

BW - 26

**PERMITS,
RENEWALS,
& MODS**

CLOSED



NEW MEXICO ENERGY, MINERALS
& NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION
2040 South Pacheco Street
Santa Fe, New Mexico 87505
(505) 827-7131

May 16, 2000

CERTIFIED MAIL
RETURN RECEIPT NO. 5051 5819

Leavell Insurance & Real Estate
Drawer D
Jal, New Mexico 88252

Re: \$5000.00 One-Well Plugging Bond No. 4382
William H. Brininstool dba Salado
Brine Sales, Principal
Underwriters Indemnity Co., Surety
Salado Brine Well #3 -125 FNL and 132 FEL of Section 32,
Ts23s-R33e, Lea County, New Mexico

Attention: Leavell Insurance & Real Estate

The New Mexico Oil Conservation Division hereby approves the cancellation of the above referenced \$5,000 One-Well Plugging Bond No. 4382 and releases Underwriters Indemnity Co., Surety of any liability.

Sincerely,

Lyn Hebert
Legal Counsel

LH/wp

cc: Underwriters Indemnity Co.
William H. Brininstool dba Salado Brine Sales
Dorothy Phillips-OCD Santa Fe

May 3, 2000

Brine Well Bond Status:

Bond # 4078 Quality Oil Service for Salado Well#2 NE/4 NE/4 Sec 20-Ts25s-R37e cannot be released until Chaparral Services provides a rider on bond RLB 0001564 correcting the legal location. Once this is complete then OCD-Hobbs will approve C-104 change of ownership for the well and OCD-Santa Fe will release Bond #4078.

Also OCD does not have a C-104 change of ownership from Brininstool to Quality Oil.

Bond #4382 William H. Brininstool DBA Salado Brine Sales for Salado Brine Well #3 125 FNL 132 FEL Sec 32-Ts23s-R33e Lea Co. NM. DP#BW-26. This well was never drilled DP has Been cancelled waiting on Chris Brininstool to request cancellation.



STATE OF NEW MEXICO

ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION

November 17, 1993



BRUCE KING
GOVERNOR

ANITA LOCKWOOD
CABINET SECRETARY

POST OFFICE BOX 2088
STATE LAND OFFICE BUILDING
SANTA FE, NEW MEXICO 87504
(505) 827-5800

Leavell Insurance & Real Estate
Drawer D
Jal, New Mexico 88252

Re: \$5,000 One-Well Plugging Bond
William H. Brininstool dba Salado
Brine Sales, Principal
Underwriters Indemnity Co., Surety
125' FNL and 132' FEL of Sec. 32,
T-23-S, R-33-E, Lea County
Bond No. BO 4382

Gentlemen:

The Oil Conservation Division hereby approves the above-referenced plugging bond effective this date.

Sincerely,

WILLIAM J. LEMAY,
Director

dr/

cc: Oil Conservation Division
Hobbs, New Mexico

William H. Brininstool dba Salado Brine Sales
P. O. Drawer A
Jal, New Mexico 88252



NEW MEXICO ENERGY, MINERALS
& NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION
2040 South Pacheco Street
Santa Fe, New Mexico 87505
(505) 827-7131

January 19, 2000

CERTIFIED MAIL
RETURN RECEIPT NO. Z 142 564 927

Mr. William H. Brininstool
Salado Brine Sales
P.O. Drawer A
Jal, New Mexico 88252

Re: Discharge Plan BW-026
Salado Brine Sales Well No. 3
NE/4 NE/4 Section 32, Ts 23 S-R33 E
Lea County, New Mexico

The New Mexico Oil Conservation Division (NMOCD) is in receipt of Salado Brine Sales letter dated October 06, 1999 requesting terminating the discharge plan for the above captioned site. Salado Brine Sales has elected not to drill the well and no equipment has been placed on site.

On December 21, 1999 the NMOCD inspected the site and hereby approves closure of the site and termination of the discharge plan.

If you have any questions, please contact Wayne Price of my staff at (505-827-7155). On behalf of the staff of the OCD, I wish to thank you and your staff for your cooperation during this discharge plan review.

Sincerely,

A handwritten signature in black ink, appearing to read "Roger C. Anderson".

Roger C. Anderson
Environmental Bureau Chief
RCA/lwp

xc: OCD Hobbs Office
NMSLO-Santa Fe



PREMIUM PROCESSING PLUS

DECEMBER 1999

William & Chris Brinninstool
Proposed
Brine Well #26
pictures taken by E.L. Gonzales
December 1999 North



PREMIUM PROCESSING PLUS

DECEMBER 1999

William &

Chris Brinninstool
Proposed

Brine Well #26

pictures taken by E.L. Gonzales

December 1999

North East



PREMIUM PROCESSING PLUS

DECEMBER 1999

William & Chris Brinninstool
Proposed

Brine Well #26

pictures taken by E.L. Gonzales

December 1999

Southwest



PREMIUM PROCESSING PLUS

DECEMBER 1999

William & Chris Brinninstool
Proposed
Brine Well #26
pictures taken by E.L. Gonzales
December 1999 EAST



PREMIUM PROCESSING PLUS

DECEMBER 1999

William & Chris Brinninstool
Proposed
Brine Well #26
pictures taken by E.L. Gonzales
December 1999 South

Oil Conservation Division
1625 N. French Dr.
Hobbs, NM 88240

Memo

To: Wayne Price
From: Donna Williams
Date: 12/21/99
Re: William & Chris Brinninstool Brine Well # 26

Wayne,

Here are some pictures taken by E.L. from every direction in the location the Brine Well should have been. The information is on the back of the pictures and I have placed a copy of the pictures as well in the file here in Hobbs. If anything else is needed let me know.

Thank you,

A handwritten signature in cursive script, appearing to read "Donna", enclosed within a hand-drawn oval.

Donna Williams

Environmental Engineer Specialist



NEW MEXICO ENERGY, MINERALS
& NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION
2040 South Pacheco Street
Santa Fe, New Mexico 87505
(505) 827-7131

Price, Wayne

From: Price, Wayne
Sent: Wednesday, November 24, 1999 3:32 PM
To: Williams, Donna
Subject: Brininstool Brine Well BW-26

Donna:

Chris Brininstool has requested we terminate DP-26. According to them this well was never drilled. Would you give them a call at 505-225-2870 and arrange for a closing site inspection. Make field notes and take a couple of pictures!

After I receive your report we will issue closure if everything is OK!

William H. Brininstool
P. O. Drawer A
Jal, NM 88252
505-225-2870

October 6, 1999

Oil Conservation Division
2040 South Pacheco Street
Santa Fe, New Mexico 87505

Attn: Roger Anderson
Wayne Price


Dear Roger and Wayne:

After our phone conversation, concerning the proposed brine well out here at the ranch, Bill decided to go ahead and cancel the lease with the state land office.

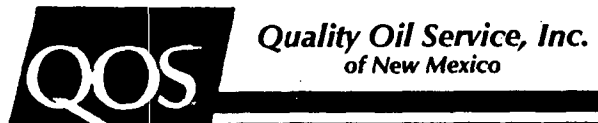
Please cancel the discharge plan BW-26. I am sending a letter to the Commissioner of Public Lands requesting them to terminate lease number MS-0001.

Be sure to call a few days before you do your inspection at the ranch. (I will have something ready for lunch).

Cordially,

A handwritten signature in black ink, appearing to read "Chris Brininstool". The signature is fluid and cursive, with the first name "Chris" being more prominent and the last name "Brininstool" written in a continuous script.

Chris Brininstool



May 27, 1999

Oil Conservation Division
2040 South Pacheco Street
Santa Fe, NM 87505

COPY

Attn: Roger Anderson and Wayne Price

Dear Roger and Wayne:

Thanks for your help yesterday.

I am sending you bond B4078 for the active brine station in Jal. This brine station is under discharge plane BW-25, well #2. Bond B4078 has been changed from William H. Brininstool dba Salado Brine Sales to Quality Oil Service, Inc.

The only other active bond you should have is B4382, William H. Brininstool for well #3, discharge plane BW-26. The location for this well is at Bill's ranch. I do not know if Bill will drill well or if he will cancel permit.

Don't forget to send letter releasing the other bond you have for the first brine well that Bill owned. (Well was 4 miles East of Jal and had the plastic lined pit.)

Cordially,

A handwritten signature in cursive script that reads "Christine Brininstool".

Christine Brininstool
General Manager

HOME - 505-225-2026
225-2870

ACKNOWLEDGEMENT OF RECEIPT
OF CHECK/CASH

I hereby acknowledge receipt of check No. dated 9/6/95,
or cash received on 9/11/95 in the amount of \$ 1430.00
from William H Brinnstool
for Salado Brine Well #3 BW-026
(Facility Name) (DP No.)

Submitted by: Date:

Submitted to ASD by: Roger Anderson Date: 9/13/95

Received in ASD by: Angela Date: 9/13/95

Filing Fee ☒ New Facility ☒ Renewal ☒

Modification Other
(specify)

Organization Code 521.07 Applicable FY 96

To be deposited in the Water Quality Management Fund.

Full Payment ☒ or Annual Increment

WILLIAM H. BRINNSTOOL
DRAWER
BALFNM-88262
88-2207/1123
Sept 6 1995
N100140 Water Quality Management \$1,430.00
One thousand four hundred thirty dollars and 00/100
Kernit State Bank
BW-026
William H Brinnstool

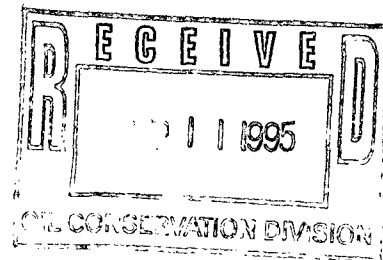
OIL CONSERVATION DIVISION

August 30, 1995

CERTIFIED MAIL**RETURN RECEIPT NO. Z-765-962-764**

Mr. William H. Brininstool
Salado Brine Sales
P.O. Drawer A
Jal, New Mexico 88252

**RE: Discharge Plan Fees BW-026
Salado Brine Sales Well No. 3
Lea County, New Mexico**




Dear Mr. Brininstool:

On January 12, 1994, Salado Brine Sales received, via certified mail, a letter from the New Mexico Oil Conservation Division (OCD) stating that the discharge plan BW-026 for Well No. 3, located in the NE4 NE4 of Section 32, Township 23 South, Range 33 East, NMPPM, Lea County, New Mexico was approved. In that letter it was also stated that, in accordance with Water Quality Control Commission Regulation 3-114.B.6, a \$50 filing fee and a \$1,380 flat fee were required upon receipt of the approval letter. As of this date, the OCD has not received either of the required fees. Please submit both fees by September 14, 1995.

Please make all checks payable to: **NMED-Water Quality Management** and addressed to the OCD Santa Fe Office.

If you have any questions regarding this matter, please contact me at (505) 827-7152.

Sincerely,


Roger Anderson
Environmental Bureau Chief

xc: Jerry Sexton, OCD Hobbs Office
Wayne Price, OCD Hobbs Office



STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION DIVISION



BRUCE KING
GOVERNOR

ANITA LOCKWOOD
CABINET SECRETARY

POST OFFICE BOX 2088
STATE LAND OFFICE BUILDING
SANTA FE, NEW MEXICO 87504
(505) 827-5800

January 12, 1994

CERTIFIED MAIL
RETURN RECEIPT NO. P-111-334-068

Mr. William H. Brininstool
Salado Brine Sales
P.O. Drawer A
Jal, New Mexico 88252

RE: **APPROVAL OF DISCHARGE PLAN BW-26**
SALADO BRINE SALES WELL NO. 3
LEA COUNTY, NEW MEXICO

Dear Mr. Brininstool:

The **discharge plan BW-26** for the Salado Brine Sales No. 2 Brine Station located in the NE/4 NE/4, Section 32, Township 23 South, Range 33 East, NMPM, Lea County, New Mexico, is **hereby approved** under the conditions contained in the enclosed attachment. The approved discharge plan consists of the discharge plan dated November 11, 1993.

The discharge plan renewal was submitted pursuant to Section 5-101.B.3 of the New Mexico Water Quality Control Commission (WQCC) Regulations. It is approved pursuant to Sections 5-101.A and 3-109.C. Please note Sections 3-109.E and 3-109.F which provide for possible future amendments or modifications of the plan.

Please be advised that the approval of this plan does not relieve you of liability should your operation result in actual pollution of surface water, ground water, or the environment which may be actionable under other laws and/or regulations. In addition, the OCD approval does not relieve you of liability for compliance with any other laws and/or regulations.

The monitoring and reporting shall be as specified in the above referenced materials. Please note that Section 3-104 of the regulations requires that "When a plan has been approved, discharges must be consistent with the terms and conditions of the plan." Pursuant to Section

Mr. William Brininstool

January 12, 1994

Page 2

3-107.C you are required to notify the Director of any facility expansion, production increase, or process modification that would result in any change in the discharge of water quality or volume.

Pursuant to Section 3-109.G.4, this plan is for a period of five (5) years. This approval will expire January 12, 1999, and you should submit an application for renewal in ample time before this date. Note that under Section 5-101.G of the regulations, if a discharger submits a discharge plan renewal application at least 180 days before the discharge plan expires and is in compliance with the approved plan, then the existing discharge plan will not expire until the application for renewal has been approved or disapproved.

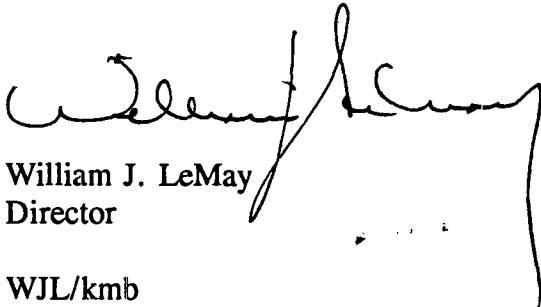
The discharge plan application for the Salado Brine Sales No. 3 Brine Facility is subject to the WQCC Regulation 3-114 discharge plan fee. Every billable facility submitting a discharge plan will be assessed a fee equal to the filing fee of fifty (50) dollars plus the flat fee of one-thousand, three-hundred and eighty (1380) dollars for brine extraction facilities.

The OCD has not received your \$50 filing fee or \$1380 flat fee (total fee \$1430). The filing fee is due upon receipt of this letter. The flat fee for an approved discharge plan may be paid in a single payment due at the time of approval, or in equal annual installments over the duration of the discharge plan, with the first payment due upon receipt of this approval.

Please make all checks out to: **NMED - Water Quality Management** and addressed to the OCD Santa Fe Office.

On behalf of the staff of the Oil Conservation Division, I wish to thank you and your staff for your cooperation during this discharge plan review.

Sincerely,



William J. LeMay
Director

WJL/kmb

Attachment

xc: Jerry Sexton, OCD Hobbs Office

**ATTACHMENT TO DISCHARGE PLAN BW-26 APPROVAL
SALADO BRINE SALES NO. 3 BRINE FACILITY
DISCHARGE PLAN REQUIREMENTS
(January 12, 1994)**

1. Well Drilling & Construction: Upon completion of the brine well all drilling, log evaluation and completion information will be submitted to the OCD. This will include casing depths, cement volumes, casing integrity tests, formation descriptions and depths, and the depth and quality of all groundwater encountered while drilling.
2. Brine Transfer Lines: All below-grade brine transfer lines will be tested for integrity once every five years with the first test conducted prior to the discharge plan renewal (January 12, 1999). Prior to conducting the integrity test the OCD will be notified of the exact method and date.
3. Sump Construction: All sumps and below-grade tanks will be approved by the OCD prior to installation and will incorporate secondary synthetic containment and leak detection in their designs. All leak detection systems will be inspected weekly and the OCD Santa Fe Office will be notified immediately upon discovery of fluids in any leak detection system.
4. Drum Storage: All drums will be stored on pad and curb type containment.
5. Tank Berming: All tanks that contain materials other than fresh water will be bermed to contain one and one-third times the capacity of the tank.
6. Spill Containment: All brine storage and transfer will be managed in such a manner to keep brine off of the ground surface. Any brine spilled onto the ground surface will be cleaned-up upon discovery.
7. Spill Reporting: All spills and/or leaks will be reported to the OCD Hobbs District Office pursuant to WQCC Rule 1-203 and OCD Rule 116.
8. Production Method: Fresh water will be injected down the annulus and brine will be recovered up the tubing. Reverse flow will be allowed once a month for a maximum of 24 hours for clean out.
9. Maximum Injection Pressure: The maximum operating injection pressure at the well head will be such that the fracture pressure of the injection formation (Salado) will not be exceeded.
10. Mechanical Integrity Testing: A mechanical integrity test will be conducted on the well annually. A pressure equal to one and one-half of the normal operating pressure will be maintained for four hours. The OCD will be notified prior to the test so that they may witness the test.

11. Production/Injection Volumes: The volumes of fluids injected (fresh water) and produced (brine) will be recorded monthly and submitted to the OCD Santa Fe Office quarterly.
12. Well Workovers Operations: OCD approval will be obtained prior to performing remedial work or any other workover. Approval will be requested at the OCD Hobbs District Office on OCD Form C-103 "Sundry Notices and Reports on Wells" (OCD Rule 1103-A).
13. Closure: The OCD will be notified when operations of the facility is discontinued for a period in excess of six months. Prior to closure of the facility a closure plan will be submitted for OCD approval. Closure and waste disposal will be in accordance with the statutes, rules and regulations in effect at the time of closure.

OIL CONSERVATION DIVISION

August 30, 1995

CERTIFIED MAIL**RETURN RECEIPT NO. Z-765-962-764**

Mr. William H. Brininstool
 Salado Brine Sales
 P.O. Drawer A
 Jal, New Mexico 88252

RE: Discharge Plan Fees BW-026
Salado Brine Sales Well No. 3
Lea County, New Mexico

Dear Mr. Brininstool:

On January 12, 1994, Salado Brine Sales received, via certified mail, a letter from the New Mexico Oil Conservation Division (OCD) stating that the discharge plan BW-026 for Well No. 3, located in the NE4 NE4 of Section 32, Township 23 South, Range 33 East, NMPM, Lea County, New Mexico was approved. In that letter it was also stated that, in accordance with Water Quality Control Commission Regulation 3-114.B.6, a \$50 filing fee and a \$1,380 flat fee were required upon receipt of the approval letter. As of this date, the OCD has not received either of the required fees. Please submit both fees by September 14, 1995.

Please make all checks payable to: **NMED-Water Quality Management** and addressed to the OCD Santa Fe Office.

If you have any questions regarding this matter, please contact me at (505) 827-7152.

Sincerely,


 Roger Anderson
 Environmental Bureau Chief

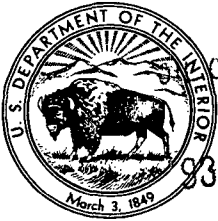
xc: Jerry Sexton, OCD Hobbs Office
 Wayne Price, OCD Hobbs Office

PS Form 3800, March 1993

Sent to	
Street and No.	
P.O., State and ZIP Code	
Postage	\$
Certified Fee	
Special Delivery Fee	
Restricted Delivery Fee	
Return Receipt Showing to Whom & Date Delivered	
Return Receipt Showing to Whom, Date, and Addressee's Address	
TOTAL Postage & Fees	\$
Postmark or Date	


Receipt for Certified Mail
 No Insurance Coverage Provided
 Do not use for International Mail
 (See Reverse)

Z 765 962 764



CONSERVATION DIVISION
RECEIVED

93 DEC 30 AM 9 27

**UNITED STATES
DEPARTMENT OF THE INTERIOR**

FISH AND WILDLIFE SERVICE

Ecological Services

Suite D, 3530 Pan American Highway, NE
Albuquerque, New Mexico 87107

December 28, 1993

Permit #GW94012

William J. LeMay, Director
New Mexico Energy, Minerals, and
Natural Resources Department
Oil Conservation Division
P.O. Box 2088
Santa Fe, New Mexico 87504-2088

Dear Mr. LeMay:

This responds to the notices of publication received by the U.S. Fish and Wildlife Service (Service) on December 1 and 7, 1993, regarding the Oil Conservation Division discharge plan applications Numbers BW-26 and GW-160, on fish, shellfish, and wildlife resources in New Mexico.

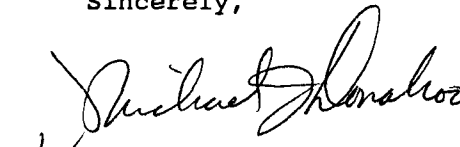
The Service has determined there are no wetlands or other environmentally sensitive habitats, plants, or animals that will be adversely affected by the following discharges:

BW-26 Salado Brine Sales has submitted a discharge plan application for their proposed insitu extraction brine well facility to be located in NE/4 NE/4 section 32, T. 23 S., R. 33 E., Lea County, New Mexico.

GW-160 Llano Inc., has submitted a discharge plan application for their Bright Federal Compressor Station located in the NE/4 NW/4 section 21, T. 19 S., R. 33 E., Lea County, New Mexico.

If you have any questions concerning our comments, please contact Joy Winckel or Mary Orms at (505) 883-7877.

Sincerely,


for Jennifer Fowler-Propst
State Supervisor

cc:

Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico
Regional Administrator, U.S. Environmental Protection Agency, Dallas, Texas

Affidavit of Publication

STATE OF NEW MEXICO)
) ss.
COUNTY OF LEA)

Joyce Clemens being first duly sworn on oath deposes and says that he is **Adv. Director** of THE LOVINGTON DAILY LEADER, a daily newspaper of general paid circulation published in the English language at Lovington, Lea County, New Mexico; that said newspaper has been so published in such county continuously and uninterruptedly for a period in excess of Twenty-six (26) consecutive weeks next prior to the first publication of the notice hereto attached as hereinafter shown; and that said newspaper is in all things duly qualified to publish legal notices within the meaning of Chapter 167 of the 1937 Session Laws of the State of New Mexico.

That the notice which is hereto attached, entitled

Notice Of Publication

~~and numbered~~ ~~XXXXXX~~

~~XXXXXX~~

~~XXXXXX~~ was published in a regular and entire issue of THE LOVINGTON DAILY LEADER and not in any supplement thereof, ~~XXXXXX~~

~~XXXXXX~~ for one (1) day

~~XXXXXX~~ beginning with the issue of

December 3, 1993

and ending with the issue of

December 3, 1993

And that the cost of publishing said notice is the

sum of \$40.68

which sum has been (Paid) ~~(Assessed)~~ as Court Costs

Joyce Clemens

Subscribed and sworn to before me this 15th day of December, 1993

Mrs. Jean Serier
Notary Public, Lea County, New Mexico

My Commission Expires Sept. 28, 1994

LEGAL NOTICE NOTICE OF PUBLICATION STATE OF NEW MEXICO ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT OIL CONSERVATION DIVISION

Notice is hereby given that pursuant to New Mexico Water Quality Control Commission Regulations, the following discharge plan application has been submitted to the Director of the Oil Conservation Division, State Land Office Building, P.O. Box 2088, Santa Fe, New Mexico 87504-2088, Telephone (505)827-5800: (BW-26)-Salado Brine Sales, William H. Brininstool, P.O. Drawer A, Jal, New Mexico, 88252, has submitted a discharge plan application for their proposed insitu extraction brine well facility to be located in the NE/4 NE/4, Section 32, Township 23 South, Range 33 East, NMPM, Lea County, New Mexico. Proposed operations are for fresh water from three commercial wells owned by the W.H. Brininstool to be injected into the Salado Formation at an approximate depth of 1500 feet and brine to be extracted through tubing. The brine will have an average total dissolved solids (TDS) concentration of approximately 350,000 mg/l and be stored in four 1000 barrel above ground tanks. Groundwater most likely to be affected by an accidental discharge is at a depth of approximately 500 feet with a TDS of 950mg/l. The discharge plan addresses injection well construction and operation, and how spills, leaks, and other accidental discharges to the surface will be managed.

Any interested person may obtain further information from the Oil Conservation Division and may submit written comments to the Director of the Oil Conservation Division at the address given above. The discharge plan application may be viewed at the above address between 8:00 a.m. and 5:00 p.m., Monday through Friday. Prior to ruling on any proposed discharge plan or its modification, the director of the Oil Conservation Division shall allow at least thirty (30) days after the date of publication of this notice during which comments may be submitted to him and public hearing may be requested by any interested person. Requests for public hearing shall set forth the reasons why a hearing should be held. A hearing will be held if the Director determines there is significant public interest.

If no public hearing is held, the Director will approve or disapprove the proposed plan based on information available. If a public hearing is held, the director will approve or disapprove the proposed plan based on information in the plan and information submitted at the hearing.

GIVEN under the Seal of New Mexico Oil Conservation Commission at Santa Fe, New Mexico, on this 29th day of November, 1993.

STATE OF
NEW MEXICO
OIL CONSERVATION
DIVISION
WILLIAM J. LEMAY,
Director

SEAL

Published in the Lovington Daily Leader December 3, 1993.

NOTICE OF PUBLICATION

**STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION DIVISION**

Notice is hereby given that pursuant to New Mexico Water Quality Control Commission Regulations, the following discharge plan application has been submitted to the Director of the Oil Conservation Division, State Land Office Building, P.O. Box 2088, Santa Fe, New Mexico 87504-2088, Telephone (505) 827-5800:

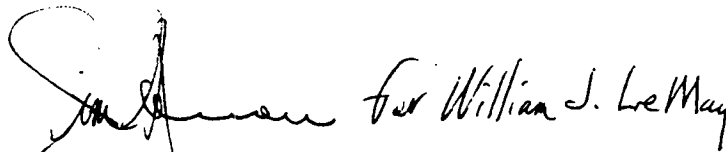
(BW-26) - Salado Brine Sales, William H. Brininstool, P.O. Drawer A, Jal, New Mexico, 88252, has submitted a discharge plan application for their proposed insitu extraction brine well facility to be located in the NE/4 NE/4, Section 32, Township 23 South, Range 33 East, NMPM, Lea County, New Mexico. Proposed operations are for fresh water from three commercial wells owned by the W.H. Brininstool to be injected into the Salado Formation at an approximate depth of 1500 feet and brine to be extracted through tubing. The brine will have an average total dissolved solids (TDS) concentration of approximately 350,000 mg/l and be stored in four 1000 barrel above ground tanks. Groundwater most likely to be affected by an accidental discharge is at a depth of approximately 500 feet with a TDS of 950 mg/l. The discharge plan addresses injection well construction and operation, and how spills, leaks, and other accidental discharges to the surface will be managed.

Any interested person may obtain further information from the Oil Conservation Division and may submit written comments to the Director of the Oil Conservation Division at the address given above. The discharge plan application may be viewed at the above address between 8:00 a.m. and 5:00 p.m., Monday through Friday. Prior to ruling on any proposed discharge plan or its modification, the Director of the Oil Conservation Division shall allow at least thirty (30) days after the date of publication of this notice during which comments may be submitted to him and public hearing may be requested by any interested person. Requests for public hearing shall set forth the reasons why a hearing should be held. A hearing will be held if the Director determines there is significant public interest.

If no public hearing is held, the Director will approve or disapprove the proposed plan based on information available. If a public hearing is held, the director will approve or disapprove the proposed plan based on information in the plan and information submitted at the hearing.

GIVEN under the Seal of New Mexico Oil Conservation Commission at Santa Fe, New Mexico, on this 29th day of November, 1993.

**STATE OF NEW MEXICO
OIL CONSERVATION DIVISION**

A handwritten signature in dark ink, appearing to read "William J. Lemay", is written over a horizontal line.

WILLIAM J. LEMAY, Director

S E A L

State of New Mexico
Energy, Minerals and Natural Resources Department
OIL CONSERVATION DIVISION
P.O. Box 2088
Santa Fe, NM 87501

OIL CONSERVATION DIVISION
RECEIVED
NOV 9 1993

DISCHARGE PLAN APPLICATION FOR BRINE EXTRACTION FACILITIES
(Refer to OCD Guidelines for assistance in completing the application.)

☒ NEW ☐ RENEWAL

- I. FACILITY NAME: Salado Brine Sales
- II. OPERATOR: William H. Brininstool
ADDRESS: P. O. Drawer A, Jal, NM 88252
CONTACT PERSON: Chris Brininstool PHONE: 505-395-2010
- III. LOCATION: NE /4 NE/4 Section 32 Township 23S Range 33E
Submit large scale topographic map showing exact location.
- IV. Attach the name and address of the landowner of the facility site.
- V. Attach a description of the types and quantities of fluids at the facility.
- VI. Attach a description of all fluid transfer and storage and fluid and solid disposal facilities.
- VII. Attach a description of underground facilities (i.e. brine extraction well).
- VIII. Attach a contingency plan for reporting and clean-up of spills or releases.
- IX. Attach geological/hydrological evidence demonstrating that brine extraction operations will not adversely impact fresh water.
- X. Attach such other information as is necessary to demonstrate compliance with any other OCD rules, regulations and/or orders.
- XI. CERTIFICATION

I hereby certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

Name: William H. Brininstool Title: Owner

Signature: W H Brininstool Date: 11-11-93

SALADO BRINE SALES

P. O. Drawer A
Jal, New Mexico 88252
505-395-2010

I, William H. Brininstool, attest that Christine Brininstool is duly authorized to represent Salado Brine Sales.

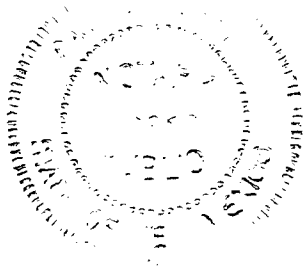
William H. Brininstool
William H. Brininstool

Signed before me the 11th day of Nov

Pam Druggers
Notary Public
State of New Mexico

MY COMMISSION EXPIRES 1/2/04

My Commission expires: _____



SALADO BRINE SALES

P. O. Drawer A
Jal, New Mexico 88252
505-395-2010

November 11, 1993

State of New Mexico
Energy, Minerals and Natural Resources Department
Oil Conservation Division
P. O. Box 2088
Santa Fe, NM 87501

Attention: Kathy Brown

Re: Discharge plan Application for Brine Extraction

Dear Kathy:

William H. Brininstool dba Salado Brine Sales, P. O. Drawer A, Jal, New Mexico 88252, is proposing to drill a new brine well, well #3, in the NE/4 of the NE/4 of Section 32, Township 23 South, Range 33 East, NMPM, Lea County, New Mexico. I am submitting this letter and a copy of the application for permit to drill so you can start processing application for approval and put notice of application in newspapers to determine if anyone protests application. Proposed well #3 will be drilled on land owned by the State of New Mexico and the State of New Mexico also owns the salt minerals. Mr. Brininstool at present has surface leased as part of his ranching operation.

Mr. Brininstool is the operator of Salado Brine Sales located in SE/4, Section 14, Township 25 South, Range 37 East, NMPM, Lea County, New Mexico, Discharge Plan DP-320. Due to a lost circulation Mr. Brininstool drilled a new brine well located in NE/4 of the NE/4 of Section 20, Township 25 South, Range 37 East, NMPM, Lea County, New Mexico, Discharge Plan BW-25.

Proposed brine well #3 will be located between Jal and Carlsbad in an area that is actively drilling new oil and gas wells. Mr. Brininstool believes that a brine station located between Jal and Carlsbad will be beneficial to the oil industry as the closest brine station is approximately a distance of 30 miles.

Proposed well will be drilled to approximately 2300 feet. A 14 3/4" hole will be drilled to a depth of 60' and 12 3/4" conductor casing will be run and cemented to the surface. The 12 3/4"

casing is schedule 20 and weights 28# per foot. A 9 7/8" hole will be drilled into the Salt formation to approximately 1460' and 7" casing will be run and cemented to the surface. The 7" casing is schedule 30 and weights 23# per foot. A 6 1/2" hole will then be drilled to approximately 2300'. Well will have approximately 2300' of 2 7/8" tubing. The 2 7/8" tubing is schedule 40 and weights 10.40# per foot. Cement work will be performed by Halliburton Services. The first stage cement will be approximately 50 sacks Class C cement and the second stage cement will be approximately 500 sacks Class C cement. At this time a casing integrity test will be performed and logs will be run that is required by the Oil Conservation Commission. The topographic map shows the approximate location of the proposed brine facility, and the location of the fresh water wells within a 1/4 mile radius.

A caliche pad will be built that will include the well site, fresh water storage tanks, brine water storage tanks and loading area. The brine facility will contain 2 fresh water storage tanks next to the brine well. Brine storage will consist of 4-1000 bbl tanks. Fresh water source will be from 3 commercial water wells owned by Mr. Brininstool that are located Northeast of the proposed brine well. Fresh water from the commercial water wells will be piped by a 2" polyethylene pipeline positioned 18 inches below ground level to the two fresh water storage tanks. Fresh water will be pumped down the casing into the salt formation forcing saturated brine water to the surface through 2 7/8" tubing, entering a 3 inch polyethylene pipeline buried 1 foot below ground level and travels via this pipeline to the brine storage tanks. Once a month for 24 hours fresh water will be pumped down the tubing and brine return through casing for clean out. Brine tanks will be bermed to contain a volume one-third more than the total volume of the interconnected tanks. If a leak, spill or other unanticipated discharge on the surface or underground occurs, Salado Brine Sales will notify the Oil Conservation Division in Santa Fe or the district office in Hobbs, Lea County within 48 hours.

Salado Brine Sales will notify the Oil Conservation Division prior to commencement of drilling, cementing of casing, well logging, mechanical integrity tests and any well work-over to allow opportunity for on site inspection by the director or his representative.

Salado Brine Sales well #3 will be visually monitored daily by Mr. Brininstool as facility will be located at his ranch house. Quarterly reports will be submitted to the Oil Conservation Commission on fresh water injected underground and brine sold. Quarterly reports of operation, production and sale of salt will be submitted to the New Mexico State Land Office. A meter will be installed at the brine well site showing bbls fresh water injected and drivers will fill out tickets for each load hauled.

The maps showing cross-section, vertical and horizontal limits of all ground water having less than 10,000/1 TDS and generalized and specific maps and cross-sections depicting both regional and site-specific geology please refer to the following report: Ground Water Report #6, Geology and Ground Water Conditions in Southern Lea County, New Mexico, United States Geological Survey, State Bureau of Mines and Mineral Resources, New Mexico Institute of Mining & Technology.

If loss of mechanical integrity in the injection well, Salado Brine Sales will shut down, pull tubing and correct problem. If loss of mechanical integrity can not be corrected facility will be abandoned. Upon abandonment, drill holes will be properly sealed to protect water bearing aquifers in a manner approved by the Oil Conservation Division. Plugging procedure proposed is placing a cast iron bridge plug at bottom of casing with 20 sacks of cement on top of plug. A cement plug at the bottom of the fresh water zone that is approximately 700 feet. The last plug will be a cement plug at the surface. Between all plugs well will be filled with 10# salt gel. Decommissioning of surface facilities would consist of selling surface equipment, ripping of caliche pad and reseeding with BLM formula seed.

Map is enclosed showing proposed location and all surrounding drill holes. No existing oil or gas wells are drill holes are within a 1/4 mile radius.

Stan Piper Surveying of Gardendale, Texas has completed on site surveying and enclosed is the final plate.

After completion of drilling, logging, and casing integrity test all information will be sent to your office. After completion of brine well facility pictures will be made and sent to your office.

An analysis of the brine water will be provided as soon as commencement of production. At the same time maximum and average injection pressures and injection volume will be provided.

Thank you for all the help you have provided. If you need more information please call.

Cordially,

A handwritten signature in cursive script, reading "Christine Brininstool". The signature is written in dark ink and is positioned above the printed name and title.

Christine Brininstool
Office Manager

Submit to Appropriate
District Office
State Lease - 6 copies
Fee Lease - 5 copies

State of New Mexico
Energy, Minerals and Natural Resources Department

Form C-101
Revised 1-1-89

OIL CONSERVATION DIVISION

DISTRICT I
P.O. Box 1980, Hobbs, NM 88240

DISTRICT II
P.O. Drawer DD, Artesia, NM 88210

DISTRICT III
1000 Rio Brazos Rd., Aztec, NM 87410

P.O. Box 2088
Santa Fe, New Mexico 87504-2088

API NO. (assigned by OCD on New Wells)

5. Indicate Type of Lease

STATE ☒

FEE ☐

6. State Oil & Gas Lease No.

APPLICATION FOR PERMIT TO DRILL, DEEPEN, OR PLUG BACK

1a. Type of Work:

DRILL ☒

RE-ENTER ☐

DEEPEN ☐

PLUG BACK ☐

b. Type of Well:

OIL
WELL ☐

GAS
WELL ☒

OTHER Brine Well

SINGLE
ZONE ☐

MULTIPLE
ZONE ☐

2. Name of Operator

William H. Brininstool dba Salado Brine Sales

3. Address of Operator

P. O. Drawer A, Jal, New Mexico 88252

7. Lease Name or Unit Agreement Name

Salado Brine Well #3

8. Well No.

3

9. Pool name or Wildcat

Salado

4. Well Location

Unit Letter

A

125

Feet From The North

Line and

132

Feet From The East

Line

Section

32

Township

23S

Range

33E

NMPM

Lea

County

10. Proposed Depth
2300'

11. Formation
Halite

12. Rotary or C.T.
Rotary

13. Elevations (Show whether DF, RT, GR, etc.)
3665

14. Kind & Status Plug. Bond
1-well

15. Drilling Contractor
West Texas Water Well

16. Approx. Date Work will start
January 1994

17.

PROPOSED CASING AND CEMENT PROGRAM

SIZE OF HOLE	SIZE OF CASING	WEIGHT PER FOOT	SETTING DEPTH	SACKS OF CEMENT	EST. TOP
14 3/4"	12 3/4"	28#	60'	50	Surface
9 7/8"	7"	23#	1460'	500	Surface
6 1/2"	2 7/8" Tubing	10.40#	2300'		

Proposed well will be drilled to approximately 2300". A 14 3/4" hole will be drilled to a depth of 60' and 12 3/4" casing will be run and cemented to the surface. Propose to use 50 sacks Class C cement. A 9 7/8" hole will be drilled to the top of the Salt formation approximately 1460' and 7" casing will be run and cemented to the surface. Propose to use 500 sacks class C cement. A 6 1/2" hole will then be drilled to approximately 2300'. Well will have approximately 2300' of 2 7/8" tubing. Cement work will be performed by Halliburton Services. At this time a casing integrity test will be performed and logs will be run that is required by the Oil Conservation Commission.

IN ABOVE SPACE DESCRIBE PROPOSED PROGRAM: IF PROPOSAL IS TO DEEPEN OR PLUG BACK, GIVE DATA ON PRESENT PRODUCTIVE ZONE AND PROPOSED NEW PRODUCTIVE ZONE. GIVE BLOWOUT PREVENTER PROGRAM, IF ANY.

I hereby certify that the information above is true and complete to the best of my knowledge and belief.

SIGNATURE William H. Brininstool TITLE Owner DATE 11-11-93

TYPE OR PRINT NAME William H. Brininstool TELEPHONE NO. 505-395-2010

(This space for State Use)

APPROVED BY _____ TITLE _____ DATE _____

CONDITIONS OF APPROVAL, IF ANY:

NOTICE OF PUBLICATION
STATE OF NEW MEXICO
ENERGY, MINERALS & NATURAL
RESOURCES DEPARTMENT
OIL CONSERVATION DIVISION
Notice is hereby given that pursuant
to New Mexico Water Quality Control
Commission Regulations, the follow-
ing discharge plan application has
been submitted to the Director of the
Oil Conservation Division, State Land
Office Building, P.O. Box 2088, Santa
Fe, New Mexico 87504-2088, Tele-
phone (505) 827-5800:
(BW-28) - Salado Brine Sales, Wil-
liam H. Brininstool, P.O. Drawer A,
Jal, New Mexico, 88252, has sub-
mitted a discharge plan application
for their proposed in situ extraction
brine well facility to be located in
the NE/4 NE/4, Section 32, Town-
ship 23 South, Range 33 East,
NMPM, Lea County, New Mexico.
Proposed operations are for fresh
water from three commercial wells
owned by the W.H. Brininstool to
be injected into the Salado Forma-
tion at an approximate depth of
1500 feet and brine to be extracted
through tubing. The brine will have
an average total dissolved solids
(TDS) concentration of approxi-
mately 350,000 mg/l and be stored
in four 1000 barrel above ground
tanks. Groundwater most likely to
be affected by an accidental dis-
charge is at a depth of approxi-
mately 500 feet with a TDS of 950
mg/l. The discharge plan address-
es injection well construction and
operation, and how spills, leaks,
and other accidental discharges to
the surface will be managed.
Any interested person may obtain
further information from the Oil Con-
servation Division and may submit
written comments to the Director of
the Oil Conservation Division at the
address given above. The discharge
plan application may be viewed at the
above address between 8:00 a.m.
and 5:00 p.m., Monday through Fri-
day. Prior to ruling on any proposed
discharge plan or its modification, the
Director of the Oil Conservation Divi-
sion shall allow at least thirty (30)
days after the date of the publication
of this notice during which comments
may be submitted to him a public
hearing may be requested by any
interested person. Requests for pub-
lic hearing shall set forth the reasons
why a hearing should be held. A
hearing will be held if the Director
determines there is significant public
interest.
If no public hearing is held, the
Director will approve or disapprove
the proposed plan based on informa-
tion available. If a public hearing is
held, the Director will approve or
disapprove the proposed plan based
on information in the plan and in-
formation submitted at the hearing.
GIVEN under the Seal of New
Mexico Oil Conservation Commission
at Santa Fe, New Mexico, on this 29th
day of November, 1993.
STATE OF NEW MEXICO
OIL CONSERVATION DIVISION
William J. LeMay
Director
Journal: December 7, 1993

STATE OF NEW MEXICO
County of Bernalillo

SS

OIL CONSERVATION DIVISION
RECEIVED
'93 DEC 13 AM 9 03

Paul D. Campbell being duly sworn declares and says that he is National
Advertising manager of **The Albuquerque Journal**, and that this newspaper is
duly qualified to publish legal notices or advertisements within the meaning of
Section 3, Chapter 167, Session Laws of 1937, and that payment therefore has
been made or assessed as court costs; that the notice, copy of which is hereto
attached, was published in said paper in the regular daily edition,
for 1 times, the first publication being on the 7 day
of Dec., 1993, and the subsequent consecutive publications
on _____, 1993

Sworn and subscribed to before me, a notary Public in
and for the County of Bernalillo and State of New
Mexico, this 7 day of Dec, 1993.

PRICE \$ 31.62

Statement to come at end of month.

Bernadette Oty
12-18-93

CLA-22-A (R-1/93) ACCOUNT NUMBER C 81184

Submit to Appropriate
District Office
State Lease-4 copies
Fee Lease-3 copies

State of New Mexico
Energy, Minerals and Natural Resources Department

Form C-102
Revised 1-1-89

OIL CONSERVATION DIVISION

P. O. Box 2088
Santa Fe, New Mexico 87504-2088

DISTRICT I
P. O. Box 1980, Hobbs, NM 88240

DISTRICT II
P. O. Drawer DD, Artesia, NM 88210

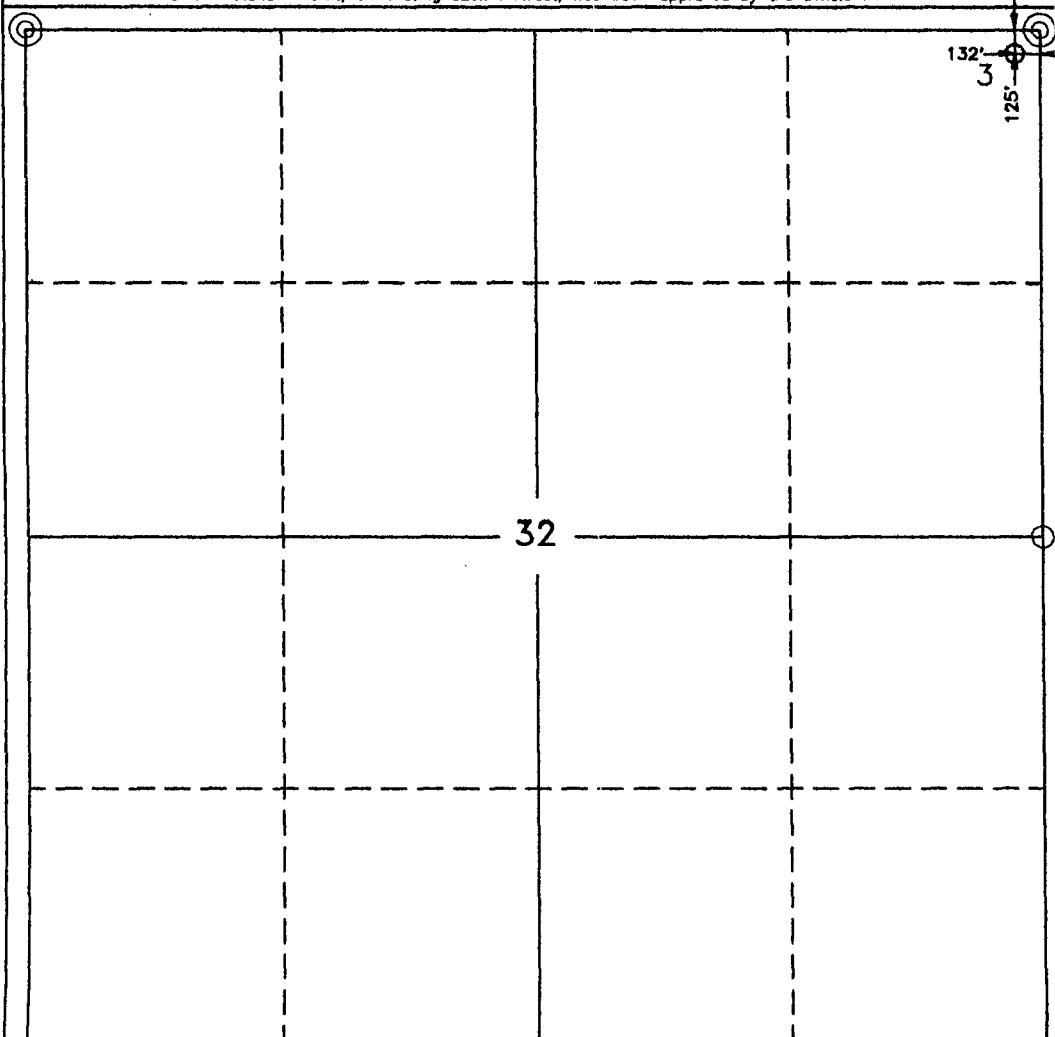
DISTRICT III
1000 Rio Brazos Rd., Aztec, NM 87410

WELL LOCATION AND ACREAGE DEDICATION PLAT

All distances must be from the outer boundaries of the section

Operator Salado Brine Sales			Lease		Well No. 3
Unit Letter A	Section 32	Township 23-South	Range 33-East	County Lea	
Actual Footage Location of Well:					
125 feet from the North line and		132 feet from the East line			
Ground level Elev. 3665	Producing Formation		Pool	Dedicated Acreage: Acres	

- Outline the acreage dedicated to the subject well by colored pencil or hatchure marks on the plat below.
- If more than one lease is dedicated to the well, outline each and identify the ownership thereof (both as to working interest and royalty).
- If more than one lease of different ownership is dedicated to the well, have the interest of all owners been consolidated by communitization, unitization, force-pooling, etc?
☐ Yes ☐ No If answer is "yes" type of consolidation _____
If answer is "no" list the owners and tract descriptions which have actually been consolidated (use reverse side of this form if necessary).
No allowable will be assigned to the well until all interests have been consolidated (by communitization, unitization, forced-pooling, or otherwise) or until a non-standard unit, eliminating such interest, has been approved by the Division.



OPERATOR CERTIFICATION

I hereby certify that the information contained herein is true and complete to the best of my knowledge and belief.

Signature

Printed Name

Chris Brinninstool

Position

Office Manager

Company

Salado Brine Sales

Date

November 9, 1993

SURVEYOR CERTIFICATION

I hereby certify that the well location shown on this plat was plotted from field notes of actual surveys made by me or under my supervision, and that the same is true and correct to the best of my knowledge and belief.

Date Surveyed

October 29, 1993

Signature & Seal of
Professional Surveyor

Certificate No.

7254 John S. Piper

Sheet



NEW MEXICO STATE LAND OFFICE
SALT LEASE APPLICATION

To The Commissioner of Public Lands
P. O. Box 1148
Santa Fe, New Mexico 87504-1148

The undersigned, William H. Brininstool, whose P. O.
address is P. O. Drawer A, Jal, NM 88252, being a
citizen of the United States and over the age of 21 years, hereby makes application for a lease for a period
of five (5) years, upon the following described land, to-wit:

NE 1/4 of the NE 1/4 of Section 32 Township 23S, Range 33E NMPM, Lea County

This application is made for the purpose of a lease for the mining or production of Salt
on State Lands, and purposes necessarily incidental thereto, in connection therewith, and the preparation
thereof for the market.

Applicant tenders herewith the sum of 25.00 dollars, as the first annual rental, and the further
sum of thirty dollars (\$30.00) filing fee, and further agrees to pay said rental annually in advance for the full
term of the lease.

Applicant further offers and agrees to pay a royalty of 10% percent, of the actual sales price at
place of extraction.

And in relation to this application, the applicant respectfully states and shows the following facts:

1. Discovery of Salt was made on said land on or about: unknown
2. The work done in connection with same is as follows: Due to the fact of drilling by other
companies in this area, drilling records show salt formation.
3. The amount of salt produced on said land is as follows: unknown
4. A brief description of the mode of occurrence of the deposit of salt and the nature
of the same is as follows: unknown
5. The salt will be prepared for market in the following manner at an estimated cost
of unknown, not including cost of production: unknown
6. The salt will be produced and marketed at: Lea County

7. The estimated tonnage or amount to be produced and general plan of operations are as follows: _____
unknown

8. Statement of any information not covered above, relating to operation of the lease applied for: _____
see attached statements After completion of well, the above information
will be submitted.

I, William H. Brininstool, do solemnly swear (or affirm) that the statements and answers
to questions in this application are true and correct, to the best of my knowledge and belief.

Signed W.H. Brininstool

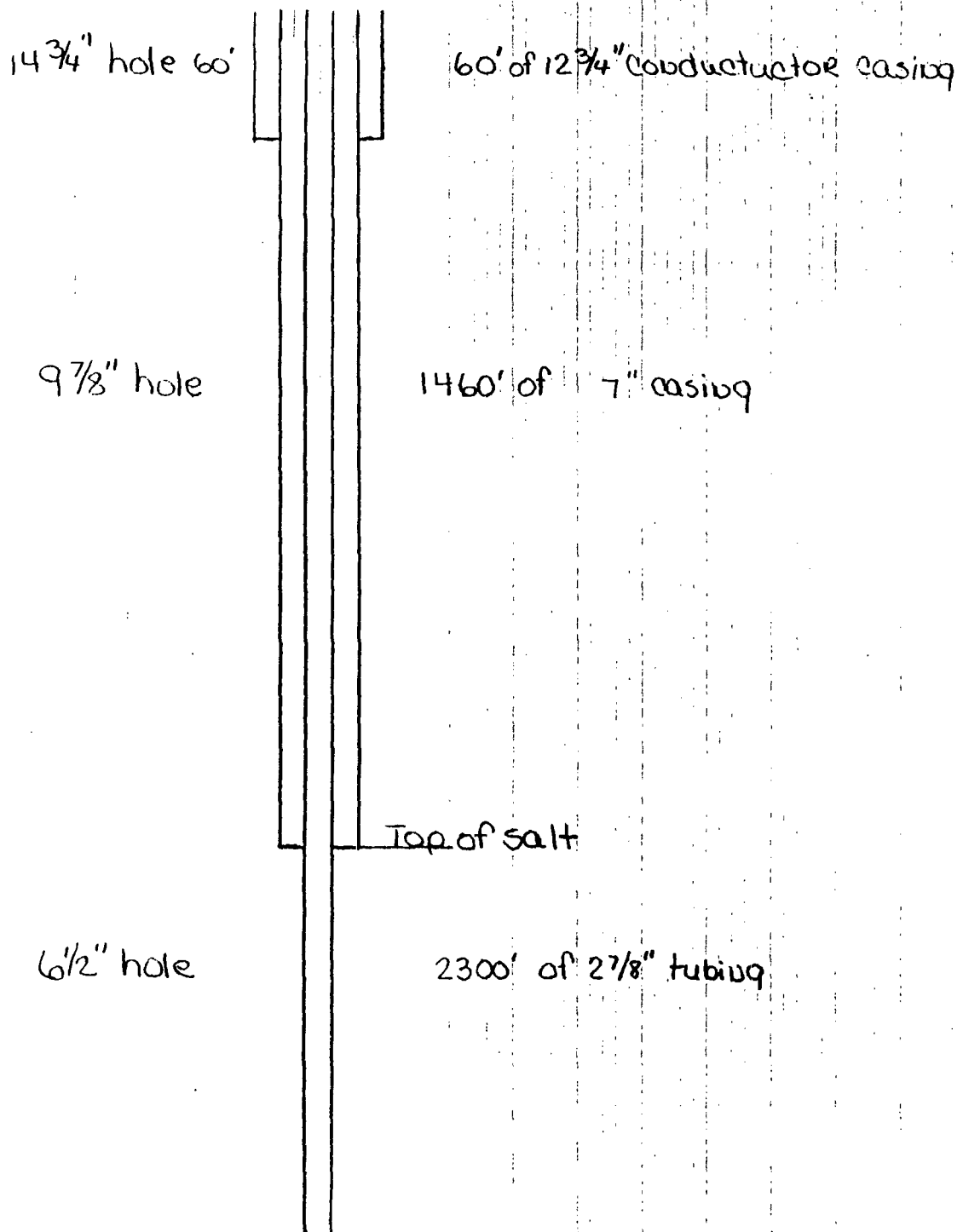
P. O. Drawer A, Jal, NM 88252

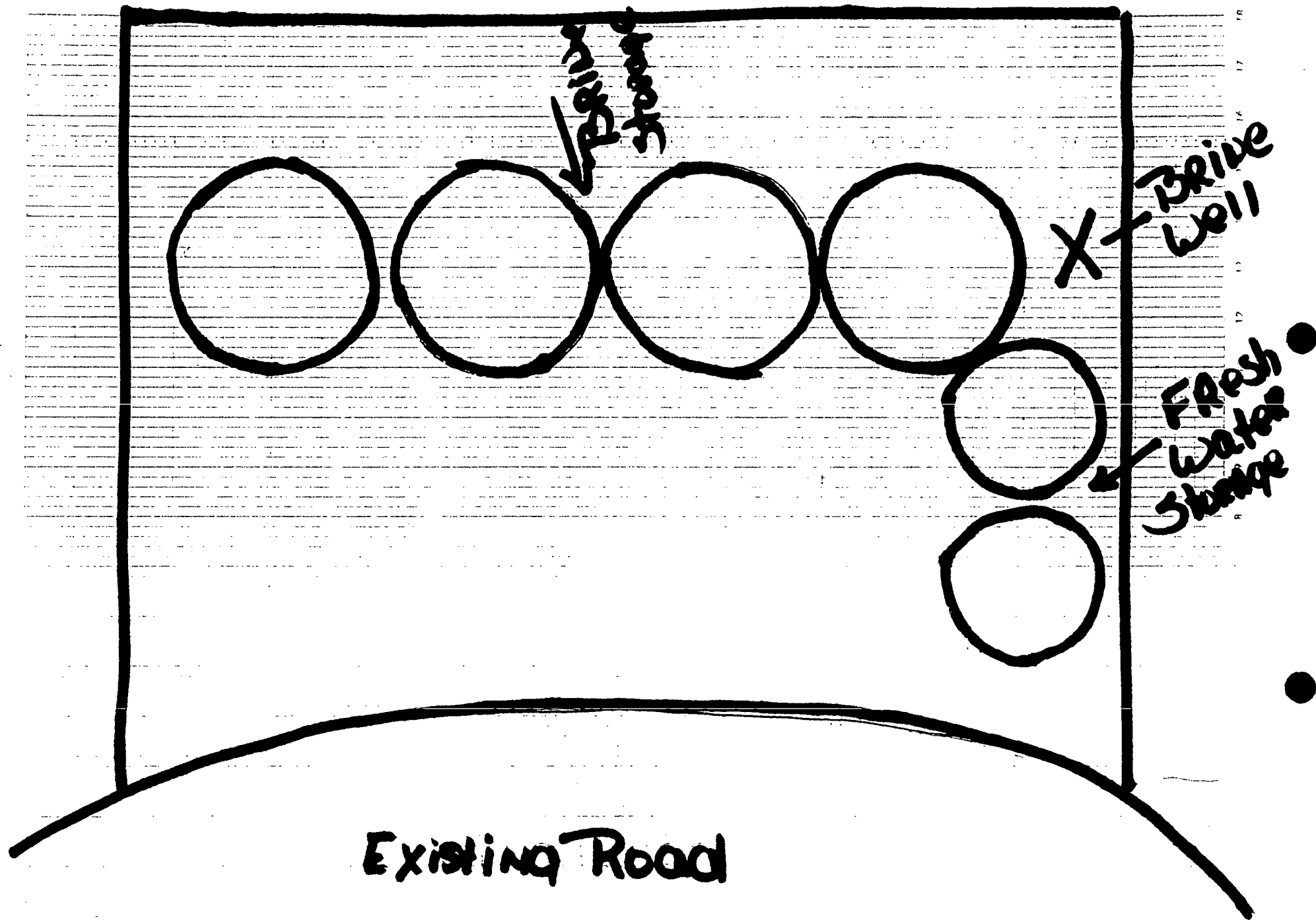
Subscribed and sworn to before me this 11th day of November, 19 93

Kary Duggan
Notary Public

COMMISSION EXPIRES 12/2/94

Salado Brine Well #3







LEGEND OF SYMBOLS

- = Access Road Federal Land (Yellow)
 = Access Road State Land (Green)
 = Resource Road on Lease (Brown)
 = Proposed Resource Road (Red)
 = Proposed Electric Line (Orange)
 = Proposed Gas Pipeline (Green)
 = Staked Well Location
 = Producing Well Location
 = Water Well
 = Found 1" Iron Pipe With Brass Cap
 = Found 2" Iron Pipe With Brass Cap
 = Unit or Lease Boundary

EXHIBIT "A" ACCESS ROAD AND FACILITIES MAP

SALADO BRINE SALES

SALADO BRINE SALES No. 3
125 FNL & 132' FEL Section 32,
T-23-S, R-33-E, NMPM, Lea County, NM

Drawn by: J.S. Piper

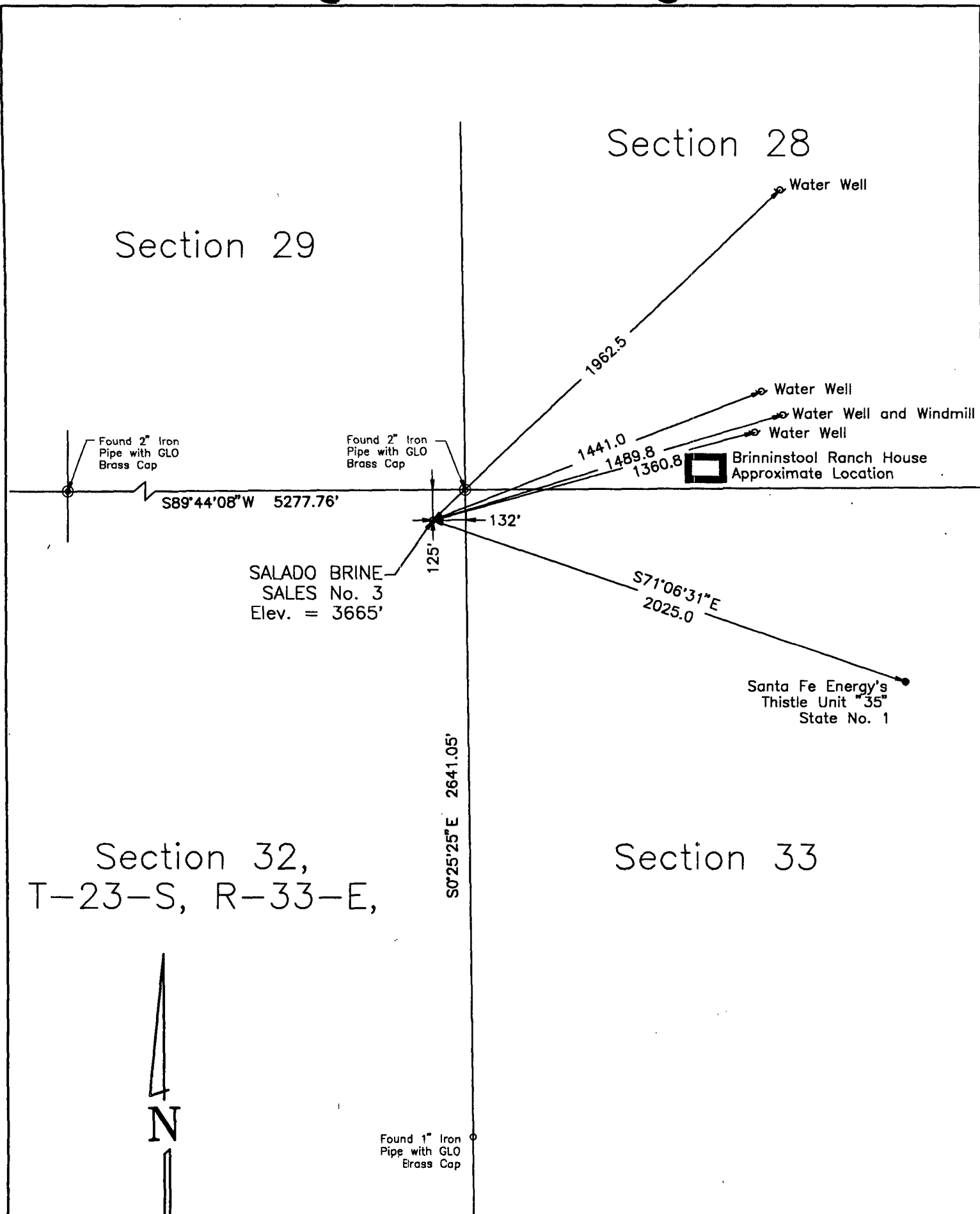
Date: November 8, 1993

Checked by: D. Ballew

Scale: 1" = 1000 Feet

Supervisor: Chris Brinninstool

Sheet 7 of 8



PIPER SURVEYING CO.

P.O. Box 60432
Midland, Texas 79711
(915) 550-7810

Bearings, distances, and coordinates are relative to the New Mexico State Plane Coordinate System, East Zone, 1983 NAD. This survey has an average combined grid factor of 0.9997994. The coordinate values are based on U.S.C.G. & S. Sta. "Brinninstool" with a delta alpha angle equal to 0° 25'09".

OPERATOR:	LOCATION ON: SALADO BRINE SALES NO. 3	FIELD: NA
SALADO BRINE SALES Attn: Chris Brinninstool P.O. Drawer "A" Jal, NM 88252	LEASE DESCRIPTION: SALADO BRINE SALES NE/4 of NE/4 of Section 32 T-23-S, R-33-E, N.M.P.M., Lea County, New Mexico	ACREAGE: NA
The well location shown on this plot represents an actual survey made by me or under my supervision to the best of my knowledge and belief. November 8, 1993	LOCATION IN SURVEY: 125' FNL and 132' FEL Section 32	ELEVATION: 3665'
JOHN S. PIPER PROFESSIONAL LAND SURVEYOR REGISTERED SEAL NO. 7254	LOCATION IN LEASE: Not Applicable	DATE: November 8, 1993
	NEAREST POST OFFICE: 25.2 Miles Northwest of Jal, NM	SCALE: Scale: 1" = 500 Ft
	GEODETTIC POSITION: LATITUDE: 32°16'05.153" LONGITUDE: 103°35'10.436"	DRAWN BY: J.S. Piper
	STATE PLANE COORDINATES: NORTH (Y) 462,070.91' EAST (X) 772,256.32'	DWG FILE: Brinstl3.DWG
		FIELD BOOK: Lea Co. 9, Pg. 61
		NORTH AMERICA DATUM OF: 1983
		ZONE: East STATE: NM



**THE REPRODUCTION OF
THE
FOLLOWING
DOCUMENT (S)
CANNOT BE IMPROVED
DUE TO
THE CONDITION OF
THE ORIGINAL**

DESERT PAVEMENT

Not shown on map. Consists of a single layer of closely spaced stones, angular or rounded, over a granular layer of sand and silt. Stones collect at the surface by a sorting action, apparently due to wind and salt heaving, or swelling and shrinking of clay. Salt heaving, however, the pavement may be partly eolian in origin. In general, within a given area, the thickness of the pavement also varies with wind and water erosion. Some areas of desert pavement also form where wind or water erodes the surface and leaves behind the coarser lag deposits. While desert pavement does not prevent runoff, it protects the ground from erosion.

CAVE DEPOSITS

Not shown on map. Commonly have a level top, recording an early stage of substantial water flow that eroded the cave. The gravel is overlain by clay or silt deposited as the flow of water diminished, and this in turn is overlain by caliche. Stalactites are common by cave. Fossil remains of Pleistocene animals have been found in deposits below the caliche. Remains of Holocene animals characterize the underlying deposits. Other cave deposits occur in historic lava, especially in the area southwest of the Zuni Mountains. These deposits include blocks fallen from the roofs, dust, and some ice.

ORGANIC DEPOSITS

Not shown on map. Accumulations of fibrous peat in sedge marshes bordering many flow and lakes. Both these and woody peat accumulated in small, poorly drained depressions and may form mounds. Mostly less than 15 ft.

DESERT VARNISH

Not shown on map. A black stain of iron and manganese oxides on bare rock surfaces and on pebbles of desert pavement. Predates prehistoric pottery-bearing occupations of the region. Predominantly middle Holocene, partly late Pleistocene. Many of these stained surfaces have petroglyphs carved by prehistoric peoples.

TRANSITIONAL DEPOSITS

Deposits transitional between those formed in situ and those transported; deposits moved downslope chiefly by gravity, particularly slow creep (colluvium). Also includes rock falls, landslides and avalanches as shown as periglacial features.

Colluvium includes the heterogeneous mantle of soil and rock fragments derived from erosion, bedrock, and/or unconsolidated surficial deposits moved slowly downslope by gravitational force and sheet wash. Slopes generally steeper than 20 percent. Mass wasting, the process causing debris to move downslope, is aided by added weight and lubrication of water-saturated debris, frost heaving, alternate wetting and drying of clays, crystallization of salts, growth of roots, burrowing and trampling by animals, falling of trees, and impact of hail or rain. These, like other erosional processes, may be accelerated by man's activities.

Colluvium is basically a chaotic mixture of angular rock fragments and finer grained material. In New Mexico colluvium is generally less than 10 ft thick, rarely 25 ft or more, but may grade into thick cones of debris at base of hillsides. In the northeast and northwest parts of the state where steep shale slopes underlie resistant caprock of sandstone in lava, two, and locally three, ages of colluvium may be distinguished. These are thought to be mid Holocene, late Wisconsinan, and early Wisconsinan, respectively. Such occurrences provide an index of retreat of cliffs. Some shale slopes are armored and protected against erosion by blocks of the caprock.

On long dry slopes such as flanks of the Zuni Mountains and east flank of the Sacramento Mountains, the colluvium is generally thin (commonly 1 to 2 ft thick) except near the base of steep hillsides and is composed of the resistant rock forming the dip slope. Some of this colluvium could as well be mapped as stony rump. Over limestone, hillslides on granitic and volcanic rocks may also be overlain by thin but bouldery sandy colluvium. Colluvium on steep, faulted mountain fronts consists of a mixture of stones representing all the exposed formations up slope.

COLLUVIUM -- Subscripts indicate the underlying hillside formation (e.g., co_{lv} , colluvium on Tertiary volcanic rocks).

TRANSPORTED DEPOSITS

Most surficial deposits are rocks and particles weathered from bedrock in one area, transported by water, wind, ice, or gravity to an area of deposition, and are susceptible to further erosion and transportation. These deposits are much younger than, and unrelated to, the underlying bedrock. They are classified according to their mode of transportation to the site of deposition.

ALLUVIUM IN FLOODPLAINS AND STREAM CHANNELS

Well-sorted, silty and silty stream deposits with gravel lenses; gravel terraces along valley sides. Formed by alluvial deposits record complex response to Quaternary climatic shifts. In the Mexican climate, were comparatively wet during the Pleistocene glacial stages. Conversely, during the interglaciations, climates were drier, with conditions similar to Holocene environments. Alluvial deposits locally contain fossils, including bones of mammals and rodents, and shells of freshwater snails and clams. Late Pleistocene deposits contain fossil remains of extinct animals such as elephants, camels, horses that re introduced until the arrival of the Spaniards), sloths, and long haired lion. Archaeological remains are common in and on Holocene deposits and help date them. Three ages of alluvium generally can be distinguished: 1st, Pleistocene, mid Holocene, and historic. At least three recognized types of alluvial floodplain deposits reflect relative capacity for sediment transport by the main stream and its tributaries. A fourth type, along the Pecos River in the southeastern part of the state, is characterized by caliche ground. A fifth is restricted to basalt-capped mesas.

FLOODPLAIN AND CHANNEL DEPOSITS ALONG MAIN RIVER -- Generally silty flat but includes terraces to about 10 ft high, shallow curved swales at right meanders, and local stabilized dunes. Mostly sand, silt, and some layers of gravel. Caliche absent or weakly developed in thin veneers, fibers, coatings on pebbles, and soft nodules. Deposits commonly 25 ft thick. Ground water shallow, subject to pollution. Extensively farmed; subject to flooding.

FLOODPLAIN AND CHANNEL DEPOSITS ALONG GENERALLY DRY ARROYOS AND WASHES -- Includes deposits along some perennial stream courses. Extent exaggerated to emphasize drainage patterns. Surface flat, mudflats 5 to 15 percent. Arroyos 10 ft deep common. Surface flat where deposit was formed by stream overflowing its banks; hummocky where built of coarse sand from mouths of tributaries that eroded the main stream deposits as the flow subsided. Shallow alluvium grades laterally into fan sand washed from adjoining hillsides. Episodic perched water table under some deposits. Depth of deposits exaggerated. Has been exaggerated but total area probably about right because both the sand and silt had to be omitted.

COVERING SILT AND SANDY ALLUVIAL FANS -- Intermediate between alluvial and eolian deposits (s and ls).

SALEE ALLUVIUM -- Borders Pecos River south of Fort Sumner.

ALLUVIUM OVER BASALT -- Restricted to basalt-capped mesas, stony, or more stony in old valleys; thickness commonly 10 ft or more. Acid soil.

GRAVEL TERRACES -- Well-rounded stream gravels with cobbles 6 inches or more in diameter; some terraces 250 ft higher than the streams. Especially well developed along the San Juan River, less so along the Pecos, Gila, and Canadian Rivers. They represent deposits by Pleistocene melt waters from mountains. Abundant caliche deposits, especially on the higher terraces, which may be Kansan; lowest are Wisconsinan.

ALLUVIAL FAN DEPOSITS

In alluvial fans, unlike floodplain alluvium, beds tend to be thick, massive, and highly lenticular rather than well stratified. This is characteristic of all the facies, whether boulder, gravel, sand, or silt. Beds lenticular and elongated down the slope of the fans; slopes 2 to 20 percent. Deposition mostly by flash floods, with poor sorting and mixed textures. Coarse-textured lenses commonly form ridges extending down the fan onto generally finer grained sediment. Boundaries between the textural facies of the deposits roughly parallel the fan contour, but detailed boundaries are irregularly lobate; those shown are approximations. Fan textures and slopes depend partly on composition of the parent rocks and partly on height and steepness of the bordering hill or mountain. Fans extensive in the Basin and Range part of the state where they comprise about half the total area; in other parts of the state, fans are small. On the larger fans, arroyos become shallower towards the toe; many head at low mounds that probably mark old mudflows. Ground subject to sheet flooding.

GRAVEL FACIES -- Bouldery towards apex of fan, grading downslope to cobble and fine gravel with increasing proportion of sand and finer grained material. Commonly dissected to form 2 to 3 levels of gravel benches up to 50 ft above present washes. A few streams (e.g., Mulligan Wash, Alamogordo River, Cuchillo Negro Creek, and Rincon Arroyo) are incised 100 ft below fan surfaces. On short, steep fans, depths of valleys generally decrease downslope. On the broad Palomas surface, west of the Rio Grande above Hatch, valleys maintain their depth. Except near the apex, extensive surfaces have smooth desert pavement. On short, steep fans, gravels show minimal weathering and are weakly cemented with caliche; age probably Wisconsinan and Holocene. On broad, more gently sloping fans, gravels are more weathered and commonly cemented by caliche; age probably pre-Wisconsinan. In south half of the state, gravel facies is characterized by creosote bush cover. Thin alluvial gravel covering pediments is denoted by lg over subscript that identifies parent formation.

SAND FACIES -- Sandy alluvium with subordinate amounts of fine gravel, silt, and clay. Forms at least four kinds of ground: 1) On short, steep fans sloping from the mountains of granitic or gneissic rock (e.g., parts of the Florida Mountains), this facies may form a smooth sandy layer a few feet thick covering gravel below; slopes 5 to 20 percent; washes 1 to 10 ft deep may expose underlying gravel. 2) On other short fans, sand facies may form arcuate belt at toe of fan with slopes averaging 10 percent, commonly reworked into coppice dunes 3 to 7 ft high (sm). 3) Other belts of smooth sandy ground commonly slope 5 percent or less and consist of sand mounds approximately 1 ft high over caliche (ls). 4) Gypsiferous sand (ls), especially in the Jornada del Muerto, Tularosa Valley, and east side of the Pecos Valley. Sand facies absent on the broad Las Palomas surface. Thin fan sand covering pediments is denoted by ls over subscript that identifies underlying formation. Boundary with residual sand, fan gravel, and fan silt is approximate.

SILT FACIES -- In Basin and Range parts of the state, toes of fans may be silty and clayey rather than sandy; surface smooth, with slopes less than 5 percent. Slow infiltration rates and low slopes result in sluggish runoff. Forms a belt below the sand facies and grades downward to plays silt (ps) with slopes less than 2 percent. Abundant swelling clays and exchangeable sodium. Surface layers predominantly Holocene; subject to sheet flooding, gradational with ls. East and west of Sangre de Cristo Mountains, also in the Las Alamos area, silty loam with little gravel in upper 3 to 4 ft, but abundant gravel below the loam. Caliche soft. Includes loess on isolated hillslopes. Boundary with residual loam (rl), plays silt (ps), and fan sand (ls) approximate.

EOLIAN DEPOSITS

Eolian deposits are laid down by wind, mostly as sheets of sand or silt (loess). Rarely, after prolonged drought on shale desert in the San Juan Basin, shale flakes may accumulate in rippled sheets or even small dunes, but with the next rain, these become mud. Sand dune shapes depend on topography, relative strength of the winds, supply of sand, and vegetation. Some dunes are concave towards the windward (parabolic), others are concave towards the leeward (barhans), and others are longitudinal or transverse. Some dune clusters (e.g., Great White Sands) have all four kinds. Dunes may climb a windward slope or fill on a leeward slope. Most of New Mexico's eolian sand sheets have a basal layer of weathered, partly cemented, reddish stabilized sand; some sand surfaces on such layers are smooth. In the Basin and Range and Great Plains parts of the state, these surfaces are generally underlain by caliche; in the San Juan Basin, sand sheets commonly overlie residuum, fan deposits, or bedrock. Where sand is thick, as on sand facies of fans in the Basin and Range and at climbing dunes east of the Pecos River (Mesquero Sands) the sand is in mounds (coppice dunes) with profuse growth of vegetation -- mesquite, and saltbush in the Basin and Range; sand sage, shinnery oak, small soapweed yucca, and occasional mesquite on the Mesquero Sands. Sand sheets are predominantly late Pleistocene; mounds and dunes are largely Holocene.

SAND UNDERLAIN BY BASALT -- Extensive on basaltic plains south and east of Zuni Mountains and on West Potrillo Mountains. At Kilbourne Hole and Hunt's Hole, the sand is of volcanic origin.

SAND UNDERLAIN BY CALICHE ON SANTA FE GROUP -- Mostly on Le Mesa and south part of the Jornada del Muerto.

THIN SAND ON CALICHE ON OGALLALA FORMATION -- Thickness about 1 ft. Chips of caliche comprise 30 percent of the sand. Generally too shallow for farming, but good shallow source for aggregates.

MODERATELY THICK SAND ON CALICHE ON OGALLALA FORMATION -- Sand 1 to 3 ft thick. Surface layers noncalicheous over reddish loam. Local sand mounds. Ground favorable for farming. Boundaries approximate.

THICK SAND ON CALICHE ON OGALLALA FORMATION -- Sand 3 to 5 ft thick. Local mounds. Brownish-red, fine sandy loam over reddish-brown, sandy clay loam; noncalicheous in depths of 3 ft; calcareous subsoil contains filaments of lime carbide. Where farmed, ground is subject to wind erosion. Boundaries approximate.

LOOSE SAND IN MOUNDS -- Coppice dunes, commonly 3 to 7 ft high and 25 to 50 ft in diameter; generally elongated north of east but a local exception lies east of Columbus where elongation is south of east. Age is Holocene. Boundaries fairly accurate.

SAND SHEETS -- Surfaces smooth except for ripples 2 to 3 inches high and scattered sand mounds 3 to 12 inches high, especially around small shrubs. Thickness of loose sand generally no more than about 12 to 24 inches, but commonly overlies stabilized sand. Underlying material where known identified by subscript.

LONGITUDINAL DUNES -- Sand commonly 6 ft thick, locally 10 ft. Forms distinct ridges generally oriented north of east. Locations diagrammatic and width exaggerated.

OTHER DUNES -- ds, quartzose sand, ds, gypsiferous sand LOAM ON OLD BASALTIC LAVA -- Prob. by pre-Wisconsinan loess.

EOLIAN SILT

EXPLANATION OF SURFICIAL GEOLOGY

by Charles B. Hunt 1977

LAKE AND PLAYA DEPOSITS

New Mexico has two kinds of lake deposits in addition to those forming today in arid or semiarid areas. The most extensive deposits were laid down in Pleistocene lakes that formed closed basins now marked by playas. Many of these deposits in the Basin and Range and Great Plains provinces are the so-called "badland hollows" of the Great Plains on the Ogallala Formation. Some of these hollows are deflation hollows with sand mounds on the lee side; others may be due to tilt and sagging of the surface. Still others may be attributed to warping. Third, some sinkholes clearly due to solution, like Batemans Lake sink in Santa Rita, and some of the depressions (related to karst) of the San Andres Formation and covered ground north of the Sacramento Mountains. A fourth type is represented by ephemeral ponds in swales marking cutoff meanders on alluvial floodplains. A fifth type occurs only in the near volcanoes at Kilauea Hole, Mont's Hole, and Zuni Salt Lake. Only the first three types appear on the map. Area of deposits represented has been exaggerated because of map scale, but total area probably about right because smaller deposits are omitted.

- psi** SILEY LAKE OR PLAYA DEPOSITS — Ground mostly bare, gypsumiferous deposits labeled psi.
- ps** SANDY LAKE OR PLAYA DEPOSITS — Gypsiferous deposits labeled ps.
- bs, dg, g** BEACH DEPOSITS — Sand or gravel; sandy stretches mostly reworked into low dunes, incompletely shown.
- ev** EVAPORITES — Saline or alkaline deposits precipitated from brines in playas having high evaporation rates, notably Estancia Valley, Animas Valley, and Zuni Salt Lake. Salts are gradational with playa silt (psi) and occur in orderly concentric zones reflecting relative solubility of the salts. Thicknesses range from 1 to several inches, but salts mixed with mud may be tens of feet deep. Efflorescent crusts subject to wind erosion contribute to salinity of ground to leeward.

GLACIAL AND PERIGLACIAL DEPOSITS

During the Pleistocene New Mexico had mountain (alpine) glaciers high on the Sangre de Cristo Range, Tuzigoot Mountains, and Sierra Blanca Peak. The source of such glaciers was in nearly circular, steep-sided basins (cirques) at valley heads. High valleys eroded by the glacial cirques tend to be U-shaped, at lower elevations where eroded by streams, these valleys are V-shaped. Gravel deposited along each side of valley ice represent debris that rolled down the mountainside onto the ice to form lateral moraines. Hummocky ridges of sand and gravel deposited across the lower ends of the glaciers form terminal moraines. Within the cirques generally stand two ramparts of boulders. An inner rampart, forming today, is located at the lower edge of the snowbank that accumulates annually in the cirque; it represents rocks broken by frost from the headwall of the cirque, rolled down the snowbank, and collected at the ridge. These inner ridges are pebbles. Further out in the cirque — perhaps at the mouth — is a second ridge, forested, with firm unconsolidated rock darkly stained with iron and manganese oxide. These outer cirque ridges are formed during the mid-Pleistocene "little ice age."

- mg** DEPOSITS AND GEOMORPHIC FEATURES OF PLEISTOCENE MOUNTAIN GLACIERS — Extent exaggerated.
- pg** PERIGLACIAL DEPOSITS ON MOUNTAIN TOPS — Primarily represented by boulder fields and patterned ground where frost action was intensive during the glaciations. Extent and boundaries approximate; graded laterally to steep residual and colluvium.
- av** AVALANCHE DEPOSITS — Bouldery; some are lag concentrates of boulders where fine-grained sediments have been removed by erosion. Deposits narrow and long down slope; commonly 10 to 50 ft thick. Apparently deposited as mudflows during late Pleistocene time when there were numerous perennial mountain snowfields. Frost action at the time was vigorous; sudden thaws could trigger floods or mudflows on the mountainsides. Slow movement down slope may be reactivated in artificial cuts through these deposits if water enters the plane of slippage.
- lds** LANDSLIDE DEPOSITS — Abundant on slopes of Cretaceous shale. Whereas avalanche deposits are along a down slope, landslide deposits are short down slope but wide along the contour. Characteristically, they retain a cap of the soil or sandstone sloping into the hillside atop a steep colluvial covered shale slope. Stabilized landslides may be reactivated if water is allowed to enter the plane of slippage.

MISCELLANEOUS TYPES OF GROUND

- Basalt** — Includes lava flows, lava cones, cones of scoria, necks, and fields of scoria. Predominantly Quaternary and late Tertiary; some young enough to have sustained minimal weathering and retained their original structures and shapes are commonly referred to as malpais (Spanish, bad ground). Includes some Tertiary basalt that conspicuously controls the topography. Locally covered by loam (lh), eolian deposits, alluvial stream deposits. These older surfaces are more deeply eroded, tilted, and faulted. Individual flows generally less than 50 ft thick; locally, several flows may aggregate a few hundred feet thick. Commonly interbedded with volcanic ash (tuff). Excludes lava mantled by loess or other sediments; such areas indicated by subscript (e.g., lh — loam over basalt; ts/h — tan sand over basalt). Boundaries shown are adequate.
- Other bedrock** — Colluvium or other cover amounts to less than half the area. Only extensive areas are shown; age and rock type keyed by symbol to State geologic map (e.g., Kd, Cretaceous Dakota Sandstone; R, Triassic Santa Rosa Sandstone). Many small areas omitted; indicated boundaries are approximate. Principal formations and subscripts used are:

- Qg — Gatuna Fm.
Qht — Bandelier Tuff
Qvt — Rhyolite Flows
Q1f — Upper Santa Fe Group
Q1s — Santa Fe Group, undivided, and related formations
Q1g — Gila Conglomerate
Q1o — Ogallala Fm.
Q1a — Lower Santa Fe Group
Q1c — Chuska Sandstone
Q1u — Alluvial and lacustrine deposits
Q1p — Carson Conglomerate (generally equivalent to Los Pinos Fm.)
Q1pi — Picuris Tuff
Q1p — Pecos volcanic series
Q1t — Tertiary volcanics; largely Datil Fm. in SW; includes some pre- and post-Datil volcanic sequences
Tbh — Blaine Basin Fm.
Tg — Galisteo Fm.
Tj — San Juan Fm.
Tn — Navajo Fm.
T — Tertiary sedimentary formations in Raton district
TKp — Pecos Canyon Fm.
TKa — Animas Fm.
TKr — Raton Fm.
TKa — Ojo Alamo Sandstone
Kv — Volcanics of Cretaceous age; various composition
Kkf — Kirtland Shale and Fruitland Fm.
Kpc — Pictured Cliffs Sandstone
Kl — Lewis Shale
Kmv — Cretaceous sandstone and shale, mostly Mesaverde Fm.
Kch — Cliffhouse Sandstone
Kpl — Point Lookout Sandstone
Ksh — Cretaceous shale
Kg — Gallup Sandstone
Kmi — Mancos Shale
Kd — Dakota Sandstone
J — Jurassic, undivided
Jm — Morrison Fm.
Jz — Zuni Sandstone
R, J — Triassic and Jurassic, undifferentiated
R — Triassic, undifferentiated
Rpe — Pecos Canyon Sandstone
Rph — Chinle Fm.
Rr — Santa Rosa Sandstone
Rt — Teller Fm.
Rat — Arroyo Group
Rsa — San Andres Fm. (limestone)
Rg — Gila Sandstone
Rc — Carrizosa Fm.

EXPLANATION FOR GEOLOGIC MAPS 40, 41, 42 AND 43

- Py — Yozo Fm.
Pa — Abo Fm.
Ph — Hueco Fm.
Pal — Paleozoic, undivided
Pms — Madera Limestone and Sandia Fm., undivided
P, P — Permian, Pennsylvanian
M, D — Mississippian, Devonian
O, O — Silurian, Ordovician, Cambrian
pC — Precambrian
g — Granitic, gneissic, and intrusive rocks of various ages

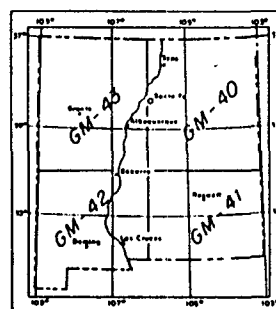
- Disturbed ground.** Mostly urban areas large enough to show on state base; farmed lands excluded. Includes airports, mined areas, tailings dumps, and feedlots. Incompletely shown.
- X** Open pits for road fill, sand, gravel, caliche, or other aggregates.
- Playa-lake depressions.** Mostly small closed basins produced by eolian activity and local solution subsidence.

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- Hawley, J.W., Bachman, G.O., and Manley, Kim, 1976, Quaternary stratigraphy in the Basin and Range, and Great Plains provinces, New Mexico and Western Texas, in *The Quaternary stratigraphy of North America*, W.C. Mahaney, ed.: Syracuse, Pennsylvania, Dowden, Hutchinson and Ross, p. 235-274.
- New Mexico State University, Agricultural Experiment Station, Research reports showing soil association and land classification for irrigation for each county.
- New Mexico State Highway Department supplied data for aggregate resources in New Mexico.
- Soil Conservation Service, 1/62,500 aerial mosaics of New Mexico Quadrangles.
- Data from these and other sources were plotted on the 1/250,000 quadrangle maps, field checked with about 40,000 mi of automobile traverses and 20 hours aerial reconnaissance over areas difficult of ground access. Mapping began spring 1974 and was completed June 1976.

ACKNOWLEDGMENTS

The author wishes to thank John W. Hawley and Robert H. Weber of the New Mexico Bureau of Mines and Mineral Resources for critically reviewing the maps and explanation; also Neils M. Pearson, for editing the explanation and for handling total cartographic compilation.



Index map of New Mexico



YUCCA PLANTS

INTRODUCTION

Surficial geology concerns origin, distribution, and significance of deposits and soils at or near the earth's surface. Completely bare bedrock forms probably less than 5 percent of New Mexico's land surface; consequently surficial materials form by far the largest and most-used part of the ground around us. Several aspects of surficial geology that contribute significantly to an understanding of our environment are water-yielding properties of the ground; its susceptibility to flooding and erosion; its susceptibility to such hazards as landslides, avalanches, and earthquakes; ease of excavation; suitability for foundations and road building; agricultural potential, including suitability for irrigation or pasturage; and mineral resources potential.

Surficial materials commonly are poorly consolidated, consisting partly of bedrock weathered in situ (residuum), but mostly of sediments derived by erosion and transported by water, wind, ice, or gravity (mass wasting) to a site of temporary deposition before being further eroded and transported downslope.

Four major categories of surficial materials are distinguished on the map by color: residual materials, transitional deposits, transported deposits, and miscellaneous types of ground.

RESIDUAL MATERIALS

Materials generally formed in place, including: residuum, formed in situ by weathering of a parent formation; caliche; travertine and related spring deposits; shale or sandstone baked by coal beds burning in situ (clinker); karst and related deposits in sinks; and the following, which are not distinguished on the map -- organic deposits; desert pavement; cave deposits; and desert varnish.

RESIDUUM

In New Mexico, residuum tends to be thin, generally less than 2 ft thick -- rarely as much as 5 ft. Texture depends upon composition of parent rock, and ranges from clay to coarse sand; texture may be bouldery in granitic areas. Areas shown as residuum include small outcrops of parent rocks and some alluvial or eolian deposits either mistaken for residuum or too small to show on the map. These materials are predominantly of late Pleistocene (Wisconsinan) or Holocene age. Ground is hummocky with slopes less than 10 percent; scattered small outcrops of resistant beds form small ledges.

LOAMY RESIDUUM — Texture variable -- mixed clay, silt, and sand. Thickness 1 to 5 ft. Parent formations fine grained, shallow, and identified by subscripts. Where clayey, this residuum generally contains appreciable amounts of swelling clay and is highly susceptible to sodium exchange, especially over the Chinle Formation (subscript Trcl), Cretaceous shale (subscript Ksh), and Tertiary clayey volcanic formations. Slopes locally 10 percent and subject to washing. Although the unit is distinctive, the indicated boundaries are approximate.

STONY RESIDUUM — Stony residuum, with accompanying sand and silt. Thickness mostly less than 3 ft. Texture variable depending on parent material, indicated by subscript. Boundaries gradational with cl and lg.

STONY LOAM OVER BASALT — Lithology highly variable; locally abundant clay and silt; probably loesslike; stony basaltic, mostly rough scoriae or angular blocks and flakes. Includes alluvium along small washes; numerous basalt mounds and low scarps along some washes and at edges of flows; thickness generally less than 3 ft. Surface smooth; slopes usually less than 5 percent except at sides of washes, bases of volcanic cones (including spatter cones), and edges of flows. Not subject to severe erosion. Boundaries indicated are fairly well defined despite variable lithology; boundaries with alluvium are approximate.

SANDY OR SANDY LOAM RESIDUUM — The shallow sandy or sandy silt substrates are distinguished by subscripts (e.g., r/Kd, sandy residuum over Dakota Sandstone). Thickness commonly 1 ft. Subject to wind erosion where vegetation is sparse; minimal washing. A distinctive unit with adequate boundaries, except in the San Juan Basin and along the Canadian River.

GYPSIFEROUS AND SANDY RESIDUUM ALONG PECOS RIVER VALLEY — Parent material Artesia (Pat) and related formations. Rarely over 2 ft thick. Numerous small outcrops of gypsum thinly mantled by loose sand with or without small pebbles. A distinctive unit; boundaries are approximate.

RESIDUUM ON LIMESTONE — Widespread on east slope of Sacramento Mountains, Chupadera Mesa, and flanks of Zuni Mountains; less extensive on Cretaceous limestone beds south of Raton. Stony and blocky; generally well cemented with calcium carbonate; little subject to erosion. Slopes average steeper than most residuum. Thickness generally less than 2 ft, rarely as much as 5 ft. A distinctive unit; boundaries indicated are adequate.

CALICHE

CALICHE — Partly indurated zone of calcium carbonate accumulation formed in upper layers of surficial deposits; 2 to 10 ft thick; commonly overlain by windblown sand. Much caliche shown on the map consists of tough, stony surface layers underlain by calcium carbonate nodules that grade downward to fibers and veinlets. Especially well developed in Eastern Range and Great Plains parts of the state. Thick caliches (locally >20 ft) associated with undisturbed High Plains surfaces of the Great Plains commonly comprise an upper sequence of several carbonate-cemented zones interlayered with reddish loamy paleosol horizons over a basal caprock zone developed on Ogallala (To) sediments. Forms on various types of parent formations, indicated by subscripts. The extensive caliche along Rio Salado northwest of Socorro is partly a travertine deposit. Where buried by sand, the caliche is identified by subscript ca. A distinctive unit; boundaries are well defined where the caliche forms rimrock and approximate where exposed in deflation hollows. Where thick and well indurated, caliche is quarried for road metal and other aggregate, subject to minimal erosion.

SPRING DEPOSITS

TRAVERTINE AND RELATED DEPOSITS — Most deposits shown have been formed at springs discharging water hotter than 100°F (34°C). Travertine mounds and benches to 50 ft high. Deposits at east base of Mesa Lucero may not have been created by hot springs.

CLINKER

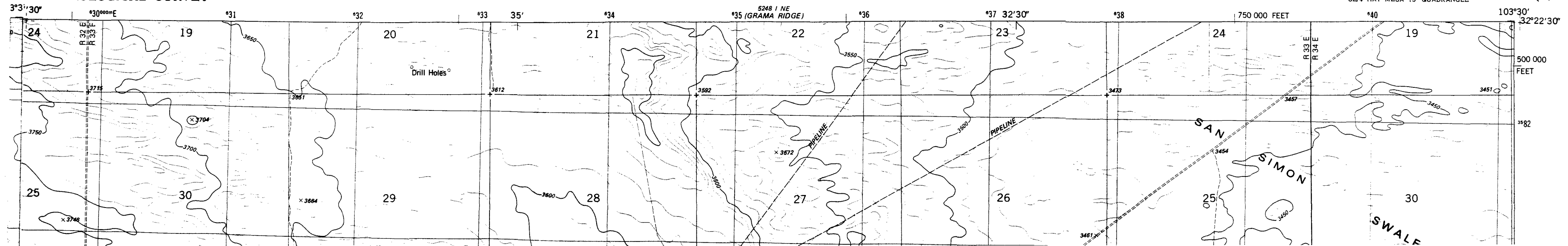
SLAGGY COAL ASH AND VITRIFIED SHALE AND SANDSTONE MASSES FUSED BY BURNING COAL BEDS — Incompletely shown -- coal may ignite spontaneously, by lightning or ground fire. Depending on oxygen availability, the coal may burn tens of feet back into the ground. Common in coal-bearing formations of San Juan Basin and Raton district. Used for road metal.

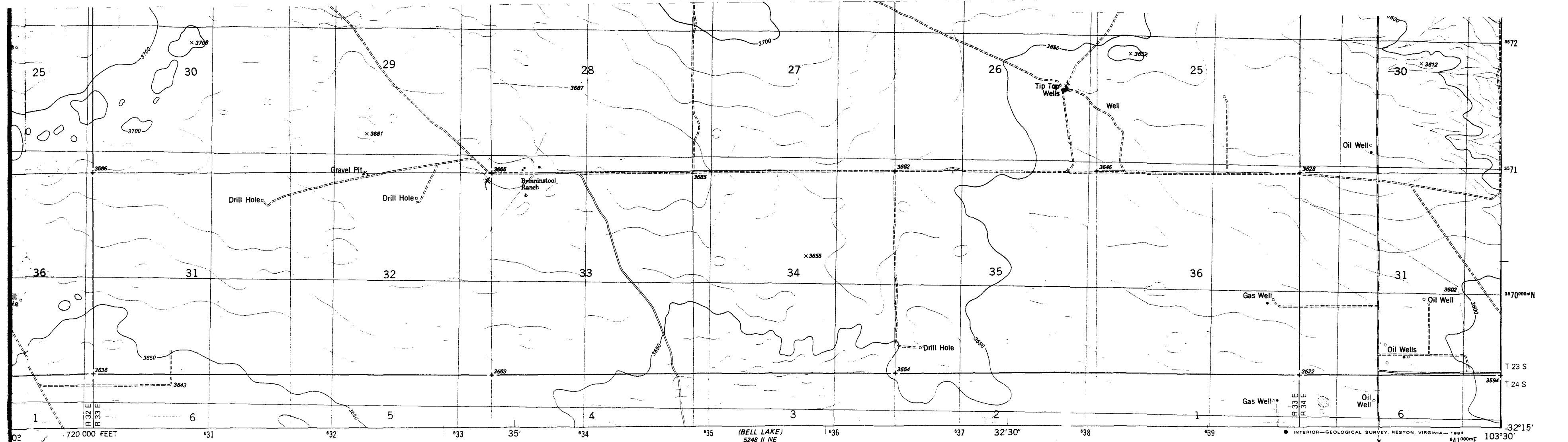
KARST DEPRESSION DEPOSITS

KARST-RELATED DEPOSITS — Underground solution of limestone and gypsum produces caverns or smaller subsurface voids, and causes roof-rock collapse, forming closed karst depressions (sinkholes) at the surface, mantled with blocks of the roof rock. Widespread in San Andres Formation (subscript Pca) north of the Sacramento Mountains and on Chupadera Mesa. Sinks commonly 50 ft deep and 500 to 1,000 ft wide. Similar deposits composed of slumped gravel and alluvium along the Pecos River valley are attributed to solution of underlying gypsum or other salts. Slumped beds dip 1 to 5 degrees into the depression; may be overlain by undisturbed gravels. Thickness to 300 ft. Although these are distinctive features, extent and boundaries, largely derived from the 1/250,000 quadrangle maps, are approximate.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TIP TOP WELLS QUADRANGLE
NEW MEXICO-LEA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SE/4 HAT MESA 15' QUADRANGLE





Mapped, edited, and published by the Geological Survey

Control by USGS and NOS/NOAA

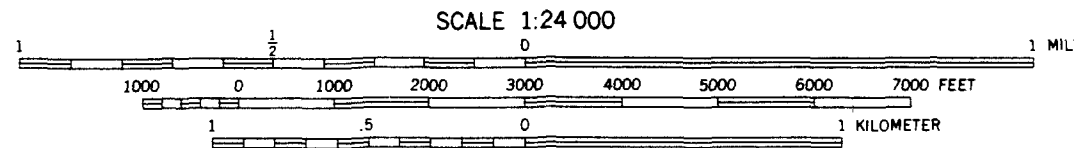
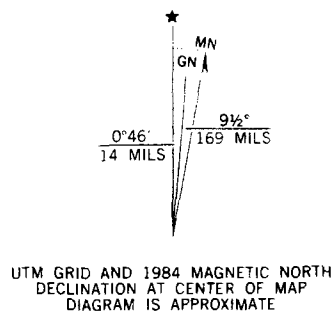
Topography by photogrammetric methods from aerial photographs taken 1977. Field checked 1978. Map edited 1984

Projection and 10,000-foot grid ticks: New Mexico coordinate system, east zone (transverse Mercator) 600-meter Universal Transverse Mercator grid, zone 13 927 North American Datum

Place on the predicted North American Datum 1983

Move the projection lines 9 meters south and 5 meters east as shown by dashed corner ticks

The red dashed lines indicate selected fence lines



CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST



QUADRANGLE LOCATION

ROAD CLASSIFICATION
Primary highway, hard surface
Secondary highway, hard surface
Light-duty road, hard or improved surface
Unimproved road
Interstate Route
U. S. Route
State Route

TIP TOP WELL
SE/4 HAT MESA 15' C
32103-C5-TF

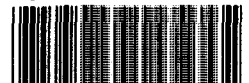
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HOLMAN'S, INC.

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USGS TIP TOP WELLS 7.5' NM TOPO MAP

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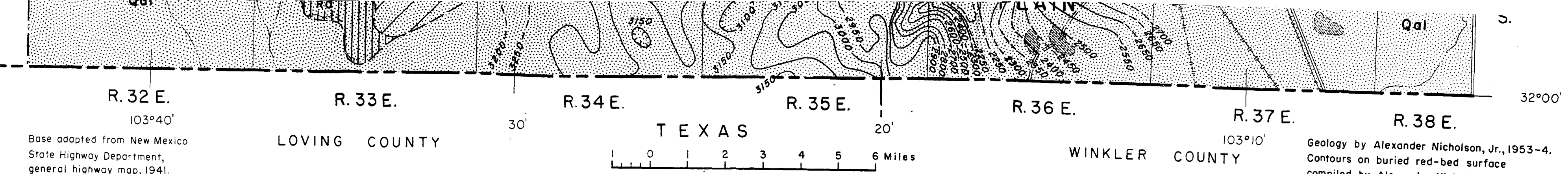


PLATE 1. GEOLOGIC MAP OF SOUTHERN LEA COUNTY, NEW MEXICO

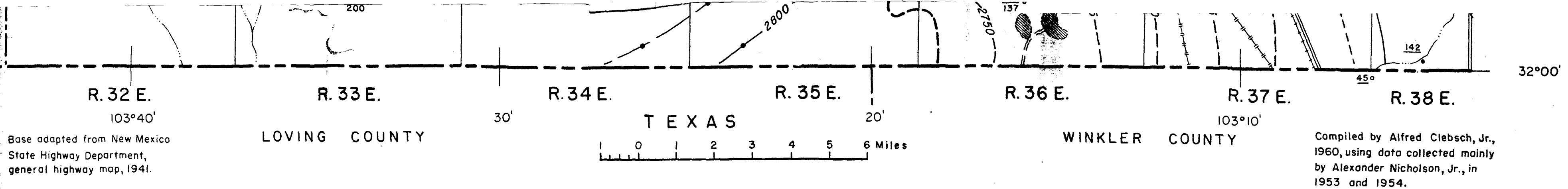
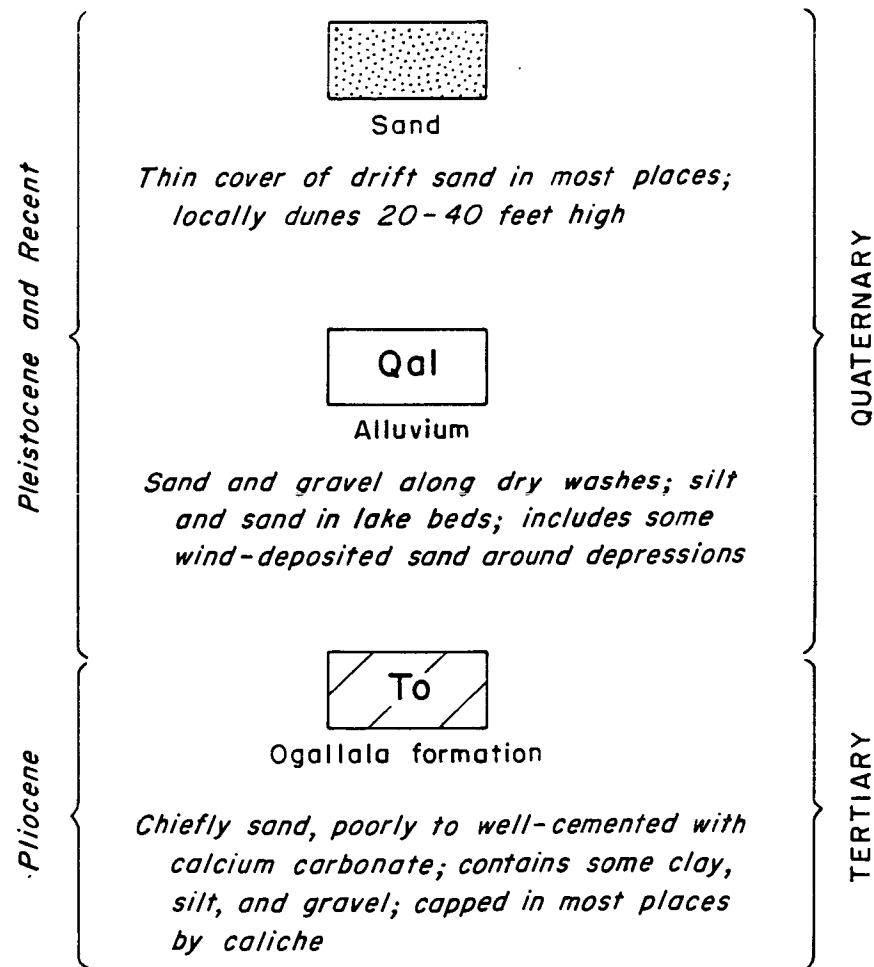
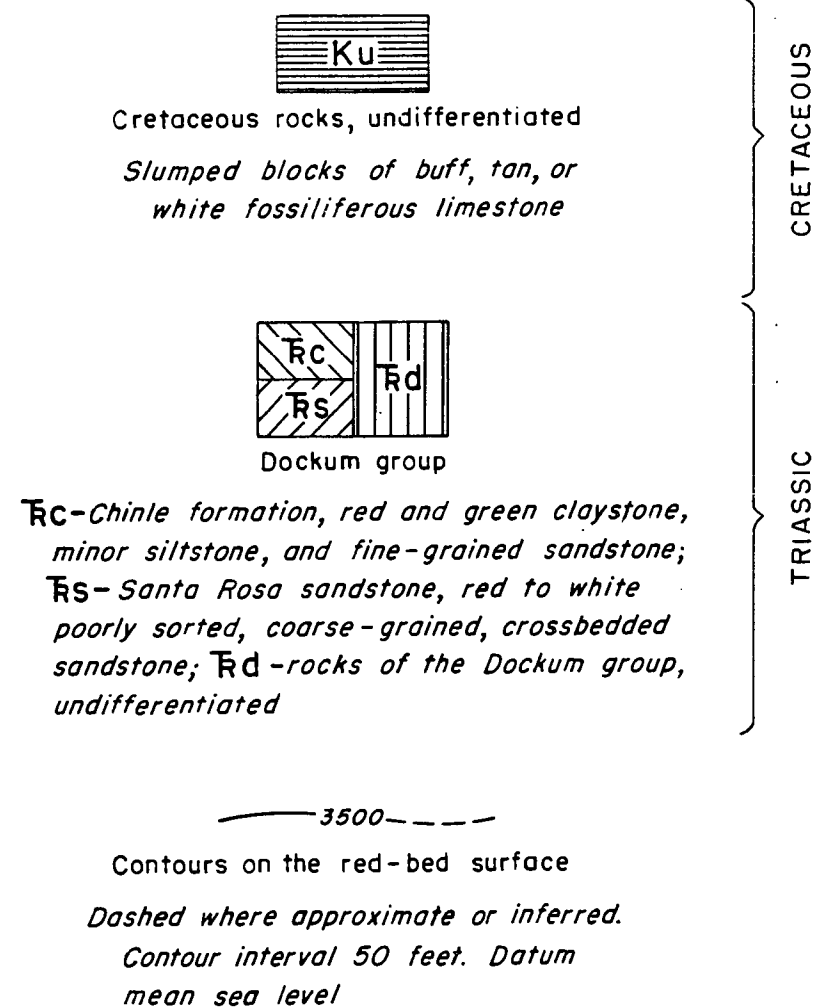


PLATE 2. GROUND-WATER MAP OF SOUTHERN LEA COUNTY, NEW MEXICO

EXPLANATION



Upper Triassic





EXPLANATION

$\frac{150}{252}^{\circ}$

Water well

Upper figure is depth to water; lower figure is depth of well. Open circles are wells finished in Tertiary or Quaternary rocks; solid circles are wells finished in Triassic rocks

F = Flowing

R = Reported

P = Water level measured while pumping

D = Dry

? = Uncertainty as to aquifer

> = More than

< = Less than

(See tables 6 and 7 for detailed well data.)

— 3925 — — —

Water-table contour in Tertiary or Quaternary rocks

*Dashed where inferred or uncertain.
Contour interval 25 feet. Datum
mean sea level*

— 3500 — — —

Water-table or piezometric contour on water body in Triassic aquifers

*Dashed where inferred or uncertain.
Contour interval 100 feet. Datum
mean sea level*

— — — — —

Approximate position of boundary between Triassic rocks and saturated Tertiary and Quaternary rocks

