

NOTICE

Reeves Drilling & Petroleum Corp., PO Box 1667, Farmington, NM 87499, phone 334-8059, contact Denny Reeves, Application for Disposal Well, location 3-D FNL, 1650 FNL Sec. 5, T30N R15W, San Juan County, injecting in to Gallup Sandstone at a depth of 2500' at a rate 150 bbl. per day average pressure 1800 psi or less. All interested parties must file objections or requests for a hearing with the Oil Conservation Division, PO Box 2088, Santa Fe, New Mexico 87501 within 15 days. Legal No. 17166 published in the Farmington Daily Times, Farmington, New Mexico on Thursday, September 19, 1985.

P 017 191 535

RECEIPT FOR CERTIFIED MAIL

NO INSURANCE COVERAGE PROVIDED
NOT FOR INTERNATIONAL MAIL

(See Reverse)

★ U.S.G.P.O. 1984-446-014

PS Form 3800, Feb. 1982

Sept. to	
OKLAHOMA OIL & GAS INC.	
Street and No.	
37161 McARTHER BLVD	
P.O., State and ZIP Code	
NEWPORT BEACH CALIF, 92660	
Postage	\$ 90
Certified Fee	75-
Special Delivery Fee	
Restricted Delivery Fee	
Return Receipt Showing to whom and Date Delivered	70
Return receipt showing to whom, Date, and Address of Delivery	
TOTAL Postage and Fees	\$ 2.35
Postmark or Date	AUG 13 1985

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PS Form 3800, Feb. 1982

Sept. to	
CHASE ENERGY INC.	
Street and No.	
2501 E. 20th	
P.O., State and ZIP Code	
FARMINGTON NM 87401	
Postage	\$ 90
Certified Fee	75-
Special Delivery Fee	
Restricted Delivery Fee	
Return Receipt Showing to whom and Date Delivered	70
Return receipt showing to whom, Date, and Address of Delivery	
TOTAL Postage and Fees	\$ 2.35
Postmark or Date	AUG 13 1985

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PS Form 3800, Feb. 1982

Sept. to	
AMARO PRODUCTION CO	
Street and No.	
501 AIRPORT DRIVE	
P.O., State and ZIP Code	
FARMINGTON NM 87401	
Postage	\$ 90
Certified Fee	75-
Special Delivery Fee	
Restricted Delivery Fee	
Return Receipt Showing to whom and Date Delivered	70
Return receipt showing to whom, Date, and Address of Delivery	
TOTAL Postage and Fees	\$ 2.35
Postmark or Date	AUG 13 1985

PS Form 3811, July 1983

SENDER: Complete items 1, 2, 3 and 4.

Put your address in the "RETURN TO" space on the reverse side. Failure to do this will prevent this card from being returned to you. The return receipt fee will provide you the name of the person delivered to and the date of delivery. For additional fees the following services are available. Consult postmaster for fees and check box(es) for service(s) requested.

1. Show to whom, date and address of delivery.

2. Restricted Delivery.

3. Article Addressed to:

W.M. GALLOWAY
3535 E 30th St Suite 10-2
FARMINGTON NM. 87401

4. Type of Service	Article Number
<input type="checkbox"/> Registered <input type="checkbox"/> Insured <input checked="" type="checkbox"/> Certified <input type="checkbox"/> COD <input type="checkbox"/> Express Mail	<i>P017 191533</i>

Always obtain signature of addressee or agent and DATE DELIVERED.

5. Signature - Addressee

X *[Signature]*

6. Signature - Agent

X *[Signature]*

7. Date of Delivery

8. Addressee's Address (ONLY if requested and fee paid)

DOMESTIC RETURN RECEIPT

PS Form 3811, July 1983

SENDER: Complete items 1, 2, 3 and 4.

Put your address in the "RETURN TO" space on the reverse side. Failure to do this will prevent this card from being returned to you. The return receipt fee will provide you the name of the person delivered to and the date of delivery. For additional fees the following services are available. Consult postmaster for fees and check box(es) for service(s) requested.

1. Show to whom, date and address of delivery.

2. Restricted Delivery.

3. Article Addressed to:

CHASE ENERGY
c/o ALLEN Consulting Inc Inc
2501 E 20th
FARMINGTON NM. 87401

4. Type of Service:	Article Number
<input type="checkbox"/> Registered <input type="checkbox"/> Insured <input checked="" type="checkbox"/> Certified <input type="checkbox"/> COD <input type="checkbox"/> Express Mail	<i>P017 191534</i>

Always obtain signature of addressee or agent and DATE DELIVERED.

5. Signature - Addressee

X *[Signature]*

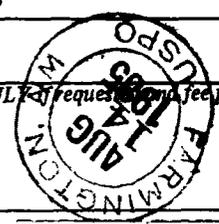
6. Signature - Agent

X *[Signature]*

7. Date of Delivery

8. Addressee's Address (ONLY if requested and fee paid)

DOMESTIC RETURN RECEIPT



Case 8742

APPLICATION FOR AUTHORIZATION TO INJECT

I. Purpose: Secondary Recovery Pressure Maintenance Disposal Storage
Application qualifies for administrative approval? yes no

II. Operator: Reeves Drilling & Petroleum Corp.

Address: P.O. Box 12145 Las Vegas Nevada 89112

Contact party: Denny Reeves Phone: 505-334-8069

III. Well data: Complete the data required on the reverse side of this form for each well proposed for injection. Additional sheets may be attached if necessary.

IV. Is this an expansion of an existing project? yes no
If yes, give the Division order number authorizing the project _____

V. Attach a map that identifies all wells and leases within two miles of any proposed injection well with a one-half mile radius circle drawn around each proposed injection well. This circle identifies the well's area of review.

* VI. Attach a tabulation of data on all wells of public record within the area of review which penetrate the proposed injection zone. Such data shall include a description of each well's type, construction, date drilled, location, depth, record of completion, and a schematic of any plugged well illustrating all plugging detail.

VII. Attach data on the proposed operation, including:

1. Proposed average and maximum daily rate and volume of fluids to be injected;
2. Whether the system is open or closed;
3. Proposed average and maximum injection pressure;
4. Sources and an appropriate analysis of injection fluid and compatibility with the receiving formation if other than reinjected produced water; and
5. If injection is for disposal purposes into a zone not productive of oil or gas at or within one mile of the proposed well, attach a chemical analysis of the disposal zone formation water (may be measured or inferred from existing literature, studies, nearby wells, etc.).

*VIII. Attach appropriate geological data on the injection zone including appropriate lithologic detail, geological name, thickness, and depth. Give the geologic name, and depth to bottom of all underground sources of drinking water (aquifers containing waters with total dissolved solids concentrations of 10,000 mg/l or less) overlying the proposed injection zone as well as any such source known to be immediately underlying the injection interval.

IX. Describe the proposed stimulation program, if any.

* X. Attach appropriate logging and test data on the well. (If well logs have been filed with the Division they need not be resubmitted.)

* XI. Attach a chemical analysis of fresh water from two or more fresh water wells (if available and producing) within one mile of any injection or disposal well showing location of wells and dates samples were taken.

XII. Applicants for disposal wells must make an affirmative statement that they have examined available geologic and engineering data and find no evidence of open faults or any other hydrologic connection between the disposal zone and any underground source of drinking water.

XIII. Applicants must complete the "Proof of Notice" section on the reverse side of this form.

XIV. Certification

I hereby certify that the information submitted with this application is true and correct to the best of my knowledge and belief.

Name: Denny Reeves Title Pres.

Signature: *Denny Reeves* Date: August 10 1985

* If the information required under Sections VI, VIII, X, and XI above has been previously submitted, it need not be duplicated and resubmitted. Please show the date and circumstance of the earlier submittal.

x Logs were submitted after well was first drilled

III. WELL DATA

A. The following well data must be submitted for each injection well covered by this application. The data must be both in tabular and schematic form and shall include:

- (1) Lease name; Well No.; location by Section, Township, and Range; and footage location within the section.
- (2) Each casing string used with its size, setting depth, sacks of cement used, hole size, top of cement, and how such top was determined.
- (3) A description of the tubing to be used including its size, lining material, and setting depth.
- (4) The name, model, and setting depth of the packer used or a description of any other seal system or assembly used.

Division District offices have supplies of Well Data Sheets which may be used or which may be used as models for this purpose. Applicants for several identical wells may submit a "typical data sheet" rather than submitting the data for each well.

B. The following must be submitted for each injection well covered by this application. All items must be addressed for the initial well. Responses for additional wells need be shown only when different. Information shown on schematics need not be repeated.

- (1) The name of the injection formation and, if applicable, the field or pool name.
- (2) The injection interval and whether it is perforated or open-hole.
- (3) State if the well was drilled for injection or, if not, the original purpose of the well.
- (4) Give the depths of any other perforated intervals and detail on the sacks of cement or bridge plugs used to seal off such perforations.
- (5) Give the depth to and name of the next higher and next lower oil or gas zone in the area of the well, if any.

XIV. PROOF OF NOTICE

All applicants must furnish proof that a copy of the application has been furnished, by certified or registered mail, to the owner of the surface of the land on which the well is to be located and to each leasehold operator within one-half mile of the well location.

Where an application is subject to administrative approval, a proof of publication must be submitted. Such proof shall consist of a copy of the legal advertisement which was published in the county in which the well is located. The contents of such advertisement must include:

- (1) The name, address, phone number, and contact party for the applicant;
- (2) the intended purpose of the injection well; with the exact location of single wells or the section, township, and range location of multiple wells;
- (3) the formation name and depth with expected maximum injection rates and pressures; and
- (4) a notation that interested parties must file objections or requests for hearing with the Oil Conservation Division, P. O. Box 2088, Santa Fe, New Mexico 87501 within 15 days.

NO ACTION WILL BE TAKEN ON THE APPLICATION UNTIL PROPER PROOF OF NOTICE HAS BEEN SUBMITTED.

NOTICE: Surface owners or offset operators must file any objections or requests for hearing of administrative applications within 15 days from the date this application was mailed to them.

Data sheet on wells in the area of review.

Malco Copple #6 Reeves Drilling & Petroleum Corp.
 Temporarily abandoned oil well.
 10-3/4" - 32.75 Lbs per foot @ 121' Surface casing
 5-1/2" - 15.50 Lbs per foot @ 3330' Production casing
 4-1/2" - 15.50 Lbs per foot @ 138'

Date drilled January 22, 1958
 Field, Verde Gallup
 SEC. 5, T. 30N. R. 15W. NMPM San Jaun County
 Location 1980' FNL 1980' FEL of Sec. 5 Elevation 5425
 Depth 3462'

Completion record, 0-121' surface casing, 0-3341' production casing, 3341-3462' production liner. Surface casing cemented with 120 sacks cement, circulated to surface. Production casing cemented with 150 sacks cement, circulated from 3341 to 1880'. Production liner set in bottom of hole no cement.

Malco Copple #3 Reeves Drilling & Petroleum Corp.
 Temporarily abandoned oil well.
 8-5/8" - 24.00 Lbs per foot @ 122' Surface casing.
 5-1/2" - 15.50 Lbs per foot @ 2559' Production casing.
 4-1/2" - 16.60 Lbs per foot @ 192' Production liner.

Date drilled May 1, 1957
 Field, Verde Gallup
 Sec. 5 T. 30N. R. 15W. NMPM San Jaun County
 Location 1800' FNL 600' FWL Sec. 5 Elevation 5432'
 Depth 2748'

Completion record, 0-122' surface casing, 0-2569' production casing, 2566-2748' production liner. Surface casing cemented with 150 sacks of cement, circulated to surface. Production casing cemented with 150 sacks of cement, circulated from 2569 to 1930. Production liner set in bottom of hole, no cement.

Malco Copple #8 Reeves Drilling & Petroleum Corp.
 Temporarily abandoned oil well.
 10-3/4" - 32.75 Lbs per foot @ 130' Surface casing.
 5-1/2" - 15.50 Lbs per foot @ 3202' Production casing.
 4-1/2" - 16.60 Lbs per foot @ 217' Production liner.

Date drilled August 25, 1957
 Field Verde Gallup
 Sec. 5 T. 30N R. 15W. NMPM San Jaun County.
 Location 990 FNL 890 FEL Sec. 5 Elevation 5458.
 Depth 3448'

Completion record, 0-130' surface casing, 0-3208' production casing, 3204-3421' production liner. Surface casing cemented with 200 sacks of cement, circulated to surface. Production casing cemented with 150 sacks of cement, circulated from 3208 to 2580. Production liner set in bottom of hole, no cement.

Sheila #1 Oklahoma Oil & Gas Inc.
 Shut-in oil well.
 9-5/8" - 36 Lbs per foot @ 125' Surface casing.
 7" - 23 Lbs per foot @ 2542' Production casing.

Date drilled June 6, 1984
 Field Verde Gallup
 Sec. 5 T. 30N. R. 15W NMPM San Jaun County.
 Location, 765 FNL 2160 FEL Sec. 5 Elevation 5471.

Depth 2814'

Completion record, 0-125' surface casing, 0-2542' production casing, 2542- 2814 open hole. Surface casing cemented with 60 sacks of class A cement, circulated to surface. Production casing cemented with 500 sacks cement, from 2542' to surface. Open hole completion.

E. Thurlani #1 Pan American Petroleum Corp.

Plugged & Abandoned

Location, Sec. 6 T30N R15W. 560' FNL 660' FEL of Sec. 6. Elevation 5354'

Date drilled, June 1, 1957

8-5/8" - 22.7 Lbs per foot @ 163'

5-1/2 - 14 Lbs per foot @ 2025'

B. O. A. #3 B.O.A. Oil & Gas Co.

Plugged & Abandoned

Location, Sec. 32 T31N R15W NMPM Elevation 5471'

760' FSL 1980' FWL Sec. 32.

Date drilled Not available

Well # 5 W.M. Gallaway

Plugged & Abandoned

Location, Sec, 31, T31N, R15W. Elevation 5359'

660' FSL 660' FEL Sec. 31.

Date drilled, February 24, 1957

8-5/8" - 24 Lbs per foot @ 89'

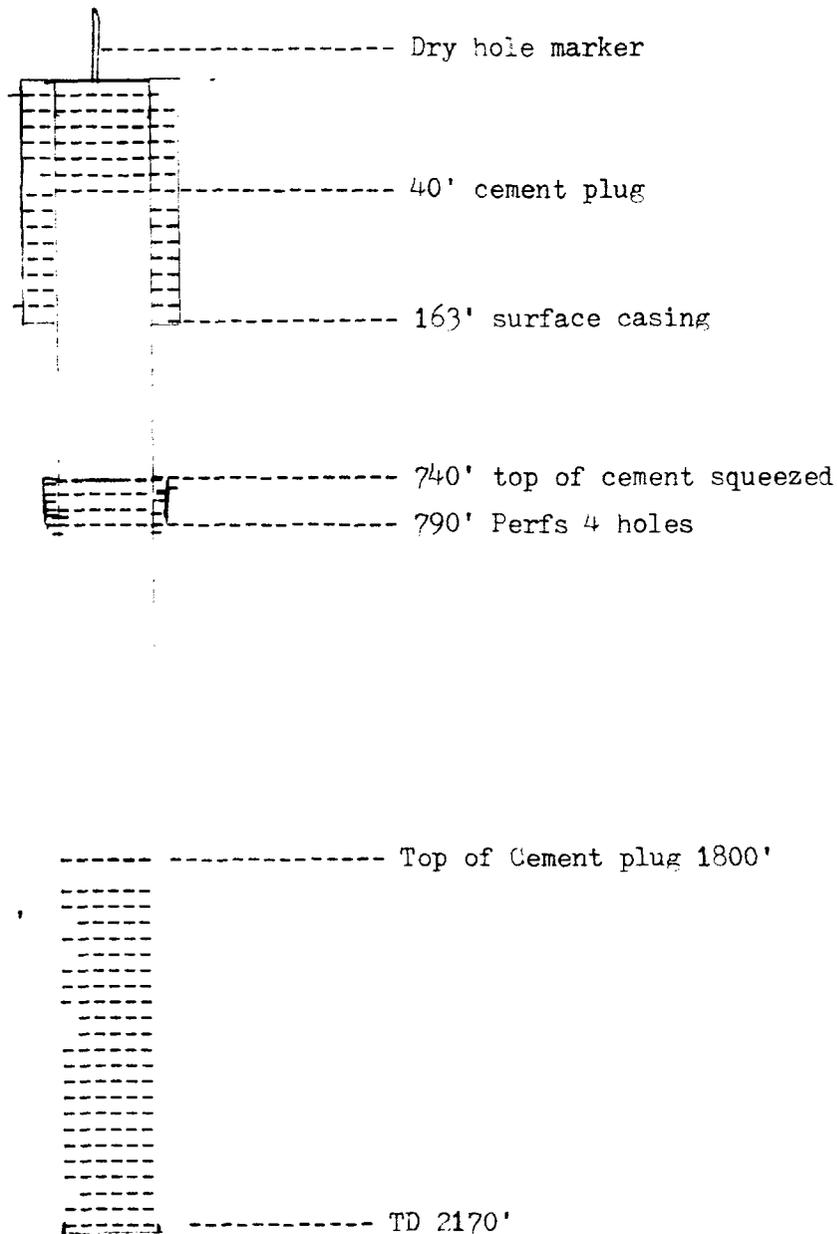
5-1/2 - 14 Lbs per foot @ 1913'

Schematic and details of plugged wells.

E. Thurland #1 Pan American Petroleum Corp.

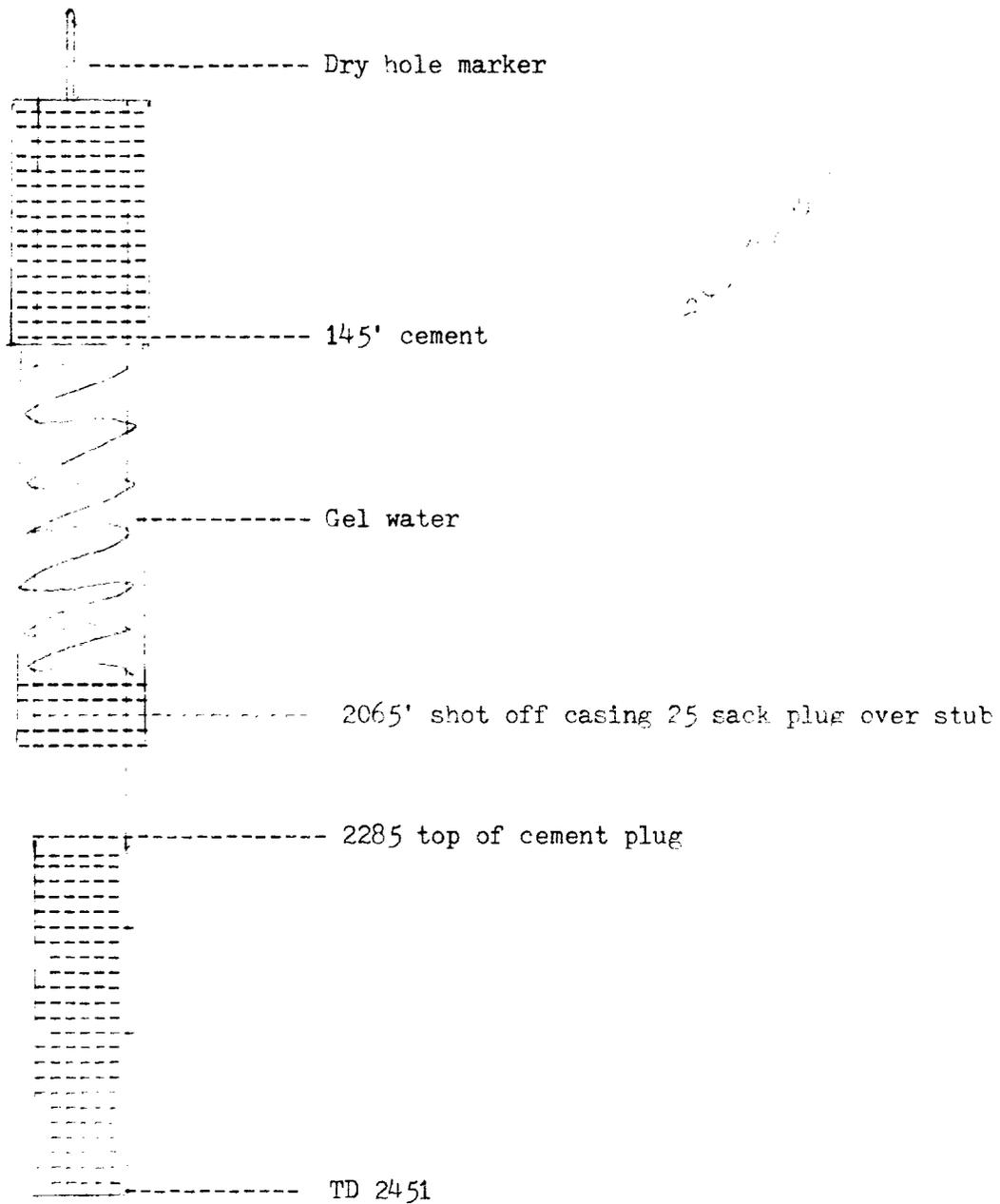
Date plugged June 25 1965.

1. Pumped 75 sack cement plug down 5-1/2" casing with cementing plug, left cement plug at 1800' and squeezing with 2500 psi.
2. Perforated 4 holes at 790' (base of Point Lookout sands) and squeezed 50 sacks of cement into perforations. Left top of cement plug at 740'.
3. Pumped 25 sacks of cement down 5-1/2" and up the annulus of 8-5/8" casing.
4. Spotted 5 sacks of cement from 0-40", and erected dry hole marker.



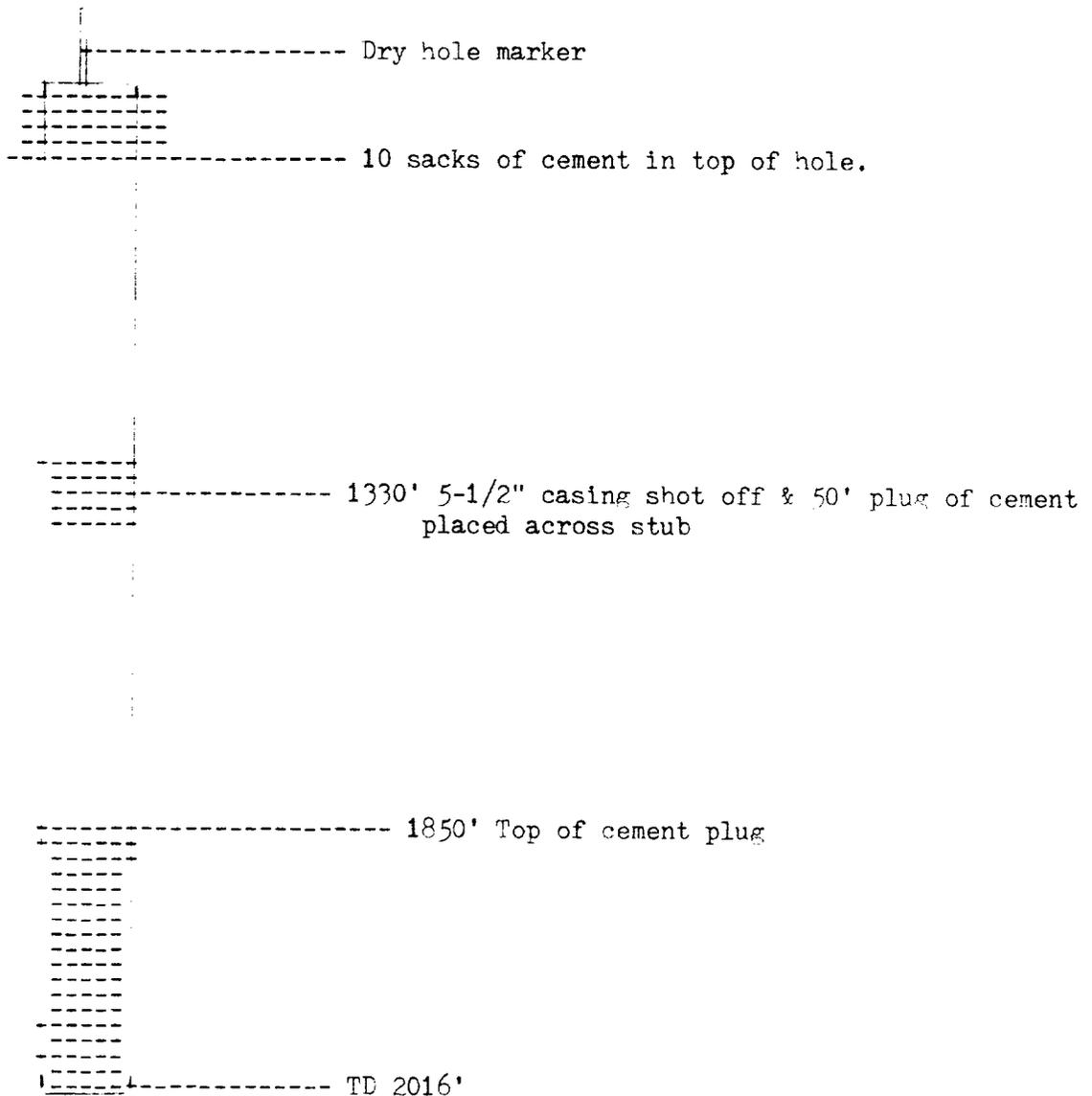
Well #3 B.O.A. Oil & Gas Co.
Date plugged September 20, 1980.

1. Ran tubing in hole and spotted 25 sack cement plug from 2451' - 2285'
2. Shot casing off at 2065'. spotted 25 sack cement plug over stub of pipe.
3. Filled hole with treated gel water.
4. Set 40 sack cement plug from 145' to surface.
5. Erected dry hole marker.



Well #5 W.M. Gallaway
Date plugged December, 1970

1. Spot plug in the Gallup open hole from 1850'- 2016', which is 50' into 5-1/2"
2. shot off casing at 1330' and spotted plug 50' across casing stub.
3. Spotted 50' cement plug across bottom of surface casing at 89'.
4. Placed 10 sacks of cement in top of hole and erected dry hole marker.



Proposed operations for disposal well.

1. The daily rate of injection of water will average between 100 to 250 barrels a day depending on successful restoration of the Malco Copple wells.
2. The injection system is to be closed, use of a closed tank and separator at the well site, that is producing the water and flow lines running to injection well.
3. The average injection pressure will be about 275 PSI. and should not exceed 500 PSI.
4. The water being disposed of is from the Gallup formation, and will be injected into the same formation

Geological data on the Gallup Sandstone

The Gallup Sandstone, a hydro-carbon producing horizon, is composed chiefly of medium to fine grain clastic particles which form lenticular bodies within the lower portion of the Mancos shale. These lenticular bodies were deposited through a normal sequence of deltaic action. The Mancos Shale was deposited along an oscillating shoreline and completely encloses the Gallup Sandstone. (Peterson, et. al.). Because of the deltaic action and oscillating shoreline the Gallup Sandstone in the northern portion of the San Jaun Basin is effectively isolated from the interfingering of the Mancos Shale from the Gallup Sandstone, in the southern portion of the San Jaun basin.

The permeability of the Gallup Sandstone averages about 37 millidarcies throughout the formation. The porosity is close to 13.6 % with water saturation about 30% in some areas. The Gallup Sandstone has a fresh water aquifer in the southern portion of the San Jaun Basin, but this aquifer is not continuous into the central or northern portions of the San Jaun Basin.

The Gallup Sandstone Formation will be utilized as the injection interval. This interval in the Malco Copple #2 well is between 2296' and 2615' depth. The quality of fluids at this depth should be identical to the analysis of the water from Sheila #1 well. Analysis report attached.

The density of the connate water combined with gravity should be sufficient for fluid transport into the Gallup Sandstone. If injection pressure should be necessary after a period of time, it should not exceed 342 psi, as hydraulic fracturing might occur, thus causing a channeling effect.

The Geological information was taken from a report prepared by C.G.(Kris) Scroggins for Reeves Drilling & Petroleum Corp., on the Malco Copple lease.

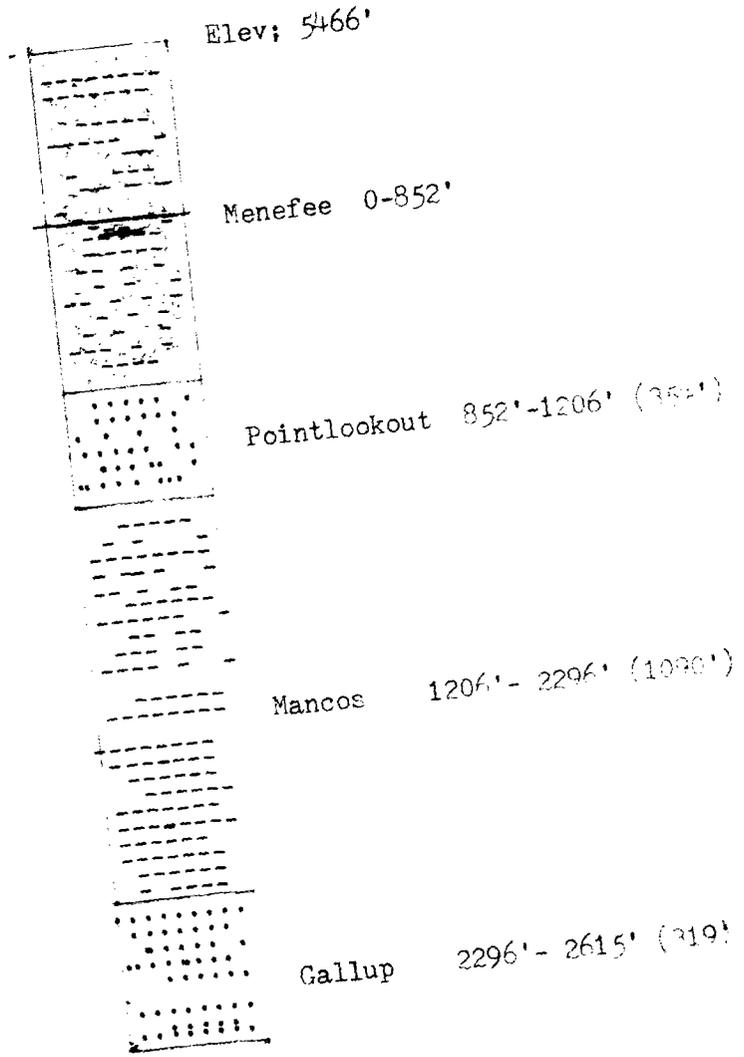
References

Bush, Daniel A., (Stratigraphic Traps in Sandstone--Exploration Techniques), American Assoc. Petroleum Geologist, Tulsa, Oklahoma, 1974, p. 61.

Peterson, James A, et. al. (Sedimentary History and Economic Geology of San Jaun Basin, New Mexico and Colorado) in Subsurface Disposal in Geologic Basins-A Study of Reservoir Strata. John E. Calley, ed. American Assoc. Petroleum Geologist, Tulsa, Oklahoma, 1968, pp. 193, 226.

Warner, Don L., and Lehr, Jay H., (An introduction to the technology of Subsurface Waste Water Injection), Office of Research and Development, U.S. Environmental Protection Agency, Ada, Oklahoma, 1977, pp. 293-316.

Malco Copple #2
Injection Well



Legend

-  Sandstone
-  Shale
-  Sandy Shale
-  Coal Seams

ERA	PERIOD	EPOCH	FORMATION	
MESOZOIC	CRETACEOUS	UPPER	MESAVERDE GROUP	CLIFF HOUSE SS.
				MENELEE FM.
				POINT LOOKOUT SS.
			<p style="text-align: center;">MANCOS SH.</p> <p style="text-align: center;">GALLUP SS. GALLUP SS.</p>	SANASTEE FM.
				LOWER MANCOS SH.
				GREENHORN LS.

Upper Cretaceous lithologic units in San Juan basin.
 Modified from Peterson, et. al. (1968).

The only fresh water zone in the area of review, is the Pointlookout Sands. The depth to the bottom of the Pointlookout Sands in the proposed injection well is 1206 . There is no known source below the injection point, there has been no holes drilled below the Gallup on or around the area of reveiw.

There is no stimulation program planned on the injection well.

Logs are on file with the Division.

There are no fresh water wells within the area of reveiw.

We have examined the geological and engineering data on the area, from the original studys done by El Paso Natural Gas Company, and have found no evidence of open faults or any connection beteen injection zone and fresh water zones.

Well data on the proposed injection well.

Lease name - Reeves Drilling & Petroleum Corp.

Well name Malco Copple #2 , Section 5, Township 30 N, Range 15W. Verde Gallup Field. 360' From the North Line and 1650' From the West Line of Section 5.
Elevation 5466'

Surface casing- 9-5/8 - 25.4 Lbs per foot. Set at 0-122', cemented with 100 sacks, and was circulated to the surface, Hole size for surface was 12-1/4".
Production casing, 7"- 20, Lbs per foot. Set at 0-2465' cemented with 150 sacks of cement, circulated single stage. Cement top at 1515', taken off of temperature survey. Copy on file with Division.
Liner - 5-1/2" 15.5 Lbs per foot, set 167' with Baker shoe from 2465' to TD.
The total depth of hole 2615'.

The tubing that is going to be used is, 2-3/8 4.7 Lbs per foot, with 8 RD threads per inch. The make of tubing is J-55. The tubing will be set at 2500', with the packer being placed at 2460', the top of the liner,.
The packer model number is II retrievable made by Halliburton.

The Gallup Sandstone will be the formation used to inject into. The well is located in the Verde Gallup field, San Juan County.
The injection interval is 2465'-2615' and it is open hole with liner, no cement. The well was originally drilled as an oil well, the well currently makes a small amount of gas and about 70 barrels of water a day.
There are no higher producing zones in this well, and the next lower zone is about 200' deeper, and it is the GreenHorn Limestone.

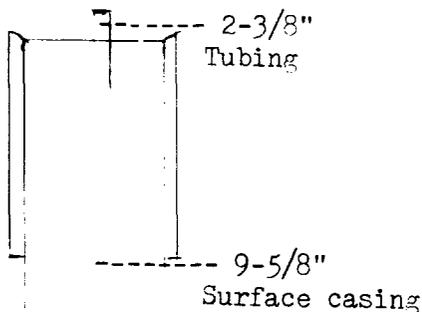
The surface is held by the BLM, where the well is located.

INJECTION WELL DATA SHEET

Reeves Drilling & Petroleum Corp Malco Copple
OPERATOR LEASE

Malco Copple #2 360' FNL 1650' FWL Sec. 5 T.30N. R. 15W
WELL NO. FOOTAGE LOCATION SECTION TOWNSHIP RANGE

Schematic



Tabular Data

Surface Casing

Size 9-5/8 " Cemented with 100 sx.
 TOC 0-122' feet determined by Temp. Survey
 Hole size 12 1/4

Intermediate Casing

Size _____ " Cemented with _____ sx.
 TOC _____ feet determined by _____
 Hole size _____

Long string

Size 7 " Cemented with 150 sx.
 TOC 1515 feet determined by Temp. Survey
 Hole size 8-3/4
 Total depth 2615

Injection interval

2465 feet to 2615 Open - Hole feet
 (perforated or open-hole, indicate which)

- ~~~~~ Packer 2460'
- Bottom of 7" casing
- Bottom of tubing 2500'
- Open hole Gallup Sandstone

Tubing size 2-3/8 lined with steel set in a
(material)
Halliburton Model II packer at 2460' feet.
(brand and model)

(or describe any other casing-tubing seal).

Other Data

1. Name of the injection formation Gallup Sandstone
2. Name of Field or Pool (if applicable) Verde Gallup
3. Is this a new well drilled for injection? Yes No
 If no, for what purpose was the well originally drilled? Oil
4. Has the well ever been perforated in any other zone(s)? List all such perforated intervals and give plugging detail (sacks of cement or bridge plug(s) used) NO other perf.
5. Give the depth to and name of any overlying and/or underlying oil or gas zones (pools) in this area. No overlying zones Next lower zone Greenhorn 200' appr.

NOWSCO SERVICES

P.O. Box 1079 • Farmington, NM 87401 • Phone 505-327-4911

API WATER ANALYSIS REPORT FORM

DATE 7/12/84
 COMPANY Oklahoma Oil & Gas
 SAMPLE NO. 1
 DATE SAMPLED 7/10/84
 FIELD Verde- Gallup
 COUNTY OR PARISH San Juan
 STATE New Mexico

TYPE SAMPLE Produced Fluid -- top of tank
 DEPTH 2,775'
 FORMATION Lower Gallup
 WELL NO. #1
 LEASE Sheila
 SAMPLED BY Denny Reeves
 REPORT BY Ray Herndon

DISSOLVED SOLIDS

Cations	mg/l	me/l	x Valence =	Product
Sodium, Na & K	<u>22,057</u>		1	
Calcium, Ca	<u>800</u>		2	
Magnesium, Mg	<u>267</u>		2	
Barium, Ba	<u>--</u>			
TOTAL	<u>23,124</u>			

Anions

Chloride, Cl	<u>36,034</u>		1	
Sulfate, SO ₄	<u>0</u>		2	
Bicarbonate, HCO ₃	<u>330</u>		1	
Carbonate, CO ₃	<u>0</u>		-	
TOTAL	<u>36,364</u>			

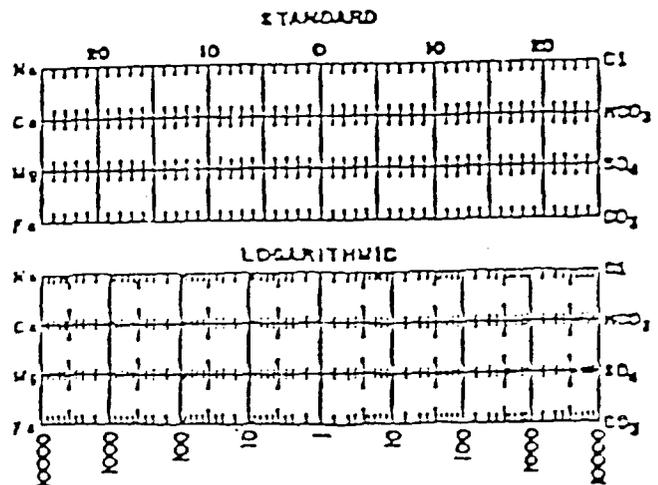
Total Hardness = 3,100
 Total Dissolved Solids (calc.) 59,498 ppm

Iron, Fe (total) 10 ppm
 Sulfide, as H₂S 0
 Specific Gravity @ 1.042 @ 66°F

pH @ Temp. 5.0 @ 66°F
 Resistivity 0.13 Ohm-meters
 BHT °F _____

Remarks: Calcium Carbonate and Calcium Sulfate scaling tendencies is remote.

WATER PATTERNS — me/l.



Raymond A. Herndon

APPENDIX A

CALCIUM CARBONATE
Solubility Calculation
Stiff and Davis Extension of Langelier Method

EQUATION: $SI = pH - (K + pCa + pAlk)$

1. Perform standard water analysis.
2. Calculate ionic strength of water.

Ion	Concentration ppm (mg/l)	Conversion Factor		Ionic Strength (μ)
Na ⁺⁺ + K ⁺	22057	x (2.2x10 ⁻⁵)	=	48525 x 10 ⁻⁵
Ca ⁺⁺	800	x (5.0x10 ⁻⁵)	=	4000 x 10 ⁻⁵
Mg ⁺⁺	267	x (8.2x10 ⁻⁵)	=	2189 x 10 ⁻⁵
Cl ⁻	36034	x (1.4x10 ⁻⁵)	=	50448 x 10 ⁻⁵
HCO ₃ ⁻	330	x (0.82x10 ⁻⁵)	=	271 x 10 ⁻⁵
CO ₃ ⁼	0	x (2.1x10 ⁻⁵)	=	0 x 10 ⁻⁵
SO ₄ ⁼	0	x (2.1x10 ⁻⁵)	=	0 x 10 ⁻⁵
Total ionic strength (μ) =				105433 x 10 ⁻⁵

3. Determine K from Fig. 2A or 2B

*Temperature = 5/9 (66 °F - 32) = 19 °C; K = 3.5

4. Determine pCa from Fig. 3

Ca⁺⁺ = 800 mg/l; pCa = 1.7

- *5. Determine total alkalinity by adding HCO₃⁻ to CO₃⁼

HCO₃⁻ = 330 mg/l

CO₃⁼ = 0 mg/l

Total Alkalinity = 330 mg/l; from Fig. 3, pAlk = 2.25

6. Add (K + pCa + pAlk) = (3.5 + 1.7 + 2.25) = 7.45

- *7. pH = 5.0

8. SI = pH - (K + pCa + pAlk)

= 5.0 - (7.45) = -2.45

If SI is negative, scaling is remote.

If SI is positive, scaling is probable.

*Temperature, pH, HCO₃⁻ and CO₃⁼ should be determined in the field on a fresh sample of water.

Anions

Cl ⁻	(ppm Cl ⁻) (0.0282) =	<u>1016</u>
SO ₄ ⁻²	(ppm SO ₄ ⁻²) (0.0208) = +	<u>0</u>
HCO ₃ ⁻	(ppm HCO ₃ ⁻) (0.0164) = +	<u>5</u>
CO ₃ ⁻²	(ppm CO ₃ ⁻²) (0.0333) = +	<u>0</u>
Total Anions	=	<u><u>1021</u></u>

Cations

Ca ⁺²	(ppm Ca ⁺²) (0.0500) =	<u>40</u>
Mg ⁺²	(ppm Mg ⁺²) (0.0820) = +	<u>22</u>
Total Cations	=	<u><u>62</u></u>

ppm Sodium and Potassium = (Total Anions - Total Cations) (23) = 22,057

XII. Resistivity Measurements:

Resistivity may be measured using either a resistivity meter or using tables which correlate specific gravity with total dissolved solids and resistivity. Resistivity is recorded in ohm-meters.

XIII. Total Dissolved Solids Determination:

The total dissolved solids is a total of all of the ions in solution recorded in parts per million (mg/l). This number may be approximated, using the enclosed chart which relates specific gravity to total dissolved solids or more precisely by the following method:

<u>Anions</u>	<u>Cations</u>
ppm Cl ⁻ <u>36034</u>	ppm Ca ⁺² <u>800</u>
ppm SO ₄ ⁻² + <u>0</u>	ppm Mg ⁺² <u>267</u>
ppm HCO ₃ ⁻ + <u>330</u>	ppm K ⁺ and Na ⁺ <u>+22,057</u>
ppm CO ₃ ⁻² + <u>0</u>	ppm Fe + <u>10.4</u>
Total Anions <u>36364</u>	Total Cations <u>23134</u>

(Total Anions) + (Total Cations) = Total Dissolved Solids = 59498 ppm

XIV. Inventory of Materials Needed for Water Analysis

Hardware:

CALCIUM SULFATE
Solubility Calculation
Skillman, McDonald and Stiff Method

EQUATION: $S = 1000 \left[\sqrt{X^2 + 4K_{sp}} - X \right]$

1. Perform standard water analysis.
2. Calculate ionic strength of water.

Ion	Concentration ppm (mg/l)	Conversion Factor		Ionic Strength (μ)
Na ⁺ + K ⁺	22057	x (2.2x10 ⁻⁵)	=	48525 x 10 ⁻⁵
Ca ⁺⁺	800	x (5.0x10 ⁻⁵)	=	4000 x 10 ⁻⁵
Mg ⁺⁺	267	x (8.2x10 ⁻⁵)	=	2189 x 10 ⁻⁵
Cl ⁻	36034	x (1.4x10 ⁻⁵)	=	50448 x 10 ⁻⁵
*HCO ₃ ⁻	330	x (0.82x10 ⁻⁵)	=	271 x 10 ⁻⁵
*CO ₃ ⁼	0	x (2.1x10 ⁻⁵)	=	0 x 10 ⁻⁵
SO ₃ ⁼	0	x (2.1x10 ⁻⁵)	=	0 x 10 ⁻⁵
Total ionic strength =				105433 x 10 ⁻⁵

*3. Temperature = 5/9 (66 °F - 32) 19 °C

4. Determine K_{sp} from Fig. 5; K_{sp} = ~~19E-5~~ 4K_{sp} = .0076

5. Calculate X.

Ion	Concentration ppm (mg/l)	Conversion Factor		M (mol/l)
Ca ⁺⁺	800	x (2.5x10 ⁻⁵)	=	2000 x 10 ⁻⁵
SO ₄ ⁼	0	x (1.04x10 ⁻⁵)	=	0 x 10 ⁻⁵

Subtract the smaller of the two values M from the larger.

$X = \Delta M = 2000 \times 10^{-5}$ $X = .02$; $X^2 = .0004$

6. Calculate S, solubility of CaSO₄ in brine.

$X^2 + 4K_{sp} = (.0004 + .0076) = .0080$; $\sqrt{X^2 + 4K} = .0894$

Total = 1000 x ($\sqrt{X^2 + 4K} - X$) = 1000 x (.0894 - .02) = S = 69.44

7. Determine actual concentration of CaSO₄ in brine.

Ion	Concentration ppm (mg/l)	Equivalent Weight	mg/l Eq. Wt.	= meq/l
Ca ⁺⁺	800	20	40	= meq/l
SO ₄ ⁼	0	48	0	= meq/l

The actual concentration of CaSO₄ in the brine is the smaller of the two values.

Actual concentration of CaSO₄ 0 meq/l

8. Compare solubility (S) vs. actual concentration of CaSO₄.

S = 69.44 meq/l

Actual = 0 meq/l

If S is greater than actual, scaling is remote.

If S is less than actual, scaling is probable.

*Temperature, HCO₃⁻ and CO₃⁼ should be determined in the field on a fresh sample of water.