the location of well isn't sort of a new appropriation masquerading as a change?

A. Absolutely.

Q. Okay.

A. Yes.

Q. What -- what indications would you have that a permit is, in fact, just a change in location -- or, I'm sorry, an application is just a change in location?

A. Change location of well is what you're referring to?

Q. Yes.

A. Okay. Well, we would look at the place of use proposed in the application and determine whether that place of use has been recorded in a declaration, for instance. There's evidence that that place of use has been irrigated in irrigation circumstance prior to the closing of the basin. So it's historically been used, and it's not an area where there's never been a water right attached to the land.

Q. Okay. It's not an area where there's never been a water right attached to the land?

A. Correct.

Q. Okay. So you are looking for a declaration

that the parcel they want to move the well to has been irrigated?
A. Yes. That's correct.
Q. Okay. Even if it was irrigated by something other than the well that they want to move the -- move to that parcel?
A. Well, let me back up. We -- often, a parcel that's in question on the application has been historically irrigated by an off-property well.
Q. Okay.
A. And so, for instance, if that well was drilled in the '50s and has gone defunct or the owner of the property that the well sits on refuses to allow the new -- the other owner access to that well, what'll happen is typically the owner who's filing the application will -- will try -- will ask to change location of well from the POD -- off-property POD to a POD to be drilled on his property. So they have to establish or we have to have record that that piece that is in question has been historically irrigated from an off-property -- off-property well prior to the closing of the basin.
Q. Okay. So in the -- in the circumstance you just described, how do you ensure that the off-property well owner doesn't continue to use the

well for different parcel? I mean, your -- in your setup, you said the off-property -- off-property well owner won't allow the applicant access. Okay. So the applicant comes in and says, "I want to get -- I want to move that well over to my property." But what about the off-property well owner, how do you make sure he doesn't continue to use that well?
A. Okay. So let's say there's a 20-acre parcel that was irrigated by this off-property well. Five acres has been purchased by the new applicant. When we file -- they file that application and we issue a permit, let's say, for that full 5 acres, what happens is we -- in the database, the waters database, that 5 acres is pulled out of the original water right file, and we give a new water right file for that new 5 acres.
Q. I see.
A. It's not new but --
Q. Yes.
A. -- it's broken out.
Q. New owner?
A. Correct. And so essentially, instead of the original off-property water right being a full 20 acres, we'll give that 15 acres, and then the -- the 5 will be attributed to a separate water right file. So

it's kind of being counting, for lack of better words, so just balancing.

Q. And then, I guess, when that -- when that permit, in -- in the example that we're describing, when that permit gets issued then that would be put into the new owner of the five acres adjudication sub file?

A. Possibly. How the adjudication handles that, I'm not sure at this point.

Q. I mean, isn't it possible the new acre -- the new owner of the five acres might not even have an adjudication sub file? Is that possible? Because the well he wants to drill doesn't exist at the time of the hydrographic survey.

A. Right. Probably what occurs will be the full 20 acres that I referred to will have been identified by the original hydrographic survey under one sub file. We, in administration, will take that five acres out and leave the rest as 15. Now, when the adjudication group, when they divide that, I don't know when they'll do that, but --

Q. Okay.

A. Yeah.

Q. Okay. So let's turn now to Page 6. So on Page 6, Paragraph 4 is option to lease off-site --

THE REPORTER: You call it what?
THE WITNESS: CRRUA, which stands for Camino Real Regional Utility Authority. I always have to think about that.
Q. (BY MS. KLAHN) It's the two R's.
A. That's right.
Q. So inside CRRUA have you had other -- what I'm getting at is you say you get accounting to reflect the offsets on the 3150 application?
A. Yes.
Q. If there are others who also develop or do a change in water right that also requires an offset, I'm just wondering how you're tracking the quantity of effluent to make sure that nothing is getting double counted for offset --
A. Right.
Q. -- purposes.
A. So far the -- the CRRUA water right is the -- is the only entity that's using discharge credits from the city of Sunland Park.
Q. Okay. Okay.
A. But to answer your question further, I think we require them to tell us how much of the effluent that they claim and they're allowed to use.
Q. Okay. Do you sort of have a formula so you

know how much -- whether that effluent is really effluent they can claim?

A. Yes.

Q. Okay. What kind of formula is that?

A. It's not really a formula. It's a -- it's a spreadsheet we use. And then I think the water master enters something into the waters database, but that's outside of my expertise. However, I keep a -- a spreadsheet, and I get those readings from the Camino Real, the CRRUA group now, and so just to verify that they're not double accounting and that they're following what they need to follow. I've been dealing with this CRRUA for years and years, so it's kind of my baby.

Q. Where does the discharge of effluent come into the Rio Grande or does it?

A. It does.

Q. At Sunland Park?

A. Well, exactly where it is, I couldn't give you a lat long, but generally --

Q. South of Mesilla?

A. Oh, yes. Yes. It's near Sunland Park. Exactly where, I don't know. But that effluent, the -- the water is actually dumped into the river.

Q. So we've talked about Paragraph 1, Page 4, and we were starting to talk about Paragraph 2, which you didn't think you had used. That's on Page 5. How many -- in your -- I forget how many years you said you've been in your position. 11?

A. This specific position, almost seven.

Q. In the seven years you've been in your position, how many applications have you dealt with where offsets were part of the resolution?

A. Maybe 15 or 20. It's not a lot.

Q. In your experience, have the discharges been --

A. That's the only available discharge credits.

Q. Okay.

A. May I say on Page 5, Paragraph 2, I think what we're doing is this. It's just kind of poorly worded in here. Does that make sense?

Q. Yeah.

A. Okay.

Q. So why do you think it's -- why do you think what you're already doing essentially is Paragraph 2?

A. I think, for instance, the state engineer might alternatively consider other methods for offsetting proposed by the applicant. For instance, instead of just surface water replacement, they can also ask for discharge credit. I guess that's the

only thing I'm referring to.
Q. Would it ever be acceptable for someone to seek an offset by offering to cap and curtail use of an active groundwater right?
A. Well, they would have to file an application for permit to change location of well, place, and purpose of use of water right. And that water right would have to be one that's groundwater only or not associated with any surface water provided by EBID.
Q. Would you -- if -- again, I know this has not happened, but if that happened, would you evaluate the distance from the river?
A. Absolutely.
Q. Okay. And why is that?
A. Well, it goes back to -- it's somewhere in here -- requiring making sure that there's no impacts to the river so we keep the river whole essentially.
Q. Okay. Let's go onto Page 5 -- or 6. Sorry. Paragraph 4. This was the paragraph we started with, and you said that you didn't -- you had not used option to lease offsets -- offset rights for appropriations outside of HI A. What is the HIA?
A. High impact area.
Q. Okay.
A. And it would be in a map at the last page.

Q. At the last page?
A. Yeah.
Q. Okay. So what -- how's the high impact area defined; do you know?
A. I know it's in this map. I think there's hydrologic parameters, but honestly I'm not --
Q. Okay. Maybe they're at the beginning of the guidelines. I can't -- I kind of remember seeing something about that, too.
MS. THOMPSON: Excuse me. Sarah, do you have another copy of this exhibit?
MS. KLAHN: I don't.
MS. COLEMAN: You can use this one.
MS. THOMPSON: Thank you very much.
Q. (BY MS. KLAHN) Calculation of surface water depletions, this Paragraph 5 steps through the situations where you have to calculate surface -- surface water depletions. As I understand it, 5A is not possible anymore, there's no new groundwater appropriations; is that correct?
A. That's correct.
Q. Okay. So the calculation of surface water depletions would be in the context of applications to transfer groundwater rights?
A. Correct.

Q. Okay. What tools do you use for -- for that evaluation?
A. If it's very, very complicated, we'll refer them to the hydrology bureau up in Santa Fe, but I kind of like doing modelling and so we use MODFLOW.
Q. Okay.
A. And the 2007 superposition model that Peggy Barrol provided to us.
Q. Okay. All right. So MODFLOW just out of the box, MODFLOW, nothing --
A. Yes.
Q. Okay.
A. That's right.
Q. Okay. All right. So let's -- this paragraph actually continues over on Page 7. This in the middle of Page 7, there's a sentence that starts, "The calculated reduction and evapotranspiration will be treated as a surface water depletion." See that?
A. I do.
Q. Can you talk me through how you calculate the reduction in ET?
A. I have no idea how to do that.
Q. You don't do that?
A. I don't do that. My assumption is it's part of that superposition model.

Q. I see.
A. Yeah.
Q. Okay. So go over to Page 8. Paragraph 6 is continued on Page 8, and in the top third of Paragraph 6 on Page 8, there's a sentence that starts, "Draw down calculations."
A. Okay. Got it.
Q. So I should set the stage a little more. I apologize. So Paragraph 6 is local drawn down impacts. I assume you use Paragraph 6?
A. Oh, yes, absolutely.
Q. Okay. In what circumstances would you use that?
A. Let's see. Particularly -- actually, when an application is filed to change a location of well or drill a supplemental well, we use this to determine whether there's any kind of local impairment to other wells of other ownership.
Q. Okay. Is there a distance that you -- that it's a default you don't have to do that or is there -- do you look at any wells in any distance from the proposed new location?
A. Typically, if it's in a very concentrated area where there are a lot of domestic wells in the area, we'll do the evaluation regardless; however, if

it's an emergency authorization, for instance, under the 7212.22, within a hundred feet, it's -- and often they're just drilled within 25 or 50 feet, we make that assumption that it's -- won't be impairing other wells of other ownership. And then this high impact area, in particular, the floodplain alluvium, the transmissivity is so high, and so if we have any question, we'll absolutely do a drawdown calculation. But those are the times where we typically won't.

Q. Okay. So, now, the question I was starting to ask you starting in the middle of my thought.

A. Okay.

Q. Paragraph 8 -- I'm sorry. Page 8, middle of Paragraph 6 starts, "Drawdown calculations may be performed using the superposition model or the Theis equation." I've looked at quite a few change of well location applications in the waters database. I don't think I've ever seen the use of the superposition model. Is that -- do you have a preference for which the Theis or superposition that you use?

A. The Theis we use because it's easy to use. A lot of the water resource specialists don't have any kind of hydrology background. This is -- it's sufficient. It's a really easy program. It's just a DOS-based type executable. So, yeah, the MODFLOW is really -- it's really not necessary, to be honest.

Q. Okay. And the next sentence goes onto say, "The method" -- well, first, we said, "Drawdown calculations may be performed using the superposition model or the Theis equation." The next sentence says, "The method resulting in the greater impact will govern unless site-specific information indicates that a particular method would be more realistic." Does that enter into your decision about using Theis?

A. It does, but as I mentioned before, the aquifer where most of our applications are filed, the transmissivety is so high, and when we get our results typically over a 40-year period, the drawdowns will be in inches. So it's really efficient. Now, if it's something we're approaching that 1 foot that's listed in here, if we're really worried about it, we'll go ahead and send it up to the hydrology group, and they will use the MODFLOW. We don't use it here in our office.

Q. Okay. Okay.

MS. KLAHN: I see that it's 11:57, and this is probably as good a place to stop as any so should we take an hour and 15?

MS. THOMPSON: Sure. Sounds fine.

MS. KLAHN: All right.

(Break.)

Q. (BY MS. KLAHN) Good afternoon, Ms. Thacker.

A. Hi.

Q. We were looking at Exhibit 69 when we broke for lunch, and I'd like you to turn now in Exhibit 69 to Page 9, Paragraph 10. Paragraph 10 talks about available transfer amounts, and I think our conversation this morning mostly was about using these guidelines in the context of a change of location of the well?

A. Correct.

Q. So keeping with that theme, this paragraph states that for changes of point of diversion or place or purpose of use, "The quantity that has been historically available and consumed will be taken as the amount which may be considered for transfer to the proposed use." Is that also true as for -- for an analysis for how much could be transferred to a new point of diversion?

A. Yes. That's correct.

Q. Okay. What method or tools do you use to calculate how much water has been historically available and consumed for beneficial purposes?

A. If it's a municipal right, for instance, or a water right where meter readings are available, that's what we will use is the highest year that the most that's ever been put to beneficial use in one year, that's what we say is available for transfer.

Q. Okay.

A. Now, for a surface and groundwater combined right, we don't allow that for transfer unless they're transferred together. So that's a whole different ball of wax. But for groundwater only acreage, we say what's actually been irrigated in the past and multiply that times the 2.6 acre feet acre per annum. That's the CIR, that consumptive irrigation requirement.

Q. So this -- your application of this paragraph simply applies the adjudication court's determination of the CIR rather than looking at actual historical use on the ground?

A. That's correct.

Q. Okay. So next paragraph I'd like to talk to you about is on Page 10, Paragraph 11, "Supplemental wells." Towards the end of that paragraph is a sentence that starts, "Application for supplemental wells for declared water rights may be approved but only as provided for in Criteria 14 and 16 below." Are -- have you processed any applications for supplemental wells for declared water rights?

A. Yes. Now, the supplemental wells, as I understand it, it's just an -- another point of diversion for the diversion for -- to add to an existing point of diversion.

Q. Okay.

A. Just so we're on the same page.

Q. Okay.

A. And then -- yes. So we've -- we've done that, yes.

Q. So when you -- you're making that distinction because of the distinction in the adjudication court's order 101 about supplemental groundwater rights?

A. Correct. Yes.

Q. Okay. And how do you understand those two to be different, what a supplemental groundwater right is versus a supplemental well?

A. Well, I would say that a supplemental well is just an additional point of diversion, and that's how we're characterizing them now with our new applications. If you look at those, it'll be an additional point of diversion as opposed to a supplemental well. So that's how I would say -- characterize the supplemental well in this document as an additional point of diversion.

Q. Okay. And so the -- the statement in this sentence that we were just talking about is that we'll call it an additional point of diversion is only available for declared water rights as provided in Criteria 14 and 16 below, and then let's turn to 14 and 16, and I wonder if you could help me understand how you've used Criteria 14 and 16 when you've processed supplemental well applications.

A. Okay. So your question was how we use these; is that correct?

Q. Uh-huh.

A. Okay. Essentially if -- on No. 14, for instance, a well, if it's only capable of pulling a certain amount of water and they're suggesting they want to pump a whole bunch more beyond that well, we'll look at that for sure, and then also, on 16, if -- if a well's existing has been declared and for an area for irrigation, but if they declare, for instance, a hundred acres, but, in fact, they've only historically irrigated 50, we'll take a position -- essentially our jurisdiction has been invoked, and we'll take a position that only 50 acres has been put to beneficial use and then quantify that right based on that, what's historically been put to beneficial use.

Q. Would that be part of what was going on with that LRG 3150 you mentioned early on with the Crowder rights?

A. That would be based on meter readings as opposed to an actual place of use --

Q. Oh, okay.

A. -- irrigation. So same concept, though, yes.

Q. Okay. In going back to what you said about 14 -- I think you said if it's -- if a well is only capable of pulling a certain amount of water and they're suggesting they want to pump a whole bunch more --

A. Right.

Q. -- but -- and so help me out here. So I've been thinking a supplemental well was actually a new point of diversion?

A. Correct.

Q. So presumably it hasn't been drilled yet?

A. Right. And let -- this Crowder water right is a really great example of that. They filed an application for a supplemental well, an additional point of diversion. The declaration said I think it was a hundred thousand acre feet that they were declaring to in the future, the intent to use that much or that's essentially. Well, of the 32 wells that were drilled and declared, it was determined by our hydrology department that only 29,000 could actually, physically be pulled from all those wells as opposed to the hundred thousand, and so that's where this comes in. Saying, okay, you may want a hundred thousand, but, gosh, you can't even physically do that.

Q.   So they could drill another well as long as they stay within the 29,000?

A.   Correct.

Q.   Okay.

A.   And that's how they --

Q.   Okay.

A.   Yeah.

Q.   So the limitation you were placing is on the well that they want to -- that exists that they want to add the point of diversion to?

A.   Correct.

Q.   Okay.

A.   In that specific instance, right.

Q.   Okay. So what about 16? I think you said a little bit about that, but then I jumped back to 14. How do you -- how do you apply Paragraph 16 to transfer applications involving pre-basin water rights? Is that similar to what we were just talking about?

A. It is. For instance, 16A, date of commencement of works relative to the date of declaration of the basin. We'll take it -- the declaration on its face that if the declarant says the well was drilled in 1950, we'll take that last date, December 31st, 1950, as the date -- the priority date of the water right, for instance.

Q. Do you do any investigation about whether the -- those kinds of sworn statements are accurate?

A. Yes. We did in the past. We don't take declarations any longer, as Jim had mentioned, but we -- when -- when declarations were filed, a field check was conducted and so we have those all on file. So if we have to consult those, in our evaluation, we can look at those field checks and say, okay, the declarant claimed this much, but we're seeing otherwise that there's other extenuating circumstances.

Q. But there's no way really to check on a priority date, is there, or would you look at aerials like Mr. Hangen was saying?

A. We would. It's not necessarily a really great way to check, because as he mentioned, sometimes you just physically can't tell where the well was, but we do use the parameters that Mr. Hangen uses.

Q. And these affidavits. In your professional capacity, when these affidavits were in use, are these documents that you would have examined as part of any overall evaluation of a -- of an application and changed point of diversion?

A. Yes.

Q. And did you -- how do you interpret, looking at the next-to-the-last page of -- the last two pages, I guess, of Exhibit -- not quite. The two affidavits at the end of Exhibit 114. And as I went through with Mr. Hangen, Ms. Lara's affidavit says from 1952 through 1969, she knew -- she allegedly knows of use, and Mr. Lara gives a different set of dates. How do you interpret that, is that's the only history of use associated with this or something else?

A. Well, I would say that this -- this helps us establish a priority date.

Q. Okay.

A. But I wouldn't use this in of itself, even though these folks say that this well has only been used until 1969. We'll use other aerial photography, for instance, or other information besides just this. Is that your question?

Q. Yes.

A. Okay.

Q. So then let's turn over to the maps, which are not necessarily awesome copies to do a specific analysis, but just walk me through. If you were evaluating the credibility of the affidavit, if you look at the -- the first map in the package that has Apodaca parcels in a white box in the middle, is that the -- you would look in an aerial of the parcel Mr. Apodaca wants to irrigate in order to -- and look historically at aerials, is that what you would do?
A. That's correct.
Q. Okay. And along with that, are you looking to see if there are other water sources that could have served that parcel?
A. Well, because the applicant or the declarant claimed the irrigation of this parcel on the map from that specific point of diversion, the surface water attachment is just a given.
Q. Okay.
A. You know, we just make that assumption because I believe it's somewhere on here, it mentions that. But we don't look at any other well -- possible well, because we're just looking at the claim of the declarant alone.
Q. Okay.
A. Is that your question?

Q. The top bullet -- second-to-the-top bullet says, "No protests were received on the application." In -- in general, in your experience during this time when you were still doing these well -- change of well location applications in the way that they were being done at that -- in 2013, 2014, and 2015, were you receiving a lot of protests for changes in location?
A. No. And we don't receive a whole lot for irrigation.
Q. Today even?
A. Right. Right. For irrigation water rights, typically, we don't.
Q. Okay. And the -- back to the first page of this memo, it states like we were just discussing that irrigation of 75.63 acres of land for the -- for the new point of diversion. That's what we were talking about before, right?
A. Yes.
Q. Okay.
MS. KLAHN: I'd like to mark this.
(Exhibit No. 116 was marked.)
Q. (BY MS. KLAHN) So do you have any involvement with owner management plans?
A. Very, very little.
Q. And there's no processes in the District 4

up at the top of Page 5. Now, are you familiar with ownership management plans at all?
A. Enough to be dangerous. Very little.
Q. Okay. So if you turn now to Page 6.
A. Okay.
Q. The owner management plan acreage to be served is under the change to words there on the middle of the page. So the -- all of these water rights that precede are to be used on 1,080 acres?
A. Yes.
Q. Now, is it your understanding that under an ownership management plan, all of the water rights associated with -- that are in the owner management plan could potentially be pumped from one of those wells?
A. Potentially within its capacity.
Q. Okay. So if the publication for the City of Las Cruces change had said that the new point of diversion could potentially pump 4,860 acre feet or be used on many more acres of land, do you think there would have been any more likelihood that there would be protests, given that those numbers are so much larger than what we saw?
A. Perhaps.
Q. Has there been any discussion that you're

aware of at District 4 or even at higher levels, excluding legal counsel, about formalizing the owner management plan process so that it becomes more of a permit process?

A. No. No. We've just been using it as it is.

MS. KLAHN: Okay. Mark this.

(Exhibit No. 117 was marked.)

MS. KLAHN: Here you go, Lisa.

MS. THOMPSON: Thank you.

MS. KLAHN: And I know all the rest of you are getting grumpy so here. You need something to look at.

Q. (BY MS. KLAHN) Okay. So, Ms. Thacker, you've been handed Exhibit 117. Would you identify this, please?

A. Sure.

Q. Just read the title?

A. It's application for permit to change an existing water right, change point of diversion groundwater to groundwater.

Q. And what's the file number associated with this, the LRG file number?

A. Oh, yes. LRG 15192.

Q. So is yours printed front and back?

A. It is.

Q. Okay. That'll make it a little easier. So let's start at the back again, and first page in my copy of Exhibit 117 is an e-mail from Julie Ruiz to Pam Molina at EBID. Do you see that?
A. I do.
Q. Is this contact with EBID routine when you get it changed to an existing water right that happens to be within EBID?
A. Yes.
Q. And what's the purpose of that?
A. It's to determine, to make sure that the applicant who has a surface water right, that that water right is still valid with Elephant Butte Irrigation District.
Q. And what if it isn't?
A. If they're requesting to change point of diversion for acreage that has been historically irrigated with surface water, we will -- I think we'll just return the application saying we don't have a water right attached to this. So I don't remember exactly if it's return, reject, deny. I can't remember.
Q. Okay. So this e-mail seems to say that this customer has not paid his assessments so Parcel 1630 does not have water rights?

numbered lettered list of A, B, C, D, it says, "Stream effects from discontinuing appropriations," et cetera. Isn't this paragraph limited to effects on the -- on the -- on the -- let me take that back. Does stream effects in this paragraph include surface water sources such as laterals?

A. We do -- when we do the MODFLOW modelling, the superposition model includes all the laterals as part of that -- the whole model and how it was put together by Peggy Barrol. So all that is taken into consideration there, so that's how when we do the groundwater modelling, that's where it's taken into consideration.

Q. So it's your understanding that the -- that the model will take -- will reflect any potential surface water depletions from laterals?

A. Yes. It takes that into account as far as -- well, I'm sorry. Are you referring to any kind of depletions to the laterals?

Q. Depletions from the laterals.

A. Oh, from the laterals. I know it's -- the laterals are part of the MODFLOW, superposition model, but I'm not sure how that works as far as -- as far as I know, it's just depletions to the river as a whole, you know, the Rio Grande.

Q. I see. So if there's an effect on the lateral, your understanding is it would show up as an effect on the Rio Grande?

A. Correct. That's right.

Q. Earlier, you stated that you don't receive a lot of protests for applications to change irrigation rights. Do you recall saying that?

A. I do.

Q. Do you receive any protests?

A. We do.

Q. About how many per year would you say?

A. I don't know that number.

Q. Okay. Do you recall any recent examples of protests to irrigation rights?

A. I do.

Q. What would be an example?

A. An example would be changing the place and purpose of use of a commercial water right to use for irrigation purposes.

Q. And what happened in the case of -- of that protest?

A. It's still pending. There's a pre-hearing scheduling conference that's forthcoming.

Q. Okay. Going back to the CRRUA scenario, and we were talking about the -- the discharge credits

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

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REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
JOHN D'ANTONIO
JUNE 26, 2020
VOLUME 3

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REMOTE ORAL AND VIDEOTAPED DEPOSITION of JOHN D'ANTONIO, produced as a witness at the instance of the Plaintiff State of Texas, and duly sworn, was taken in the above-styled and numbered cause on June 26, 2020, from 9:02 a.m. to 12:59 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-234

properly, if they have the -- if they're in the right location within the -- to account for a totalizing meters that you're actually getting accurate results, are they in working order. I have numbers for 2018. I know we had -- we had 103 enforcement actions, roughly 70 or 70 percent of those enforcement actions in 2018 were -- were solved. The other 30 percent had to go through a hearing unit action, so that we could enforce through our administrative litigation unit, and we're very successful in -- in coming to an agreement on -- on those particular actions. So we're -- we're very good. We've got a very good water master group down there. The -- the compliance -- it's voluntary compliance on filing water meters or water meter readings essentially is in the high 90 percentile. If you consider the completion of the enforcement actions and everything we do, we're in high 90 percentile of -- of completion -- of compliance.

Q. So let me understand, for your 103 enforcement actions in 2018, were those enforcement actions for over diversion or were they enforcement actions for some irregularity in the meter readings?

A. Some irregularity in the meter readings. I can't tell you how many were over diversions, but it could have been a non-functional meter or not in the right location or, you know, not a meter that wasn't appropriate for the situation, so there were just -- they were actions that are -- and we do have a really good unit down there that gets involved in -- in clients and enforcement every day -- every day of the week.

Q. I'm interested in actually the amount of water that's being diverted, being pumped. So these enforcement actions, you said you can't tell me how many were over diversions. Why not? Give me an idea how many times you went out there in 2018 and stopped groundwater pumpers for pumping more than they -- they're either declared or permanent amounts?

A. Well --

MR. WECHSLER: Object to form.

A. Because -- because I'm -- not all the actions have to come through me and so like I said we will have -- if there's any illegal diversions, over diversions, whatever the problem might be, they red tag -- our unit down there red tags them, and a vast majority of those issues get resolved within the district office, and I don't have to see those. The time I see things is when there -- it gets critical. There's some bad actors, and there's -- there's really very few bad actors, but the ones -- and these are onesies and twosies that are bad actors that may be repeat offenders that we have to send out cease and desist orders. But my -- my -- my water masters take care of the vast majority of all those issues, so your question is why don't I know. I know when they get bad and they come to my level and we have to -- to take additional legal action, but for the most part, it's handled administratively and through administrative litigation unit until that needs to come to my attention.

Q. (BY MR. LEININGER) And let me just ask about this because we're using words of over diversion and illegal diversion intermixed here so enforcement against illegal diversion, is that over diversion beyond declared or permanent amount? Is that what you're defining as an illegal diversion?

A. The main example I have for that is a river pumper, somebody that would throw away a pump into a river and directly divert out of that river. A lot of the -- a lot of the over diversions that happen, happen as a result of how the project is managed so many -- many times, you know, we get a March 4th -- March 1st forecast, April 1st forecast, and there's -- there's a supply of surface water and project water a shared domestic with four or more people, I believe that's still in effect. We don't require metering if it's -- unless there's a shared well with -- with more folks, and each -- each branch of that domestic well would have to require a totalizing meter.

Q. Is there some estimate of water use for a single family which you don't require a meter or is it just a single family?

A. It's a -- I changed the domestic well rules. It used to be up to 3 acre-feet per acre, and any of those domestic wells that were in place were grandfathered in. The -- when -- when we promulgated rules and regulations to change that, we allow up to an acre foot of water a year for outside irrigation for domestic purposes essentially, and so that's -- that was in the mid 2000s, which we changed that law. So what was your question? Yeah, there's -- you know, a typical household might use a quarter of an acre-foot of water per year.

Q. But the rules and regulations now is -- is one acre-foot for domestic use?

A. Any new domestic well applicant shall -- yeah, the -- they had the ability to go in and get a domestic well permit for up to one acre-foot of water.

Q. So what type of monitoring, if any at all, is

there for the single-family homes up to and not exceeding one acre-foot?

A. They're -- through -- and this is through our observations and historical use. As I mentioned, it's very difficult to use more than even a quarter of an acre-foot per a regular household, quarter acre lot, you know, 2,500, 2,000 square foot home, they don't use that much water, and most of the water essentially returns -- returns to the system for domestic wells. So the consumptive use portion is -- is really considered de minimus. We -- we keep records of -- of numbers of domestic wells throughout the State of New Mexico and so -- so we understand what percentage of it is, and it's a very low percentage of water use. I can't tell you what it is right off the bat for Lower Rio Grande, but it's -- it's domestic wells are very small users of water.

Q. Is there any monitoring at all going on for these permitted exempt domestic wells?

A. When you say "monitoring," there's no -- as I mentioned before, there's no measuring or meter required. We -- we can calculate them based on averages, and as I -- as I said, we use probably about a quarter of an acre foot per domestic well as a reasonable average as to water use within a certain area. So when you say monitoring, we know how much approximately water use, but there's no --

Q. Have you brought any enforcement actions against a domestic well user that exceeded 1 acre-foot?

A. Well, not to my knowledge. I mean, we have the ability to go in and declare domestic well management areas. It's a management tool that I put in place when I was trying to change -- change the law from -- from 3 acre-feet down to an acre foot. So if there's an area that's problematic with respect to domestic well development, as it affects surface water -- and, again, this is in the statute, then I have the ability to go in and create a domestic well management area to reduce that one acre-foot down to a quarter of an acre-foot or actually require water transfers into that particular area, and to date, there's -- there's been some inquiries here and there around the State of New Mexico, but there's not been the need, and I have that tool, but there's not -- there's not a need, and there's certainly not a need in the Lower Rio Grande to put in the domestic well management area within that particular basin based on the current uses of domestic wells.

Q. Okay. Let's leave the subject matter. We're

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS)) Plaintiff,)) VS.)) STATE OF NEW MEXICO,) and STATE OF COLORADO,)) Defendants.)	Original Action Case No. 220141 (Original 141)

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REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
CHERYL THACKER
SEPTEMBER 18, 2020
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REMOTE ORAL AND VIDEOTAPED DEPOSITION of CHERYL THACKER, produced as a witness at the instance of the United States, and duly sworn, was taken in the above-styled and numbered cause on September 18, 2020, from 1:33 p.m. to 4:42 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, remotely at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-235

specific farmers of surface water.

Q. How would you define over diversion?

A. What we do here in the District 4 office is we monitor how much water is pumped from each well, and specific to a specific water right, and an over diversion would be that amount of water diverted that goes beyond their water right.

Q. Okay. Looking at your answer here, you talk about monitoring of how much water is pumped from each well. Do you monitor how much water -- how much surface water is diverted by each water right holder?

A. What we do is in our WATERS database, we include the allotments set by the surface water allotments set by EBID, and we just assume that every water user takes that full allotment of surface water, and then we make sure that the groundwater amount of water is constrained within the Stream System 101 settlement agreement.

Q. Okay. So the OSE does no administration of the amount of surface water that is beneficially used by each of the EBID farmers; is that correct?

A. We just make the assumption that every EBID farmer takes their full allotment.

Q. And the OSE does no monitoring of that or -- well, let's just start there. The OSE does no

monitoring of each farmer diversion of surface water?

A. Not in this office, we don't.

Q. With regard to groundwater, does the OSE monitor how much each farmer is diverting to the groundwater?

A. Absolutely.

Q. Okay. How do you go about doing that?

A. Well, we require metering all wells for irrigation purposes, as well as commercial and non-domestic purposes, and so for irrigation purposes in particular, we require quarterly meter readings and those meter readings are entered into our WATERS database, and that allows us to account for the amount of water each farmer is using.

Q. Okay. In your previous answer, you said with regard to ensuring there's not an over diversion, you make -- I'm looking at your answer here on Line 26:17. "We make sure the groundwater amount of water is constrained within the Stream System 101 settlement agreement." So how does -- how do the OSE then administer to constrain groundwater pumping within the Stream System Issue 101 settlement agreement?

A. Well, I'll go ahead and give you a scenario. In our WATERS database, we input for every farmer the amount of the allotment EBID has designated for that year. So, for instance, if the amount of water the allotments from EBID surface water is 2 acre-feet per acre per annum, we input that into our WATERS database, and then we look at the Stream System 101 settlement agreement, and we see for most farmers, they have a total FDR farm delivery requirement of 4.5 acre-feet per acre per annum. So what we'll do is straight away, we assume that the farmer will use all the full 2 acre-feet per acre per annum, and what that does, we subtract that from the 4.5 farm delivery requirement, and that gives us a number stating that they have 2.5 acre-feet per acre per annum that can be diverted from their well or wells.

Q. If they exceed -- under your scenario, if they exceed the 2.5 acre-feet per annum, is that an over diversion?

A. It is.

Q. And how do you enforce against an over diversion?

A. Our water master, who is Ryan Serrano and his staff, will notify the farmer that is over diverting, and they will often red tag, literally put a red tag on the well, and there's also written correspondence to those farmers and they investigate and work with the farmer to rectify that over diversion.

Q. Is your well metering, is that realtime?

A. It is not. It's -- we require the farmers to submit their meter readings January, April, July, and October by the 10th of those months.

Q. So let's say in July, you get a meter reading, and it appears that under this scenario which the farmer was entitled to 2.5 acre-feet per annum, pumping, and it's been exceeded, what -- what actions do you take when you get that information?

A. Well, the water master again will contact that farmer and investigate the situation, for instance, talk to the farmer about, well, is -- is your meter working correctly, were the meter readings written down and submitted correctly. Often, that's what happens. The farmer will inadvertently report the meter readings incorrectly or there may be a metering -- there's -- a meter can be tenths or hundredths. They may have a decimal place off. So they'll -- the water master is real diligent about working with the farmers to make sure that those meter readings were entered correctly and submitted correctly. And we'll also go out -- they will, not me, but the water masters will go out and inspect the wells and work with the farmer to make sure that that well is working correctly.

Q. Okay. Let's --
A. And --
Q. I'm sorry. Go ahead. I didn't mean to interrupt.
A. No, that's okay. Go ahead.
Q. Let -- let's assume that the meter is reading correctly, that the well is working correctly, and the 2.5, which is what should be the limit to groundwater pumping has been exceeded in July and you've got the meter reading, it's accurate, the water use is being exceeded, what does the OSE do to rectify this over diversion at that time?
A. So a water master will work with the farmer, and he will come up with a replacement plan so that that farmer will pay back that water. Typically it occurs in the following irrigation season.
Q. So is the -- is the farmer allowed to continue to pump?
A. No.
Q. In irrigation season?
A. I don't believe so, no.
Q. And how do you prevent farmer from pumping beyond that 2.5 after notification that they've exceeded their amount they're entitled to?
A. Well, the water masters go out and inform the

farmer that he can no longer pump that water from that well.

Q. And --

A. And then if there's -- if they refused to follow those instructions, it'll -- it can go to a compliance order and eventually to the administrative litigation unit for full compliance.

Q. Do you take any physical action at the time you're aware of the over diversion to prevent additional pumping that well had?

A. What do you mean by physical action?

Q. Do you lock it down so that --

A. I am not aware of locking that down. I would have to ask -- or you would have to ask Ryan Serrano.

Q. How many compliance orders do you typically issue every year?

A. I think there was between 10 and 20 a year. Not very many.

Q. That is the number of over diversions that you've discovered?

A. I believe that's the number of over diversions where the farmer hasn't come into our office and worked with our water masters to come up with a replacement water plan, and I think they -- those are the folks that just refuse to cooperate.

diversion? Is there any method that you use other than reducing the amount that they could pump in the following year?

A. Well, they could be a part of an ownership management program for future years; however, if they have over diverted and were not previously part of same ownership management on the program, they still will be required to pay back that over diversion.

Q. Mr. Serrano gave quite a bit of testimony about ownership management programs, but if you could just encapsulate exactly what an ownership management program is and how over diversions are accounted for in future years under that program?

A. Okay. I'm going to take that first part. The same ownership management program is at least two farms that are managed by one entity, one farmer, one manager, and what can be done is the two farms are more. Those water rights were kind of pulled, as it were, so one farm field can be fallowed, and the water associated with that piece can be used on a different piece of land as long as the total water right allowed diversion isn't exceeded.

Q. So I don't understand. How does that allow a farmer to come in compliance with over diversions under this program?

A. So, for instance, if it's a pecan orchard and the farmer has over diverted in the past, he will have to, of course, pay back those over diversions, but he can enter in a same ownership management program and use water on a separate farmer's land from a separate farmer's land who chooses not to irrigate that, and so what that does is allows a pecan farmer to go ahead and divert more, but the whole water rights, the two farmers, it's not -- it's not exceeded.

Q. Okay. So -- so let me understand. So if there is a determination that there is an over diversion, a water right is exceeding its amount it's entitled to pump from the ground, and they're a part of this ownership management program, then they're not having to offset that over diversion, they just need to enter into an agreement where other lands are fallowed that would normally receive water; is that right?

A. Right. So the mass balance of the water right isn't exceeded for the two farms.

Q. And when you say not exceeded into the future, are you talking about the immediately succeeding year of over diversion or can this be stretched out over a number of years?

A. Well, this arrangement can be stretched out as long as the two farmers are in agreement that they plan to do the same thing.

Q. Okay. And the same thing is to come into compliance with the water use that would normally be applied from groundwater pumping on those lands?

A. Can you restate that? I'm not sure I followed.

Q. Yeah. Sorry. I -- the question is that the agreement is an agreement that water use on those lands is in compliance with the permitted or declared amount of water for that acreage?

A. Right. For the two farms together, the total water rights is not exceeded. The allowable water for the two farms together isn't exceeded as a whole.

Q. Okay. That is essentially based on a 4.5 acre-foot per acre farm delivery requirement?

A. For the most part, yes.

Q. When you make these determinations of over diversion, is there any evaluation of groundwater pumping that is making depletions to surface flows?

A. Well, I'm kind of puzzled with determinations of over diversion. What are you referring to there?

Q. Sure. So you just testified with regard to how you define -- how the OSE defines over diversion for purposes of groundwater pumping, right?

A. That's right, yes.

Q. You used the term nuclear option with regard to curtailment. Why is curtailment a nuclear option?

A. No. I would say priority administration. Curtailment isn't a nuclear option. And I guess the question, too, is what do you mean by curtailment in your eyes.

Q. Shutting down a water right period.

A. Okay.

Q. Lock the well, lock the head gate, don't let them take water. That's curtailment.

A. Okay.

Q. How do you define it?

A. I would agree. And when I say nuclear option, I mean priority administrations where we make a call on the river and shut a whole bunch of water rights down. Yes, the state engineer has that authority, but we would prefer to use the active water resource management tools so we don't have to do that.

Q. So in your view, in your job, active water resource management provides you tools so you can avoid operating under strict priority system?

A. Well, I think it's to encourage shortage sharing and cooperation with the farmers and just managing the river so that -- excuse me -- managing

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS)
)
Plaintiff,)
) Original Action Case
VS.) No. 220141
) (Original 141)
STATE OF NEW MEXICO,)
and STATE OF COLORADO,)
)
Defendants.)

****
ORAL AND VIDEOTAPED DEPOSITION OF
RYAN SERRANO
APRIL 17, 2019
VOLUME II
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ORAL AND VIDEOTAPED DEPOSITION of RYAN SERRANO, produced as a witness at the instance of the Plaintiff State of Texas, and duly sworn, was taken in the above-styled and numbered cause on April 17, 2019, from 9:17 a.m. to 4:34 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the HOTEL ENCANTO DE LAS CRUCES, 705 S. Telshor, Las Cruces, New Mexico, pursuant to the New Mexico Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-236

Q. And that also includes adjudication -- adjudicated --

A. Yes, ma'am.

Q. Okay. And that includes both groundwater and surface water rights, correct?

A. Yes, ma'am.

Q. Earlier, you meant when we were looking at Column F, the surface meter amount, I -- I believe you said that that could represent an EBID allotment?

A. Yes.

Q. Could you -- could you explain what you meant by that?

A. So when the -- the allotment is announced, the initial allotment is announced, we take that number, which is in the form of acre inches that EBID allots. We have to convert that to acre feet, and then that's entered into what's called a virtual meter under the surface water points of diversion in the waters database as a total for the entire district within EBID. So it's a large number. It's in the tens of thousands of acre feet. Then the database goes through a process of distributing that water pro rata to each file that has a surface water right identified as part of it.

Q. So when you say "surface water right," you

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS)	
)	
Plaintiff,)	
)	Original Action Case
VS.)	No. 220141
)	(Original 141)
STATE OF NEW MEXICO,)	
and STATE OF COLORADO,)	
)	
Defendants.)	

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REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
ESTEVAN LOPEZ
SEPTEMBER 18, 2020
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REMOTE ORAL AND VIDEOTAPED DEPOSITION of ESTEVAN LOPEZ, produced as a witness at the instance of the United States, and duly sworn, was taken in the above-styled and numbered cause on September 18, 2020, from 9:02 a.m. to 12:38 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, remotely at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
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NM_EX-237

inform that apportionment, and in my report and in responses to my prior depositions, I've explained how the 57/43 that I assert is the apportionment below Elephant Butte we get from a reading of the Compact together with those downstream contracts and the historical practice of how the project has been operated up until essentially 2006.

Q. So is the contract with EBID the sole means for New Mexico obtaining its apportionment under the Compact?

MR. WECHSLER: Object to form.

A. Are you referring only to that -- the apportionment below Elephant Butte?

Q. (BY MR. DUBOIS) Yes. I'm sorry. I should have been clear on that. I apologize.

A. I believe that it is, yes.

Q. Okay. Is it New Mexico's position that the contracts between the United States and the two districts and the contract between the two districts are integrated into the Compact?

A. I think what I testified is that they -- that the Compact and the project are inextricably linked, and the -- and the contracts are also kind of inextricably linked to -- or inextricably intertwined, I think is what I -- what I said in my report. I was

A. I think that it is non -- for non-project uses. If it is for non-project uses, those might have to be offset, but not if it's for project uses.

Q. (BY MR. DUBOIS) Why not if it's for project uses?

A. Because -- well, one of the -- one of the purposes of the Compact is to -- is to make the -- the project viable over the long haul, and that viability includes getting -- or having access to groundwater for conjunctive use, and that's consistent in both states.

Q. Is there any limitation on New Mexico as to how much surface water can be depleted by pumping in New Mexico?

MR. WECHSLER: Object to form.

A. Are you asking about for a specific purpose or just generally?

Q. (BY MR. DUBOIS) Generally.

A. Well, yes, I think there is a limitation. If -- if Texas is not getting 43 percent of its project supply of the project supply then I think that would -- that would set the limitation.

Q. But you've told me that depletions to the water supply from pumping, at least for pumping for project beneficiaries, does not count against the

apportionment; is that right?

A. I guess what I'm saying is that the use of conjunctive -- the use of groundwater for conjunctive purposes on project ag lands does not -- does not have to be counted.

Q. There's a logic after that I'm trying to figure out. You told me that if I -- tell me if I'm correct in my understanding. You've told me that Texas is entitled to 43 percent of the surface supply; is that right?

A. That is correct. What I call the project supply.

Q. And you told me that New Mexico can pump groundwater and the depletions from that pumping affect the record; is that right?

A. Yes.

Q. And that the depletions from pumping are not accounted against the apportionment; is that right?

A. That's correct. That's -- that's true on both New Mexico and in Texas.

Q. It's -- it's nice that you're wanting to throw in Texas, and I don't have any problem with -- with sort of the sauce for the goose, sauce for the gander, but what's the limitation on New Mexico on how much the surface water can be depleted by pumping in

Mexico.

Q. (BY MR. DUBOIS) Is there anything in the contracts between EBID and the United States that precludes EBID from taking groundwater in lieu of surface water and accounting for that as part of their allocation?

A. So let me -- let me be clear about, earlier you were asking me about the contracts and -- and -- and whether that was the only mechanism by which New Mexico got water. What -- the downstream contracts and -- and what the -- the importance of those is, as I said before, they inform the -- the appropriation. That was the split of -- of lands that were contemporaneous with the -- with the Compact, and that resulted in the 57/43 apportionment between the two states. Those contracts -- that's the importance of those contracts. The rest of that and what you just asked me about, EBID and taking groundwater and doing surface water, no, the -- the Compact apportions the surface water. It did not apportion the groundwater, and that's not part of the equation there.

Q. So you -- you just said the contracts are generally informing the apportionment. What do you mean by generally informing?

A. I'm saying that they laid out the proportions of return flows for water that's been transferred to municipal uses, I think that's inconsistent for the Compact. In recent times since 2008 with a new operating agreement where, in essence, all -- all of the project inefficiencies are assessed, in essence, to EBID, I think that is inconsistent with the -- with the Compact and that it, again, changes the -- the allocation such that it's not consistent with the apportionment. That includes things like impacts from Mexico pumping, and it includes all of the other things that I've already mentioned.

MR. WECHSLER: Jim, when you get a chance, I could --

A. Excuse me. I'm looking at the -- at the -- I'm looking at the realtime, and I -- I did not say New Mexico pumping. I said Mexico pumping.

Q. (BY MR. DUBOIS) Thanks for catching that.

MR. WECHSLER: Yeah. Jim, I was just going to say, when you get a chance, I could use a break.

MR. DUBOIS: Sure. Let's take ten minutes.

MR. WECHSLER: Thanks.

MR. DUBOIS: Come back at 11:30?

MR. WECHSLER: Sounds good.

element could not be modified without going back and re -- renegotiating the Compact, if you will.

Q. (BY MR. SOMACH) I want -- I want to come back to that in a minute, but let me -- let me ask you this question: Does New Mexico -- is New Mexico -- if I'm looking to try to figure out what New Mexico's apportionment is below Elephant Butte reservoir, is -- is New Mexico entitled to the water from the Rio Grande for use outside of the four corners or the boundaries of the Elephant Butte Irrigation District?

A. So, yeah, I think there is some entitlement, and I guess there's -- there's a few uses within New Mexico that precede the -- the Compact, and -- and those -- those, I believe, are protected by the Compact. It's not a large amount of use, but the -- the Bonita lateral comes to mind, and I think that those are not, per se, within the Elephant Butte Irrigation District, at least that's not my understanding of it, so I guess -- I hadn't thought about that earlier when Mr. Dubois was asking me questions. As I thought about it a bit more, that came to mind.

Q. Well, you mentioned the -- when we talked before, you mentioned the rights in the Bonita -- the Bonita lateral, but other than those, maybe

pre-existing rights that may have been grandfathered in, so to speak, I'm talking about in the context of this 57/43 that we've been talking about, can any of that 57 percent that you say is apportioned to New Mexico be utilized outside of the Elephant Butte Irrigation District?

A. So at present, I would say -- I would say no. And here again, after I responded to -- to Mr. Dubois earlier, I thought -- I thought about something else, and I don't know how this would work, but I think the apportionment that resulted from those contracts is -- is an apportionment to New Mexico. If for, by some crazy occurrence, if Elephant Butte Irrigation District ceased to exist, they are -- as I understand it, they are a creature of statute. If -- if they were -- if they were no more, I think New Mexico would still have a right to that 57 percent. I don't know how it would play out, but I don't think it goes away with -- you know, if -- if Elephant Butte suddenly went away, I don't think that portion goes away. It would still be available to New Mexico.

Q. Right. Would New Mexico be able to use -- with -- under the -- the hypothetical, which is an interesting hypothetical, but under the hypothetical where EBID goes away, would New Mexico still be

constrained in using its apportionment to the lands that previously had been within the Elephant Butte Irrigation District?

A. You know, I think that is a correct read of it. I think as I've -- as I've talked about in my previous depositions and reports and so forth, it's -- it's for use within the authorized project acreage. So, you know, I -- it's -- the hypothetical that we're talking about is not something that I envision or desire or anything else. It's -- it's just the question that Mr. Dubois asked me and, now, that you're asking me made me think about that, and I thought -- I just wanted to emphasize that the -- that the apportionment, while it arises out of -- out of a contract with EBID, the apportionment itself is -- is to New Mexico.

Q. I understood that. I just want to make sure, you did say, however, even if it was a New Mexico apportionment, it would have to be used within those project boundaries; is that correct?

A. I think at least at present, yes. There probably will be some process to change that. Could be perhaps a miscellaneous purposes contract, let's say, that could change it, but I think you would -- there would be -- there would have to be some process

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

****
ORAL AND VIDEOTAPED DEPOSITION OF
IAN FERGUSON
FEBRUARY 19, 2020
VOLUME 1
****

ORAL AND VIDEOTAPED DEPOSITION of IAN FERGUSON, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on February 19, 2020, from 9:11 a.m. to 4:50 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the offices of TROUT RALEY, 1120 Lincoln Street, Suite 1600, Denver, Colorado, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

after that period of time that Mr. Cortez is talking about, 2006/2007, what was the purpose then for the 2008 operating agreement?

MR. DUBOIS: Objection to the form of the question.

A. My understanding is that the 2008 operating agreement is part of a compromise and settlement agreement between Reclamation, EBID, and EP1.

Q. (BY MS. THOMPSON) Anything else?

A. I think the 2008 operating agreement, it formalizes some of the procedures that were being discussed and partially implemented in 2006 and 2007.

Q. Do you have any other opinions about what the purpose of the 2008 operating agreement was?

A. My understanding of the purpose is that it is a mutually-agreeable set of procedures for determining project allocations and accounting, that, again, are part of a negotiated compromise in settlement between Reclamation and the two districts.

Q. Is the operating agreement intended to offset some amount of pumping in New Mexico?

A. Addressing the impacts of groundwater pumping in New Mexico, my understanding was a strong driver in negotiation of the operating agreement.

Q. And how did you develop that understanding?

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS,	:	
	:	
Plaintiff,	:	
	:	
VS.	:	Original Action Case
	:	No. 220141
STATE OF NEW MEXICO AND	:	(Original 141)
STATE OF COLORADO,	:	
	:	
Defendants.	:	

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ORAL AND VIDEOTAPED 30(b)(6) DEPOSITION OF
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
BY AND THROUGH
KELLY WADE MILLS, P.G.
AUGUST 27, 2020

****

ORAL AND VIDEOTAPED 30(b)(6) DEPOSITION OF TEXAS COMMISSION ON ENVIRONMENTAL QUALITY BY AND THROUGH KELLY WADE MILLS, P.G., produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on August 27, 2020, from 1:09 p.m. MDT to 2:44 p.m. MDT, via Zoom videoconference, before PHYLLIS WALTZ, RMR, CRR, CRC, Texas CSR, TCRR, Louisiana CCR, in and for the State of Texas, recorded by machine shorthand, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed before any Notary Public.

TX v. NM # 141
New Mexico Exhibit
NM_EX-239

keyword. There was a full ability?

A. I'd like to look at the transcript, if I could.

Yes. So, you know, with the -- what I recall with that report -- and I was not the author of that report, but what I recall with the report was there -- was that drawdown and groundwater usage was exceeding the -- the recharge to the Hueco Bolson in El Paso County and it was exasperated by pumpage on the other side of the Rio Grande and that a groundwater conservation district under the confines of Chapter 36 would not have the ability to manage that issue because of the international challenges.

Q. So I want to ask you about what you've said. And, thankfully, you have the transcript. So, you know, I'm not going to butcher your words or say something that isn't exactly what you've said. Now, if I remember correctly, you said -- because I'm just writing this down; I'm not looking at the transcript -- that the drawdown exceeded discharge. Is that what you said?

A. That the drawdown in the Hueco Bolson exceeded the recharge.

Q. The recharge, I'm sorry. And how did you determine that? Or how did TCEQ determine that?

A. That was based on information in --

Q. So your video froze and I did not hear your answer. I apologize.

A. Okay. I'm sorry. That was based on data and information that -- that was provided by the Texas Water Development Board in their report.

Q. Okay. And then you said that -- well, you didn't say the problem. But the issue was exacerbated by pumping on the other side of the Rio Grande, word -- you know, words to that effect. Is that accurate?

A. Yes, sir.

Q. Now, what do you mean by that? Is that groundwater pumping in Mexico?

A. Yes, sir.

Q. Would you please explain what you know about how groundwater pumping in Mexico affected either surface water on the Rio Grande or groundwater underneath El Paso County.

A. There were in -- like I said, I have to look at the report. But there were -- I believe that the -- the information that the Texas Water Development Board provided included drawdown, some drawdown maps that showed cone -- pretty good size cones of depressions stretching across the Rio Grande from Mexico.

Q. Now, I have heard, and you're the geologist, not me, that the -- that the -- that the barrier between

Q. (BY MR. ROBLES) Okay. Now, is it correct that groundwater development -- or groundwater conservation districts create comprehensive management plans for the groundwater resources?

A. Yes, sir.

Q. And the groundwater conservation district also implements policies and procedures to ensure that the plan, the conservation plan is executed; is that correct?

A. That is correct, they can adopt the rules and policies to implement their management plans.

Q. Has TCEQ, either one of its commissioners, the Commission, or any of its staff, you know, employees ever made a specific recommendation for the creation of a groundwater conservation district in Basin 23 or El Paso County?

A. No, sir.

Q. Why is that?

A. Well, as I explained earlier in the conversation, the -- when El Paso County PGMA was studied in 19 -- 1990 [inaudible] and designated in 1998, recommendation was that a groundwater conservation district under the confines -- operating under the confines of Chapter 36 of the Texas Water Code would not have the full ability to manage the groundwater resources in El Paso.

Q. So I want to make sure I understand your testimony correctly. So I want you to -- you know, to push back on me if I say something incorrect. Is it the position of the Texas -- or the TCEQ that a ground- -- groundwater conservation district in El Paso County was inappropriate because it could not properly manage the groundwater resources underneath El Paso County?

MS. BARFIELD: It's asked and answered. The question is argumentative as phrased.

Q. (BY MR. ROBLES) Now, you...

MS. BARFIELD: He's frozen.

MR. ROBLES: Okay.

MS. BARFIELD: Oh, we lost him.

THE VIDEOGRAPHER: We lost him. Would you like to go off the record?

MR. ROBLES: Do you want to take a ten-minute break? Is this a good time for that?

MS. BARFIELD: Hold on one second.

THE WITNESS: Oh, am I back?

MR. ROBLES: Okay.

MS. BARFIELD: There he is. I want to make sure he's hearing us.

THE WITNESS: Sorry about that. I'm not sure what my hiccup was.

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

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REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
NICOLAI KRYLOFF
AUGUST 6, 2020

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REMOTE ORAL AND VIDEOTAPED DEPOSITION of NICOLAI KRYLOFF, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on August 6, 2020, from 9:02 a.m. to 2:52 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-240

Q. We didn't see any of the items that were listed in Page 44, those projects didn't involve water rights or water. Have you worked on other projects that involved water rights or water?

A. Yes.

Q. What are those other projects?

A. This is the confidential project I was talking about or the -- the project that may be confidential.

Q. Other than that one, are there other projects that you have worked on that relate to water rights?

A. That's the one that springs to mind. It's possible that there have been others.

Q. Let me get you to turn to Page 47 of deposition Exhibit 2. And here, this is Appendix C. This is compensation. What I'm curious about is it indicates that you were assisted by HRA Historians. How many people assisted you in your work on this project?

A. There was one principal other researcher who accompanied me on, I believe, one of the research trips, and there also would have been senior staff at HRA who read my report.

Q. Those senior staff would have given comments or input; is that right?

Q. Finally in that paragraph -- I'm sorry, Page 4, Paragraph 4, that opinion reads, "Some information about groundwater and its connection to surface flow was available to the Compact parties." And later in the text, you also use that phrase, "some information." What do you mean by that?

A. I think there's evidence in the sources that I reviewed that there was at least a basic understanding that groundwater was there and that it had some connection to surface flows.

Q. Turning to Page 5 under the general heading, "Rio Grande Background," you talked about, again, the -- the First Interim Report serving as the foundation and then you, in the next sentence, say that you offer the following summary. If you scroll through the citations, which start on Footnote 6, and go through to Footnote 40, almost all of those -- I can see maybe three exceptions, four exceptions are citations to the First Interim Report. Do you see that?

A. Yes.

Q. With this background section, were you intending to summarize the background provided in the First Interim Report or are you doing more than that here?

Q. And the Rio Grande is a river?

A. Correct.

Q. And the river is generally surface water, right?

MR. DUBOIS: Objection; calls for a legal conclusion.

A. I'm not sure I can agree to that one way or the other. I think that --

Q. (BY MR. WECHSLER) Well --

A. -- there is some reference that surface flows and groundwater flows were connected.

Q. Was there -- was the surface water in New Mexico fully appropriated as of 1938?

A. In the Rio Grande Basin, right?

Q. Yes.

A. Yes.

Q. Later in your report, and we'll have a chance to look at it, in Opinion 4, you talk about groundwater, and you reference the fact that in the 1950s or beginning in the 1950s, that there was an expansion of groundwater use in the project area; is that right?

A. I may have made a passing reference to that in my report. I can't recall specifically, but that is my understanding that that was the case, yes.

Q. Are you aware of any protests filed by Reclamation or the United States to any groundwater permits in either New Mexico or Texas?
A. During which time frame?
Q. Let's start with 1950 to 1978.
MR. DUBOIS: Objection; lack of foundation.
A. The scope of my research assignment did not go that far into that time period.
Q. (BY MR. WECHSLER) Are you aware of any protests filed by either Reclamation or the United States to groundwater permits in either Texas or New Mexico in any time period?
A. No.
Q. Do you know if the United States or Reclamation generally was aware of the groundwater use in the 1950s?
A. I can't comment on it, because my research didn't go that far.
Q. How far did your research go?
A. I would say probably up until ratification of the Compact.
Q. 1938? 1939?
A. 1939.
Q. Prior to the -- the discussion we were

under the project were hydrologically connected and pumping could diminish the flow of the Rio Grande." Is that right?

A. Yes. I see it.

Q. I think, though, that you say you recognized later on in your Opinion 3 that there's nothing within the Rio Grande Compact that specifically talks about groundwater; is that correct?

A. In Opinion 4 about groundwater?

Q. Yes. I can point you to the language. If you look on Page 32, in the paragraph that begins, "However," and then you say in the last two sentences of that paragraph say, "Although groundwater conditions may have factored into the data underlying these schedules, there was rarely any direct mention of groundwater. Neither the temporary 1929 Rio Grande Compact nor the 1938 Rio Grande Compact addressed groundwater for pumping and neither Compact defined groundwater or used the term." That's your understanding, right?

A. Yes.

Q. Is there -- so if I understand your testimony generally or your Opinion No. 4, you're saying that there was some awareness, and you're identifying a number of -- of ways that there was a connection

between surface water and groundwater below the Elephant Butte Reservoir that existed in 1938, that awareness existed in 1938; is that a correct summary?

A. I think so, yes.

Q. But despite that awareness of the connection, there's no language in the Rio Grande Compact about groundwater; is that correct?

MR. DUBOIS: Objection; argumentative.

A. That is also true.

Q. (BY MR. WECHSLER) Is there any documents that discuss groundwater and whether there was an intentional treatment of groundwater in the Compact?

A. In the Compact, no.

Q. On Page 31, in the first full paragraph there, you can see you're -- you're referring to activities included increased water sampling. Do you see that?

A. On Page 31?

Q. Correct. Towards the top, first full paragraph, three lines down. The sentence says, "Activities included increased water sampling and drains and groundwater test wells." Page 31. Are you there?

A. I'm on Page 31, yeah.

Q. Do you see the language I'm referring to?

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

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REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
SCOTT MILTENBERGER
JUNE 8, 2020

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REMOTE ORAL AND VIDEOTAPED DEPOSITION of SCOTT MILTENBERGER, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on June 8, 2020, from 9:03 a.m. to 3:30 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-241

what Mr. Davis doesn't say is he doesn't say that water that the wells would be tapping to, that's the same right that the United States already has?

A. He does -- no, he does not say that.

Q. And you're -- you're familiar with the concept of a claim for impairment; is that right, from your previous work?

A. I'm not sure. I'm not sure the question you're asking.

Q. Do you understand that a senior water rights holder can claim that a junior user is impairing their right generally as a matter of prior appropriation law?

A. Yes.

Q. In your review of the historic record, did you find any instance in which the United States made a claim of impairment against a groundwater well or right in New Mexico?

A. As I sit here today, not that I recall.

Q. Did Texas?

A. I don't know.

Q. How about EP No. 1?

A. I don't know, as I sit here today.

Q. Let's turn to Page 11 of your rebuttal, and I'm looking at the middle paragraph that

investigation, doesn't it?

A. It does.

Q. And in parts of that joint investigation, it actually directly addresses the possibility of groundwater as a future supply of water; would you agree with that?

A. In some places, yes, it does.

Q. The -- I think you talk about this in your original report, but would you agree with the statement that the drafters intended to allow for continued development of water resources?

MR. HOFFMAN: Drafters of what?

MR. WECHSLER: The Compact.

MR. HOFFMAN: Okay. I mean, just to make clear what you're asking him.

A. I think that there was a recognition that the various states had, I think the term that Raymond Hill uses is freedom of development, but that was within the context of the inflow/outflow schedules established for the three states. That is subject to that inflow and outflow requirements, development was available so long as Colorado and New Mexico met their obligations at various points in the basin to deliver water.

Q. (BY MR. WECHSLER) Is there any language you

would point to specifically to say that that was intended for the inflow/outflow model above Elephant Butte?

A. I'm sorry. What do you mean by "what was intended"?

Q. The ability of the states to continue to develop their water resources?

MR. HOFFMAN: You mean language in the Compact itself or do you mean language in the documents other than the Compact or both?

MR. WECHSLER: Any language anywhere Dr. Miltenberger is interested in pointing to.

Q. (BY MR. WECHSLER) I'm trying to understand the basis for that opinion, Dr. Miltenberger.

A. I think I -- I think I -- I may need you to restate the question.

Q. Sure. We were talking about you have a general opinion expressed in your first report that the states intended to continue to allow development of water resources following the Compact. You just indicated that that principle applied to the areas above Elephant Butte that utilized an inflow/outflow model, and I'm asking you to identify the basis for that opinion. And more specifically, specific documents that you would rely on for that statement.

A. Well, I think I already gave one document, which is Hill's development of the Rio Grande Compact, his statements, his recollections about what the intent of the -- of the project was. And then I would refer you to other documents that I discuss in my expert report wherein there are general statements made by John Bliss, and I believe Royce Tipton that provide the same -- support the same idea that the basis of the Compact was the inflow/outflow schedules, but within those targets, if you will, that the states were permitted to utilize the waters as a -- so long as they met their obligation, they could utilize the waters, as -- as they saw necessary or fit.

Q. Do any of those documents that you're pointing us to, do they specifically say and this concept does not apply to below Elephant Butte or words to that effect?

A. That development does not apply below Elephant Butte?

Q. Right.

A. I don't recall there being a statement like that.

Q. We were talking about the -- the statements from Mr. Hill, and we were looking at Deposition Exhibit SAM 9. I just want to make sure that there's

engineers in Colorado and for the Middle Rio Grande Conservancy District that, in fact, the amount of water would be increased. That was his sort of central sense of concern. Once again, I think that his -- his question about limitation was about trying to focus on what were the most saline issues that he believed at the time needed to be addressed within a -- trying -- trying to meet the -- trying to fit within a fixed budget, trying to fit in with a fixed time frame, as everyone was eager to develop a Compact. I think isolating this out from that context has the potential to be misleading.

Q. Did you review any documents that come in the immediate years following the Compact that specifically indicate that all of the states thought that each state was permitted to develop its water resources at will?

A. I think I mentioned some of those already.

Q. These are ones immediately post dating the Compact?

A. Well, I believe the Bliss document I referenced was post dating the Compact. I believe Tipton is the same. Raymond Hill's statement, I believe, comes several years after the fact.

Q. Let's move on to Page 12 and 13. Here is

A. As I sit here today, my recollection is that El Paso's -- potential for El Paso's water needs were discussed in the context of the 1920s -- or during the 1920s leading to the 1929 Compact. I can't think right at this moment off the top of my head of documents closer to the '38 Compact that specifically address that issue about El Paso relying on groundwater.

Q. And what do the documents that you're aware of from before the 1929 Compact reflect?

A. They speak to the fact that El Paso -- land below El Paso may yet need to be considered in the context of negotiating a Compact. I believe this is actually the substance of Richard Burgess' presentation, I believe in 1923, to the Compact commissioners. I believe he may have been supported in that -- if memory serves, supported in that by Julian O. Seth, the New Mexico negotiator in the 1920s.

Q. I think in your first report, you also discuss how it was known that the City of El Paso was likely to continue to grow; is that correct?

A. There is discussion about its continued growth.

Q. And it would need additional water supplies?

A. I believe there was discussion about that, as well.

Q. That was a concern for the State of Texas?

A. Well, I know that -- as I recall, that there was an understanding that -- broadly that Colorado -- excuse me -- El Paso was going to grow. I don't recall specific discussion among the engineers or the Compact negotiators, other than the one that I just mentioned.

Q. In your first report, you talk about the possibility that project water would be an option for the City of El Paso. Is there any language in the Compact that reflects this?

A. There's no language in the Compact that discusses using Reclamation Rio Grande project water for El Paso.

Q. In the 1929 Compact, there was language that gave a priority to municipal water. Do you recall that?

A. I do.

Q. That language does not show up in the 1938 Compact?

A. To my recollection, it does not.

Q. Do you recall the definition of usable water in the final Compact?

well, talking about Mr. Theis. Did you do any investigation of whether Mr. Theis was involved in assisting the districts in evaluating or conducting groundwater pumping in the 1940s and '50s?

A. Other than being aware that Dr. Theis passed this information on to EBID's general manager and to the Office of the State Engineer, I'm not aware of his participation in any other activities.

Q. Let's turn to Page 19 of your report, and here, you're talking about Conover at the bottom. I'm looking at the bottom of the indentated -- indented paragraphs, and you have a sentence that says, "Most importantly, Conover retained his negative assessment of groundwater pumping. In EBID on the Rio Grande project water supply, particularly -- particularly to lands in Texas." Do you see that?

A. Yes.

Q. Did Reclamation ever complain to the State of New Mexico about groundwater pumping?

A. I don't know.

Q. You didn't find any documents reflecting that?

A. I don't recall if we did.

Q. If you had found those kinds of documents, would you have put that in your report?

A. I think as I stated earlier, it's the obligation of historian to acknowledge the entire historical record to the best they can and so to the extent that that would provide additional context or additional information through this and to address this answer, I would have.

Q. I asked you about New Mexico. Did Reclamation complain to the State of Texas about the groundwater pumping that was going on in that state in the 1940s and '50s?

A. I don't know.

Q. Do you know if, in the 1940s or 1950s, the State of Texas complained to the State of New Mexico about groundwater pumping?

A. I do not know.

Q. I have the same questions really on Page 21. We -- we looked at that paragraph on Page 21 that identifies the wells and the well numbers that starts with the words, "As for the irrigation wells themselves." Are you aware of any complaints from Reclamation, the State of Texas, or EP No. 1 about irrigation wells in the State of New Mexico?

A. As I sit here today, I'm not aware.

Q. Turn, please, to Page 23. And here, you're talking about -- you can look at Page 22 for context

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS,	§	
	§	
Plaintiff,	§	
	§	
vs.	§	ORIGINAL ACTION
	§	CASE NO.: 220141
STATE OF NEW MEXICO,	§	(ORIGINAL 141)
and STATE OF COLORADO,	§	
	§	
Defendants.	§	

****
REMOTE VIDEOCONFERENCED DEPOSITION OF
GARY ESSLINGER
AUGUST 18, 2020
****

Job No. 63595

TX v. NM # 141
New Mexico Exhibit
NM_EX-242

A. Yes, sir, he is.

Q. If you can turn to page 6, .pdf page 6 of this document, and you should see at the top an affidavit of Jim Salopek, president of Elephant Butte Irrigation District.

Do you see that?

A. Yes.

Q. So I just showed you that page for reference. A couple paragraphs I want to ask you about. The first is page 7, .pdf page 7, paragraph 7, and we don't need to read that paragraph into the record. This document will be part of the record. But this is consistent with your testimony of yesterday about groundwater pumping in EBID during the drought in the '40s and '50s; is that right?

A. Yes.

Q. We can see in the second sentence there Mr. Salopek is saying that during that drought, the United States Bureau of Reclamation encouraged EBID's constituent farmers to supplement their project surface water supply by drilling irrigation wells.

Do you see that?

A. Yes, sir, I do.

Q. Is that your understanding?

A. Yes, sir, it is.

Q. And are there records within the District that reflect encouragement by the Bureau of Reclamation?

A. I'm sure there are. I'm not familiar with -- where I can just put my hands on them, but the evidence of the fact that farmers were pumping into canals, because there was no surface water, the Bureau was allowing that to happen, to move water around. And certainly, in my opinion, that was a -- an obvious intent that the Bureau was encouraging EBID to use whatever means they could to water their crops, whether it was groundwater or lack of surface water.

Q. If you turn to the next page, to paragraph 8, there's a little bit more -- talk about the Bureau and here we can see that sentence reads -- well, I'll let you get there.

Are you on paragraph 8, Mr. Esslinger?

A. I'm geting there. Okay. I'm there. It blurs and then it comes to focus, so I have to wait.

Q. The challenges we all face with a remote setting.

Paragraph 8 reads "When the drought of the 1950's subsided in the 1960's, the Bureau of

Reclamation encouraged EBID to engage in a well drilling program which culminated in the District drilling large production irrigation wells (Exhibits 1 through 5) in an effort to supply irrigation waters when the surface supplies were low and the Bureau of Reclamation could provide less than the 3 acre foot allotment to New Mexico lands."

Do you understand that to be accurate?

A. Yes, I do.

Q. Are there documents within EBID that also reflect this action in the 1960s?

A. Yes. We do have records of the well drilling program. And I believe there's board minutes when they sent the manager to Salt River Project to understand the program that was being set up in Arizona. He came back and shared that program with the board and I believe the Bureau of Reclamation.

Q. The application that this document is a part of is for five different wells, EBID wells. Were those irrigation wells drilled as part of this effort that you're describing from the 1960s -- or I'm sorry, that Mr. Salopek is describing?

A. Yes, sir. They were drilled and in place and pumped -- were pumped for a little over a year,

consulted at all as part of that preliminary investigation that the State Engineer conducted?

A. I don't recall, but it's possible that they were involved. Maybe it was counsel to counsel or technical staff to technical staff.

Q. And then we can see that this application was actually approved for 13,000 acre-feet because that was the amount that the State Engineer thought would not be detrimental to other existing water rights; is that correct?

A. That's correct.

(Deposition Exhibit GE-19 marked for identification.)

Q. (BY MR. WECHSLER) I'll show you another document related to groundwater in the District and I've marked that document as Deposition Exhibit 19.

Do you see that document?

A. Yes.

Q. Do you recognize it?

A. Yes.

Q. What is it?

A. It's a historical abstract regarding Elephant Butte Irrigation District's conjunctive manager.

MS. BARNCASTLE: Let me just go on the record, Jeff, and note that this appears to be a privileged document that either was inadvertently disclosed or -- to be honest, I'm not sure how it got where it got today. But I suppose we can proceed with questions under the objection that this is believed to be a privileged document that EBID provided to OSE in the context of negotiations over EBID's offer of judgment in the adjudication in state court.

MR. WECHSLER: Very well. My understanding is that it was submitted as part of the adjudication, but we can go through it.

MS. BARNCASTLE: I don't believe it was ever submitted on the record and, like I said, I believe that this was part of confidential discussions that the attorneys were engaged in in 2008.

MR. WECHSLER: All right. Well, I don't see any indices of either privilege or confidentiality, so we can straighten that out later, I suppose.

Q. (BY MR. WECHSLER) Mr. Esslinger, did you help to put this document together?

A. I have to look more at the content. I notice our logo and that certainly reminds me that something must have attributed to this. But until I see the content, I don't recognize it other than the logo.

Q. If you turn to page 2, you can see what's called an Executive Summary and let's see if I can't find the -- where it actually gets signed here.

Yeah, if you turn to page 38. I guess it's not signed, although there are affidavits as part of it. You can see -- it indicates submitted on behalf of the Elephant Butte Irrigation District and its board of directors, this 11th day of July, 2008.

Do you see that?

A. Yes.

Q. Do you recall this being a project of the board of directors or the board of directors discussing this abstract?

A. I can't recall. Just based on going from the front page to this page, what was involved in submitting this, other than perhaps an understanding that EBID is a senior holder of the surface water right and we're trying to explain our -- also our position with what we believe is our groundwater rights. And so that's all I can tell you from what I'm seeing.

Q. Do you know if this document was widely distributed?
A. I can't remember that.
Q. Let's go back up to that executive summary, which is on page 2.
The first sentence reads, "The farmers of the Elephant Butte Irrigation District have practiced the conjunctive management of groundwater and surface water since the inception of the Rio Grande Project in 1906."
Do you see that?
A. Yes.
Q. To your knowledge, is that accurate?
A. I believe we've tried to practice the conjunctive management of groundwater and surface water. Whether we had electric wells back in 1906, I can't recall, maybe there were windmills and things of that nature. But perhaps the idea later on in the '50s and '40s where turbine wells were put in to this Valley, then we did conjunctively manage. We moved water through our canal system whether it was groundwater, surface water, we tried to use both.
Q. (Examined exhibit.) I'm just looking to see if there's anything we haven't covered already,

Mr. Esslinger.

(Short pause.)

One question on page 18 that we haven't covered, this is .pdf page 18, the page of the document is page 17. The last bullet point there, Mr. Esslinger, reads in there -- if you look up, we can see that they're talking about a 19 -- a report written by a Mr. Conover received in 1947.

And the last bullet point says, "That the quality of the shallow groundwater in the alluvium of the Rincon and Mesilla Valleys is slightly poorer than drain water, but is satisfactory for most irrigation requirements."

Do you see that?

A. Yes.

Q. Does the District evaluate the water quality on either the surface or groundwater within the District?

A. We definitely have a team that goes out and tests the water quality of the surface water in our drains. That's done through my hydrology department.

Also in our pump policy, we also required farmers to give us a quality test on their well and what they were pumping out of their wells into our canal system, and so we have a combination of both.

Q. Why do you require farmers to get a quality test before pumping their wells into your canal system?

A. Because of that last bullet. Their wells are put into the ground and some areas the salinity levels are higher in that water. And so when they pump in, we want to make sure that they're not pumping in a saline water when we have a better water quality of surface water quality flowing in the canal. And so we want to make sure it's the sufficient quality to match what's in the canal.

Q. Does the District have a standard for what is sufficient quality?

A. I think we've gone to the environment department and we've used 2,000 parts per million on total dissolved solids.

Q. Is that going to be reflected in one of the board's policies?

A. Yes.

MR. WECHSLER: I just want to pause for a moment. I don't see Sam in her seat. Sorry.

MS. BARNCASTLE: I could hear you. I'm sorry. I just had to turn the air down in my office.

MR. WECHSLER: Oh, no. No problem. I just didn't want to keep going if you had to leave for an emergency or something.

Q. (BY MR. WECHSLER) If you turn to page 19 and here this abstract is still talking about the Conover report, and have you ever seen that Conover report?

A. Umm, in the time that I was reviewing a lot of documents in the archives, I crossed paths with the Conover report.

Q. And here it's calling that the USGS report and it says "Irrigation supplies of Rio Grande Project water continued to diminish into the 1950s and the EBID board, based on the USGS report, began to develop a plan to allow farmers to share Project water and pumped groundwater, among constituents in an effort to keep farming alive in the Rio Grande Valley and New Mexico."

Is that referring back to the plan that we saw in the previous document related to the 36 wells, the master plan I think that other document referred to?

A. No. I believe that this was way before this plan was in place. This is just the facts of the matter that when you're in a drought, you need to use groundwater and these farmers need to have access to it and we've always tried to protect that access that they can have, as well as protect the surface water that could come available.

As we said yesterday, farmers prefer to use surface water and depend upon their groundwater as a last resort.

Q. And the practices that you're describing, it sounds like they've been a part of EBID operations since at least the 1950s; is that correct?

A. Yes. Farmers, when they're growing a crop, even if I can supply them the surface water, I can always -- I can't always provide it when they need it. The crop demands that at a certain time, so they'll pump. And then later on when I can meet their schedule, then I'll give them surface water. So it depends on the crop, the timing, the heat, the conditions of the soil, the conditions of the plant.

So pumping groundwater and supplying surface water, they have to work hand-in-hand. You just can't do one and then say, well, we're gonna depend on the other. You have to conjunctively manage both.

Q. In the passage I just read in that paragraph, it talks about an effort to keep farming alive in the Rio Grande Valley of New Mexico. Without groundwater pumping during a drought, is there a -- would farming within EBID be at risk?

A. Oh, yes, definitely.

Q. Why?

A. The groundwater right now is what is getting us through this irrigation season. We're going to be ending our season the end of next week and to finish out the crop and get ready for harvest, the farmers are gonna turn to their wells to complete the growing season. So yes, the timing is everything.

Q. Can you turn to the next page, page 20, .pdf page 20, page 19 of the abstract?

A. Yes.

Q. And at the bottom we can see that the board passed a resolution related to this report that's under the discussion directed to the Secretary of Interior.

Do you see that?

A. Yes, I do.

Q. Are resolutions of the board kept on file with the EBID office?

A. They're in board minutes and attached to the back of the board minutes.

Q. Do you know whether the Secretary of Interior had any response to this resolution?

A. I don't know that.

Q. If you look at the next page, I think this is consistent with your earlier testimony. I just want to make sure. The top paragraph we can see that it says "In response to the Irrigation District's inquiries, the Bureau of Reclamation issued licenses allowing the transport of groundwater in District canals and laterals upon obtaining a license from the Bureau to do so."

Is that what you were describing earlier?

A. Yes, sir. I didn't know if it was a policy. They're calling it a license, which makes sense.

Q. And we can see, actually, Exhibit 9, according to this paragraph, is a sample license from the Bureau of Reclamation.

A. Is that someplace?

Q. We can look at it if you'd like. We can go and find it. I'm just reading what it said.

A. If it says it's there, it's there. I've not -- I'm not familiar with the license.

Q. If you turn to page 22, .pdf page 22, 21 of the abstract. At the top -- I'm sorry, the upper partial paragraph, the last sentence there reads "The matter of keeping the irrigation district viable by accessing groundwater and sharing groundwater and surface water supplies, was reported by the local newspapers with great regularity."

Do you see that?

A. Yes.

Q. And then it's referencing Exhibit 12, which we could go and look at.

Have you reviewed local newspapers from the 1950s that are discussing this subject?

A. No. But I was alive and living on my farm where my dad would go and check his wells and I was with him. And that was a great blessing for all the farmers in the Valley to have a means to access groundwater to provide the water to their farms.

And as a little boy, it was just amazing to watch the water come out of the ground and be utilized as a means of irrigating. Because I was also at that time just riding around in my dad's truck and visiting with the ditch riders that were working for the Bureau of Reclamation and they were also trying to supply surface water at the time and it's difficult times. I just remember those times as a little boy.

Q. Turn to page 31.

A. (Complied.)

Q. And I'm looking at the second full paragraph, the one that starts, "The general hydrologic logic."

Do you see that?

A. Yes.

Q. The second sentence there reads, "The release, diversion, conveyance, and on-farm use of District surface water are by far the largest recharge components of the area's groundwater system.

Do you see that?

A. Yes, sir.

Q. Do you have an understanding of what that sentence means?

A. Yes, sir.

Q. What does that mean?

A. Well, this whole Valley was developed based upon water that was furnished by the Rio Grande, but it was uncertain times before the dam.

So when the dam was built and

completed in 1916, the operations and maintenance of that dam began what I referred to as the times when you release the water and it's in the river and it's going to the downstream users in Texas and New Mexico, that river itself, while the water is flowing in it, is recharging.

The aquifer, now that in 1980 we diverted into canal systems, even though it was diverted back in the '50s as a single purpose, now it's diverted between our diversion to New Mexico and the diversions in Texas.

Once it gets in the canals, it's also recharging because our earth and lime system in our area are another source of recharge.

The conveyance which is through this 400 miles of canals and sublaterals is another means of spreading the water out across the Valley floor. And so, again, there is seepage because our sublaterals are earth and lime and that contributes to the groundwater recharge.

And then finally, when you put it on the farm and spread it out through flood irrigation, which at the time was prevalent; then, again, you're recharging the aquifer, so agriculture here benefits everybody who puts a straw into the aquifer. If you don't have that ability to spread the water out and recharge like the farmers do with their water, then it hurts the entire system.

Q. And then if you don't have surface water, does that mean that you don't have that source of recharge?

A. That's my primary purpose of that recharge, yes, you could get it also through flood events. There's other means. But primarily it would be flood events and rain events that could somehow help recharge, but it's not a big component.

Q. The next sentence reads "Farmers developed conjunctive management of the surface water-groundwater system in response to drought, and continue to informally conjunctively manage the resources to produce a robust, diverse, and profitable crop mix."

Do you have an understanding of that sentence?

A. Yes.

Q. What's your understanding?

A. Well, as we look at the slide yesterday, the crops grown here in this Valley, there's four major crop varieties. There's pecans, alfalfa, vegetables, and forage crops. And all of those crops, from as far back as I can remember, those four crops have always been prevalent in this District. And both -- all four crops use both surface and groundwater to be produced here.

Q. And how does that relate to conjunctive management?

A. Like I said before, there's times when a seed is planted in the ground you need -- it's in the fall when the surface water's not available. So it's groundwater that puts the water to begin growing the seed.

When the seed grows into a plant, then surface water that next year is available to continue to water it out. So you have a balance of using conjunctively both ground and surface to start a crop and to end a crop.

Q. Page 35 of the .pdf, page 32?

A. Yes.

Q. Under the heading Monitoring Aquifer Health. We talked about that a little bit already.

A. Excuse me. Are you on page 31?

Q. It says page 32 at the bottom of my --

A. Is it a letter? Is there a letter or something?

Q. No. And there's a heading Number 4,

Monitoring Aquifer Health. Are you on page -- .pdf page 35 out of 200 and --

A. Oh. Okay. I'm sorry. It's crazy. Okay. Monitoring Aquifer Health, yes, sir.

Q. And we talked a little bit about some of the monitoring the District does. The sentence reads "As water use in the area increases and becomes more diverse, the health and sustainability of the aquifer must be maintained."

Is that a statement with which you agree?

A. Yes, I still agree with that.

Q. Why?

A. Because the cropping patterns change, based upon what the cropper -- the farmer grows. And so you have to be flexible and be able to provide whatever means of water that the crop needs.

EBID is an extension to the farm operation as supplying the surface water. The farmer himself has wells on his property that also he uses to beneficially provide the water when I don't have the surface water available.

Q. What does the "health and sustainability of the aquifer" mean to you?

A. It means that you have to understand the connection between the river and the aquifer and that both surface water and groundwater have to be monitored, metered, observed, so that you can sustain the aquifer.

MR. WECHSLER: I'll mark Exhibit GE-20.

(Deposition Exhibit GE-20 marked for identification.)

Q. (BY MR. WECHSLER) This is a PowerPoint presentation dated July 11th, 2008, entitled "Conjunctive Management of Surface Water and Groundwater in EBID."

Do you see that?

A. Yes, sir.

Q. It doesn't have anybody's name on the front page or anywhere that I saw.

Do you know who put together this PowerPoint?

A. If I looked more in the content, it's probably something I did with the help of Dr. King, perhaps our counsel Steve Coubert (phonetics) and Steve Hernandez.

MS. BARNCASTLE: Let me just interject another objection here.

This, again, looks like part of the

what we used. And like I said, we had full water supply, so it never bothered anybody we had plenty of water.

In 1990 there was kind of a lull and it came back up for discussion. Again, we weren't in favor of carryover storage. It went away. And then the drought of 2003 hit and we realized we needed to -- we needed to address an operating plan that would clear all the issues that had been raised from 2003 to 2007.

Q. Why did EBID to carryover as part of the overall Operating Agreement?

MS. BARNCASTLE: Objection; form.

Gary, to the extent that you can answer without getting into attorney/client privilege communications, you can do so.

A. I think -- I think it was because we felt like if this was a settlement, nobody was gonna win everything and nobody was gonna lose everything. And the EP Number 1, when the carryover, as part of their Operating Agreement, and EBID wanted all of the wells from 1951 to 1978 grandfathered in so that they wouldn't come after our farmers pumping water after our allotment ran out.

Q. (BY MR. WECHSLER) Is that mean -- does

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

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REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
GARY ESSLINGER
AUGUST 17, 2020
VOLUME 1

****

REMOTE ORAL AND VIDEOTAPED DEPOSITION of GARY ESSLINGER, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on August 17, 2020, from 9:06 a.m. to 4:34 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-243

A. Yes.

Q. Do you recall that policy?

A. Yes, I do.

Q. What is that policy?

A. Well, prior to 2003, farmers had well over 3 acre-foot allotments, sometimes as much as 4-and-a-half acre-feet, and so they were easily and readily available to a lot of surface water at the time. There was no need to turn on their wells. The wells in our view, my view, and the EBID board view is the savings account. You draw from that when your checking account, which is a surface water, is low, and in this case, the surface water was low, so we needed a -- a policy that allowed a farmer who needed to move groundwater around his farm into a farm maybe adjacent or across the street, and the only way he could get his well water to that was put -- was pumping the water into our canal system and then taking it down to another turnout and irrigating his farm.

Q. When you're talking about the difference between surface water as a savings account and groundwater as a checking account, does that mean that you would use surface water as your primary source and then use groundwater as a supplemental supply if

necessary to meet irrigation demands?

A. You've got that backward in your question. Surface water is our checking account, and groundwater is our savings account.

Q. And does it -- am I correct, though, that you would use surface water first and then, if necessary, you would use groundwater as a supplemental supply to meet irrigation demands?

A. That's correct. The -- the farmers down here in our district always prefer surface water over groundwater.

(Exhibit No. 10 was marked.)

Q. (BY MR. WECHSLER) I'm going to show you another document from your Website, which I'll mark as deposition Exhibit GE-10. And this is a two-page description of the flat rate delivery, also known as small tract irrigation. Are you familiar with -- with flat rate irrigation?

A. Very much so.

Q. Can you please summarize that subject?

A. Small tract irrigations are -- are provided on a pro rata basis based upon the allotment to farms less than 2 acres, and farm rates are pro rata shared to those farms with more than 2 acres. So small tract irrigations, we have a lot of constituency that are

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

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REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
JESUS REYES
AUGUST 31, 2020

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REMOTE ORAL AND VIDEOTAPED DEPOSITION of JESUS REYES, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on August 31, 2020, from 9:01 a.m. to 1:54 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-244

platform?

A. Yes. I believe Jay set it up. Should be working.

Q. If you have any difficulty with that, please let me know. You should have the ability to look at any of the exhibits once they're revealed, and you can move throughout those exhibits to look at any part that you want. Can you please state your full name and spell it for the record?

A. Yes. It's Jesus Reyes. It's J-E-S-U-S, R-E-Y-E-S.

Q. What's your current professional position?

A. I am the general manager for the El Paso County Water Improvement District No. 1.

Q. I know from your previous deposition that you have been deposed before; is that right?

A. That's correct, yes, sir.

Q. Have you ever been deposed on behalf of EP No. 1, in other words, in your capacity as general manager?

A. Yes, I have.

Q. In what cases were those?

A. It was a case involving a pipeline that was crossing our canals and our drains and going with a pipeline into Mexico.

canals are now lined with concrete?

A. Oh, I don't know about the miles, but it's -- we probably have about 30 percent of our -- of our system concrete lined and working them.

Q. When did that project begin?

A. Well, there was some done by the Bureau of Reclamation back in the '50s, I believe, and -- and then our efforts started, oh, maybe 10, 12 years ago, and we've been working on it every winter.

Q. What's the purpose of the lining the canal -- lining the canals with concrete?

A. Well, it speeds up the delivery system, the water delivery to the different turnouts. It eliminates almost all the maintenance in -- in the canal by not having to mow or reshape and so on, and it helps with some seepage and -- and evaporation. If you can deliver the water faster, you can conserve.

Q. If you look at the next paragraph on Page 2 of Exhibit 2, the second sentence reads, "We have 60 supplemental well fields that help us tremendously during the drought." Do you see that?

A. Yes.

Q. What do you mean that the --

MS. O'BRIEN: Objection that it -- the language in Exhibit 2 was misquoted. It's helped, not

No. 1 members?

A. Not to my knowledge. I -- I never heard of it.

Q. Since you have been general manager at EP No. 1, EP No. 1 has participated in the New Mexico adjudication; is that right?

A. Not that I know of.

Q. You're not aware of any filings that EP No. 1 has done in the New Mexico adjudication?

A. No.

Q. Are you aware there is a New Mexico adjudication of the lower Rio Grande that's ongoing?

A. Yes. From what Gary had -- Gary Esslinger has told me, yes.

Q. Have you kept informed at all about the -- the status or the rulings in the New Mexico adjudication?

A. No.

Q. Do you know if anybody else at EP No. 1 has kept informed about the New Mexico adjudication?

A. I'm sure our lawyers probably have.

Q. I want to talk about the -- some of the general description of EP No. 1, and to do that, I first want to ask you about some of the statements in deposition Exhibit 2, which is the 2008 paper that we

looked at earlier.

A. Okay.

Q. In particular, if you'd turn to the second page of that document, and I'm looking at the second column, Mr. Reyes, in the second full paragraph there that starts, "Where it gives EPCWID No. 1" -- I'm sorry -- "What it gives EPCWID No. 1 is five major conservation and drought mitigation efforts that we have been working on." Do you see that?

A. No, I -- I tell you, the -- the screen changed for some reason. I'm still on the last page. What -- what is Exhibit --

Q. Exhibit No. 2. So hopefully you can go back to the list, and you can click on the JR-02.

A. Okay. Let me see if I can figure out how to go back to -- it went to a -- a complete screen on -- on the last exhibit.

MS. O'BRIEN: Mr. Reyes, if you'd just click again on the JR-02, it should bring you back.

THE WITNESS: There is -- that -- that section has -- is no longer shown, Maria.

MS. O'BRIEN: So all the way to your left, you don't have listed out JR-01, JR-02, JR-03, 04, 05?

THE WITNESS: No. That erased for some

reason. I can't figure out how to get back to it.

MR. WECHSLER: Well, I'm seeing if there's anything I can do. I don't think there's anything.

MS. O'BRIEN: Maybe we could exit you out and get you back in. Maybe if we just take a little bit early morning break --

MR. WECHSLER: Sure.

MS. O'BRIEN: -- Jeff, and we could take the -- everybody take their coffee and restroom break, and we can also get Mr. Reyes back on AgileLaw in the way he needs to be.

MR. WECHSLER: Good idea. Why don't we come back at 10:05. Hopefully that's enough time.

THE WITNESS: Okay. I'll get Jay to come in and look at it.

MS. O'BRIEN: Okay.

THE VIDEOGRAPHER: The time is 9:49 a.m. We're off the record.

(Break.)

THE VIDEOGRAPHER: The time is 10:10 a.m. We're on the record.

Q. (BY MR. WECHSLER) Back from the break, I understand, Mr. Reyes, you're able to view the exhibits again?

A. Yes, sir.

Q. So if we could take a look at Exhibit 2.

A. Okay.

Q. And that's the paper from 2008, and then I'm looking at the second page of that document. Do you have that?

A. Let me get to it. Okay. That would be JR-02 Page 2.

Q. Correct. I'm looking at the second column and the second paragraph, and it says, "What it gives EPCWID No. 1 is five major conservation and drought mitigation efforts that we have been working on," and then it has five numbered clauses. Do you see that?

A. Yes.

Q. Looking at the first one, you say, "We've been changing policy to help us conserve water." Do you recall what that refers to?

A. Yes.

Q. What does it refer to?

A. The way we -- we deliver water, we try and -- and, through the water master, set up, if we have water at a certain canal, we try and set up as many people as -- that want to irrigate off that canal and in one step, instead of irrigating one and then shutting down the water and then having to bring water a few days later down the same canal, so we changed our policy as far as that's concerned.

Q. The second clause says, "We have reworked our information management system." What does that refer to?

A. The -- the way that our water master keeps his records, we're -- we're trying to become as efficient as possible.

Q. How are those records kept?

A. He keeps them through his computer and then they go into our server.

Q. They're kept electronically by the district?

A. Yes.

Q. No. 3 says, "We have upgraded our automation system of gates and canals." What is that describing?

A. Okay. We've been automating some of our gates that used to be controlled by a cheater bar. The men would have to physically use a cheater bar to open gates, adjust gates. Now, we have them set through telemetry, and depending on if there's electrical power available; if not, we use solar power to operate the gates.

Q. Do you have an estimate of the percentage of the gates that are operated -- or that are automated, I should say?

A. Right off the top of my head, no, I don't have that figure. I would have to look at our records.

Q. Number four says, "We have worked on on-farm conservation." What does that refer to?

A. We've been working with some of the farmers. We got a grant from the Texas Water Development Board that monitors soil moisture, that we tested on, I think it was three or four different locations, farms. We've also been in the meetings with the farmers passing on information as far as laser levelling and funding available to concrete line their -- their -- their private ditches and so on.

Q. How do you monitor soil moisture?

A. It's -- it's an apparatus that's -- it's controlled by -- by a sensor that's actually placed in the field, and then it monitors the moisture and sends it back to a control box located near one of our canals.

Q. No. 5 says, "We have made improvements to our conveyance system." What does that refer to?

A. We've been concrete lining canals, making it more efficient, narrowing some when we concrete line them to speed up the water delivery.

Q. Do you have an estimate of how many miles of

canals are now lined with concrete?

A. Oh, I don't know about the miles, but it's -- we probably have about 30 percent of our -- of our system concrete lined and working them.

Q. When did that project begin?

A. Well, there was some done by the Bureau of Reclamation back in the '50s, I believe, and -- and then our efforts started, oh, maybe 10, 12 years ago, and we've been working on it every winter.

Q. What's the purpose of the lining the canal -- lining the canals with concrete?

A. Well, it speeds up the delivery system, the water delivery to the different turnouts. It eliminates almost all the maintenance in -- in the canal by not having to mow or reshape and so on, and it helps with some seepage and -- and evaporation. If you can deliver the water faster, you can conserve.

Q. If you look at the next paragraph on Page 2 of Exhibit 2, the second sentence reads, "We have 60 supplemental well fields that help us tremendously during the drought." Do you see that?

A. Yes.

Q. What do you mean that the --

MS. O'BRIEN: Objection that it -- the language in Exhibit 2 was misquoted. It's helped, not

help.

MR. WECHSLER: I thought I said helped.

MS. O'BRIEN: I heard help, and that's what the court reporter heard, so I was trying to clarify the record.

Q. (BY MR. WECHSLER) Mr. Reyes, what did you mean by that statement?

A. Well, it's 60 wells that -- that we have that we own and -- and can operate if we need them.

Q. And what drought are you referring to in that sentence?

A. What drought? The one we're in right now.

Q. So when you say that those well fields helped you tremendously during the drought, what did you mean?

A. We used them one year, I believe it was in -- I think it was in 2003. We -- we pumped the wells pretty strongly. Of course, they only produce -- I think if you run them 24 hours a day 7 days a week, they'll only produce, like, 30,000 acre-feet of water. But --

Q. Is that --

A. But --

Q. Sorry to interrupt.

A. It has helped.

Q. You indicated that if you run them 24/7, they produce 30,000 acre-feet of water. Is that if all of the wells are operated at the same time?

A. That's correct. If we were to run them all seven days a week, 24 hours a -- a day, that's all they would produce.

Q. Further down in that same paragraph, you have a sentence where you're talking about the lining. You say, "We have been lining some canals with concrete and using the EPDM material." What is the EPDM material?

A. It's like a rubber type liner that we used in some areas that we were having problems. It's a -- a quick fix. If you have a -- a sandy canal that you could -- could become a -- a problem, a ditch break, we -- we use that -- that liner.

Q. I understand that the district measures the flows at the drains; is that right?

A. Some drains, yes.

Q. Since you've been lining the canals with cement or this EPDM, has it changed the amount of water that is measured at the drains?

A. Has the concrete and -- and the liner changed it? I'd have to say no.

Q. If you look further down on that same column,

you say, the last partial sentence on Page 2 says, "As I mentioned, we have drilled 60 shallow alluvium," and then switching over to Page 3, "aquifer wells, Figure 2. Our wells are in the shallow alluv -- shallow aquifer about 100 feet deep, but they work tremendously well during the drought. We were able to mix three sources of water, project water, our well water, and sewer-treated water." Do you see that?

A. Yes.

Q. What did you mean at that last sentence where you're talking about mixing the three sources of water?

A. Well, we bring down what -- what water is available. If there's not a full allocation, whatever -- whatever the allocation is, we bring -- bring it down our canal system, and then -- or we take the -- the sewer-treated water, we will mix it in -- into our project water, and -- and then when we did use the wells, we -- we pumped well water into our canal system to produce more water.

Q. Figure 2, is that the location of the district's wells?

A. Yes, I believe so.

Q. Further down in that column, you say that -- you say, "By the way, the farmers did a lot of work to

refurbish their wells during the worst years of the drought four or five years ago." Do you see that?

A. Okay.

Q. What did you mean by that sentence?

A. Well, the -- when we went into real serious bad drought situations, we farmers started refurbishing some of their old wells trying to make some of them operable again. They hadn't been utilized from what I understand in years and so they -- they did a lot of work to their private wells.

Q. Do you know how many private wells were refurbished?

A. I sure don't.

Q. Do you know how many farmers within EP No. 1 have private wells?

A. I sure don't.

Q. Does EP No. 1 collect data on the amount of water that is pumped from private wells?

MS. O'BRIEN: Objection; asked and answered. He's told you that he doesn't know how many private wells were refurbished. He told you he doesn't know how many private wells exist within EP No. 1.

Q. (BY MR. WECHSLER) You can answer, Mr. Reyes?

A. I do not know, no, sir.

Q. Has EP No. 1 evaluated the impacts or depletions on the project supply from groundwater pumping?

MS. O'BRIEN: Objection; form. Groundwater pumping, vague.

A. What -- what area are you talking about?

Q. (BY MR. WECHSLER) I'm talking about groundwater pumping within Texas.

A. No, I can't say that we have.

Q. Has EP No. 1 evaluated the impact of groundwater pumping on project supply from groundwater pumping that occurs in New Mexico?

A. Not EP No. 1, no.

Q. Does EP No. 1 rely on an evaluation of groundwater pumping in New Mexico from some other source?

A. You know, that would be a question that you would have to ask Dr. Al Blair. I don't know if he's received any information from any other entity or source.

Q. Further down in that column, you say that, "We have also been working on other projects like placing canals underground in pipelines." Can you describe that effort?

A. Yes. If you'll look at Figure 3 on that page, we have put some -- some canals, especially we did this project in front of a new elementary school that was built. We did this, we talked -- we worked -- it's a project that we worked together with the school district, and because of the issues of school buses going over a big hump and other areas where we had been successful in placing those sections underground where they wouldn't have any accidents, any buses rolling back and hitting either students or vehicles behind them.

Q. What's the purpose of putting in the underground pipelines?

A. Removing the -- the urban banks, especially like I -- I've said. We've worked with two different school districts on two -- two different issues on -- on this type of matter.

Q. In Figure 4 on this Page 3, we see a picture of the American Canal Extension. When was the American Canal Extension put in?

A. In the '90s.

Q. Mr. Rios described that the American Canal Extension is now the primary conveyance of water into the district; is that right?

A. Into the lower valley, yes.

Q. Does EP No. 1 use the river to convey water

anymore?

A. Well, in the upper valley, yes, we do.

Q. What do you mean in the upper valley? Where -- where do you use the river?

A. Well, there -- there's some -- some sections that we have used the -- the river like in the Anthony area and I believe the Vinton and Canutillo area.

Q. When you use the term upper valley, what do you mean?

A. Upper valley is the section of El Paso No. 1 location irrigation district. It's from the New Mexico state line to roughly the Sunland Park area.

Q. And that's the area where the river is still used as a conveyance?

A. Yes.

Q. Just below Figure 4, you talk about the Figure 5 showing a capturing facility reservoir. Do you see that?

A. Okay. Let me -- let me go to the next page. Okay.

Q. Well, I'm still looking at Page 3. You just indicate there that we want to utilize about 300 of those acres for a capturing facility to capture some of the storm water that comes down the Rio Grande that nobody makes use of. Is -- has that project ever been

completed?

A. No. I'm still working on it.

(Exhibit No. 6 was marked.)

Q. (BY MR. WECHSLER) I'm going to show you another exhibit, which I'll mark as deposition Exhibit 6. Do you recognize this document?

A. Yes. It's an old operations guide.

Q. Is there a more recent operations guide?

A. No.

Q. Is this document still used for any purpose by EP No. 1?

A. I believe our water master still uses some of it.

Q. Let me ask you about a -- some parts of this document. And I'm going to go all the way to -- if you go to Page -- PDF Page 42, Mr. Reyes, there's a title page that says, "Lateral and canal data by unit."

A. Okay.

Q. And then you can see in the subsequent pages that it describes the lateral and canal data. What I want to do is go to the aggregate data, which shows up on Page 50 under the heading, "Total numbers by unit."

A. Okay.

Q. And at the bottom there, you can see there's

district?

A. Yes.

Q. Looking back at that same paragraph, the next sentence says that, "The district has three sources of water, project water slash Elephant Butte Dam, 62 district water wells, and treated sewer water through agreement with the PSB." Do you see that?

A. Yes.

Q. Is that still accurate?

A. No. We've lost some of the wells. We're down to 58 wells.

Q. With that correction, is that accurate still?

A. Yes.

Q. In the next sentence -- next paragraph where it says, "Drought and its effects," and this goes back to when those wells were used. You say, "During the first year of the drought, they deliver 2 acre-feet of water and in the second year, they deliver 3 acre-feet of water including water delivered to the Rio Bosque, PSB, and others." Do you see that?

A. Just a minute. Let me read it over.

Q. Sure.

A. Okay.

Q. So my question is it appears to be indicating that the wells were used during the first two years of

drought. Do you know what years it's referring to?

A. I believe it was 2003 that we used it, that we used them all.

Q. And what about the second year, would that have been 2004?

A. Yes. And I -- without reviewing the -- our records, I wouldn't be able to tell you how much they were used then. I believe I was referring to a mixture of well water with project water and sewer treated water in order to produce those amounts.

Q. Other than '03 and '04, what years were those wells used for irrigation purposes?

MS. O'BRIEN: Objection; mischaracterizes the testimony. He didn't indicate that he was sure or clear without reviewing records when the wells had been used.

Q. (BY MR. WECHSLER) Mr. Reyes?

A. I believe the next time we used them was in 2013.

Q. Why were they used in 2013?

A. We were down to very poor allocation of, I think, 6 -- 6 inches.

Q. In the next paragraph, you indicate there, "We came to agreement with the Hudspeth Irrigation District. El Paso Water Utilities, and

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

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REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
DR. J. PHILLIP KING
MAY 18, 2020
VOLUME 1

****

REMOTE ORAL AND VIDEOTAPED DEPOSITION of DR. J. PHILLIP KING, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on May 18, 2020, from 10:07 a.m. Central to 3:01 p.m. Central, before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, remotely at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-245

A. At least, yes.

Q. Who else does that include?

A. Could you clarify that?

Q. Well, I'm just trying to understand the distinction that you're making about non-project users or non-project diversions.

A. Well, you -- you have -- you have several, for example, M&I providers whose water use has gone up dramatically over the past few decades, pumping water that is hydrologic connected to the Rio Grande. There is some question about timing, but I think there's not much doubt that the pumping of hydrologic -- hydrologic connected groundwater ultimately affects the surface water supply of the project.

Q. Do you understand the primary concern of Texas to be non-project users or depletions caused by non-project users?

A. No.

MS. BARNCASTLE: Objection; form and foundation.

A. No, I don't believe they differentiate, but we are -- you know, you asked me specifically about EBID's position --

Q. (BY MR. WECHSLER) I did, yes. So to follow up on that, EBID's position is that the EBID members

who are conjunctively using groundwater is authorized?
A. It is authorized, yes.
Q. And so it's non-project users that -- that is a concern?
A. All of it's a concern. All of the groundwater use is a concern, and it does -- it's all linked. It's -- it's a complex system. What we certainly are interested in seeing is a mechanism whereby non-EBID groundwater users could offset their impact on the surface water supply. One way to look at it is that in terms of getting water to Texas, EBID is offsetting the whole thing. What we are trying to do is get the other water users in the lower Rio Grande to pay their freight, to -- to carry their fair share.
Q. Let me ask you this: If all depletions from non-project users were offset, will you agree with me that Texas would have no cause to complain?
MS. BARNCASTLE: Objection; form.
MR. LEININGER: And foundation.
A. I wouldn't speculate on Texas' motivation.
Q. (BY MR. WECHSLER) Well, I'm asking you if -- if they would have a cause to complain?
A. It depends on how they were offset, and that's a very complicated aspect of all of this.

have a sentence that says, "Farmers in EBID supplement their surface supply with groundwater produced from private wells." Do you see that?

A. Yes.

Q. To your knowledge, does that also occur in EP No. 1?

A. I believe it does. I don't remember if I made the distinction here, but the -- I would say to -- to a lesser extent, I believe there are some individual wells, but to a lesser extent.

Q. There also are some district wells; is that right?

A. That's right.

Q. The -- fair to say that there's a long history of conjunctive use in the project?

A. Define "long."

Q. Since the 1940s and '50s?

A. Yes.

Q. And on the next page, top of Page 8, you indicate here that, "Groundwater is primarily used for irrigation when drought reduces the available surface water supply to EPCWID." Do you see that?

A. Yes.

Q. Again, that's something that has historically occurred, right?

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

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REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
PATRICK R. GORDON
JULY 15, 2020
VOLUME 2

****

REMOTE ORAL AND VIDEOTAPED DEPOSITION of PATRICK R. GORDON, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on July 15, 2020, from 9:02 a.m. to 2:21 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-246

the operating agreement?

A. Yes.

Q. It doesn't say what the basis for EBID's allocation is in that bullet point. Do you have an understanding of what EBID's allocation is under the operating agreement?

A. I think the D3 is EBID's allocation.

Q. The next bullet point says, "1951 to '78 level of groundwater pumping grandfathered in." Do you see that?

A. That's correct.

Q. Is that consistent with your understanding of the operating agreement?

A. Yes. Because that's the D2 basis.

Q. Does -- what does that mean?

A. That means EP1 gets a D2 delivery.

Q. What does that have to do with groundwater pumping?

A. The D2 is based on 1951 to '78 operations of the project, which included groundwater pumps.

Q. The -- the 2008 operating agreement then grandfathers in this level of groundwater pumping. Do I have that right?

A. That's right.

Q. In this lawsuit, is the State of Texas

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

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REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
PATRICK R. GORDON
JULY 14, 2020
VOLUME 1
****

REMOTE ORAL AND VIDEOTAPED DEPOSITION of PATRICK R. GORDON, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on July 14, 2020, from 9:03 a.m. to 3:33 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM #141
New Mexico Exhibit
NM_EX-247

from your law firm Website, I believe. Do you see that?

A. Yes.

Q. Do you recognize that document?

A. Yes.

Q. Is it accurate?

A. It should be. I think I -- my law firm prepared it. Should be. I don't...

Q. Do you have an estimate of what percentage of your time you spend in the practice of law and what percentage you spend in your real estate practice?

A. That's a fluid dynamic. It depends on, you know, the time and what's going on. I would have said, you know, a few years ago, it was probably 50/50, but my son now is working in the real estate business. He's president. I'm chairman. And so my time in the day-to-day activities is a lot less. So -- but it just depends.

Q. Could you please describe your education?

A. I have a BBA in finance from Texas A&M and an MBA and a JD from Texas Tech.

Q. Prior to your becoming the Texas commissioner, did you have any educational background in water administration?

A. No.

Q. How about hydrology?
A. No.
Q. Interstate water compacts?
A. None.
Q. Did you have any previous experience as a farmer?
A. I grew up close to Dallas, and we grew coastal Bermuda hay, but we didn't have to irrigate.
Q. How did you grow the hay?
A. We got 22 inches of rain a year.
Q. In what areas do you practice law?
A. I'm a tax and transactional lawyer.
Q. And have you ever practiced in the area of water law?
A. I have not.
Q. How about natural resources of any kind?
A. No.
Q. Environmental law?
A. No.
Q. Prior to becoming Compact commissioner, did you have any prior professional experience in the area of water?
A. I did not.
Q. As part of your professional practice, did you ever act as a mediator?

A. I did not.
Q. Did you ever participate in mediations on behalf of clients?
A. I may have on occasion.
Q. When you were participating in a mediation on behalf of clients, did you advise the clients that the mediator should be neutral?
A. I don't recall.
Q. Do you think it's important that a mediator be neutral?
A. I'm not a mediator, so I -- I'm assuming that the mediator tries to just facilitate the communication.
Q. Do you know if the normal rules for conflict of interest apply to mediators?
A. I don't know.
Q. Prior to becoming the Compact commissioner for the State of Texas, did you ever work for or represent the City of El Paso?
A. Yes. Our firm did. Sorry.
Q. Did you personally work on that representation?
A. I worked on some pension matters, yes.
Q. Did you say pension?
A. Pension.

Q. Do you know when those matters began?
A. Ten years ago.
Q. Are they ongoing?
A. I believe they are. I'm not working on them.
Q. When did you stop working on them?
A. Probably five or six years ago.
Q. Prior to becoming the Compact commissioner for the State of Texas, did you ever work for or represent EP No. 1?
A. No.
Q. Did anyone else in your firm?
A. Not that I -- oh, for the -- for the district itself? No.
Q. Prior to becoming the Compact commissioner, did you ever work for or represent EBID?
A. No.
Q. Did anyone else in your firm?
A. No.
Q. Prior to becoming the commissioner, did you ever work for or represent the Hudspeth Irrigation District?
A. No.
Q. How about anyone in your firm?
A. No.
Q. When did you become the Compact commissioner

for the State of Texas?

A. In the end of January of 2006.

Q. Since that time, have you done any work as a lawyer for EP No. 1?

A. No.

Q. Has anyone in your firm?

A. No.

Q. I'm going to show you what's been marked as deposition Exhibit No. 3 -- or what I'm marking now as deposition Exhibit PG003.

(Exhibit No. 3 was marked.)

Q. (BY MR. WECHSLER) Let me know when that comes up.

A. Yeah, I have it.

Q. So you can see these are minutes from EP No. 1 meeting dated July 11th, 2007, and I'm going to ask you to turn to the PDF page -- you can see those at the top -- 44.

A. How do you get to that page?

Q. Is there a box up above the document that says 1/75?

A. Yes.

Q. If you type into that box 44, it should automatically go there.

A. Okay.

Q. Yeah, if you take a minute, Commissioner Gordon, to take a look at this document, it's a -- looks like it's a five-page document.

A. Yeah. Okay.

Q. Do you recognize this document?

A. I don't re -- well, I don't recall this document, but it is a document from our law firm from one of my partners.

Q. Looks like it's dated August 15th, 2007. You would have been Compact commissioner at that time; is that right?

A. Correct.

Q. And then if -- if you go down to Paragraph 3 of that document, it indicates, "Responsible professionals." Do you see that?

A. Yes.

Q. And it lists you and Mr. Davis as having primary responsibility for representing the district, right?

A. Correct.

Q. And -- and this is a retention letter from your law firm for legal services to be provided to EP No. 1; is that right?

A. Correct. That's correct.

Q. And then if you look at the final page, which

is Page 5 of the letter, you can see it was signed by Mr. Davis and copied to you; is that right?

A. Correct.

Q. And it looks like it was also signed by Mr. Stubbs on behalf of EP No. 1?

A. Correct.

Q. Is this retention letter still active?

A. No.

Q. When was it cancelled?

A. I don't know. I don't recall ever doing any work.

Q. Do you know if Mr. Davis did any work?

A. I don't think so. It may have been some litigation matter that they were using him on, but I can't recall.

Q. Yeah. And if you look -- if you look at -- if you look at the first page, the first paragraph, and then the one numbered Paragraph 1, it talks about the scope of engagement. I didn't see any specific engagement identified there. It sounds like you're -- you don't recall what the engagement was for?

A. I -- I don't. I didn't do any work for the district.

Q. Do you know if Mr. Davis did?

A. I don't know.

Q. Since the time that you've become Compact commissioner, has anybody at -- have you or anybody at your firm done any work for the City of El Paso?

A. I previously answered that my firm did some work for the pension board. I think that's independent from the City, actually, but I can't tell if it is or not. But, no, we're generally adverse to the City.

Q. Let's take a look at what I'm going to mark as deposition Exhibit PG004.

(Exhibit No. 4 was marked.)

Q. (BY MR. WECHSLER) You see it's labeled -- well, let me know when that comes up Commissioner Gordon.

A. Okay.

Q. You can see it's labeled, "Appendix 2." I'll represent I took this from Mr. Lopez's expert report, and if you scroll down, you'll see that it's a copy of the Rio Grande Compact. Do you see that?

A. Yes.

Q. I'm interested in going to Page 10 of this document, which is Article 12. Article 12, you'll see it towards the bottom.

A. Okay.

Q. And if you'll take just a moment to read that

first paragraph to yourself.

A. Article 12?

Q. Yes, sir.

A. Okay.

Q. For both Colorado and New Mexico, the Compact commissioner is also the state engineer, but for Texas, the commissioner is appointed by the governor. Is that your understanding?

A. That's correct.

Q. Do you know why the Compact is different for the State of Texas?

A. I don't know.

Q. Is there a state official in Texas with primary authority over water administration?

A. I don't think it's like the state engineer in Colorado and New Mexico. We have -- for example, the Texas TCEQ and the Texas Water Development Board in Texas, so I don't think there's one particular person.

Q. I'll ask you about those agencies in -- in a moment. When you were appointed as the Rio Grande Compact commissioner in January of 2006, did you have the opportunity to talk to any of your predecessors?

A. I did not.

Q. Are you aware of who your predecessors were?

A. I remember the one prior to me was a

Mr. Hanson.

Q. But you never had an opportunity to discuss the Compact or the Commission with Mr. Hanson?

A. No.

Q. Is Mr. Hanson still alive?

A. I -- I don't know.

Q. Do you know if Mr. Hanson lived in El Paso?

A. I believe he did, but he was out of town a lot. Never had the opportunity to meet him.

Q. Did you attempt to talk with him?

A. I don't recall. I probably tried to reach out to him, but he had resigned and left so I was -- I filled an empty spot.

Q. Before you were appointed as the commissioner to Texas by the governor, did you have to express interest in the position?

A. I did not.

Q. How did it happen that -- well, did the governor or someone in the governor's office reach out to you about the position?

A. That's correct.

Q. Who reached out to you?

A. The governor's appointments office.

Q. Did you have to tell them that you were interested in the position?

A. I was already serving on a governing board for the -- for the governor, and they asked if I'd be interested in this board because I'm from El Paso and this involves El Paso.

Q. What was the governing board that you were already serving on?

A. Texas Department of Housing and Community Affairs.

Q. You obviously told them that you would be interested in serving on the commission; is that right?

A. I did.

Q. Why were you interested in it?

A. I just thought it would be interesting to do it.

Q. Do you know why the governor selected you for the role of the Texas Rio Grande Compact Commissioner?

A. I do not.

Q. When you were appointed as the commissioner, did you do anything to learn about the duties of the -- either the Commission or of the commissioners?

A. I did.

Q. What did you do?

A. Well, I met with the attorney general's staff, who was in charge of the water areas for the

State of Texas. I met with the EP1 district, their board members. I met with EBID and their board members, tried to do whatever I could to get all the background, read materials on the Compact.

Q. You say you read materials on the Compact. Did you read previous Compact meeting minutes and transcripts?

A. No. I read, like, a book by Little. Just -- there's just materials out there on the Compact. Mainly it was talking to, you know, the districts to get the information, you know, what -- how things operated, how -- just trying to get up to speed as best I could.

Q. Did you read any -- or review any historical documents?

A. Well, I think there was some -- some publications on the Compact and how it came around.

Q. How about the negotiating minutes of the Compact, did you read those?

A. I did.

Q. Why did you read those?

A. Because I thought it was important to learn about the Compact, including the joint investigation report. I read that.

Q. Any other historic documents that you recall?

A. Not that I recall.

Q. Did you read the Compact?

A. I did.

Q. The statutes -- the Texas statutes indicate that a commissioner serves for six years; is that correct?

A. That's correct.

Q. You have served for one term already; is that right?

A. That's -- I think I've served for two.

Q. Two. Are you in your second term now?

A. I'm in my third. I -- I took over a partial one so Mr. Hanson resigned. I don't know where he went. I think he was traveling or left town. So I took over his remaining term and then I've been appointed twice.

Q. When is your current term up?

A. Four years, I believe.

Q. The statutes indicate that the Texas commissioner receives a salary. Do you receive a salary?

A. I do.

Q. What is that salary?

A. It's about 40,000 a year.

Q. That salary is received from the State of

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

****

REMOTE ORAL AND VIDEOTAPED DEPOSITION OF
DANIEL CHAVEZ
JULY 22, 2020

****

REMOTE ORAL AND VIDEOTAPED DEPOSITION of DANIEL CHAVEZ, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on July 22, 2020, from 9:09 a.m. to 3:13 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the offices of HEATHER L. GARZA, CSR, RPR, The Woodlands, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

TX v. NM # 141
New Mexico Exhibit
NM_EX-248

from EP1 each year?

A. No.

Q. When was the last time you bought effluent from EP1.

A. I believe it was 2009.

Q. 2009. Do you recall how much you bought in that year?

A. No.

Q. So since 2009, have you actually taken delivery of any effluent?

A. No.

Q. Is that because EP1 made a determination in each of those years that there was no effluent available to sell to you?

A. It's available to them, but they're using it.

Q. I see. So they only sell it to you when they have more than they need for their use?

A. Correct.

Q. And I believe you said this earlier, but you take delivery of that effluent at one of the three points that we discussed where you also take delivery of the project water, correct?

A. Correct.

Q. Have you ever taken delivery of effluent from the river itself?

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS, §
§
Plaintiff, §
§
vs. § ORIGINAL ACTION
§ CASE NO.: 220141
STATE OF NEW MEXICO, § (ORIGINAL 141)
and STATE OF COLORADO, §
§
Defendants. §

****
REMOTE VIDEOCONFERENCED DEPOSITION OF
LARRY FRENCH
AUGUST 31, 2020
****

Job No. 65191

REMOTE VIDEOCONFERENCED DEPOSITION OF LARRY FRENCH, produced as a witness at the instance of Defendant State of New Mexico and remotely duly sworn by agreement of all counsel, was taken in the above-styled and numbered cause on August 31, 2020, from 9:02 a.m. to 10:33 a.m., before Karen L. D. Schoeve, RDR, CRR, reported remotely by computerized machine shorthand, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

This deposition is being conducted remotely regarding the COVID-19 State of Disaster status of the world.

REPORTER'S NOTE: Please note that due to the quality of a Zoom videoconference and transmission of data and overspeaking causes audio distortion which disrupts the process of preparing a videoconference transcript.

Please be advised that an UNCERTIFIED ROUGH DRAFT version of this transcript exists. If you are in possession of said rough draft, please replace it immediately with this CERTIFIED FINAL TRANSCRIPT.

Quotation marks are used for clarity and do not necessarily reflect a direct quote.

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Certified Realtime Reporter
Registered Diplomate Reporter
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PROCEEDINGS
THE VIDEOGRAPHER: The time is 9:02 a.m. We're on the record.
MR. ROBLES: Good morning, Mr. French.
THE WITNESS: Good morning.
MR. ROBLES: Now I'm going to ask the court reporter to swear in the witness.
LARRY FRENCH,
having been first duly sworn to tell the truth, the whole truth, and nothing but the truth, so help him God, testified as follows:
EXAMINATION
BY MR. ROBLES:
Q. Would you please state and spell your name.
A. Yes. My name's Larry French. L-a-r-r-y F-r-e-n-c-h.
Q. Mr. French, have you ever had your deposition taken before?
A. Yes.
Q. So you're familiar with the process by which you will be asked questions, and in doing so, be asked to answer those questions; is that correct?
A. That's correct.
Q. And if I ask a question that's confusing

or otherwise hard to understand, would you let me know?
A. I will, yes.
Q. And if at any time you would like to take a break, consult with -- you know, take a break for convenience or talk to your lawyer, will you let me know that?
A. I will.
Q. And if for any other reason you have questions or concerns about the proceeding, will you let us know so that we don't move into this deposition with there being a concern that has yet to be -- that's not addressed?
A. Yes, I'll let you know.
Q. That sounds good.
Well, first, I'd like to begin by asking you for -- to tell me about your education that ultimately led to you working for the Texas Water Development Board.
A. Okay. I have a Bachelor of Science degree in Geological Sciences from the University of California at Riverside. And I have a Master of Arts degree in Geological Sciences from the University of Texas at Austin.
Q. Now, something that surprised me a little

bit. I've often heard geological sciences, you know, being associated with a master's of science, not a master's of art. And I was just curious, are there two different degrees for geological -- a master's for geological science, one master's of art and master's of science?

A. At the time I was -- received my master's degree at the University of Texas, they only offered a master of arts degree. I believe they now offer a master of science, but it was one choice then.

Q. Beyond receiving your master's -- and I apologize that I believe I cut you off, did you receive any additional education that's relevant to the work you do for the Texas Water Development Board?

A. That's the only academic background that I have, besides taking various short courses and conferences.

Q. I forgot to ask as you were going through the process of describing your education, will you please tell me the year that you graduated from -- you received your undergraduate degree and the year you received your master's degree?

A. I received the bachelor's degree in 1975 and the master's degree in 1979.

Q. Before you began working with the Texas Water Development Board, what other relevant work-related experience did you have?

A. Since receiving my master's degree, I've worked as a private consultant for various consulting firms dealing with geological and groundwater issues.

Q. What are those consulting firms?

A. I first joined a firm called Sargent & Lundy Engineers in Chicago.

From there I was employed by a company called Radian Corporation in Austin, Texas. And I worked there in Austin as well as Los Angeles and in London.

And I worked at another firm McCulley, Frick & Gilman.

And then a firm called URS.

And then the last firm before joining the Water Development Board was Brown and Caldwell.

Q. In the time that you were involved in this consulting work, did you ever work on groundwater issues in the State of Texas?

A. Yes, I did.

Q. In which of those firms did you do that work?

A. Let's see, that would have been every one of those firms I did.

Q. During the time that you were working with these consulting -- I believe they're engineering firms. Is that a correct statement?

A. Yes, engineering and technical services firms.

Q. Were you ever involved or did you work on water issues in the State of New Mexico?

A. I believe I had a couple of projects that were in New Mexico, yes.

Q. Would you please identify those projects for me?

A. There was a project dealing with coal resources in northwestern New Mexico. This is several decades ago. I don't recall specifics at this point about that, but that's the one that I can remember.

Q. Is that -- how is that related to water?

A. There was a -- the question had to do with some groundwater impacts and water resources related to coal exploration or extraction.

Q. In addition to the coal-related, groundwater-related issues that you mentioned that you worked on in Northwestern New Mexico, I believe

there was another or a second time when you worked on New Mexico water-related issues; is that correct?

A. I worked on a groundwater contamination project associated with a railroad south of Albuquerque for a short time.

Q. In the course of performing that work for the railroad south of Albuquerque, were you ever involved or have any -- did your work involve the Rio Grande?

A. Not specifically.

Q. How did you find yourself working at the Texas Water Development Board?

A. I responded to a opportunity to -- there was a vacancy in the director of groundwater resources, and I applied for that position and was accepted.

Q. So you became the groundwater -- the director of groundwater resources as your first position at the Texas Water Development Board?

A. That's correct.

Q. In what year was that?

A. That was 2011.

Q. Is it correct to say that you have held the position of the director of -- I guess it's

groundwater resources since 2011?
A. That's correct.
Q. So now I'm going to turn your attention to the Texas Water Development Board. I may ask you questions that seem to be asking you what you think. But as you know, you're here to testify as a witness on behalf of the agency. So I apologize in advance if I use the more informal way of asking the question, asking will you please tell me; and you, you, you, you. Is that okay with you?
A. Yes.
Q. All right. So what are -- based on your time with Texas Water Development -- Texas Water Development Board, with regard to groundwater, what are the goals of the agency?
A. The goals of the agency overall are to provide planning and assistance to the State of Texas for the responsible development of water resources in the state.
Q. In your current -- in your current position with the board, please identify for me your mission task for which you are responsible.
A. For the Groundwater Division, we are responsible for the collection and dissemination of groundwater data and to inform the citizens of the

state and lawmakers of groundwater conditions throughout the state.
Q. In your position as director, what is your role in achieving the goal you just explained?
A. I provide overall supervision to the staff of the Groundwater Division, and I'm engaged with both the formulation of staff initiatives, the oversight of reports and data that our division produces, and I provide information to the executive management of the agency regarding groundwater conditions within the state. And occasionally, I will also deal with outside stakeholders and lawmakers when they have questions or needs of information.
Q. Is it correct to say that the Groundwater Division is responsible for all aspects of groundwater studies in the State of Texas?
A. Our responsibilities encompass the entire state. We are not the only organization that conducts groundwater studies, but we encompass the entire state.
Q. How is the need for groundwater study determined by your agency?
A. We receive input and direction from various stakeholders, including lawmakers, and

directions from our executive management. And we interface with a number of local water districts throughout the State, and the combination of those inputs provide direction to our division.
Q. You've used the word "stakeholder," I believe twice during your testimony. Just so that I know what you mean by the term "stakeholder," would you please define what you mean when you say the word "stakeholder"?
A. I use it very broadly and to basically refer to people with an interest in groundwater, and typically, those are people that have a professional interest in the management and understanding of groundwater resources.
Q. So by your definition of professional interest, if we had, let's say for example, an environmental group, would they fall into that definition of stakeholder?
A. Yes, an environmental group could be a stakeholder.
Q. How about a citizen who voiced concerns about a particular issue involving groundwater, is that a stakeholder?
A. That could be a stakeholder as well.
Q. Now, is that -- are those -- is an entity

such as an environmental group, a private citizen, are they encompassed in your definition of stakeholder?
A. Yes.
Q. How does your agency determine the priority for conducting a groundwater study knowing that there are competing -- you know, that resources are limited and that there are others who want, you know, a groundwater study?
A. Priorities are set by a number of factors. The legislature sets priorities for our agency or the management within the -- executive management sets priorities, and those are the primary drivers for our priorities.
Q. With regard -- would it be fair to say that your agency -- I should say the Groundwater Division is responsible for monitoring groundwater levels in groundwater quality in the nine major and 22 minor aquifers in the State of Texas?
A. Monitoring groundwater levels and quality is one of our key functions in those aquifers.
Q. How does your agency define the term "monitor"?
A. We refer to monitoring as the measurements of -- repeated measurement of water levels in

aquifers and also the collection and analysis of groundwater samples.

Q. So when you use the word "level," how do you -- when you say the word "level," what do you mean?

A. We mean the -- basically the elevation of water -- the water surface within a well as we have measured it directly.

Q. So is it fair to say that when there are changes in elevation, that is the functional equivalent of that there are changes in the level of water in a groundwater system?

A. At the particular well point, that would indicate a change in -- change of water level in the well from time to time would reflect changing conditions within the aquifer itself.

Q. In conducting groundwater quality testing, what does "quality" mean and how is it tested?

A. We collect samples from wells and we submit those to a contracted laboratory for chemical analysis. The analytes that we routinely measure are what we call naturally occurring parameters such as cations and anions, that reflect natural ambient groundwater quality.

Q. How do you address, I guess, artificial,

you know -- well, I'll call them pollutants, for lack of a better term, is that something you test for regularly, or is that something that you only test when the need becomes apparent?

MS. BARFIELD: Objection as to form. Overbroad, vague and ambiguous. You're going into areas that are outside the areas designated for this witness to testify on.

I've been giving you some freedom to get some background information on Texas Water Development Board in general. But I'm going to caution the witness to testify for the reason he's here to testify.

A. Can you repeat that question?

Q. (BY MR. ROBLES) How do you address, I guess -- or how do you address --

How do you look for or when do you look for pollutants in groundwater?

MS. BARFIELD: Same objection. Overbroad, vague and ambiguous. What geographic area as phrased. It goes outside the scope of the testimony that this witness is designated to give today.

A. Our scope is to look at naturally-occurring groundwater parameters and not to evaluate

groundwater contamination.

Q. (BY MR. ROBLES) So that's not a function that your Groundwater Division performs?

A. Our function is to look at naturally-occurring groundwater quality.

Q. Is it correct to say that your division conducts regional-scale groundwater modeling?

A. Yes.

Q. What is the purpose of conducting groundwater models on the regional level?

A. Our groundwater modeling is -- the primary purpose is to support the efforts of regional water planning within the state.

Q. How does a groundwater model help you achieve that goal?

A. Groundwater models can be used to evaluate the effects of proposed groundwater development projects. And can provide information on predictive scenarios for various drought conditions or groundwater development conditions that would assist planning groups.

Q. Are the groundwater models that are kept, developed and run by your division able to determine that groundwater is being -- is being drawn into surface water?

MS. BARFIELD: Overbroad, vague and ambiguous, goes outside the scope of testimony the witness is designated to give today.

A. The models are generally not calibrated or at a scale to look at individual groundwater and surface water conditions.

Q. (BY MR. ROBLES) So it's correct to say that the groundwater models that are developed by the Groundwater Division do not seek to determine the interplay -- the exchange between surface water and groundwater?

MS. BARFIELD: Objection; also foundation and goes outside the scope of the testimony the witness is designated to give.

A. Would you mind repeating that question again?

Q. (BY MR. ROBLES) So is it correct to say that the groundwater models that are developed by the groundwater -- Groundwater Division do not seek to determine the interplay and the exchange between surface water and groundwater?

MS. BARFIELD: Same objections.

A. That is not the primary purpose of the groundwater model.

Q. (BY MR. ROBLES) Do you know who, in your

agency, does that work, if anyone?

A. Can you define who does which work? I'm sorry.

Q. Determines the interchange -- the exchange between surface water and groundwater. Is there anyone in your agency who does that work?

A. We have conducted a general study throughout the state, so our division has evaluated that question on a statewide level.

Q. Have you done that specifically for the Bolson Basin and its interaction with the Rio Grande?

MS. BARFIELD: Objection. Hold on one second, Mr. French.

This goes outside the scope of the testimony that Mr. French has been designated to give here today. It also goes outside the scope of New Mexico's notice. Groundwater modeling is not in the notice for Mr. French. Go ahead.

A. Again, can you repeat the question?

Q. (BY MR. ROBLES) Sure. Has your agency specifically conducted a study between -- that examines the Bolson Basin and its interaction in exchange with the Rio Grande?

MS. BARFIELD: Same objections.

A. I am not -- I am not aware of a specific study that specifically examined that exchange.

Q. (BY MR. ROBLES) I understand your division conducts -- or I should say reviews and approves groundwater management plans. Is that correct?

A. Yes. We do an administrative completeness review of groundwater management plans.

Q. What is a "groundwater management plan"?

A. A groundwater management plan is prepared by a Groundwater Conservation District, which outlines the scope and the goals and the -- and how a district will address the goals and objectives of their programs.

Q. Is a groundwater district the only entity that can prepare and submit a groundwater management plan to your division?

A. They -- the Groundwater Conservation District that is under the jurisdiction of what we call a Chapter 36 of the Water Code is required to prepare and submit to the agency a groundwater management plan for administrative completeness review.

Q. Now, aside from Groundwater Conservation District, can another political subdivision such as

a city or a county or a water authority of some sort, submit to your division a groundwater management plan?

A. Someone -- some other group could, but I'm not aware that that has ever happened and we would not review it.

Q. Why would you not review it?

A. That would be outside the scope of our responsibility.

Q. So let me just ask you a question: If -- and this is a hypothetical -- if the El Paso Water Improvement District submitted to your division a water management -- a groundwater management plan, would you conduct an administrative review of said plan?

A. That would be outside our scope and so we would not complete a review of it.

Q. What is the process by which your division conducts a groundwater management plan review?

A. We have a team of staff members that use a checklist based on statute to read through and compare the plan and to ensure that it addresses the statutory required elements that are required for the management plan.

Q. Is it correct -- and please let me know if

this question doesn't seem clear to you: Does your division conduct a substantive review of the groundwater management plan to ensure it meets the objectives of the legislation?

A. We conduct only an administrative completeness review to ensure that it addresses the required elements.

Q. So if a groundwater management plan was submitted to your division and, in fact, suggested that groundwater was not being efficiently or adequately conserved, would that be a basis upon which to reject said plan?

A. We would reject a plan if the plan did not address the required goals or elements required by law.

Q. Is conservational groundwater resources a goal of the applicable law?

A. Yes, it is.

Q. So if a groundwater management plan was submitted to your division, which in your -- which in the opinion of the professionals working with you and for you, allowed for an inordinate amount of waste of groundwater, would you reject that plan?

A. We would look only at the -- whether they have a plan to address conservation. That would be the -- that's what the limit of our review consists of, a completeness review.

Q. So I just want to be clear about this point. That if a groundwater management plan was submitted to your division and it was -- it did not effectively or efficiently provide for the conservation of groundwater resources, your division does not have the authority to reject the plan?

A. We only have authority to reject it if they do not address the issue that's required by law.

Q. What are the specific administrative -- what specifically does your -- I should say, your agency administrative review entail for groundwater management plans?

A. Like I mentioned, we have a checklist which is based on the required elements of a management plan, which is included in Chapter 36 of the Texas Water Code. And we use that checklist to guide our review -- our completeness review of the plan.

Q. What is on that checklist?

A. I couldn't tell you off my memory. I can provide that information if you need it later.

Q. Okay. There will come a time when we take a break, and I'll just ask you to do that, if that's all right with you and your attorney.

MS. BARFIELD: I'm not sure what you're asking the witness to do. He's not gonna do homework for you.

MR. ROBLES: Well, I'm asking a question that's relevant to the review that's conducted by the Division of Groundwater Management plans, and I asked for the checklist that the Division follows to ensure that the plan is administratively complete. And he had said that, you know, he doesn't remember that off the top of his head. So I'm asking him if he would like to, he can look over that particular issue during a break. And if you direct him not to, I suppose I'm not in any position to do so, but it does leave a hole where I think I'm allowed to ask questions about.

MS. BARFIELD: Well, I disagree that it leaves a hole. He said he does a checklist pursuant to the terms of the statute. If you'd like to show him a copy of the statute and ask him questions about that, then you can do that. It's your deposition.

We can discuss it later. Go ahead.

Q. (BY MR. ROBLES) I'd like to change the topic a little bit to the "desired future conditions." You've certainly heard of that term?

A. Yes.

Q. What does it mean?

A. "Desired future condition" is a quantitative description of what an aquifer would look like at some time in the future.

Q. Is there one word that describes that process, such as prediction?

A. I'm sorry, did you say "prediction"?

Q. Is there one word that describes that process, such as the word "prediction"?

A. No, I would -- the desired future condition is a policy goal.

Q. Okay. And how does your division achieve that goal or implement that goal?

A. Our division does not achieve or implement that goal. That is the responsibility of Groundwater Conservation Districts.

Q. What must a Groundwater Conservation District do in order to achieve a desired future condition?

A. The Groundwater Conservation Districts are -- have authority to manage groundwater by

permitting groundwater wells, by -- which include well spacing, groundwater production limits, and other measures to regulate or manage groundwater to achieve the groundwater -- to achieve a desired future condition for the aquifer.

Q. Is it the -- so is there any way to quantify a desired future condition for a particular aquifer?

A. Yes. A desired future condition can be expressed as -- in multiple ways, such as a water level decline over a period of time as for a particular aquifer. It can be expressed as maintaining a certain amount of spring flow over time. Or it may be achieved -- or may be described as maintaining a certain storage volume of groundwater in an aquifer. That is really a decision by the individual districts, how to -- how to quantify that.

Q. In your work as division director of the Groundwater Division, have you ever come across a document, of whatever kind, that describes the desired future conditions for the Bolson Aquifer?

A. No.

Q. During your time working as a director of the Groundwater Division, have there been any

discussions by you, others in your division, or others from other governmental entities that have talked about what would be a desired future condition for the Bolson Aquifer?

A. I could only speak for myself, and that answer would be no.

Q. What is the value of identifying a desired future condition for an aquifer?

A. That value will vary from district to district, but it provides a policy goal that the districts can use to implement groundwater management strategies within their territory.

Q. Is having a desired future condition a way in which to conserve groundwater resources?

A. That is a possible -- that is a possible goal that could be implied to a desired future condition.

Q. Turning your attention to a different topic, what is the Texas Water Development Board's management structure for groundwater matters?

A. I'm sorry, could you repeat the last part, groundwater matters?

Q. Yes.

A. Yes, the Groundwater Division is -- we're structured with three departments within our

division. We have a Groundwater Monitoring Department. We have a Groundwater Technical Assistance Department, and we have a Groundwater Availability Modeling Department.

Q. What does the monitoring department do?

A. The monitoring department has staff which are deployed to the field to measure groundwater levels throughout the state. They also are charged with collecting groundwater samples for chemical analysis, and maintain -- and they're also charged with maintaining our groundwater recorder well network which consists of wells with instrumented recorder devices that provide real-time data.

Q. What is the role of the technical department?

A. The technical department will do a variety of activities such as research in -- selective research in groundwater issues. They also provide -- man telephones to answer any questions from the citizens and state on groundwater conditions in their area. And they also participate or attend groundwater management area meetings and provide technical resources to those groups.

Q. What is the role of the availability and modeling department?

A. The Groundwater Availability Modeling Department develops and uses groundwater models -- regional groundwater models to assist water planning throughout the state.

Q. As your agency uses the term, what do you mean by "water planning"?

A. That is a five-year -- it's a process that occurs every -- it is repeated every five years whereby regional -- regional areas within the state composed of a number of stakeholders within a region are charged with evaluating current supplies, future demands and developing strategies to address water availability within their region. Those various regional groups then develop plans, and those plans are then combined into a state water plan.

Q. You used the term "strategies"; is that correct?

A. I believe so.

Q. What do you mean by that?

A. That would be an approach to address needs that are identified within a region.

Q. And it would be fair to say that the needs identified by the region are specific to that region?

A. Yes.

Q. How do you collect that information, which helps you understand the needs of a region, so that your division can identify strategies for a -- remedying or addressing the needs of that region?

A. I'll have to say that this -- this is an area dealing with the planning which I am not responsible for. And that's another area within the agency that handles that.

Q. So is it fair to say that you're not involved in groundwater planning?

A. I'm not involved in regional planning, that's correct.

Q. What is the management structure for the groundwater -- well, I guess I should back up. Is it correct to say that the Texas Water Development Board has groundwater management areas?

A. There are groundwater management areas within the state that have been identified and defined by the Water Development Board.

Q. And so there is a groundwater management area for the entire State of Texas?

A. There are a total of 16 groundwater management areas within the state.

Q. Do they cover the entire State of Texas --

A. Yes.

Q. -- those 16?
A. Correct.
Q. And there is a groundwater management area for El Paso County and the adjacent counties in that area; is that right?
A. Yes. Groundwater Management Area 5 covers much of -- maybe all of El Paso County and part of the adjacent Hudspeth County.
Q. Who is the person, or persons, responsible for Groundwater Management Area Number 5?
A. I do not know. Groundwater management areas are simply areas on a map. And where there are Groundwater Conservation Districts within those areas, those are the entities that engage in groundwater resource planning.
Q. So it's correct to say that your agency does not devote a particular person or people to a Groundwater Management Area. But it is the responsibility of your agency as a whole, your division as a whole, to manage those particular areas?
MS. BARFIELD: Objection, that mischaracterizes the witness's testimony.
A. We do not manage the areas. We -- we observe and provide technical resources to those

districts within an area as they request them.
Q. (BY MR. ROBLES) So although the Texas Water Development Board has identified groundwater management areas, the Texas Water Development Board does not manage those areas; is that a correct statement?
A. That is correct.
Q. Who, if you know, is responsible for groundwater -- Groundwater Management Area Number 5?
MS. BARFIELD: Objection (audio distortion).
A. There are no Groundwater Conservation Districts in Groundwater Management Area 5, so there is no person that would be responsible.
Q. Do you know why there are no groundwater management districts in Groundwater Management Area Number 5?
MS. BARFIELD: Objection. This goes beyond the scope of the testimony that this witness is designated to give, as you are aware. Texas responded formally to the notice and subpoena with objections and responses clearly identifying the categories that each witness would be produced to testify on. This is outside the scope.
Q. (BY MR. ROBLES) You can go ahead and

answer.
A. My answer's no.
Q. Does the Texas Water Development Board have a policy or a goal that it hopes to achieve having Groundwater Conservation Districts in all the groundwater management areas?
MS. BARFIELD: Same objection.
A. No.
Q. (BY MR. ROBLES) What effort, if any, does the Texas Water Development Board make or take to create or foster Groundwater Conservation Districts in its Groundwater Management Area?
MS. BARFIELD: Same objection.
A. We provide technical resources and assistance to those districts as they make those decisions.
Q. (BY MR. ROBLES) So is it fair to say that the Texas Water Development Board leaves it up to the constituents, the citizens, the political subdivisions, the water authorities in a particular Groundwater Management Area to determine whether they should create a Groundwater Conservation District?
MS. BARFIELD: Same objection. One second, please.

Same objections, mischaracterizes the witness's testimony and lacks foundation. Go ahead.
A. In Texas, groundwater is really done by local control.
Q. (BY MR. ROBLES) Is there anyone in your division who's responsible for collecting information regarding groundwater salinity?
A. That would -- groundwater salinity would be a -- or total dissolved solids would be a parameter that the groundwater monitoring team, or department, would be measuring as part of their groundwater quality program.
Q. Now, as I've been reprimanded by my biochemistry son, who's simply saying a salt is not an accurate term. So I'm going to ask you that when -- and I think it's an assay of total dissolved solids -- and if I'm using the wrong terms, please correct me -- that a sodium salt is a component of a total dissolved salt; is that right?
MS. BARFIELD: I'm gonna object and instruct the witness not to answer as phrased. That's an expert witness question. It also goes beyond the scope of the notice.
Mr. French is not here to testify on salinity issues. It's very clear in Texas's

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responses. I'm just not gonna let him answer that question. We're not gonna do chemistry.

MR. ROBLES: So, Teresa, are you going to -- because we did ask for someone to discuss salinity. And the Texas Water Development Board is involved in that issue. Are you actually going to propose someone who can?

MS. BARFIELD: We can talk about that when we're not in the middle of this deposition, but Mr. French is not the person who's designated to talk on salinity issues.

Q. (BY MR. ROBLES) Does the Groundwater Division examine salinity in the Bolson Aquifer?

MS. BARFIELD: Same objection. You can answer the question as phrased, though.

THE WITNESS: I'm sorry, am I to answer that question?

MS. BARFIELD: You can. If you're able to answer a yes or no question in that regard, you can. But, again, it goes beyond the scope of this witness's designated testimony.

A. The Groundwater Division collects samples and submits those samples for chemical analysis and then those results are put in our database. We do not do any other evaluation.

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Q. (BY MR. ROBLES) Does the monitoring department, or the technical department, determine whether there's too much sodium or there is sodium in the water?

A. No.

(Zoom audio cut out.)

MS. BARFIELD: Same objection.

THE COURT REPORTER: I'm sorry, what was the objection?

MS. BARFIELD: Same objection is what I said.

Q. (BY MR. ROBLES) Does the Groundwater Division determine whether there is sodium chloride in the water?

MS. BARFIELD: Same objection.

A. We evaluate -- we submit samples for chemical analysis and when those -- when sodium and chloride is reported, we include that information in our database.

Q. (BY MR. ROBLES) So if there is no sodium or chloride, that's not reflected in the reports that you create?

A. We simply post the results as we receive them from the laboratory under our -- in our database.

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Q. What effort, if any, is made by the Groundwater Division to assess sodium or chloride levels in groundwater?

MS. BARFIELD: Same objections. Outside the scope of the testimony this witness is designated to give. It also lacks foundation, calls for speculation. Go ahead.

A. We do not assess the results.

Q. (BY MR. ROBLES) Does the Groundwater -- or I should say -- does the Groundwater Division -- is the Groundwater Division involved in the Rio Grande Salinity Management Program?

A. Did you say the Groundwater Division?

Q. Yes.

A. Okay. Not to my knowledge.

Q. Do you know of any other division of the Texas Water Development Board that is involved in the Rio Grande Salinity Management Program?

A. I don't -- I don't know.

Q. Have you ever heard of a Rio Grande Salinity Management Program?

A. Not specifically, no.

Q. When you mean "not specifically," why do you say that?

THE COURT REPORTER: Excuse me. I'm

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sorry, I need to take a technical break.

(A recess was taken from 9:49 a.m. to 10:02 a.m.)

THE VIDEOGRAPHER: The time is 10:02 a.m. We're on the record.

Q. (BY MR. ROBLES) Before we took the break, I had asked you a question regarding the checklist that your division follows to ensure the adequacy of a groundwater management plan. What is that checklist?

A. That checklist is available on our agency website and certainly we can provide that to you.

Q. But you do not know the answer to that question, as we sit here today?

MS. BARFIELD: Mischaracterizes his testimony.

A. That's the checklist that I don't have memorized, so I would have to refer to it directly.

Q. (BY MR. ROBLES) So before the break, we were discussing salinity. Has the Texas Water Development Board identified an acceptable salinity level or budget for groundwater?

MS. BARFIELD: The question lacks foundation, and also it goes outside the scope of the testimony that this witness is designated to testify about. I'll give you a little bit of leeway here.

If you know an answer, Mr. French, you can give it.

A. We -- our Division simply collects the data, and we don't provide any judgment as to what's acceptable or not.

Q. (BY MR. ROBLES) Do you know if the Texas Water Development Board has undertaken an economic assessment of the impacts of salinity in a particular area of Texas -- in any particular area in the State of Texas?

MS. BARFIELD: Again, the questions continue to go outside the scope of the testimony this witness is designated to give. Go ahead.

A. I'm not aware of such a study.

Q. (BY MR. ROBLES) Has your division ever written a report, conducted a study, or written a paper about groundwater salinity in Groundwater Management Area Number 5?

MS. BARFIELD: Same objections. Goes outside the scope of this witness's testimony. Lacks foundation.

A. Our agency has produced previously reports on groundwater conditions in that area. And as part

of that report, we address groundwater quality.

Q. (BY MR. ROBLES) Does that include salinity?

A. Salinity or total dissolved solids would have probably been included.

Q. Where would I find -- well, what is the name of the report your referencing?

A. There are several reports. All of the relevant reports are listed on our agency website under Groundwater Management Area Number 5.

Q. So all the reports that you're referencing are readily available on the website for Groundwater Management Area Number 5?

A. Correct.

Q. From your memory, do you recall if the Texas Water Development Board, or your division -- what conclusions they render about groundwater salinity in Groundwater Management Area Number 5?

MS. BARFIELD: Same objection. It's outside the scope of the witness that this -- of the testimony that this witness is designated to give today.

A. I don't have any recollection of what conclusions have been made.

Q. (BY MR. ROBLES) How does the Texas Water

Development Board, in your division more specifically, ensure the efficiency use of groundwater generally?

A. That's outside the scope of our division. That's really under local control of Groundwater Conservation Districts.

Q. How does the Texas Water Development Board and your division, more specifically, control and prevent waste of groundwater?

A. That, again, is not under our scope of responsibility, that's a local issue for Groundwater Conservation Districts.

Q. How does the Texas Water Development Board or your division ensure that withdrawals of groundwater do not affect surface water?

A. Again, that's not a responsibility of the Water Development Board. That would be, again, a local issue for Groundwater Conservation Districts.

Q. Does the Texas Water Development Board -- or I should say does the Groundwater Division monitor the impact of withdrawals of groundwater and their effects on surface water?

A. Maybe not monitor that specifically. We monitor water levels in aquifers and water quality, but not specifically withdrawals related to surface

water.

Q. How does the Groundwater Division ensure effective management of groundwater resources during drought conditions?

A. We can provide technical information and resources, but that management is not under our responsibility. That would be under local Groundwater Conservation Districts' authority.

Q. You reference "technical information" and "technical resources." As you use those terms, what do you mean?

A. I would mean results of water level monitoring of water quality analyses. That's what I would be referring to.

Q. Are there any -- is there any advice, technical or otherwise, on how to effectively manage groundwater resources in a drought condition?

A. We would not pro -- go ahead.

MS. BARFIELD: I'll object again that the questions continue to go outside the scope of the witness -- of the testimony that this witness is designated to give. Lacks foundation. Go ahead.

A. Again, our role is to provide technical support and information, but not advise on management strategies.

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Q. (BY MR. ROBLES) You would agree with me that the elements of groundwater management plan provide for an efficient use of groundwater; that's one.
A. One of the goals of a groundwater management plan is to promote efficient use of groundwater.
Q. Another goal of a groundwater management plan is to prevent waste of groundwater?
A. That's correct.
Q. Another element of a groundwater management plan is to control and prevent subsidence?
A. That would be correct.
Q. And another element of a groundwater management plan is to address conjunctive surface water management issues?
A. Yes.
Q. As your division uses that term, "conjunctive surface water management issues," what does that mean?
A. That meaning can probably vary and apply locally. So we look at a groundwater management plan to see if that is addressed and if it applies to their district.

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Q. So what would "conjunctive surface water management" mean in Groundwater Management Area Number 5?
A. We don't have a -- we have not reviewed or seen a groundwater management plan for that area, so I wouldn't be able to tell you.
Q. Please identify for me a Groundwater Conservation District -- or Groundwater Management Area that has addressed conjunctive surface water management issues.
MS. BARFIELD: The question is outside the scope of the testimony that the witness is identified to give testimony today.
A. All of the Groundwater Conservation Districts in the state are required to at least address that issue. They will all do so in different ways that reflect their local conditions.
Q. (BY MR. ROBLES) Are there Groundwater Conservation Districts that propose plans by which the use of groundwater does not adversely affect the flow of surface water in a river or reservoir?
MS. BARFIELD: Same objections. Overbroad, lacks foundation.
A. I can't recall that from memory.
Q. (BY MR. ROBLES) In what way would your division examine a groundwater management plan to determine whether it properly addresses conjunctive surface water management issues?

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A. The scope of our responsibility is really limited to the administrative completeness review of the plan and not to evaluate the particular merits of those individual goals.
Q. If, for example, a groundwater -- Groundwater Conservation District presented a groundwater management plan that allowed for groundwater pumping that would essentially eliminate a naturally flowing stream, would you prevent -- or would you not approve that particular plan?
MS. BARFIELD: Incomplete hypothetical. It lacks foundation. Mischaracterizes the testimony you just gave.
A. Yes. The only reason we would not approve a plan is if that plan did not address the statutory required elements of a plan.
Q. (BY MR. ROBLES) So one of the statutory requirements -- required elements is that it needs to address a conjunctive surface water management issue.
So my question to you is: How do you determine if that particular term from the statute is administratively met?

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A. We -- using the checklist, we look at the specific elements of the plan. And if the plan addresses that issue, then we would deem it administratively complete in that area.
Q. Are you able to provide any more detail to the description you just gave?
A. Not that I can think of.
Q. With regard to groundwater management plans, it's also true to say that one of the goals is to address drought conditions. Is that correct?
A. Yes.
Q. How -- what does your division look for to determine whether a groundwater management plan does, in fact, adequately address drought conditions?
MS. BARFIELD: Again, it mischaracterizes the witness's testimony. Goes outside of the scope of the categories he's designated to testify on, lacks foundation.
A. We look at the individual plans to see if they have addressed -- that element of drought. How they would address drought conditions. And that is the scope of our review for administrative completeness.

Q. (BY MR. ROBLES) And it's correct to say that there are no groundwater management plans for Groundwater Management Area Number 5.
A. That is correct. There are no Groundwater Conservation Districts in Groundwater Management Area Number 5.
Q. What is a Groundwater Conservation District?
MS. BARFIELD: Outside the scope of the testimony that this witness is designated to give today.
A. A Groundwater Conservation District is a political entity that is charged with the management of groundwater resources in its area.
Q. (BY MR. ROBLES) What is the criteria by which your division approves a water conservation district?
(Computer chime interruption.)
A. Could you repeat that? I'm sorry, there was a noise that interrupted it.
Q. Sure. Sure.
What is the criteria by which your division, the groundwater -- your Groundwater Division determines whether -- well, determines whether there is a -- I mean, that question got out

of hand, didn't it?
What is the criteria by which the Texas Water Development Board, in your division most particularly, must find in order to approve a groundwater conservation district?
MS. BARFIELD: Same objections. He's not here to testify on that category. Go ahead.
A. We have no role in approving whether there's a Groundwater Conservation District or not.
Q. (BY MR. ROBLES) Does the Texas Water Development Board advocate, or otherwise strongly suggest, that a particular area, or a particular region, should adopt a Groundwater Conservation District -- or create a Groundwater Conservation District?
MS. BARFIELD: Same objections, lacks foundation, argumentative as phrased.
A. We do not advocate.
Q. (BY MR. ROBLES) Is it fair to say that the goal of the Groundwater Conservation District is to control and monitor and otherwise conserve groundwater resources?
MS. BARFIELD: Lacks foundation, outside the scope of this witness's testimony.
A. The statute provides -- describes the

roles in Groundwater Conservation Districts which are due -- which are several -- and I don't recall all of them, but they're required -- they're listed in Chapter 36 of the Water Code.
Q. (BY MR. ROBLES) From the very name of the Groundwater Conservation District, isn't it true, based on your experience and working in the Texas Water Development Board, that the purpose of the Groundwater Conservation District is to conserve groundwater resources?
MS. BARFIELD: Outside the scope of this witness's designated testimony. Lacks foundation.
A. That would be one -- that would be one of the purposes.
Q. (BY MR. ROBLES) What other purposes are you aware of?
MS. BARFIELD: Same objections.
A. Other purposes would include protection of private property rights as related to groundwater, mitigation or prevention of land subsidence in other areas.
Q. (BY MR. ROBLES) Do you know of any effort made by a group, a citizen, or any other entity in Groundwater Management Area Number 5 to create a

Groundwater Conservation District?
A. I do not.
MS. BARFIELD: Same objection.
A. I'm sorry. I said "I do not know."
Q. (BY MR. ROBLES) What, if anything, does your division do to determine the flow into and out of aquifers from surface water in -- in Groundwater Management Area Number 5?
A. To my knowledge, we have not conducted any studies on that topic, in that area.
Q. With regard to Groundwater Management Area Number 5, is there a place I can go to where I can learn information about the amounts of groundwater that are pumped out of the Bolson Aquifer?
A. Our agency does collect information on groundwater pumping throughout the state, and that information would be available on our website.
Q. Would you please explain to me the purpose of providing that raw data?
A. Those raw data can be used by interests -- people interested in groundwater resources, can be used by regional planning groups, water suppliers, anybody who has the need to understand information about groundwater pumping in an area.
Q. Is it fair to say that the data collected

and disseminated by the Groundwater Division is used for water planning?

A. Yes. That data that is collected by our division that is used in water planning, yes.

Q. And it's also correct to say -- or I should say that that data that's collected and disseminated by the Groundwater Division is also used for groundwater planning?

A. Yes.

Q. What role, if any, does the Texas Water Development Board play in planning the use of groundwater resources?

A. The planning of -- or planning of groundwater resources is really done on a local level. And we provide the data and technical information that can be used to support those decisions and plans. But our role is to provide information.

Q. Now, are you able to, with more specificity than simply saying it's on your website, tell me where I can find the raw data that you have referenced in the testimony you've given in the last few minutes?

A. The groundwater pumping information, you can find by going to the agency website under the

Water Planning tab, and there will be, I believe, subtabs which direct you to historical groundwater pumping.

Q. Is it correct to say that in the course of the work of your division, you collect information about water wells?

A. Yes. We receive information from water well drillers throughout the state, and we post that information in our groundwater submitted drillers database.

Q. And what role do you play in deciding whether a water well permit should or should not be issued?

A. We have no role in that kind of decision.

Q. Who has a role in determining whether a water well permit should or should not be issued?

A. That would be a local Groundwater Conservation District where they exist.

Q. If there is no water conservation district, who, if anyone, determines whether a water well permit should or should not be issued?

A. It may depend upon the area and any local government authorities, or whatever their scope of authority or responsibilities are, but it would not be a State responsibility.

Q. So it's correct to say that the Texas Water Development Board does not play any role in the decision as to whether a particular groundwater well permit request is granted or not?

A. Yes. We have no role in the review or approval or denial of permits for water wells.

Q. If, in the course of the Division's groundwater monitoring, an assessment is made that there is a concerning drop in the level of groundwater, what role will the Texas Water Development Board play in trying to prevent this concerning drop in groundwater level?

A. That would not be one of our roles. That would be a role of the local Groundwater Conservation District to address that.

Q. What, if anything, would the Texas Water Development Board say in a written communication or an oral communication to the affected area where there is a concerning drop in groundwater levels?

A. I don't think I can answer that question.

MS. BARFIELD: Lacks foundation and incomplete hypothetical. Go ahead.

Q. (BY MR. ROBLES) To your knowledge, has the Texas Water Development Board, your division, contacted a local -- a local government body and

expressed their concerns about a -- concerning -- or their concerns about a groundwater level decrease that is of concern?

A. I'm not aware of any such communication along those lines.

Q. What communication, if any, has your division had with the various governmental entities in Groundwater Management Area Number 5 about the groundwater levels that exist in that particular area?

A. I'm not aware of any communication we've had with any authorities in Groundwater Management Area 5 on that topic.

Q. What role, if any, does the Groundwater Division play in assessing the flow in drains and other such, you know, irrigation devices?

A. We have no role in that topic.

MR. ROBLES: So those may be all my questions. But if we could take a short break, let's just say five minutes, I can look at my notes, and we may be done with this particular deposition.

MS. BARFIELD: Okay. What time do you want to come back? Just 5?

MR. ROBLES: Just 5. So that would be 10:30 Mountain Standard Time and 11:30 Central.

MS. BARFIELD: Okay.
THE VIDEOGRAPHER: The time is 10:26 a.m. We're off the record.
(A recess was taken from 10:26 a.m. to 10:32 a.m.)
THE VIDEOGRAPHER: The time is 10:32 a.m. We're on the record.
MR. ROBLES: Mr. French, those are all the questions I have for you.
Other attorneys may have questions for you, but those are the questions I had for you today.
Thank you very much for appearing for this deposition.
THE WITNESS: Okay. Thanks.
MS. BARFIELD: Anybody else have any questions before we go off the record for this deposition?
MS. DUNCAN: Nothing from Colorado. Thanks.
MR. TUSTIN: Nothing from the United States.
MR. ROBLES: And since everyone's on the line here. I want to make sure.
We can begin the next deposition right

after this one if you'd like, or we can take a break for lunch because I understand in the Central Time zone it's about that time.
MS. BARFIELD: Why don't we first go off the record. She's recording all of the lunch conversation. So is that okay? Off the record.
THE VIDEOGRAPHER: 10:33. We're off the record.

(Remote deposition concluded at 10:33 a.m., August 31, 2020.)

CHANGES AND SIGNATURE
WITNESS NAME: LARRY FRENCH
DATE: AUGUST 31, 2020
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I, LARRY FRENCH, solemnly swear or affirm under the pains and penalties of perjury that the foregoing pages contain a true and correct transcript of the testimony given by me at the time and place stated with the corrections, if any, and the reasons therefor noted on the foregoing correction pages(s).

____
LARRY FRENCH

Job No. 65191

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS, §
§
Plaintiff, §
§
vs. § ORIGINAL ACTION
§ CASE NO.: 220141
STATE OF NEW MEXICO, § (ORIGINAL 141)
and STATE OF COLORADO, §
§
Defendants. §

****

REPORTER'S CERTIFICATE
REMOTE VIDEOCONFERENCED DEPOSITION OF
LARRY FRENCH
AUGUST 31, 2020

****

I, Karen L. D. Schoeve, Registered Diplomate Reporter, Certified Realtime Reporter, and Realtime Systems Administrator, residing in the State of Texas, do hereby certify that the foregoing proceedings were reported by me and that the foregoing transcript constitutes a full, true, and correct transcription of my stenographic notes, to the best of my ability and hereby certify to the following:

That the witness, LARRY FRENCH, was duly remotely sworn by the officer and that the transcript of the oral deposition is a true record of the testimony given by the witness;

I further certify that I am neither counsel for, related to, nor employed by any of the parties in the action in which this proceeding was taken, and further that I am not financially or otherwise interested in the outcome of the action.

That the amount of time used by each party at the deposition is as follows:

LUIS ROBLES	-	01:25
STUART L. SOMACH	-	00:00
THERESA C. BARFIELD	-	00:00
PRISCILLA M. HUBENAK	-	00:00
JOHN P. TUSTIN	-	00:00
EMILY HALVORSEN	-	00:00
BOBBY SALEHI	-	00:00
BROOKE PAUP	-	00:00
KATHERINE DUNCAN	-	00:00

Subscribed and sworn to on this the 8th day of September, 2020.

Karen L.D. Schoeve, CSR, RDR, CRR
Realtime Systems Administrator
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Job No. 65191

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS, :
:
Plaintiff, :
:
VS. : Original Action Case
: No. 220141
STATE OF NEW MEXICO AND : (Original 141)
STATE OF COLORADO, :
:
Defendants. :

****

ORAL AND VIDEOTAPED 30(b)(6) DEPOSITION OF
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
BY AND THROUGH
KELLY WADE MILLS, P.G.
AUGUST 27, 2020

****

ORAL AND VIDEOTAPED 30(b)(6) DEPOSITION OF TEXAS COMMISSION ON ENVIRONMENTAL QUALITY BY AND THROUGH KELLY WADE MILLS, P.G., produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on August 27, 2020, from 1:09 p.m. MDT to 2:44 p.m. MDT, via Zoom videoconference, before PHYLLIS WALTZ, RMR, CRR, CRC, Texas CSR, TCRR, Louisiana CCR, in and for the State of Texas, recorded by machine shorthand, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed before any Notary Public.

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Ms. Cari-Michel La Caille
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Ms. Bonita DeWitt

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EXHIBITS

TX v. NM #141
New Mexico Exhibit
NM_EX-250

THE VIDEOGRAPHER: Time is 1:09 p.m. We're on the record.

MR. ROBLES: Good afternoon, Mr. Mills. My name is Luis Robles. How are you today?

THE WITNESS: I'm good, thank you.

MR. ROBLES: Well, good to hear. Well, we're here for your deposition, and there will be a time, I think, when they will be swearing you in for your deposition.

Is that correct? Phyllis?

THE REPORTER: Yes, sir. Would you like me to swear him now?

MR. ROBLES: Yes, that would be great.

KELLY WADE MILLS, P.G.,
having been first duly sworn, testified as follows:

E X A M I N A T I O N

BY MR. ROBLES:

Q. Mr. Mills, would you please spell your full name.

A. First name is Kelly, K-e-l-l-y. Middle name is Wade, W-a-d-e. Last name is Mills, M-i-l-l-s.

Q. Have you ever had your deposition taken before?

A. No, sir.

Q. Well, in this particular matter I'll be asking

you some questions and I'll ask you to answer those questions and in the course of that conversation there will be times when my questions won't make any sense. They will be confusing and sometimes difficult to understand. Would you let me know if I ask you a question like that?

A. Yes, sir.

Q. Additionally, you know, this is a deposition, not an interrogation. If there is a time when you need to take a break, want to take a break, confer with your counsel, would you let me know that as well.

A. Yes, sir.

Q. And if in the course of asking you questions, you have any questions about what -- where we're headed or what we're talking about, will you let me know that as well?

A. Yes, sir.

Q. Now, I'd like to begin in a very simple way and that is to ask you to provide me with the education you have received that qualifies you for the -- you know, for the job that you currently hold with the Texas Commission on Environmental Quality.

A. I have a Bachelor of Science in geology geoscience from Texas Tech University. And I'm also a licensed professional geologist in the state of Texas.

Q. Now, what relevant work did you have before becoming a member or on staff for the Tex- -- TCEQ? And if I can use that acronym, of course, it'd make things go a lot quicker.

A. That's fine with me.

Yes, sir, I worked for an Austin consulting firm. The name of the firm was Raba Kistner Brightest Consultants, Inc. And I worked for them for a couple of years before I started working with TCEQ.

Prior to that I worked for a general contractor that installed wastewater treatment type infrastructure.

Q. I should have asked when we were covering your education, when did you graduate from Texas Tech?

A. In 1985, May of '85.

Q. And when did you start your first jo- -- I guess, professional job in this field?

A. That would be in 1990 -- 1991, I believe. I haven't looked at my transcript in a while.

Q. Okay. Fair enough. When did you begin working for TCEQ?

A. In February of 1993.

Q. And what -- and, if you would, would you please explain the progression that you have had in terms of the positions you've held at TCEQ, so that we

know where you began and where you are today.

A. All right. So I hired on as a staff member in the groundwater -- and I can't even remember what the section was called. Groundwater assessment section of TCEQ and I was a member of staff and I hired in as a Geologist III and I was a member of staff until 2007. And in 2007 I had advanced up to become a Geologist V on the staff. And my supervisor retired. I applied for his job as a team leader, and I became the team leader of the groundwater planning and assessment team. I did that until June of 2015. And I was selected to be assistant director of the water availability division, and that's my current position.

Q. And I apologize if I missed it. When did you begin your work as an assistant director of the water availability division?

A. In June of 2015.

Q. Now, what is the water availability -- what are the responsibilities of the water availability des- -- division?

A. Our primary responsibility is surface water rights permitting. We also have a watermaster section. We also have a bis- -- compliance and business section. And then we also have a groundwater team that reports directly to me.

Q. Is it correct to say that the water availability division, one of their primary responsibilities is to ensure compliance with the Texas Water Code?

A. I -- certain sections of the Water Code, I would say yes. Not the entire Texas Water Code.

Q. Fair enough. Fair enough. So in your capacity as an assistant director, it's fair to say that you must know certain sections of the Texas Water Code?

A. Yes, sir.

Q. And in your capacity as assistant director, you must apply certain provisions of the Water Code to the issues that face you and your division?

A. Yes, sir.

Q. And in your capacity as assistant director, you would agree with me that you have to determine whether there is compliance or lack of compliance with regard to certain issues that come before you; is that fair to say?

A. Yes, I think that's fair to say.

Q. Now, does the wa- -- is it also true that the water availability division also has the responsibility of protecting groundwater?

A. We -- we facilitate the Texas Groundwater Protection Committee, and that is a committee that is

composed of ten state agencies and organizations. The groundwater planning and assessment team supports that effort.

Q. So in your capacity as assistant director, how do you assist this particular committee?

A. I serve as the designated chairman of the Texas Groundwater Protection Committee for the executive director of TCEQ.

Q. Now, is it correct to say that the water availability division processes water right permits and amendments?

A. Yes, sir.

Q. It also maintains water availability models for all river basins, including the Rio Grande basin?

A. Yes, sir.

Q. And you also in your capac- -- or I should say, your division also reviews water conservation and drought planning; is that right?

A. That is correct.

Q. So how does your division perform groundwater planning and assessment or go about the process of doing that?

A. Can I look at my transcript real quick?

MS. BARFIELD: You can refer back to the realtime anytime you need to, Kelly.

THE WITNESS: Okay. It kind of faded out on me there.

A. So can you repeat that question for me, Mr. Robles?

Q. (BY MR. ROBLES) Sure. How does your division go about the process of, you know, planning and assessing groundwater quality?

A. The Texas Groundwater Protection Committee has two subcommittees, a public education and outreach subcommittee, and a groundwater issues subcommittee. They meet quarterly and they provide -- you know, they make their findings and present them to the committee for their consideration.

The other part of what the groundwater planning and assessment team does is to -- they -- we implement the ground- -- the Priority Groundwater Management Area program, and we also have certain responsibilities under Chapter 36 of the Texas Water Code relating to groundwater conservation districts.

Q. I should have asked you these questions when you first mentioned Texas Groundwater Protection Committee, but I didn't, so let me do that now. So what is the goal or the purpose of this committee?

A. The primary goal of the committee is to make sure that all of the member agencies understand what

groundwater protection activities are going on. The committee is responsible for develop- --

THE WITNESS: Oh, hang on, you disappeared on me.

Sorry about that. I'll try to move my mouse. Okay.

MR. ROBLES: Don't let it get away from you, you know. You're going to need it today.

A. So the -- if I understand the question, what are the responsibilities of the Texas Groundwater Protection Committee? So the committee is charged to develop and update a groundwater protection strategy for the state of Texas. The committee, on an annual basis, is charged to doc- -- to provide a report that documents all affirmed groundwater contamination cases that are under the jurisdiction of the member agencies, and every biennium the committee is charged to prepare a report and any recommendations to the Texas Legislature for -- that covers the activities of the -- the committee for the previous biennium and to recommend any groundwater protection actions, if we believe there are regulatory gaps.

Q. All right. What is the relationship of the Texas groundwater protection -- you know, the groundwater protection committee and the watermaster

program, if any?
A. There are none.
Q. Okay. So those are two separate entities, and they don't intersect?
A. That's correct.
Q. All right. So is it correct to say that the -- the committee reports that you have just described are all found on the web -- on -- on the TCEQ website and that's where I would obtain them?
A. The Texas Groundwater Protection Committee has its own -- it's a quasi state agency that's set out in Chapter 26 of the Texas Water Code and it has its own website and most all of the reports are available there.
Q. Now, is it correct to say that your water availability division essentially runs the watermaster program; is that correct?
A. The -- yes, I mean, the -- the -- we have four water -- four watermaster programs out there. They report to a section manager in the water availability division, who reports to my boss in the water availability division.
Q. What is the watermaster program?
A. It's, you know, a little outside of my area of expertise. But watermaster programs are, basically, where we have -- we have a watermaster and we have

deputies and it's more hands-on surface water management.
Q. Okay. Now, when you say it's outside your area of expertise, is it all -- but it's not unfair to say that the water availability division oversees the watermaster program?
A. That is not unfair to say.
Q. Okay. So is there someone else in your division who knows and understands the program with a -- with a much deeper depth than you?
A. Yes. I believe y'all are going to be speaking with Dr. Kathy Alexander from the water availability division, and she will be able to speak in depth on the watermaster program and what they do.
Q. Well, I appreciate that. Thank you.
Now, it's also my understanding that the water availability division -- I'm going to have problems with that word, for no -- who knows why -- also supports the interstate river compacts to which Texas is a party.
A. We have -- we -- yeah, we do have some responsibilities to support the -- the interstate compacts. We have a senior hydrologist that supports all of the compacts except for the Rio Grande Compact. They have their own adviser. And then we have -- we process their administrative function. So if they're

going to be traveling or they've got some bills we need to pay, we handle all of that for them.
Q. If I understand what you said correctly, the Rio Grande Compact, in terms of -- you know, you would handle administrative matters, but it's overseen by a different division of the TCEQ; is that right?
A. No, sir. What I'm saying is the Rio Grande Compact has its own engineering adviser, and in the water availability division we have a senior hydrologist who is the technical adviser for the other compacts.
Q. So where would I -- where -- in what division is that engineering adviser who provides services to the Rio Grande Compact?
A. She works directly for the commissioner of the Rio Grande Compact, Texas commissioner.
Q. Okay. Now, it's my understanding that there are limited number of areas in which you're going to testify, and my hope is, of course, that to stay true to those. If there -- if I ask you a question about an area that you do not want -- you know, you're not competent to -- to testify about or that's just outside your area of expertise, would you tell me that?
A. Yes, sir.
Q. All right. So I wanted to -- to clear something up. I know that when you probably read our

deposition notice -- and I should probably have that available for you, so I'm going to make that available for you.
All right. Hopefully, you're able to see that on your screen.
A. Do I need to click and open it up?
Q. So my hope is -- yes?
A. Yes, I can see it. I've got to toggle back and forth, so...
Q. Okay. Well, you let me know if I need to slow down and sort of jumping back and forth on different things. Just let me know.
A. Yes, sir.
Q. So one of the things that, you know, and hindsight always being -- you know, always, you know, coming back to haunt you. You know, there is a number of different terms that were used in this particular Notice of Deposition, and I wanted to sort of clear up some -- you know, something in my head, and that is the appropriate use of the geographical areas which the TCEQ uses in order to, I guess, basically, organize its services to the state of Texas. And what do I mean by that? Is it correct to say that the TCEQ has designated different water body segments within the state of Texas using a basin system?

A. I'm not sure I'm following the question exactly.

Q. Okay. Is -- well, I mean -- maybe if I just slow down. Is it correct to say that the TCEQ has designated different water body segments within the state of Texas with what I've seen on your website termed the basin system?

A. I don't know that the TCEQ has designated -- designated them as basins. Those are just the basins that we have within the state of Texas.

Q. Okay.

A. The river basins that we have.

Q. Right. And that's what I mean, because I want to be able to talk about a particular area of Texas by its basin and its basin number, and then you and I can have a conversation and hopefully we understand one another. That's certainly my hope.

A. I -- and I'll -- I'll do my best, but this might be more information you will need to ask for Dr. Alexander.

Q. Okay. Well, fair enough. And so as a preliminary matter, I know that the Texas Water Development Board has certain -- has created certain designations for geographical areas that are really creatures of the Texas Water Development Board, such as

groundwater management areas. Is that -- is that right?

A. That is correct.

Q. And, in fact, if you look for groundwater management areas on the TCEQ website, you only find references that deal directly with the Texas Water Development Board?

A. That's probably correct. I don't know the answer to that.

Q. All right. But you understand what I'm talking about when I refer to groundwater management areas? That's a creature of the Texas Water Development Board; does that sound about right?

A. Yes, sir, that's correct.

MS. BARFIELD: Object; speculation, calls for a legal conclusion.

Go ahead.

Q. (BY MR. ROBLES) And with regard to regional water planning areas, that's also a creation of the Texas Water Development Board?

A. Yes, sir.

MS. BARFIELD: Same objection.

THE WITNESS: Oh.

Q. (BY MR. ROBLES) And that's a term that you-all don't use internally because that's not a term that's, I guess, part of the way that your organization

TCEQ defines geographical areas?

A. Well, I don't understand the question very well.

Q. Okay. Well, fair enough. Is it fair to say that regional water planning areas is -- is a term that's not used by the TCEQ in describing geographical areas within the state of Texas?

A. Well, you know, we have in our surface water right permitting program, which Kathy can talk to you more about when you visit with her, you know, when we have an application for a new appropriation of water, we have to make sure that that application for that use of water is not inconsistent with the strategies in the regional -- within a regional water plan.

Q. Okay.

A. So we do have some -- I mean, we do look at regional water plans from time to time, so...

Q. Okay. Well, maybe this is a better -- now, that I'm thinking about it and the confusion I may be causing, and I apologize for that, that instead of asking you in an indirect way, let me ask you in a direct way about the basin system. And I'm going to show you an exhibit, Exhibit No. 2. And do you see that particular document?

A. Yes, sir.

Q. Now, are you familiar with a TCEQ document or I should say map entitled "Texas River Basins"?

A. I'm familiar with it, as I have seen it on our walls and at the office and everywhere else, you know.

Q. So I'm not trying to pull a fast one on you and showing you a map that you've never seen before; is that fair enough to say?

A. I would say I've seen this map before and if it's not this exact map, it was something very similar.

Q. Well, good, good. Now, I want to -- hopefully, you and I can -- can have an agreement. When I say the words, you know, Basin 23, that you and I are talking about the Rio Grande River Basin. Is that something that you and I can agree on?

A. Looking at this map, yes.

Q. Now, is there anything about me labeling this particular geographical area Basin 23 that causes you any concern?

A. No, no, sir.

Q. Okay. Now, in the rest of this particular deposition I'm going to refer to Basin 23, and, hopefully, if you have any concerns about my use of it, you'll let me know, because instead of trying to refer to terms that I could not find on a TCEQ website or any of its documents, I decided, if -- if it's okay with

you, to use that as a way of identifying the area -- the subject -- or the area that concerns me in this particular case. Does that work for you?
A. Yes, sir.
Q. All right. So let's talk about something more interesting. What is a priority groundwater management area?
A. It is an area that has been designated by the Commission where there are critical ground- -- where the Commission has determined there are critical groundwater problems, including shortages of surface water or groundwater supply, subsidence, or subsidence or groundwater contamina- -- subsidence from groundwater withdrawal or groundwater contamination.
Q. Is it correct to say that Basin 23 is expected to or is, in fact, experiencing groundwater problem -- critical groundwater problems?
A. No, sir.
MS. BARFIELD: Hold on. Hold on. Overbroad, vague and ambiguous, calls for expert opinion, lacks foundation, outside the scope of this witness' testimony.
Q. (BY MR. ROBLES) I'm sorry, I did not hear your answer.
A. No, sir.

Q. So if -- so Basin 23 is not experiencing critical groundwater problems?
MS. BARFIELD: Same objections.
A. No, sir.
Q. (BY MR. ROBLES) Okay. Basin 23 does not stock -- suffer from shortages of surface water?
MS. BARFIELD: Same objections.
A. I think I need to answer that Basin 23 has not been designated or studied as a priority groundwater management area. There has not been a priority groundwater management area study encompassing all of Basin 23.
Q. (BY MR. ROBLES) Okay. Is there a problem with me asking these questions focused on Basin 23 to the -- and is there a better way of asking this question that -- because I can see in your face that -- that maybe some of this question is correct and maybe some of this question is wrong. Is that fair?
A. That's --
MS. BARFIELD: I'll just -- I'll object to form. That's -- that -- I don't even know what your question was there. It's not the witness' job to phrase the questions.
Q. (BY MR. ROBLES) So in asking you about Basin 23 and the applicability of priority groundwater

management areas, is there something fundamentally wrong about using Basin 23 as a geographical area to ask that question?
A. I don't know if I know what that question means.
Q. Fair enough.
A. I'm not trying to be difficult. I just don't know what it means.
Q. Sure. So let me continue to ask, since you gave me some different items by which to determine whether an area should be under the priority ground- -- groundwater management area program. Do you know if Basin 23 suffers from shortages of groundwater?
MS. BARFIELD: Overbroad, vague, ambiguous, outside the scope of this witness' testimony as designated, calls for expert opinion, foundation.
A. We -- I'm sorry, go ahead.
Q. (BY MR. ROBLES) I was going to say, you can go ahead and answer.
A. We have not initiated a priority groundwater management area study to make that evaluation for Basin 23.
Q. Do you know or have you heard that there has been land subsidence as a result of groundwater removal in Basin 23?

MS. BARFIELD: Same objections.
A. I do not know.
Q. (BY MR. ROBLES) What are the procedures for desig- -- practices and procedures of your division for designating a priority groundwater management area?
A. We meet annually with the Texas Water Development Board to review data that has been collected, to help form an opinion if a new study needs to be conducted in a part of the state. And it is the call of the executive director of TCEQ to initiate a priority groundwater management area study. When a study is initiated, we file -- we provide a notice to the water stakeholders that are in that study area, and they have 45 days to respond. We also request studies from the Texas Water Development Board and the Texas Parks & Wildlife department, and we solicit information from the Texas Department of Agriculture, and they are provided 180 days to provide their reports back with the TCEQ.
The executive director takes their information and files a report and recommendation within 240 days of the -- of the request for the reports from the other agencies. And the report and recommendation -- the report and rec- -- the report summarizes all the information and makes a recommendation on whether the

executive director believes the Commission should designate an area as a priority groundwater management area or not. And as statute stands today, we also include a recommendation on if a groundwater conservation district should be created and what that looks like.

If the -- and if the Commission -- if the Commission adopts an order and designates a PGMA, then that order is provided to the stakeholders in the PGMA and they are given a two-year time frame to either create a district through the petition or legislative processes or to add their area to an existing district, if that is an available option. And if they do not do so, then the executive director is supposed to pick that area up and either, A, create a groundwater conservation district or, B, have it added to an existing district. And if neither one of those options are feasible, we have authority to make a recommendation to the legislature to figure out -- to provide some kind of groundwater management mechanism for that area.

Q. What is the purpose of designating a particular area as a priority groundwater management area?

A. The primary purpose is to start -- start the wheels in motion to create a groundwater conservation

district operational under Chapter 36 of the Texas Water Code.

Q. And is it also correct to say that one of the purposes of creating a priority groundwater management area is to ensure the proper management of groundwater resources for the affected area?

A. Yes, through the creation of -- of a groundwater conservation district or another special law type district through the legislative process.

Q. Does Basin 23 or any part of it meet the definition of a priority groundwater management area?

A. In 1997 the -- well, let me back up.

The predecessor to the priority groundwater management area program was enacted into the Texas -- was enacted in Texas law in 1985. There were -- in 1987 studies began for -- and I don't know the -- I don't remember -- I don't recall the exact number of studies. For 13 to 17 studies around the state. El Paso County was one of those areas that was evaluated at that time frame. The executive director back in 1989 filed a report -- no, 1990 filed his report recommending that El Paso County should be designated as a critical area. And the Commission -- the Commission did not take a final action to designate the area at that point in time.

In 1997 omnibus water legislation Senate Bill 1 was passed by the Texas Legislature, and it significantly changed the old critical area process to the new priority groundwater management area process, and there are provisions in the Senate Bill 1 that instructed the Commission to complete two studies they never did finalize, with El Paso being one of those two studies.

In 1998 the -- the Commission designated -- oh, hang on.

Okay. In 1998 the Commission designated the El Paso County PGMA to cover the areas of the El Paso County that included the Hueco and Mesilla Bolsons and included the Franklin Mountains and the Hueco Mountains. And the statute at that time was -- was a two-part process. The -- the statute at that time did not require the Commission's order to have a finding on a groundwater conservation district. But the Commission and the executive director had recommended and the Commission found that a groundwater conservation district, under the confines of Chapter 36 of the Texas Water Code, would not have the full ability it would need to manage the groundwater issues that were presented at that time.

Q. And that last phrase that you said, I lost the

keyword. There was a full ability?

A. I'd like to look at the transcript, if I could.

Yes. So, you know, with the -- what I recall with that report -- and I was not the author of that report, but what I recall with the report was there -- was that drawdown and groundwater usage was exceeding the -- the recharge to the Hueco Bolson in El Paso County and it was exasperated by pumpage on the other side of the Rio Grande and that a groundwater conservation district under the confines of Chapter 36 would not have the ability to manage that issue because of the international challenges.

Q. So I want to ask you about what you've said. And, thankfully, you have the transcript. So, you know, I'm not going to butcher your words or say something that isn't exactly what you've said. Now, if I remember correctly, you said -- because I'm just writing this down; I'm not looking at the transcript -- that the drawdown exceeded discharge. Is that what you said?

A. That the drawdown in the Hueco Bolson exceeded the recharge.

Q. The recharge, I'm sorry. And how did you determine that? Or how did TCEQ determine that?

A. That was based on information in --

Q. So your video froze and I did not hear your answer. I apologize.
A. Okay. I'm sorry. That was based on data and information that -- that was provided by the Texas Water Development Board in their report.
Q. Okay. And then you said that -- well, you didn't say the problem. But the issue was exacerbated by pumping on the other side of the Rio Grande, word -- you know, words to that effect. Is that accurate?
A. Yes, sir.
Q. Now, what do you mean by that? Is that groundwater pumping in Mexico?
A. Yes, sir.
Q. Would you please explain what you know about how groundwater pumping in Mexico affected either surface water on the Rio Grande or groundwater underneath El Paso County.
A. There were in -- like I said, I have to look at the report. But there were -- I believe that the -- the information that the Texas Water Development Board provided included drawdown, some drawdown maps that showed cone -- pretty good size cones of depressions stretching across the Rio Grande from Mexico.
Q. Now, I have heard, and you're the geologist, not me, that the -- that the -- that the barrier between

the Rio Grande, the -- you know, the geological barrier between the Rio Grande and -- and the groundwater on the Mexico side of the Rio Grande makes it so that recharge by the Rio Grande is very minimal. Is that a correct statement?
MS. BARFIELD: Objection; that calls for expert testimony. You specifically just asked him to testify as a geologist. I'm going to instruct him not to answer. It's also outside the scope of testimony that he's been designated by Texas to give today.
Q. (BY MR. ROBLES) Based on your review of the documents that were used to assess that a portion of El Paso County was a priority groundwater management area, what did you learn about the effect of Mexico groundwater pumping on the availability of surface water on the Rio Grande as well as groundwater underneath El Paso County?
A. I do not know.
Q. You don't remember reading any information with regard to the question I have asked?
MS. BARFIELD: Asked and answered. Asked and answered, argumentative.
Give me one second, Kelly. You can go ahead now.
A. I recall seeing the drawdown maps with a cone

of depression, meaning indicated originating in -- on the Mexico side is what I recall seeing.
Q. (BY MR. ROBLES) All right. Now, let me show you Exhibit 4. Exhibit 3 wasn't necessary, so that's why I'm skipping it. But don't you worry. It was just another one of the maps that you-all have on your website.
Are you able to see Exhibit 4?
A. Yes, sir.
Q. Okay. Now, do you recognize this particular map?
A. Yes, sir.
Q. What is it?
A. It is a map that shows -- let me make sure I know exactly which one we got here.
Yeah, it is a map that the water availability division has put together that shows the areas that have been designated as a priority groundwater management area. It also shows the county boundaries in the state, 254 counties. It shows areas shaded in gray where groundwater conservation districts have been created. And then it also shows one area where there was an un- -- an unconfirmed groundwater conservation district.
Q. Now, based on what's represented in the map -- and you can correct me if -- or you can change -- or you

can address what I'm saying by saying that's not ac- -- the map's not accurate. Is it fair to say that a portion of El Paso County is designated as a priority groundwater management area?
A. Yes, sir.
Q. And if I remember your testimony correctly, I believe it was in 1998 when that portion of El Paso County was designated a priority groundwater management area?
A. Yes, sir, and that is indicated on this map. The -- the priority groundwater management areas have a date by them when they were designated.
Q. Why were only parts of El Paso County, not the entire county, designated as a priority groundwater management area?
A. To the best of my recollection, the area excluded the Hueco Mountains to the east and the Franklin Mountains to the west because they did not produce groundwater in those areas in the county.
Q. Okay. Now, do you agree that the boundaries of the El -- I'll just call it the El Paso priority groundwater management area do not follow the boundaries of the Bolson Aquifer?
A. It's been so long since I've looked at the Bolson Aquifer map. I think that -- I think it covers

the Hueco -- yeah, the Hueco Bolson Aquifer.

Q. Well, let me show you what's been marked Exhibit 5, and I'll have you look at this. And let me know if you recognize it.

A. Oh, let me blow it up a little bit here.

So this appears to be a map prepared by the Bureau of Economic Geology in 2001, showing different aquifers and -- okay, I think I understand your question now.

Q. Okay.

A. And it shows the Hueco Bolson Aqu- -- well, I don't know what they have it labeled as.

MS. BARFIELD: Well, let's go ahead and let him ask his question.

Q. (BY MR. ROBLES) So --

A. Okay. I recognize the map. Or I recognize the substance of the map.

Q. What I'd like for you to help me understand is why TCEQ designated the -- you know, as demonstrated in Exhibit 4, that portion of El Paso County as a priority groundwater management area and that those boundaries don't necessarily follow the location of the Bolson Aquifer, as demonstrated in Exhibit 5?

MS. BARFIELD: The question is asked and answered, in part. It's argumentative as phrased. It

lacks foundation and is potentially outside the scope of this witness' testimony.

A. So to answer the question, you know, the Water Development Board in -- has also delineated aquifer boundaries in the state of Texas based on geology and based on water quality, to a certain extent. When we did the study in El Paso County, we looked only at El Paso County. We didn't look at the entire extent of what is labeled here as the Bolson Aquifer.

There was a -- a second -- there was a study done in Hudspeth County, adjacent to El Paso County, that was done in the 2004, 2005 time frame, and the results of that study were -- was that it was not a priority groundwater management area.

Q. Comparing the area that's been designated as a priority groundwater management area in Exhibit 4, comparing it with the location -- or, I guess, the existence of the Bolson Aquifer in Exhibit 5, what can we -- what -- what should we know about why the TCEQ designated areas of -- that are priority groundwater management areas that extend beyond the boundaries of the Bolson Aquifer?

MS. BARFIELD: The question lacks foundation, as phrased, seeks expert testimony that's outside the scope of this witness' testimony.

A. I don't think I understood the question.

Q. (BY MR. ROBLES) Maybe I should ask in a different way. Shouldn't the priority groundwater management area for that portion of El Paso County only cover the Bolson Aquifer and not areas where there is probably no aquifer?

A. Yes, and --

MS. BARFIELD: Objection; the question is argumentative as phrased, lacks foundation.

Go ahead.

A. It is my understanding that the -- the El Paso County PGMA covers the Hueco Bolson Aquifer and excludes the Franklin Mountains and the Hueco Mountains where there is not much groundwater.

Q. (BY MR. ROBLES) Okay. So let me ask you about a term that you had mentioned previously, and I think it was called a groundwater conservation district; is that -- is that correct?

A. Yes, sir.

Q. What -- what is a groundwater conservation district?

A. A groundwater conservation district is a unit of local government that has the authority to regulate groundwater production and use, to permit water wells, to develop management plans for the management of

groundwater resources, and develop rules to -- to manage the groundwater resources. There -- they are generally authorized under Chapter 36 of the Texas Water Code.

Q. How is a groundwater conservation district created?

A. There are -- on our map of the groundwater conservation districts, we have 101 groundwater conservation districts in the state ranging in the size from a part of a county to up to 16, 17 counties. The vast majority of the groundwater conservation districts have been created because of local interest and through legislative acts. A smaller subset have been created by the Commission, the Texas Commission on Environmental Quality and its predecessor agencies in response to landowner petitions. There is a procedure in the Texas Water Code Chapter 36, whereby landowners can petition the Commission to create a groundwater conservation district.

And the other two ways that a district can be created is in a -- is if a -- an area can -- landowners in an area adjacent to a groundwater conservation district or in the same groundwater management area can petition a groundwater conservation district to be added to that area. And then the last way is by the Commission and the priority groundwater management area process as it exists today.

Q. Is it -- generally speaking, is it fair to say that the purpose of a groundwater conservation district is to manage very carefully groundwater resources?

A. Yes, sir.

Q. Is it fair to say that one of the goals of having a groundwater conservation district is to ensure that only permitted water wells are actually drilled?

A. I don't know that that is quite accurate. You know, there -- there are certain wells in groundwater conservation districts that are exempt from permitting under -- under Texas Water Code Chapter 36.

Q. But, for the most part, aside from the wells that are exceptions to the permitting requirement, you would agree with me that the -- the vast majority of wells require a permit in a groundwater conservation district?

MS. BARFIELD: Objection; the -- the question goes outside the scope of this witness' testimony. He's specifically not been offered to testify on well permitting.

A. And I can say that, you know, that is a -- one of -- a primary function of groundwater conservation districts, is to register and permit water wells and -- and TCEQ has no role in how they go about doing that.

Q. (BY MR. ROBLES) Okay. Now, is it correct that groundwater development -- or groundwater conservation districts create comprehensive management plans for the groundwater resources?

A. Yes, sir.

Q. And the groundwater conservation district also implements policies and procedures to ensure that the plan, the conservation plan is executed; is that correct?

A. That is correct, they can adopt the rules and policies to implement their management plans.

Q. Has TCEQ, either one of its commissioners, the Commission, or any of its staff, you know, employees ever made a specific recommendation for the creation of a groundwater conservation district in Basin 23 or El Paso County?

A. No, sir.

Q. Why is that?

A. Well, as I explained earlier in the conversation, the -- when El Paso County PGMA was studied in 19 -- 1990 [inaudible] and designated in 1998, recommendation was that a groundwater conservation district under the confines -- operating under the confines of Chapter 36 of the Texas Water Code would not have the full ability to manage the groundwater

resources in El Paso.

Q. So I want to make sure I understand your testimony correctly. So I want you to -- you know, to push back on me if I say something incorrect. Is it the position of the Texas -- or the TCEQ that a ground- -- groundwater conservation district in El Paso County was inappropriate because it could not properly manage the groundwater resources underneath El Paso County?

MS. BARFIELD: It's asked and answered. The question is argumentative as phrased.

Q. (BY MR. ROBLES) Now, you...

MS. BARFIELD: He's frozen.

MR. ROBLES: Okay.

MS. BARFIELD: Oh, we lost him.

THE VIDEOGRAPHER: We lost him. Would you like to go off the record?

MR. ROBLES: Do you want to take a ten-minute break? Is this a good time for that?

MS. BARFIELD: Hold on one second.

THE WITNESS: Oh, am I back?

MR. ROBLES: Okay.

MS. BARFIELD: There he is. I want to make sure he's hearing us.

THE WITNESS: Sorry about that. I'm not sure what my hiccup was.

Q. (BY MR. ROBLES) Well, you know, there is a question that was asked. You may have answered it and we just didn't hear it. So if you --

A. Can you reask that question, please? Can you repeat it for me, please?

Q. I believe the ques- -- you know, so I need to back up a bit. And I asked you, and you can correct me if I'm wrong, has the TCEQ ever made a recommendation for El Paso County to be a groundwater conservation district?

And I believe you said no, they have not.

And then I asked you, why is that?

A. Yes, and -- and I responded that -- that the Commission believed that a groundwater conservation district operational under the confines or the restraints or the limited authority in Chapter 36 of the Texas Water Code would not enable that district to address all of the issues it would be needing to address to manage the groundwater.

Q. Is it correct to say that -- that TCEQ did not pursue a groundwater conservation district in El Paso County because such a district could not manage all the groundwater issues that you find in El Paso County?

A. Yes, that's -- I believe that's what I said.

Q. Is it correct to say that the decision not to

move forward with the groundwater conservation district, that it isn't a result of the fact that there aren't groundwater -- significant groundwater issues and concerns in El Paso County?

A. At that time, yes, I believe that was the -- the thinking at 1998, yes, sir.

Q. Okay. Today, is TCEQ's view on -- on the existence of groundwater problems and issues --

A. Uh-oh.

Q. Okay -- has -- has it changed?

A. I'm sorry, you -- you -- can you repeat it?

Q. Sure.

A. You blacked out on me for a second.

Q. Today does TECQ [sic] have a different position on whether there are sufficient groundwater issues in El Paso County to warrant the creation of a groundwater conservation district?

A. I do not know that.

Q. Has anyone, after the initial assessment as to whether there should be a groundwater conservation district in El Paso County, has TCEQ or any of its employees gone out and made a -- another, a second, or a third assessment as to whether there should be a groundwater conservation district there?

A. No, sir.

Q. Do you know why TCEQ has not revisited the issue in El Paso County as to whether there should be a cre- -- the creation of a groundwater conservation district?

A. I do not know why, other than it was evaluated at the time it was evaluated and a finding was made.

Q. In the efforts -- or in the consideration as to whether there should be a groundwater conservation district in El Paso County, did TCEQ receive any opposition or push-back from citizens, industry, governmental entities against that particular position?

A. I do not recall.

MS. BARFIELD: Luis, is it -- Luis, is it a good time for a break? We've been going about an hour.

MR. ROBLES: Yes. So if -- come back in ten minutes?

MS. BARFIELD: Sure.

THE WITNESS: Okay.

MR. ROBLES: All right, thanks.

THE VIDEOGRAPHER: Time is 2:05 p.m. We're off the record.

(Recess from 2:05 p.m. to 2:19 p.m.)

THE VIDEOGRAPHER: The time is 2:19 p.m. We're on the record.

Q. (BY MR. ROBLES) I thought about some of the concerns that you raised to me about the -- the questions that I had asked, and I think -- I thought about it over the course of the break, and I'd like to ask you questions, I think, in a more digestible way. So, to begin, when TCE -- well, when that portion of El Paso County was designated a priority groundwater management area, TCEQ had concerns about groundwater availability in that area?

A. To the best of my recollection, it had concerns about -- about pumpage exceeding the recharge rate.

MS. BARFIELD: The answer broke up a little bit because of the transmission feed. Did the court reporter get it? If -- Kelly, if you could read back on the transcript and make sure that answer is there.

THE WITNESS: Okay. Let me see.

MS. BARFIELD: I ask because I didn't get it.

THE WITNESS: It looks like the transcript caught it.

MS. BARFIELD: Thank you, okay.

Q. (BY MR. ROBLES) So when groundwater use exceeds recharge, there will be problems with

groundwater availability in the future, correct?

MS. BARFIELD: Question calls for expert testimony, as phrased.

A. I would say holistically that when groundwater withdrawal exceeds the recharge on a long-term basis, it can lead to availability challenges, yes.

Q. (BY MR. ROBLES) And when you increase groundwater use and recharge stays -- or I -- and there is not enough recharge, you would agree with me that groundwater availability becomes more of a problem closer in time?

MS. BARFIELD: Question calls for expert testimony, lacks foundation. It also goes outside the scope of what this witness is designated to testify on.

A. I'm not quite sure what you mean with your question "closer in time."

Q. (BY MR. ROBLES) As a TCEQ geologist, is it -- has it been your experience in the performance of your work that the faster you pump water out of the ground, the quicker the prob- -- the quicker that the problem of groundwater -- groundwater availability will happen?

MS. BARFIELD: So I'm -- as this question is phrased, I'm going to instruct this witness not to answer. You've just asked him as a TCEQ geologist. He is not offered to give you expert testimony here today.

He is offered to talk about certain things within the purview of TCEQ as designated by Texas in our response and objections to your notice.

Q. (BY MR. ROBLES) Did TCEQ have concerns as the population of the city of El Paso increased, that the problem of groundwater availability will become more apparent as time went on?

A. The -- the -- when El Paso County was designated, the statute had us look out over a 25-year period. So that was part of the data provided by the Water Development Board, is that the water use demand projections using surface water and groundwater. So that was part of the information that was reviewed back at that point in time.

Q. So based on that 25-year review, was the concern as the city of El Paso's population grew, that the problem with groundwater availability would become more immediate?

A. The -- I've stated several times the concern was that -- that groundwater discharge was exceeding the recharge, and that can lead -- you know, the Commission at that point in time considered that a criteria, one of the criteria necessary to designate that area as a -- as a priority groundwater management area.

Q. What other criteria does the Commission use to

determine the creation of such an area?

A. They can also consider in their evaluation shortages of surface water, they can consider subsidence caused by groundwater withdrawal, and they can consider groundwater contamination.

Q. Was the dwindling availability of water in the Rio Grande a concern in making the assessment?

A. I do not know.

Q. Today, does TCEQ have concerns about the availability about the availability of groundwater in El Paso County?

MS. BARFIELD: Asked and answered.

A. I would say no.

Q. (BY MR. ROBLES) TCEQ is of the position -- it takes the position that there are adequate groundwater resources in El Paso County to meet the needs of the growing population of El Paso and surrounding communities?

A. And I do not know. That's kind of outside of my -- my area.

Q. Statewide, how does TCEQ ensure the efficient use of groundwater?

A. That's not a role that TCEQ has.

Q. So is it fair to say that TCEQ is not concerned with the efficient use of groundwater?

MS. BARFIELD: The question, as phrased, is argumentative. It mischaracterizes this witness' testimony. It's also outside the scope of the testimony that this witness has been designated to offer.

A. I -- I wouldn't -- I wouldn't -- I would not say that TCEQ is not concerned with the efficient use of groundwater, but it is outside of our jurisdiction to monitor or to enforce that.

Q. (BY MR. ROBLES) So TCEQ does not have the lawful -- well, I guess I'm asking rel- -- in your work at TCEQ, it's your understanding that TCEQ does not have the authority to enforce the -- or monitor the efficient use of groundwater resources?

MS. BARFIELD: The question has been asked and answered multiple times. At this point it's argumentative.

A. And I'd say, yes, that's not -- that's not a role that TCEQ or any of my programs perform.

Q. (BY MR. ROBLES) What, if anything, does TCEQ do to ensure the effective management of groundwater resources?

MS. BARFIELD: Question lacks foundation. Go ahead.

A. So the groundwater conservation districts, when they are created, they are supposed to adopt,

within a five-year period, a groundwater management plan. That management plan is submitted to the Texas Water Development Board for approval to make sure it meets all of -- all of the standards that the statute requires. And within a few years of that, the groundwater district is supposed --

MS. BARFIELD: He's frozen on my end. Is anyone else hearing him?

MR. ROBLES: No.

THE VIDEOGRAPHER: No, he's frozen on my side, too. We might get him again.

Would you like to go off the record?

MS. BARFIELD: Sure. Luis, is that okay, while we wait for him to come back?

MR. ROBLES: Yes.

THE VIDEOGRAPHER: Time is 2:20 --

MR. ROBLES: Videographer's call. All right. That's fine with me.

(Recess from 2:28 p.m. to 2:30 p.m.)

Q. (BY MR. ROBLES) So I had asked you a question and you began to answer and then you cut out. You may have already given an answer. So I just would have you -- I would just have you answer the question I had asked.

A. Okay. So I'll just -- I'll just start --

start all the way over.

So a groundwater conservation district is required to adopt a groundwater management plan. Within a few years of adopting that management plan, they are required to adopt rules to implement the management plan, and the management plan must be updated every five years.

TCEQ's role is if a GCD -- and I'm going to call a groundwater conservation district a GCD. If a GCD does not adopt a management plan or cannot get their management plan approved by the Texas Water Development Board or if the state auditor has a finding that a groundwater conservation district is not operational or if a G -- or if the Commission receives a petition to make an inquiry of a GCD on -- on nine certain subjects, then TCEQ can step in into a peer review kind of role, where we, basically, try to -- where we first try to work with the districts to get them to address their statutory responsibilities on their own motion. If they do not respond with that, then we will enter into, like, a voluntary compliance agreement with milestone dates for them to achieve compliance.

In rare occasions we have taken GCDs to -- taken enforcement action against GCDs. And that's our role, is to make sure the GCDs are trying to manage the

groundwater resources the way they say they're going to in their groundwater management plans.

Q. (BY MR. ROBLES) Has -- to your knowledge, has any citizen petitioned the Commission to create a groundwater conservation district in El Paso County?

A. I am not aware of any petitions ever being received by the TCEQ to create a -- to create a GCD in El Paso County.

Q. And, just to be clear, you don't recall the El Paso Water Improvement District No. 1 ever having taken any steps to create a groundwater conservation district in El Paso County?

A. I have no memory of that.

Q. In the last ten years has the TCEQ conducted any studies, created any models, undertaken any research or -- or study that has suggested that a water conservation -- or I should say a groundwater conservation district may be appropriate for El Paso County?

A. No, sir.

Q. Has any action been taken by TCEQ in the last ten years that either -- that show that a con- -- a groundwater conservation district is inappropriate or somehow not a proper use of the district in El Paso County?

A. No, sir, we have not done any additional studies.

Q. Does TCEQ do any work to determine the amount of groundwater use in the state of Texas?

A. No, sir.

Q. Which entit- -- which entity, if any, does that?

A. The -- you know, the Texas Water Development Board is the state agency that would most likely have informative information on how that is -- how that information is generated and collected and used in the -- the state and regional water planning process.

Q. Please help me understand, if your division, the water availability division is responsible for determining the existence of groundwater resources, where does it -- your jurisdiction end and the Texas Water Development Board's jurisdiction begin in determining the availability of groundwater resources in the state of Texas?

A. We -- you know, the Texas Water Development Board is the state's -- basically, the -- and this is not my area of expertise, what the water development board does. But they are, basically, the state's water bank and they are the state's water researchers.

TCEQ is a regulatory agent.

Q. So with regards to regulation, would it be fair to say that the TCEQ is responsible for determining the use of groundwater resources?

A. No, sir, TCEQ does not have authority to regulate groundwater production or use.

Q. In the course of the work of the groundwater availability division, has there been any study or modeling conducted with regard to the amount of recharge by the Rio Grande of El Paso County's groundwater resources?

A. No, sir, not that I'm aware of, no.

Q. Now, would you please explain TECQ's [sic] role in groundwater well drilling, monitoring, and closures?

A. We have a very small role. We have water well dr- -- okay, let me back up.

So the Texas Department of Licensing water well drillers and pump installers program is the state agency that has the rules, the licensure of water well drillers and for water well construction standards. When a water -- and since about the '60s, when a water well driller drills a well, he has to file a state well report with -- with TCEQ. And the -- and there's millions and millions of them.

So since about 2003 the water development board, TDLR, and TCEQ developed a system so water well drillers could file their driller -- their state well reports on-line. So most all of the water wells that have been drilled since around 2003 are contained in a -- in a -- the TW -- the Texas Water Development Board's groundwater viewer. So there is a lot of well information that's available in their viewer.

And then TCEQ has a water well report viewer that contain -- and let me back up.

So the water development board also has a ambient groundwater monitoring program, and they have a lot of other wells in there besides ones from 2003 to the present. They have a lot of wells in there. TCEQ's viewer has digitally scanned copies of the water well reports that have -- from about the mid '60s up to 2003, and there is millions and millions of them. And that is our sole responsibility with water wells, is to make water well reports -- water well drillers' reports available for the public.

Q. So with regard to water quality, TCEQ doesn't have any role in monitoring the number of wells drilled, the -- whether they're plugged, or anything of that nature, whether they're abandoned?

MS. BARFIELD: The question --

A. They're --

MS. BARFIELD: One second, Kelly.

Questions regarding water -- objection; questions regarding water quality go outside the scope of the areas of testimony for which this witness is designated.

Go ahead.

A. So I would respond that the water well viewers that are out there that contain all the data we have, they have information in them on plugged water wells and -- and those types of water wells. I believe there is information on some -- some monitor wells and that's -- that's about the best I can tell you.

Q. (BY MR. ROBLES) As I understand it -- changing the direction of our deposition just a little bit -- that you have knowledge regarding the TCEQ's communications and discussions regarding the designation of a priority groundwater management areas with the other entities that are involved. What is -- what is your knowledge about the -- you know, their role, the communication that the entities have amongst each other?

A. You know, I think what I can tell you is I'm familiar with what it looks like when we do a priority groundwater management area study. We have communication with the staff at the water development board. We have -- you know, now we have communication

with the staff from now Texas Parks & Wildlife Department. We work internally predominantly at TCEQ to develop a stakeholder list for who we believe the water stakeholders are, using various sources. And there is also some statutory guidance in Chapter 35 of the Water Code -- Texas Water Code on who -- who we provide -- who we try to identify as stakeholders in that process.

Q. Are there any entities or individuals who have an obligation, statutory or otherwise, to provide you information in the determination of whether there should be a priority groundwater management area or a groundwater conservation district?

A. Entities, yes. The Texas Water Development Board and the Texas Parks & Wildlife Department, the Texas Department of Agriculture is -- you know, we solicit information from them. They're not required to provide anything.

Q. Have any of the entities you just listed ever informed TCEQ that TCEQ should consider or reconsider its decision to implement a conservation -- a groundwater conservation district in El Paso County?

A. No, sir.

Q. Has any entity or individual gave -- given their opinion to the TCEQ that there should be a groundwater district -- or conservation district

implemented in El Paso County?

MS. BARFIELD: Asked and answered.

A. I -- not to my knowledge.

Q. (BY MR. ROBLES) Now, what obligations, legal or otherwise, does TCEQ have to inform other stakeholders of its decisions in terms of the creation of groundwater management areas and groundwater conservation districts?

A. So TCEQ does not create groundwater management areas, so we have no obligation there. When TCEQ creates a groundwater conservation district, it's either done in response to a landowner petition, and we would certainly -- if the Commission created a district through that process, we would be providing notice to county officials, elected officials, the petitioners, of course. And if we -- if we created a -- a groundwater conservation district on our own motion in a priority groundwater management area, we would also be providing that order to the local elected officials.

MR. ROBLES: Those are all the questions I have for you. There may be other attorneys that have questions for you, but those are all the questions I have at this time. Thank you very much.

THE WITNESS: Thank you.

MS. BARFIELD: Anyone else?

Okay. I think that's a wrap.

THE VIDEOGRAPHER: Time is 2:44 p.m. We're off the record.

(The deposition concluded at 2:44 p.m.)

WITNESS CORRECTIONS AND SIGNATURE

KELLY WADE MILLS, P.G. AUGUST 27, 2020

Please indicate changes on this sheet of paper, giving the change, page number, line number and reason for the change. Please sign each page of changes.

PAGE/LINE CORRECTION REASON FOR CHANGE

____

KELLY WADE MILLS, P.G.

I, KELLY WADE MILLS, P.G., have read the foregoing deposition and hereby affix my signature that same is true and correct, except as noted above.

____
KELLY WADE MILLS, P.G.

STATE OF T E X A S)
COUNTY OF ___________)

Before me, ____________________________, on this day personally appeared KELLY WADE MILLS, P.G., known to me, or proved to me under oath or through ___________________) (description of identity card or other document)), to be the person whose name is subscribed to the foregoing instrument and acknowledged to me that they executed the same for the purposes and consideration therein expressed.

Given under my hand and seal of office on this, the _____ day of ________________, _____.

____
NOTARY PUBLIC IN AND FOR THE
STATE OF TEXAS

My Commission Expires: _______________________

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS, :
:
Plaintiff, :
:
VS. : Original Action Case
: No. 220141
STATE OF NEW MEXICO AND : (Original 141)
STATE OF COLORADO, :
:
Defendants. :

I, PHYLLIS WALTZ, a Texas Certified Shorthand Reporter, Texas Certified Realtime Reporter, Louisiana Certified Court Reporter, Registered Merit Reporter, Certified Realtime Reporter, and Certified Realtime Captioner, in and for the State of Texas, do hereby certify the following:

That the witness, KELLY WADE MILLS, P.G., was duly sworn by the officer and that the transcript of the oral deposition is a true record of the testimony given by the witness;

I further certify that pursuant to FRCP Rule 30(e)(1) that the signature of the deponent:

__X___ was requested by the deponent or a party before the completion of the deposition and is to be returned within 30 days from the date of receipt of the transcript. If returned, the attached Changes and Signature Page contains any changes and the reasons therefor;

_____was not requested by the deponent or a party before the completion of the deposition.

I further certify that I am neither counsel for, related to, nor employed by any of the parties or attorneys to the action in which this proceeding was taken. Further, I am not a relative or employee of any attorney of record in this cause, nor am I financially or otherwise interested in the outcome of the action.

GIVEN UNDER MY HAND AND SEAL OF OFFICE, on this, the 11TH day of SEPTEMBER, 2020.

PHYLLIS WALTZ, RMR, CRR, CRC
Expiration Date: 12/31/20
TEXAS CSR, TCRR NO. 6813
Expiration Date: 12/31/21
LOUISIANA CCR NO. 2011010
Expiration Date: 12/31/20

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IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS,	:	
	:	
Plaintiff,	:	
	:	
VS.	:	Original Action Case
	:	No. 220141
STATE OF NEW MEXICO AND	:	(Original 141)
STATE OF COLORADO,	:	
	:	
Defendants.	:	

****

ORAL AND VIDEOTAPED 30(b)(6) DEPOSITION OF
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
BY AND THROUGH
KATHY ANN ALEXANDER, PH.D.
AUGUST 28, 2020

****

ORAL AND VIDEOTAPED 30(b)(6) DEPOSITION OF TEXAS COMMISSION ON ENVIRONMENTAL QUALITY BY AND THROUGH KATHY ANN ALEXANDER, PH.D., produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on August 28, 2020, from 9:00 a.m. MDT to 11:53 a.m. MDT, via Zoom videoconference, before PHYLLIS WALTZ, RMR, CRR, CRC, Texas CSR, TCRR, Louisiana CCR, in and for the State of Texas, recorded by machine shorthand, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed before any Notary Public.

TX v. NM #141
New Mexico Exhibit
NM_EX-251

A. I do provide input on making sure that our work products are consistent with our rules and statute.

Q. Now, what's specifically --

MS. BARFIELD: Hold on, hold on. I -- sometimes the Q and A is too fast for me to get in there. So that last question regarding the Texas Water Code was overbroad, vague, and ambiguous, completely nonspecific as to which portions or aspects of the Texas Water Code you were referring to.

Go ahead, please.

Q. (BY MR. ROBLES) You had mentioned previously in -- in your testimony that you provide, I guess, technical assistance to the Water Availability Division so that it is con- -- so that in the process of creating rules, they are compliant with the Texas Water Code; is that right?

MS. BARFIELD: Objection.

A. So I do have rule-making duties as part of my position. So in that respect I do develop -- develop rules for consideration by the Commission.

Q. (BY MR. ROBLES) So is it fair to say that you as a technical specialist actually draft proposed rules for consideration by TCEQ?

A. Yes, along with our legal staff.

Q. As a technical specialist in the Water

Availability Division, what activities does the TCEQ undertake in order to protect and assess groundwater resources?

A. We don't have groundwater responsibilities.

Q. Your responsibilities are limited to surface water; is that correct?

A. Yes.

Q. Now, do you play any role in the groundwater protection committee?

A. No.

Q. Do you play any role in the implementation of the Texas groundwater protection strategy?

A. No.

Q. You do play a role with regard to the watermaster program of the state of Texas?

A. I provide input, technical input and technical support to the watermaster section.

Q. Like I did with Mr. Mills, I want to make sure that what we're talking about when we are talking about geographical areas, what we're talking about the same thing. When I refer to Basin 23 the river -- you know, Rio Grande River Basin, do you -- do you know what I'm referring to?

A. Yes.

Q. Okay. So, you know, in my deposition of

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

STATE OF TEXAS,	§	
	§	
Plaintiff,	§	
	§	
vs.	§	ORIGINAL ACTION
	§	CASE NO.: 220141
STATE OF NEW MEXICO,	§	(ORIGINAL 141)
and STATE OF COLORADO,	§	
	§	
Defendants.	§	

****
REMOTE VIDEOCONFERENCED DEPOSITION OF
TEMPLE MCKINNON
AUGUST 31, 2020
****

Job No. 65192

TX v. NM #141
New Mexico Exhibit
NM_EX-252

their -- we would not take a plan to our board and recommend they approve it.

Q. So the sanction that's available -- and correct me if I'm wrong, the sanction that's available for a region that's not enacted -- or does not prepare and produce a final plan that meets all the comments that's provided by your department, is that it simply won't be approved by the Commission?

A. By the Water Development Board, yes.

Q. Board, I'm sorry. Is that right?

A. Yes.

Q. What authority does the Texas Water Development Board have when a region does not follow its Regional Water Plan?

A. Can you define what you mean by "follow"?

Q. If, for example, a particular region prepares and submits to you a conservation plan and you approve the Regional Water Plan with the understanding that this conservation strategy will be implemented, which you find out later that the region is not implementing the strategy that the Texas Water Development Board approved, what authority do you have to take any action?

A. It's -- our agency does not have authority to force implementation of any recommended strategy.

That's up to local level and utilities to develop projects that they identify and recommend.

Q. What steps or efforts are undertaken by the Texas Water Development Board to ensure that a region is following its approved Regional Water Board?

MS. BARFIELD: I'm sorry. The question lacks foundation based on her prior response. Go ahead.

A. You mean "implementing" when you say following?

Q. (BY MR. ROBLES) I'm fine with the term that you're using, and maybe I should restate it.

A. Okay.

Q. If a region fails to implement the approved Regional Water Plan, what steps or efforts does the Texas Water Development Board take to find out if that's happened?

A. Each regional water planning group, as part of their plan development, they're required to assess implementation progress from the previous plan, so with their implementation survey that's conducted with each plan. So that's how we assess implementation progress.

Q. So it's correct to say that the way in

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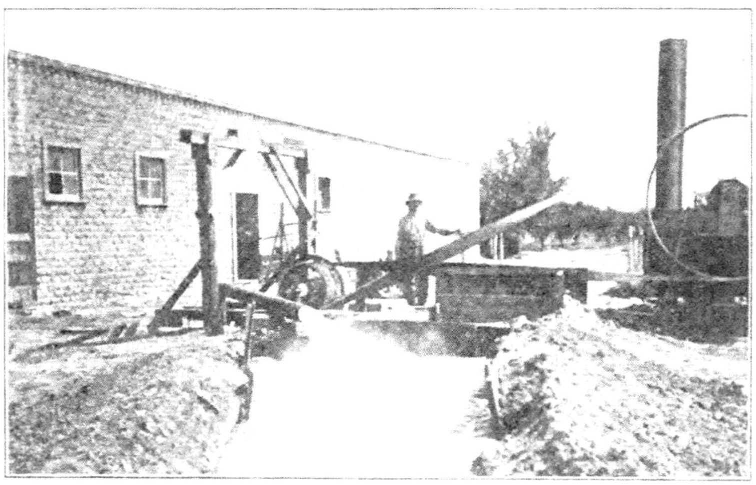
New Mexico College of Agriculture and Mechanic Arts

AGRICULTURAL EXPERIMENT STATION

MESILLA PARK, N. M.



PUMPING FOR IRRIGATION FROM WELLS

BY

JOHN J. VERNON and FRANCIS E. LESTER

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1903.

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The Bulletins of this Station will be mailed free to Citizens of New Mexico on application to the Director

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SUMMARY

1 An ample quantity of water for irrigating purposes exists throughout the Rio Grande Valley in Southern New Mexico at a comparative shallow depth

2. This water, termed the underflow, can be easily made available by sinking pipe wells, with slotted strainers, into the gravel strata at comparatively low cost

3 The station at Mesilla Park sank an experimental well six inches in diameter and 48 feet deep from which was pumped a continuous stream of over 1,000 gallons a minute

4 From this well it was found possible, using a 20 horse power steam engine with tornillo wood as fuel, to irrigate average land three inches deep at a maximum cost of from 51 cents to 64 cents an acre, according to the pump used This estimate is for short runs, for long runs this cost will probably be reduced, a point to be determined later

5 Eight pumps of various types and sizes were tested by the station upon the well above referred to and comparative results are set forth in tabular form

6 A comparative test of four kinds of fuel was made and the results are compiled in tabular form

7 Data concerning pumping plants in New Mexico and other states has been collected and is compiled and presented in tabular form under the heads of Wells, Pumps, Engines, Lands Irrigated, and Railroad Pumping Plants

8 A study of the relative conditions existing in New Mexico and other states, shows that, in the Rio Grande Valley in Southern New Mexico at least, the conditions are unusually favorable for the successful and economical operation of pumping plants as a means of supplying water for irrigating purposes

INTRODUCTION

Without water nothing will grow It is as much a necessity to vegetable life as air or light Moreover, to secure the best results vegetation requires water at certain intervals Nature sometimes fails to provide this supply when most required, and the work of man steps in with the practice of irrigation Herein lie the advantages which irrigated regions possess over those which rely solely upon the rainfall

New Mexico is blessed with a genial climate and, for the most part, with a fertile soil The conditions existing in her valleys and on many of her plains are, except for the matter of rainfall, exceedingly favorable to agricultural pursuits Farming operations may here be carried on the whole year through But the amount of rainfall in the territory is light, averaging in different localities not more than 8 to 16 inches in the year This being the case, it is evident that the solution of the problem of successful agricultural work in New Mexico is a sufficient quantity of water for irrigation It was with a view to demonstrate the practicability of providing such a supply of water from the underflow that the experimental work described in this bulletin was undertaken

The funds available for the prosecution of the investigation conducted were limited, but enough has been done to emphasize its importance to the development of the agricultural interests of our territory

DEVELOPMENT OF PUMPING PLANTS

Irrigation by pumping, no doubt, grew out of gravity systems From irrigation by gravity it was only a step to that of pumping from river channels and canals to high lying contigous areas In natural sequence, pumping would follow upon lands lying slightly above gravity systems or upon areas having no water supply other than that of the underflow

Irrigation by pumping dates far back in history "We are told that 'the numerous remains of huge tanks, dams, canals, aqueducts, pipes and pumps in Egypt, Assyria, Mesopotamia, India, Ceylon, Phœnicia, and Italy, prove that the ancients had a far more perfect knowledge of hydraulic science than most people are inclined to credit them with ' " *

At the present time much greater areas are irrigated by pumping from wells than is generally supposed King, in writing on this subject says "It is further estimated for the whole Indian Peninsula, British and native, that no less than 300,000 shallow wells are in use, while they serve certainly more than 6,000,000 acres of land ' Large areas are being successfully irrigated by pumping from wells in the various sections of the United States, notably, parts of the great rice region of the South, considerable areas of fruit lands in California, and certain alfalfa and fruit sections in Colorado, and elsewhere

GENERAL IMPORTANCE AND LOCAL CONDITIONS

Few parts of New Mexico are favored with an abundant supply of water for irrigation purposes To one familiar with the agricultural conditions of the territory, it is hardly necessary to emphasize the importance of such a supply In an irrigated region it may mean all the difference between heavy loss or large profit in the management of a farm

Throughout the whole length of the Rio Grande Valley in New Mexico, which includes a large part of the lands of the

* King Irrigation and Drainage p 60

territory at present devoted to agriculture, there has seldom been in the past ten years or more, a sufficient quantity of water in the river thoughout the irrigating season to meet the demands of the lands at present in cultivation With the increase of the area in cultivated lands, the conditions grow worse instead of better Enterprises that have sought to make the existing supply available for a greater length of time by means of storage reservoirs have been contemplated but never successfully completed As a result, the average New Mexico farmer in the Rio Grande Valley has been impressed with the necessity of turning his attention to means of supplementing the available water supply The question of pumping for irrigation is therefore of great importance in the first place, to such farmers In the second place, it affects the question of reclaiming immense areas of fertile lands suited to agriculture that exist in New Mexico, and that lack only a water supply to bring them into cultivation As a means of providing such a water supply the question of pumping for irrigation is attractive for two reasons If it can be shown to be successful at all, it provides a supply that is reliable and secure, subject to no fluctuation beyond possible breakage of machinery, and making it possible to put the water on the land at the exact time required Secondly, it places the farmer in an independent position, making him independent of water companies or ditch corporations with their sometimes annoying regulations

Local Conditions

The conditions existing in the Mesilla Valley, where the experiment station is located, are probably fairly typical of those to be found throughout the greater part of the valley of the Rio Grande Largely as a result of shortage of water in recent years, the farmers of the Mesilla Valley have turned their attention to the cultivation of those crops that can not be seriously injured by an uncertain water supply Chief among these crops, is alfalfa, and in the Rio Grande Valley, at least, the cultivation of orchards, vineyards, corn and vegetables on lands relying entirely upon river water for irrigation has received much less attention in recent years than formerly Few farmers have cared to go to the expense of planting a crop or orchard, and cultivate it perhaps for years with the risk of a possible loss of the entire crop, from shortage of water through the summer months

SOIL STRATA AND UNDERFLOW IN THE RIO GRANDE VALLEY

No very definite statements can be made regarding the soil strata of the Rio Grande Valley in the absence of a systematic investigation of the question We can only be guided by the incomplete data secured on this important question from the little work that has been done up and down the Valley From this it becomes apparent that conditions do not vary much throughout the length of the Rio Grande Valley in New Mexico which is cultivated In a general way, the valley consists of made lands, that is to say, sand, gravel and sediments that have been washed down and deposited in the valley through past ages What the depth of this deposit is, it is impossible to state with any degree of accuracy but it is undoubtedly very great in some parts.

Soil Strata

The various strata found throughout the valley consist of layers of soil, sand and gravel, of varying degrees of coarseness, with occasional layers of hardpan or clay. Sand evidently forms the greater part of the strata in the valley and in many parts extends to the surface, although usually covered by a layer of sediment and rich soil varying in thickness from a few inches to many feet It seems to be generally true that most of the valley is underlaid at a reasonable depth with gravel beds sufficiently thick to procure from them by means of slotted strainers an ample water supply In the Mesilla Valley a gravel bed is usually found at from 20 to 80 feet in depth although there is no certainty as to the depth at which it will be found or the thickness of the stratum

Along the foot hills of the valley the question of underlying strata is a much more uncertain one, but in the valley proper we know that large quantities of sand and varying thicknesses of gravel will be met with Only more extensive exploitation will demonstrate what may reasonably be expected to be encountered in sinking a well

Underflow

When it comes to the matter of underflow the question is no uncertain one Throughout the whole length of the valley proper, water will be found at a depth of from 4 or 5 feet to 20 or 30 feet, depending upon the height of the ground above the level of the river bed This water appears to be generally of a good and fairly uniform quality throughout the valley, though near to the foot-hills the quality is an uncertain thing In the matter of quantity, it seems to be more a matter of providing means for making the water available than any question as to the underflow Some New Mexico farmers using gauze covered strainers in a small size quite unsuited to the securing of large quantities of water, have met with very unsatisfactory results, as the strainers have filled up and the flow greatly diminished, and they have come to the erroneous conclusion that the water was not there Where suitable strainers have been placed in a gravel bed which allows the free passage of the water to the well there has been no complaint of the amount of the supply

The whole valley appears to be underlaid with water Whether this is an immense reservoir or a river flowing in any direction is not certain, arguments being advanced to support both theories We do know, however, that the amount of water below is enormous and amply sufficient to meet all reasonable needs It is probably safe to say that a sufficient quantity of water exists under every acre of irrigable land in the Rio Grande Valley which if raised to the surface would irrigate it, and there seems to be no reasonable ground for believing that this supply will cease to exist

WELLS

For convenience, wells may be classified under two heads, viz open wells and pipe wells The latter are sometimes termed driven wells For the purpose of this bulletin, an open well is defined as one in which no part of the well is utilized as an aid either in lifting or directing the water to the surface of the ground A pipe well, on the other hand, is one to which the pump is directly attached to the well itself, it therefore, may be said to form a part of, or a necessary adjunct to, the pumping machinery Some wells, are not, strictly speaking, under either of these heads, but for the present discussion such may be ignored, since all wells referred to in this bulletin come in one or the other of these classes

Open Wells

Everything being equal, that is, in capacity, cost, ease of sinking, and the life of the well, the open well is the better Under the conditions existing in the Rio Grande valley and other similar areas, the open well, however, is a difficult and costly undertaking, and until improved and less expensive methods are devised, the first cost of an open well will preclude its general adoption. By referring to the tables shown in this bulletin, it will be seen that the experimental six-inch station well, costing $150, has a capacity equal to or greater than that of open wells, costing several thousands of dollars A number of open wells costing considerable more than this six-inch pipe well, have a less capacity Nevertheless, the open well or its equivalent, with its accompanying minimum cost for lifting the water to the surface of the ground, is the ideal that should be constantly borne in mind

Method of Sinking

A large area of the irrigable land in New Mexico is underlaid with sand, and the great difficulty in sinking wells in such sand arises from the tendency of the sand to move with the water, "since the specific gravity of sand is only about 2 65, just as soon as a pressure greater than three feet is developed to force the water out of the sand, the sand must move with it " * In sinking an open well, it is usually necessary to remove the water as fast as it accumulates The effort must, therefore, be to minimize the movement of the sand which is forced upward into the bottom of the well by the pressure from without

There are two principal methods used where sand forms the bulk of the under-stratum The first of these is to sink the well only a few feet below the water level, and then sink several perforated pipes or strainers in the bottom of the well These pipes will usually flow when the head of water in the open well is pumped off The second method, and the one by which probably the most permanent well can be secured but at a comparatively high cost, is by building a circular wall of masonry, say two feet thick. upon a platform supported by a wooden curb some two inches thick, and from 4 to 6 feet long (See Fig 1) The weight of the wall causes the curb to sink deep into the sand, considerably in advance of the excavation within. The pressure of the sand and water within the curbing thus tends to equalize the pressure from without and, therefore, to greatly expedite the work In making an open well of this type, it is usually desirable at the finish to have the curbing penetrate a short distance into the gravel stratum so as to shut off further entrance of sand into the well from without the wall In sinking the water is usually kept down by a centrifugal or other kind of pump capable of handling a large quantity of water

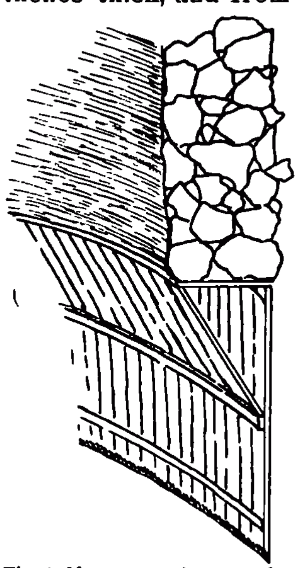

Fig 1 Masonry curb on wooden platform

*King, Physics of Agriculture, p 281

Pipe Wells

Pipe wells are frequently sunk by drilling Under the conditions existing in the Rio Grande Valley, however, in which sand or sand and gravel, form the water bearing stratum beneath the the surface of the soil, they are either driven or sunk by means of a sand-bucket, in which case, some form of strainer is common With small wells three inches or less in diameter, the strainer or point, as it is frequently termed, is fastened to the lower end of the pipe and driven with the pipe to the desired depth Large wells of this type have been driven, but it is customary with such large wells to sink the open pipe first and lower the strainer inside to the bottom The pipe is then jacked up until the entire length of the perforated part of the strainer is exposed

Strainers.

There are three types of strainers The common strainer, consisting of a perforated pipe covered with brass gauze or closely wrapped with brass wire, the "Cook's" (a strainer consisting of a pipe cut with horizontal slots, wider on the inner side), and the slotted strainer The first two are too well known to require special mention here. They are used largely to secure water from sand The last named strainer which is illustrated in Fig 12, consists of a pipe perforated by round holes or oblong slots, and is used in drawing water from a gravel, or a gravel and sand, stratum

Influence of Capacity

An increase in the capacity of a well means that more water can be secured by pumping off the same head, or that the same amount will be supplied when pumping off a somewhat less head. In the latter case, the water would stand nearer the surface of the ground while pumping, and for this reason, the lift would be less, thus reducing the cost of pumping It is evident, therefore, that the cost of pumping a given volume of water diminishes with the increase in the capacity of the well It naturally follows that a saving in the cost of pumping will soon compensate for the relatively larger expenditure for the construction of a well of greater capacity The size of the well, and the length of the strainer both affect the capacity of the well, if the water enters from the bottom or through the sides near the bottom

Size of the Well

The area of the bottom, as well as that of the sides of the well, increases as the well grows larger, and it is thus evident that the greater the area the greater the space through which water can enter the well From this we conclude that the capacity of a well, other things being equal, increases with its size

Length of Strainer

Under equal conditions, and within the limit of the carrying capacity of the pipe, it may be said that the longer the strainer the greater its capacity This increase in capacity is brought about in much the same way as the increase in the capacity of the well with its size King says "Leaving the bottom of the well out of consideration, it is clear that doubling the depth of the well in the water bearing beds doubles the area for water to enter * * * * . This capacity increases in a somewhat slower ratio than the depth, * * * * "* This statement also applies to the increase in capacity of a well through its increased size

Depth of Well

So long as the head of water while pumping is above the strainer, the depth of the well does not affect the capacity, unless the conditions differ This statement refers to pipe wells with strainers

THE STATION WELL

The experiment station well is 48 feet deep, and consists of an open well dug to water level, in the bottom of which is sunk a six-inch pipe, 21½ feet long, with a 12 foot strainer be-

*Physics of Agri , page 278

low the pipe, located in a water bearing gravel stratum To facilitate the attachment of pumps, the pipe was allowed to project six inches into the open portion of the well

The following equipment and materials were used in sinking the well

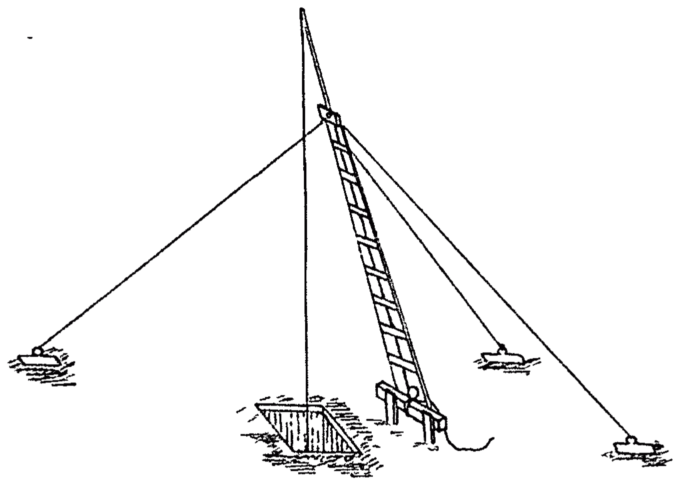

Fig 2 Timber derrick used in sinking the Station well.

Equipment

Derrick The derrick used consisted of a ladder, made of 3 by 8 inch pine, 22 feet long, with an extension piece 4 by 6 inches, 6 feet long, in the end of which was placed a pulley Three 1 1 4 inch guy ropes were used to hold the derrick in position (See Fig 2) Any form of derrick may be used, provided, of course, it is stable and of sufficient height to allow ample space between the end of the pipe and the pulley for the free play of the sand bucket and drill.

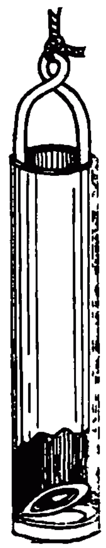

Fig 3. Common type of sand-bucket

Sand-Bucket The sand-bucket used was of the piston or plunger type (See Fig 3) This type of sand-bucket operates on the same principle as a suction pump, by simply letting the plunger to the bottom of the sand-bucket, raising it up and down a few times until sufficient sand and gravel is drawn by suction into the bucket with the water, raising the sand-bucket out from the well, empting it, and lowering it again into the well A cheap sand bucket which will do satisfactory work may be made by any blacksmith, by putting a bail on the top, and a valve in the bottom, of an ordinary pipe This pipe should be slightly smaller than the well pipe, and from 3 to 5 feet long The length, however, may vary, but should be such as to be conveniently handled. (See Fig 4) With this type of sand-bucket, the whole bucket must be moved up and down in filling, requiring more work than the plunger type above described It is, however, a lighter bucket, which compensates somewhat for the extra effort in filling It is usually best to raise the sand-bucket up some distance, and allow it to drop, as by coming down with some force, the water and sand open the valve in the bottom and rush inside

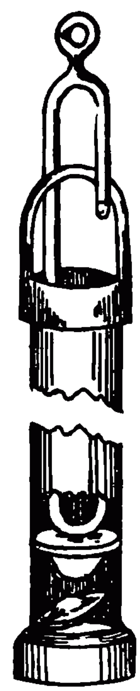

Fig 4 Plunger type of sand bucket used in sinking Station well

Drill The drill used was simply a piece of steel half an inch thick, three inches wide, eighteen inches long, properly pointed and hardened. This was threaded so as to be attached to a 1 1-4 inch pipe, eighteen to twenty feet in length, in order to give it weight A ring was fastened in the upper end of the pipe in which to tie the rope (See Fig 5)

Rope A 3-4 inch rope 200 feet long was used on the sand-bucket and drill In sinking a well, the length of the rope will depend upon the depth of the well, height of the derrick, whether or not a horse is used, and if so, whether the filling is done by a horse or by men. This, however, will be more fully explained in discussing the sinking of the well

Clamps Two sets of heavy wooden clamps were fastened upon the pipe with bolts to support the sacks of sand or other weights (See Figs 6 and 6½)

Weights From ten to sixteen sacks were filled with sand and used as weights for assisting in settling the pipe, and to insure that it keep pace with the sand bucket during the sinking of the well In the regular business of sinking wells of this character, heavy iron weights with rings attached would doubtless be preferable to sacks of sand, but for those contemplating the sinking of their own wells, the latter will prove entirely satisfactory

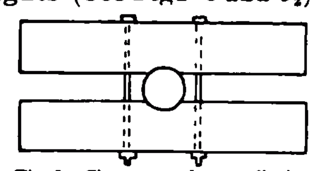

Fig 6 Clamps used on well pipe during sinking to support weights (top view)

Fig 5 Drill used in sinking the Station well

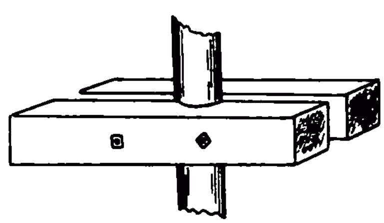

Fig 6½ Side view of clamps shown in Fig 6

Wrenches Two heavy chain pipe wrenches were used for connecting and disconnecting pipes, and for turning the well pipe while sinking

Miscellaneous Hammers, small wrenches, nails, rope, plank for platform, timbers for holding pipe perpendicular in starting, etc, completed the equipment

Material Below is given a list of the materials used

Lumber for the curb, one length 21½ feet, standard black pipe six inches in diameter, one No 16 gauge galvanized iron strainer, 14 feet long, perforation extending for 12 feet

Curbing

The curb was made 8 feet wide and 9 feet long from two inch Texas pine This size was necessary in order to facilitate the exchanging of pumps tested In a private plant, however, the curb should be of a size to suit the pump to be installed At the top of the curb a heavy timber, six by eight inches, extending 3 to 4 feet beyond each end of the curb, was securely bolted to each side in order to prevent the curb from settling (Fig 11 illustrates a good type of curbing)

Sinking the Well

With the station well, the open portion was dug, the pipe sunk, and the strainer placed, before the curb was put in place This was found to be a mistake by reason of the fact that, owing to the splashing of water, etc, the soil caved in and much difficulty was encountered in placing the curb, necessitating an amount of extra digging before it could be satisfactorily accomplished

After the open portion of the well was dug, the location of the pipe was decided upon, and the derrick was then raised and placed in a slanting position in such a manner that the rope swung entirely clear, and fell upon the point selected for the pipe The guy ropes were fastened to "dead men," consisting of eight inch logs, laid about three feet in the ground, and the derrick securely anchored at its base to two posts set deep in the soil A hole was dug as deep as possible where the pipe was to enter, and the latter was then put in position Before placing the pipe however, slanting teeth about an inch deep were cut in its lower end for the purpose of assisting in moving aside any gravel that might impede the progress of the pipe, or in order to cut through any hard-pan that might be encountered (See Fig 7.) Care was taken to have the pipe perpendicular at the start, and timbers were placed on all four sides both at the top and bottom of the open portion of the well so as to keep it perfectly plumb until it had penetrated the earth to a distance of several feet This is an important feature in well construction of this kind Great care should be taken to keep the pipe perpendicular at all stages of the sinking of the well, as otherwise it may be out of plumb when the well is completed, causing consequent difficulty in properly connecting the pump

Fig 7 Showing the teeth cut in lower end of well pipe to aid in sinking

Using the Sand-Bucket Weights were placed and the sand-bucket was then brought into requisition The pipe settled about 4 feet in five minutes More weights were added as needed, and the pipe turned frequently with the large pipe wrenches Frequent turning of the pipe was found to expedite its sinking The pipe would often seem to be stuck, but upon giving it a few turns it would settle down several inches, and occasionally drop almost a foot at a time It is probable that more weights and more frequent turning would have made the pipe precede the sand-bucket all the time This would have been an advantage, inasmuch as during the sinking of the pipe the sand bucket two or three times preceded it, so that the flange around the outside at its lower end became fastened under the end of the pipe, necessitating jacking up the latter before it could be extricated With a common sand-bucket this difficulty would not have been encountered

Necessary Labor It requires three strong men to draw a well filled sand-bucket out of the well, continuing the work from day to day The work, however, may be done by a horse during the entire operation In sinking the station well, a horse was used part of the time and was found entirely satisfactory In order to fill the sand-bucket by horse power, the rope instead of being tied to the single-tree was merely run through the ring of the single tree, while a man grasped the double rope a few feet from the horse as illustrated in figure 8

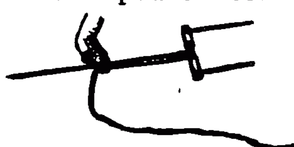

Fig 8 Single tree with rope illustrating the adaptation of horse power in sinking

After the sand bucket was raised a sufficient distance, the man let go of the rope, thus allowing it to run back with the weight of the falling sand-bucket As soon as the bucket struck the bottom of the well, the rope was again grasped quickly as before, the operation being thus repeated again and again until the sand bucket was filled, the horse moving forward all the time The horse was then brought back to the well and the sand-bucket drawn out and emptied By using a horse, one man and the superintendent who may empty the sand-bucket, can sink a well, if strict economy is required, but it usually saves time to provide two men in order to handle the weights and turn the pipe with ease Without a horse there should be three good men in addition to the superintendent

Gravel was struck at a depth of 32 feet, and the teeth in the bottom of the pipe were found to be of great assistance in pushing aside the gravel during the turning of the pipe The drill was used occasionally in order to loosen the bed of gravel, and to break any stones that were too large to enter the sand-bucket The pipe was sunk a few feet below the gravel so that the strainer could be located at the proper place without interference from the sand rising through the bottom of the pipe The strainer was fastened to a 1¼ inch pipe with a fine copper wire strong enough to support its weight, and yet sufficiently thin to be easily broken when the small pipe was withdrawn Just before lowering the strainer into the well, the sand which had accumulated in the bottom was removed with the sand-bucket, the strainer then being lowered and the small pipe securely anchored at the top, thus leaving the strainer suspended (Fig. 9) The small pipe to which the strainer was fastened was closely watched during this operation to guard against any possible displacement of the strainer by the upward thrust of the sand. The well pipe was then jacked up until all of the perforated part of the strainer was left exposed, as shown in Fig 10

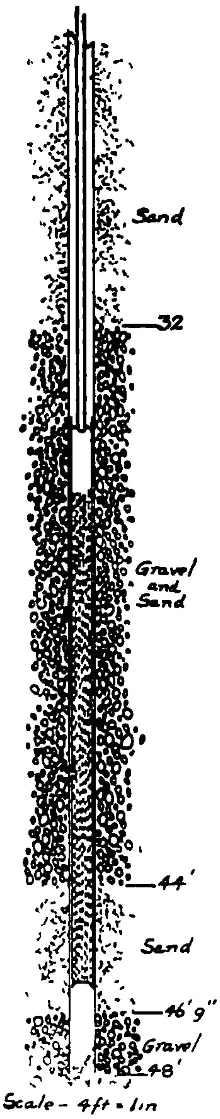

Fig 9 Slotted strainer suspended in well by one fourth inch pipe prior to placing

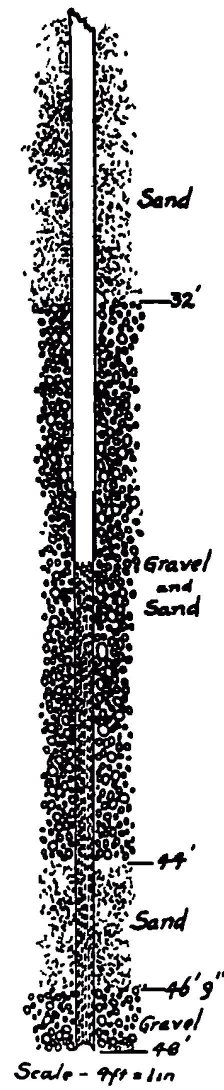

Fig 10 Strainer in place, well pipe jacked up (Note the position of sand and gravel before any pumping has been done and compare with Fig 11)

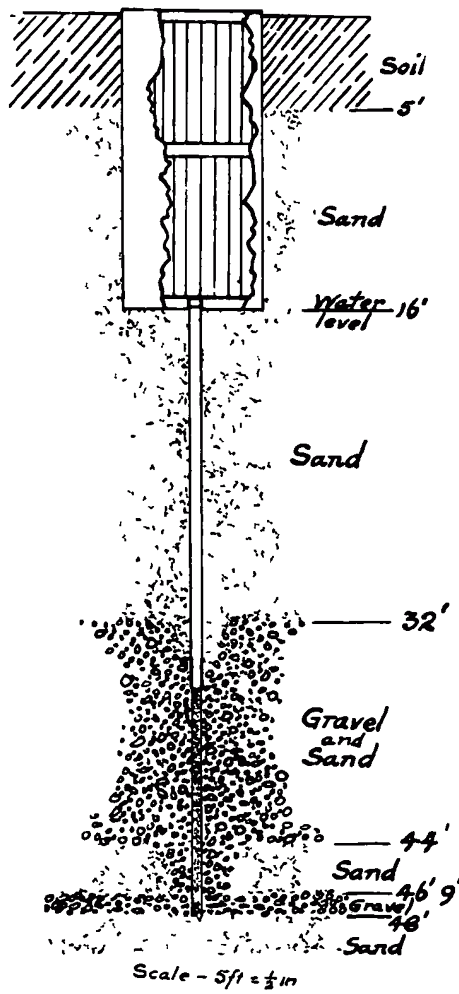

Fig 11 Showing the Station six inch well with curb 8x9 feet by 16 feet deep The position of sand and gravel strata are shown after the well has been pumped for some time (Compare with strata shown before pumping in Fig 10)

Soils Penetrated

Figure No 11 illustrates the soils penetrated It will be seen that the first five feet of soil consists of heavy clay (adobe) Beneath this was sand of varying fineness to a depth of 32 feet, when a gravel stratum 12 feet thick was encountered mixed with from 20 per cent to 50 per cent of sand Below this gravel stratum came another of sand three feet thick, followed by another gravel stratum one foot thick

Strainer

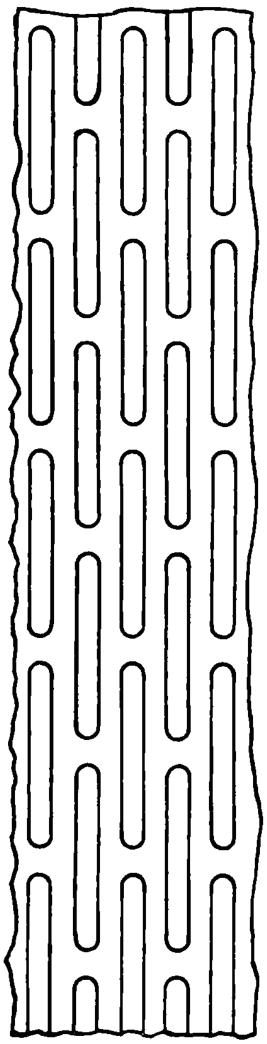

Fig 12 A section of the wall of the slotted strainer used in Station well slightly reduced in size

The strainer used, a small section of which is shown in Fig No 12, was 14 feet long, closed at the bottom and made of No 16 guage galvanized iron, 12 feet of which was perforated with holes 1½ inches long and ¼ inch wide, the intervening spaces being of like dimensions This type of strainer furnishes the largest safe amount of open space through which water can enter the well The openings are sufficiently large to permit all the sand to enter the well and be pumped out, and at the same time small enough to restrain the gravel, thus forming a very porous water-bearing stratum One or two feet of blank at the top of the strainer is important, so as to avoid possible danger of disconnecting the pipe and strainer

The El Paso Novelty Works, El Paso, Texas, makes a strainer almost identical with the one described above The El Paso Foundry and Machine Co, El Paso, Texas, also makes a strainer of this type but with some difference in detail

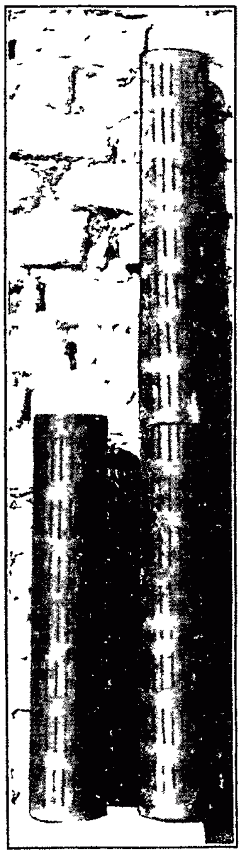

Fig 12½ A home made six inch slotted strainer made and used by J S Porcher El Paso Texas

Fig 12½ illustrates a home made strainer, made and used by Mr J S Porcher, El Paso, Texas

Placing the Strainer

The success of the well may depend upon the proper location of the strainer in the gravel stratum If the stratum consists of pure gravel the top of the strainer may be placed about one foot below the top of the gravel stratum but in cases where 20 per cent to 50 per cent of sand is intermixed with the gravel the top of the strainer should be placed not less than four feet below the top of the gravel stratum This is necessary for the reason that since the slots of the strainer are ¼ inch wide all the sand surrounding the strainer will enter the well and be pumped out with the water, and the gravel, which is held back by the strainer, will settle to take the place of the sand removed If the top of the strainer were placed at the top, or near the top, of the gravel stratum it will be readily seen that when the gravel settles after the sand has been removed, the top of the gravel stratum will be considerably below the top of the strainer and therefore, a portion of the strainer would be surrounded by pure sand This would mean that the sand around this portion of the strainer would constantly be coming into the well and eventually enough sand would be removed so that caving would finally extend to the surface

A remedy for this would be to throw gravel into the caving portion around the pipe. This would gradually settle and form a slight obstruction to the sand but of course the area of water beaiing gravel would be proportionately reduced.

Flushing

By flushing out the well we mean the pumping out of the well to its limit of capacity in order to remove the sand intermingled with the gravel around the strainer. It is somewhat doubtful whether a well under our conditions can be so thoroughly flushed out that no more sand will appear in the water.

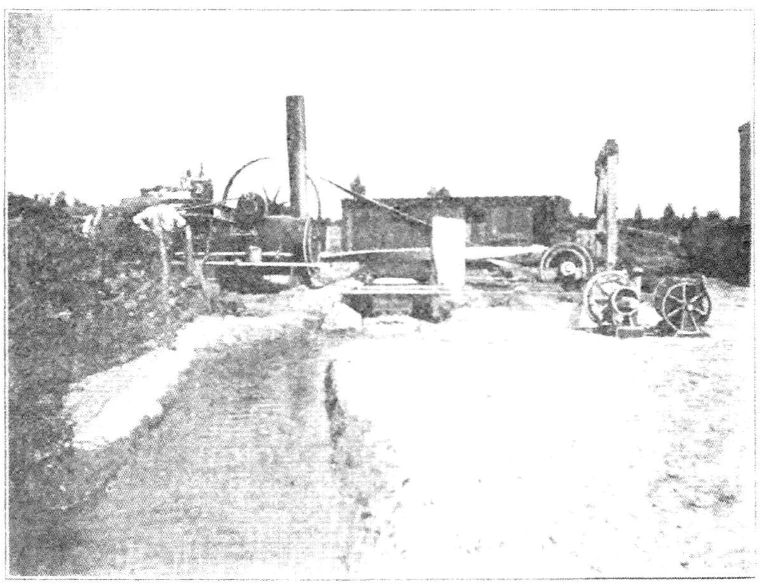

Figure 13. The Station experimental well, pump and engine in use.

The necessity for flushing at all depends entirely upon the type of pump to be used later for pumping. Flushing is extremely desirable if a piston pump is to be used or any other type of pump having close fitting wearing parts. If a centrifugal pump or similar type is to be installed it is not

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necessary to go to the trouble or expense of flushing the well Such a pump will not be injured perceptibly by the sand and it will do its own flushing, gradually removing the sand and thus leaving a porous gravel stratum around the strainer through which the water can find its way into the well freely

Analyses of Water

Parts per 100,000

	Station Well	Rio Grande Water from Acequia	Pecos River
Suspended matter	———	831 4	179 6
Total solids	104 00	44 11	312 59
Lime, CaO	25 30	8 26	53 28
Magnesia, MgO	5 65	1 36	17 08
Soda, Na_2O	18 38	7 76	53 55
Potash, K_2O	2 13	0 94	2 65
Iron and aluminum, Fe_2O_3 Al_2O_3	0 00	1 85	0 93
Silica, SiO_2	2 50		
Sulfates, SO_3	2 11	10 42	103 26
Chlorids, Cl	15 33	5 41	63 94
Carbonates, CO_2	9 90	5 06	3 19
Crystal water	26 16	4 27	29 16
Total	107 46	45 33	327 04
Oxygen equivalent of Cl (deduct)	3 46	1 22	14 45
Corrected total or total solids	104 00	44 11	312 59

Cost of Station Well

The cost of the experimental well on the Station farm, including curb, pipe, strainer, and sinking did not exceed $150

POWER

The question of the most economical power is of course a very important one in connection with the matter of installing a pumping plant A brief discussion of this matter may therefore be of interest

Wind and water constitute two of the cheapest sources of power The use of the first of these does not appear to have been productive of very successful results in this territory

To begin with, the greatest wind movement during the year is in the spring season when, as a rule, water from wells is least needed In those parts of the territory relying upon river water this source seldom runs short until the spring season is well passed and in these localities pumping for irrigation is not likely to be much resorted to at that time During the summer months when the greatest need for water for irrigation purposes exists, there is much less wind movement than earlier in the year and it frequently happens that when the water is most needed there is the least amount of wind The use of storage reservoirs to make more available the water pumped by wind power is open to the criticism of expense for the installation of such reservoirs, together with the high loss through evaporation if the reservoirs are open

Water as a source of power is available in comparatively few parts of our territory The question of developing power from our water courses and transmitting it by electricity to the locality where it is most needed has received some attention in the territory and may be of some use in connection with pumping plants for irrigation purposes

Among the remaining sources of power are steam, oil, including gasoline. kerosene and crude oil, and horse power The statistics shown in Table 11 will be of interest in a comparison of steam and oil on a basis of economy The question of which is the most economical fuel must depend largely upon the conditions existing in each locality In many parts of our territory wood and coal may be procured at relatively so low a cost that steam becomes by far the cheapest available power It should be borne in mind in this connection that under average conditions a steam engine requires skilled labor to operate it, but, on the other hand, is considered one of the most reliable means of power and the least subject to breakdowns or getting out of order Gasoline heretofore has cost so much that the question of whether or not it will pay to use it at the present price for developing power for irrigation plants is still a debatable one On the other hand it will be noticed by looking at Table 11 that the majority of oil engines are operated by common and not skilled labor

Crude oil as a means of power is being successfully used in various parts of the country Mr J A Smith, of El Paso, Texas, has recently installed a 28 horse power, Fairbanks-Morse, crude oil engine which, although at the time these lines are written, has not been running for any length of time, is giving entirely successful results An important consideration in the use of crude oil is the tendency that appears to exist of increased price of the oil During the past six months the price of crude oil in the vicinity of El Paso has steadily advanced and a number of users of crude oil in that city have recently discarded it in favor of other fuel The manager of the El Paso Water Works, under date of Feb 18th, writes in this connection as follows

"The price of Beaumont oil has gone to $1 21 per barrel, El Paso delivery This is equal to coal at $4 84 per ton and we can get coal at $4 50, so you see oil burning in El Paso and vicinity is a thing of the past We have half our furnaces changed to coal now "

It is thus evident that, before installing a pumping plant, the owner should carefully investigate the cost of available fuel, including, of course, delivery charges on oil, coal, and wood It is suggested in this connection that the reader consult the data shown in Table No 11

PUMPS

Various Types and Relative Efficiency

"There are four distinct types of pumps—the plunger or piston pump, ****, the vacuum, the rotary, and the centrifugal, besides elevators which raise water by means of flights attached to an endless chain "* Probably only the three last named types can be relied upon for cheap production of large quantities of water for irrigation by pumping It is

* Wilcox, Irrigation Farming, p 251

not the purpose of the writers, however, to enter into a lengthy discussion of the relative efficiency of the various types of pumps other than those under the test

For our present purpose the efficiency of the pumps is reckoned upon the relative cost of lifting a given amount of water from the same well

Centrifugal pumps having no close-fitting or complicated working parts, create comparatively little friction, are seldom or never out of order, and are not appreciably injured by sand or gravel in the water, yet in this type of pump there is a considerable loss of power by the slippage or play of the water upon the loosely fitting paddles

Rotary pumps have closs fitting working parts, which may or may not be of a complicated nature, with a relative increase in friction, and in the latter case are more difficult to keep in repair But on the other hand the suction is positive and there is almost no loss of power by slippage of water upon the paddles, and thus result in a greatly increased efficiency Sand must not exist in the water unless there is some method of taking up the wear upon the working parts.

We are unable, at this time, to pass upon the durability of the pumps tested more than what may be said from the working of the pumps and from their individual appearance. There is little question as to the durability of centrifugal pumps As to the rotary, with its cams and rollers to operate the pistons and springs to take up the wear, caused by sand, etc , to say the least, it will require greater intelligence and care in operating

PUMPS TESTED BY THE STATION

Conditions of the Test

The pumps were tested practically under like conditions, namely, upon the same well, placed the same distance from the water level in so far as the form of the pumps would permit, with the same engine, a 20 H P steam engine and boiler (except where otherwise specified) with the same kind and amount of wood by weight, namely, one quarter of a cord, weighing 492 pounds, of small dry tornillo wood, under the same steam pressure, with a few necessary exceptions where the work was heavy, with the water level in the boiler practically the same, and with the same weir and apparatus for measuring the water discharged by the pumps

Results Secured From Pumps Tested

(1) *Van Wie Centrifugal Pump*

The Van Wie Centrifugal Pump, illustrated in Figs 14 and 15, is of the vertical single top side suction, belted type, made by the Baldwinsville Centrifugal Pump Works, Syracuse, N Y A No 5 pump with a 6 inch suction and a 5 inch

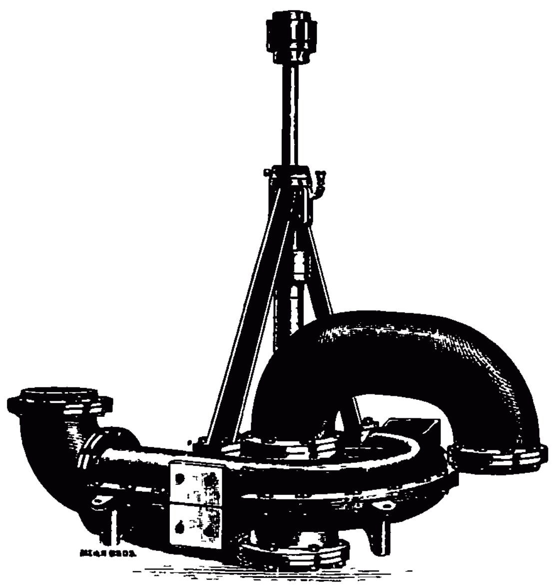

Fig 14 Exterior view Van Wie Centrifugal Pump, vertical single top side suction type

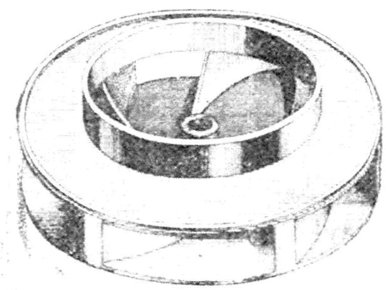

Fig. 15. Showing the Enclosed Piston used in the Van Wie Centrifugal Pump shown in Fig. 14.

discharge, fitted with a six-inch suction and 7 inch discharge pipes, was tested.

Figure 16 shows the manner in which this and the Kingsford, both vertical pumps, were belted to the engine by the use of an idler.

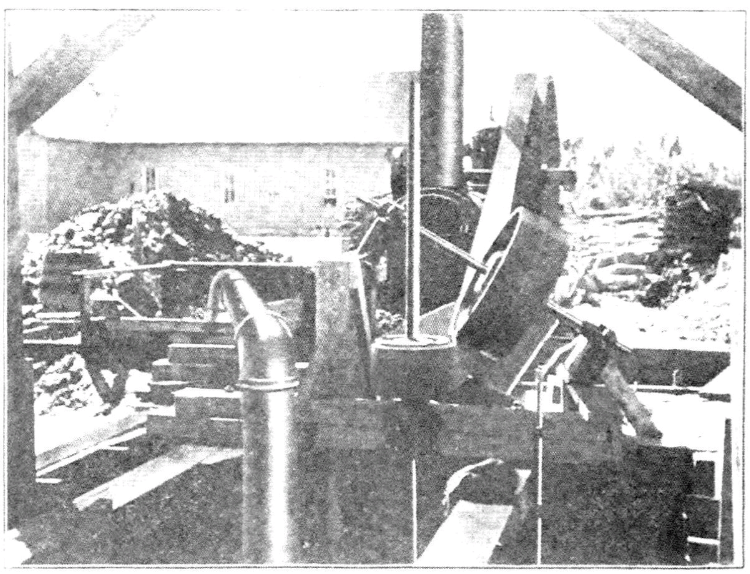

Fig 16. Showing the use of an Idler in belting a Vertical Pump to the Engine.

Figure 17 shows the discharge thrown from a 7 inch pipe by this pump, running at a speed of about 750 revolutions per minute.

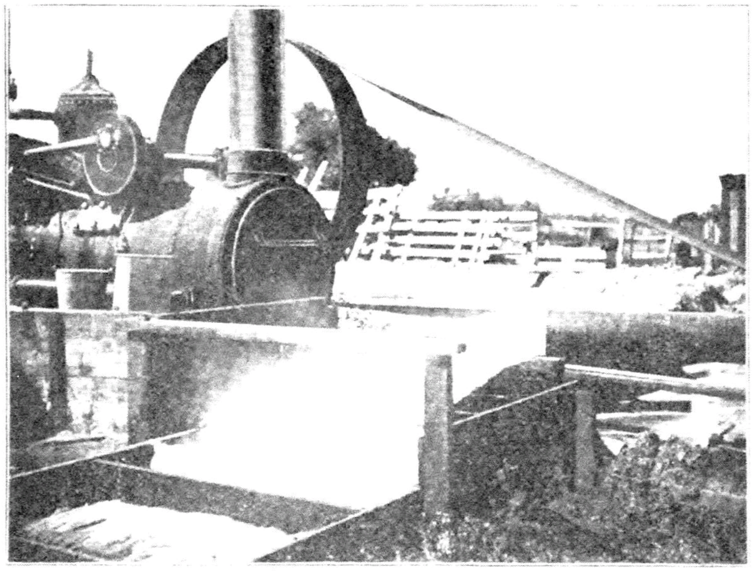

Fig. 17. Discharge thrown from a seven-inch pipe by the Van Wie No. 5 Centrifugal Pump, running at a speed of about 750 revolutions per minute.

The results of the test are recorded in the following table:

Gallons per minute	Speed of Pump, Revolutions per Minute	Time run on ¼ Cord Wood (492 lbs)
600	455	2 hours. 29 min.
824	515	1 " 43 "
944	530	1 " 29 "
988	540	1 " 14 "
997	760	

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(2) *R. D. Wood Co's Centrifugal Pump*

The R. D. Wood Co's. Centrifugal Pump, illustrated in Figs. 18 and 19, is of the horizontal, double side suction, belted

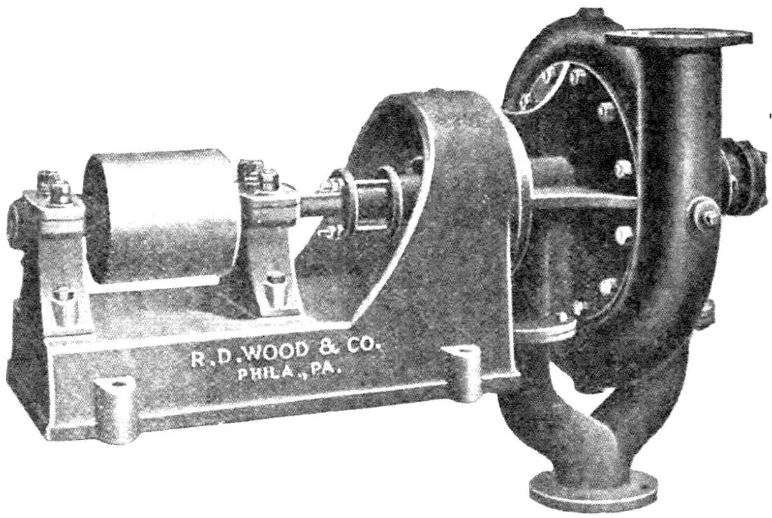

Fig. 18. Exterior view R. D. Wood Co's. Centrifugal Pump, double side suction type.

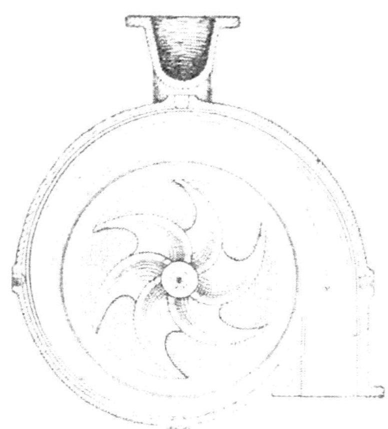

Fig. 19. Interior view of the R. D. Wood Co's Pump illustrated in Fig. 18.

type, made by R. D. Wood & Co., Philadelphia, Pa. A No. 6 pump with a 6 inch suction and 6 inch discharge, fitted with 6 inch suction and 6 inch discharge pipes, was tested. Figure 20 shows the discharge from a 6 inch pipe thrown by this pump at a speed of about 900 rev. per min.

The results of the test are given below:

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The results of the test are given below:

Gallons per Minute	Speed of Pump Revolutions per Minute	Time run on ¼ Cord Wood (492 lbs.)
600	695	1 hr., 58 min.
824	797	1 hr., 23 min.
944	900	1 hr., 9 min.

This pump was tested first and again after two others as a check.

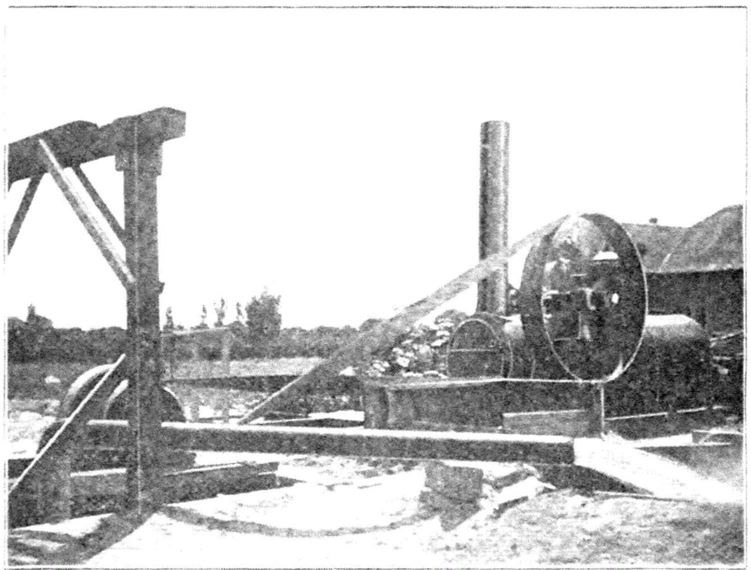

Fig. 20. Discharge thrown from a six-inch pipe by the R. D. Wood Co's. No. 6 Pump running at a speed of about 900 revolutions per Minute.

(3.) *Kingsford Centrifugal Pump*

The Kingsford Centrifugal Pump, illustrated in Figure 21, is of the vertical single bottom side suction, belted type, made by the Kingsford Foundry and Machine works, Oswego, N. Y. A No. 6 pump with a 7 inch suction and a 6 inch discharge, fitted with 7 inch suction and 6 inch discharge pipes, was tested. Figure 22 shows the discharge from a 6 inch pipe

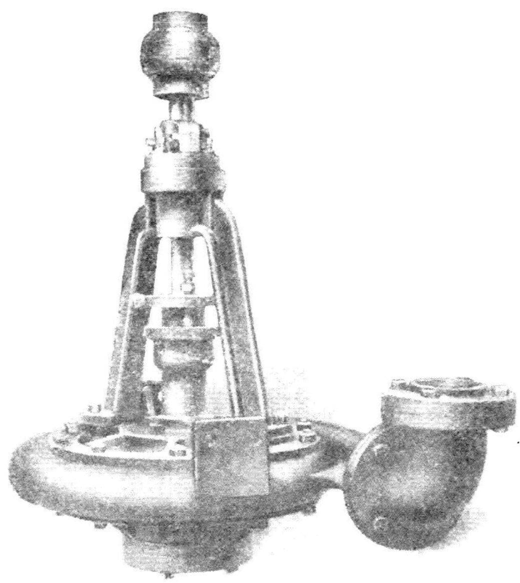

Fig. 21. Kingsford Centrifugal Pump, Vertical single bottom side suction type.

thrown by this pump running at a speed of about 640 revolutions per minute.

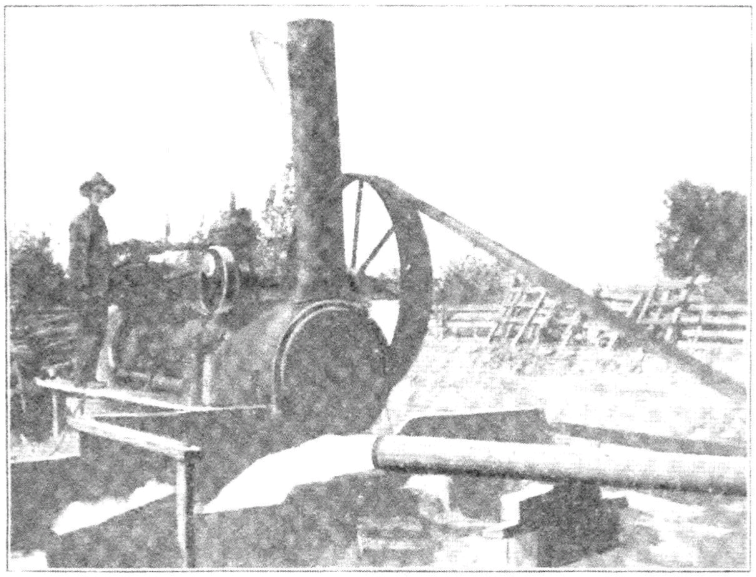

Fig. 22. Discharge thrown from a six-inch pipe by the Kingsford Centrifugal Pump No. 6, running at a speed of about 640 revolutions per minute.

The results of the test are recorded below:

Gallons per Minute	Speed of Pump Revolutions per Minute	Time run on ¼ Cord Wood (492 lbs.)
600	415	2 hr., 4 min.
824	450	1 hr., 33 min.
944	505	1 hr., 18 min.
988	600	0 hr., 51 min.
1000	640	

(4.) *Byron-Jackson Centrifugal Pump*

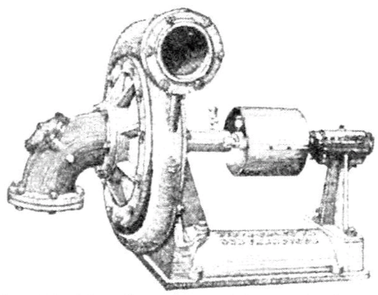

Fig. 23. Exterior view of Byron-Jackson Centrifugal Pump, horizontal single side suction type.

The Byron-Jackson centrifugal pump, illustrated in Figure 23 is of the horizontal, single side suction, belted type, made by the Byron Jackson Machine Works, 411 Market St., San Francisco, Cal. A No. 6 pump with 6 inch suction and discharge, fitted with 8 inch suction and discharge pipes was tested. Figure 24 shows the dis-

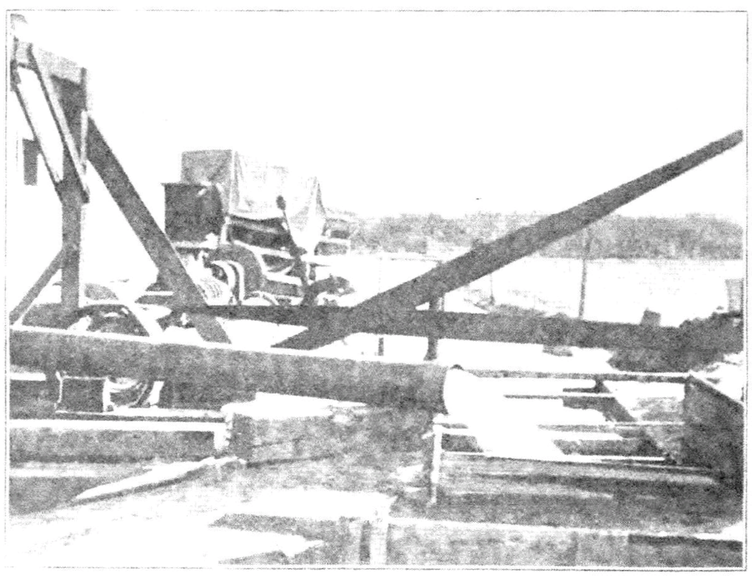

Fig. 24. Discharge of about 1,000 gallons a minute thrown from an eight-inch pipe by the Byron Jackson Centrifugal Pump No. 6.

charge thrown by this pump from an 8 inch pipe,—about 1000 gallons per minute.

The results of the test are recorded in the following table.

Gallons per Minute	Speed of Pump Revolutions per Minute	Time run on ¼ cord wood (472 lbs)
600	570	1 hour 46 min.
824	650	1 hour 24 min.
944	700	1 hour 19 min.
988	730	1 hour 15 min.
1028	790	

(5) *Fairbanks-Morse Centrifugal Pump*

The Fairbanks-Morse centrifugal pump, illustrated in Figure 25, is of the horizontal, double side suction belted type, made by Fairbanks, Morse and Company, Chicago, Ill.

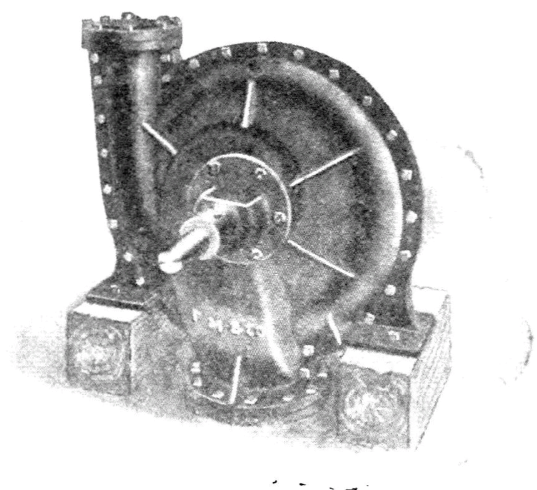

Fig. 25. Fairbanks-Morse Centrifugal Pump: horizontal double side suction type.

A No 6 pump with an 8 inch suction and a 6 inch discharge, fitted with 8 inch suction and discharge pipes, was tested. The discharge thrown by this pump is practically the same as shown in Figure 24.

The results of the test are recorded in the following table:

Gallons per minute	Speed of Pump Revolutions per Minute	Time run on ¼ cord wood (492 lbs)
600	448	1 hour 53 min
824	517	1 " 30 "
944	528	1 " 14 "
988	545	1 " 6 "
1085	680	

(6) *Roots' Rotary Pump*

In accordance with the invitation extended by the Station to the leading pump manufacturers of the country, the P. H and F M Roots Co, of Connersville, Indiana, sent to the station one of their rotary pumps with 16 inch suction and 14 inch discharge Some trouble was experienced in securing satisfactory results in the operation of this pump, which was placed at the surface of the ground, in accordance with the instructions of the manufacturers, and not at the bottom of the open portion of the well, as the other pumps were placed The pump will be tested under different conditions later and the results announced, but in the meantime, and until it is felt that the pump has been given a proper test, it is deemed better to give no statement in this bulletin of the results obtained

Tests with Smaller Pumps

These tests were run with a 12 horse power engine and first class tornillo wood

(1) *Byron Jackson Pump*

A test was also made with a Byron-Jackson pump, No 4, made by the same firm as the No 6, with a 4 inch suction and a 4 inch discharge, fitted with 4 inch suction and 5 inch discharge pipes (See Table No 2)

Figure No 26 shows the discharge thrown from this pump from a 5 inch pipe, about 500 gallons per minute

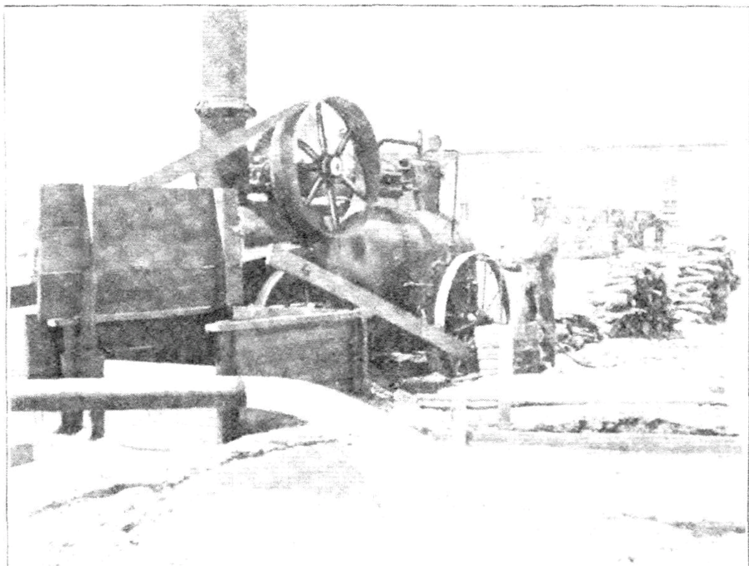

Fig. 26. Discharge of about 500 gallons per minute thrown from a five-inch pipe by a Byron-Jackson No. 4 Centrifugal Pump.

The results of the test are given below:

Gallons per minute	Speed of Pump Revolutions per Minute	Time run on ¼ cord wood
378	700,	3 hrs., 00 Min.
487	800	1 " 15 "

Johnson Rotary Pump

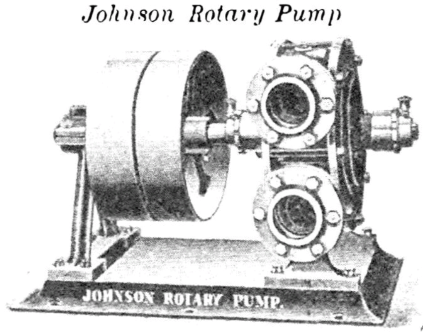

Fig. 27. Exterior view of Johnson Rotary Pump; front single suction type.

The Johnson Rotary Pump, illustrated in Figures 27 and 28, is of the front, single suction, belted type, made by the Davis, Johnson Co., 41 West Randolph St., Chicago, Ill. A No. 5 pump, fitted with 5 inch suction and 5 inch discharge pipes, was tested. Figure 29 illustrates the discharge thrown by this pump from a 5 inch pipe, 330 gallons per minute.

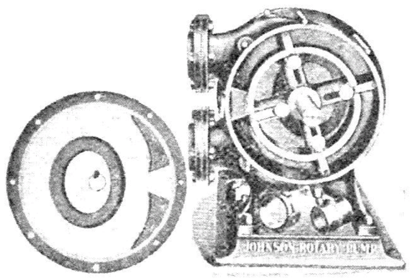

Fig. 28. Interior view of Johnson Rotary Pump shown in Fig. 27.

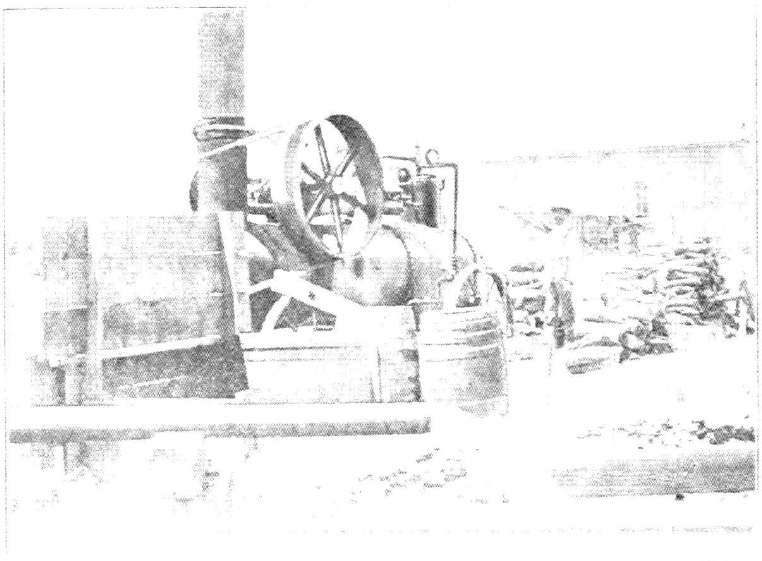

Fig. 29. Discharge of about 330 gallons per minute thrown from a five-inch pipe by Johnson Rotary Pump No. 5.

The results of the test are given below:

Gallons per min.	Speed of Pump Revolutions per min.	Time run on ¼ cord wood.
322	125	4 hrs., 30 min.

This pump was put in a second time, fitting it with 6 inch suction and 6 inch discharge pipes There was no material change in the results

COMPARATIVE RESULTS OF PUMPS TESTED

The following tables, Nos 1 and 2, show the results of the comparative tests made with the foregoing pumps

Table No. 1

Comparative Test of Pumps

Showing the relative standing of the pumps tested at different speeds.

Name of Pump	At 600 Gal per Min	At 824 Gal per Min	At 944 Gal per Min	At 988 Gal per Min	At the Most Economic Speed	Gal per Min Most Economic Speed
Van Wie No 5	1st	1st	1st	3rd	1st	600
R D Wood No 6	3rd	5th	5th		5th	600
Kingsford No 6	2nd	2nd	3rd	4th	2nd	824
Byron Jackson No 6	5th	4th	2nd	1st	3rd	944
Fairbanks-Morse No 6	4th	3rd	4th	2nd	4th	824

Table No 2

Relative Economy of Pumps Tested

Showing for each pump the speed, gallons per minute pumped, and time run on one quarter cord of small tornillo wood

Name of Pump	Kind of Pump	Speed of Pump	Gallons per minute	Suction Feet	Suction Inches	Discharge Feet	Discharge Inches	Total Lift Feet	Total Lift Inches	Time run on ¼ cord wood* Hrs	Time run on ¼ cord wood* Mins
Van Wie No 5	Vertical Centrifugal	455	600	12	6⅔	15	3½	27	10¼	2	29
"	"	515	824	17	8	15	3½	32	11½	1	43
" "		530	944	21	4¼	15	3½	36	7¾	1	29
"	"	540	988	22	2¼	15	3½	37	5⅔	1	1
"		760	997	22	2¼	15	3½	37	5⅓		
Kingsford No 6		415	600	12	6½	15	6	28	0½	2	4
		450	824	17	7⅔	15	6	33	1⅔	1	33
"	"	505	944	20	5¾	15	6	35	11⅔	1	18
"		600	988	21	0½	15	6	36	6½	0	51
"		640	1000	22	2	15	6	37	8		
R D Wood No 6	Horizontal	695	600	14	5½	14	4	28	9½	1	58
		797	824	20	1½	14	4	34	5½	1	23
	"	900	944	22	4⅔	14	4	36	8⅔	1	9
Byron Jackson No 6		570	600	12	9¼	15	2	27	11¼	1	46
	"	650	824	19	3¼	15	2	34	5¼	1	24
" "		700	944	21	6½	15	2	36	8½	1	19
" "	"	730	988	23	9⅔	15	2	38	11⅔	1	15
		790	1028	24	1¼	15	2	39	3¼		
Fairbanks Morse No 6		448	600	18	8¼	15	3	28	11¼	1	53
		517	824	20	5¾	15	3	35	8¾	1	30
" "		528	944	21	10⅜	15	3	37	1⅜	1	14
" "		545	988	23	0½	15	3	38	3½	1	6
"		680	1085	26	8½	15	3	41	11½		
†Byron Jackson No 4	"	700	378	16	1¼	15	0½	31	1⅔	3	00†
†Johnson Rotary No 5	" Rotary	125	322	9	8¼	14	6½	24	2⅔	4	30†

*One cord of tornillo wood weighed 1 968 pounds, one quarter cord 492 pounds

†These pumps were tested with a 12 H P steam engine and with large tornillo wood

COST OF IRRIGATING BY PUMPING

In order to aid in the calculation, by those interested, of the probable cost of irrigating from wells by means of pumps, the series of tables which follow have been compiled The information given in these tables is based upon the experimental work that has been done by the Station, as already set forth It is well known that for short runs the expenses are proportionately higher than for long continued runs with plants of this kind, and it is, therefore, safe to say that the figures shown in these tables are an outside limit of the cost of irrigating for any continuous length of time under conditions similar to those which governed the work conducted by the Station

The tables shown herewith are as follows

List of Tables on Cost of Pumping

4

Table No 3

Comparative Cost of Fuel for Pumps Tested

Showing the quantity and cost of fuel used by the different pumps tested, pumping at different speeds and for runs of 10 and 24 hours

Name of Pump	Pumping 600 Gal per Minute				Pumping 824 Gal per Minute				Pumping 944 Gal per Minute				Pumping 988 Gal per Min			
	Cords Wood used in 10 Hrs	Cords Wood used in 24 Hrs	Cost of fuel for 10 Hrs Run	Cost of fuel for 24 Hrs Run	Cords Wood used in 10 Hrs	Cords Wood used in 24 Hrs	Cost of fuel for 10 Hrs Run	Cost of fuel for 24 Hrs Run	Cords Wood used in 10 Hrs	Cords Wood used in 24 Hrs	Cost of fuel for 10 Hrs Run	Cost of fuel for 24 Hrs Run	Cords of Wood used in 10 Hrs	Cords Wood used in 24 Hrs	Cost of fuel for 10 Hrs Run	Cost of fuel for 24 Hrs. Run
Van Wie	1 006	2 416	$2 26	$5 44	1 456	3 495	$3 28	$7 86	1 685	4 044	$3 79	$9 10	2 459	5 901	$5 53	$13 28
Kingsford	1 209	2 903	2 72	6 53	1 612	3 870	3 63	8 71	1 923	4 615	4 33	10 38	2 941	7 058	6 62	15 88
R D Wood	1 271	3 05	2 86	6 86	1 807	4 337	4 07	9 76	2 173	5 217	4 89	11 74				
Byron Jackson	1 415	3 396	3 18	7 64	1 785	4 285	4 02	9 64	1 898	4 556	4 27	10 25	2 000	4 800	4 50	10 80
Fairbanks-Morse	1 327	3 185	2 99	7 17	1 666	4 000	3 75	9 00	2 027	4 864	4 56	10 94	2 272	5 454	5 11	12 27

NOTE The above tests were run with small dry tornillo wood as fuel, costing $2 25 per cord

Table No 4

Duty of Fuel with the Pumps Tested

Showing the number of gallons pumped by one cord and one ton dry tornillo wood at the different speeds and at the most economic speed for each pump

Name of pump	600 Gals per min		824 Gals per min		944 Gals. per min		988 Gals per min		At most economic speed		Gallons per minute at most economic speed
	1 cord	1 ton	1 cord	1 ton	1 cord	1 ton	1 cord	1 ton	1 cord	1 ton	
Van Wie	357600	363414	339488	345008	336064	341528	241072	244991	357600	363414	600
R D Wood	283200	287804	273568	278016	260544	264780			283200	287804	600
Kingsford	297600	302439	306528	311512	294528	299317	201552	204829	306528	311512	824
Byron Jackson	254400	258536	276864	281365	298304	303154	296400	301219	298304	303154	944
Fairbanks Morse	271200	275609	296640	301463	279424	283967	260832	265073	296640	301463	824

Table No 5

Comparative Cost of a Three-inch Irrigation

Showing the cost of fuel per acre for irrigating three inches deep using dry tornillo wood at $2 25 per cord

Name of Pump	At most economic speed	At 600 gallons per minute	At 824 gallons per minute	At 944 gallons per minute	At 988 gallons per minute
Van Wie	$ 512	$ 512	$ 539	$ 545	$ 760
R. D Wood	647	647	669	703	
Kingsford	597	615	597	622	909
Byron Jackson	614	720	661	614	618
Fairbanks Morse	617	675	617	655	702

Table No 6

Comparative Test of Fuel

Showing the number of gallons pumped with one cord and one ton of fuel, using three kinds of wood and coal

Kind of Fuel	Weight of one cord Pounds	Hours one cord ran 824 Gal per min	Hours one ton ran 824 Gal per min	Cost of one cord	Cost of one ton	Gallons one cord Pumped	Gallons one ton Pumped	Cost of Pumping 100,000 Gal
Medium Cottonwood	2218	5 hr 49 m	5 hr 14 m	$2 00	$1 80	287576	258736	$ 70
Small Tornillo	1968	6 hr 0 m	6 hr 5 m	2 25	2 29	296640	300760	76
Large	2830	8 hr 0 m	5 hr 39 m	2 50	1 76	395520	279386	63
Coal (Gallup)			9 hr 21 m		6 00		461796	1 29

NOTE The above test was run with the R D Wood & Co Horizontal Centrifugal Pump

Table No 7

Acres Irrigated by Varying Quantities of Water

Showing the number of acres irrigated in 1,10 and 24 hours, pumping various quantities, and irrigating various depths

Gallons pumped per minute	Acres irrigated in one hour						Acres irrigated in 10 hours						Acres irrigated in 24 hours					
	1 in deep	2 in deep	3 in deep	4 in deep	5 in deep	6 in deep	1 in deep	2 in deep	3 in deep	4 in deep	5 in deep	6 in deep	1 in deep	2 in deep	3 in deep	4 in deep	5 in deep	6 in deep
600	1 3	6	4	3	2	2	13 2	6 6	4 4	3 3	2 6	2 2	31 8	15 9	10 6	7 9	6 8	5 3
824	1 8	9	6	4	3	3	18 2	9 1	6 0	4 5	3 6	3 0	43 7	21 8	14 5	10 9	8 7	7 3
944	2 1	1 0	7	5	4	3	20 8	10 4	6 9	5 2	4 1	3 4	50 0	25 0	.6 7	12 5	10 0	8 3
988	2 2	1 1	7	5	4	3	21 8	10 9	7 2	5 4	4 3	3 6	52 4	26 2	17 4	13 1	10 4	8 7
1000	2 2	1 1	7	5	4	3	22 1	11 0	7 3	5 5	4 4	3 7	53 0	26 5	17 6	13 2	10 6	8 8
1200	2 6	1 3	9	6	5	4	26 5	13 2	8 8	6 6	5 3	4 4	63 6	31 8	21 2	15 9	12 7	10 6
1500	3 3	1 6	1 1	8	6	5	33 1	16 5	11 0	8 2	6 6	5 5	79 5	39 7	26 5	19 9	15 9	13 2
2000	4 4	2 2	1 4	1 1	9	7	44 2	22 1	14 7	11 0	8 8	7 3	106 0	53 0	35 3	20 5	21 2	17 6

Note—In the above computation all fractions below 08 have been dropped

Table No 8

Size of Farm Irrigated by Varying Quantities of Water

Showing the acreage of land that can be irrigated by a given quantity of water (from 600 to 2,000 gallons per minute), pumping 10 or 24 hours a day, and irrigating every 10, 14, 21 or 30 days

Gallons Per Minute	Number Hours Run	Irrigated Every 10 Days: 1 inch deep	2 inches deep	3 inches deep	4 inches deep	5 inches deep	6 inches deep	Irrigated Every 14 Days.: 1 inch deep	2 inches deep	3 inches deep	4 inches deep.	5 inches deep	6 inches deep
600	10	132	66	44	33	26	22	185	92	61	46	37	31
	24	318	159	106	79	63	53	445	222	148	111	89	74
824	10	182	91	60	45	36	30	255	127	85	63	51	42
	24	437	218	145	109	87	73	611	305	204	153	122	102
944	10	208	104	69	52	41	34	291	145	97	72	58	48
	24	500	250	167	125	100	83	700	350	233	175	140	116
988	10	218	109	72	54	43	36	305	152	101	76	61	51
	24	524	262	174	131	104	87	733	366	244	183	146	122
1000	10	221	110	73	55	44	37	309	154	103	77	62	51
	24	530	265	176	132	106	88	742	371	247	185	148	123
1200	10	265	132	88	66	53	44	371	185	123	92	74	62
	24	636	318	212	159	127	106	890	445	297	222	178	148
1500	10	331	165	110	82	66	55	463	231	154	116	92	77
	24	795	397	265	198	159	132	1113	556	371	278	222	185
2000	10	442	221	147	110	88	73	618	309	206	154	123	103
	24	1060	530	353	265	212	176	1484	742	495	371	297	247

Gallons Per Minute	Number Hours Run	Irrigated Every 21 days.: 1 inch deep	2 inches deep	3 inches deep	4 inches deep	5 inches deep	6 inches deep	Irrigated Every 30 Days,: 1 inch deep	2 inches deep	3 inches deep	4 inches deep	5 inches deep	6 inches deep
600	10	277	138	92	69	55	46	396	198	132	99	79	66
	24	668	334	222	167	133	111	954	477	318	238	191	159
824	10	382	191	127	95	76	63	546	273	182	136	109	91
	24	917	458	305	229	183	153	1311	655	437	327	262	218
944	10	437	218	145	109	87	73	624	312	208	156	125	104
	24	1050	525	350	262	210	175	1500	750	500	375	300	250
988	10	458	229	152	114	91	76	654	327	218	163	131	109
	24	1100	550	366	275	220	183	1572	786	524	393	314	262
1000	10	464	232	154	116	93	77	663	331	221	165	132	110
	24	1113	556	371	278	222	185	1590	795	530	397	318	265
1200	10	556	278	185	139	111	92	795	397	265	198	159	132
	24	1335	668	445	334	267	222	1908	954	636	477	381	318
1500	10	695	347	231	173	139	116	993	496	331	248	198	165
	24	1669	834	556	417	334	278	2385	1193	795	596	477	397
2000	10	928	464	309	232	185	154	1325	662	441	331	265	221
	24	2226	1113	742	556	445	371	3180	1590	1060	795	636	530

NOTE. In the above computations all fractions below 8 have been dropped

PUMPING PLANTS IN NEW MEXICO

Comparatively little has been done in New Mexico in the way of irrigating lands from wells by means of pumping plants. The statistics for the census of 1900 show that only 1,004 acres of land in New Mexico are irrigated from wells as against nearly 203,000 acres which are irrigated from streams. The irrigation from wells so far practiced in New Mexico has been confined to the few farmers who have prac-

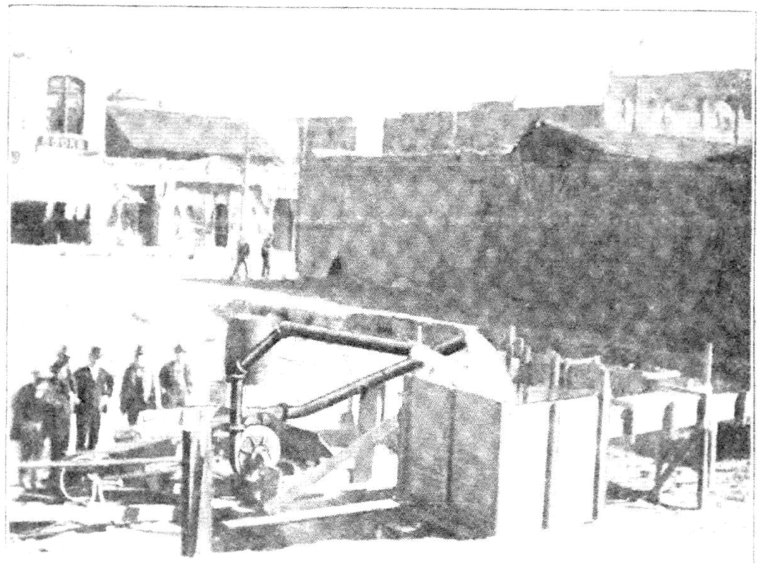

Fig. 30. Competitive Test of Pumps at the El Paso, (Texas) Carnival January 18, 1902. Water pumped from Open Tank, with lift of nine feet. Slanting pipe from six-inch Johnson Rotary Pump discharging 700 gallons per minute: horizontal pipe from six-inch Byron-Jackson Centrifugal Pump discharging 800 gallons per minute.

ticed irrigation in this manner from small plants when they have had no other source of water or as a means of supplementing the regular supply when the latter fails, and in most of these cases the plants have been operated by wind-mills. The practice of irrigating from wells is in its infancy in our territory and the possibilities of the work appear not yet to have been generally recognized by our citizens

Although not in New Mexico, the conditions existing near El Paso, which is less than than thirty miles from the southern border of our territory, deserve some notice. The experience of the farmers in that region is of some value. Through a constant fuilure of the regular supply of the irrigating water from the Rio Grande the farmers of that locality have been compelled to turn their attention to other water supplies or else abandon all agricultural work. As a consequence they have demonstrated the fact that crops can be profitably

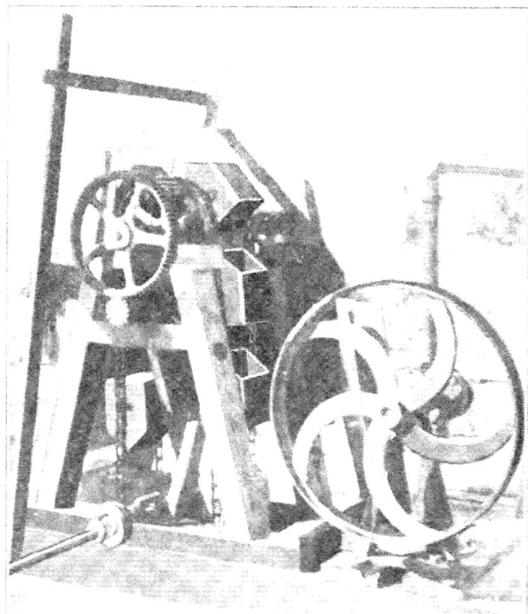

Fig. 31. A Gould's Endless Chain Bucket Pump used by Mann Bros. of Albuquerque for Irrigating.

grown by irrigation from wells tapping the underflow in the Rio Grande Valley. Some of these plants have been in operation for several years past and by statistics secured it is shown that the work is a profitable one. The conditions there are almost exactly similar to those prevailing over a large part of the Rio Grande Valley and it is largely because the river water has failed in that region that the work of irrigating by means of pumps has been more fully developed than throughout the Rio Grande Valley generally of New Mexico.

The tables presented herewith upon the wells and pumping plants of New Mexico and the Rio Grande Valley show comparative statistics which have been secured by personal investigation and by extensive correspondence with the owners of such plants. Some of the most valuable data received regarding wells in New Mexico have been gained through the experience of the Santa Fe Railway Company in sinking wells for the necessary water supply along its line in our territory and a separate table is made on this subject. (See Table 13.) The tables show, further, the comparative conditions existing in our territory and in other regions from which data have been secured.

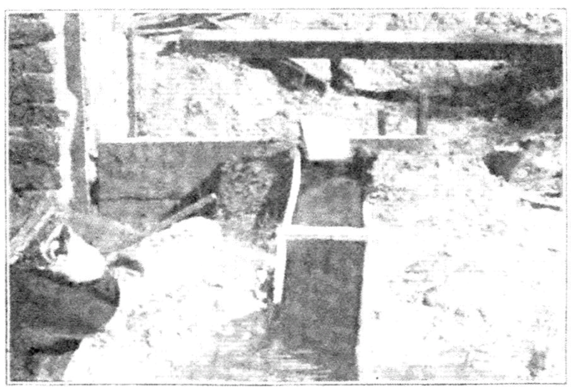

Fig. 32. Discharge of about 450 gallons per minute through a six-inch pipe from pump of J. Stoney Porcher, El Paso, Texas.

PUMPING PLANTS IN OTHER STATES

For the purpose of presenting comparative data in this bulletin a systematic correspondence has been conducted by means of which statistics concerning pumping plants in other parts of the United States have been secured. In gathering and compiling these statistics, representative cases so far as possible have been taken and the reader is thus enabled to compare in the same table relative figures as to the cost and the utility of plants as they exist in various regions.

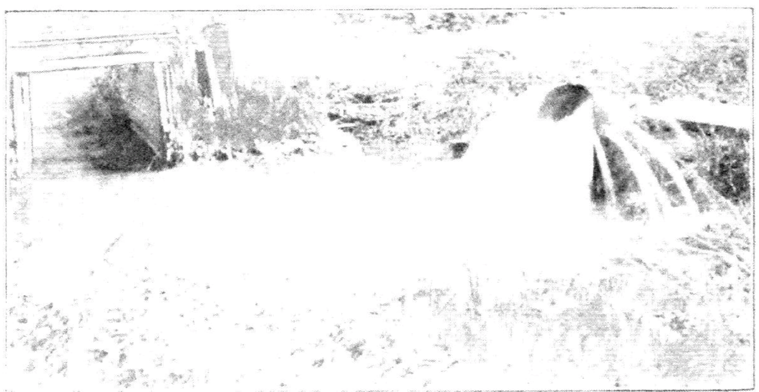

Fig. 33. Discharge of about 300 gallons per minute through a six-inch pipe from pump of E. J. Hadlock, El Paso, Texas.

California leads all other states in the number of acres irrigated from wells. The last census shows that a total of 152,506 acres of land were in 1899, irrigated from wells, or more than ten per cent of the total acreage irrigated in that state. Colorado comes next with a much lower percentage, 7,050 acres, irrigated from wells. From these two states representative cases have been used in the compilation of the tables presented herewith. In Lousiana and East Texas the recent development of the rice industry has been the reason for the irrigation of enormous tracts of land by pumping plants. Most of these are operated on very low lifts from beds of water under different conditions from those which must prevail in our territory. Through the higher lands, however, pumping is practiced for the irrigation of rice and other crops from deep wells and a few instances of this kind have been compiled in the tables shown.

RELATIVE CONDITIONS IN THE RIO GRANDE VALLEY

It may not be amiss in this bulletin to call attention to the conditions in the Rio Grande valley for pumping for irrigation as they compare with other states and regions. In the pumping of water for irrigation the most important consideration is a large available amount of water at a reasonable depth. From this standpoint alone it becomes apparent to the person who gives any thought to the matter of comparative conditions that hardly any, if any, other locality can show better advantages than the Rio Grande valley. Water throughout the valley in large quantities may be secured any where below a depth of from 15 to 20 feet, and the whole valley appears to be underlaid by, so far as we know, an almost

Fig. No. 34. Irrigating ditch filled by pump of E. J. Hadlock referred to in Plate 33.

inexhaustible supply of water. This water is of good quality and occurring at so short a distance below the surface of the ground may be raised very economically. It appears probable that in almost any part of the valley sufficiently thick beds of water bearing gravel may be met with to allow the placing of a strainer such as that used in the station well. This being so, it makes unnecessary the expensive strainers that are used in some regions to secure water from sand. The cost of the construction of a well need not be heavy. The work of the experiment station appears to have demonstrated the fact that with a well costing from $100 to $200 an ample supply of water may be secured for the irrigation of a farm of 100 acres or more.

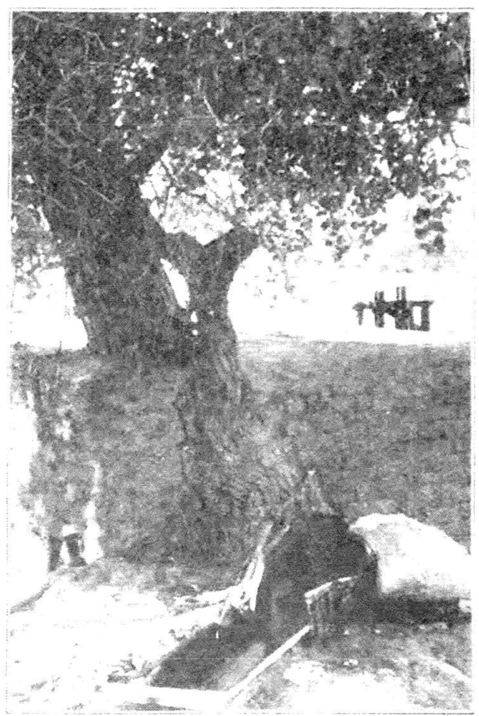

Fig. No. 35. Discharge of about 450 gallons per minute through a seven-inch pipe from pump of Julius T. Porcher, El Paso, Texas.

Probably no part of the country has been more often referred to for successful examples of profitably pumping for irrigation than Southern California The Rio Grande Valley possesses many advantages which Southern California has not and lacks few that are possessed by the Golden State Many of the wells from which water is pumped for irrigating purposes in California are several hundred feet deep and sunk at an expense for original cost far greater than is necessary in this valley Land is many times more expensive in California than here and labor much more costly The prices received for products are about the same in both California and New Mexico and the matter of markets, with proper development, ought to be extensive enough in this territory to take care of all the products that can be raised We can, however, learn from the California irrigator the lesson of economical methods and the proper use and duty of water

A comparison of the conditions existing in the valleys of New Mexico in which irrigation by pumping can be practiced can not but inspire faith in the great possibilities of our territory in any one who will carefully study the question

The data secured regarding pumping plants in New Mexico and in other states is herewith presented in the following

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LIST OF TABLES CONCERNING PUMPING PLANTS

PUMPING PLANTS AND COOPERATION

Pumping plants resolve themselves into two classes, namely, cooperative and individual plants, in each of which there is much of merit The former may be defined as a pumping plant from which two or more formers may obtain water, while the latter refers to pumping plants located upon each farm under individual control and supplying individual needs The moment the control is divided or there is a division of water, however obtained, the plant passes into the cooperative class, though it may be a modified form of cooperation

A cooperative plant wherever located, for obvious reasons, should render the maximum of efficiency and economy of production Objections which might justly be made against a large plant located at the head of a ditch are

1st The difficulty and great cost of developing water at one place in a sufficiently large quantity

2nd Opportunities for misappropriation and waste of water

3rd Loss of water by seepage and evaporation

4th Making and maintaining a just and equitable division of the water.

The same objections, in a much modified degree, might be raised against plants so placed as to supply only a small number of shareholders With a few shareholders, however, it would be a much easier task to divide the water properly and there would be far less danger of misappropriation

Perhaps the strongest objections that can be made against individual plants are 1st, a relatively large initial cost of installation, and 2nd, a low rate of efficiency and economy However, the individual pumping plant has advantages that should not be overlooked They are 1st, misappropriation of water is impossible The water is developed upon the farm where it is used and therefore at all times is within the domain and under the control of its owner 2nd, loss by evaporation and seepage is minimized 3rd, there is no division of water and, therefore, injustice from a lack of equitaille

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ble distribution is entirely eliminated 4th, there are no long ditches to maintain at great cost, and 5th, the initial cost is within the means of every farmer

The writers, however, believe that a combination under favorable circumstances, of these two systems will prove not only satisfactory but at the same time the most economic method of producing large quantities of water for irrigation during droughty periods This combination consists in the maintenance of individual pumping plants upon each farm, thus securing all the desirable features of such plants as heretofore enumerated, and at the same time eliminating the objectionable points proposed against a single large pumping plant at the head of a ditch, in conjunction with these a centrally located electrical power plant, through which the farmer would receive the benefits of efficiency of control and economy of production which such a power plant should give

Another suggested plan is to maintain along the line of a ditch, at suitable distances apart, pumping plants of sufficient capacity to supply the land to be watered from each, such plants to be operated by a central electrical power plant, and there would seem to be nothing to prevent a successful working of this plan

COST OF A PUMPING PLANT

Under a system of cooperation, a pumping plant should not cost each farmer more than $350 00 to $400 00 This figure includes the two items of well and pump If, however, an individual pumping plant is to be installed, to the items of say $200 00 for the well and $200 00 for one of the pumps giving the best results in the test, the cost of an engine must be added This will be found the most expensive item Engines, both steam and oil combustion, vary considerably in price, and, therefore, it is impossible to give definite figures on the cost An engine large enough to furnish power for pumping 1000 gallons per minute would probably cost from $900 00 to $1,500 00 depending upon the make It is probably safe to say that for supplying water for large areas, an individual pumping plant would cost not far from $10 00 for each acre of land irrigated

CARE OF BOILERS, ENGINES AND PUMPS

By J S MacGregor Assistant in the Department of Mechanical Engineering

The following general statements on the care and operation of boilers, engines and pumps are intended for laymen, and if carefully adhered to will add to the life, safety and economy of pumping plants

The Boiler

Before firing see that there is a moderate supply of water in the boiler The fire should then be raised gradually so that the metal in the shell may expand evenly Next regulate the feed pump, or injector, to supply water as steam is used Keep the wood or coal spread evenly over the grate, and do not allow the great bars to become bare, as cold air will rush in and cool the heating surface The thickness of the fire will depend on the draft, if the draft is strong the fire should be heavier than if it is weak When burning wood maintain a bed of live coals about three inches deep with plenty of wood on top to maintain this thickness In order to clean the fire push the upper part of the fire to the back of the grate, remove ashes and cinders, then pull the fire forward and draw the ashes and cinders of the back over the fire into the ash pit, distribute the fire evenly over grate and add new fuel If burning soft coal break the fire up occasionally with a bar as it has a tendency to crust on top Do not allow the ash pit to become full of ashes as there is danger of burning out the grate bars in such case

When working with fire or firing do so as quickly as possible for cold air rushing in not only cools the boiler, but also causes uneven contraction in it, and uneven contraction and expansion of the shell and tubes of a steam boiler do it great injury Leakage and cases of rupture are often caused by forced heating and cooling Be moderate in everything that tends to change the temperature of the boiler The safety or pop valve should be raised once or twice a day when under pressure doing so very gently to make sure it is in working order

Sediment collects in all boilers, due to the precipitation of solid matter in feed water used This sediment forms a scale, and the presence of a scale results in fuel loss It has been estimated that one-sixteenth inch causes a loss of 13 per cent of fuel. one fourth inch 38 per cent, and one half inch 60 per cent Further, the circulation of water in the boiler causes loose particles of this scale to be deposited in some one place, which is generally over the fire box This place becomes overheated and results in "bagging" In order to avoid the accumulation of sediments with the resulting evils, open the manhole and clean the boiler out occassionally, or boiler compounds may be used which aid in decomposing the scale

The Engine

The following directions pertain to the ordinary types of stationary steam engines Before starting the engine, oil up all around, and see that the cylinder lubricator is in working order Then open all drain cocks, open throttle valve slightly, and allow the steam to warm the walls of the steam chest and cylinder Now start the engine slowly and allow it to run a few minutes before closing drain cocks, for if drain cocks are closed too soon water will collect in the cylinder and either split it or burst out the head During the run feel the bearings occassionally avoid all lost motion by keeping parts well tightened up

On closing down first open drain cocks, then close throttle slowly allowing the engine to slow down gradually Never close or open the throttle-valve quickly If any unusual noises occur during the run close down immediately and investigate Clean off the engine thoroughly after each run It pays to use a good quality of cylinder oil Give the cylinder oil in quanties of about one drop a minute

The method of starting and stopping gas and oil engines vary so much with different makes that we have not enumer ated them here Suffice it to say that the same caution should be taken about oiling up, and keeping all parts tightened as with steam engines

Pumps

In order to start a centrifugal, or rotary pump, it is first necessary to raise the water into it This can be done by use of the ejector, when in connection with a steam plant To do this, close the mouth of the exhaust water pipe by some convenient means, a good way being to place a piece of soft leather, stretched on a board, over it. Now turn steam through the ejector, this will exhaust the air and raise the water into the pump When this is done start the engine, gradually coming to speed If the pump is run by a gas or oil engine, an ordinary hand pump may be used to raise the water During the run keep the bearings of the pump and counter shaft, if any, well oiled Feel each occasionally Keep the belts in good condition, and avoid slippage by the use of belt dressing A pump fails because it leaks, there can be no other reason, find the leak and repair it Leaky valves can be repaired by grinding valve seats Always drain the pump in cold weather, for water remaining in it will probably freeze and either loosen joints or burst the pump Lastly always keep material for gaskets and packing on hand

ACKNOWLEDGMENTS

Available literature upon the subject of pumping for irrigation has been freely consulted by the writers in planning the tests reported in this bulletin and in its preparation Grateful acknowledgment is hereby given for the general interest and encouragement received from the citizens of the Rio Grande Valley of New Mexico, and from those in various parts of the country, who have aided the work of securing data by filling in the blanks sent out The writers wish to acknowledge their indebtedness to the Mechanical Engineering Department of the College for ready assistance given in

the use of tools, operation of machinery and for various supplies provided during the progress of the work, to Prof A B Sage, of that department, who accompanied one of the writers on a tour of inspection of the pumping plants of New Mexico, to Mr J S MacGregor of the same department, and to Prof J D Tinsley, the soil physicist, for valuable and timely assistance throughout the progress of the work, and to the Chemical Department of the College for analysis of water furnished, to the F H Bascom Co , of Las Cruces, New Mexico, for the loan of sundry equipment, and to the Atchison, Topeka & Santa Fe Railroad Company for transportation facilities and courtesies extended Acknowledgment should also here be made to the Aermoter Company of Chicago for providing the institution with a complete Aermoter wind mill tower and pump for irrigating purposes, the results of tests with which will be published later, and to Irvin Van Wie of Syracuse, New York, for the gift to the institution of the five inch centrifugal pump used in connection with the pumping tests reported in this bulletin

Comments Bearing on Compact Negotiations.

1. PURPOSE OF A COMPACT.

The purpose of a compact on the part of New Mexico and Texas with Colorado with regard to the Rio Grande would be to assure a continued supply of water to their lands in the Middle Rio Grande Conservancy District, the Rio Grande Project and other irrigated lands, as good as has been enjoyed heretofore, leaving to Colorado, after accomplishing this, such leeway as she could find to use more water and bring in more land in the San Luis Valley than has been the case in the past.

2. COLORADO ALLEGES SURPLUS WATER IN THE RIO GRANDE.

Colorado asserts that further use of water can be made in Colorado, without detriment to the irrigation interests in New Mexico and Texas, by storage of flood and surplus waters.

3. NOT BORNE OUT BY FEDERAL REPORTS AND ACTION..

Under the Reclamation Act thru steps undertaken in 1902 and 1903 the United States Government initiated the Rio Grande Project. Settlement was effected with regard to earlier rights in Texas and New Mexico; Elephant Butte Dam was built to provide a reservoir of such a capacity as would feasibly utilize all the flood and unappropriated water of the Rio Grande, and such an area of land was opened and entered as could feasibly be served and safeguarded by the Elephant Butte storage. The basis of the Rio Grande Project of the Federal Government is that all of the surplus, flood and unappropriated waters of the Rio Grande are required to safely maintain an adequate supply of water for its lands. The official reports of the Federal Government consistently maintain this position, and application of other lands for participation in the Project have been refused for this reason.

4. CONTINUED EXTENSION OF IRRIGATION BY COLORADO.

Colorado continues to extend her irrigated area in the San Luis Valley and, if no new conditions arise, will continue to do so for an indefinite period, thus yearly increasing her relative use of the waters of the Rio Grande.

This arises from:-

a. Occupation of and use of water on new units of raw land.

b. Extension of irrigation to the unirrigated portions of already entered lands.

c. Extension of drainage and resulting rediversion and dispersion of surplus ground water to areas insufficiently supplied.

d. Change of short season deficiently irrigated grass lands with decreed rights to longer season crops requiring more water.

e. Pumping recently begun but practically unlimited in extent if economical.

5. FOUR MILLION ACRE FOOT STORAGE RESERVOIR NOW AVAILABLE BY USE OF PUMPS.

The lands of the San Luis Valley seem to present almost ideal conditions for pumping developments, which would at the same time provide irrigation water and deep drainage and a storage reservoir. Considerably over one million acres lie with grades of from one foot to the mile to not over eight or nine feet to the mile and with the ground water approximately paralleling the ground surface and varying in depth from the surface to ten feet in depth. The general statement is made that under the surface soil the sands and gravels extend to some fifty feet in depth.

PUMPING POSSIBILITIES - SAN LUIS VALLEY.

Lands Susceptible of Irrigation, with Shallow Water Table.

(Grades not exceeding about 9 ft. per mile.)

	Townships	Acres	Underground Storage for 16 ft. Drawdown.+ Acre-Feet.
San Luis Valley	47	1,081,000	4,324,000
Rio Grande Basin: S. W. Area:-	16	368,000	1,472,000
"Trough" Area Rio Grande Control	16	368,000	1,472,000
Rio Grande Served Totals	32	736,000	say 3,000,000
Trough area Trough water.	15	345,000	1,380,000

+ One foot depth of water equal to four feet of drawdown.

6, RUNOFF AND STORAGE, SAN LUIS VALLEY.

AVERAGE ANNUAL RUNOFF-COLORADO AREA.
(1890 to 1923, Meeker.)

	Acre Feet.
Entire San Luis Valley	1,625,000
Rio Grande and S. W. Tributaries	1,312,000
"Trough" Area	252,000
Rio Grande at Colorado State Line	613,000

PUMPING STORAGE FOR SIXTEEN FEET DRAWDOWN.

San Luis Valley, 47 Townships	4,324,000
Rio Grande Served Area, 32 Townships	3,000,000
Trough Area Served by Trough Water, 15 Twps.	1,380,000

SAN LUIS VALLEY STORAGE SITES.

	Height Ft.	Area-Acs.	Acre-Feet	Cost
Conejos, U.S.R.S.	170	480	140,000	$3,204,000
Vega Sylvester U.S.R.S. 1919	(128	2,000?	238,000	3,102,000
State Line (Giroux) USS.R.S. 1919	(110	12,000	200,000	1,557,000
Totals		14,000?	438,000	$4,659,000
Wagon Wheel Gap	250		480,000	7,591,600
Tipton-1924	300		730,000	10,035,700
	347		1,080,000	13,757,000

Tipton:- "At 347 feet high the Wagon Wheel Gap Reservoir would practically control the flow of the Rio Grande in the maximum year's runoff to be expected, thus insuring complete flood control of the Rio Grande in San Luis Valley." "CONCLUSIONS:- 3. It would be necessary for water to be from one-half to once gain more valuable than it is now to justify the construction of the Wagon Wheel Gap Reservoir for irrigation alone. Sugar beets, etc. might justify it.--------- As a combination flood control and storage reservoir, the Wagon Wheel Gap site surpasses anything on the Rio Grande in the San Luis Valley. Its position is such that if the dam were built to its full height, (347 ft.) it would practically control the river and take care of almost all of the water of the maximum flood to be expected, thus insuring against damage from floods, the towns situated on the river as well as all other property adjacent to the river."

One of the chief points of comparison can be restated as follows:-

	Acre Feet.
Average annual discharge of the Rio Grande at Colorado State Line,	613,000
Storage in four feet only of drawdown on the 736,000 acres of land served by the Rio Grande and tributaries in S. W. Area.	736,000

7. DANGER TO NEW MEXICO AND TEXAS FROM PUMPING IN SAN LUIS VALLEY.

Extension of irrigation development by pumping in Colorado represents the greatest ultimate threat there is of a disastrous depletion of the water supply now passing over the Colorado State Line. It is perhaps, not too much to say that by this means alone, except with a small storage on the Conejos River, and enlargement of the Rio Grande ditches that the Rio Grande could be permanently made dry at the mouth of the canyon where it leaves the valley. The economic changes now rapidly taking place in this country suggest the inevitable outcome sometime in the near future of extensive pumping developments. Stabilized crop prices and cheapening of prime power costs would hasten it.

8. DANGER FROM CONTINUED NORMAL DEVELOPMENT.

Whether rapid pumping development does or does not take place it is evident that future development in Colorado due to merely continued normal growth under present conditions and regulations will ultimately prove disastrous to irrigation below the Colorado State line.

9. NO DIRECT RESTRICTION OF COLORADO DEVELOPMENT.

At the present time in Colorado any parties believing that they can divert surplus flood waters for one or more irrigations and thereby profitably produce some crop can ask for an appropriation for such water, and if successful in diverting and spreading such waters can get an adjudicated right to the same. Also, parties developing drainage or seepage waters are entitled to use the same if they can be put to use.

Furthermore there are no regulations whatever governing the development of water by artesian wells or by pumping. There are no restrictions on unlimited development.

10. A COMPACT AND RESTRICTIONS.

For a compact to be made effective on the part of Colorado it appears that, depending upon the form of the compact, new legislation may be required, particularly with regard to control of pumping from drains or ground water or channels, when such would affect outflow.

11. A PROPOSAL BY LOWER STATES FOR A COMPACT DIVISION OF THE WATERS.

A. A Division on the Basis of a Proportion of the Flow. This would seek to divide at the moment the flowing waters on the basis of the amount that would ultimately be discharged at the end of the season many months later. It can be appreciated that to divide violently fluctuating natural stream flows with the purpose in view of effecting a proportional part of a future amount presents too many difficulties to Colorado. Even if the authority were in Colorado's hands, the administration of forecasting events and determining what ditches to close down and at what times during the season to close them would prove too difficult.

B. A Division Depending Upon State of Elephant Butte Reservoir and Requirements of the Middle Rio Grande Conservancy Dist.

If Elephant Butte Reservoir were full and flowing to waste, Colorado would be free in any case to divert to the extent of the waste. If the Reservoir were empty the Lower States would have to seek all discharge possible from Colorado. A division by proportion would properly vary in an effort to meet these extreme conditions and, at the same time, care for the direct diversions to which the Middle Rio Grande Conservancy District would be entitled. This would appear to only enhance the difficulties of a division.

C. Proportional Division Call for Flood Storage and Controlled Drainage.

It would seem that for any proportional division the waters must be under control for division and adjustment of the division from month to month or time to time. This would indicate the requirement of more or less Flood Storage and Controlled Drainage, if benefit from drainage is to be sought by Colorado.

12. UNDER A COMPACT LOWER STATES VIRTUALLY RELINQUISHING RIGHTS.

Colorado alleges that over 200,000 acre feet of water on the average are surplus waters. It should be noted that if a compact division of the water is entered into, then New Mexico and Texas are giving up all rights to further appropriation of the alleged surplus, but freeing Colorado, subject to the Compact, to such capture of water as she can effect and to such extension of irrigation as she can accomplish. In other words, Colorado only is the applicant for further and new rights.

13. POSSIBILITIES UNDER A STREAM ADJUDICATION.

From the engineering point of view, a Stream Adjudication apparently would provide the means and the simple terms necessary for an accurate administrative division of the water supply under any conditions of flow and any stages of Elephant Butte Reservoir, etc., so solving the almost insuperable conditions met in trying by Compact to divide natural stream flow.

But, as regards the Lower States, the word "apparently" was used because even with a Stream Adjudication, a widespread pumping development with enlarged ditches could nullify the protection of the decree unless proper power of control over these developments was provided for in the decree and the court exercising control.

As regards Colorado, unless further flood storage of large amount were provided, the present conditions would, largely, have to be continued because the Lower States would be entitled to maintain Elephant Butte at maximum possible storage.

14. FLOOD CONTROL ADVANTAGEOUS.

Any settlement of mutual advantage seems to predicate the necessity of flood control of any surplus waters.

A Compact without such control would hardly appear possible.

A Stream Adjudication without such control would require plenary powers over Colorado developments in order to protect the Lower States.

15. "BURDEN OF PROOF" FOR PROPOSALS ON COLORADO.

Colorado is the party seeking new rights on a stream whose natural flow is many times over appropriated. Unregulated storage on her part will damage others. The "burden of proof" is on her to show how her plans can be carried out without detriment to others. This position is very fully set forth in the recent paper by Mr. Samuel C. Wiel entitled, "Water Law and Country Values", dealing with the proposed control of precisely this same situation in California.

16. A POSSIBLE SPECIFIC PROPOSAL TO COLORADO.

It would seem that a tentative offer might be made to Colorado along the following lines:

"The rights of the Middle Rio Grande Conservancy District to necessary direct diversion for its ________acres of land and of the Rio Grande Project for the sufficiency of the maintenance of the Elephant Butte Storage are being safeguarded by the present flows of the Rio Grande (up to 1927?) across the Colorado State line, represented by an average flow of _______acre-feet annually. If Colorado has plans to propose that will equally well serve the Middle Rio Grande Conservancy District as to the stated direct diversions required and which will maintain the storage of the Elephant Butte Reservoir to those same levels, based on an average annual discharge from said reservoir of 820,000 (?) acre-feet, which would have been maintained if changes should not have been made in the regimen of the Rio Grande, then Texas, New Mexico and the United

States are prepared to entertain them."

Such would require the disclosure of the detailed plans and such would seem necessary to permit of scrutiny of the feasibility of her plans as to in how far they would guarantee the safeguarding of the rights of New Mexico, Texas and the United States.

E. P. Osgood
Engineer.

OSE/LF-00026088

NOTICE TO PROJECT WATER USERS

August 27, 1946

Rio Grande Project Irrigation Schedule
Announced

The fall and winter irrigation schedule for the Rio Grande Irrigation Project previously recommended with a view of conserving the available water supply has been adopted after consideration by the Boards of Directors of the Elephant Butte Irrigation District and the El Paso County Water Improvement District No. 1 and will become effective as outlined. The allocation of reservoir stored water commencing October first seems to be a very essential measure and required as a part of the necessary conservation program.

The almost negligible reservoir replenishment this year as a result of the general extreme drought conditions through the Southwest makes it imperative that measures be taken to conserve the Project's water supply to maintain this year's use within the average annual amount available and to provide the necessary carry-over of a partial supply for next year's irrigation.

(a) Caballo Dam gates to be closed September 11th - following which water will remain available through the various sections of the project for from 1 to 5 days depending on the distance from the dam. No orders for water will be accepted after September 10th.

(b) Gates to be opened for release of stored water to serve land for which return flow is not available October 1st to 9th; November 8th to 15th; December 15th to 21st. Water released will be available 1 to 5 days later than these dates depending on the distance from the dam.

(c) In units of the Project for which return flow is available it will be rotated in the various canals throughout the unit up to December 31st in accordance with schedules to be announced for each such unit.

(d) There will be no water run in any part of the Project during January at which time canal and structure maintenance and repair work will be accomplished.

(e) It is proposed to provide a run of water for a short period commencing about February 20th after which the gates will again be closed, to be opened for the 1947 season about March 10th.

The schedule and dates, also the allotment of water, would be subject to modification or change depending on water supply and weather conditions.

Apparently the allotment of the Project water supply will be necessary as the normal procedure every year to maintain releases from Project storage within the average annual amount of water available. As for the season of 1947 the amount of water now in storage at the present low stage of the reservoir and the absence of inflow replenishment indicates a tentative allotment of two acre feet per acre of construction repayment land. There will be no allotment to suspended land.

All water delivered during the periods of availability of reservoir released water in accordance with the above schedule after October first will be charged against the allotment for 1947.

After giving full consideration to water supply conditions, crop programs and irrigation requirements recommendation of the above Project schedule was decided upon as appearing to be in the best interest of Project water users generally, and under the circumstances required to meet the present situation; the schedule of deliveries adopted for the El Paso Valley is as follows:

YSLETA DIVISION

Gates at the reservoir are being closed on September 11th, water will be run simultaneously in all ditches as long thereafter as possible, then the following schedule will go into effect on the dates applicable.

Upper and Lower Franklin and Clint and Salatral Ditches		San Elizario, Riverside, Island, Hansen and Tornillo Ditches	
Sept. 16 to 20 incl.	5 days	Sept. 23 to 27 incl.	5 days
Sept. 30 to Oct. 4 incl.	5 days	Oct. 7 to 11 incl.	5 days
Oct. 14 to 18 incl.	5 days	Oct. 21 to 25 incl.	5 days
Oct. 28 to Nov. 1 incl.	5 days	Nov. 4 to 8 incl.	5 days
Nov. 11 to 15 incl.	5 days	Nov. 18 to 22 incl.	5 days
Nov. 25 to 29 incl.	5 days	Dec. 2 to 6 incl.	5 days
Dec. 9 to 13 incl.	5 days	Dec. 16 to 20 incl.	5 days
Dec. 23 to 27 incl.	5 days	Dec. 27 to 31 incl. (Tornillo)	5 days

It is requested that all water users place orders for irrigation water with the ditchriders well in advance of date scheduled. For further information see your ditchrider.

Any released storage water will be distributed evenly throughout the District during the fall irrigation season and all interested water users will be notified as early as possible. Deliveries after October 1st made during periods storage water is available in the Valley will be charged against the tentative allotment of 2 acre feet per acre.

Your ditchrider will advise you of the dates storage water may be available. Tentatively these dates are: October 7-15; November 15-21; December 21-27. Weather conditions permitting releases from the reservoir will be reduced; or eliminated entirely.

- - - -

L. R. Fiock
Superintendent

RIO GRANDE PROJECT IRRIGATION SCHEDULE
ANNOUNCEMENT
August 12, 1947

In consideration of the present record low stage of Rio Grande Project storage reservoirs as a result of five consecutive years of below normal inflow, a recommendation that there be no release of water from storage for fall and winter irrigations made by the Elephant Butte Irrigation District Board and concurred in by the El Paso County Water Improvement District No. 1, is to be carried out by the Bureau of Reclamation.

Other elements of an irrigation schedule which have been agreed upon to become effective are:

(a) The present irrigation season is to terminate with the closing of Caballo Dam gates about September 10th, depending on conditions and requirements, following which reservoir water will remain available through the various sections of the Project for from 1 to 5 days depending on the distance from the dam. No orders for such water will be accepted after September 10th.

(b) Caballo Dam gates to remain closed until the commencement of the 1948 irrigation season about March 1st, 1948, contingent upon conditions and requirements at that time with definite date to be determined and announced then. No release of reservoir stored water will be made for fall and winter irrigation.

(c) In units of the Project for which return flow water is available it will be rotated in the various canals throughout each such unit up to December 31st in accordance with requirements and schedules to be announced locally for the respective units. Deliveries from return flow water will not be charged against the allotment. No water will be run in any part of the Project during January at which time canal and structure maintenance and repair work will be accomplished.

(d) For the season of 1948 the available water supply actually on hand in Project storage will be allotted to land subject to repayment of Project construction charges. All water delivered during the time of availability of water released from storage after October 1, 1947, is to be charged to the allotment. No allotment will be made to so-called suspended land or land not subject to payment of Project construction charges.

(e) On the basis of the amount of water now actually in Project storage and the probable carry-over for the commencement of the 1948 season, an allotment is now made of one acre foot to each acre of land subject to the repayment of Project construction charges for the beginning of the 1948 season to become effective October 1, 1947. The allotment would be subject to increase to be announced if, when and as additional water becomes available.

United States
Department of the Interior
Bureau of Reclamation
Rio Grande Project

CONSERVATION IN THE
USE OF IRRIGATION WATER

PRINCIPLES AND PRACTICES
TO BE OBSERVED AND FOLLOWED

IN THE

CONTROL, DISTRIBUTION AND USE
OF THE
IRRIGATION WATER SUPPLY

FOR ITS CONSERVATION
AND
MAXIMUM PRODUCTION RESULTS

To land owners, farmers and the
Project operating organization:

The present low stage of Project Storage and the extreme shortage of water in the Southwest generally as a result of five successive years of below normal runoff, with the last two extremely low, being less than 30% of normal, emphasize the imperative need for the most economic control, efficient distribution and conservative use of available water supplies, not only for the immediate present but as a general practice at all times.

Review the "Summary Outline of Principles of Conservation in the Use of Irrigation Water" now. It may be to your best interest. Then read and study the explanation of those principles and the "Statement on Rio Grande Project Water Supply" which follow, at your leisure. Save them and read them over until you have determined which of them apply to, and should be followed in, your particular case.

SUMMARY OUTLINE OF PRINCIPLES FOR
CONSERVATION IN THE USE OF IRRIGATION WATER

C. Application of Irrigation Water to the Land

6. Use of Water on Land to Produce Crops

a. Water belongs to the landowner. He should be most interested in its conservation.

b. Most conservative use produces greatest yields per acre foot of water used, rather than per acre of land.

c. Irrigation requirements vary. Farmer must determine those which best fit his particular conditions.

d. Soil moisture conditions and crop requirements must be carefully watched and studied.

e. Do not use excess water or over-irrigate.

f. Use just enough water if available to keep crop in continuous healthy growth. Do not wait until crop is suffering and then expect immediate relief on demand or short notice.

g. Place orders sufficiently in advance to allow time required for water to come from storage. Do not expect water delivery service if you have not ordered. Use water ordered.

h. Do not delay ordering nor postpone or cancel orders. To avoid peak demands which result in delayed deliveries following periods of light showers or cool weather pay particular attention to soil moisture conditions and crop requirement during such periods.

i. Irrigation water must be used continuously. Do your share of night and week end irrigating. Do not cut back or reduce delivery heads.

j. Cultivate to conserve moisture.

k. Do not over-irrigate early in the season. Force crops to develop a good root system.

l. Have large enough ditches and boxes. Keep them clean.

m. Start irrigation at far end of field. Shut delivery gate soon enough to avoid waste of ditch full of water.

n. Change runs soon enough to prevent water, running onto roads, into drains or accumulating at lower end of the field.

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United States
Department of the Interior
Bureau of Reclamation
Rio Grande Project

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CONSERVATION IN THE USE OF
IRRIGATION WATER SUPPLY

The feasibility and extent of an irrigation project are generally dependent on, and determined by, the available water supply rather than being restricted by the amount of land that may be susceptible of irrigation or upon topographical obstacles necessary to overcome in the construction of works. This is especially true in the semi-arid west and in particular the arid southwest. Briefly the major and principle steps in making use of the water supply to the ultimate objective of crop production may be briefly outlined as follows:

A. Control and Regulation of Water Supply	1. Storage and Release to meet Irrigation Requirements 2. Diversion of Natural Stream flow or Storage Water
B. Distribution and Delivery	3. Operation of the Distribution System 4. Delivery of Water to Farms
C. Application to Land	5. Preparation of Land for Irrigation 6. Use of Water on Land to produce Crops

True conservation in the use of the water supply then should be the production of the greatest quantity of crops attainable by the most efficient use of the amount of water available. Contra to the use of the available supply beginning with its control and regulation its conservation should begin with the end objective, its use on the land to produce crops. Our subject being the conservation in the use of the available water supply we will then proceed in reverse order of the above outline.

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SUMMARY OUTLINE OF PRINCIPLES FOR
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o. Check closely on hired irrigators.

p. Adjust crop and irrigation program particularly for specialized crops to irrigation schedule adopted to meet major requirements. This applies especially to winter irrigations.

q. Do not gamble with water supply by attempting to force the season with too early irrigation and planting.

r. Land should be properly prepared for irrigation.

5. Preparation of Land for Irrigation

a. Whether the method of irrigation be surface flooding, bordered tables, beds, furrows or corrugations conservative and efficient use of water requires a very fine balance between type of soil, slope of land, length of runs and head of water applied.

b. Do not level light or sandy soil land to too flat slope. Do not have too long runs.

c. Use proper head of water in each border or furrow for most efficient and economical application.

d. Each farmer must work out the best combination to fit his particular conditions.

e. Whatever can be done or is done about the others the head of water can always be adjusted to effect a practical conservative, if not an ideal, combination.

f. Level down high spots and fill in low places.

B. Distribution and Delivery of Irrigation Water

4. Delivery of Water to Farms

a. Deliveries to farms may be by continuous flow, in rotation, upon advance orders or on demand.

b. Continuous flow involves use of small heads with large percentage of loss and is unusually impractical.

c. Strict rotation too may be wasteful and not provide service when most needed.

d. Delivery on demand is the most wasteful of all. Water cannot be on hand and available for delivery on demand or short notice without going to waste when not being used.

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e. Delivery on orders placed in advance to meet anticipated actual requirements modified by rotation sufficiently to keep deliveries bunched is most conservative and efficient practice especially where water supply is controlled by storage and orders are received sufficiently in advance to make reservoir releases accordingly.

f. Economic control of the water supply, its equitable and efficient distribution and conservative use with uniformity of service require reliable measurements of water both in its distribution to canals and deliveries to farms.

g. In the case of irrigation water as with any utility service flat rates are conducive to wasteful practices and use.

3. Operation of the Distribution System

a. The distribution system can be operated most efficiently and best service rendered by keeping deliveries to farms bunched. This may be referred to as the rotation system but when combined with an order system becomes a modified rotation - order system. Deliveries from a canal or lateral should be worked upstream and the rotation repeated.

b. Each ditchrider should order the amount of water required for his unit on the basis of orders he has received in advance and then account for all the water alloted to him. He should see that the water is used continuously.

c. All water should be accounted for by reliable measurements. Ditchriders should report by telephone daily to their watermaster.

d. Water cannot be run through one unit to another for the purpose of having it immediately available for use in the first.

A. Control and Regulation of Irrigation Water Supply

2. Diversion of Storage Releases of Natural Stream Flow

a. Available water should be alloted to the various diversions according to requirements, orders or priority as the case may be.

b. Water for lower diversions, or units should not be run through ones above for the purpose of having it available for immediate demand in the upper one.

c. Each district, division, unit and farm must be held responsible for its share of waste depending on how well or how lax its operations are conducted.

1. Control of Water Supply by Storage

a. The most conservative use can be made of the water supply when controlled by storage and released to meet requirements based on orders received sufficiently in advance.

b. Constant vigilance, alertness and full cooperation is required of the operation organization and farmers; Farmers to anticipate requirements and order sufficiently in advance to permit reservoir releases to be made accordingly; Ditchriders to obtain order in advance and request water required by his unit; Watermasters to inform the Project water dispatcher of Division requirement. Water dispatcher to determine and order necessary release.

c. Most beneficial and economic use of water contemplates occasional years of partial shortage.

d. Harmonious cooperative relations between the Bureau and Districts is essential to best operating conditions.

Note:

See following "Explanation of Principles for Conservation in the Use of Irrigation Water" and "Statement of Rio Grande Project Water Supply."

Captions and paragraph numbers in the following explanation correspond with those pertaining to the same subject matter and in the same order as they appear in the above summarized outline.

This pamphlet may be referred to in future statements on Project water supply or notices calling attention to various phases of the subject discussed herein.

EXPLANATION OF PRINCIPLES FOR
CONSERVATION IN THE USE OF IRRIGATION WATER

6. Use of Water on Land for Crop Production:

a. The basis for the ownership and retention of a water right is beneficial use of the water. The landowner therefore is the owner of irrigation water but, depending on its availability, he can hold a water right only to the extent he can and does make beneficial and efficient use of the water. It is to the interest of the property owner then, whether he be a resident farmer, or conducts his farming operations through a manager, foreman or tenant, to make it a point to see that all of the principles for the most conservative and beneficial use of the water supply are complied with to the fullest extent.

b. The most conservative use of the available water supply may be said to be that which results in the maximum crop production. This does not mean the excessive use of water to produce the highest possible yield per acre. A point is reached in the application of irrigation water where the increase in yield is not in proportion to the additional water applied and then even begins to decrease. Shortly after the point is reached where increased yield is no longer in proportion to the additional water applied, another point is reached where it becomes more productive and profitable to apply any remaining available water on other crops or on additional land. The most conservative use of the water supply should result in the greatest yield of the most profitable crop per acre foot of water, rather than the largest yield per acre of land. Experiments should be conducted on test plots with records kept of irrigations and yields for comparison to determine how the optimum results may be attained.

c. The frequency of irrigation and amount of water required varies greatly with the kind of crop and type of soil assuming proper preparation of the land for irrigation and other conditions being equal. With a wide variation in surface topography or terrain, climatic conditions, soil types, crops grown, etc., no two irrigation projects have exactly the same practices in irrigation. Adjoining farms differ widely and even on the same farm there is rarely a uniformity of conditions over the entire farm. Each farmer must observe and study conditions and requirements on his own farm and of the crops he is growing and then regulate his operations according to his best judgment, based on his knowledge and understanding of his own problems. He may obtain help and advice from technical and agricultural agencies such as the County Agent, experiment stations, etc., but after all he must adapt the general theories and principles to his own particular conditions. There are no set rules that can be applied universally without judicious adaptation and variation, if indicated, to fit the immediate conditions and requirements.

d. Soil moisture conditions and crop requirements should be carefully watched and studied at all times and irrigations regulated accordingly. This is essential not only to effect the proper combination of soil type, slope of land, length of run and head of water, but to give

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the crop just enough water to meet its requirements without either deficiency or excess and waste. It is especially important during and immediately following periods of light showers, or cool weather when assumed soil moisture conditions may be erroneous, in order to prevent subsequent suffering of crops and the accumulation of orders resulting in peak demand on the system beyond its capacity to serve in a reasonable time. Depth of soil saturation by irrigation or rain can be easily determined by a probe rod, soil auger or shovel. It need not extend below the root zone.

e. While considering that a limited portion of the water applied to the land must perculate on through the soil and by eventually making its way to the drains, provides the circulation needed to prevent the accumulation of alkali salts on the surface, do not over-irrigate. Irrigation in excess of requirements constitutes a waste of water. Furthermore, if excess water reaches the ground water table faster than it can escape to the drains, the water table rises resulting in seepage and alkali surface condition. Remember a rising water table, high water delivery charges, and waste of water are companion evils of excess or over irrigation.

f. On the other hand if sufficient water is available irrigation applications should be just those necessary to keep the crop in continuous healthy growth. Do not wait until the crop is suffering and then demand or expect immediate relief by delivery of water on request or short notice. Such practices disrupt normal irrigation schedules. Also under such circumstances there may be too many others doing the same thing and so lead into an irrigation peak demand which cannot be relieved except to irrigate out in due time by delivery of regular irrigation heads of water on a rotation schedule or make deliveries as near as possible in the sequence in which orders were received. Furthermore, depending on the distance, time is required for an increase in storage release to arrive at the point of use.

g. By careful observation of the soil moisture and crop conditions irrigation requirements should be anticipated and water ordered sufficiently in advance of its need to permit storage releases to be made on the basis of the consolidation of such orders, provided the supply is controlled by storage. Do not expect water delivery service or count on water being available if you have not ordered it sufficiently in advance to allow for its arrival from storage by the time it is needed. It should not be available if not so ordered.

Water should be used when ordered unless someone else who has not ordered can be found to take it. Do not postpone acceptance of delivery and expect special service later. Water once released from storage to meet an anticipated requirement or order cannot be put back in the reservoir. It simply goes to waste if not used.

h. Delayed ordering whether due to lack of up to date information on soil moisture conditions and crop requirements or otherwise and postponement or cancellation of orders especially during periods of light rain showers and cool weather when soil moisture condition may be misleading unless watched with extra care, result not only in the

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loss of water which had been released from storage to meet anticipated requirements, but also in subsequent accumulation of orders and peak irrigation demands that may temporarily tax the distribution system beyond its capacity to provide service within the usual time. Such emergency conditions and situations should be avoided. No irrigation system can be economically constructed and maintained to sufficient capacity to serve the entire area or a major portion of it simultaneously or even in a very limited time, especially if such demands occur only for comparatively brief periods once or twice in a season. Such peak demands are sometimes greatly aggravated both as to suddenness of occurrence and magnitude by a predominately one-crop system that cannot successfully be continued indefinitely.

i. Irrigation water must be used continuously 24 hours a day, 7 days each week. Each irrigator must do his share of night and week end irrigating. Do not cut back or reduce night irrigation heads as it results in increased use of water as well as causing canal fluctuations and waste of water. Water cannot be made available for use when needed and then taken only as preferred without going to waste when not being used, causing intermittent service to others and generally disrupting operation throughout the system.

j. Irrigations should be followed by cultivation to the extent that the kind of crop and stage of its growth will permit not only for weed control but to conserve the soil moisture to the greatest extent possible.

k. During the early part of the growing season plants should be forced to develop a good deep root system by avoiding over-irrigation. Over-irrigation of young plants tends to the development of a small shallow root system which requires continued frequent irrigations throughout the season with the application of more water than the plants actually use resulting in consequent waste. A well-developed root system will require less frequent irrigations and produce better plants with higher yield when the later irrigations are applied.

l. Have large enough ditches, gates and boxes. Keep them clean. Large enough heads of water should be used to expeditiously complete the irrigation without the application of water in excess of crop requirements resulting in loss by deep perculation below the root system which constitutes waste and raises the ground water table.

m. Start irrigation at far end of the field to avoid waste of a ditch full of water upon completion of irrigation. If the headgate is located some distance away from the field, close it soon enough to finish irrigation without the waste of the ditch full of water.

n. Do not allow water to run over on to roads or into drainage ditches. Change runs in time to avoid the accumulation of excess water at the lower end of the field.

o. Frequently irrigation abuses are the fault of employed irrigators especially if they are inexperienced or inclined to make it easy for themselves. Under such circumstances farmers should watch their irrigations closely to see that hired help comply with requirements of best practices.

p. Crop and irrigation programs of individual operators, particularly for specialized and minor uses should be adjusted to irrigation water schedules established to meet major requirements. Adherence to such schedules should be especially observed for fall and winter irrigations when irrigation runs are made intermittently. Operation of the system for special deliveries to very limited and scattered acreage is extremely expensive both in operating cost and waste of water, also seriously interferes with necessary maintenance work. There are certain non-irrigation periods when water must be out of thecanals to accomplish maintenance work.

q. Do not gamble with irrigation water, especially when the supply is limited. The gain if any is most apt not to be worth the risk. Pre-season planting in attempts to force the growing season too often results in re-planting or stunted growth requiring extra irrigations and not only extra seed and planting cost, but with the consequent loss without benefit of the additional water used, particularly if it has been drawn from storage. Crops planted in season when germination and continued growth is assured will in the end out-germinate, out-grow and out-produce replantings, or plants stunted and retarded by unfavorable weather when too early planting is attempted.

r. The amount of water required to produce a crop depends to a very great extent upon the preparation of the land for irrigation as well as upon the skill and judgment of the irrigator in applying the water to the land.

5. Preparation of Land for Irrigation:

a. Preparation of the land for irrigation should depend upon the surface topography or terrain, type of soil, kind of crop to be grown and method of irrigation. Whether the method of irrigation be surface flooding, bordered tables, beds, furrows or corrugations, the most conservative and efficient use of water requires a very fine balance between type of soil, slope of the land, length of runs and head of water applied.

b. If the soil is sandy or light and the slope is too flat, or the runs too long, or the head of water too small, the upper end of the field will be over-irrigated before the lower end has received a sufficient amount of water. The excess water absorbed at the upper end constitutes waste and may result in a rising water table.

c. If the soil is adobe or heavy and the slope is too steep or the runs too short or the head too large, the lower end of the field will be flooded before the upper end has absorbed enough water. This also constitutes a waste of water and may result in drowning out the crop at the lower end as well as a rising water table.

d. Again each individual farmer must, by trial and test, study the conditions on his particular farm to achieve the right combination of soil type, slope of land, length of runs and head of water to best meet his conditions and requirements. In this too there can be no fixed rules which may be universally applied. Combinations should be worked out which will adequately meet requirements in the shortest time and with the minimum waste so that the irrigations can be completed as economically and as soon as possible and to permit service to proceed on to others.

e. Little, if anything, can be done about type of soil; desired slope can be given to the land in levelling operations if cost is not too great; length of runs can usually be established to fit the above conditions; but the irrigation heads or size of stream turned into each table, or furrow, can always be regulated and adjusted to other conditions to effect a practical, if not the best, combination. The additional water and consequent waste resulting from long rows or runs established to reduce the amount of turning of farm equipment and the relative small area required for header ditches is a very high price to pay for those luxuries especially where the water supply is limited and at a premium.

f. Land should be levelled to a uniformly smooth plane surface, with proper slope depending on type of soil and length of run. Depressions which impond water become over-irrigated with waste, possible injury to the crop and rising water table. High spots will not receive enough water, or if water is run on surrounding land long enough to reach the high spots it becomes over-irrigated with the same results.

4. <u>Delivery of Water to Farms</u>:

a. The manner of making deliveries of irrigation water to farms may vary considerably in accordance with established practices and customs, but it is influenced largely by the character of the water supply. Some of those in use are con-

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tinuous flow, delivery in rotation, upon advance orders or on demand. There may be variations and modifications by partial combination. All can be subject to restriction by allotment or rationing in times of deficiency or as regular procedure but in different ways.

b. Continuous flow is not generally the most efficient as it usually involves the use of small heads of water continuously rotated around over the farm which itself results in a high percentage of loss, may also mean the use of water sometimes when it is not really needed and that constitutes waste. It would seem that such a system could be used only where there is wide diversification of crops on each farm or on large farms.

c. Strict rotation means the delivery of a fixed head of water for a set period of time at regular or established intervals. The rotation period may not always coincide with the time of actual requirements and that too may result in the use of water when not really needed and to that extent is a wasteful practice.

d. Delivery on demand is the most wasteful practice of all and cannot be adhered to anyway when the demand exceeds the capacity of the irrigation system, or there is a deficiency in the water supply. Water cannot be on hand and made available for delivery on demand or short notice without its going to waste when not being used. None but the most conservative practices should be tolerated except possibly where natural stream flow without storage control is being diverted and then only during the periods when the flow is in excess of immediate requirements and no other areas are affected thereby.

e. Deliveries on orders placed in advance to meet anticipated actual requirements modified by rotation sufficiently to keep deliveries bunched, would seem to be the most conservative and efficient practice, especially where the water supply is controlled in storage and releases can be regulated when and as needed to meet requirements. Orders should be placed sufficiently in advance of actual requirement to be consolidated so that reservoirs releases can be made accordingly with minimum of waste or deficiency.

f. The equitable distribution of the available water supply providing uniformity of service to all water users; economy in control of the water supply; its efficient distribution and conservative use, all depend upon the obtaining of necessary records as a basis for their accomplishment, which requires the application and use of reliable methods or devices for measuring the individual deliveries to farms as well as diversions and distribution to lateral canals. This becomes increasingly important or essential when the supply is limited and rationing of the supply, or delivery by allotment, is necessary.

g. In the case of irrigation water as in any utility service, flat rates are conducive to wasteful practices and use. Flat rate charges should not be tolerated except possibly when limited to communities of small home sites where the relatively small per cent of the area of the tract not covered by improvements is irrigated and the amount of water used cannot justify the extra cost of making accurate measurements, charges and billing on the basis of each separate irrigation. A graduated rate schedule with increasing rather than decreasing rates in proportion to the amount of water used should tend to encourage conservative use of water.

3. Operation of the Distribution System:

a. The distribution system can be operated most efficiently and best service rendered by keeping irrigation deliveries to farms bunched in the same general area as much as possible This may be referred to as the rotation system but when combined with an order system becomes a modified rotation - order system. This calls for deliveries to be made in accordance with orders received but varying enough from the sequence in which they were received to hold deliveries in the same general area moving up the canal or lateral. It permits the ditchrider to keep better control of the water, render better service, and reduces waste. He does not have the water deliveries scatter over his entire unit and be continually travelling from one end of it to the other. It reduces losses and waste by avoiding the handling of small heads in the laterals spread over the entire unit. Deliveries should be worked out upstream, rotating from the lower end of the canal or lateral to the head and repeated to avoid the loss and waste of a lateral full of water upon completion of the rotation.

b. Each ditchrider should request the amount of water required for his particular unit in the next reservoir release on the basis of the orders he has received sufficiently in advance to allow for its reaching his unit by the time delivery is to be made. When the water he has ordered is allotted to him he should account for all of it in water delivery charges except a reasonable allowance for system losses and possibly, where permissible, a minimum of unavoidable operating waste which must also be reported. Delivery and use of all water available should be continuous 24 hours a day, 7 days per week. Night and week end irrigations should be rotated so that every farm gets its share of each. Water should be allotted to the various ditchriders in accordance with their needs as indicated by the orders they have received. When deficiencies occur the immediately available water should be prorated over the various units in proportion to the requirements in each.

c. All of the water allotted to each ditchrider unit as well as deliveries to farms should be measured by means of some reliable method or device and reported daily. Each ditchrider should report by telephone daily to the watermaster of his division stating the amount of water he is receiving, the total number of acres for which he has outstanding water orders, general conditions in his unit, etc. Watermasters should then make a summarized daily report of water distribution and general conditions within their respective divisions to the Project water dispatcher.

d. The running of extra water through one unit, counting on the next unit below making use of the waste, cannot be tolerated in good operation. The lower unit cannot operate on waste from one above. The only object of running extra water through a unit is to have it available immediately on demand or in case an unexpected increasing demand comes in and then if the lower unit has been depending on waste from one above the waste suddenly ceases and the lower unit is doubly short for it too has an unexpected increase in demand.

2. Diversion of Storage Release or Natural Stream Flow:

a. Whether diversions are from storage release or natural stream flow the available water should be allotted to the various divisions or districts in accordance with requirements, previous orders or priority of water right as the case may be and deficiencies should be prorated accordingly. Diversions should be measured and reported daily.

b. Where water rights are equal in priority extra water cannot be run through the canals and laterals of one division of a project for the purpose of having it available immediately on demand or in case of an unexpected increase in demand counting on lower divisions absorbing and making use of any waste. When the increased demand develops the waste ceases and if a lower division has been depending on it that division suddenly finds itself doubly short on water, for it too probably has increased demand also because of the same conditions, usually weather, that caused the increased demand in the upper division.

Waste water from upper division is of no more value to a lower division, and cannot be depended on by them any more than, any one unit, or lateral or farm can depend on the waste from the one above for its irrigation or than users on the lower end of a canal or lateral can depend on waste from the upper end.

c. Each district, division, unit and farm, on a project, must be held responsible for its proportionate share of waste reaching the lower end of the project depending on how well or how lax its distribution and use of water is conducted. Those lower down should not be expected to, and cannot, depend on or absorb the waste from ones above.

1. Control of Water Supply by Storage:

a. It is reasonable to expect that the most conservative use can be made of the water supply where it is controlled by storage within a reasonable distance from the point of use and releases can be regulated to meet requirements with a minimum of waste or deficiency if based on orders received sufficiently in advance to allow the released water to reach the point of use by the time it is needed.

b. The most complete accomplishment of this requires the constant vigilance and alertness of both, and full cooperation between the farmers and the operating organization all along the line and at all times: The farmers by close observation of soil moisture conditions and crop requirements to anticipate need for water and place orders for it with the ditchrider sufficiently in advance to allow reservoir releases to reach the land by the time it is needed; The ditchrider to make it a point to get the orders in advance and turn in request to his watermaster for the amount of water he will require to fill the orders; The watermaster to inform the project water dispatcher of the total amount of water requested by ditchriders in his division; The project water dispatcher then by totalling the requests of all divisions, making allowances for river losses or gains in transportation and time required for water to travel from the reservoir to various sections of the project, also taking into consideration return flows from drains and probable operating waste available for rediversion determines the amount necessary to be released from storage and directs the gatetender to regulate the outlet gates accordingly.

c. Generally the most beneficial and economic use of the water supply contemplates occasional years of partial shortages or curtailment as well as some years of over-abundance, so that the area under irrigation may be as large as the available water supply will permit with anticipation of the possibility of occasional restrictions but without creating undue hazards to agricultural operations rather than, in order to insure that the area in cultivation may always have a full unrestricted supply the area under irrigation be limited to the point where any considerable amount of water normally goes by unused or wasteful and extravagant practices can be indulged in. This is especially true where irrigation is limited by available water supply rather than land susceptible of irrigation as in the arid southwest and where watershed runoff is the source of the supply, is extremely erratic from year to year, varying from an annual minimum to maximum of ten to fifteen times the minimum. Under such conditions reservoirs with large carry over capacities are necessary.

d. It is essential to best operating conditions that harmonious cooperative relations exist between the Bureau and Irrigation Districts, and between the water users and the operating organization.

Note:

The above remarks are intended to be a statement of guiding principles for the conservative use of available irrigation water supply based on long experience in the operation of the Rio Grande Project. While some of the rules may have specific application to local conditions, in general principle most of them probably are applicable to almost any other irrigation project. Following is a statement of Rio Grande Project water supply.

L. R. Fiock, Superintendent

STATEMENT OF
RIO GRANDE PROJECT
WATER SUPPLY

The basis for development and operation of the Rio Grande Project is the control by storage of the very erratic runoff of the Rio Grande with an annual discharge varying from 200,000 acre feet to 2,800,000 acre feet at the head of the reservoir area which has produced an average annual reservoir inflow of 1,053,000 acre feet. 790,000 acre feet is considered to be the average annual reservoir outflow available for release to meet irrigation requirement. The difference between the average annual inflow and outflow constitutes reservoir losses principally by evaporation estimated at approximately 6 feet per year over the reservoir area.

The capacity of Project storage reservoirs is sufficient to control practically the entire runoff of the Rio Grande entering the reservoirs and carry over water from years of abundant runoff for use in years of deficient runoff. Sometimes the surpluses from years of high runoff are carried over for several years to make up deficits in years of below normal runoff when they occur.

The capacity of Elephant Butte Reservoir is 2,200,000 acre feet at spillway elevation corrected for accumulated deposit of silt to date and of Caballo Reservoir 345,000 acre feet, a total of 2,545,000 acre feet. In 33 seasons of operation overflow spill has occurred in only one year, 1942, or 27 years after the commencement of storage operation in 1915 one year before completion of Elephant Butte Dam. Also there has never been an actual shortage although it might be said that there have been threatened shortages at the beginning of four years, 1919, 1935, 1941 and perhaps 1948, but these have in the past been alleviated by the occurrence of adequate spring runoff.

This record might be taken to demonstrate how fine a balance has existed between the water supply and irrigation use, but it must be recalled that at the time storage water was first available in 1915 there were in cultivation only about 70,000 acres and that the area in cultivation gradually increased until the project development now approximates 100% with 155,000 acres being irrigated, the area for which there has been considered to be a safe and reliable water supply. So that, as the irrigated area has increased the more economically and conservatively it has become necessary to control and use the water in order to serve the increased area as there has been and is now no means of increasing the water supply. A change in crop system such as a material decrease in acreage planted to cotton with a corresponding increase in the acreage of other crops having a higher water requirement, as must inevitably come about, may make such control and use all the more difficult, but imperative, and may eventually require the delivery of water on an allotment basis as normal practice each year in order to hold annual reservoir releases to 790,000 acre feet.

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It has been concluded that the average amount of water available for release from storage is 790,000 acre feet annually. Although this amount is mentioned in the Rio Grande Compact, it is not an arbitrary amount fixed by the Compact but was arrived at by the Compact Engineers in their study of past records and substantially agrees with findings stated in the reports on several previous studies of the Project water supply. It is what past records indicate has actually been the average annual amount of water available to the Project and by the operation of the Compact may be expected to continue to be available.

790,000 acre feet being the average annual amount of water available for release from Project storage, it means that for each year when water is released in excess of 790,000 acre feet, there must be compensatory amounts below 790,000 acre feet released in other years. Aside from any disadvantages or penalties devolving upon the Project through the operation of the Compact for having exceeded an average annual release of 790,000 acre feet, and the operation of the Compact does inflict such penalties, if excess releases are not compensated for by under releases, the inevitable result will be to hasten and intensify shortages when they do occur, both as to frequency of occurrence and acuteness. Such would be the consequences during low reservoir stages which are sure to occur if wasteful practices in the use of water are indulged in during periods of high reservoir stages.

Of the 790,000 acre feet considered as the average annual amount which may be available for release from storage, 60,000 acre feet have been allotted to Mexico by the Treaty of 1906 providing for the distribution of the waters of the Rio Grande. The balance of 730,000 acre feet, taking into consideration river and distribution losses also operating waste and drainage return flow available for rediversion at the Project's five successive diversion points located on the river at varying distances from 2 miles to 120 miles downstream from the storage reservoirs, may, under economical control, efficient distribution and conservative use with reliable means of water measurements, provide for the delivery of approximately 3.5 acre feet of water per acre per year to an irrigated area of 155,000 acres. Charges to farms for the irrigation season during recent years have averaged about 3.3 acre feet per acre irrigated, but this is based largely on ditchriders' estimates of deliveries and is considered to be lower than actual.

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RIO GRANDE PROJECT IRRIGATION SCHEDULE
ANNOUNCEMENT
January 7, 1948

On August 12, 1947 an announcement allotting one acre-foot of water for each acre of land subject to repayment of Project Construction Costs was made for the 1948 season; this allotment was based on water in storage on that date; the same announcement outlined the conservation measures, including the discontinuance of fall and winter releases that was considered necessary in view of the extreme low storage at that time.

The water conserved as a result of that program together with the release of some 100,000 acre-feet of debit water by New Mexico from El Vado Reservoir during November and December now make it possible to increase the initial allotment made on August 12, 1947 for the season of 1948. On the basis of storage on January 1, 1948, the allotment for each acre subject to Project Construction Charges is now two acre-feet.

The early winter snows have been disappointing, and the snowfall as of January 1, 1948 is apparently below normal; for this reason it appears unlikely that any change can be considered in the present allotment before the spring runoff is definitely known.

The fact that the Project must operate on an allotment makes it necessary that water users and the operating organization exercise all care and diligence in ordering, and using water; the following schedule has been adopted for release from storage:

(a) Gates will be opened at Caballo on March 15 and will remain open for the season, except as shutdowns may be made, resulting from rains in the valleys.

(b) This schedule will make early water available as follows:

Rincon Valley -	March 17th - 18th
Mesilla Valley -	March 19th - 20th
El Paso Valley -	March 21st - 22nd

The first release of water will be at a minimum rate, and it is not expected that full service will be available until about the fourth week in March.

(c) Water users, in view of the necessity of operating on an allotment, are requested to place their orders at least four days in advance of the date the water is desired.

Water in storage on January 1, 1948 amounted to 488,900 acre-feet. Storage the same date last year was 781,800 acre-feet, and the average storage on January 1 since Elephant Butte began storing water is 1,153,000 acre-feet. Inflow to Elephant Butte during 1947 was only 39 per cent of the average; the inflow for the past five years has only been 54 per cent of the average for the period. These figures portray the necessity of operating on an allotment this year.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

WATER SERVICE ANNOUNCEMENT
April 1, 1948

To residents living on tracts two acres or less in the Country Club and White Spur Community.

A water delivery schedule for the residents of the Country Club and White Spur Community who own or are living on tracts of two acres or less has been adopted. This schedule has been decided to be the most practical manner in which residents on tracts of two acres or less may comply with the allotment of two acre-feet per acre which is in effect on the Rio Grande Project. This notice of allotment of water "Rio Grande Project Irrigation Schedule Announcement" was made January 7, 1948. Notice of "Curtailment In Delivery And Use Of Irrigation Water On Small Tracts Of 2 Acres Or Less Under Allotment Restriction" of February 16, 1948 was mailed to water users affected, including the Country Club and White Spur Community.

The cooperation of all is requested in complying with this schedule. Do not take water when your schedule date for your water delivery is not indicated. The water in the canals and ditches on dates other than your schedule is going to other water users under a delivery schedule different from yours. Remember if you take water on days different from the following schedule you are taking someone else's water.

Dates water will be available during 1948 to residents on small tracts of two acres or less in the Country Club and White Spur Community are:

March	- 27th and 28th	July	- 3rd and 4th
April	- 10th and 11th		- 17th and 18th
	- 24th and 25th	July	- 31st and August 1st
May	- 8th and 9th	Aug.	- 14th and 15th
	- 22nd and 23rd		- 28th and 29th
June	- 5th and 6th	Sept.	- 11th and 12th
	- 19th and 20th		

Should inflow to Elephant Butte during the runoff period be of sufficient volume a reappraisal of this schedule will be made and any change in your delivery schedule will be duly publicized for the water users' information.

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT

STATEMENT OF WATER SUPPLY CONDITIONS AND
ANNOUNCEMENT OF INCREASE IN ALLOTMENT
May 26, 1948

Project storage at this time is still 54,000 acre-feet below what it was on May 26, 1947 as may be noted from a comparison of present storage of 602,000 acre-feet with the 656,000 acre-feet on the same date last year. Average storage for June 1 since Elephant Butte began storing water in 1915 has been 1,243,000 acre-feet. However, there is now sufficient water to increase the allotment for water-right lands in repayment of construction charge status to three acre-feet. This represents an increase of one acre-foot since the announcement of January 7, 1948 establishing an allotment of two acre-feet for the 1948 season.

There is nothing at this time in the runoff picture that indicates a posibility of further increasing the allotment for this year above the total of three acre-feet effective with this announcement. Water users are advised to be as careful and conservative in the use of water as possible; the need for this is revealed in the current status of Project water supply which is only approximately 50 per cent of the average Project storage as of June 1 since Elephant Butte storage began in 1915.

This announcement of increasing the allotment of water to three acre-feet is concurred in by the Boards of Directors of the Elephant Butte Irrigation District, and the El Paso County Water Improvement District No. 1.

Present reports of runoff indicate that there is a prospect that within the next ten days Rio Grande Project storage will be equal to that on a corresponding date last year. This is about the best that can be expected from present indications. On this basis, an increase in the allotment from 2 to 3 acre-feet per acre is warranted at this time. The average use last year was 3 acre-feet per acre which, as a result of conservative measures taken last year due to a depleted supply, was less than the average use of 3.2 feet for the preceding four years. There is not a sufficient amount of water in sight at the present time to permit the complete removal of allotment restrictions, and no allotment can be made to suspended land.

Runoff now taking place is badly needed and has permitted the increase in allotment, but is insufficient to provide much gain,

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if any, in reserve or carry-over. The peak discharge of the runoff will not reach maximum proportion of previous high years. It is occurring too late and will be of too short duration to produce any considerable volume of water for storage. Indications are that the inflow for the period January 1 to June 30 will be considerably below the average for that period. If such proves to be the case, this will be the sixth consecutive year of below normal runoff.

The above condition can be changed only by prevailing general rains if they should occur. Project water supply condition this fall and the carry-over for commencement of the next season can be improved or deteriorated over what they were last fall by what happens in weather conditions during the remainder of the season. There has been no considerable reservoir inflow from summer and fall rains since 1929 and a flood from that source is long overdue. The reservoir inflow in 1947 after July 1 was 235,700 acre-feet. The average for the same period is 304,500 acre-feet and the maximum has been 981,000 acre-feet.

UNITED STATES - DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION - RIO GRANDE PROJECT
STATUS OF PROJECT WATER SUPPLY

July 16, 1948

Following consideration of the matter by the Elephant Butte Irrigation District and the El Paso County Water Improvement District No. 1, in view of the present status of the Rio Grande Project water supply the Bureau of Reclamation can now announce that the allotment restriction of three acre-feet per acre of Project water right land for the season of 1948 has been lifted. Delivery of water on a normal operating basis may be made to Project water right land during the remainder of the season. It may become necessary, however, to yet place a maximum limitation on the amount of water which can be delivered to any water user within his proportionate share of water available. It is essential that the most rigid control and conservative use of water be maintained to the end that releases from storage not exceed the average annual amount of 790,000 acre-feet determined by the Rio Grande Compact. This is particularly important now in view of the unprecedented drafts presently being made on storage to meet the present demand resulting from above-normal temperatures. Later consideration must be given to the date for closing the reservoir gates to end the current irrigation season. Project storage today is 818,700 acre-feet as compared to 474,700 acre-feet on the same date last year. The increased storage this year is the result of above-normal inflow to Elephant Butte Reservoir for the period January 1 - July 1, which was 876,000 acre-feet, or 111 per cent of normal. At the same time use of water on the Project since June 20 has been extremely high with the highest release from storage in the history of the Project having been made to meet peak requirements.

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UNITED STATES - DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION - RIO GRANDE PROJECT
RIO GRANDE PROJECT IRRIGATION SCHEDULE
ANNOUNCEMENT
August 13, 1948

The present irrigation season is tentatively scheduled to terminate with the closing of Caballo Dam gates on September 18th depending on conditions and requirements, following which reservoir water will remain available through the various sections of the Project for from 1 to 5 days depending on the distance from the dam. No orders for such water will be accepted after September 15th.

Releases of water from the reservoir for fall and winter irrigation are contemplated for periods of approximately one week during each of the months of October, November and December. No releases will be made during January.

Dates of the releases will depend upon requirements and orders and will be stated in schedules to be announced at a later date. Where return flow water is available it will be rotated continuously from one section or one ditch to another, also in accordance with schedules to be announced at a later date.

The above program may be subject to some modifications due to conditions and requirements as well as to the very urgent necessity that every effort possible be made to maintain reservoir release each year within 790,000 acre-feet this being considered to be the safe average annual draft from Project storage and referred to in the Rio Grande Compact as being the average annual amount of water available to the Rio Grande Project.

UNITED STATES - DEPARTMENT OF THE INTERIOR
Bureau of Reclamation - Rio Grande Project

1949 FALL AND WINTER WATER SCHEDULE
for
EL PASO VALLEY

Water available during the fall and winter months of 1949 will be delivered in the El Paso Valley according to the schedule set up below. The return flow water will be supplemented in minimum amounts following scheduled reservoir release during early October and mid-November. No definite scheduling of a December release is being made. Such a release will be governed by accumulated orders and weather conditions. Weather conditions will also control release of reservoir water in October and November. Releases will be held to an absolute minimum.

At such time during October and November that reservoir water may be available the schedule shown below will be shifted a few days to permit use of reservoir water, as required by advance orders.

YSLETA DIVISION

Upper and Lower Franklin, Juan de Herrera, Clint and Salitral ditches		San Elizario, Riverside, Island, Hansen and Tornillo ditches	
Sept. 19 to Sept. 23	Inclusive	Sept. 26 to Sept. 30	Inclusive
Oct. 3 to Oct. 7	"	Oct. 10 to Oct. 14	"
Oct. 17 to Oct. 21	"	Oct. 24 to Oct. 28	"
Oct. 31 to Nov. 4	"	Nov. 7 to Nov. 11	"
Nov. 14 to Nov. 18	"	Nov. 21 to Nov. 25	"
Nov. 28 to Dec. 2	"	Dec. 5 to Dec. 9	"
Dec. 12 to Dec. 16	"	Dec. 19 to Dec. 23	"
Dec. 26 to Dec. 30 If Needed.			

It is requested that all waterusers place their orders for irrigation water well in advance of the date scheduled for service in the various localities.

No water will be delivered in any part of the Project during January. At this time canal and structure maintenance will be accomplished.

FOR ANY FURTHER INFORMATION CONTACT YOUR DITCHRIDER OR CALL YSLETA 8-7311

L. R. Fiock
Project Manager

JAN. 3, 1989 0:38

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT

February 17, 1949

SCHEDULE FOR COMMENCEMENT
OF THE 1949 IRRIGATION SEASON

It is contemplated that irrigation water releases from Caballo Reservoir will be made for a run of one week commencing some time between March 1 and March 5 depending on the demand and orders for water. It is expected that the gates will then be closed again for a week before opening for continuing through the season. Definite dates will be announced about March 1. Where return flow is available it may be turned into the canals for irrigation deliveries a week or so earlier. The amount of water in storage now is 647,000 acre-feet compared to an average of 1,100,000 acre-feet as of this date.

JAN. 3, 1989 0:38

March 1, 1949

United States Department of the Interior
Bureau of Reclamation - Rio Grande Project

RESERVOIR WATER RELEASES TO BEGIN
FOR 1949 SEASON

Caballo Dam Outlet gates are scheduled to be opened for release of reservoir water on March 4. Water will be available for irrigation deliveries through the Project 2 to 5 days later depending on the distance from the dam. It is expected that water will be run for one week and then shut off for a week before being released again to continue through the season.

In consultation with the Project Irrigation Districts it has been decided to commence the season on a normal operating basis for Project land within the Districts. However, every precaution and effort at close regulation and conservative use of water are required throughout the season to maintain the reservoir release within ghe 790,000 acre-feet average annual amount available and allowed by the Rio Grande Compact.

The amount of water in storage is 675,000 acre-feet compared to 575,000 acre-feet a year ago and to approximately 1,100,000 acre-feet average for March 1st. Based on latest snow reports, prospects seem fair for a normal run-off. However, what may materialize depends upon weather conditions during the next two to four months. The last report received for February 21st showed slightly more snow than on the corresponding date in 1944 when the run-off was not quite up to normal.

United States - Department of the Interior
Bureau of Reclamation - Rio Grande Project

STATEMENT ON STATUS OF WATER SUPPLY
March 24, 1949

Due to the rapid and extensive deterioration of snow conditions on the Rio Grande water shed since the January storms prospects for a normal run-off this year have vanished. The last weekly report from the Forest Service as of the first of this week indicates about half the depth of snow as of the corresponding date last year; Cumbres Pass 47 inches as compared to 112 inches in 1948, River Springs Ranger Station 10 inches this year to 31 inches last year, Wolf Creek Pass 107 inches now to 148 a year ago, South Fork Ranger Station 12 inches to 22 last year.

The total inflow to Elephant Butte Reservoir for the year 1948 was only 88 per cent of normal, 933,540 acre-feet compared to a normal of 1,060,000 acre-feet. The total amount of water in Project reservoirs is now 710,930 acre-feet compared to 588,420 acre-feet on the same date last year but still only 65 percent of the average amount in Project storage on the corresponding date for past years which has been approximately 1,100,000 acre-feet.

It is past the time now to expect much, if anything, more from snows this year. The only hope for improved conditions now is for rains in April and May as did occur in 1941 and 1942 but that was very unusual and the chances for early recurrence remote.

United States - Department of the Interior
Bureau of Reclamation - Rio Grande Project

STATEMENT ON STATUS OF WATER SUPPLY

April 15, 1949
(Supplemented Issue)

With snow melt runoff from the Rio Grande water shed due to begin, prospects for 1949 are about the same as they were a year ago for 1948, based on the April 1, 1949 Snow Survey Report just received, and Forest Service reports for stations in Colorado as of April 12, 1949.

Unusually heavy late snow storms during the last week of March and the first week of April improved the outlook. The reports indicate about the same amount of snow on the ground as for corresponding dates last year. The Forest Service reports show: Wrights Ranch 24 inches as compared to 16 inches in 1948; Wolf Creek Pass 120 inches this year to 124 last year; River Springs Ranger Station 4 inches now to 6 a year ago; Cumbres Pass 70 inches to 60 last year.

The runoff for 1948 to July 1st was just about normal but due to deficiency in precipitation during the last half of the year the inflow to Project reservoirs for the year was only 88 percent of normal, 933,540 acre-feet compared to a normal of 1,060,000 acre-feet.

The total amount of water in Project reservoirs is now 663,500 acre-feet compared to 523,100 acre-feet on the same date last year, but only about 60 percent of the average amount in Project storage on the corresponding date for past years which has been approximately 1,100,000 acre-feet.

UNITED STATES - DEPARTMENT OF THE INTERIOR
Bureau of Reclamation - Rio Grande Project

1950 FALL AND WINTER WATER SCHEDULE
for
EL PASO VALLEY

Pursuant to agreement with the El Paso County Water Improvement District No. 1 and the Elephant Butte Irrigation District, the irrigation season will officially end with the closing of the gates at Caballo Dam on September 12, 1950. No water will be released from Caballo Reservoir between the closing date on September 12, and the opening date in the spring of 1951 unless an appreciable increase in storage results from late summer or early fall rains.

In case that reservoir water is available at any time, the schedule shown below will be modified to permit the use of reservoir water. Otherwise, return flow only will be available for the completion of the following schedule:

YSLETA DIVISION

Upper and Lower Franklin, Juan de Herrera, Clint and Salitral ditches		:	Riverside, San Elizario, Island, Hansen and Tornillo ditches	
Sept. 16 to Sept. 25	Inclusive	:	Sept. 26 to Oct. 5	Inclusive
Oct. 6 to Oct. 15	"	:	Oct. 16 to Oct. 25	"
Oct. 26 to Nov. 4	"	:	Nov. 5 to Nov. 18	"
Nov. 19 to Dec. 2	"	:	Dec. 3 to Dec. 16	"
Dec. 17 to Dec. 31	"			

Where return flow water is not available, pumping from the drains will be permitted during the period between the close of the regular 1950 irrigation season in September and the beginning of the regular 1951 irrigation season. Arrangements may be made for pumping water direct from drains by submitting an application to the Division office at Ysleta, Texas, which will recommend the issuance of a permit by the Project Manager.

No water will be delivered in any part of the Project during January as this time will be required for canal and structural maintenance.

FOR ANY FURTHER INFORMATION CONTACT YOUR DITCHRIDER OR CALL YSLETA 9-7311

L. R. Fiock
Project Manager

JAN. 3, 1989 3:55

NM_00029138

RIO GRANDE PROJECT
IRRIGATION WATER ANNOUNCEMENT
February 21, 1950

WATER ANNOUNCEMENT

Water will be released from Caballo Reservoir today, February 21, 1950, for the commencement of the irrigation season and will be run through the canal systems as it reaches the successive diversion dams.

The number of days after release that water will be available for irrigation in the several operating divisions is estimated as follows:

Rincon Valley -	1-1/2 to 2 days	after	Caballo	Release
Leasburg Unit -	2-1/2 to 3 days	"	"	"
Mesilla Unit -	3-1/2 to 4 days	"	"	"
El Paso Valley	5 to 6 days	"	"	"

Time of delivery of water in the various parts of each unit may depend upon local conditions. Requests for water will be filled in the order received; it will be to the advantage of those desiring early water to place requests with the ditchrider as soon as possible.

Project storage as of February 20, is 901,700 acre-feet which is 77 per cent of the average storage for this date.

Latest snow reports from United States Forest Service at Monte Vista indicate the depth of snow at stations on the Rio Grande water shed in Colorado on February 14 was about 61% of that on the corresponding date of 1949 and a little above the average for the past five years.

Water users and the operating organization are urgently requested to use all possible means of conserving water in order that the safe annual draft of 790,000 acre-feet will not be exceeded.

L. R. Fiock
Project Manager

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT

STATEMENT OF WATER SUPPLY
May 1, 1950

Present indications are that runoff for the year may be as little as one quarter of normal. The only remaining snow is on the high mountains in Colorado. Melting of that occurs later and may continue to July. There has been no flood runoff from snow on lower elevations and no snow remains there. While the amount of water in storage plus what can be expected from runoff during the remainder of the season based on present indications will be enough for this irrigation season, prospects are that there will be very low reservoir carryover with which to begin next season. It seems now that allotment of water for the commencement of next year is almost certain. Under the circumstances it is most advisable that every effort be made to use water as conservatively as possible during this year.

Reservoir gain in storage over last year has been rapidly drawn down and reduced. On January 1, 1950 reservoir storage was 817,300 acre-feet or 224,700 acre-feet more than on January 1, 1949. Reservoir storage on May 1 this year is 808,800 acre-feet or only 151,200 acre-feet more than on May 1, 1949. The rapid draw down of last year's gain has been due to a combination of circumstances, greater releases to meet earlier high irrigation demands and very low inflow, practically no snow runoff occurring to date this year.

L. R. Fiock
Project Manager

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO-TEXAS

Statement of Water Supply

June 20, 1950

The runoff into Elephant Butte Reservoir for the period January 1 - June 20 this year has been disappointing. The total runoff has been 259,600 acre-feet, which includes approximately 140,000 acre-feet of debit water released from El Vado Reservoir during February and March. If the total inflow for the year to date into Elephant Butte is arbitrarily corrected by this amount, the result of 119,600 acre-feet indicates this is one of the lowest years of record for the runoff season. Average inflow 1895-1949 for the period January 1 - June 30 is 790,000 acre-feet; it may thus be estimated that the normal runoff this year has been only 15 per cent of the average.

Project storage as of today is 649,900 acre-feet. This is 128,600 acre-feet less than on the same date in 1949. Average storage on this date is 1,286,900 acre-feet; the storage as of today is consequently only 50 per cent of the average.

Release from storage for irrigation this year is 40,000 acre-feet more than it was the corresponding period in 1949. In view of the present storage being so far below average, the water users and operating personnel of the Project are requested to be as conservative as possible in the use of water during the remainder of the irrigation season in order that a reserve to begin 1951 will be available. It appears at this time that rationing of water for 1951 will be prevented only by runoff into Elephant Butte from summer and early fall rains being considerably above the average.

W. F. Resch
Acting Project Manager

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT, NEW MEXICO-TEXAS

WATER ANNOUNCEMENT

July 18, 1950

Inflow to Elephant Butte Reservoir continues to be below average with no appreciable change since the Statement of Water Supply of June 20, with the result that Project storage is still dropping. Some saving of water has resulted from recent rains below Elephant Butte, but above Elephant Butte the Rio Grande is still below average. Project storage today is 559,800 acre-feet as compared with 901,400 the same date last year. Average storage for this date is 1,302,100 acre-feet.

A program of reservoir operations for the fall-winter period 1950-1951 based on conservation of water has been submitted for consideration of the Project's two irrigation Districts. Under the program it is proposed to close the gates at Caballo Dam on September 12, approximately the same date as during the past four years; in addition no water will be released between the closing date of September 12, and the opening date in the spring of 1951, should no appreciable inflow occur during the late summer.

The Elephant Butte Irrigation District Board of Directors has concurred in the program and the El Paso County Water Improvement District No. 1 Board of Directors will consider the program during its meeting on August 7.

Water users, and the operating personnel are urged to be as careful in the use and distribution of water as possible, in order by economical use of the available supply, to offset to some degree the low inflow to the reservoir this year.

Water users will be advised from time to time the status of Project storage so their planning can proceed accordingly.

L. R. Fiock
Project Manager

JAN. 3, 1989 3:56

NM_00029142

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO-TEXAS

WATER ANNOUNCEMENT

July 28, 1950

Both the Elephant Butte Irrigation District, and the El Paso County Water Improvement District No. 1 have approved the fall-winter irrigation schedule which may be stated as follows: The irrigation season will officially end with the closing of the gates at Caballo Dam on September 12, 1950. No water will be released from Caballo reservoir between the closing date on September 12 and the opening date in the spring of 1951 unless an appreciable increase in storage results from late summer or early fall rains.

The rains during July on the Project have resulted in a saving of water as of today which, while helpful, have not been of sufficient volume to materially increase storage. Inflow during July is considerably below average for the month. The total inflow January 1 - July 28 for the year of an estimated 262,000 acre-feet is only 30 per cent of the average runoff at San Marcial, at the head of Elephant Butte reservoir, for the period since 1895.

Project storage on July 28, of 538,000 acre-feet, is 364,400 acre-feet below the same date last year and is 43 per cent of the average since storage began in 1915.

Water users, and the operating organization are again urged to be as careful and conservative as possible during the remainder of this irrigation season.

L. R. Fiock
Project Manager

JAN. 3, 1989 3:56

NM_00029143

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO-TEXAS

WATER ANNOUNCEMENT

August 18, 1950

Project storage continues to drop, reflecting the lack of normal or average inflow to Elephant Butte Reservoir during the summer period to date.

Storage as of today is 464,200 acre-feet which is 379,600 acre-feet below last year and is only 40 per cent of the average storage for this date.

The gates at Caballo reservoir, as previously announced, following consultations and approval of the Irrigation Districts, will be closed on September 12 and will not be opened until the date of beginning the 1951 season.

Return flow water will be alternated between canals and laterals, but where return flow water is not available, pumping from drains will be permitted only during the period between the close of the regular 1950 irrigation season in September and the commencement of the regular 1951 irrigation season. Arrangements may be made as heretofore by submitting an application and obtaining a permit. Water pumped from the drains will be charged for the same as deliveries from canals but will not be charged against an allotment for the 1951 season. In case rationing of water is necessary, which at this time appears will be required, any water that is pumped from drains after reservoir gates are opened for commencement of the irrigation season in 1951 will be charged against the allotment. Water users desiring to pump from drains should contact their ditchrider, or the Division office at Las Cruces, or Ysleta.

L. R. Fiock
Project Manager

JAN. 3, 1989 3:56

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO-TEXAS

WATER ANNOUNCEMENT

August 28, 1950

The gates at Caballo reservoir will be closed, ending the 1950 irrigation season, on September 12. Water orders will be accepted as late as Friday, September 8. Do not order water unless you absolutely need it, as Project storage continues to drop.

L. R. Fiock
Project Manager

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO-TEXAS

WATER ANNOUNCEMENT

November 1, 1950

Project storage on November 1, 1950 is 384,300 acre-feet; this is 382,900 acre-feet less than on the same date in 1949, and is only 35 per cent of the average since storage began in 1915.

Inflow to Elephant Butte reservoir for the period January 1 - November 1, 1950 has been approximately 284,000 acre-feet or only 28 per cent of average. The inflow includes approximately 100,000 acre-feet of compact debit water received from El Vado reservoir during February and March; the natural inflow after removing the debit water which was stored during 1949 is only 18 per cent of average for the period.

The summer, and fall inflow to Elephant Butte reservoir has been far below average; consequently, on the basis of the present Project storage an allotment for the repayment lands of one acre-foot per acre for the 1951 irrigation season is being made at this time. An announcement will be made on March 1, 1951 as to available water on that date; should winter inflow be near normal, an increase of one-quarter or one-half acre-foot in the allotment will be possible; conversely, should winter inflow reflect the present drought condition, it is doubtful if an increase will be possible on March 1. Any change in allotment after March 1 will be dependent upon snow conditions and the beginning of the spring runoff on the watershed as of May 1 or June 1.

There will be no water released during February 1951 due to the low storage; water users will be advised on or before March 1, 1951 the date storage water will be released.

L. R. Fiock
Project Manager

JAN. 3, 1989 4:03

NM_00029146

FUTURE WORK

Power and Storage System

Communications and Control Equipment. It is proposed to issue specifications and purchase the required carrier current telephone and supervisory control equipment for the Albuquerque, and Central Substations, the Belen, and Las Cruces Switching Stations, and the Elephant Butte Power Plant.

Elephant Butte Switchyard. The existing oil circuit breaker on the Elephant Butte-Las Cruces Transmission Line is to be replaced with a 115 KV 500 MVA oil circuit breaker.

Las Cruces Switching Station. A control house, 115 KV motor-operated switch, and one 4SWT structure, together with the required control and electrical equipment is to be installed at this location.

Hollywood Substation. Equipment for this substation will be purchased and installed during F. Y. 1951 on a site purchased during F.Y. 1950.

Albuquerque Substation. Design of this substation started during F.Y. 1950. It will be completed and construction started during F.Y. 1951, and completed during F.Y. 1952.

Willard Substation. Specifications will be issued during F.Y. 1951, and the equipment purchased and installed during F.Y. 1951, and F.Y. 1952.

Socorro-Albuquerque, and Belen-Willard Transmission Lines. Issuance of specifications, award of contract, and start of construction are scheduled for F. Y. 1951, and completion during F.Y. 1952.

Belen Switching Station. A switching station on the Socorro-Albuquerque Transmission Line at Belen, New Mexico will be constructed during Fiscal Years 1951, and 1952.

Deming and Holloman Air Force Base Substations. Alterations and modification of these two substations will be undertaken during F.Y. 1952.

Mobile Radio Equipment. It is proposed to buy the necessary mobile radio equipment and install a transmitter and relay stations to permit constant two-way contact with operating personnel of the Power and Storage Division. This will be financed as a part of the O&M Program.

89 3:31

Operation and Maintenance. Normal operation and maintenance activities and replacement of work equipment will continue.

Irrigation and Drainage. Normal operation and maintenance, and replacement of work equipment will continue. With the disapproval of the proposed Rehabilitation Program by the farmers, a program of replacement of timber irrigation and drainage structures with permanent structures with O&M monies will be developed. Providing the present drought conditions continue, a study will have to be undertaken to determine means of irrigating the Rio Grande Project, with no available runoff from the upper watershed. At present, pumping from wells appears to be the most feasible for a short time.

It is proposed to start an investigation during the latter part of F. Y. 1951 into the arroyo runoff in the Mesilla Valley, and the salt cedar growth at the head of the Caballo Reservoir, with corrective construction and measures to take place in Fiscal Years 1952 to 1956.

Water-Supply and Irrigation Paper No. 188

Series { B, Descriptive Geology, 103
O, Underground Waters, 66

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

WATER RESOURCES

OF THE

RIO GRANDE VALLEY IN NEW MEXICO

AND THEIR DEVELOPMENT

BY

WILLIS T. LEE

WASHINGTON
GOVERNMENT PRINTING OFFICE
1907

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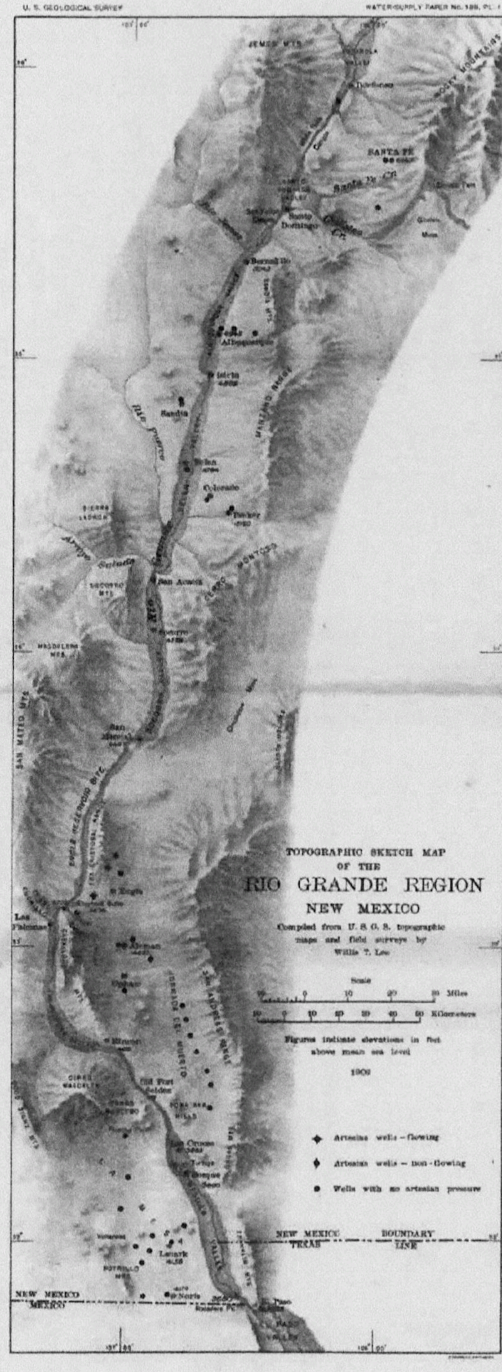
ILLUSTRATIONS.


TOPOGRAPHIC SKETCH MAP
OF THE
RIO GRANDE REGION
NEW MEXICO
Compiled from U. S. G. S. topographic
maps and field surveys by
Willis T. Lee
Scale
Miles
Kilometers
Figures indicate elevations in feet
above mean sea level
1906
Artesian wells – flowing
Artesian wells – non-flowing
Wells with no artesian pressure
JEMEZ MTS.
ROCKY MOUNTAINS
SANTA FE
Santa Fe Cr.
Albuquerque
Socorro
San Antonio
San Marcial
Las Palomas
Engle
Rincon
Las Cruces
Lanark
SAN MATEO MTS.
MAGDALENA MTS.
NEW MEXICO
TEXAS
BOUNDARY
LINE
MEXICO

WATER RESOURCES OF THE RIO GRANDE VALLEY IN NEW MEXICO, AND THEIR DEVELOPMENT.

By WILLIS T. LEE.

INTRODUCTION.

The investigations described in this paper were undertaken for the purpose of gathering information which might aid in the development of the water resources of the Rio Grande Valley in New Mexico. Two general lines of observations were followed, one pertaining to underground waters and their utilization, the other to the storage and conservation of the surface waters. The work was done during the field seasons of 1904 and 1905 under the general direction of Mr. N. H. Darton. The area examined extends along the Rio Grande from the southern boundary of New Mexico northward to Santa Fe.

The valley of the Rio Grande, lying west of the Rocky Mountain uplift, extends in a north-south direction through a part of New Mexico which is characterized by comparatively small and more or less isolated mountain groups separated by basinlike depressions partly filled with rock débris. The valley is a part of the semiarid region of the southwestern part of the United States, in which the rainfall is insufficient for agriculture without irrigation.

A comparatively small amount of the water derived from the mountains to the north sustains a small but permanent flow in the river in the northern part of the region, but this water gradually disappears and the river bed in the southern part is often dry.

The Rio Grande is essentially a storm-water stream, subject to great and sudden floods. Within the area described only three permanent streams—the Rio Puerco, Rio Jemes, and Galisteo Creek—enter the Rio Grande, and their discharge, except in times of storm, is comparatively small. The rainfall in the region occurs principally in the form of violent showers or "cloud-bursts," which fill the dry stream courses with turbulent floods of short duration. When these showers occur simultaneously in many parts of the region they cause more or less destructive floods in the river. For these reasons the fertile irrigable lands along the river are sometimes unproductive for want of water and at other times crops are ruined because the fields are submerged or irrigation ditches destroyed by floods.

Much of the diminution in the volume of flow downstream is due to the fact that a large part of the water of the river sinks beneath the surface into the porous material of the valley bottom. Many of the tributary stream courses that are dry where they join the river contain flowing water in their upper reaches, the water sinking beneath the surface when it reaches the detrital material of the valley. The water entering the ground from the river and from the tributary streams is sufficient in volume to warrant its development for irrigation.

GEOGRAPHY.

RELATION TO OTHER REGIONS.

New Mexico consists of four general geographic provinces—the plains, occupying its eastern part; the Rocky Mountain province occupying its central part; the plateau province, in its northwestern part; and the basin range province, in its southwestern part. The Rocky Mountains proper terminate in northern New Mexico, but the general mountain uplift extends southward across the Territory as a succession of comparatively small mountain groups. These have not been generally recognized as parts of the Rocky Mountains, altho they belong to the same general system. The Rio Grande region lies between the Rocky Mountain province on the east and the plateau and basin range provinces on the west.

EASTERN MARGIN.

The crest of the Rocky Mountain uplift, consisting of the southern extremity of the Rocky Mountains proper, the Sandia and Montoso mountains, Sierra Oscura, San Andreas Range, and the Organ and Franklin mountains, form the eastern boundary of the area here described. The uplift becomes progressively lower toward the south, the maximum altitudes varying from 13,000 feet in the Rocky Mountains east of Santa Fe to 7,000 feet in the Franklin Mountains in the southern part of the region, and the minimum altitudes from 7,500 feet in Glorietta Pass near the northern end of the region to 3,700 feet at the southern end where the Rio Grande cuts through the uplift at The Pass. The rocks consist of granites and sedimentary rocks that range in age from pre-Cambrian to Tertiary.

WESTERN MARGIN.

The western margin of the Rio Grande Valley is much more irregular than the eastern margin, in both outline and altitude. It is formed by the Jemes Mountains at the north, by the Ladron, Socorro, Magdalena, and San Mateo mountains in the central part, and by the

Good Sight and Potrillo mountains farther south. These groups are more or less widely separated, either by undrained detrital plains like La Mesa, lying between the Potrillo Mountains and Cerro Magdalen, or by broad valleys like that of the Rio Puerco.

The older sedimentary formations extend over the same wide range of geologic age as those in the eastern margin, but the exposures are small, the greater part of the surface being occupied by effusive rock and unconsolidated detritus.

CENTRAL AREA.

MOUNTAINS.

Three large groups of mountains, the Caballos, the Fra Cristobal, and Cerro Magdalen (not to be confused with the Magdalena Mountains) occur within the limits of the Rio Grande region, and several small groups and isolated peaks, like the Dona Ana Hills, Cerro Robledo, and Cerro Cuchillo.

The Caballos and Fra Cristobal ranges consist of granite and overlying sediments dipping eastward beneath the Jornada del Muerto. (Pl. VI, *B*.) The Socorro Mountains, Cerro Magdalen, the Dona Ana Hills, and a large number of smaller hills in the central part of the region are of eruptive origin, but many of the hills, such as Cerro Robledo (see Pl. III), Tortuga, Cerro Cuchillo, and Sierra Ladron, are tilted blocks of sedimentary rocks.

PLAINS.

In the southern half of the Rio Grande region there are two broad plains, which, on account of their important bearing on questions connected with underground-water conditions in the Rio Grande region, require special description. These are the Jornada del Muerto and La Mesa. The Jornada has been described in a former water-supply paper,[a] but certain characters directly affecting the problems here discust require further consideration.

In the paper above cited[b] the Jornada del Muerto is regarded as including Mesilla Valley on the south and the plain lying northeast of San Marcial between Sierra Oscura and Cerro Montoso, thus comprising an area having a length of about 200 miles and an average gradient of 12 feet per mile. This extension of the Jornada proper may be advisable in describing the structural geology, but it is thought best to use here the name in its original meaning, applying it only to the high plain between Las Cruces and San Marcial, since, thus defined, it corresponds not only with the local usage but also with the ancient course of the Rio Grande described on page 21.

[a] Keyes, C. R., Water-Sup. and Irr. Paper No. 123, U. S. Geol. Survey, 1905.
[b] Ibid., p. 13.

The Jornada del Muerto, according to this usage, is the nearly level detrital plain, 10 to 20 miles or more in width, extending from San Marcial southward to Las Cruces, between the San Andreas and the Caballos-Fra Cristobal mountain ranges—a distance of about 100 miles. It has no drainage lines except at the southern end, near the river, but throughout its length slight depressions occur near its center, in which storm waters gather and form small temporary lakes. The altitude of the plain at the northern end, near San Marcial, is about 4,700 feet, and at its southern end 4,250 feet, a difference in surface elevation of 450 feet in the 100 miles of length, or an average gradient of 4.5 feet per mile.

The rocks exposed in the mountain slopes on either side of the Jornada are the upturned sedimentary rocks forming the floor of the syncline described by Keyes in the report previously referred to. The central plain, however, is covered to a depth of at least several hundred feet with detritus, consisting of sand, gravel, and angular rock débris. As indicated by well records, the material in the central part of the Jornada is largely sand and rounded pebbles of quartzite and argillite, while angular detritus, consisting mainly of limestone and sandstone, is apparently more abundant near the sides.

The second plain, locally known as "La Mesa," lies in the southern part of the Rio Grande region west of Mesilla Valley, and extends from the vicinity of Las Cruces southward into Mexico. It is similar to the Jornada in many ways. Its altitude is the same as that of the southern end of the Jornada, and the two formed a single plain previous to the excavation of Mesilla Valley. La Mesa has a width of 20 miles or more and is undissected by erosion and entirely wanting in lines of surface drainage. It contains several broad, shallow depressions, but, unlike those of the Jornada, these do not retain storm waters for any appreciable length of time. Although inclined slightly to the south, the surface appears practically level over an area of more than 1,000 square miles.

To a depth of at least 945 feet, the depth of the deepest well, the material in La Mesa consists of clay, sand, and rounded pebbles of quartzite, argillite, and a great variety of hard igneous and metamorphic rocks, with a subordinate amount of angular débris. The surface is notably more sandy than that of the Jornada, and wells sunk in it encounter a greater proportion of fine material than occurs in the Jornada.

In the northern part of La Mesa there are gravel beds of considerable size at the surface, but these become less numerous toward the south, until near the Mexican boundary sand alone is exposed and the surface becomes practically level. The region was not explored south of the Mexican boundary for the purposes of this report, but from the summit of the Potrillo Mountains the sandy plain appeared to continue southward unbroken as far as the eye could reach. It is probable that La Mesa is the northern extremity of the broad interior basin of northern Mexico, the lowest parts of which, containing undrained lakes, occur 25 to 50 miles south of the international boundary. At some former time this basin was probably occupied by a large lake, the northern extremity of which covered La Mesa.

SLOPES.

The greater part of the surface of the Rio Grande region is made up of long, corrugated slopes, extending from the bordering mountains to the river. East of the river the slope varies in length from 5 to 20 miles. Near Santa Fe it is 12 miles long and has an average gradient of 125 feet per mile. East of Albuquerque it is about 10 miles long and has a gradient of about 70 feet per mile, and east of Las Cruces it is 10 miles long and has a gradient of about 100 feet per mile. In places where the river is located near the mountains, as at the northern end of the Sandia and west of the Caballos Mountains (Pl. VI, *B*), the gradient is 250 to 300 feet per mile.

The slopes of the western part of the Rio Grande region are much more varied than those that lie east of the river. Some are short, steep, and deeply dissected; others are many miles in length and perfectly graded, and still others, like those drained by Arroyo Salado and Rio Puerco, are but slightly inclined.

The material exposed on the corrugated slopes consists of angular rock fragments derived from the mountains. These fragments vary in coarseness with the variations in the hardness of the rock from which they were formed and with the gradient of the slopes on which they are deposited. In general, they are large near the hills and on the steep slopes and small on the lower grades and near the foot of the slopes, where they are often found intermingled with sand and pebbles that have been rounded by stream action.

TERRACES.

The long slopes terminate more or less abruptly near the river in bluffs or terraces, two of which are more or less conspicuous throughout the Rio Grande region. The highest is not continuous. It is represented west of Santa Fe by the lava-capped detrital bluffs exposed in the canyon of Santa Fe Creek, where it forms a shelf 500 feet above a lower terrace and about 800 feet above the river, as shown in the Santa Clara sheet of the United States Geological Survey. West of Albuquerque it is represented by the broad, sandy plain upon which the lava flow from Albuquerque volcanoes rests, 500 feet above the lower terrace and 800 feet above the river. (See Pl.

II, *B*, and section D–D on Pl. III.) Near the southern end of the region a similar relation occurs, the high detrital plain west of Cerro Robledo being 500 feet higher than La Mesa and 800 feet higher than the river, as shown in the Las Cruces sheet of the United States Geological Survey. The ancient surface represented by these remnants apparently had the same gradient as the Rio Grande has at the present time.

On either side of the river, at altitudes about 500 feet lower than the isolated remnants of the high terrace, are well-defined terraces, which are practically continuous from White Rock Canyon to El Paso. They are remnants of a surface that was formed principally by aggradation and later dissected by the river and its tributaries. This surface is represented at Albuquerque by the wide shelf between the lava flow and the river, shown in the foreground of Pl. II, *B*. Farther south it is represented by the Jornada and La Mesa. (See sections of Pl. III.) The surface was formed, first, by the deposition of river sand and gravel; second, by the erosion of previously deposited gravels and volcanic tuffs, illustrated in Pl. II, *A*; third, by lava flows, such as those near San Marcial (Pl. IV, *A*) and San Acacia, and, fourth, by the planation of upturned sedimentary rocks, like those exposed at the surface along the eastern base of the Caballos Mountains in the vicinity of Engle, shown in Pl. IX.

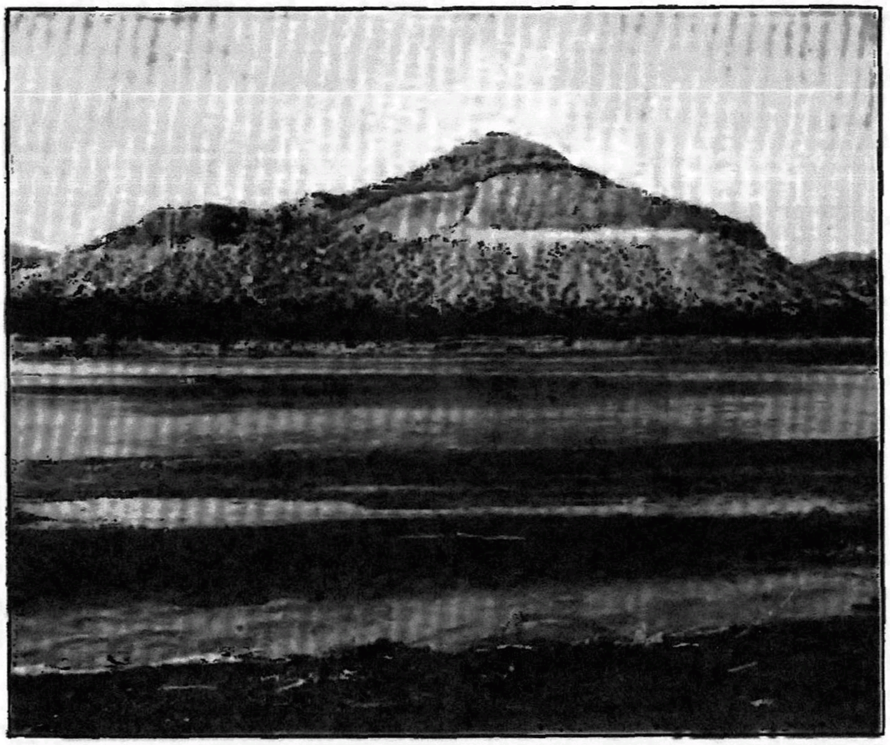
EROSION BASINS AND CANYONS.

Introductory statement.—Along the Rio Grande there are erosion basins, separated by rock canyons, as shown in Pl. I, and limited in form and size by the character of the material in which they were excavated. These basins are parts of the valley of the Rio Grande that have been broadened on account of the easy erosion of unconsolidated material while the narrower canyons were being cut in the hard rock.

Espanola Valley.—This valley extends from the head of White Rock Canyon northward beyond the region here considered. The southern end of the valley has been described as a possible reservoir site,[a] and a contour map of it has been made. The valley is excavated in unconsolidated sand, gravel, and rhyolitic tuff. The gravel beds are exposed in bluffs several hundred feet high and are protected from erosion by the overlying igneous rock, consisting of rhyolitic tuff and basalt flows. The depth of the sands and gravels beneath the river is not known.

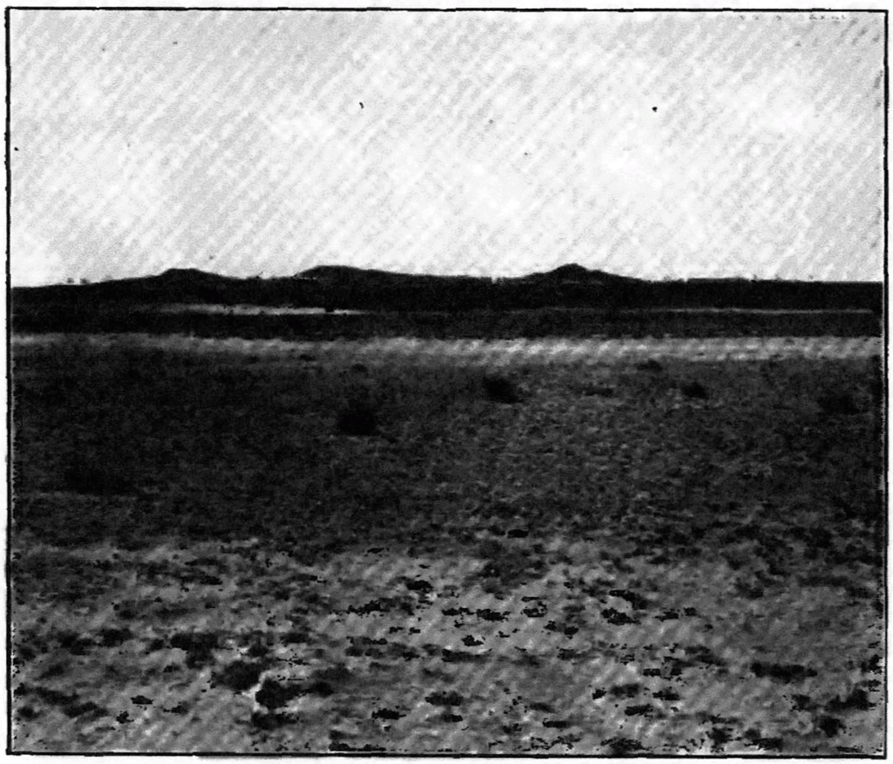
White Rock Canyon.—This canyon begins south of Espanola Valley, at a point where the Rio Grande enters a narrow gorge about 20 miles in length. The canyon owes its existence to sheets of hard igneous

[a] Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 4, 1899-1900.



A. FACE OF TERRACE WEST OF CABALLOS MOUNTAINS.

Showing stratified sand and gravels overlain by rhyolitic tuff.



B. ALBUQUERQUE VOLCANOES AND LAVA FLOW.

Lower terrace, 300 feet above the river, in the foreground. Lava flow, capping the detritus, 800 feet above the river.

rock, which protect the underlying sands and gravels. West of the river this rock is principally light-colored rhyolite, the color of which suggested the name White Rock Canyon, but east of the river it is basalt, of which there are two sheets, separated by a few feet of sand. The structure is indicated in a general way in fig. 2 and Pl. IV, *B*.

Near the mouth of the canyon a stream entering the Rio Grande from the east has carved a gorge, exposing about 400 feet of basalt. This gorge (Pl. IV, *B*), although comparatively small, illustrates the rugged character of the topography in the vicinity of White Rock Canyon.

Santo Domingo Valley.—This valley extends from the mouth of White Rock Canyon to a point 7 miles south of the Indian pueblo of Santo Domingo. It is 1 to 3 miles wide and contains about 13,000 acres of bottom land, which is owned mainly by the Santo Domingo Indians and has been irrigated by them for many years. The greater part of this land lies only a few feet above the bed of the river and is subject to frequent overflow.

San Felipe Canyon.—This is a short gorge separating Santo Domingo Valley from Albuquerque Valley. The canyon walls are composed of unconsolidated sand and gravel, capped by sheets of basaltic lava.

Albuquerque Valley.—This valley extends from San Felipe Canyon southward to Isleta, where it narrows on account of the basaltic lava which extends thence westward over a large part of the Sandia Mesa. The valley is about 35 miles long and 1 to 5 miles wide and comprises an estimated area of 70,000 acres of bottom land. It is terminated abruptly on either side by steep bluffs of sand and gravel forming the terraces previously described. The bluffs west of the valley consist of sand and clay, capped in places by sheets of basalt. Those to the east are composed of stratified sand overlain by coarse unstratified gravels separated from the underlying sands by erosional unconformities.

Isleta Narrows.—The constriction through which the river flows at Isleta is not properly a canyon. The broad Albuquerque Valley here narrows on account of the presence of the hard igneous rock of Isleta Volcano, an extinct volcanic cone west of the town. The lava occurs not only in the bluffs west of the river but extends nearly across the valley at the town of Isleta.

Belen Valley.—This valley, so named from the principal town within its area, extends from Isleta to San Acacia, a distance of about 45 miles, and contains an estimated area of 65,000 acres of bottom land. The Rio Puerco and the Arroyo Salado, the two largest tributaries of the Rio Grande, join the river in this valley. The Rio Puerco flows across the broad stretch of unconsolidated and horizontally bedded sand and gravel, locally known as Albuquerque Mesa.

It is a sluggish, muddy stream, practically impassable on account of quicksand, except at times of low water. The Arroyo Salado enters the valley through a canyon in the partly consolidated and upturned Tertiary strata illustrated in Pl. V, *A*.

San Acacia Gorge.—This is the narrows at the southern end of Belen Valley. The mesa east of the river near San Acacia is covered by a sheet of basalt, which originally extended farther northwestward across the present course of the Rio Grande. The river has cut thru an arm of this lava sheet, making a short narrow gorge, the walls of which, about 250 feet high, are composed of sand and gravel, protected by the cap of igneous rock.

The portion of lava left west of the river is less than one-half mile in length. West of this, and 75 feet higher than the river level, is a wide sand and gravel plain, which evidently marks the course of the Rio Grande previous to the time the river broke through the lava at the gorge. Still farther west the beds of loose sand and gravel give place to the Tertiary sediments shown in Pl. V, *B*.

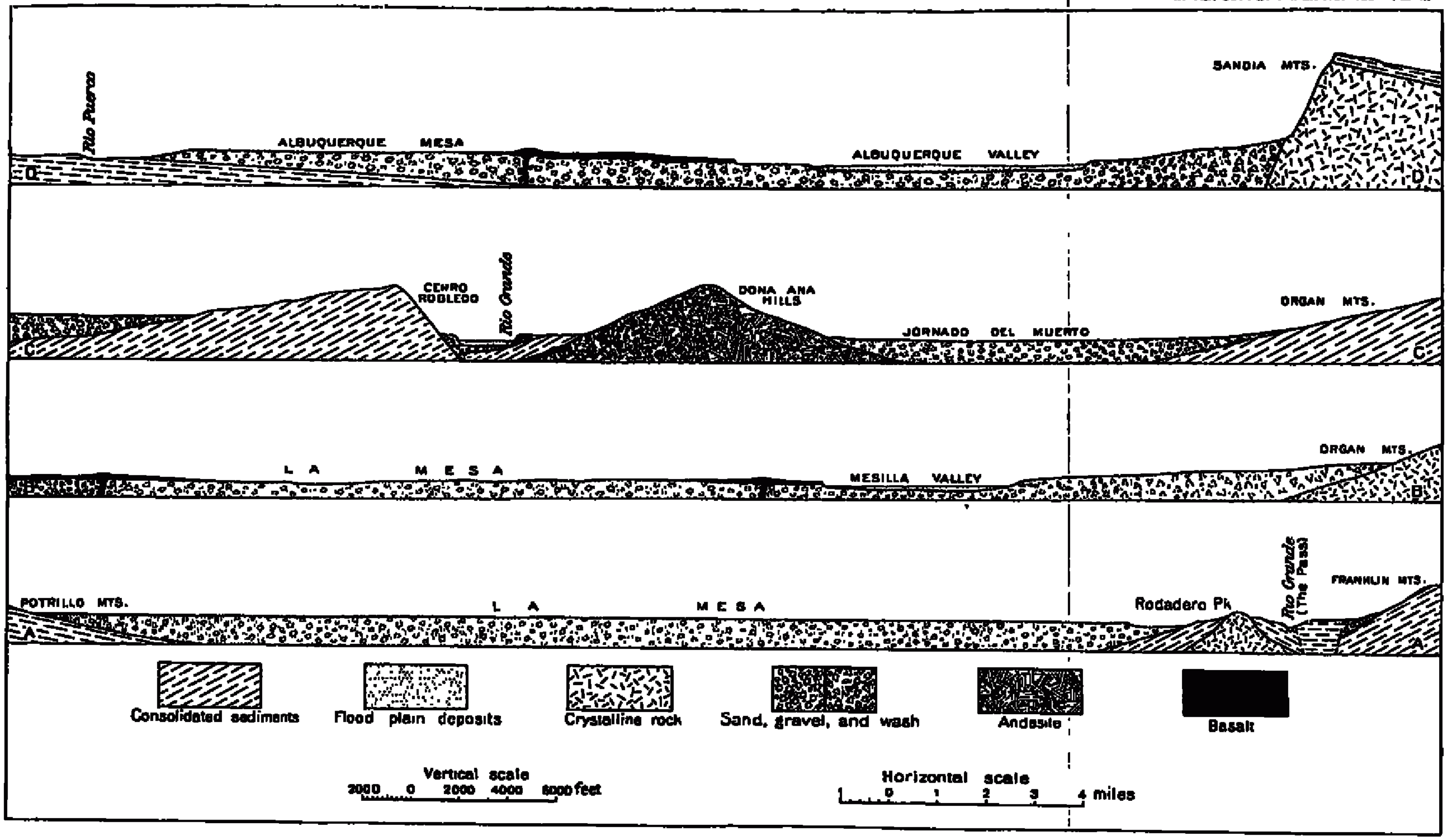
Socorro Valley.—This valley, so named from its principal town, extends from San Acacia Gorge southward to San Marcial, a distance of about 40 miles, and includes an estimated area of about 60,000 acres of bottom land. It is similar to Albuquerque and Belen valleys, except that the mountains on its sides are nearer and the corrugated detrital slopes correspondingly steeper and more eroded than those bordering the valleys previously described.

Engle Valley.—This valley extends from San Marcial to Elephant Butte, a distance of about 40 miles. This valley differs from the others described in being very narrow, as shown in Pl. I, and in its lack of bottom land. The northern half has been described and mapped as a reservoir site.[a] From this map it appears that the contour marking elevations 100 feet above the river incloses a strip of land varying in width from about 800 feet to 2 miles. The southern half of the valley is somewhat wider in places. According to the reports of the United States Reclamation Service the maximum area to be submerged in the Engle reservoir, described on pages 26–29, is about 38,400 acres, contained in a strip 40 miles long and about 1½ miles in average width.

Altho Engle Valley is cut in detritus, it is not so broad as the valleys to the north and to the south. West of the rock hills, near Elephant Butte, the detrital beds extend continuously southward (Pl. VIII) and seem to present an easy passage for the river, but it does not follow the course thus afforded.

Elephant Butte Canyon.—A few miles north of Elephant Butte the river leaves the detrital beds and enters a narrow rock canyon, which

[a] Twelfth Ann. Rept. U. S. Geol. Survey, pt. 2, p. 203.



CROSS SECTIONS OF THE RIO GRANDE REGION.

A-A, at New Mexico-Mexico boundary; B-B, near Las Cruces; C-C, at northern end of Mesilla Valley; D-D, near Albuquerque.

it occupies thence southward to the end of the Caballos Mountains. This canyon is described in detail as the Engle dam site (see pp. 26–29) and need not be further discussed in this connection.

Las Palomas Valley.—This valley, extending from Elephant Butte to Rincon, a distance of about 50 miles, is much broader than Engle Valley. The bottom lands form a part of the irrigable area, 26,000 acres in extent, under the proposed Engle reservoir. The terrace bluffs bordering this valley are especially conspicuous. West of the river they consist of well-stratified sands and gravels, but east of the valley they are more varied in both form and composition, containing not only stratified sand and gravel, but volcanic tuffs, as shown in Pl. II, *A*.

Selden Canyon.—This canyon, extending from Rincon to the head of Mesilla Valley, a distance of about 18 miles, is not so uniformly narrow as some of the other canyons. At some places, as at Penasco Rock, where a dike crosses the course of the river, the canyon is narrow. At other places it broadens to considerable dimensions. It contains about 8,000 acres of bottom land.

Mesilla Valley.—This is the largest of the erosion basins of the Rio Grande region, extending from old Fort Selden southward to The Pass, a distance of about 50 miles. It has a maximum width of 8 miles and includes about 150,000 acres of bottom land, of which 100,000 acres are irrigable. It contains the principal body of land to be irrigated from the proposed Engle reservoir, and has been surveyed in detail by the United States Reclamation Service, as shown in Pl. X. The valley is cut in the unconsolidated sand and gravel, typically exposed in the bluffs, 300 feet or more in height, bordering La Mesa on the west.

As in the Elephant Butte region, the detrital bed in which Mesilla Valley is cut extends uninterruptedly southward, west of the rock hills near El Paso; but the river, instead of following this seemingly easy course, abandoned the detrital bed and cut a canyon through the hard rock ridge at El Paso.

El Paso Canyon.—This is a rock gorge through which the Rio Grande, formerly a stream of the interior basin region of New Mexico and Mexico, past and became thenceforth a part of the Gulf drainage. The character of this canyon and its relation to the mountain ridge and the ancient course of the river—La Mesa—is indicated in section A–A of Pl. III. Rock terraces at the same altitude as the surface of La Mesa indicate that after the river had formed a graded surface over the region, principally by building up its course, it found a way across the rock ridge at The Pass. The epoch of erosion that followed was not of sufficient duration to cut more than the narrow canyon in the hard rock of The Pass, although the broad Mesilla Valley was excavated at the same time.

El Paso Valley.—This valley is similar to Mesilla Valley in being a broad basin cut in unconsolidated sand and gravel. It lies outside of the Territory of New Mexico, and is therefore not properly included in this paper, although it contains part of the land included in the Rio Grande reclamation project. The valley has been described by Richardson[a] and by Slichter.[b]

GEOLOGY.

INTRODUCTION.

No attempt is made to discuss the geology of the Rio Grande region further than is necessary to give an understanding of the physical conditions likely to affect the storage of the surface waters and the occurrence and development of the underground waters; but in order to describe these conditions some knowledge of the rocks is necessary. Three kinds of rock are recognized in this report. The first consists of granites, gneisses, and consolidated sediments, including sandstones, limestones, and shales. The second consists of unconsolidated sediments or detritus of comparatively recent origin, including river sands and gravels and mountain wash. The third comprises effusive rocks, mainly of Tertiary and Quaternary age.

ROCK FORMATIONS.

CONSOLIDATED SEDIMENTS.

The older sedimentary rocks of the Rio Grande region include strata that range in age from Algonkian to Cretaceous and that are well exposed throughout the area described. These, together with the underlying granites, form the rock basins that contain the water-bearing formations and to some extent are themselves water bearing. The consolidated sediments have special importance near Elephant Butte, where the Rio Grande cuts a sharp gorge through them at the Engle dam site, and near El Paso, at the site of the proposed International dam.

UNCONSOLIDATED SEDIMENTS.

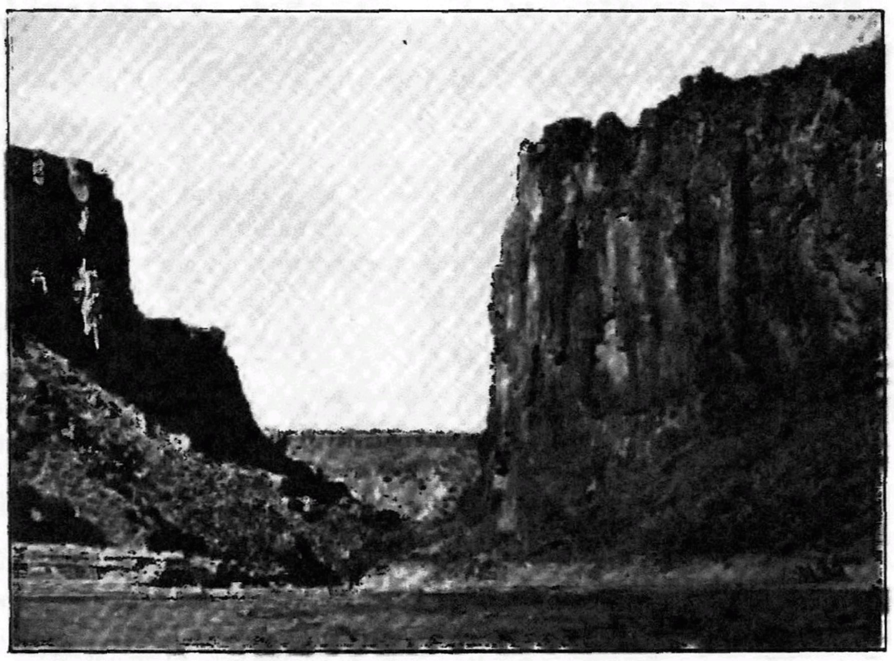
Unconsolidated material, consisting of clay, sand, and water-worn gravel, occurs generally in the lowlands along the river, in the terraces on either side of the Rio Grande Valley, in the central part of the Jornada del Muerto, and in La Mesa, west of Mesilla Valley. The slopes lying between the river and the mountains consist largely of angular rock débris, derived as wash from the mountains.

The older detrital beds are partly cemented, but the younger ones are wholly unconsolidated and allow water to pass freely through them.

[a] Richardson, G. B., Reconnaissance in trans-Pecos Texas: Bull. Univ. Texas No. 23, 1904, pp. 95-108.
[b] Slichter Charles S., Observations on the ground waters of the Rio Grande Valley: Water-Sup. and Irr. Paper No. 141, U. S. Geol. Survey, 1905, pp. 9-51.

A. LAVA-CAPPED MESA AT SAN MARCIAL.

The sheet of basalt resting upon the sand and gravel is the edge of the great flow covering the north end of the Jornada del Muerto.



B. SIDE GORGE AT THE ENTRANCE TO WHITE ROCK CANYON, NEAR ESPANOLA DAM SITE.

Showing columnar basalt in the foreground, and the rhyolite west of the river in the background.

The detritus has a great, though unknown thickness. A well at Santa Fe penetrates it nearly 1,000 feet; another at Sandia, N. Mex., 893 feet; one at Lanark, west of Mesilla Valley, 945 feet; and one in a neighboring basin,[a] near El Paso, 2,285 feet, but in none of these wells has bed rock been reached. Where the older and partly cemented beds have been upturned and exposed to view in Arroyo Salado, they have an observed thickness of several thousand feet. Their character is indicated in Pl. V, *A*, *B*. The younger or uncemented sands and gravels are well exposed in the terraces on either side of the river.

IGNEOUS ROCKS.

The igneous formations that are important in a discussion of the water supply are principally of Tertiary and Quaternary age, and occur in the form of massive flows, beds of tuff, volcanic necks, dikes and sheets, and crater cones. The older effusive masses, consisting of andesites, rhyolites, and other rocks closely related to these, occur in more or less isolated masses at many places throughout the Rio Grande region and are perhaps best represented by the thick beds of tuff on the eastern slope of the Jemes Mountains in the northern part of the Rio Grande region, by the Socorro Mountains and Cerro Magdalen in the central part, and by the Dona Ana Hills in the southern part. Their formation antedates the accumulation of at least the upper part of the detritus as fragments of the rock are contained in the detrital beds.

The younger igneous rocks consist of dark-colored basalts, occurring mainly in sheets capping the detritus and in crater cones which retain their original form in great perfection, as shown in Pl. VI, *A*. Basaltic rock also occurs in dikes and volcanic necks penetrating the older rocks. Among the more conspicuous sheets capping the detritus may be mentioned those west of Santa Fe, through which the river has eroded White Rock Canyon, those covering parts of the mesa west of Albuquerque (see Pl. II, *B*), the San Marcial flow (see Pl. IV, *A*,) and the basalt flows of La Mesa west of Mesilla Valley. The dikes and volcanic necks become important in the vicinity of the Engle reservoir (Pl. IX), where they will probably supply building stone for the proposed dam.

STRUCTURE.

GENERAL CHARACTERISTICS.

The geologic structure of the Rio Grande region is complicated, and much detailed investigation is necessary before it can be adequately described. The main structural features, however, are known in a general way. Great synclines, such as the Jornada del Muerto, occur,

[a] Richardson, G. B., Reconnaissance in trans-Pecos Texas: Bull. Univ. Texas No. 23, 1904, p. 96.

and monoclinal mountains, formed by faulting and the tilting of crust blocks. The rocks thus flexed and faulted are mainly of pre-Tertiary age, but the Tertiary beds are strongly upturned in places, indicating that some crustal movement took place after these beds were formed. (Pl. V, *A*). The older valleys of erosion and the troughs formed by the tilted blocks have been partly filled with unconsolidated detritus consisting of sands, waterworn gravels, and angular mountain wash.

EASTERN BORDER.

The eastern part of the Rio Grande region is occupied by the Rocky Mountain uplift, which extends through central New Mexico. The southern end of the Rocky Mountains, terminated at the south by Glorieta Pass, is a granitic mass upon which lie strata that dip away from it to the east, south, and west. But south of this pass the underlying granite is covered, more or less completely, with sedimentary rocks dipping in various directions. The strata of Glorieta Mesa incline toward the south, and those of the Sandia Mountains, the Manzano Range, and Sierra Oscura toward the east. The strata of Chupadera Mesa are nearly horizontal, while those of the San Andreas Range and the Organ and Franklin mountains dip toward the west. Numerous faults occur, with displacements measured in hundreds of feet and several with displacements of thousands of feet.

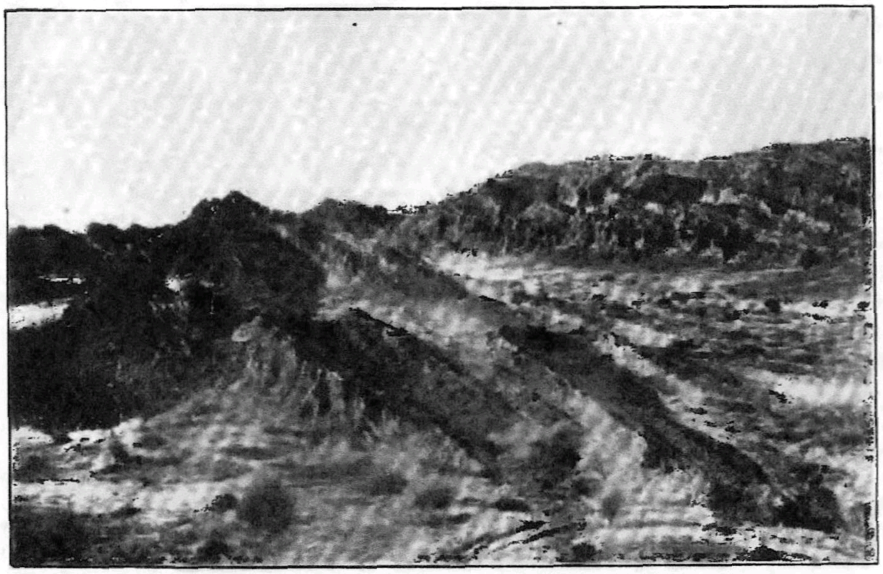
WESTERN BORDER.

The western part of the Rio Grande region is less mountainous than the eastern part, and a greater proportion of it is covered with detritus, which obscures the structure to a large extent. In the Rio Puerco Valley strata dip to the east and are believed to pass beneath the Rio Grande Valley, while strata of the same geologic age occur in the Sandia Mountains, several thousand feet above the Rio Grande Valley, the difference in elevation being due to faulting along the western face of the Sandia Mountains and the eastward tilting of the Sandia block, as indicated in section D–D of Pl. III. On the other hand, the crust block forming Sierra Ladron, a few miles south of Rio Puerco, has been tilted steeply to the west.

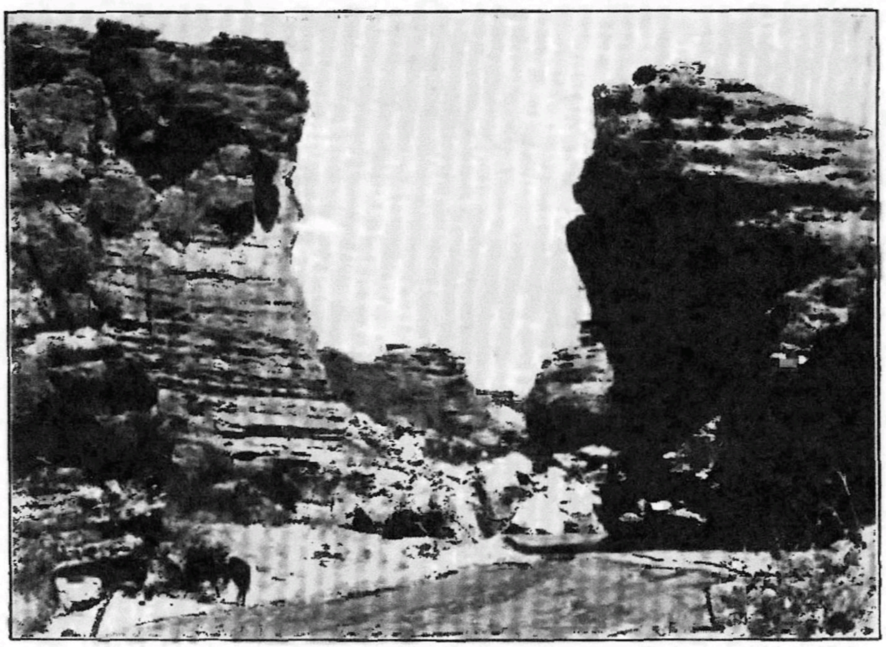
In the western part of the region many of the mountain groups, such as Jemes and Socorro mountains and Cerro Magdalen, are composed principally of effusive rock.

CENTRAL AREA.

The structure of the Rio Grande region is best shown in the central portions, where the river has removed the detritus in many places, exposing the consolidated rocks. The Caballos and Fra Cristobal ranges, forming the western limb of the Jornada syncline, are cut off



A. TERTIARY STRATA IN ARROYO SALADO AT THE BASE OF SIERRA LADRON.



B. CANYON IN TERTIARY SEDIMENTS WEST OF SAN ACACIA, N. MEX.

abruptly on the west by great faults which are plainly exposed and traceable for longd istances. (See Pl. VII.) Cerro Robledo furnishes a characteristic type of structure. (See Pl. III.) East of the river Carboniferous limestone, dipping westward, passes beneath the Rio Grande Valley. The same limestone occurs in the hills to the west 2,000 feet above the river, the difference in altitude being due to faulting and the tilting of the Cerro Robledo block.

Displacements by faults much greater than that at Cerro Robledo are evident at a number of places. The western face of the Caballos Mountains (see Pl. VI, *B*) and the Fra Cristobal Mountains (Pl. VII) are fault scarps, and Cerro Cuchillo is an excellent example of a tilted block. With the exception of the Jornada del Muerto, the Rio Grande region may be properly said to consist of a series of block mountains with troughlike depressions intervening between them.

TOPOGRAPHIC DEVELOPMENT.

EROSION.

Altho the elevations and depressions constituting the Rio Grande region are due principally to crustal deformation, the topography has been more or less modified by erosion and deposition. Many of the mountain slopes are precipitous and show little modification by erosion, as illustrated in the Caballos Mountains. (Pl. VI, *B*.) Other slopes are comparatively mature. Along the eastern base of the Caballos and Fra Cristobal ranges, particularly in the vicinity of Engle, the stratified rocks dipping eastward beneath the Jornada have been practically base-leveled over a considerable area. Whether the base-level extends beneath the Jornada generally, as stated by Keyes,[a] or is local, can only be conjectured at the present time, as the older rocks within the syncline are exposed over a comparatively limited area, being for the most part buried to unknown depths by detritus.

SEDIMENTATION.

Tertiary.—The older portions of the detritus contained in the rock basins consist of well-stratified beds of sand, gravel, and mountain wash, more or less faulted in places and otherwise disturbed by crustal movements. They are undoubtedly of Tertiary age. In other places sediments, apparently of Tertiary age, are not separable at present from the younger or Quaternary deposits.

Quaternary.—The unconsolidated sands, gravels, and "wash" covering the greater part of the Rio Grande region is of Quaternary age and occurs in at least two distinctly separable formations. The more extensive one, locally known as the mesa gravels, occurs in the terraces along the river and forms the corrugated slopes lying between

[a] Keyes, C. R., Water-Sup. and Irr. Paper No. 123, U. S. Geol. Survey, 1905, p. 25.

the river and the bordering mountains. The second occurs in the flood plains in all of the erosion basins previously described. In the Jornada del Muerto and La Mesa the sand and gravel beds belonging to this formation are not dissected by erosion, but lie practically as they were deposited, at an altitude 300 to 350 feet above the present bed of the river.

The mesa gravels originally filled the basins to altitudes represented by the terraces, and in them the erosion basins were cut. The depth to which these were excavated and later filled is not definitely known, but the general relations of the various gravel beds to each other and to the rock basins containing them are illustrated in fig. 1.

TERTIARY AND QUATERNARY HISTORY.

SURFACE DEFORMATION AND FIRST VOLCANIC ERUPTION.

The crustal movements that produced the structural and geographic features described began at the commencement of or sometime during the Tertiary period with the formation of monoclinal mountains and troughlike intermontane valleys. About the same

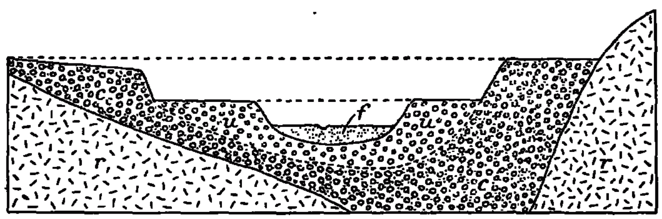
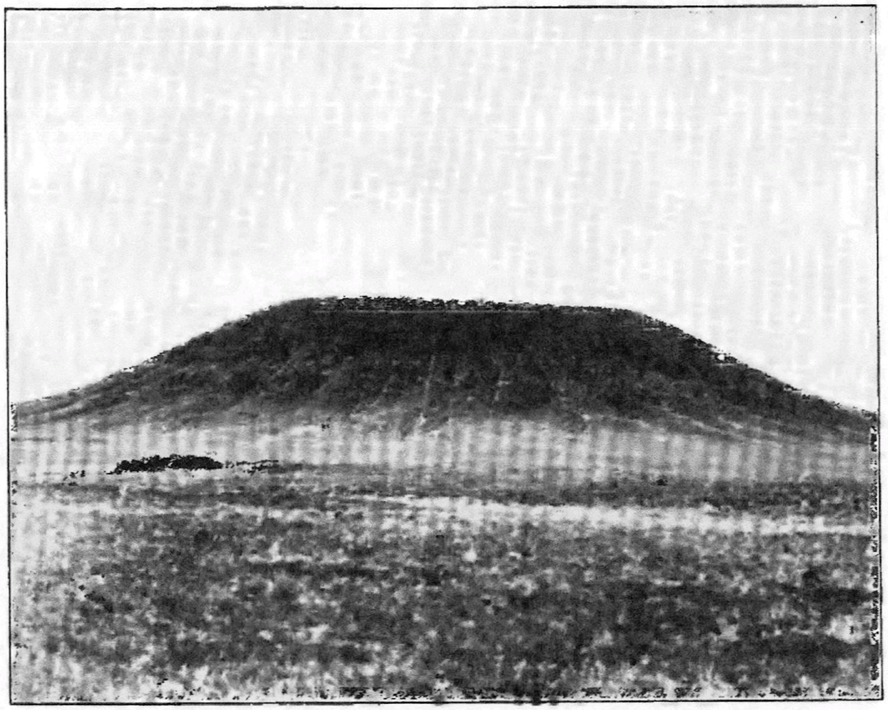


FIG. 1.—Sketch section illustrating the detrital deposits of Rio Grande Valley. *r*, Rock basin; *c*, detritus of the higher terrace; *u*, detritus of the lower terrace; *f*, flood-plain deposits.

time great masses of andesite and rhyolite were extruded, remnants of which are now found in the Jemes Mountains, the Socorro Mountains, the Dona Ana Hills, and elsewhere. This deformation and volcanic activity evidently occurred late in the Tertiary period, as Tertiary strata are upturned and in places intersected by rhyolite.

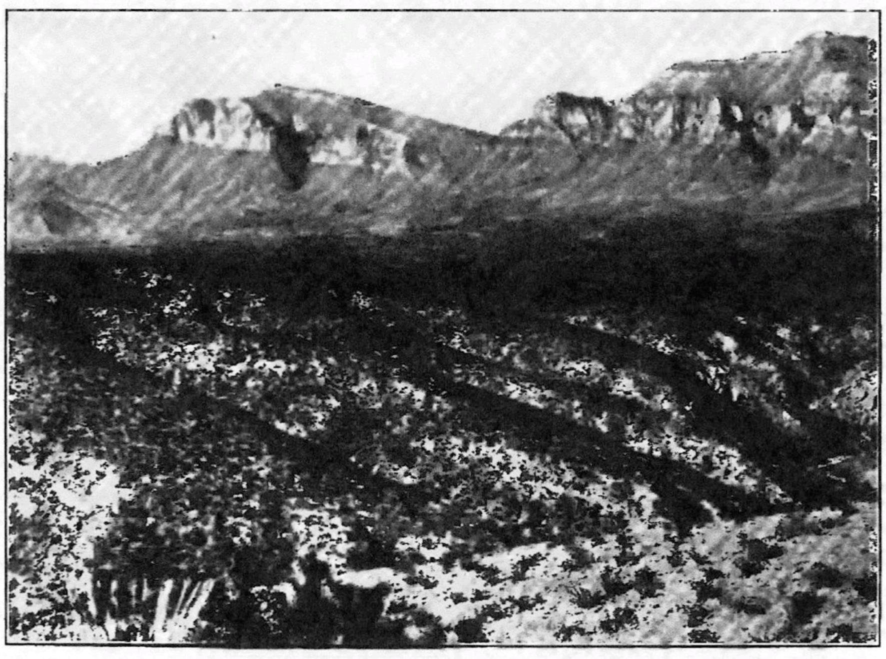
FIRST ACCUMULATION OF GRAVELS.

The structural troughs between the tilted mountain blocks formed natural lodgment areas for sediment. It can not be stated at present whether the sediments are partly of lacrustrine origin or wholly subaerial, nor is their maximum thickness known, but well records indicate a thickness of thousands of feet. The material exposed in the terraces and penetrated by the shallow wells, consisting mainly of coarse sand and gravel, is presumably of river origin, but some of the deep wells penetrate thick beds of sandy clay, possibly of lacustrine accumulation. The surface of this first gravel accumulation is preserved in a number of places, where it forms the upper terrace, 800 feet above the river, described on page 11.



A. SANDIA VOLCANO, WEST OF ISLETA, N. MEX.

A volcanic cone of recent origin, composed of basaltic cinders.



B. CABALLOS MOUNTAINS.

Showing the western escarpment and the corrugated alluvial slope at its base.

SECOND VOLCANIC ERUPTION.

After the depressions had been filled to altitudes represented by the upper terrace, extensive sheets of basalt were outpoured over the sands and gravels. In the lava fields west of Santa Fe, and in those near Bernalillo, two sheets of basalt occur, separated by a few feet of gravel, as shown in fig. 2. West of Albuquerque (Pl. II, *B*), and also in the extensive lava fields west of Isleta, the older sheets apparently belong to this epoch of eruption, and it is probable that many of the older masses of basalt in other parts of the Rio Grande region were extruded at about the same time.

FIRST EPOCH OF EROSION.

The second volcanic eruption was apparently accompanied by some change, possibly climatic, which caused the Rio Grande to erode its channel. During this epoch the river probably flowed through the Jornada del Muerto south of San Marcial, across La Mesa west of El Paso, and southward into the basin region of northern Mexico, eroding a valley 10 to 20 miles wide.

Ancient course of the Rio Grande.—Many facts point to the inference that the ancient course of the Rio Grande was not the same as its present course south of San Marcial. Some of the data leading to this inference have been given and others will be presented in the following paragraphs. Briefly stated, the facts are these:

The Jornada and La Mesa have the geographic position, form, surface elevation, and gradient that would be expected in a débris-filled valley; they contain unconsolidated sands and gravels as deep as wells have penetrated; their surface elevations and gradients indicate that they are parts of a graded surface that formerly extended throughout the Rio Grande region and is now represented north of San Marcial by the low terrace previously described, this ancient surface having the same gradient as that of the river at the present time.

At the point where the river leaves this old valley the surface is covered by an extensive basalt flow (the San Marcial lava sheet, covering about 160 square miles) resting on sand and gravel beds. The lava is not eroded at the surface and is covered only by windblown sand. Large quantities of loose shifting sand lie immediately north of the lava beds.

Engle and Las Palomas valleys are much narrower than the other erosion basins, and are cut in detritus which contains gypsum in places. The beds are cemented to some extent, and are associated with rhyolite, presumably much older than the basalt and its underlying detritus at San Marcial.

The measure of consolidation, presumably due to difference in age, is indicated in the size of the erosion basins. While the river cut canyons in hard rock it excavated narrow valleys in the cemented detritus west of Caballos and Fra Cristobal mountains and broad basins like Socorro and Mesilla valleys in the unconsolidated detritus to the north and south.

From these facts the inference is drawn that the ancient Rio Grande flowed through the Jornada and La Mesa into the interior basin of Mexico, and that in comparatively recent geologic time changes occurred which turned it out of its valley and away from the interior basin toward the Gulf of Mexico.

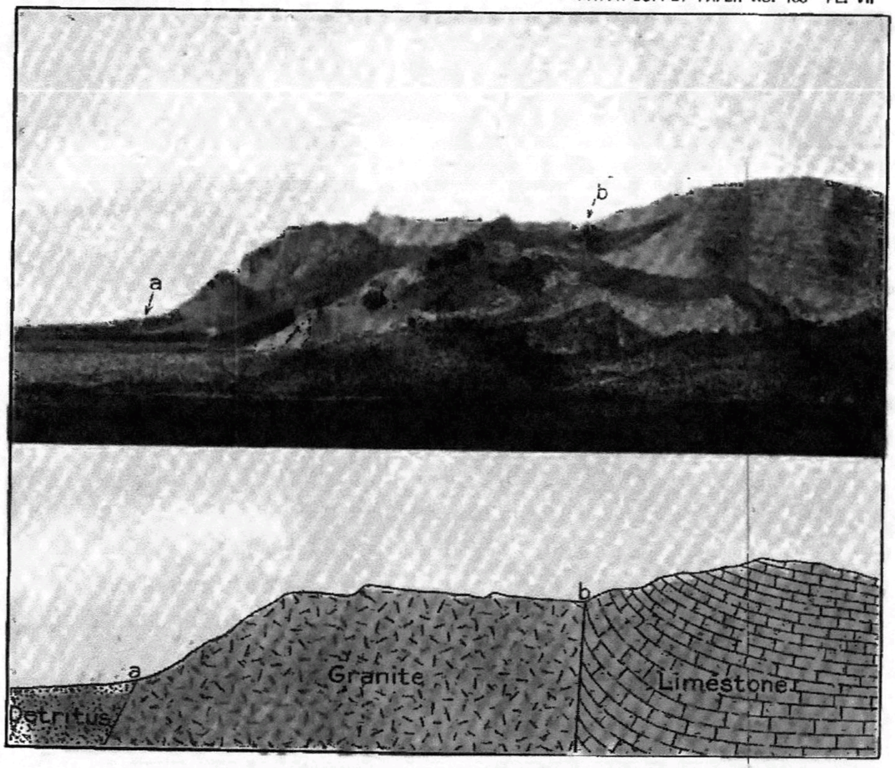
SECOND ACCUMULATION OF GRAVELS.

During the second epoch of deposition the river filled its valley with sand and gravel to the grade represented by the lower terrace (*uu* of fig. 1) and by the surface of La Mesa and the Jornada del Muerto. In La Mesa the ancient valley is about 20 miles wide and the filling is mainly fine sand near the surface and somewhat coarser sand and gravel beneath. In the Jornada del Muerto the filled valley is narrower and the material is coarser, many of the pebbles having a diameter of several inches. In Albuquerque Valley the quantity of filling during this epoch is much less than in La Mesa and the Jornada, and is best represented by the coarse gravel deposits of the bluffs near Albuquerque. Still farther north, in Santo Domingo Valley, near the northern end of the Rio Grande region, the deposits are very limited, and the river here was apparently employed mainly in broadening its valley.

The graded surface formed by the river during this epoch was one mainly of erosion in Santo Domingo Valley, where a broad shelf was cut 500 feet below the surface of the older gravels; one formed partly by erosion and partly by deposition in Albuquerque Valley; and one mainly of deposition in the Jornada and La Mesa. Throughout the Rio Grande region this surface, represented now by the terraced bluffs, is about 300 feet above the river, except where it has been cut down by later erosion.

THIRD VOLCANIC ERUPTION.

Near the close of the second period of sedimentation extensive volcanic disturbances occurred throughout the Rio Grande region, resulting again in the outpouring of great sheets of basalt. The most conspicuous of these are near San Marcial (Pl. IV, *A*) and on La Mesa west of Mesilla Valley. The San Marcial flow, covering about 160 square miles, was outpoured on the Jornada del Muerto, then occupied by the Rio Grande, and probably created a dam that formed a temporary lake in which were accumulated the great quantities of sand found on the Jornada north of the lava sheet.



A. WESTERN FACE OF THE FRA CRISTOBAL MOUNTAINS.

Showing two faults, a and b.

B. FAULT PLANE AT THE WESTERN BASE OF FRA CRISTOBAL MOUNTAINS.

Showing near view of a, above.

DIVERSION OF THE RIO GRANDE.

There is no evidence that the river ever flowed over the San Marcial lava sheet. The surface of this sheet is not eroded and, so far as observed, is devoid of foreign matter except a small amount of wind-blown sand. The volcanic dam, aided possibly by surface movements accompanying the volcanic eruptions, evidently diverted the river from its old valley in the Jornada to a new course for a distance of about 100 miles west of the Caballos and Fra Cristobal mountains. At Dona Ana it returned to the old débris-filled valley, which it crossed diagonally and abandoned again at El Paso.

Several phenomena which otherwise are difficult to explain are made clear by a recognition of this change in the course of the river.

First, as previously stated, the surface of the Jornada between San Marcial and Mesilla Valley has an average gradient of 4.5 feet per mile, which is practically the gradient of the river at the present time.

Second, the detrital beds cut by the river west of the Fra Cristobal and Caballos mountains are associated with rhyolite, apparently extruded at the same time as the rhyolites previously described as of Tertiary age, indicating that the detritus is older and probably more difficult to erode than the loose sands and gravels that were deposited later.

Third, near Rincon, and again in Selden Canyon, gypsum was noted in the detrital beds, but nowhere was any indication of gypsum found in the mesa gravels referable to the epoch in which the Jornada and La Mesa were filled.

Fourth, as previously stated, Engle Valley is much narrower than the other erosion basins formed at the same time—as, for example, Mesilla and Belen valleys, which have been excavated from river sands and gravels known to be of recent origin. This difference is due, no doubt, to the greater resistance to erosion of the older detritus.

SECOND EPOCH OF EROSION.

The volcanic eruptions and the change in the course of the river were followed by a second epoch of erosion. In again eroding a valley, the river worked principally in the unconsolidated sands and gravels previously deposited, excavating the erosion basins, but at a number of places where it had wandered from its old course it cut its channel in hard rock, forming the various canyons. The result is the succession of comparatively broad basins and short rock canyons that characterize the Rio Grande region.

ACCUMULATION OF SILT.

The second epoch of erosion was followed by the deposition of the silt and sand that now form the flood plains of the erosion basins. The depth of this third valley filling is not great. Borings indicate a maximum depth of 85 feet at the International dam site in El Paso Canyon and of 72 feet at the Engle dam site, near Elephant Butte. The depth within the basins probably does not differ greatly from that in the canyons, but this can not be stated positively.

The well records given in the section on underground waters indicate that the mesa gravels (*uu* of fig. 1) are probably encountered at depths of 30 to 80 feet. The first "cemented sand" in the Albuquerque well (p. 34) is presumably a hardened layer of the Tertiary beds, and the gravel beds in the Mesilla Valley wells (pp. 41-46), encountered at depths of 30 to 75 feet, are interpreted as belonging to the mesa gravels. The depth of flood-plain deposit thus indicated corresponds well with the known depth of filling in the canyons.

The deposition of sand and silt in the erosion basins causes frequent changes in the course of the river, so that bayous, sloughs, and oxbow lakes are common in the bottom lands. This is well illustrated in Mesilla Valley (Pl. X), where many abandoned courses occur, particularly near the southern end, some still occupied by streams and others nearly filled with silt. A characteristic change in the channel of the river occurred in 1905 near the head-gate of Las Cruces canal, at the northern end of Mesilla Valley. During the spring floods of that year the river broke through the narrow neck of land on the western side of the valley, leaving the head-gates about a mile from the new channel.

B. M. Hall, supervising engineer of the United States Reclamation Service, in charge of the Rio Grande project, has made computations of the amount of silt carried by the Rio Grande. He arrives at the conclusion that the river carries, on the average, 14,580 acre-feet of mud a year, or enough when dry to cover 14,580 acres 1 foot deep. The computation, although made for the purpose of estimating the time required to fill the reservoirs with mud, is useful in this connection in indicating the possibilities of rapid accumulation wherever opportunity is offered.

During times of flood the river naturally carries its maximum amount of silt, which is thus admitted to the sloughs and overflow districts and gradually fills them to the common level of the flood plain. A similar action takes place in the irrigation ditches, which rapidly fill with silt. Some of the older ditches have thus been built up many feet above the level at which they were originally constructed.

RESERVOIR SITES.

INTRODUCTORY STATEMENT.

The alternation of erosion basins and rock canyons in the Rio Grande Valley is especially favorable for the construction of reservoirs and the conservation and use of the flood waters of the river. Available dam sites occur in the canyons, while the broad basins are suitable for storage reservoirs or for irrigation, according to location and character. Several reservoir sites have been selected and the two most promising ones—the International reservoir, at the southern end of the region, and the Engle reservoir, west of the Fra Cristobal Mountains—have been investigated in detail.

INTERNATIONAL RESERVOIR.

The proposed International reservoir is located at the southern end of Mesilla Valley and was designed by its promoters to store water to be used in El Paso Valley, which lies partly in Texas and partly in Mexico. The dam site is in the canyon about 4 miles north of the city of El Paso.

El Paso Canyon is a narrow gorge carved in solid rock, consisting of Lower Cretaceous sediments and eruptive rocks. The strata have been considerably fractured and faulted. Rodadero Peak, to the west, has a granitic core overlain by highly inclined Lower Cretaceous sandstones, shales, and limestones. East of the river the strata lie more nearly horizontal, while in the Franklin Mountains, still farther to the east, strata older than Cretaceous dip steeply to the west. The shattered and faulted state of the rock is apparently the only geologic condition unfavorable to El Paso Canyon as a good dam site. The gorge is narrow, the rock abutments are firm, and the depth to bed rock in the channel is not prohibitive, as it is found at a maximum depth of little more than 80 feet. The site has been described in detail in the report of the International (Water) Boundary Commission.[a]

Although the dam site of the proposed reservoir is a good one, geologic conditions are not favorable to the successful storage of water in the southern part of Mesilla Valley. As previously pointed out, the old gravel-filled valley of the Rio Grande passes southward into Mexico west of Rodadero Peak. The water of the reservoir would be impounded in the basin eroded from the unconsolidated gravels of the old valley fillings and would undoubtedly escape to some extent through these gravels until such time as they might become impervious from silting. It is an open question how much time would elapse before this silting would become effective in preventing leakage.

[a] Proceedings International (Water) Boundary Commission, United States and Mexico, 1903; vols. 1 and 2.

ENGLE RESERVOIR.

LOCATION.

The proposed Engle reservoir site is located in Engle Valley, west of the Fra Cristobal Mountains, and is best reached from Engle, a small town on the Atchison, Topeka and Santa Fe Railway. The site of the proposed dam is in the rock canyon near Elephant Butte, a large volcanic neck standing near the river, as shown in Pl. IX.

ROCK FORMATIONS.

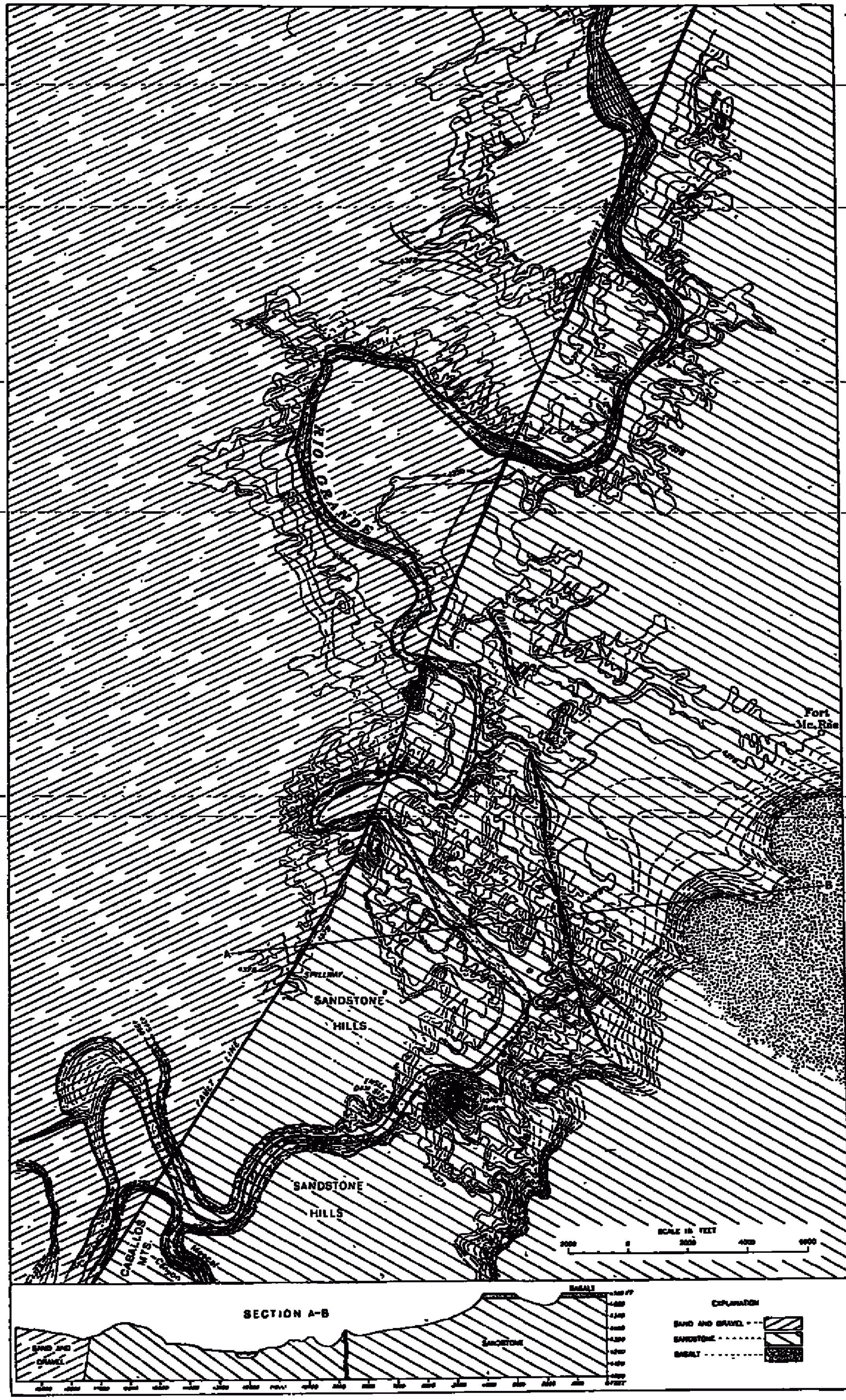
The rocks near the proposed reservoir are of several kinds. In the mountains, a few miles distant, there are pre-Cambrian granites overlain by Paleozoic and Mesozoic sandstones, shales, and limestones, and in the valleys there are Tertiary and Quaternary sands, gravels, and eruptive rocks. The rocks that will probably be of economic importance in building the proposed dam are the Carboniferous limestones and shales of the Caballos Mountains, the Cretaceous sandstones forming the abutments of the dam and comprising the greater part of the area mapped in Pl. VIII as "rock," also shown in the foreground of Pl. IX, and the basaltic rock found in Elephant Butte and in the dikes of that vicinity, as well as in the lava flows and crater cones on the Jornada to the east, shown in the distance in Pl. IX.

The unconsolidated sands and gravels of Tertiary and Quaternary age are mainly of negative importance, since they form the floor and confining walls of the reservoir and endanger leakage.

STRUCTURE.

The geologic structure in the vicinity of Elephant Butte has been described in a general way under the heading "Central area" (pp. 9–16), where it is shown that the face of the Fra Cristobal and Caballos mountain ranges (see Pl. VII) are due to faulting and that the detrital valleys are due to the filling of the troughs thus formed with rock débris. The structure is illustrated in detail in the Elephant Butte area, a map and cross section of which are given in Pl. VIII. The fault at the western base of the mountains passes through this region, separating the unconsolidated detrital beds to the west from the rock formations to the east. The rocks, consisting mainly of Upper Cretaceous sandstones and shales, are more or less fractured near the fault and incline in a general easterly direction, the dip varying from about 10° to 90°.

The high lava-covered surface, shown at the right in the section Pl. VIII and in the distance in Pl. IX, is the western edge of the Jornada del Muerto. About 300 feet below this level and 150 feet above the river a broad terrace is cut in the sandstones east of the fault line and in



GEOLOGIC MAP OF ELEPHANT BUTTE REGION.

Showing the areal distribution of the rocks, the fault line between consolidated rock and detritus, and the superimposed course of the Rio Grande.

the detrital beds west of the fault. This terrace is traceable throughout the length of Engle and Las Palomas valleys and is most conspicuous west of the river, where it forms a shelf several miles wide in places. It differs from the terraces illustrated in fig. 1 in being a surface mainly of erosion, probably formed at a time when the down cutting of the river was temporarily arrested, for some reason as yet unknown, during which time the river cut laterally, flowing in part over the rock and in part over the detrital beds to the west, crossing and recrossing the fault line. When the river resumed its down cutting it eroded a canyon partly in rock and partly in detritus, as shown in Pl. VIII, instead of taking the course to the west, where no hard rock would have been encountered.

SPILLWAY.

The ease with which erosion is accomplished in the detrital beds is well illustrated in the three oxbows formed west of the fault line, where the river passes from the rock into the detritus. The southern and middle bows are now only 2 miles apart and are separated by a ridge of detrital material already partly eroded away. The spillway of the Engle reservoir has been located tentatively in this depression. Considered from the topography alone the depression is an excellent location for a spillway, since the waters from the overflowing reservoir would escape at a point far enough away from the dam to insure the safety of that structure. The nature of the rock, however, must also be considered.

A small valley heading in the spillway at the summit of this ridge is indicated in Pl. VIII. The map was not completed to the south but a similar valley extends from the spillway southward to the bend in the river at the northern end of the Caballos Mountains. These valleys have been carved from the unconsolidated sediments by such temporary streams as result from the drainage of a very small area, a fact distinctly unfavorable to the location of the spillway of a great reservoir in material so easily eroded.

The proposed spillway is close to the fault line and it is possible that solid rock might be found at no great depth beneath the surface. In a small valley south of the spillway sandstones occur in a nearly vertical position. But whether these are near enough to the surface to warrant the establishment of a spillway at the point proposed remains to be determined.

A spillway constructed near the dam might have the disadvantage of greater cost, since it would require the excavation of a considerable amount of hard rock, but the advantage of greater durability and the absence of danger from rapid erosion along the course of the overflowing waters would probably more than compensate the additional cost.

CONSTRUCTIONAL MATERIALS.

Building stone.—Several varieties of building stone are found within the Elephant Butte area. Massive limestones and red sandstones of Carboniferous age occur in the Caballos Mountains, the northern end of which is 1½ miles distant from the site of the proposed dam. Massive sandstones of Upper Cretaceous age occur at the dam site in the walls of the canyon. Field observations indicate that these will probably prove valuable for purposes of construction. But the strongest and most durable as well as the most accessible building stone is the basalt of Elephant Butte, which occurs close to the dam site. (Pl. VIII.)

Cement material.—The problem of procuring cement for the construction of the dam is important. Cement must either be hauled about 12 miles from the nearest railway station or manufactured near the dam site. Cement material is available in the Elephant Butte area. In the northern end of the Caballos Mountains, at the mouth of Mescal Canyon, limestone and shale occur in abundance. Samples of each were taken and were analyzed in the laboratory of the United States Reclamation Service at Berkeley, Cal. The samples were not selected by one familiar with the technical requirements of cement manufacture, and probably more suitable material may be found. The analyses of these samples, given below, must be regarded as preliminary, but indicate that good cement materials may be found near the dam site.

Analysis of limestone from the northern end of Caballos Mountains.

[C. H. Stone, analyst.]

Silica (SiO_2) and insoluble matter	7.94	Soda (Na_2O)	0.28
Alumina (Al_2O_3) and ferric oxide (Fe_2O_3)	0.80	Sulfur trioxide (SO_3)	0.30
Lime (CaO)	44.99	Carbon dioxide (CO_2) calculated to combine with CaO	39.29
Magnesia (MgO)	1.23		95.30
Copper oxide (CuO)	0.38	Moisture	0.11
Potassa (K_2O)	0.09		

Analysis of shale from the northern end of Caballos Mountains.

Silica (SiO_2)	63.74	Soda (Na_2O)	Undet.
Ferric oxide (Fe_2O_3)	6.44	Potassa (K_2O)	Undet.
Alumina (Al_2O_3)	17.33	Sulfuric trioxide (SO_3)	Trace.
Lime (CaO)	5.51	Ignition loss (H_2O, CO_2)	
Magnesia (MgO)	1.86		94.88

RATIONAL ANALYSIS.

Clay substance	27.20
Quartz	3.25
Feldspathic detritus	69.55

ENGLE DAM SITE.

Showing Elephant Butte at the right, the edge of the Jornada del Muerto in the distance, the tilted Cretaceous sandstones in the foreground, and the dry bed of the Rio Grande.

UNDERFLOW OF THE RIO GRANDE REGION.

WATER PLANE.

In Mesilla Valley the surface of the ground water is practically at the river level, as has been previously stated. The water plane in the valleys farther north can not be accurately represented for lack of detailed topographic maps, but the depths to water in wells situated in the bottom lands throughout the Rio Grande region indicate that the surface of the ground water is always at or very near the river level. The water plane determined for Mesilla Valley and mapped in Pl. X is probably typical, and the map doubtless expresses with sufficient accuracy the relation of the water table to the river and to the land surface for the entire region.

QUANTITY OF UNDERFLOW.

The investigation of the quantity and rate of underflow in Mesilla Valley, carried on in 1904 by Professor Slichter,[a] shows (pp. 11–13) that there is practically no underflow through the canyon near El Paso, but (pp. 25–29) that near Mesilla Park, where a series of experiments were made, water enters the underflow both from the river and from the drainage of the mesas. His conclusions are tabulated as follows:

TABLE 7.—*Amount of water contributed to the underflow of the Rio Grande near Mesilla Park, N. Mex., between September 20 and October 23, 1904.*

Dates.	Number of days.	Amount of ground water contributed by each mile of the river.			Amount of ground water contributed by rainfall upon mesa east of the valley per mile of river valley.		
		Cubic feet of water per 24 hours.	Cubic feet per second.	Gallons per minute.	Cubic feet of water per 24 hours.	Cubic feet per second.	Gallons per minute.
September 20 to October 1	11	110,500	1.28	575	40,500	0.47	211
October 1 to 9[a]	8	640,000	7.40	3,330	152,000	1.76	794
October 9 to 16	7	248,000	2.87	1,290	29,900	.35	155
October 16 to 23	7	117,200	1.36	745	5,950	−.069	−31
	33	[b] 8,900,000	....	....	[b] 1,517,000	....	....
Average per day	....	270,000	3.03	1,360	45,800	.515	232

[a] Heavy flood on October 5, 1904.

[b] Total amount contributed for each mile of the valley in thirty-three days. By converting cubic feet into acre-feet it is found that the river lost 204 acre-feet of water to the gravels of the underflow in thirty-three days, and that 34.8 acre-feet were contributed by the rainfall in the same period. These amounts are for each mile of the valley.

If the amounts shown by these figures are applied to Mesilla Valley as a whole the result is large. The valley is about 50 miles long, and if the seepage amounts to 204 acre-feet of water per mile a total of 10,200 acre-feet of water was contributed to the underflow of the valley by the river during the thirty-three days included in the table.

[a] Slichter, Charles S., Observations on the ground waters of Rio Grande Valley: Water-Sup. and Irr. Paper No. 141, U. S. Geol. Survey, 1905.

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TABLE 6.—*Records of wells in Mesilla Valley.*

	Owner.	Location.	Total depth.	Depth to water.	Yield per minute.	Water lowered by pumping.	Specific capacity per minute.	Specific capacity per square foot of strainer per minute.	Size of well.	Power used.	Use.	Cost of water per acre-foot.	Total lift in feet.
			Feet.	*Feet.*	*Gals.*	*Feet.*	*Gals.*	*Gals.*	*In.*				
1	F. C. Barker	1 mile south of Las Cruces	48	14	131	22.48	5.83	0.337	6	Gasoline	Irrigation	$13.20	45.58
2	Mrs. E. M. Boyer	Las Cruces	52	20	658	19.76	33.30	1.969	6	do	do	3.47	40.30
3	F. Burke	¾ mile south of Mesilla Park	60	14	755	22.85	31.75	.930	12	do	do	4.87	40.45
4	J. C. Carrera	2 miles north of Mesilla Park	58		648	8.48	74.60	3.530	6	do	do	3.16	26.85
5	W. N. Hager	½ mile west of Mesilla Park	63		325	15.20	22.30	.760	10	do	do	9.57	34.77
6	A. L. Hines	1 mile northeast of Mesilla	59	20	271	14.08	19.20	1.790	6	do	do	8.95	36.05
7	T. Roualt	3 miles northwest of Las Cruces	48		351	23.86	16.00	.620	10	do	do	7.91	34.16
8	G. H. Totten	½ mile west of Mesilla	62	17	464	22.50	20.60	.760	10	do	do	8.19	43.35
9	Agricultural College	Mesilla Park	48		1,000	11.37	88.00	2.320	12	Steam	do	4.70	29.55
10	Horaco Ranch Co. No. 1	Berino	75	5	837	13.75	60.80	1.690	10	Gasoline	do	2.21	23.89
11	Horaco Ranch Co. No. 2	do	53	8	191	23.64	8.10	.178	10	do	do	10.90	35.26
12	Horaco Ranch Co. No. 3	do	62	8	750	18.55	40.40	.892	10	do	do	2.46	32.36
13	Academy Loretto	Las Cruces	66	26	300					do	Domestic		
14	P. S. Ames	do	51	21	130					do	Irrigation		
15	A., T. & S. F. Rwy	Earlham	25	10	40				120	Wind	Engines		
16	Agricultural College	Mesilla Park, west of railway	62	19	1,000				12	Gasoline	Irrigation		
17	F. H. Bascom & Co	Las Cruces	46	35	30				4	do	Factory		
18	F. C. Barker	Las Cruces, near station	53	18	150				6	do	Irrigation		
19	do	1 mile south of Las Cruces	85	16	800				8	do	do		
20	S. F. Bean	Las Cruces	64	34	35				6	do	do		
21	Catholic Church	do	36	34	50				Dug	do	do		
22	City waterworks	do	63	22	300				6	Steam	City		
23	R. Elwood	do	100	17	800				8	Gasoline	Irrigation		
24	W. S. Gilliam	Mesilla Park	52	16	800				10	do	do		
25	Doctor Lane	5 miles east of Fort Fillmore	260	Dry					6				
26	do	6½ miles east of Fort Fillmore	330	Dry					6				
27	L. Quintero	1 mile south of Las Cruces	35	20					6	Steam	Irrigation		
28	Shalam Colony	Las Cruces	197	9	1,500				6	do	do		
29	S. A. Steele	1 mile south of Las Cruces	83	17					8	Gasoline	do		
30	W. G. Stewart	2 miles north of Las Cruces	35	25	30				2	do	do		
31	J. B. Thompson	2 miles southeast of Earlham	138						6	Windmill	Domestic		

R. F. Hare, of the New Mexico agricultural experiment station, indicate that the waters vary in the amounts, but not in the kinds of salts they contain, that from the upper sand containing 1,566 parts and that from the lower sand 1,123 parts of total solids per million parts of water.

Table showing well records in Mesilla Valley.—The following table comprizes data concerning wells in Mesilla Valley. Descriptions of pumping tests for the first twelve wells of the table may be found in Prof. Charles S. Slichter's paper on ground waters of Rio Grande Valley:[a]

[a] Water Sup. and Irr. Paper No. 141, U. S. Geol. Survey, 1905, pp. 51-73.

Well of Shalam Colony.—Several years ago an elaborate pumping plant was constructed for irrigation purposes at Shalam Colony, west of Dona Ana. A circular pit 18 feet in diameter was sunk to a depth of 30 feet and its sides and bottom were cemented. In the bottom of this pit five wells were bored, three of which are 6 inches in diameter and 90 feet deep (60 feet below the bottom of the pit), one is 12 inches in diameter and 90 feet deep, and one 6 inches in diameter and 197 feet deep. At a depth of 90 feet there is a 3-foot gravel stratum, which apparently yields the greater part of the water. The sand beneath this stratum entered the pipe so freely that it was impracticable to draw water from horizons lower than 90 feet.

A storage reservoir, covering an area of 1 acre and 5 feet deep, was constructed, and into this a 60-horsepower steam engine pumps water at the rate of 1,500 gallons per minute.

The ground water at this place is 9 feet beneath the surface, making a normal depth of 21 feet of water in the pit. The pump lowers the water surface 18 feet to a level at which it remains stationary, the flow from the wells equaling the discharge of the pump.

Well of J. R. Thompson.—Mr. Thompson's well is situated at the eastern edge of the valley, about 2 miles south of Earlham. It is a 6-inch bored well, 138 feet deep, and obtains water from the coarse sand at the bottom of the well. An accurate driller's record was obtained as follows:

Record of J. R. Thompson's well.

	Feet.
Sand and silt	0- 80
Clay	80-100
Sand	100-118
Clay	118-128
Coarse sand	128-138

Well of G. H. Totten.—Mr. Totten's well is located 1 mile west of Mesilla. It is a 10-inch well, 62 feet deep, with 24 feet of strainer. Water is raised by a centrifugal pump and 28-horsepower gasoline engine at the rate of 464 gallons per minute. When tested the well contained only 12 feet of strainer, which had been placed in the upper sand layer. Later the well was lowered and a second 12-foot strainer was added, greatly increasing the flow.

Record of G. H. Totten's well.

	Feet.
Soil	0-17
Sand	17-51
Clay	51-53
Sand and gravel	53-62

Samples of the waters were taken from both sand layers of this well to ascertain if they varied in quality. The analyses, made by Prof.

Water is raised by a centrifugal pump and 8-horsepower gasoline engine at the rate of 271 gallons per minute.

Record of A. L. Hines's well.

	Feet.
Soil	0–8
Sand	8–19
Quicksand	19–47
Sand and gravel	47–59

Wells of Horaco Ranch Company.—The Horaco Ranch Company has three wells separated by a few hundred feet and located west of Berino.

No. 1 is an 8-inch well, 75 feet deep, with an 18-foot strainer. Water is raised by a centrifugal pump and 12-horsepower gasoline engine at the rate of 837 gallons per minute.

No. 2 is a 10-inch well, 53 feet deep, with an 18-foot strainer. Water is raised by a centrifugal pump and 12-horsepower gasoline engine at the rate of 191 gallons per minute.

No. 3 is a 10-inch well, 62 feet deep, with an 18-foot strainer. Water is raised by a centrifugal pump and 12-horsepower gasoline engine at the rate of 750 gallons per minute.

Las Cruces city well.—During the summer of 1905 a pumping plant was constructed to furnish the city of Las Cruces with water. A 6-inch well was bored to a depth of 63 feet and an 18-foot strainer placed at the bottom of the pipe in a bed of gravel, occurring below the depth of 46 feet. A pit 8 feet square and 20 feet deep contains an Advance steam pump, which is placed 2 feet above normal water level. The water is drawn by suction from the capped casing at a rate of 300 gallons per minute.

The water drawn from a depth lower than 46 feet is apparently much better for domestic use than that obtained from the surface wells of Las Cruces. An analysis of the water made by Geo. W. Lord Company, of Philadelphia, Pa., is as follows:

Analysis of water from Las Cruces city well.

	Parts per million.		Parts per million.
Total solids	998	Chlorine (Cl)	133
Calcium (Ca)	156	Silica (SiO_2)	27
Magnesium (Mg)	19	Carbonate radicle (CO_3)	120
Sodium (Na)	159	Organic and volatile	Trace.
Sulfate radicle (SO_4)	338		

Well of Theodore Roualt.—Mr. Roualt's well is located on his ranch near the river, 3 miles northwest of Las Cruces. It is a 10-inch well, 48 feet deep, with a 10-foot strainer. Water is raised by a centrifugal pump and 18-horsepower steam engine at the rate of 351 gallons per minute.

Well of Mrs. E. M. Boyer.—Mrs. Boyer's well is located on her ranch, about one-fourth mile north of the railroad station at Las Cruces. It is a 6-inch bored well, 52 feet deep, with a 12-foot strainer. Water is raised by a centrifugal pump and 12-horsepower gasoline engine at the rate of 658 gallons per minute.

Record of Mrs. E. M. Boyer's well.

	Feet.
Soil	0- 2
Sand	2-22
Sand and gravel	22-52

Well of Frank Burke.—Mr. Burke's well is located one-half mile south of Mesilla Park. It is a 12-inch well, 60 feet deep, with a 12-foot strainer. Water is raised by a centrifugal pump and 21-horsepower gasoline engine at the rate of 755 gallons per minute.

Record of Frank Burke's well.

	Feet.
Soil	0- 8
Sand	8-22
Sand and gravel	22-60

Well of J. C. Carrera.—Mr. Carrera's well is located about 1 mile south of Las Cruces. It is a 6-inch well, 58 feet deep, with a 15-foot strainer. Water is raised by a centrifugal pump and 8-horsepower gasoline engine at the rate of 648 gallons per minute.

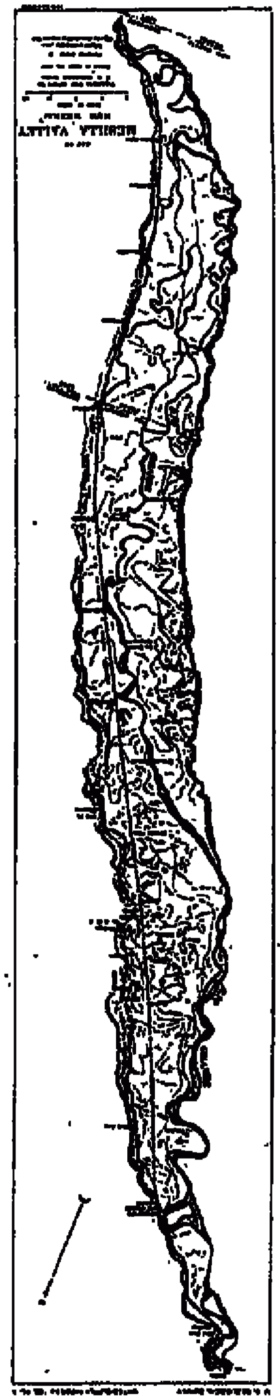
Well of Robert Elwood.—Mr. Elwood, of Las Cruces, constructed a pumping plant for irrigation during the summer of 1905, in which two 8-inch wells 40 feet apart are connected with a 5-inch centrifugal pump and 12-horsepower gasoline engine. The first well was bored 100 feet deep, but the casing was later withdrawn to the 64-foot level, where the most productive gravel bed occurs. The second well is 64 feet deep, and both are supplied with 24-foot strainers. The yield is estimated at 800 gallons of water per minute.

Record of Robert Elwood's well.

	Feet.
Sand and gravel	0- 32
Clay	32- 35
Sand and gravel	35- 50
Cemented sand	50- 52
Coarse sand and gravel	52-100

Well of W. N. Hager.—Mr. Hager's well is located one-half mile west of Mesilla Park. It is a 10-inch well, 63 feet deep, with a 12-foot strainer. Water is raised by a centrifugal pump and 12-horsepower gasoline engine at the rate of 325 gallons per minute.

Well of A. L. Hines.—Mr Hines's well is located 1 mile northeast of Mesilla. It is a 6-inch well, 59 feet deep, with an 8-foot strainer.


MESILLA VALLEY

6-inch well, each 48 feet deep. This plant has been described by members of the college faculty[a] in a bulletin of the experiment station. The wells penetrate gravel beds, from which water is readily obtained, the yield being about 1,000 gallons a minute.

Record of experiment station well.

	Feet.
Soil	0– 5
Sand	5–32
Sand and gravel	32–47
Sand	47–48

During the summer of 1905 a pumping plant was installed on the horticultural farm near Mesilla Park station. A 12-inch well was bored 62 feet deep and an 18-foot strainer was placed at the bottom. A pit 8 feet square was dug to water level, 19 feet below the surface. It contains a centrifugal pump with gasoline engine, which discharges 1,000 gallons of water per minute.

Wells of F. C. Barker.—Mr. Barker has three pumping plants. One, at Las Cruces, pumps from a 6-inch well 53 feet deep, which is capable of supplying about 150 gallons of water per minute. The well penetrates a gravel bed 35 feet thick, which supplies the water.

Record of F. C. Barker's well at Las Cruces

	Feet.
Soil	0– 3
Sand	3–18
Gravel and bowlders	18–53

Mr. Barker's second pumping plant is situated about 1 mile south of Las Cruces and consists of a 6-inch well 48 feet deep, supplied with pump and gasoline engine which raise 131 gallons of water per minute.

Record of F. C. Barker's well, 1 mile south of Las Cruces.

	Feet.
Soil	0– 8
Sand	8–16
Sand and gravel	16–30
Coarse gravel	30–48

A third plant is reported to have been established during the summer of 1905 near the second. An 8-inch well was bored to a depth of 85 feet and supplied with centrifugal pump and gasoline engine, which raise a volume of water estimated at 800 gallons per minute.

Record of F. C. Barker's 8-inch well.

	Feet.
Soil	0–17
Quicksand	17–36
Sand and gravel	36–58
Gravel and bowlders	58–75
Caliche	75–79
Sand and gravel	79–85

[a] Vernon, John J., and Lester, Francis E., Bull. No. 45, New Mexico College Agric. and Mechanic Arts, Mesilla Park, N. Mex., 1903.

formations and their relation to one another are indicated in the sections on Pl. III. The rock basin was partly filled with débris, in which a secondary valley was eroded and later partly filled with sand and silt.

WATER TABLE.

Underground water is found throughout Mesilla Valley at practically the river level. The depth to water was measured in the wells in the valley, and the results were plotted on the contour maps prepared by the United States Reclamation Service, and from these the map forming Pl. X has been prepared, which shows by contours the depth to water.

The water table changes position to some extent, according to changes in the volume of water in the river. Professor Slichter[a] has shown that the ground water of the valley is derived largely from the river and that the gradient of the water plane in a direction parallel to the river is practically constant at 4.64 feet per mile where measured near Mesilla Park, while the gradient away from the river varies from 0.4 foot per mile during low water to 2.3 feet in times of flood. A rise of the water table of 5 feet is reported near the river during the six months for which records were kept.

WELLS OF MESILLA VALLEY.

General statements.—A number of wells have been bored in Mesilla Valley for pumping water in large quantities, mainly for irrigation. Twelve of these have been carefully tested by Professor Slichter[b] with a view to ascertaining their capacity, the cost of pumping, etc. Some of his results are included in Table 6 (p. 47). It should be noted, in comparing the figures of the column showing depth to water with the map (Pl. X), in which depth to water is indicated by contours, that these wells are usually placed on ground high enough to allow the water to flow over the land to be irrigated. The depth to water is therefore somewhat greater than the average depth indicated on the map.

Wells at Agricultural College.—Several wells have been bored for the Agricultural College at Mesilla Park.

A bored well at the college building is 75 feet deep and 4 inches in diameter. Water was encountered at a depth of 43 feet in 1896, but in 1903 it was found to have lowered to 53 feet.

Another 4-inch well at the college machine shop is 120 feet deep. Saline water was found at this depth and the pipe was drawn back to 75 feet, where better water was found.

An irrigation plant was established in 1902 at the experiment station of the Agricultural College, consisting of one 12-inch and one

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[a] Slichter, C. S., Observations on the ground waters of Rio Grande Valley: Water-Sup. and Irr. Paper No. 141, U. S. Geol. Survey, 1905, pp. 22-29.

[b] Slichter, C. S., ibid., p. 34.

Mesilla Valley (3,680 feet), a distance of about 32 miles, is 3.7 feet per mile. It is evident from these facts that the surface of the underground water has a regular gradient down the old channel through La Mesa, although it is less than the gradient of the river. A line of wells a few miles farther east in the center of the old valley would probably show a steeper gradient of the water plane.

The facts upon which the determination of gradient rests are not sufficiently numerous to make it conclusive. The depths to water determined and the indications that La Mesa is a part of the ancient débris-filled valley naturally leads to the inference that the course of the underflow should be southward through the detritus of La Mesa. It is possible, on the one hand, that additional data will show a gradient steeper than 1.7 feet per mile. On the other hand, it is possible that the original course of the underflow down the old channel has been reversed by reason of the down cutting of the river in Mesilla Valley and the accumulation of surface water in the gravels of La Mesa. The latter possibility is strengthened by the facts that La Mesa is nearly level and the material so porous that rain enters it without producing even temporary streams.

TABLE 5.—*Records of bored wells in La Mesa district.*

Owner.	Location.	Total depth.	Depth to water.	Power used.	Material encountered.
		Feet.	*Feet.*		
Henry Brock	Sec. 30, T. 25 S., R. 2 W.	240	221	Gasoline	Sand and waterworn gravels.
Do	Sec. 7, T. 24 S., R. 1 W.	430	386	do	Do.
Do	T. 24	515			Clay.
Mr. Hawkins	5 miles west of Picacho Mountain.	218	170	Gasoline	
Robert Herrington.	2 miles northwest of Noria.	435	350	do	Sand and gravel.
J. F. Kilburn	T. 27 S., R. 1 W.	[a] 478	408		Do.
Do	6 miles northwest of Lanark.	388	370	Gasoline	Sand and waterworn gravel.
S. P. Rwy. Co	Lanark	945	380	Steam	Do.
Lewis Bros.	5 miles northeast of Lanark.	365	340	Gasoline	Sand and gravel.
J. B. Stahling	10 miles west of Lanark.	[b] 460	440		
Do	6 miles west of Lanark	350	311	Gasoline	
El Paso and S. W. Rwy.	Potrillo	240	220	do	Sand and clay.
Do	Noria	438	358	do	Sand and gravel.

[a] 170 feet in bottom of crater. [b] 200 feet in bottom of crater.

MESILLA DISTRICT.

LOCATION AND CHARACTER.

The Mesilla district is confined to Mesilla Valley, the southernmost of the erosion basins of the Rio Grande region. During floods the river submerges a large part of the valley floor, a level flood plain formed by the deposition of silt and fine sand. As previously stated (p. 24), Mesilla Valley was once deeper than it is now, and has been recently filled to some extent by flood-plain deposits. The geologic

INDICATIONS OF ARTESIAN WATER.

The occurrence of water under pressure in several wells near Engle indicates the presence of artesian conditions beneath a small area of the Jornada, but in areas lying beyond the immediate vicinity of Engle the presence or absence of artesian water must be inferred entirely from surface indications. Since water is found in the Cretaceous sandstones near Engle it might be expected in wells that penetrate these sandstones elsewhere, provided the sandstones extend uninterruptedly beneath the surface in this region. Their extent, however, and their depth beneath the surface over the greater part of the Jornada are unknown.

The water in the unconsolidated gravel beds may perhaps be confined beneath impervious layers, since the Jornada del Muerto slopes southward at an average rate of 4½ feet to the mile, but nothing now known proves either the presence or absence of such layers. The surface indications are moderately favorable to the occurrence of artesian water in certain areas, particularly at the southern end of the Jornada and still farther south, in the Mesilla Valley.

LA MESA DISTRICT.

La Mesa district lies in the southern part of the Rio Grande region west of Mesilla Valley. Wells have been sunk in various parts of this district, both for railroad use and for stock purposes. No solid rock was encountered in any of the wells, most of which find water in abundance, but at a considerable depth, as indicated in Table 5. The deepest well on La Mesa, 945 feet, was bored by the Southern Pacific Railway Company at Lanark. The company owns two other wells at the same place, one 648 feet and one 615 feet deep, the three yielding 50 gallons of water a minute. The material penetrated is sand with small waterworn pebbles, and contains water below a depth of 380 feet.

Since the altitude of Lanark is 4,156 feet, the altitude of the water surface is 3,776 feet, while that at Bosque Seco, in Mesilla Valley, 15 miles northeast of Lanark, is 3,800 feet—24 feet higher than at Lanark. At Noria, the altitude of which is 4,114 feet, the water surface, 358 feet below the surface of the land, is 3,756 feet above sea level. In the 12 miles between Lanark and Noria the water surface inclines to the south 20 feet, or at an average rate of 1.7 feet per mile. A line drawn through Bosque Seco, Lanark, and Noria would run somewhat west of the center of the old débris-filled valley of the Rio Grande for a distance of 27 miles. Along this line there is a fall of the water surface of 44 feet, or an average of 1.7 feet per mile. The gradient of the water table in Mesilla Valley between Bosque Seco (3,800 feet) and the southern end of

The other wells belong to the Santa Fe Railway Company and the water is pumped to Engle for railway use. The wells are located in the canyon leading from Engle to the Rio Grande. One near old Fort McRae was drilled to a depth of about 1,200 feet in search of coal. No coal was found, but water was encountered under pressure sufficient to produce a considerable surface flow but not great enough to raise it to the level of the town. From this well and a second one put down about 2 miles farther east water is pumped into a reservoir on the Jornada, from which it flows to Engle by gravity.

NONFLOWING WELLS.

A number of wells have been bored in the Jornada del Muerto, but definite records of only a few of them are obtainable. Those near the western border of the plain, along the railroad, penetrate the Cretaceous sandstones and find water under slight pressure, but the greater number have been bored in depressions along the center of the plain and penetrate only unconsolidated sand, gravel, and wash. The record of Mr. Linger's well may be taken as representative of the material found in the center of the Jornada.

Record of well of G. W. Linger & Company, 5 miles east of Upham.

	Feet.
Red clay	1–10
Cement	10–19
Sand and silt	19–235
Bowlders (maximum diameter, 8 inches)	235–240

Partial records obtained of a few of the wells are given in the following table:

TABLE 4.—*Records of bored wells in the Jornada del Muerto.*

Owner.	Location.	Total depth	Depth to water.	Power used.	Remarks.
		Feet.	*Feet.*		
J. D. Isaacks	Sec. 35, T. 20 S., R. 2 E.	265	230	Wind	Penetrates 35 feet soil; 23 feet sand and gravel
Do	Sec. 25, T. 21 S., R. 2 E.	330	292	Gasoline	In sand and gravel.
Do	Sec. 13, T. 20 S., R. 2 E.	115	95	Wind	
J. W. Taylor	Sec. 17, T. 19 S., R. 2 E.	360	345	do	Penetrates 345 feet angular material, with 15 feet rounded bowlders
A., T. and S. F. Rwy	8 miles west of Engle	1,200	Flow.	Gasoline	In sandstone and shale.
Do	2 miles south of Upham	480	140	Steam	
Do	1 mile west of Alaman	400	No water		
L. Baldwin & Co.	Alaman	140	140	Steam	Water raised 100 feet.
Victoria Land and Cattle Co	4 miles north of Engle	200			In red sandstone.
Do	10 miles north of Engle	500	492	Gasoline	Water raised 327 feet.
G. W. Linger & Co.	5 miles northeast of Upham.	240	236	do	Sand and gravels (maximum 6 inches in diameter) at bottom. Water raised 102 feet.
Mr. Turner	18 miles east of Rincon	350	300(?)	do	In sand and gravel.

Record of Atchison, Topeka and Santa Fe Railway Company's well at Sandia, N. Mex.

	Feet.
Unconsolidated sand	0–340
Sand, with clay bands	340–400
Clay	400–440
Sand	440–480
Gravel	480–490
Sand, with clay bands	490–530
Sand	530–585
Clay	585–640
Sand and clay	640–893

JORNADA DISTRICT.

GEOLOGIC STRUCTURE.

The Jornada district extends from San Marcial to Las Cruces, between the San Andreas and the Caballos-Fra Cristobal mountain ranges. The geologic structure of the Jornada del Muerto has been described[a] as a syncline, in which the older or consolidated rocks pass underneath the unconsolidated material which covers the surface.

Along the eastern base of the Caballos-Fra Cristobal range the upturned Cretaceous sandstones are truncated and exposed in such a way as to freely admit the water crossing them as streams from the mountains, as well as that falling upon them as rain. These sandstones are not exposed elsewhere within the Jornada district, and it is uncertain whether they occupy the entire trough of the syncline, as stated by Keyes.[b]

The Jornada del Muerto, as has been previously stated, is probably a part of the old Rio Grande Valley that has been filled with unconsolidated sands and gravels of comparatively recent origin. This material has been penetrated by wells to a depth of 360 feet, but its total depth has not been determined and very little is yet known of the underground conditions in this region. The Cretaceous sandstones may extend without interruption beneath the detrital filling, or, if they were originally present, may have been largely eroded away previous to the deposition of the detritus.

FLOWING WELLS.

In the vicinity of Engle flowing water is obtained from three wells, which penetrate the Cretaceous sandstones. One about 10 miles northwest of Engle, near the base of the Fra Cristobal Mountains, is said to be 260 feet deep. The flow is not sufficient to water a few hundred cattle for which it is used, and the water is pumped to increase the yield.

[a] Keyes, C. R., Water-Sup. and Irr. Paper No. 123, U. S. Geol. Survey, 1905.
[b] Ibid., p. 10 (geologic map).

50,000 gallons a day, and would probably yield more if necessary. The well is situated on the flood plain of the river in gravel and coarse sand, and the water level in the well rises and falls with that of the river.

No important deep wells have been sunk on the lowlands of the Belen district. One at the Belen flour mill, 35 feet deep, owned by John Becker, and another at the Catholic Church, 85 feet deep, are the deepest.

Three deep wells have been bored in the mesa gravels. One at Colorado siding, on the Atchison, Topeka and Santa Fe Railway branch, known as the Belen cut-off, is 500 feet deep and contains 34 feet of water. This well is 9 miles southeast of Belen (altitude, 4,788 feet), at an elevation of 5,012 feet, or 224 feet higher than Belen, the water level in this well being 234 feet lower than the water at Belen.

Record of Atchison, Topeka and Santa Fe Railway Company's well at Colorado siding, New Mexico.

	Feet.
Soil	1–24
Sand	24–290
Light-colored clay	290–340
Red sandy clay	340–500

At Becker siding, 15 miles southeast of Belen, the railway company has a 6-inch bored well, 427 feet deep, with water standing 364 feet below the surface. The altitude at the well is 5,140 feet, or 352 feet above Belen, making the water level in the well 4 feet lower than that in the valley at Belen.

Record of Atchison, Topeka and Santa Fe Railway Company's well at Becker siding, New Mexico.

	Feet.
Cemented gravel	0–100
Red clay	100–150
Red clay and gravel	150–275
Red clay	275–290
Red clay and gravel	290–300
Red clay and gravel, with bowlders	300–340
Gravel	340–345
Red clay and gravel, with bowlders	345–378
Gravel	378–388
Red clay and gravel	388–400
Water bearing gravel	400–420
Gravel and clay	420–427

At Sandia, a siding on the main line of the Atchison, Topeka and Santa Fe Railway, west of Isleta, the railway company bored a 12-inch well 893 feet deep during the summer of 1905. It is in sand, gravel, and clay throughout, and encountered water at a depth of 445 feet.

All the wells together yield an average of 3,000,000 gallons a day, or 2,083 gallons a minute.

The 710-foot well has been tested alone and yielded 600 gallons a minute, with a local depression of the water surface within the well of 18 feet.

Record of the city waterworks well at Albuquerque, N. Mex.

	Feet.
Soil	0- 10
Sand and coarse gravel	10- 35
Clay	35- 40
Sand and coarse gravel	40- 71
Cemented sand	71- 75
Clay	75- 80
Cemented sand and bands of "sandstone"	80-179
Sand and gravel	179-185
Clay	185-189
Cemented sand and clay	189-243
Yellow clay	243-292
Cemented sand	292-320
Yellow clay	320-362
Sand and clay	362-386
Shale and sand	386-397
Cemented sand	397-442
Yellow clay	442-456
Cemented sand	456-471
Sand and clay	471-487
Clay, sand, and gravel	487-572
Quicksand	572-614
Clay and cemented sand	614-710

BELEN DISTRICT.

GENERAL CONDITIONS.

The Belen district extends from Isleta southward to a point a few miles north of Socorro, where the Rio Grande Valley narrows between the encroaching hills, as shown in Pl. I. Through the center of this district extends the erosion basin known as Belen Valley. The surface of the broad flood plain formed by the deposits flooring the valley stands only a few feet above the river bed, and the material composing the deposits is saturated with water. Shallow wells throughout the bottom land reach this water at depths of 5 to 15 feet and readily obtain it in large quantity.

WELLS.

The Atchison, Topeka and Santa Fe Railway Company's well, 1.5 miles south of Belen, is the only one within this district from which a large and constant supply is pumped. It is a dug well, 15 feet deep and 20 feet in diameter, and contains 7 feet of water. It has yielded drilled in 1905 at the Santa Fe Indian School, is a 12-inch well, 989 feet deep, and penetrates angular wash principally except for 75 feet of conglomerate encountered at a depth of 225 feet. Water was found at a depth of 100 feet and rose 44 feet, but its volume is small and the supply is easily exhausted by pumping. Water was also obtained in the 75 feet of conglomerate and in several thin gravel strata not recorded. This well is on comparatively high ground, its altitude being about 7,000 feet, and near the eastern or highest part of the detrital formation. It is probable that on lower ground, nearer the river, water might be found under pressure sufficient to produce surface flows. Water emerges from this formation as springs along the river at an altitude about 1,500 feet lower than that at Santa Fe and along the lower reaches of Santa Fe Creek. At La Cienaga, 12 miles southwest of Santa Fe and about 700 feet lower, there are several springs of sufficient volume to irrigate a considerable tract of land.

Record of well at Santa Fe Indian School.

	Feet.
Mountain wash	0–225
Conglomerate	225–300
Mountain wash	300–989

ALBUQUERQUE DISTRICT.

The Albuquerque district may be considered as extending from Galisteo Creek southward to Isleta. The geologic formations, so far as they have been penetrated by wells, are composed of unconsolidated material and carry no water under pressure. Water saturates the flood-plain material to the level of the river and is found in abundance wherever wells penetrate to that level.

A few wells sunk on the "mesa" east of Albuquerque obtain water at horizons somewhat higher than that of the river. A well at the University of New Mexico,[a] 1 mile east of Albuquerque, is 240 feet deep and contains water at a depth of 200 feet, about 20 feet higher than the river level, while the "military well," 7 miles east of Albuquerque, contains water at a depth of 420 feet, or about 130 feet above the river level.

The deepest well in this district, 710 feet, is in Albuquerque, at the city waterworks. It is a 12-inch double-steel-cased well, to which water is admitted only below a depth of 350 feet. In addition to this deep well the water company owns seven 6-inch wells and one 12-inch well, each 291 feet deep, and a 65-foot dug well, from the bottom of which 25 pipes are driven to depths of 35 feet, the water being admitted only from the bottom of these pipes, or 100 feet below the surface.

[a] Weinzirl, John, Bull. Hadley Climatological Laboratory of University of New Mexico, vol. 10, 1905, p. 12.

TABLE 3.—*Monthly discharge of the Rio Grande, in acre-feet*—Continued.

ILDEFONSO, N. MEX.

Month.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.
January	28,715	21,705	26,009	38,770	24,410	29,643	23,127	20,910	43,470
February	30,101	24,936	35,599	32,322	36,543	27,183	24,724	24,220	51,590
March	60,750	33,449	81,164	52,818	45,624	33,709	75,193	21,340	158,100
April	303,113	265,864	176,430	51,531	83,423	97,577	172,324	27,310	218,900
May	702,254	200,328	117,687	211,517	319,367	73,567	406,612	24,160	785,200
June	366,128	223,973	23,742	173,395	130,850	28,215	709,468	17,020	572,700
July	97,274	161,590	36,647	18,262	44,824	16,730	136,780	15,130	53,740
August	27,423	39,168	22,197	10,145	50,850	34,165	26,563	91,990	38,680
September	40,463	19,279	53,137	42,605	34,512	28,790	22,314	148,300	23,150
October	136,196	21,890	26,563	23,796	30,190	17,157	21,828	252,800	25,950
November	71,881	35,583	44,985	25,289	27,491	18,386	25,170	49,450	37,960
December	32,220	39,168	38,184	29,022	28,468	19,220	23,611	35,420	37,940
Year	1,896,518	1,086,933	682,344	707,472	856,554	424,342	1,667,714	728,050	2,047,380

Total for nine years, 10,097,307; average for eight years, 1,121,923.

CENICERO, COLO.

Month.	1899.	1900.	1901.	1902.	1903.	1904.	1905.
January	(a)	39,229	36,524	32,035	1,537	18,820	59,640
February	(a)	42,153	32,267	42,097	1,388	23,990	66,370
March	(a)	35,847	22,443	33,757	2,091	7,563	53,490
April	(a)	20,826	16,542	18,744	18,684	9,104	44,270
May	(a)	87,927	103,299	30,129	123,713	1,322	399,300
June	(a)	84,734	61,408	6,783	379,339	1,208	507,600
July	2,582	1,783	5,041	1,353	72,432	1,076	15,880
August	3,259	1,353	3,689	1,045	2,890	8,608	9,469
September	6,069	1,845	2,975	1,547	5,356	11,660	3,725
October	7,194	2,275	3,320	1,968	3,935	97,770	6,044
November	15,412	9,223	4,284	1,785	12,674	24,750	12,850
December	19,553	35,109	20,721	2,275	18,569	53,310	31,730
Year	....	362,304	312,513	173,518	642,607	259,181	1,210,000

[a] No record.

Total for six years, complete, 2,960,123; average for six years, 493,354.

UNDERGROUND WATERS.

The Rio Grande region embraces several more or less separate geologic provinces and the underground-water resources may be most conveniently described by districts.

SANTA FE DISTRICT.

The Santa Fe district is located in the Rocky Mountains region on the Rio Grande north of Galisteo Creek. The strata, composed of partially consolidated sands, gravels, and beds of mountain wash of Tertiary age, dip to the west away from the mountains. The inclination of the strata and their exposure in the region of greatest precipitation within the area described are favorable to the occurrence of artesian water.

Only two deep wells have been sunk in these deposits, and in neither of them was water found under notable pressure. The first one, drilled several years ago in search of artesian water, is 8 miles south of Santa Fe. In this no surface flow was obtained. The second,

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derived mainly from the mountains north and east of the area described. The tributaries within the Rio Grande region yield little permanent supply, although Galisteo Creek and Rio Puerco contribute small volumes of water during the greater part of the year. Many of the tributary channels carry small permanent streams near their heads in the hills, but the water in most of these sinks beneath the surface before reaching the river.

The floods that supply the greater part of the flow of the Rio Grande are of two general kinds, one due to the annual melting of snows in the mountains, often accompanied by general rain storms, the other due to local showers or "cloud-bursts." The first occur regularly, but those due to local showers are very irregular, both in volume and in time of occurrence. Sometimes the river bed is dry for several months and at other times it carries disastrous floods, the yearly discharge, for example, at El Paso, varying from 50,768 to 2,011,794 acre-feet, or a proportion approximating 1:40.

The records of discharge kept by the Geological Survey since 1897 at El Paso, San Marcial, and Ildefonso, and since 1899 at Cenicero, near the Colorado and New Mexico boundary, are as follows:

TABLE 3.—*Monthly discharge of the Rio Grande, in acre-feet.*

EL PASO, TEX.

Month.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.
January	18,754	30,129	12,912	8,110	278	8,291	615	972	35,920
February	10,774	33,655	11,330	5,660	4,502	5,772	1,289	387	43,309
March	4,427	20,044	7,071	460	3,669	635	22,602	0	188,480
April	103,537	97,944	8,807	300	0	7,904	49,468	0	197,911
May	511,068	140,192	10,330	44,810	158,102	526	203,623	0	545,950
June	362,677	111,570	0	93,100	77,038	307	586,909	0	851,147
July	81,770	196,269	19,553	70	12,576	20	158,202	0	58,800
August	8,116	31,236	430	0	60,655	14,499	4,334	7,398	19,785
September	41,950	2,362	0	16,483	21,005	9,313	1,031	10,959	3,322
October	108,096	160	123	0	5,336	1,428	2,033	366,486	4,225
November	67,359	119	119	0	12,813	298	298	48,397	25,458
December	41,812	5,718	2,828	738	7,993	1,775	2,440	38,182	37,478
Year	1,380,360	669,298	73,503	169,751	363,967	50,768	1,032,844	472,781	2,011,794

Total for nine years, 6,205,066; average for nine years, 689,452.

SAN MARCIAL, N. MEX.

Month.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.
January	19,553	57,675	27,854	40,582	24,718	22,731	17,197	16,840	39,114
February	24,325	59,425	24,603	35,099	25,468	17,435	21,927	18,902	63,868
March	40,767	62,164	27,546	33,203	15,114	7,954	46,790	6,060	217,904
April	212,548	271,458	54,089	6,248	23,683	40,106	100,007	0	279,392
May	755,196	165,832	35,048	123,590	256,126	26,787	318,367	0	962,221
June	366,426	126,268	952	159,888	96,178	6,407	660,476	0	714,268
July	65,977	167,062	28,407	123	59,286	0	77,841	10,532	35,782
August	6,149	13,835	6,395	0	65,534	49,210	3,064	55,974	20,083
September	114,188	4,641	2,916	73,190	37,607	13,349	1,438	44,727	5,276
October	281,677	1,230	676	123	17,018	823	545	463,240	7,349
November	175,715	11,722	9,521	2,440	20,053	4,641	5,534	51,769	42,397
December	152,736	23,365	21,828	10,084	19,240	11,286	18,883	41,752	34,344
Year	2,215,257	964,677	239,835	484,570	660,025	200,729	1,272,069	709,796	2,422,008

Total for nine years, 9,168,966; average for nine years 1,018,774.

TABLE 1.—*Rainfall in the Rio Grande region, New Mexico, in inches.*

Locality.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	Average for the years recorded.
Albuquerque	7.02	9.74	6.39	(7.45)	5.90	10.19	4.94	5.83	6.82	4.20	6.85
Bernalillo	7.89	11.49	5.82	6.89	4.89						7.39
Cambray						7.71	6.64	8.02	11.46		5.06
El Paso	9.79	12.41	6.16	7.30	7.95	8.68	10.15	16.63	11.30	17.80	10.82
Engle	10.84	16.89	14.38	7.72	6.03	8.49					10.72
Espanola	8.08		7.78	6.25	10.20						8.08
Galisteo	12.22		9.30	(11.59)		16.49					12.30
Hillsboro	12.21	17.13	10.54	4.60	6.43						10.18
Los Lunas	7.65				6.05				10.45		8.71
Mesilla Park	7.99	8.96	11.21	9.67	8.40	11.96	10.90	10.29	10.13	17.09	10.65
Rincon		11.74	11.13								11.44
San Marcial	6.55			6.78		1.17					4.84
Santa Fe	14.28	20.40	12.97	10.15	15.89	17.41	13.36	9.79	14.19	17.22	14.56
Socorro		10.61		7.71	7.05	10.06				22.40	11.57

General average for the Rio Grande region 9.57

EVAPORATION.

Evaporation throughout the Rio Grande Valley greatly exceeds the rainfall. Records for only three years are obtainable, but these were made near the extremities of the region here considered, and probably represent adequately the evaporation for the entire area. The first was made at the International dam site near El Paso during the year 1890.[a] Those for the years 1900 and 1903 were made at the Climatological Laboratory of the University of New Mexico at Albuquerque.[b]

TABLE 2.—*Evaporation in the Rio Grande region, in inches.*

	At International reservoir site for 1890.	At Albuquerque for 1900.	At Albuquerque for 1903.		At International reservoir site for 1890.	At Albuquerque for 1900.	At Albuquerque for 1903.
January	2.0	2.04	1.81	August	11.4	10.21	11.73
February	2.0	2.63	2.07	September	9.2	8.00	9.65
March	7.0	6.17	5.21	October	6.8	4.38	6.62
April	7.3	6.82	10.05	November	4.6	1.73	4.21
May	10.8	10.08	10.98	December	2.9	1.40	1.88
June	11.2	12.63	11.33				
July	9.6	11.78	12.36	Total	84.8	77.87	87.90

Average for three years, 83.5.

DRAINAGE.

The drainage area of the Rio Grande north of El Paso, according to the reports of stream measurements made by the United States Geological Survey, is 38,000 square miles, of which 7,695 square miles lie north of Cenicero, Colo., leaving about 30,000 square miles as the area of the drainage basin within New Mexico.

The Rio Grande is mainly a flood-water stream and is subject to great fluctuations in volume. Its permanent flow is slight and is

[a] Thirteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1890-91, p. 411.

[b] Weinzirl, John, Bull. Hadley Climatological Laboratory, Univ. New Mexico, vol. 11, No. 10, 1905, pp. 5-8.

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Rock Canyon, given in fig. 2. The material to an unknown depth beneath the lava sheet is sand and gravel, rendering the gorge undesirable as a dam site.

ESPANOLA RESERVOIR.

The Espanola dam site, located at the head of White Rock Canyon' has been described[a] as consisting of clay beds in which blocks of basalt are embedded, the unconsolidated material extending indefinitely beneath the bed of the river. Near this site thick beds of rhyolite tuff, west of the river, and basalt, to the east, rest on the detrital beds, as shown in the section forming fig. 2 and in Pl. IV, *B*. The absence

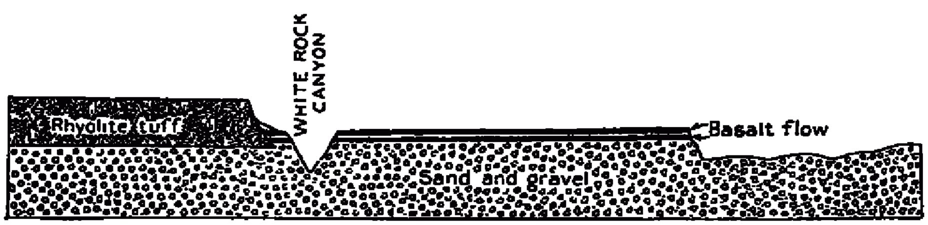

FIG. 2.—Section across White Rock Canyon near Espanola dam site.

of bed rock near the surface makes this locality of doubtful value as a dam site.

The proposed reservoir covers 5,437 acres and has a capacity of 186,861 acre-feet.

WATER SUPPLY.

SURFACE WATERS.

RAINFALL.

On account of the great differences in altitude of places that lie within short distances of one another in the Rio Grande region the amount of rainfall varies greatly from place to place, the mountain peaks serving as foci about which local storms gather. Few storms occur in which precipitation is uniform over a large area. The greater part of the rain falls as local showers close to the hills in which they originate. This fact is indicated quantitatively in the following table of rainfall, in which the stations nearest the hills show the greatest precipitation. At Santa Fe, situated at the base of the Rocky Mountains, the average yearly precipitation is 14.56 inches, while at San Marcial, situated near the center of the Rio Grande region and far from high mountains, the average is 4.84 inches and the minimum is only 1.17 inches.

[a] Newell, F. H., Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 4, 1901, pp. 265-269.

The ratio $\frac{SiO_2}{Fe_2O_3+Al_2O_3}=2.6$ is well within the limits of the ratio >2.3 or <3.6. The MgO content is low, and the absence of SO_3 makes this material one of the purer clays, considered from a technical point of view.

Coal.—Coal has been found in Mescal Canyon about 4 miles south of Elephant Butte. Where exposed at the surface the beds are only a few inches thick, but are associated with a considerable amount of carbonaceous shale. The coal is in the same formation that contains valuable deposits of coal at Carthage and other places farther north, but the prospects have not been developed.

SAN ACACIA RESERVOIR.

The narrow gorge at San Acacia is one of the proposed dam sites of the Rio Grande region. The broad Belen Valley, to the north, narrows abruptly at this point on account of the sheet of basalt which here covers the detritus. Measurements made at this point by Mr. R. H. Chapman, of the United States Geological Survey, indicate that a dam 50 feet high would be 1,200 feet in length and would flood about 18 square miles to an average depth of 25 feet, thus impounding about 288,000 acre-feet of water. A higher but longer dam might be constructed, but the maximum possible height is less than 75 feet above the river bed, the limiting factor being the broad sand gap to the northwest, the surface of which is about 75 feet above the river level.

Probably the most serious objection to San Acacia Gorge as a dam site is found in the nature of the rock. The hard basalt, which maintains the steep walls of the gorge, is a comparatively thin sheet resting on unconsolidated sand and gravel, cut by basalt dikes representing the vents through which the material of the sheet was extruded. Judging from surface indications, there is little prospect of finding solid rock sufficiently near the surface to be useful as a foundation for a dam, and the loose gravels would probably allow serious loss of impounded waters by leakage.

SAN FELIPE RESERVOIR.

Little can be added to the published description[a] of this gorge as a reservoir site. The proposed dam would be 2,350 feet long and would submerge only 1,511 acres. San Felipe gorge is similar to that at San Acacia in being formed by flows of basalt capping unconsolidated sands and gravels. At this point there are two flows of basalt separated by a few feet of sand, as shown in the cross section of White

[a] Newell, F. H., Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 4, 1901, pp. 275-276.

During the same time a total of 1,741 acre-feet was contributed by the rainfall, making a grand total for the valley of 11,941 acre-feet in the thirty-three days, or about 362 acre-feet a day.

No measurements are available for the valleys farther north, but judging from the uniformity of conditions throughout the region a like amount probably enters the ground in the other valleys.

ORIGIN OF UNDERFLOW.

The waters of the underflow are derived mainly from the Rio Grande. The rainfall is comparatively unimportant as a source of supply, since the rains are usually violent and of short duration; and although the material upon which the rain falls is very porous the greater part of the water enters the river. According to Slichter's table just quoted, the local rainfall contributes about one-seventh of the underflow. The tributary streams evidently contribute some water, but since they are small and intermittent the amount is probably negligible, leaving the Rio Grande as the main source of supply. Measurements of the flow of the Rio Grande demonstrate the fact that the river is continually losing water, the greater volume of flow being measured at the upstream rather than the downstream gaging stations. This is made clear by an inspection of the tables of discharge previously quoted (pp. 31–33). For purposes of convenient comparison the following table of totals is given:

TABLE 8.—*Discharge of the Rio Grande in acre-feet.*

	El Paso.	San Marcial.	Ildefonzo.	Cenicero.
Total for 9 years—1897-1905	6,205,066	9,168,966	10,097,307	....
Total for 6 years recorded at Cenicero	4,101,906	5,749,197	6,431,512	2,960,123

From this table it appears that during the nine years recorded a loss of 32 per cent of the flow at San Marcial occurred between San Marcial and El Paso, a distance of about 140 miles, and that within the same period a loss of 38 per cent of the Ildefonso flow, over and above the total amount entering the Rio Grande from tributary streams during those years, occurred in a distance of about 280 miles. This loss is due to evaporation, diversion for irrigation, and absorption into the gravels. It is probable that could the discharge of the tributary streams be included the loss would be about double that shown by the river alone. To illustrate: During the nine years recorded the river lost 3,892,241 acre-feet in the 280 miles between Ildefonso and El Paso, in addition to the total discharge of such important tributaries as Galisteo Creek, Rio Jemes, Rio Puerco, Arroyo Salado, and scores of smaller tributaries. It is evident that the actual loss is much greater than that indicated by measurements of river discharge alone, An effort has been made to determine what percentage of the known loss is due to irrigation and what to seepage and evaporation. The discussion may be found in the Proceedings of the International (Water) Boundary Commission, United States and Mexico, vol. 2, pp. 405–424. The results indicate that there is a notable loss of water over and above that diverted for irrigation. An average of three comparisons (p. 417) shows that 13 per cent of the San Marcial flow was lost by seepage and evaporation above El Paso.

COURSE OF UNDERFLOW.

All known facts point to the conclusion that a large amount of water is continually passing from the river into the underflow, and must either return to the surface and evaporate or find some underground passage by which to escape. Professor Slichter's[a] investigation proves that the escape is not through the canyon at El Paso.

The débris-filled valley west of El Paso and the apparently regular gradient of its water plane suggest that the course of the underflow may be down this old valley to the basin region of northern Mexico. On the other hand, the meager data available seem to show that this gradient is lower than that for Mesilla Valley, and that the flow should be toward the river rather than away from it, as would be the case if the course of the underflow was down the old valley. The data available at the present time are not adequate to solve this problem.

A more probable means of escape is by evaporation. Accepting Slichter's measurements of 362 acre-feet a day, contributed in Mesilla Valley, about 132,000 acre-feet of water would enter the gravels in a year. The evaporation of approximately 7 feet a year would remove from the 150,000 acres of Mesilla Valley about 1,050,000 acre-feet if the water were freely exposed, or about 8 times the amount of water entering the underflow. Over a considerable part of the valley the water plane is near enough to the surface for considerable loss by capillary action.

CHEMICAL CHARACTER OF RIO GRANDE WATERS.

MESILLA DISTRICT.

A large number of chemical analyses of waters of Mesilla Valley have been published by Goss.[b] Others have been collected from various sources and preserved in the records of the United States Geological Survey. It appears from these analyses that the total solids are not high as compared with those found in waters used elsewhere for irrigation, and that the salts are not those most deleterious

[a] Slichter, C. S., ibid., pp. 9-13.

[b] Goss, Arthur, Principles of water analysis: Bull. No. 34, New Mexico College of Agric. and Mech. Arts, 1900.

to crops. "Black alkali" (Na_2CO_3) is wholly absent from both river and ground waters. "White alkali" is abundant and accumulates as incrustations of salts due to the evaporation of water brought to the surface by capillary action.

The well waters are not very satisfactory for domestic uses. The quantities of magnesium, sodium, and sulfuric acid, probably present in the form of Glauber's salt (sodium sulfate = Na_2SO_4) and Epsom salt (magnesium sulfate = $MgSO_4$), indicate that the waters of the valley in general are not very good for drinking purposes. The river water contains the same substances that are found in the wells, but in smaller amounts.

Waters obtained from the mesa gravels at El Paso, Deming, and elsewhere are much better for domestic use than those derived from gravels that are obviously supplied from the river. This is probably true of the Mesilla region, though not enough data are at hand concerning the mesa waters to permit positive statements. Two analyses have been made of samples of water taken west of Mesilla Valley. One, from J. F. Kilburn's well, contained 1,315 parts per million of dissolved solids, and is more saline than many in the valley; the other, from the railway well at Lanark, contained 585 parts per million of total solids, and is better than that from many of the valley wells.

OTHER DISTRICTS.

Little can be said of the chemical character of water from the Rio Grande region north of Mesilla Valley, few complete analyses being available. Those that could be obtained are included in Table 10. These analyses have been collected from various sources and are nearly all to be found in the records of the United States Geological Survey.

In the lowlands throughout the Rio Grande region the salts contained in the waters accumulate as white incrustations over the soil. In Albuquerque Valley these accumulations are particularly abundant and in many places prevent the growth of vegetation. This condition is probably caused by crude methods of irrigation. The land thus affected has been for many years in the possession of Mexican ranchmen, who seldom take proper care of the land.

TABLE 9.—*Analyses of Rio Grande water.*[a]

AVERAGE SAMPLES TAKEN DAILY FROM ACEQUIA NEAR AGRICULTURAL COLLEGE.

[Parts per million.]

Date.	Suspended matter.	Total solids.	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Oxides of iron, aluminum, and silicon (Fe_2O_3, Al_2O_3, SiO_2).	Sulfate radicle (SO_4.)	Chlorine (Cl).	Carbonate radicle (CO_3).	White alkali.	Black alkali.
June, 1893	2,680	196	29	4	16	3	35	28	14	55	54	0
July, 1893	11,090	478	64	10	66	7	20	119	81	65	240	0
August, 1893	28,370	626	91	10	64	9	22	237	48	75	239	0
September, 1893	23,760	793	75	19	84	10	16	332	68	85	350	0
October, 1893	8,870	470	48	10	61	8	18	116	54	65	238	0
December, 1893[b]	2,610	417	54	1	73	6	19	101	62	72	228	0
January, 1894	2,570	439	60	11	57	8	12	95	68	85	230	0
February, 1904	2,160	360	35	9	65	6	7	108	68	40	245	0
March, 1904	3,380	462	56	1	84	7	15	103	74	71	242	0
April, 1904	4,360	360	51	9	40	6	24	84	42	71	170	0
May, 1904	5,860	267	39	7	30	16	21	56	23	65	129	0
June, 1904	4,070	426	55	6	59	7	14	120	49	74	224	0
Average of Rio Grande samples for 12 months	8,314	441	59	8	58	7	19	125	54	70	221	0

SAMPLES TAKEN FROM MIDDLE OF RIVER AT EARLHAM BRIDGE.

Date.	Suspended matter.	Total solids.	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Oxides of iron, aluminum, and silicon.	Sulfate radicle.	Chlorine.	Carbonate radicle.	White alkali.	Black alkali.
July 23, 1899	107,800	1,615	230	39	194	22	5	830	100	94	827	0
August 13, 1899	123,960	1,911	225	43	242	18	10	1,033	101	79	1,013	0
December 4, 1899	11,470	536	65	12	75	16	0	181	60	64	295	0

[a] Goss, Arthur, Principles of water analysis: Bull. No. 34, New Mexico College of Agric. and Mech. Arts, 1900, p. 72.

[b] No water in river during November.

TABLE 10.—*Analyses of well waters from the Rio Grande region.*

[Parts per million.]

Location of well.	Date of taking sample.	Total solids.	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Fe_2O_3 Al_2O_3 SiO_2	Sulfuric radicle (SO_4).	Chlorine (Cl).	Carbonic radicle (CO_3).	White alkali.	Black alkali.
Mesilla Valley.												
Agricultural College	July, 1894	6,700	131	16	54	14	16	118	60	194	255	0
Agricultural College, old pulsometer well	do	1,026	161	24	113	17	10	278	165	150	451	0
Agricultural College, old pulsometer farm well	May, 1904	960	131	28	131	18	26	251	145	194	......	0
Agricultural College, windmill well	Dec., 1901	1,041	131	34	136	17	25	25	133	135	621	0
Agricultural College, farm well	July, 1893	1,235	161	28	171	6	17	330	268	131	621	0
F. E. Lester, Mesilla Park	Aug., 1894	656	108	12	77	7	78	135	88	154	287	0
O. C. Snow, 2 miles west of Mesilla Park	Aug., 1894	633	105	14	74	7	5	142	76	154	287	0
Shalam Colony, 1½ miles west of Dona Ana	Aug., 1895	745	82	13	150	10	23	152	154	131	493	0
A. Goss, ½ mile north of Agricultural College	May, 1900	1,912	240	39	282	30	7	506	309	161	936	0
1 mile northwest of Las Cruces	Oct., 1902	680	108	80	27	......	10	144	79	123	......	0
G. H. Totten, Mesilla [a]	Oct., 1904	1,566	......	......	......	......	Trace.	144	232	196	......	0
G. H. Totten, pumping plant [a]	do	1,123	......	......	......	......	Trace.	152	186	180	......	0
T. Rouault, near old Fort Filmore [a]	do	1,128	161	27	151	23	Trace.	150	176	215	......	0
Francisco Misques, Bosque Seco [a]	do	823	115	19	109	26	6	106	103	150	......	0
J. B. Barncastle, Dona Ana [a]	do	777	105	29	94	15	9	109	92	156	......	
La Mesa district.												
J. F. Kilburn, 9 miles west of Lanark [a]	do	1,315	......	......	......	......	Trace	109	200	315	......	0
Lanark, railway well	......	585	16	14	......	......	......	9	0	51	......	......
Jornada district.												
Rincon	Sept., 1895	1,057	48	16	30	22	19	30	156	181	......	......
Rincon, railway well	......	678	110	14	......	......	......	192	......	73	......	......
Engle, railway surface well	......	573	40	7	......	......	Trace.	27	Trace.	165	......	......
Engle, railway artesian well	......	808	4	2	......	......	Trace.	0	0	297	......	......
San Marcial, railway well	......	579	86	8	......	......	Trace.	82	0	140	......	......
Belen district.												
Belen	......	3,139	531	108	......	8	22	175	63	101	......	0
J. F. Chaves	Aug., 1896	2,820	443	146	76	12	33	1,420	13	172	894	......
Isleta railway well	......	487	102	10	......	......	3	141	37	86	......	......

[a] Samples taken by the writer and analyzed by R. F. Hare of the New Mexico experiment station.

TABLE 10.—*Analyses of well waters from the Rio Grande region*—Continued.

Location of well.	Date of taking sample.	Total solids.	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Fe_2O_3 Al_2O_3 SiO_2.	Sulfuric radicle (SO_4).	Chlorine (Cl).	Carbonic radicle (CO_3).	White alkali.	Black alkali.
Albuquerque district.												
Albuquerque, city well	1905	307	41	8	40	....	68	51	15	83	....	....
University well, 1 mile east of Albuquerque	1904	213	30	8	25	....	45	28	10	70	....	....
Military well, 7 miles east of Albuquerque	1904	197	34	2	31	....	30	24	2	75	....	....
Albuquerque, railway well	....	326	61	8	....	....	....	61	....	71	....	....
Albuquerque, railway-shop well	....	365	64	13	....	....	....	36	....	106	....	....
Bernalillo, railway well	....	828	55	8	....	....	9	Trace.	Trace.	240	....	....
Thornton, railway well	....	398	60	14	....	....	Trace.	Trace.	Trace.	175	....	....
Santa Fe district.												
Santa Fe city supply, from Santa Fe Creek	May, 1899	40	5	1	4	2	10	2	1	11	10	0
Do	Jan., 1900	85	14	4	3	3	8	1	6	27	14	0

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APPLICATIONS.

UTILIZATION OF UNDERFLOW.

Shallow wells.—The flood-plain material of the lowlands along the river, although saturated, does not, in general, allow the water to pass through it freely enough for the successful use of shallow irrigation wells. In certain places, however, as at Belen, where the railway well is dug in coarse sand, large volumes of water are readily obtained from this material.

Deep wells.—Beneath the fine silt of the flood plains there is coarser material, from which large quantities of water are obtained, as in the various irrigation wells in Mesilla Valley and the city wells at Albuquerque. A considerable amount of fine sand and silt occurs in the gravel beds as well as in the flood-plain deposits and prevents the rapid movement of water through them, causing the high lift and to a large extent the great cost shown in Table 6. In spite of its great cost, however, the pumping of water for irrigation has proved profitable in El Paso and Mesilla valleys. In the valleys farther north the gravels are apparently coarser and water could probably be pumped at less cost than in Mesilla Valley. In Mesilla Valley the quantity of water recovered might be greatly increased by additional wells, and pumping plants might be established with profit in Palomas, Socorro, Belen, and Albuquerque valleys. Although the data at hand show that in this region, as compared with other valleys of the Southwest, the underflow is small and the water not readily obtainable on account of the fineness of the material in which it is contained, enough water may be pumped from the sands and gravels to warrant development.

Seepage ditches.—The construction of seepage ditches as a means of obtaining the waters of the underflow has been proposed for the Rio Grande Valley, but no such ditches have been dug, and the large proportion of fine sand and silt is apparently unfavorable to this method of procuring the water.

WATER STORAGE.

The alternation of broad basins and narrow canyons along the course of the river is apparently favorable to the establishment of storage reservoirs, but at only two points are the rock formations suitable for the construction of masonry dams. These are in El Paso canyon, the dam site of the proposed International reservoir, and at Elephant Butte, the dam site of the proposed Engle reservoir.

From a geologic standpoint the Engle reservoir is much more favorable for water storage than the International reservoir. The most important geologic considerations favoring the location of a storage reservoir in Engle Valley are (1) a narrow canyon with hard rock walls; (2) rock foundation for the proposed dam; (3) good building material near the dam site, and (4) a long, deep, narrow storage reservoir, in which loss by evaporation will be comparatively small and from which the mud may to some extent be removed by sluicing.

No other good reservoir sites were found within the Rio Grande region, nor are the geologic conditions favorable to the occurrence of good sites. Since the Rio Grande Valley is a succession of débris-filled intermontane troughs it is only where the river in its superimposed course has left the old filled valleys and cut channels in the hard rock that good dam sites are found. This action has occurred at only two places in the region described—one near El Paso and one near Elephant Butte. In the other canyons the unconsolidated detritus beneath the sheets of basalt extends to some unknown depth beneath the river and prohibits the construction of bed-rock dams.

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CLASSIFICATION OF THE PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY.

[Water-Supply Paper No. 188.]

The publications of the United States Geological Survey consist of (1) Annual Reports, (2) Monographs, (3) Professional Papers, (4) Bulletins, (5) Mineral Resources, (6) Water-Supply and Irrigation Papers, (7) Topographic Atlas of United States—folios and separate sheets thereof, (8) Geologic Atlas of United States—folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publication; the others are distributed free. A circular giving complete lists can be had on application.

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2. A certain number are delivered to Senators and Representatives in Congress for distribution.
3. Other copies are deposited with the Superintendent of Documents, Washington, D. C., from whom they can be had at prices slightly above cost.
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Correspondence should be addressed to

THE DIRECTOR,

UNITED STATES GEOLOGICAL SURVEY,

WASHINGTON, D. C.

JANUARY, 1907.

O

RIO GRANDE COMPACT 1929

By Francis Wilson, Commissioner

N.M. State Engineer Office No: 1-R-18

RIO GRANDE COMPACT

by

Francis C. Wilson ,

Compact Commissioner

1929

1/31/85

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

RIO GRANDE COMPACT

The State of Colorado, the State of New Mexico, and the State Texas, desiring to remove all causes of present and future controve among these States and between citizens of one of these States a citizens of another State with respect to the use of the waters of Rio Grande above Fort Quitman, Texas, and being moved by consid ations of interstate comity, have resolved to conclude a Compact for attainment of these purposes, and to that end, through their respect 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, appoi by the President as the representative of the United States of Amer have agreed upon the following articles, to-wit:

ARTICLE I.

(a) The State of Colorado, the State of New Mexico, the S of Texas, and the United States of America, are hereinafter design "Colorado," "New Mexico," "Texas," and the "United States," spectively.

(b) The term "Rio Grande Basin" means all of the terri drained by the Rio Grande and its tributaries in Colorado, New Me and Texas, above Fort Quitman, Texas.

(c) The term "tributary" means any water course, the water which naturally flow into the channel of the Rio Grande.

(d) The "Closed Basin" means that part of the San Luis V in Colorado where the streams and waters naturally flow and drain the San Luis Lakes and adjacent territory, and the waters of whicl not tributary to the Rio Grande.

(e) "Domestic" use of water has the significance which att to the word "domestic" in that sense at common law. "Municipal' means the use of water by or through water works serving the p "Agricultural" use means the use of water for the irrigation of la

(f) The term "power" as applied to the use of water mea uses of water, direct or indirect, for the generation of energy.

(g) "Spill" or waste of water at a reservoir means the flo of water over the spillway, or the release of water through outlet s tures other than for domestic, municipal or agricultural uses, and l incident thereto.

The provisions hereof binding each signatory State shall in 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 appı al, directly, indirectly or impliedly, of any statement or conclusion pearing in this Article.

ARTICLE III.

(a) Colorado, under the direction and administration of its S Engineer, shall cause to be maintained and operated an automatic cording stream gauging station at each of the following points, to-

(1) On the Rio Grande near Del Norte at the station now m tained, known and designated herein as the Del Norte G ing Station, (the water records from this station to inc the flow diverted into the canal of the Del Norte Irriga System);

(2) On the Rio Conejos near Mogote, a station known and ignated herein as the Mogote Gauging Station;

(3) On the Rio Grande at or near the Colorado-New Me Interstate line, a station known and designated herein as Interstate Gauging Station;

(4) Such other station or stations as may be necessary to coı with the provisions of this Compact.

(b) New Mexico, under the direction and administration o State Engineer, shall cause to be maintained and operated, an a matic 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 ou

(4) Such other station or stations as may be necessary to coı with the provisions of this Compact.

(c) Texas, under the direction and administration of its duly stituted official, shall cause to be maintained and operated an autor 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 other gauging station or stations as may be necessary for ascertai and recording the release, flow, distribution, waste and other dis tion of water at all points between the Elephant Butte Reservoir the lower end of the Rio Grande Project, both inclusive. Prov however, that when the United States shall maintain and op through any of its agencies, an automatic gauging station at any o points herein designated, it shall not be necessary for the State w 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 forth give notice to Colorado and New Mexico of the estimated amou such spill, and of the time at which water may be impounded or div above San Marcial, and thereupon Colorado and New Mexico ma in equal portions the amount of such estimated spill so found b State Engineer of New Mexico, and on notice from the said State I neer of New Mexico that the period of said spill, or estimated sp terminated, Colorado and New Mexico shall desist from such incr use.

ARTICLE VII.

(a) On or before the completion of the closed basin drain the State line reservoir, and in any event not later than June 1, a commission of three members shall be constituted to which the ernor of each of the signatory States shall appoint a commissione the purpose of concluding a Compact among the signatory State providing for the equitable apportionment of the use of the wate the Rio Grande among said States. The Governors of said States request the President of the United States to name a represent to sit with said Commission.

(b) The Commission so named shall equitably apportio waters of the Rio Grande as of conditions obtaining on the rive within the Rio Grande Basin at the time of the signing of this Co and no advantage or right shall accrue or be asserted by reason of struction of works, reclamation of land or other change in conditi in use of water within the Rio Grande Basin or the Closed Basin d the time intervening between the signing of this Compact and th cluding of such subsequent Compact to the end that the right equities of each State may be preserved unimpaired. Provided, ever, that Colorado shall not be denied the right to divert, store, a use water in additional amounts equivalent to the flow into the from the drain from the Closed Basin.

(c) Any Compact concluded by said Commission shall be force or effect until ratified by the legislature of each of the sig States and approved by the Congress of the United States.

ARTICLE VIII.

(a) Subject to the provisions of this Article, Colorado co to the construction and use of a Reservoir by the United States a New Mexico, and/or Texas, as the case may be, by the erectio dam across the channel of the Rio Grande at a suitable point Canyon below the lower state bridge, and grants to the United 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 (charged so as to prevent or impair use for such dominant purposes.

ARTICLE XII.

New Mexico agrees with Texas, with the understanding that pr vested rights above and below Elephant Butte Reservoir shall never impaired hereby, that she will not cause or suffer the water supply the Elephant Butte Reservoir to be impaired by new or increased div sion or storage within the limits of New Mexico unless and until su depletion is offset by increase of drainage return.

ARTICLE XIII.

The physical and other conditions characteristic of the Rio Gra and peculiar to the territory drained and served thereby, and to development thereof, have actuated this Compact and none of the s natory States admits that any provision herein contained establishes a general principle or precedent applicable to other interstate streams.

ARTICLE XIV.

This Compact may be terminated, or extended, at any time by unanimous legislative action of all of the signatory States, and in t event all rights established under it shall remain and continue uni paired.

ARTICLE XV.

Nothing herein contained shall prevent the adjustment or set ment of any claim or controversy between these States by direct leg lative action of the interested States, nor shall anything herein c tained be construed to limit the right of any State to invoke the jur diction of any court of competent jurisdiction for the protection of a right secured to such State by the provisions of this Compact, or enforce any provision thereof.

ARTICLE XVI.

Nothing in this Compact shall be considered or construed as rec nizing, establishing or fixing any status of the river or the accuracy any data or records or the rights or equities of any of the signator or as a recognition, acceptance or acknowledgment of any plan or pr ciple or of any claim or assertion made or advanced by either of signatories or hereafter construed as in any manner establishing a principle or precedent as regards future equitable apportionment of water of the Rio Grande. The signatories agree that the plan her 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 abc Fort Quitman, Texas, was signed by Commissioners for the States Colorado, New Mexico, and Texas, at Santa Fe, New Mexico, February 12th, 1929, which in effect provides for a truce between t States interested, to June 1st, 1935, during which period of time Co rado agrees not to impair the flow of the river by new or increased versions or storage within the limits of Colorado, unless and until su depletion is offset by increase of drainage return. The Compact w executed by me as Commissioner for the State of New Mexico, acti under authority of Section 1, Chapter 112, of the Session Laws of 19 and Chapter 114 of the Session Laws of 1925, supplemented by the pr visions of Chapter 120 of the Session Laws of 1927, by Hon. Delph Carpenter, Commissioner for the State of Colorado, and by Hon. T. McGregor, Commissioner for the State of Texas. Col. William Donovan, Assistant to the Attorney General of the United States w appointed by the President as the representative of the United Stat of America to participate in the meetings. Col. Donovan has approv the Compact in behalf of the United States. The instrument has be executed in quadruplicate originals, one of which will be deposited the archives of the Secretary of State for the United States at Was ington, and one with the Secretary of State of each of the signato States. The Compact will become effective when ratified by the Leg lature of each of the signatory States and approved by the Congress the United States.

I am handing you herewith, the original signed draft which is be deposited in the archives of the Secretary of State of the Sta of New Mexico.

Generally speaking, the Compact settles for a period of six yea to-wit, until June 1st, 1935, the controversy which has been in existen 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 deple-

tion of their resources occasioned by the Treaty. The closing parε graph of this Articles recites: "The signatory States agree that approv: by Congress of this Compact shall not be construed as constituting a acceptance or approval, directly, indirectly or impliedly, of any stat(ment or conclusion appearing in this Article."

ARTICLE III provides that Colorado shall maintain and operat automatic stream gauging stations at each of the following points, t(wit: (1) On the Rio Grande near Del Norte at the station now mair tained, known and designated herein as the Del Norte Gauging Statioı (the water records from this station to include the flow diverted int the canal of the Del Norte Irrigation System); (2) On the Rio Conejc near Mogote, a station known and designated herein as the Mogot Gauging Station; (3) On the Rio Grande at or near the Colorado-Ne Mexico Interstate line, a station known and designated herein as th Interstate Gauging Station; (4) Such other station or stations as ma be necessary to comply with the provisions of this Compact; New Mex ico shall maintain and operate automatic stream gauging stations at: (1 On the Rio Grande at the station known as Buckman; (2) On the Ri Grande at San Marcial; (3) On the Rio Grande at the Elephant Butt Reservoir outlet; (4) Such other station or stations as may be necessar to comply with the provisions of this Compact; Texas shall maintai and operate automatic stream gauging stations at: (1) On the Ri Grande at Courchesne; (2) On the Rio Grande at Tornillo; (3) O the Rio Grande at Fort Quitman. This article also provides tha there shall be complete cooperation between the officials of the respectiv States whereby records and data obtained from the stations mentione shall be exchanged and checked.

ARTICLE IV provides for a Committee to consist of the Stat Engineer of Colorado, the State Engineer of New Mexico and an officer of Texas designated by the Governor of that State, the jurisdic tion of which shall extend, (1) to the ascertainment of the flow of th river, (2) to prevent waste of water anywhere in the Basin above For Quitman, and (3) to make findings of fact upon conditions which ma exist upon the river, and to communicate them to the officers of th respective States charged with the performance of duties under th Compact.

ARTICLE V contains the agreement which from the standpoin of New Mexico and Texas is the principal consideration for this Com pact, to-wit, that until the construction of the Closed Basin Drain an the State Line Reservoir, but not subsequent to June 1st, 1935, Colo rado will not cause the water supply in the river as measured at th interstate gauging station to be impaired by new or increased diversion 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 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 obligati which the United States might assume to satisfy the claims of t United States of Mexico. In 1906, the Treaty with Mexico was cc cluded (34 Stat. 2953) and it was approved and confirmed by the S ate in January, 1907. It was conceded that since the water originat entirely in the United States, which had been used in Mexico in t El Paso District, that the United States of America were under no ol gation imposed by international law to pay the claims or to provide f the continuation of irrigation of lands in Mexico out of the flow of t Rio Grande, but the State Department desiring to avoid friction w Mexico and "being moved by considerations of international comit agreed in the Treaty to deliver to the United States of Mexico, si thousand acre-feet of water annually and forever, with certain conditi attached, depending upon whether there was a universal drought up the river or not. To discharge this international obligation thus vol tarily assumed by the United States, and to create a great reclamati project in this country, the Rio Grande Project was undertaken, a the Elephant Butte Dam constructed and completed during the peri from 1907 to 1914. Thus, there was created at that point in the ri a mighty catch-basin which conserved all of the water of the river applied to beneficial use above San Marcial and there was impo upon the resources of the river above that point a burden of si thousand acre-feet, which the United States were obligated to deliver Mexico. It is true that this project has greatly benefited the secti between the dam in New Mexico and Fort Quitman in Texas, but ab San Marcial the burden of the obligation to Mexico operates as a dir drain during dry cycles upon the resources of the stream in the ba above San Marcial. The embargo mentioned was continued until it w lifted by Secretary Work in 1925, and all development upon the ri of any extensive character has been thereby prevented. The figu presented by the Engineers retained for the States of New Mexico a Texas show that nothwithstanding this embargo there was, has been, a is an increasing consumptive use of water in Colorado which has sulted in depletion of the flow of the river at the New Mexico-Co rado State line. The Middle Rio Grande Conservancy District has be organized and is now being financed for the purpose of repairing t damage which in part, at least, has been caused by this depletion w respect to the flow of the river. The future of this district and that all of the users of the water of the Rio Grande above the district the Colorado State line will be in jeopardy so long as these depleti continue, and there is no water returned to the river to take the pl of the water consumptively used in Colorado in the San Luis Vall

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 b agreement embodied in this Compact, the Colorado Engineers estin that the increase to the flow of the river by this means would amou one hundred seventy-five thousand acre-feet per annum, and while estimate may be high, there seems to be no question but that there be a very large increase to the river flow by means of this drain. F ermore, the drain will return to the river a steady and equated throughout the year. To the extent that this return will increas normal flow of the river at the State line, the uses equivalent th above that point in Colorado could be multiplied without damage to Mexico and Texas. Thus, the construction of the drain will be Colorado greatly and also New Mexico.

As regards the State Line Reservoir, the effect would be to reg the river so that Colorado could deliver at the State line a quanti water equivalent to the present flow annually at times in the year side of the irrigation season, or during flood periods when such co bution to the river would not damage her development and would p the increase of that development. In other words, instead of deliv the present normal flow during all seasons of the year, Colorado c deliver in a few months water equivalent to the present annual su without regard to seasons which could be conserved in the reservoir let down the river at a time when it would be important and usef those below who divert water from the channel of the river for ir tion. Thus, the State Line Reservoir would be particularly of v to the Middle Rio Grande Conservancy District and it would serv bring about the most efficient use of the waters of the river bot Colorado and in New Mexico.

It is estimated that the cost of both the drain and the State Reservoir would be in the neighborhood of two million and a dollars. Upon a conservative basis the sixty million acre-feet w the United States, to preserve friendly relations with Mexico, agreed to deliver to the citizens of that nation, is worth nine mi dollars, and since in the final analysis this draft upon the river mus made by the sections of New Mexico and Colorado above San Mar it is equitable and just that the Government should compensate the the extent of this comparatively small expenditure.

If there is any surplus in the river caused by spill and alleged w at the Elephant Butte, it can be used under the Compact in New Me and Colorado equally without danger of damage to the users of w in New Mexico and under the Rio Grande Project.

From the foregoing I recommend to your favorable considera the following benefits to New Mexico obtained by virtue of the C 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.

February 7th, 1927.

Mr. D. C. Henny,
Spalding Bldg.,
Portland, Ore.

Dear Mr. Henny:

I have just returned from Santa Fe where I had a conference with Mr. Yeo, the new state engineer. A previous conference made me think that he favored together with the Texas commissioner employing you to make the San Luis valley studies. It seems now, however, that although he would like to follow this course, he does not now think it practical. Certain other interests in the northern part of the state are bringing political pressure to influence the appointment of the engineer that makes investigations. Mr. Yeo thinks it best to contract with an engineer that has no sectional affiliations. Influenced by a visit from Mr. Ethelbert Ward, who spoke very highly of Mr. Osgood, Mr. Yeo favors employing Mr. Osgood direct to make these investigations. I told Mr. Yeo that I was not in a position to advise him in this matter until I counselled with you and the Texas interests, and I have some hesitancy in making any recommendation before our legislative appropriation of $25,000 from the general fund is passed. This legislation went through the house by unanimous vote but the house has made appropriations much in excess of the anticipated revenues, and as the Republican party went in on a program of economy, it is anticipated that the senate will cur many of the appropriations. We are carefully watching this situation and hope to get our legislation through before much feeling is stirred up on the various cuts which are sure to occur.

The new bill provides for the expenditure of the money under the directions of the government and there might be come criticism as to our motives in signing the contract before the bill passed. Of course the Irrigation District has guaranteed the state engineer $3,000 in case the state funds were unavailable, but it will be necessary, it seems to me, to have the governor concur in Mr. Osgood's appointment and in the necessity of taking action before the passage of the legislation.

When I left Santa Fe last night, it seemed best to leave the matter a few days as there will be an effort to bring the bill up in the senate this week. I would like very much to hear from you promptly as to whether you advise the appointment of Mr. Osgood and I hope to discuss the matter with Major Burges as to the Texas attitude. We should reach a prompt decision in this matter for as soon as the bill is passed there will no doubt be efforts by various interests to have special counsel appointed to take care of the preparation of the suit and it may be that this special counsel might have some effect in the appointment of engineers.

I do not believe that this will seriously embarrass us as I believe that Governor Dillon will be very sympathetic to our suggestions in any appointment that he may make. It may not be that we can name counsel that is directly identified with our interests and there may be some difficulty in securing a man that is satisfactory to the middle Rio Grande. The Rio Grance Conservancy District is engaged in a three cornered fight regarding legislation as to the methods of election of its board of directors and this fight is developing a lot of factional bitterness and no one can tell what ef ect it might have on the appointment of counsel. There are several good Albuquerque attorneys for this position but they may become so involved in Middle Rio Grande disputes as to be unacceptable. It might be that the feeling will be so bitter that they might accept a man from our section. We have a good man in Judge Meechem. He was so popular a district judge when he was on the bench, that in the election preceding thelast term, he had no Democratic opponent. It might develop, however, that having securing the state engineer, it would be inadvisable for us to attempt to name the special counsel.

It is not entirely unthinkable that should the Republicans stir up too much discord that the governor might consider Mr. Seth, but I am sure that this would not be considered unless all good republican appointees would prove unacceptable to some faction. The appoi tment of counsel, prior to the engineer being employed, might have some influence on the engineering appointment. I know that one or two attorneys of high reputation are seeking the appointment and I am satisfied that these attorneys, or at least one of them will want Mr. Neal both from regard of his professional qualifications and at the same time to demonstrate that this is not a matter of partisan politics. I shall confer promptly with Major Burges and shall keep you posted as to any further development and in the meanwhile, I should like very much your advise as to favoring the employment of Mr. Osgood directly by the two states.

Very truly yours,

(sgd) J. W. TAYLOR

President and Manager.

COPY

PRELIMINARY REPORT

UPON

THE USE, CONTROL AND DISPOSITION OF THE WATERS

OF THE

RIO GRANDE AND ITS TRIBUTARIES

ABOVE FORT QUITMAN, TEXAS.

11/30/85

E. P. OSGOOD, ENGINEER

FOR NEW MEXICO AND TEXAS.

CONFIDENTIAL.

[March 31, 1928]

N. M. State Engineer Office, Santa Fe, N.M.

El Paso, Texas,
March 31, 1928.

Mr. Herbert W. Yeo, State Eng.,
Santa Fe, New Mexico.

Dear sir;

I am hereby submitting a preliminary report, with copies, on work to date. A great many reports and much data is available pertaining to the Rio Grande system above Ft. Quitman. My effort will be to outline, as shortly as possible, my own work and the work that has gone on before that is of most importance. Matters have to be viewed with the possibility, even probability, that they may be settled by the Supreme Court of the United States. In preparing for such an eventuality it seems essential to speak frankly in order that proper consideration may be given to any and all questions. Hence I would suggest that it would be best for the report to be confidential except as New Mexico and Texas saw fit to release same.

Very truly yours,
E. P. Osgood
E. P. Osgood, Engineer.
For New Mexico & Texas.

Preliminary Report Upon

THE USE CONTROL AND DISPOSITON OF THE WATERS

OF THE RIO GRANDE AND ITS TRIBUTARIES

ABOVE FORT QUITMAN TEXAS.

1. THE PROBLEM INVOLVED. Irrigation first started at a very early date on the lower Rio Grande in Texas and New Mexico, and reached very considerable proportions. Development then also went forward in the San Luis Valley in Colorado. A very large acreage was put under water in Colorado until a setback set in in about the nineties which is generally attributed to rise of groundwater and seepage troubles. However, the amounts of water diverted to use were of such considerable proportions that the early irrigated areas in lower New Mexico and Texas suffered increased severe shortages and the dimunition of the flood flow caused such a silting and raising of the stream bed that areas in the Middle Rio Grande district were ruined by seepage and a decline in irrigation efforts forced on the lower valleys.

The decline in Colorado was by no means due entirely to seepage as so often alleged; this resulted to shifting to new lands and substitution of the available waters to them, but the real difficulty was the exhaustion of the dependable "natural" flow sufficient to carry the lands thru the entire season. It is confirmed by the direct statements of Mr. Goudy for the Monte Vista Canal as early as about 1891 in the Rio Grande adjudication proceedings of that year under direct examination. Development has gone forward nearly steadily, however, in the San Luis Valley, but with severe shortages increasingly the portion of the new lands. Also it should incidentally be noted here that the abovementioned "seepage" trouble so often quoted is probably better described by Mr. W. P. Headdon of the Colorado Agricultural College to small but most dangerous amounts of "black alkali" brought up by the rising ground waters to the root zone in the very extensively developed North or "Dead" area, who says that this was the larger or principal cause for the abandonment of the lands in the eastern portion of this area.

Efforts had been under way since about 1890 to bring some 230 000 acres under the Elephant Butte reservoir. Conflict with Mexico ensued and resulted in the construction of the Rio Grande Project and the guaranteeing to Mexico of 60 000 acre feet of water each year as representing her rights in full to waters of the Rio Grande. However, as to Mexico, it must be borne in mind that this treaty has not entirely eliminated the Mexican situation. The Rio Grande Project was initiated by the United States thru its Reclamation Service and the then unappropriated waters of the Rio Grande filed upon for this project. The Rio Grande Project is tentatively placed at 155 000 acres. The Middle Rio Grande Conservancy District in the vicinity of Albuquerque proposes to rehabilitate its 140 000 acres of land with reports indicating, generally, that, rather than depleting the river it will increase the flow to the Rio Grande project.

The Problem involved is this,- That Colorado alleges that there are over 200 000 acre feet of water that can be stored in Colorado in the Vega Sylvester proposed storage site, or elsewhere, without detriment to the projects of New Mexico and Texas, and right of Mexico.

2. PARTIES INVOLVED. Reports heretofore made have been primarily prepared with only the interests in sight of the immediate project. The situation now calls for consideration of all parties, Colorado included. It is of great importance. The listing will bring out several features calling for study.

The United States:-	1. Rio Grande Project. 2. Mexican Treaty; 60 000 a. f. guaranteed. 3. Warren Act disposal of water.
Mexico :	1. By treaty, 60 000 ac. ft., for Upper Juarez Valley (over 60 000 a. f. being received. 2. Lower Juarez Valley,- developing under 7 or more unauthorized headings.
Colorado :	1. For San Luis Valley, a great area of 1,500,000 acs. capable of absorbing entire runoff.
New Mexico :	1. Middle Rio Grande Conservancy District. 2. Elephant Butte Irrigation District, Rio Gr. Pr. 3. Tributaries of Rio Grande. 4. Palomas, Rincon & Mesilla Valley areas by gravity & pumping; not in Rio Gr. Project.
Texas :	1. El Paso Improvement District No. 1, Rio Gr. Proj. 2. Hudspeth Co. Con. & Rec. Dist. No. 1. Not in Pr. 3. Ft. Quitman area by some 6 pumps. " " "

The United States, New Mexico and Texas will also be interested in utmost feasible power development for the stability and necessities of the communities and for expansion of irrigation.

3. AREAS INVOLVED. There is considerable variation in data pertaining to areas irrigated, etc., but an approximate statement will be made in order to better visualize the matter.

Area	Acs. Irr'd.	Acs.Prop. or Poss.	Gross Area Acres.	
San Luis Val.	325 000			to 425 000 per Meeker-Tipton Colo. rpts., 1924.
	653 564			*Per Colo. St. Eng. Div. Rpts.1926
	356 904			By Rio Grande alone,-same rpts.
		810 000		Conkling-Debler Rpt.,1919
			1 500 000	See Meeker rpt., etc.
				*See Debler-Elder Rpt.,1928
Mid.Rio Gr. Con. Dist.	49 000			Conkling-Debler rpt.1919.
		140 000		Debler-Elder rpt.1928
			206 000	N.M. & Con.-Deb. rpt.1919,p.77.
Rio Grande Project.	137 553			Project History, 1927.
		16 000		Rincon Valley - "
		41 000		Mesilla Val.,N.M. "
		9 000		" " Texas. "
		58 000		El Paso Val. " "
		155 000		Rio Gr. Proj., Per Proj. History.
		200 000		More or less by expansion in Rincon, Palomas & Mes. Valleys.
			228 000	Project statement, Palomas to El Paso Val. to Hud. Co. line.
Hud. Co. Con. & Rec. D.#1.	12 567			Project History, 1927. Und. War.Ac
		16 000	20 300	"
Ft. Quitman Area.	1 000	5 000	7 000	No data. Observation only.
Palomas Val.	253	5 000	13 550	Pr.Hist.1927, etc. Und.War. Act.
Mexico,Upper Juarez Val.	25 000	25 000		Project"Estimates" only
Low. " "	5 000	15 000		Mere guesses; no data yet.

Irrigation on Tributaries not at hand.
Of the Lower Rio Grande Areas only that of 155 000 acres for the present Project is claimed for by the United States under the Elephant Butte filings. As against this, per W. W. Follett Report or Sen. Doc. 229, 55 Cong., 2nd. Session, efforts towards irrigating these lands were initiated in 1889 and filings made in 1893 and 1895 for Elephant Butte Dam proposing that under the entire works, - "over 230 000 acres of bottom lands and about 300 000 acres of mesa lands will be under ditch."
I am not yet familiar with the history of this period but as far as the Senate Document goes it appears that valid rights of that date must have been assumed by the Government in forcing itself into position to deal with Mexico.

If the claims of Colorado have any basis in fact ~~####~~ as to surplus water in the river then additional amounts of the lower river area as listed above would be subject to development.

4. REPORTS AND DATA AVAILABLE. A very considerable volume of material is available regarding most phases of the Rio Grande system. It primarily naturally divides into the three sections,- A. San Luis Valley. B. Middle Rio Grande Valley. C. Lower Rio Grande Area. Of course the Annual Reports of the State Engineers of Colorado and New Mexico, of the U. S. Reclamation Service and of the U. S. Geological Survey contain much data but will not be referred to specifically unless for a special feature.

Most of these reports and data I have been over; they will be listed and some special features of many will be commented upon in the listing which generally will follow the chronological order of publication.

GENERAL REPORTS.

	Year	Author	Dept.
1. Equitable Distribution of Wats. of the Rio Grande.	1896	W.W.Follett	State
2. Senate Doc.229,55th. Cong.,2nd. Sess. Follett Rpt. (Early data to 1896.)	1898	Senate	Cong.
3. Destructive Flood on Rio Grande	1904	W.S.P. 147	USGS.
4. " " " " "	1905	W.S.P. 162	USGS.
5. Synopsis of Wat. Sit. in Rio Gr. Basin for use at 20th. Natl.Irr. Cong.	1912	W.W.Follett	Texas?
6. Wat. Sup. for & Poss. Dev. of Irr'n & Dr'e projs. on Rio Gr.Riv. abv.El Paso, Texas. (Det. study of wat,sup.from San Luis Val. to Rio Grande Pr. Most important report)	1919	Conk.-Debler	USRS
7. Aplication of Prob.Meth.of Analysis to Str. Flow of Rio Gr.Basin.(To fill out data)	1924	R.J.Tipton	Colo.
8. Rev.of Wat.Sup.,Irr.& Dr'e of Irr'd Area abv.Ft.Quitman,Texas.	1924	R.I.Meeker	Colo.
9. Comments on Meeker's Rpt. above. For El Butte Irr.Dist.,Compact Negot'ns.	1925	D.C.Henny	Irr.Dis.
10. Consumptive Use of Wat By Crops,Rio Gr.Bas.	1925	C.R.Hedke	N.M.
11. 12th.Ann. Rpt.& 11th. Ann. (Early data; warning sounded)	1890	Newell	USGS
12. 20th. Ann.Rpt. (Conkling work & review; quite adverse to Colo.dev't.p.406)	1920	Har.Conkling	USRS

4-A. SAN LUIS VALLEY DATA.

	Year	Author	Dept.
1. 11 th. Ann. Rpt. Pt. II. p.146. Dits.,221.	1890	Newell	USGS
2. 12th. " " " p.249. Irr'n.	1891	"	"
3. Soil,Survey, Cir. 32 (or Field Opers. 1903, p.1101)	1903	Lapham	USBR
4. Geol. & Wat. Resources of S.L.V. W.S.P.240, pub'd 1910.(Basic data-imp.)	1904	C.E.Siebenthal	USGS
5. Some 14 Rpts. on Dr'e in S.L.V.1907 & later.Unpub.(Copies-St.Eng.N.M.)	1907	A.E.Morgan,& Elliot et al.	USDA
6. Rpt.on Hydr.Sur of Rio Gr. Dr'e in Colo. (Basic data.Sound conclusions re Dr'e Ret.)	1910	J.A.French	USRS
7. Dr'e Rpt.-S.L.V. (See 19th.An.Rpt.,St.Eng. Colo.,1917-'8,p.30)	1911	D.G.Miller	USDA
8. Rpt. of Oper's.,S.L.V.,Invest'ns. 1913 &	1912	J.D.Stannard	USRS
9. " " " " " Dr'e	1914	"	"
10. Rpt. of Dr'e in S.L.V.	1913	"	"
11. Coop.Rpt.,Dr'e S.L.V.	1915	J.D.Stannard D.G.Miller	USRS USDA

		Year	Author	Dept.
12.	Adv. Sheet;Det.Sur.,S.L.Lakes to Rio Gr.,Coop.wk.for abv.rpts.(Imp. re disposal of dr'e in"Dead" area) (Abv.USRS Rpts.all avail.Denver &El Paso)	1914	Contour map (On file-N.M.)	USGS
13.	Irr'd Agri. in S.L.V. (not obt'd.)	1915	Cone & Keezer	USDA?
14.	15th.An.Rpt. p.520. (Good review of French & Stannard-Miller rpts.)	1915-'6	Dept.	USRS
15.	Waters of Rio Gr. Bul.230	1917	W.P.Headdon	Colo.Ag.Col.
16.	"Black Alkali" in S.L.V. " 231	1918	"	"
17.	Alkalis in Colo. (S.L.V.) " 239 (Abv.imp. in confirming lack of Rtn.Flow & re abd. of land.)	1918	"	"
18.	Rpt. on Land Values.(Avail.at Wichita)	1918	J.N.Kerr	Fed.Ld.Bk.
19.	Possibilities in S.L.V.	1918	J.L.Burkholder	USRS
20.	Year Books(began) Colo.& S.L.V.data (Irr'n, Crops, Weather data,Taxes,etc.)	1919	Bur. Immig.	Colo.
* 21.	Wat. Sup.for & Poss. Dev. of Irr'n & Dr'e Proj.on Rio Gr.Abv.El Paso, Texas (Det.basic data;most imp.rpt.of all)	1919	Conkling-Debler	USRS
22.	20th.An.Rpt.,1920-'1.(Rev. of Conkling-Debler rpt., p.406.)	1921	Dept.	USRS
23.	20th.&21st. Bien. Rpts.,St. Eng.Colo. pps.9 & 15, resp.,re Supp. Stat. Law. (cancelling abd'd wat. filings.)	1922	State Eng.	Colo.
24.	Prelim.Rpt.on Irr'n Wat.Sup.& Dr'e of S.L.V. (summary of data)	1924	R.I.Meeker (Ex.8L-N.M.)	Colo.
25.	Storage for Irr'n,Colo. Area (based on full supply only 8 yrs. in 19; tacit criticism of basis of El Butte storage provisions.)	1924	R.J.Tipton (Ex.8R-N.M.)	Colo.
26.	Soil Cond's & Dr'e in S.L.V. (imp. re low "Con.Use".)	1924	R.J.Tipton (Ex.8E.-N.M.)	Colo.
27.	Deductions of Irr'd Area-S.L.V. 1924? (tot.375 000 to 425 000 acs.irr'd.) (Abv.Colo.rpts. & Nos. 7&8 of general rpts. prep'd for Compact Comm.)	?	R.J.Tipton (Ex.8A.-N.M.)	Colo.
28.	Dev't of S.L.V. Memo to Chf.Eng. (dev't of dr'e wat. to precede stor'e.)	1924	Debler-Walker	USRS

Re Climatology see Consumptive Use Data.

4-B. MIDDLE RIO GRANDE DATA.

		Year	Author	Dept.
1.	Irrigation in N.M. O.E.S.,Bul.215.	1909	V.L.Sullivan (Ter.Eng.)	USDA
2.	New Mexico Area. Rio Grande (& tribs.) (basic data;dits.,irr'n, resrs.,etc.)	1910	H.W.Yeo	USRS
3.	Soil Sur. of Mid.Rio Gr.Val.,1912.	1914	J.W.Nelson L.C.Holmes E.C.Eckman	USBS
4.	Rpt. on Dr'e Invest'ns,Mid.Rio Gr.Val.	1919	J.A.French	N.M.
5.	Dr'e Sur. by H.J.Gault, U.S.R.S., in 5th.Bien.Rpt., 1921-'2.	1922	State Eng.	N.M.
6.	Mid. Rio Gr. Rec. Proj.,	1923	H.J.Gault	USRS
7.	Irr'n Dev. & Wat. Sup.of Mid.Rio Gr.V. for Rio Gr.Val.Sur.Comm. (depl'n curves)	1925	C.R.Hedke	N.M.

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		Year	Author	Dept.
* 8.	Wat. Sup.for & Poss. Dev. of Irr'n & Dr'e Projs.on Rio Gr.abv.ElPaso,T. (basic data;most imp.rpt.of all)	1919	Conkling-Debler	USRS
9.	Dev. in Mid. Rio Grande Memo to Chf. Eng.	1924	Debler-Walker (Ex.8F.N.M)	USRS
10.	Prelim. Progress Rpt.on Hyd. Invest'ns, Mid. Rio Gr. Val. (imp. on Con.Use & Evap.data.)	1927	C.C.Elder	(Con.Dis. (USRS
11.	Prelim.Rpt. on Inves'ns in Mid. Rio Gr. Val, N.M.	1928	Debler-Elder	USRS Con.Dis.

4-C. LOWER RIO GRANDE AREA.

		Year	Author	Dept.
1.	Equitable Dist. of Wats.of Rio Gr. United States & Mexico	1896	W.W.Follett	State
2.	Sen.Doc.229,55th.Cong.,2nd.Sess. Follett Rpt.(early data to 1896)	1898	Senate	Cong.
3.	12th.Natl.Irr'n Cong.,El Paso. A.p.107. Ratification for El Butte Pr., U.S. & Mex. Delegates. B.p.213. Past & Pres. Pland for Irr. of Rio Gr. Val., B.M.Hall,USRS. Tot.230 000 acs. prop'd. C.p.216.Rio Gr.V.Underflow,Slichter. D.p.293.Irr'n Pub.Lds.,Texas. E.p.351.Pumping for Irr'n, N.M. F. Climatology.p.387.	1904	Secretary	Irr.Cong.
4.	Ground Wats. in Rio Gr.Val.W.S.P.141.	1905	C.S.Slichter	USGS
5.	Wat.Res.Rio Gr.Val.,N.M. (Mes.Val,etc) W.S.P.188.(Good on geol: p.48,imp. re underflow of riv.to land.To Con.Use.)	1907	W.T.Lee	"
6.	Irr'n in N.M. O.E.S.Bul.215.	1909	V.L.Sullivan	USDA
7.	Soil Sur. of Mesilla Val.	1912	Nelson-Holmes	USBS
8.	Irr'n & Dev.of Low.Mes.Val.	1913	Board Engs.	USRS
9.	Wat. Res. Rio Gr.Val. W.S.P.358 (wat records, evap.etc.)	1913	Follansbee-Dean	USGS
10.	Designation of Irr'e Lds. for Rio Gr. Proj. (duty wat.,wat.rqts.,etc.)	1914	Board Engs.	USRS
11.	Soil Reconnoisance of Palomas,Rincon & El Paso Vals. (folder-proj.) ("lds.reclaimable-1 irr'g season.")	1914	A.T.Strahorn	USBS
12.	Silt in the Rio Grande	1915	W.W.Follett	State
13.	Chapters re Silt in Rio Gr.W.S.P.274			USGS
14.	Dr'e of Rio Gr. Proj., Mesilla & El Paso Vals.	1915	Board Engs.	USRS
15.	Community Dits.in Rio Gr. Proper	1915		USRS
16.	Profile Surs.of Rio Gr.etc.,N.M.	1916	W.D.Henon	USGS
17.	Silt, El. Butte Resr.	1916	Coghlan-Lieb	USRS
18.	Dr'e in Rio Gr. Proj.(Con.Use)	1917	Board Engs.	USRS
19.	Dr'e for Rio Gr.Proj. " "	1918	" "	"

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		Year	Author	Dept.
* 20.	Wat.Sup.for & Poss.Dev.of Irr'n & Dr'e Projs.on Rio Gr. Riv.abv. El Paso,Texas.(most imp.det'd study)	1919	Conkling-Debler	USRS
21.	Prop.Hi.Line Cans.& Pow.Plants of Rio Gr.Proj.& Fut.Wat.Sup.of El Paso,Texas.-Quinton,Code & Hill. (p.11.Pr.Sup.820 000 a.f.adeq.270 000 acs. p. 1. Sup.adq.for 200000 acs. in U.S.)	1919	L.C.Hill	Irr'n Dists.
22.	Rpt.on Wat.Sup.& Proj.Area,Hi.Line Can. Con? & City of El Paso Wat. Sup. from Storage. Henny, Munn & Pease (Wat.sup.data fr.#20;answer to #21 abv.-unfavorable)	1919	Board Engs.	USRS
23.	Dr'e in Mesilla Val, N.M. Reclamation of Alkali Lands Agri.Exp.Sta. Bul. 129.	1921	D.W.Bloodgood A.A.Laferriere	N.M.
24.	Alkali Investigations,El Paso Val.. (Not pub'd; in proj. folder)	1922	A.T.Strahorn	USBS
25.	Rio Gr. Proj.Wat.Sup.Reqts.	1924	Debler-Walker (Exs.8F,8M-N.M.)	USRS
26.	Rpt.for El.Butte Ir.Dis. to Colo.-N.M. Comm.	1924	D.C.Henny (Ex.8T.-N.M.)	El.B.Ir.D.
27.	Rpt.forEl.B.Ir.Dis.& El Paso Co. Wat.Imp.Dis.No.1.	1924	D.C.Henny (Ex.8U.-N.M.)	Irr.Dists.
28.	Comments on Meeker's Rpt.on Embargo (see Gen.Rpts.#8)	1924	D.C.Henny (Ex.8C.-N.M.)	Irr.Dists.
29.	Ex.VIII,Pt.of Stat.of El.Butte Irr.D. to Colo.-N.M.Comp.Comm.	1924	D.C.Henny (Ex.8S.-N.M.)	El.B.Ir.D.
30.	Statement of El Butte Irr.Dist.to to Colo.-N.M.Comp.Comm.	1924	J. Taylor,Pres. (Ex.8S.-N.M.)	EL.B.Ir.D.
31.	Net Reqts.of Crops for Irr.in Mesilla Val.,N.M. Ag.Ex.Sta.,Bul.149	1925	D.W.Bloodgood	N.M.

The above lists do not exhaust the material available but do cover the principal offical data, in substantial form. Private and Government reports are now being considered with regard to development of commercial power at Elephant Butte dam and at proposed power storage dam at the Gaballo site. These must be considered later. They are of importance as the project supply must be assumed in working them out. The Yearly Project Histories of the Rio Grande Project are another source of valuable data. As an instance the Weather Records may be noted that give Monthly Precipitation and greatest amount in a 24 hr. period, for Elephant Butte, Mesilla Park, El Paso and Clint. They bear on a direct factor affecting Consumptive Use and partly explain the large variance in the different figures set forth for it.

5. SAN LUIS VALLEY AREA and WORK OF WRITER. Colorado has for several # years been maintaining Mr. Burgess, Hydrographer, here in El Paso under the direction of Mr. Meeker, Compact Engineer, who himself is here a week or two at intervals, three or four times a year, it is said. Detailed measurements are taken of the Project Supply and Drainage and other data worked up for use in the anticipated settlement of the water situation. The same measurements are taken by the Bureau of Reclamation so it seems evident that Colorado deems it essential to take her own records in order that her own witnesses can be put on the stand.

San Luis Val. map in back.

It was considered essential that the writer should become as familiar as possible with conditions in the San Luis Valley. The Colorado position is that she is entitled to a large expansion of her irrigated area there;that a remarkable economy in consumptive use of water exists there such that one acre foot of water there will irrigate twice the area that can be cared for in New Mexico and Texas; that her drainage systems that are proving relatively successful in reclaiming the alkalied land assure large and steady flows to the Rio Grande to replace any further storage of water,etc.

It was known that these claims were more or less excessive and it was the writer's special work to investigate the whole situation to ascertain as clearly as possible the actual facts in order that Texas & New Mexico could be prepared for rebuttal of excessive claims.

It is believed that a relatively clear understanding of most matters has been obtained but the following statement will be made as much of a summary as possible, as to work done:-

5-A. Drainage Systems. The smallest Clason map of the San Luis Valley, 18" x 28", is furnished herewith and on it are correctly located the various drainage systems determined by field examinations.

The many reports dealing with the SAN LUIS VALLEY refer it to important sections or areas. The original areas were the NORTH or DEAD area originally cut off from the Rio Grande for the past many centuries. The LIVE area was that of the SOUTHWEST and SOUTHEAST areas tributary to the RIO GRANDE. The Rio Grande is partly diverted to serve a large portion of the DEAD area;a portion of this,- The RIO GRANDE DRAINAGE DISTRICT has,by drains and by control, been so placed that it may or may not contribute to RETURN FLOW going to NEW MEXICO and TEXAS. The following diagram will visualize the situation:-

SAN LUIS VALLEY:-

DEAD or NORTH AREA
Originally non-contributing to Rio Gr.

1.SERVED BY MOUNTAIN RUNOFF.
SERVED BY RIO GRANDE
Non-contributing to Rio Gr.

2.SERVED BY RIO GRANDE.
Can be contributing or non-contributing to Rio Gr.

LIVE AREAS
Contributing to Rio Grande.

3.SOUTHWEST AREA
Rio Grande,Alamosa,LaJara, Conejos and San Antonio.
Abt.8 principal dr.systems

4.SOUTHEAST AREA
Costilla & Trinchera Dists.
No regular drainage reqd.

The map is colored to set out the above four principal areas.

To return to statement of work. The control, re-diversion and disposal possibilities of the drainage waters has been worked out. The COMPLETE REDIVERSION (except of the two NORTON DISTRICT drains) is already practiced except when there may be a surplus of water or no demand for water as in winter.

2. Measurements of drains were made and regimen noted from July 1927 thru the winter to Feb. 1928. A very low minimum flow occurs in winter;some entirely dry up.

3. Colorado maintains monthly or bi-monthly measts.I have these up to about 1923;more especially I have the most important complete

set covering over a two year period ending in Feb.1928.

4. Water filings have been checked; they show claims for all and more water than has been or can be developed.

5-B.1. Seepage Return to Rio Grande. Low amounts found between Monte Vista and Alamosa but river flow sent thru to Costilla ditch stopped observations.

2. A series of measurements was in hand from dry river below Costilla ditch to mouth of canyon, preparatory to trip thru canyon to Embudo with minimum water to determine origin of canyon inflow. A September flood came on and stopped all chance of the work for the year. The work done indicated material inflow above Alamosa(subject to ultimate control by Chicago & Wilkins dits.) but very little below with possibility,even, of less.

3. The real proof of failure of return flow is the record at State Line showing recurringly minimum flows of even less than 50 sec. ft.

4. Confirmation is further made from Colorado data per W. P. Headdon in his bulletin"Waters of the Rio Grande"(see 4A-No.15) as found by him and so stated based on his water analyses.

5. Colorado's position as to large seepage return similarly to on the Cache le Poudre and South Platte is quite without basis.

5-C. Re San Luis Val. Underflow to Embudo Canyon.

1. Examination was made of the volcanis San Luis Hills. It is believed that Siebenthal is only partly right in calling them basalt table-topped uplifts of the valley floor. Outcrops indicate primarily an uplift due to intrusion of igneous and granitic masses that must cutoff any underflow from valley.

2. Position is confirmed by Geological report of Kirk Bryan on State Line dam site made for Middle Rio Grande Conser. District.

3. A series of these outcrops have been platted for proof.

5-D. Conditions in DEAD area.

1. Drains were measured and disposal of water noted. Provisions are made for use of the waters on cultivated or wild hay land. The winter flow of the new San Luis Irr. Dis. Drain is considerable and is filling San Luis Lake and thence running south to a large alkaline waste area that can provide disposal.

2. The entire area is (except for Rio Gr. served area & part of Saguache) most deficiently supplied with water. The president of the company operating the Gibson or Saguache drains asked about the "Trough" drain. I asked if he had any water to give up to it. He said he could use all the drain water they had and then some, - that he would not care to contribute to cost of the drain.

3. Stannard & Miller estimated 600 000 ac. ft. per year recoverable in this area, figuring in 1915, from 600 or 800 000 acs. of so-called seeped lands. It is without doubt, I think, the origin of Colorado's proposals to return great amounts of water to the river. Though Debler cut these figures to something like 150 000 ac. ft. I see no opportunity of getting hardly a fraction of that amount away from the lands to which it can be sent.

4. As regards the "Trough" or lowest area it has been said it always will be a swamp and worthless. Cattle men are operating it for wild hay and it was "dried up" last summer with water 2 to 4 ft. below the surface. Only "wet" years will reverse this normal condition. Soil borings developed this feature.

5. Re "Seeped Area". Some dozen reports estimate 600 000 acs

more or less as seeped. Mr. Debler noted this was greatly overestimated. Some high water occurs north and northwest of Hooper and west of Mosca and, necessarily, in some parts liberally served with Rio Grande water. Generally the water table is down 4 ft. more or less. In many places, unirrigated, it is 6 to 8 ft. In a channel of the Saguache in the wild hay land 1 mile west of R.R. just prior to a September storm flow reaching it, water was not obtained at 7 ft.,- or at a depth of 9 ft. below the wild hay meadows.

6. The "Seeped Area" is roughly the "brown water" area noted by Siebenthal. Headdon (referred to) brings out that this is evid~~ently~~ due to the small contained amounts of "black alkali", contained in the soil and in the artesian waters of this area; that the rise of groundwater to the root zone brought this alkali to the plant and was the principal cause of the ruin of the agriculture.

7. This trouble would indicate further difficulty in financing any "Trough" drain even if desired, and that any recovered waters would be the least desirable from the valley.

8. Presumably, only state action will bring about any "Trough" drain and only drastic provisions provide any material amount of water for it to bring to the Rio Grande.

5-E. Mapping of Area. By means of cooperative work with a friend, a Federal Land Bank Engineer, we made a reconnoisance survey of practically the entire Rio Grande served area and to south to include the San Antonio river.

1. My work was started on large "Clason" map but the greater opportunity thru cooperation permitted us to change to the larger township plats. We attempted to delineate the irrigated and brush areas of each quarter section of 160 acres; difficulties were encountered along the river but in balance of area with section line roads the work was quite easy and good results obtained. The Costilla-Trinchera areas could not be covered. Rougher maps by estimate were obtained of the wild hay areas of the Crestone and San Luis Creek areas. It is the only record we know that gives a positive check, of this date, on areas actually irrigated.

2. Plats also show drainage systems, drainage districts, a large part of the ditches and the roads and trails by which entry was obtained.

3. Other plats show all ditch diversions from the streams as called for by the court and filed records.

4. Another set are partly worked up showing the actual diversions found and in use. This can be extended some.

5-F. Tabulated Data.

1. Typed tabulations of the Court Water Decrees.
2. Tabulations of the Incorporated ditches. Shares, etc.
3. Yearly reports to Colo. St. Eng. tabulated to show irrigated area and cropped areas, etc. by 8 Water Districts and consolidated to Division 3.
4. Water Comissioners' Reports for 1927 by <u>Ditches</u> for each Water District (except #35 Trinchera-Medano) was copied. Shows, if properly made, area irrigated, area irrigable; acres in each crop; water diverted; storage used, etc.

   An effort is made to make these according to law but many "estimates" have to be made and the Division Engineers themselves are authority for statement that the data, as a whole, is undependable. The hydrographic measurements I believe are good but one man cannot expect or be expected to care for an area greater than the size of Connecticut. Field books show measurements or observations once or twice a week and flows prorated the balance of time.

5. Irrigation and tax tabulations from Colo. Year Books for San Luis Valley counties:- Alamosa, Conejos, Costilla, & Saguache counties. From 1919. These afford some comparative checking of Colorado claims.
6. Crop and Acreage tabulations for same Year Books showing per cent of crops grown with and without irrigation in Larimer, Logan, Morgan and Weld Counties. Meeker cites irrigation data on the Cache le Poudre & South Platte as strongest proof for basis of a Consumptive Use of about only 1.0 ac. ft. per acre for San Luis Val. This data shows the semi-humid character of the area and the unsoundness of the figures.
7. Abstract of San Luis Val. data on drains, drainage, etc of the Stannard and Miller reports from 1912 to 1915; drain flows, estimates, etc. As heretofore noted this was evidently the original source of the claims for and hope of large return flows to the Rio Grande.

6. WORK STILL TO BE DONE IN SAN LUIS VALLEY. In the Conkling-Debler report of 1919 it was assumed that 1.25 ac. ft. per ac. for the single acre alone would represent the Consumptive Use. As a result the studies predicate the possibility of irrigating 810 000 acs., yet with a flow down the Rio Grande to Elephant Butte sufficient to satisfy the demands of 155 000 acres yet with an average spill of some 100 000 acre feet per year from the reservoir. If this Consumptive Use figure is too low, as presumably it is, it needs to be disproven by data from the San Luis Valley itself. The needed data is actual area irrigated and water used and return flows. The following is suggested:

1. Completion of the Reconnoisance surveys, especially for the Rio Grande served area that is over 90 % done now. The Alamosa, La Jara, Conejos areas are practically complete but could be improved for a few strips along the rivers.

2. Extension of surveys to the Costilla-Trinchera areas. The claim is made that these are operating successfully on 1.0 to 1.5 acre feet per acre delivered. The general assumption seems to have been that this is not true. Same for northern area, Dist. 25, etc.

3. Checking actual diversion figures.
   a. Thru the Water Commisioners field books and reports on each individual ditch in Alamosa office of Div. Eng.
   b. Field measurements if same could be undertaken.

4. Drain and seepage determinations for minimum water conditions in San Luis Val. and Embudo canyon. This might be just prior to June flood if a low year or would be normally in later summer for the valley and Embudo canyon.

5. Review and abstracting of adjudication testimony on two or three principal ditches to develop the possibilities in the testimony of checking early irrigation data and excessive decrees.

6. Historical. Data was reviewed in Denver. It furnished mostly only dates. It tallied with the present Court Decrees. It is thought that court testimony itself taken in the nineties offers the best chance of important data, as witnesses are prone to state their views. F.C.Goudy's testimony has already been referred to.

7. CONSUMPTIVE USE DATA. The old question of Duty of Water has given away entirely to one of CONSUMPTIVE USE. The figure assumed for this is the basis of every report pertaining to the various areas. Much confusion exists regarding it on account of not clearly defining the irrigation water from rainfall and that too often the entire rainfall is assumed as included in consumptive use yet not so stated; also the figure varies according as to whther additional losses are included in the figure stated for the net actually irrigated area. The voluminous data that I have reviewed on this makes it desirable to refer to it in condensed form:-

1. Abstract of data from forthcoming report of Am. Soc. C.E. dealing with various phases of consumptive use; covers 15 or 20 sets of data.
2. The above also includes the 9 sets of data set up by Mr. Meeker.
3. Copies and part copies of 5 Rec. Ser. reports from Denver, sent to Santa Fe for file.
4. Personal work in Nevada.
5. Figures from reports covering the Rio Grande system.
6. Meteorological data, Rio Grande system & Ft. Collins area.
7. Am.Soc. paper by Houck on Evaporation on U.S.R.S.Projects with discussions before Society.
8. Year Books of Colorado showing areas in Cache le Poudre and South Platte areas and per cents grown "With Irrigation" and "Without Irrigation", & Bul.1026,U.S.D.A.re Cache le Poudre Irr.
9. C.R.Hedke's study for determination of Consumptive Use, and application to the Rio Grande system. His general presentation appears very promising but some factors are uncared for, notably soil evaporation as affected by number of required irrigations. The Cache le Poudre figure assumed as a "standard" can hardly be so taken. Debler & Hawthorne are authority for statement that the area suffers about a 50 % shortage nearly one year in three; areas are merely the "water commissioner" figures; rainfall is large, even over 22" at times and conditions are semi-humid per #8 above.

A rough statement agreed on in Denver was that about 2.25 ac. ft. per acre for more northern areas might represent the consumptive use; rainfall, if effective, would, to such extent, reduce same; in southern areas 3.0 might be reached. Project and valley losses might very materially increase these figures. It is worth noting that Meeker's Valley figures indicate decrease in that his as shown are only 1.0 ac. ft. per acre more or less; errors in acres irr'd, etc. or uncared for inflow seems the explanation. As regards rainfall, "Max. Amt. in 24 Hrs." & occasion,- is the most important figure,- and availability to crop.

8. AERIAL SURVEY FOR SAN LUIS VALLEY. A very careful crop census appears to give accurately the area under irrigation in the Rio Grande Project. Aerial work to be done possibly this month will disclose, if data available, from the Boundary Commission, the present status of the entire Juarez Valley of Mexico. Numerous surveys delimit conditions in the Middle Rio Grande District. In the San Luis Valley we have no reliable surveys whatever. The only authentic data is the Reconnoisance surveys to township plats as obtained by me this past summer. The conclusions with regard to the San Luis Valley all rest on assumptions the largest of which is as to the area actually irrigated Actual figures would be of great value and of important legal value

in setting an estoppal on the continued expansion of present most junior rights into an assimilation with decreed rights of relatively very old priority. There would seem to, be no question of the great value of such a survey; the problems are of cost and carrying one through.

Cost data is exceedingly scarce. My first search of the Transactions of the Amer#ican Soc. of C. E. gave only the statement that large city surveys would cost not less than $100 per square mile. I turned the search over to an assistant of the Denver Library and the only further data indicated the cost as found in a Memphis survey at about $50 per square mile. Certain features indicated that a considerably better figure should be possible and I wrote the Fairchild Aerial Surveys, Inc. I have just heard from them and in a carefully stated letter they suggest a true map at a cost of $22.25. per square mile.

Mr. Lawson of the Boundary Commission advises me that the surv veys he is obtaining from the Army Fliers is based on cost, aeroplane depreciation being figured at $25 per day, salaries of fliers, lost time, etc. and is now being arranged for on basis of $10 per lineal mile, the Commission also furnishing "supplies" as far as possible.

The tri-lens camera is used along the river; side views are oblique but this would indicate about 3 square miles per lineal mile for the $10; in flat views only about one mile width per flight is taken. If need be the tri-lens work could be done in the San Luis Valley. The figures indicate the possibility of doing the work either thru the Fairchilds people or the Army fliers.

If done by Army fliers consent would be required of Colorado and her assent and concurrence in the request for same before the War Department. They will have accomplished surveys up to as far as El Paso; the idea would be to propose that the Army carry these up to the head of Rio Grande irrigation with the idea of furnishing all parties immensely valuable maps of their respective areas. Colorado might be averse to disclosure of her irrigated areas but objection on her part would be compromised by the fact that her men in concurrence with the assistance of the Rio GrandeProject officials, etc. are engaged in getting the most detailed information possible. Her position will be such that she cannot well refuse to join in the proposals.

9. MIDDLE RIO GRANDE AREA. Discussion can probably be limited. The plans of the Conservancy District have been studied sufficiently to indicate, on the whole, that re-habilitation of the project will improve the river regimen and conserve water. The alkali and silt problems raise a question but over a long course of years the same "balance" must result, ultimately, it would seem.

10. LOWER RIO GRANDE AREA. As the last area on the river system the situation calls, theor#etically, for the consumption of the available water supply. This is impossible but Colorado will force the situation to its limits. With development here as set against development in the San Luis Valley every possible question comes up. The facts regarding the area and features of the Rio Grande project are probably quite thoroughly covered in a considerable number of reports; no great difficulty should occur in rounding out others. If reports heretofore have been limited to the project view it only remains to take them up from the viewpoint of Colorado and the development of the river system.

14-Rpt.

The Rio Grande Project, as served by the Elephant Butte reservoir, stands at present limited to 155 000 acres. But as noted on pps. 2 & 3, numerous other areas are using or could use Elephant Butte water and its seepage return, in addition to the 60 000 ac. ft. called on for Mexico by treaty.

The matter requires most decidedly to be considered as a whole. It must be borne in mind that if the efforts of any section to retain supposed special advantages were successful then ~~####~~ the outcome most probably would be the stripping of the Lower Rio Grande of some of its water supply.

11. PROBLEMS REQUIRING CONSIDERATION. The foremost study of the Rio Grande predicated an ultimate 810 000 acres development carried by a 400 000 ac. ft. storage supply for the San Luis Valley, under which, with the Middle Rio Grande caring for itself, there would result an average supply of 980 000 ac. ft. into Elephant Butte reservoir. The distribution of this 980 000 ac. ft. supply was worked out as showing:-

Unavoidable regulatory loss, and waste		115 000 ac. ft.
Reservoir spill or waste		109 000 " "
	Total waste	224 000 " "

The 1927 history shows	142 285 acs. irrigated	*Project
	235 " "	Pal. Val.
	12 567 " "	Hudspeth
Total	155 087 " "	

and much over 60 000 acre feet delivered to Mexico. In addition a considerable acreage, unknown, is being irrigated in lower Juarez Val. in Mexico, and in the Ft. Quitman section by pumping, but served by water passing Ft. Quitman station. There follows:-

Waste by Ft. Quitman:*		Data
1923	332 558 ac. ft.	Mex. Bdy. Comm.
1924	373 706 "	"
1925	367 843 "	"
1926	259 092 "	Colorado
1927	240 923 "	"

The 1925 Project History states that there was no special effort prior to 1924 for conservation of water, as not necessary.

Colorado's position is that studies and the records show a great surplus that can be stored in Colorado without detriment to interests below. If there is a surplus then the project limits have unnecessarily been restricted, for the limit was supposed to be the limit of the water supply.

From the farmers' standpoint an adequate supply must be protected but it must be noted that if too large a figure per acre is taken then too small a project area will be cared for in an adjudication and the surplus water revert subject to Colorado storage.

As regards the supply coming to Elephant Butte the study was based on a Consumptive Use of irrigation water of 1.25 ac. ft. for the single acre in San Luis Valley while for requirements for the Rio Grande Project lands this was taken at 2.50, which was again used later for the Project. Quite possibly neither figure is large enough which would be a double danger for the lower Rio Grande. Direct study in the San Luis Val. is quite out of the question. When the flood flows start the ditches there, as stated by Hydrographer Jones of the valley, start diverting, too, and continue as long as the flow lasts. The irrigation ranges from zero supply to full supply.

The depletion of the river flow hence is not so much a factor of the area irrigated(supposedly, from statistics) and its requirements but depends much more on the size and duration of the flood flows. In consequence "over-all" studies of the valley must be very deceptive; it is a sponge that takes up water with ease but from which it is very difficult to get it out. It may be noted, however, in passing that Tipton's study for Colorado stated a loss of 1 256 000 ac. ft. for less than 425 000 acs., which would be a loss per acre of about 3.0 ac. ft. He assumed Meeker's figure for Consumptive Use of 0.9 ac. ft. p. ac. so indicated enormous possibilities of recovery by drainage.

On the Rio Grande Project the record of deliveries to the farms (as determined by estimates) has been varying around 2.0 acre ft. p. ac. and would seem to support a Consumptive Use of 2.5, as taken, or something less than this. With an extra long, warm season and year this hardly seems credible though actual heavy rains in July and August may materially help out on use. The Quitman records and special study of Mesilla Valley tend towards 3.0 ft. for irrigation use. The matter is so important that it cannot be neglected.

As against under estimate of supply and use it seems likely there is overemphasis on SALT OR ALKALI DANGER. The reservation of a large factor or supply for washing would again mean area restriction and ultimate loss of the water. The normally porous lands are reclaimed in one season, or even with one leaching in cases. Mr. Strahorn who made the principal soil surveys and alkali examinations saw little difficulty of control and considered that even the San Eleazario heavy soilsrequired only more care and time to reclaim. Mr. Schofield himself has stated in his bulletin- "The Movement of Water in Irrigated Soil" as reprinted by the U.S.Dept. of Agriculture, in regard to salt concentration control, p. 668,- "-----that at least occasionally some water should pass on." In other words, surplus salts are readily washed down, which is borne out by the immediate reclamation effected on the project lands with the provision of drains. The Hudspeth lands deserve study for they are producing with the use of water averaging relatively very high in salt contents.

By treaty the supply to Mexico was supposed to be a delivery of 60 000 ac. ft. per year, to satisfy all claims. There is no American control and measurement at the head of the Acequia Madre provided for by treaty so delivery is exceeding the stipulated amount. Also some 7 ditches are diverting to lower Juarez Vall. to extend irrigation in Mexico still further.This keeps the International situation alive. If additional water is diverted to Mexico then some cooperation can be expected, in case the surplus could be stopped. This is partly so thru the American headings on the river; Mr. L.C. Hill in his High Line Report suggested pumping for drainage, as an additional possibility. Its use in the Hudspeth Dist. and great success in the Salt River Project and the San Joaquin Valley suggests, that if a situation made it desirable here, where crop values are high, that it deserves consideration. The present proposed losses by Ft. Quitman are so large that any chance to lessen them should be considered.

The question of the limits of the Rio Grande Project with respect to the present irrigated areas not included seems open. Will legal or adjudicated rights to storage water run only to "Project Lands" or can storage also be held for lands served under the Warren Act? Presumably the greater the lands included in the "Project" the greater the demand can be for stream discharge to be claimed for the reservoir.

The last point that will be mentioned at the present time is that of the character of any proposed storage in Colorado. The present proposal from there is that Vega Sylvestre should be permitted, a site capable of holding about 230 000 ac. ft. It has also been proposed that Colorado should "guarantee" 600 000 ac. ft. on the average to pass State Line. The question is what guarantee can be given? If the Vega site is used there will be sufficient only for current Colorado needs; drain flows are still hypothetical and prospects of future development exceedingly poor. The logic of the situation would seem to be that if any storage at all is permitted it is flood storage that should be demanded in a volume to prevent spill from Elephant Butte and operated under a stipulated decree similar to the Tahoe decree in California for the Newlands Project. This would produce a tangible form of guarantee. The only feasible site is presumably Wagon Wheel Gap, the expense of which has been considered too great.

Tipton's Colorado figures are as follows; the cost per ac. ft. being estimated on the dependable supply furnished 8 years out of ten, or shortages in 1 of 5.

Capacity Ac. Ft.	Site	Ht. Ft.		Cost	Dependable Supply Per Ac. Ft.
238 000	Vega Sylvester	128	E.&R.F	$2 700 000	$16.35
400 000	Wagon Wh.Gap	250	Masy.	$7 600 000	$36.20
650 000	"	300	"	$10 000 000	40.00
988 000	"			$13 000 000	48.40.

It is to be noted that Colorado proposes to stand a shortage 1 year in 5 as against an apparent possibility for the Rio Grande Project of 1 indicated in perhaps 25 or 35 years, possibly, and will so try to strengthen her position.

THe Wagon Wheel Gap site seems to have an average discharge of nearly 600 000 ac. ft. as against only 380 000 for the Vega Sylvester. The costs are large but something of tangible value would be created whereas other possibilities offer hardly more than increased difficulties. As actual flood control would be a feature it seems possible that a number of sources could be turned to for the cost; one of the largest items is for removal of the D.& R.G.W. R.R. track. As this line has prominently identified itself with development of the San Luis Valley in the controversy it might well shoulder some burden. If the State governments (and even Mexico) came in then an apportionment of costs might bring such a plan within the possibility of consideration.

12. CONCLUSIONS. The investigations here have brought such a diversity of problems to the front that I feel a conference would be highly desirable to clear up some of the questions. This is needed, not only to carry a report forward to best adavantage, but also to settle upon a policy or line of action that would best safeguard the interests of the many sections looking to the Rio Grande for their welfare.

I hope that this may meet with your approval and action.

Very truly yours

E. P. Osgood

E. P. Osgood, Engineer
For Texas and New Mexico.

OSE/LF-00017175

November 26, 1937

MEMO to Mr. Clayton:
In re Meeting of Committee of Engineers, at Santa Fé, November 22 to 24, 1937:-

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The meeting was attended by Debler, representing the United States; Tipton, representing Colorado; Bliss, representing New Mexico; and Hill, representing Texas.

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On the first day Neuffer came in but Debler requested that he not sit in on the conference, as, in Debler's opinion, it would be better for only the four of us to talk matters over. Neuffer was promised, however, that before any tentative schedule was worked out, it would be discussed with him as the representative of the Conservancy District.

Colorado's Position

Early in the proceedings, Tipton stated Colorado's position. This, briefly, is as follows:

a. Colorado can not consider anything less than present requirements, which means that depletion in the future will be at least as great as during the past few years.

b. The people in the San Luis valley are strongly opposed to any state line schedule that will restrict their use of water prior to the time that storage is provided.

c. Even after storage is provided, they do not want any schedule that will give more water in dry years than actually did pass the state line.

The above restrictions, if adhered to by Colorado, mean that no effective compact can be entered into which will be restrictive upon the use of water by Colorado. However, the State authorities - Hinderlider, Stone, and Tipton, apparently want a compact, and will try to have some reasonable schedule accepted.

As a basis for negotiations, Tipton worked out a tentative schedule of deliveries at the state line which could have been satisfied under natural conditions during the past eight or nine years. He said he would present this to the people in the San Luis valley, and try and persuade them to be bound by such a schedule. The rest of us did not accept this proposal of Tipton's, but stated that some such schedule might be acceptable.

Colorado also presented its usual claim for credits in the amount of any water salvaged from Mexico by restrictive diversion.

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New Mexico's Position

The point of view of New Mexico, as nearly as I could judge from the statements Bliss made, is one of willingness to continue deliveries into Elephant Butte reservoir, to the extent that water actually entered the reservoir in past years. They are, however, very fearful of any fixed schedule, on account of uncertainty of physical conditions, particularly as to the amount of tributary inflow between Ottiwi and San Marcial. If some formula can be developed that will protect them against under-deliveries through causes beyond their control, I believe that they will accept a schedule of deliveries corresponding to actual inflow in past years.

In brief, they are afraid to commit themselves, but are not unreasonable in their demands.

The matter of extra deliveries on account of increased salinity was discussed at length with Bliss, after the others had left for Denver, Wednesday afternoon. Bliss recognizes the validity of our position but does not know how to measure the effect upon the water supply produced by any irrigation development above Elephant Butte. I believe, however, that if allowance is made for change in quality at Lovatos and use-averages over a reasonable period of years, rather than for individual years, are used, Bliss will recommend that some allowance be made for change in quality of water.

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Texas' Position

Both Tipton and Bliss, and, to some extent, also, Debler, cross examined me severely on the 800,000-acre-feet requirement. I showed them by different methods of calculation that this amount would be needed for equivalent service to lands below El Paso, in the Rio Grande project, or to maintain a salt balance in the El Paso area. In fact, it worked out about the same either way. If the salt balance is maintained, then equivalent service is given, and vice versa.

Unfortunately, the project, with 1,500,000 acre feet in storage and more acres in crop than in any year, or in several years, the relase from Elephant Butte has been only about 730,000 acre feet, and will be less than 750,000 acre feet for the entire year 1937. This desire to save water in one year, when there was every reason for using larger amounts, has made and will make it very difficult to substantiate the 800,000 acre feet requirement, especially as we can look to some reduction in diversion, particularly on that to Mexico.

The economy in use this year may cost the project 50,000 acre feet annually hereafter.

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General Comments

The progress made was less than I had hoped for, but, nevertheless, favorable to final successful negotiations. I believe that Colorado will accept something that will prevent further encroachment or, at least, make such encroachment more difficult. And I believe that New Mexico has every intention of working out a fair division. They of course are entirely confident that the Middle Rio Grande operations have increased our water supply, and that it will further increase it, with the result that they are willing to concede continued deliveries into Elephant Butte of amounts equal to those received in the past.

The only other matter of importance was the question of transmountain diversions. Debler is wholly convinced that no permanent solution can be reached unless new water is brought into the Rio Grande basin. Of course if this is done and the supply is used largely on existing lands, the situation will be corrected automatically. I stressed the principle that any new water coming from outside sources should belong to the State which paid for the construction, to the extent that payment was actually made, but that any water brought in at the expense of the federal government should be divided equally among the States. Tipton "screamed like a fox" at any suggestion that we should derive any benefit but did not dispute the equity of the provision, restricting himself to the ground that we have no use for the water. To this I countered with the statement that there is quite a little land in Texas and that the State could use beneficially any amount of water that might be so developed.

The next meeting has been tentatively set for December

13 but I do not know whether it will be at Santa Fé or elsewhere. Debler will be on the Coast the preceding week and would like to have it out there, and I said I would prefer it there and if not there, then in El Paso.

Sincerely,

RAYMOND A HILL

RAH:ESC
dictated but not signed