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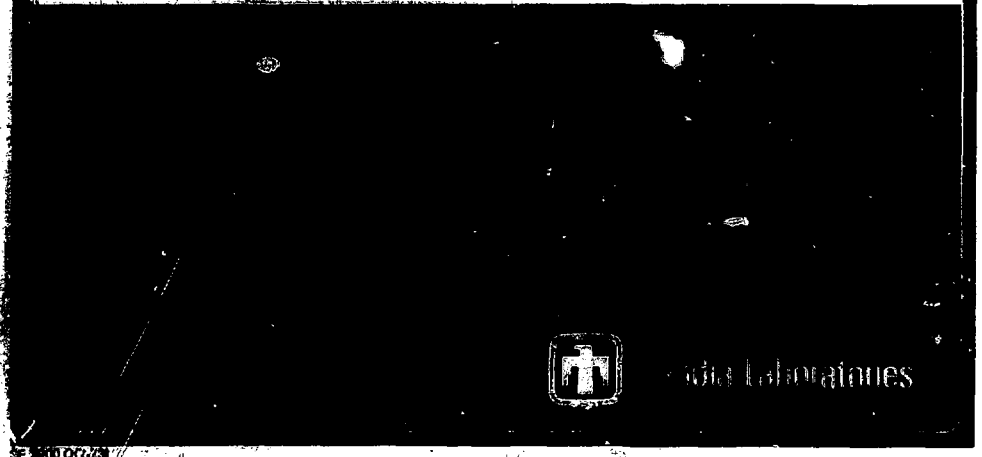
Basic Data Report for Drillhole WIPP 13 (Waste Isolation Pilot Plant - WIPP)

Sandia Laboratories and
United States Geological Survey



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for

Drillhole

WIPP 13

(Waste Isolation Pilot Plant - WIPP)

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Compiled by

Sandia Laboratories

(Division 4511)

and

United States Geological Survey

(Special Projects Branch)

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1.0 ABSTRACT

The borehole WIPP-13 was drilled in the SW 1/4 section 17, T22S, R31E of eastern Eddy County during July and August, 1978, to investigate the nature of a resistivity anomaly. The stratigraphic section was normal, consisting of 13 feet of Quaternary deposits (including artificial fill for drill pad), 53 feet of the Triassic Santa Rosa Sandstone, 451 feet of Dewey Lake Red Beds, 269 feet of the Rustler Formation and 179 feet of the upper member of the Salado Formation. Consecutive cores were taken from 570 to 595, 656 to 729, and 827 to 878 feet. Cuttings were collected at 10-foot intervals throughout the rest of the hole. Geophysical logs were run to aid in interpretation of the stratigraphy.

The WIPP is to demonstrate (through limited operations) disposal technology for transuranic (TRU) defense wastes. Eventual conversion of the facility to a repository for TRU defense wastes is anticipated. The WIPP will also provide research facilities for interactions between high-level waste and salt.

2.0 INTRODUCTION

by

D. W. Powers[1] and W. D. Weart[2]

The introduction describes background information on the Waste Isolation Pilot Plant (WIPP) and the investigations involving WIPP 13.

2.1 The Purpose of WIPP

The purpose of the WIPP is distinct from that of several other projects for the disposal of radioactive waste. The WIPP is planned to demonstrate disposal technology for the transuranic (TRU) waste resulting from this nation's defense programs of over 30 years. After a period (5-10 years) of limited (pilot) operation, during which the waste is readily retrievable, it is anticipated that the WIPP will be converted to a full-scale repository for permanent disposal of defense TRU waste. The WIPP plans also include a research facility to examine, on a large scale, the interactions between bedded salt and high-level radioactive waste resulting from thermal and radiation fluxes. There is no plan at this time to dispose of high-level waste or spent fuel in the WIPP. DOE had expressed an intent to request licensing of the WIPP by the Nuclear Regulatory Commission (NRC). This licensing policy was not acceptable to the Congressional committees responsible for WIPP and DOE has agreed to proceed without licensing.

Additional information on the WIPP and characterization of the WIPP site may be found in Powers, et. al. (1978).

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2.2. The Purpose of WIPP 13

Vine (1963) and Reddy (1961) have mapped various surficial features around Nash Draw and Malaga Bend which have more recently been called "breccia pipes." Mississippi Chemical Corporation has mined under Hill C (Vine, 1963) where a brecciated mass of rock was encountered in the McNutt potash zone. Thus concern was born that such structures might pose paths for radionuclide migration from the WIPP. Field mapping and exploration methods were applied to screen for such structures at the WIPP.

The most useful screening method has been electrical resistivity. Tests of the method over Hills A and C and the Weaver location, known to be brecciated at depth, produced anomalously low resistivities (Elliot, 1976). While these and other tests of resistivity do not indicate a unique response to "breccia pipes," the technique is useful for screening.

A 1977 resistivity survey of the WIPP site (Elliot, 1977) at close, regular spacings indicated a resistivity anomaly in section 17, T22S, R31E, similar to, but of lesser magnitude than, that found at Hill C. A resurvey in 1978 (Bell, 1979) verified the anomaly and more precisely located the center for drilling of WIPP 13.

WIPP 13 is located near the center of the resistivity anomaly in order to best examine the nature of the anomaly. It is expected that a "breccia pipe" would be manifest as very disturbed or uninterpretable stratigraphy. The normal stratigraphy was forecast as a measure of any disturbance. Geophysical logs, including electrical logs, were utilized to determine physical properties useful in interpretation of the stratigraphy.

This report is of basic geological data which may be compared with other boreholes and normal stratigraphy. An interpretive report of the subsurface causes of the resistivity anomaly is in preparation.

Additional details regarding the background and justification for WIPP 13 are in Appendix A.

3.0 GEOLOGIC DATA FOR BOREHOLE WIPP 13

by

J. L. Gonzales[1] and C. L. Jones[2]

3.1 Abstract

Borehole WIPP 13 was drilled in the north-central part of the Waste Isolation Pilot Plant site in eastern Eddy County, New Mexico, during July and August, 1978, to test a near-surface resistivity anomaly. The rocks penetrated included the Santa Rosa Sandstone of Triassic age and the Dewey Lake Red Beds, the Rustler Formation, and the upper part of the Salado Formation of Permian age. Detailed lithologic and geophysical logs of the borehole are presented in this chapter.

3.2 Introduction

Borehole WIPP 13 is an exploratory borehole drilled to determine the nature of a resistivity anomaly in the north-central part of the WIPP (Waste Isolation Pilot Plant) site. The drilling was done on behalf of the WIPP project office of the DOE (U.S. Department of Energy).

All measurements related to the drill hole are reported in the inch-pound system. These units are used to facilitate direct comparison of measurements made by surveyors in establishing the geographic coordinates of WIPP 13, by drillers in reporting well depths for cuttings and cores, and by geophysical loggers in recording inhole variations in rock properties with depth. If Metric units are desired, the following conversion factors should be used:

Multiply English unit	By	To obtain Metric unit
foot (ft)	0.3048	meter (m)
inch (in)	25.4	millimeter (mm)
inch (in)	2.54	centimeter (cm)
pounds per square inch (lb/in^2)	0.06895	megapascal (MPa)

[1]Fenix & Scisson, Inc., Carlsbad, New Mexico

[2]U.S. Geological Survey, Denver, Colorado

3.3 Description of WIPP 13

WIPP 13 is in eastern Eddy County, New Mexico, in the SW 1/4 section 17, T22S, R31E (Figure 1; Table 1). The borehole was drilled between July 24 and August 4, 1978, to a depth of 1,025 feet, measured from a land-surface altitude of 3,405.43 feet above mean sea level. Consecutive cores were taken from 570 to 595, 656 to 729, and 827 to 878 feet; cuttings were collected at 10-foot intervals throughout other parts of the hole. The cuttings and cores were logged at the drill site, and a detailed lithologic log of the borehole (Table 2; Figure 2) was prepared by S. L. Drellack, Jr., J. L. Gonzales, and A. F. McIntyre of F&S (Fenix & Scisson, Inc.).

WIPP 13 penetrated a normal stratigraphic section of red beds and evaporites resembling the section found in other parts of the WIPP site (Jones, 1973). The red beds included sandstone and siltstone of the Santa Rosa Sandstone of Triassic age and siltstone, mudstone, and sandstone of the Dewey Lake Red Beds of Permian age. The evaporites comprised anhydrite (partially altered to gypsum), halite, dolomite, mudstone, and siltstone of the Rustler Formation, and about 160 feet of halite, polyhalite, and siltstone of the Salado Formation, both of Permian age. Additional stratigraphic details are summarized in Table 2. Lithologic details of the formations are given in Table 3. The lithology is interpreted and correlated with selected geophysical logs on Figure 2.

As part of the exploratory work, geophysical logs were taken the full length of the borehole. The logging was done to facilitate the identification and correlation of rock units, the identification of gross lithologies (i.e., dolomite, anhydrite, polyhalite, and halite) and to provide a depth determination independent of that indicated by drill-rod measurement. The geophysical logs included (1) gamma-ray curve that recorded variations in the distribution of potassium and other radioactive elements, (2) a gamma-gamma curve that recorded variations in rock density, and (3) a neutron curve that recorded variations in the distribution of hydrogen.

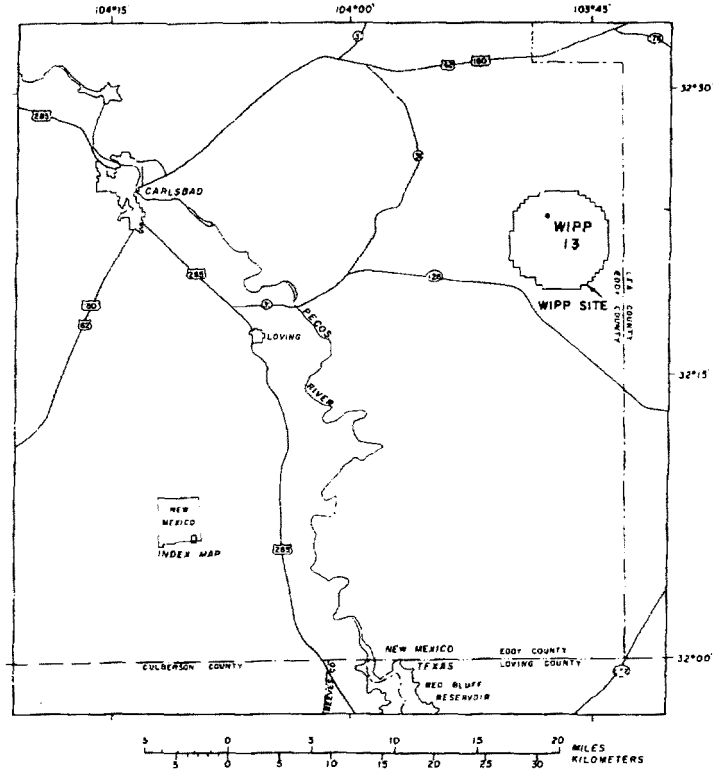

Figure 1. -- Index map showing location of borehole WIPP 13.

Table 2.--Stratigraphic summary of borehole WIPP-13

Rock unit	Depth interval[1] Feet
Quaternary deposits[2]	0-13
Triassic rocks	
Santa Rosa Sandstone	13-66
Permian rocks	
Dewey Lake Red Beds	66-517
Rustler Formation	517-846
Dissolution residue	543-550
Magenta Dolomite Member	565-583
Dissolution residue	679-686
Culebra Dolomite Member	703-726
Dissolution residue	730-735
Top of highest salt in section	745
Salado Formation	846-1,025
Upper member	846-1,025
[3]MB 101	~967
[3]MB 102	~1,003
[3]MB 103	([4])
Maximum depth recorded	1,027

[1]Depth interval recorded from compensated neutron-formation density log.

[2]Includes artificial fill for drill pad, unnamed sand dune deposits, and the Mescalero caliche of Pleistocene age.

[3]MB, marker bed.

[4]Base of unit.

[5]Top of unit at 1,018 feet; base below 1,027 feet.

Table 1.--Abridged borehole history of WIPP-13

LOCATION: Section 17, T. 22 S., R. 31 E.
2566 feet from south line
1731 feet from west line

ALTITUDE (LAND SURFACE): 3,405.43 feet. Datum for depth measurements in drilling and logging operations.

LITHOLOGIC LOG PREPARED BY: S. L. Drellack, Jr., J. L. Gonzales, and A. F. McIntyre (F&S), July 26 to August 4, 1978.

DRILLING CONTRACTOR: Pennsylvania Drilling Co.

DRILLING RECORD: Commenced drilling July 26, 1978, and completed on August 4, 1978, at 1,025 feet below land surface.

Hole temporarily abandoned pending conversion to a hydrologic observation well.

Core No.	Depth interval Feet	RPM	Weight on bit (lbs)	Circulating pressure (lb/in^2)	Feet cored	Feet recovered	Percent recovered
1	570-581	60	14,000	200/300	11.0	11.0	100
2	581-590	50/60	14,000	200	9.0	9.0	100
3	590-595	50/60	14,000	200	5.0	5.0	100
4	656-669	80/60	15,000	200/300	13.0	12.6	97
5	669-689	80/60	14,000	200/300	20.0	20.4	102
6	689-709	65	14,000	200/300	20.0	20.0	100
7	709-722	65	14,000	200/300	13.0	13.0	100
8	722-729	65	14,000	200/300	7.0	5.0	71
9	827-853	60	14,000	200	26.0	26.0	100
10	853-878	60	14,000	300	25.0	22.0	88

Table 3.--Lithologic log for borehole WIPP-13

[Color designations are from the Rock-Color Chart (Goddard and others, 1948). Depth interval; no core designates intervals where core was lost during drilling operations]

Lithologic description	Depth interval Feet
No core	0-36.0
Siltstone, grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4); with large greenish-gray (5GY 6/1) reduction spots, moderately hard; trace of very fine grained, greenish-gray (5GY 6/1) sandstone; contains some biotite	36.0-40.0
Sandstone (50 percent), grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4), fine-grained, subrounded; grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4) mudstone (25 percent); siltstone (25 percent), same as above; trace of very fine grained greenish-gray (5GY 6/1) sandstone	40.0-50.0
Sandstone, grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4), fine-grained, some very fine grained, subrounded, hard, biotitic; trace of grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4) siltstone; trace fine-grained to very fine grained, subrounded, hard, biotitic, light-olive-gray (5Y 6/1) sandstone; trace of greenish-gray (5GY 6/1) siltstone	50.0-60.0
Sandstone (80 percent), light-olive-gray (5Y 6/1), same as above; moderately hard to soft grayish-red (10R 4/2) mudstone (10 percent); light-olive-gray (5Y 6/1) sandstone; grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4) siltstone (10 percent), same as above; trace of greenish-gray (5GY 6/1) siltstone, same as above	60.0-70.0
Siltstone (60 percent), grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4), grading toward mudstone, hard to moderately hard; some fissile, grayish-red (10R 4/2) mudstone (40 percent); trace of greenish-gray (5GY 6/1) siltstone, same as above	70.0-90.0
Siltstone (70 percent), grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4), same as above; mudstone (30 percent), same as above; trace of greenish-gray (5GY6/1) siltstone, same as above	90.0-100.0
Siltstone (90 percent), grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4), same as above, contains some biotite, few reduction spots; mudstone (10 percent), same as above; light-olive-green (5Y 6/1) and greenish-gray (5GY 6/1)siltstone	100.0-110.0
Siltstone (80 percent) same as above; moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4) mudstone (20 percent); trace of grayish-green (5G 5/2) mudstone, and biotitic, light-olive-gray (5Y 6/1) siltstone	110.0-130.0
Siltstone (90 percent), same as above; mudstone (10 percent), same as above; trace of light-olive-gray (5Y 6/1) siltstone; contains biotite	130.0-140.0

Table 3.--Lithologic log for borehole HPW-13--Continued

Lithologic description	Depth interval Feet
Siltstone (60 percent), same as above; mudstone (35 percent), same as above; very hard, pale-yellowish-brown (10YR 5/4) siltstone (5 percent)----------	140.0-150.0
Siltstone (90 percent), same as above; dark-reddish-brown (10R 3/4) mudstone (10 percent); trace of moderate-reddish-brown (10R 4/6) mudstone----------	150.0-160.0
Mudstone (40 percent), dark-reddish-brown (10R 3/4); dark-reddish-brown (10R 3/4) siltstone (30 percent); very fine grained, grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4) sandstone (30 percent)----------	160.0-170.0
Siltstone (80 percent), same as above; mudstone (20 percent), same as above; trace of sandstone, same as above----------	170.0-180.0
Siltstone, grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4), grades into mudstone, trace of small (less than 1 mm in diameter), grayish-green (10GY 5/2) reduction spots; trace of very fine grained, subrounded, light-olive-gray (5Y 5/2) sandstone; trace of very fine grained to medium-grained, light-olive-gray (5Y 5/2) sandstone----------	180.0-190.0
Siltstone (90 percent), same as above; moderately hard, some slightly friable, very fine grained, dark-reddish-brown (10R 3/4), some light-olive-gray (5Y 5/2) to greenish-gray (5GY 6/1) sandstone (10 percent); trace of mudstone, same as above----------	190.0-210.0
Siltstone (90 percent), same as above; argillaceous, very fine grained, dark-reddish-brown (10R 3/4) sandstone (10 percent); trace of very fine grained to medium-grained, poorly sorted, dark-reddish-brown (10R 3/4) sandstone----------	210.0-220.0
Siltstone, dark-reddish-brown (10R 3/4), approaching very fine grained sandstone in size, hard; trace of reduction spots----------	220.0-230.0
Siltstone, same as above, becoming finer grained, and biotitic downward; trace of reduction spots; trace of greenish-gray (5GY 6/1) siltstone----------	230.0-240.0
Siltstone (70 percent), same as above; moderately hard to slightly friable; subrounded fine-grained, grayish-orange-pink (5YR 7/2) sandstone (20 percent); dark-reddish-brown (10R 3/4) mudstone (10 percent)----	240.0-250.0
Siltstone, same as above; trace of dark-reddish-brown (10R 3/4) and greenish-gray (5GY 6/1) mudstone----------	250.0-310.0
Siltstone, dark-reddish-brown (10R 3/4), slightly biotitic; trace (less than 1 mm in diam) of greenish-gray (5GY 6/1) reduction spots; trace of greenish-gray (5GY 6/1) siltstone----------	310.0-320.0
Siltstone (80 percent), same as above; firm, smooth-textured, dark-reddish-brown (10R 3/4) mudstone (20 percent)----------	320.0-330.0
Siltstone (80 percent), same as above; some grading to mudstone; mudstone (20 percent), same as above----------	330.0-340.0

Table 3.--Lithologic log for borehole WIPP-13--Continued

Lithologic description	Depth interval Feet
Siltstone, same as above; trace of slightly friable, subrounded, fine-grained, dark-reddish-brown (10R 3/4) sandstone	340.0-350.0
Siltstone, same as above; trace of mudstone, same as unit at 320.0-330.0 feet	350.0-360.0
Siltstone, dark-reddish-brown (10R 3/4); few light-olive-gray (5Y 6/1) reduction spots (2-4 mm in diam)	360.0-390.0
Siltstone, same as above	390.0-420.0
Siltstone (70 percent), dark-reddish-brown (10R 3/4); trace of greenish-gray (5GY 6/1) reduction spots (less than 1 mm in diam); dark-reddish-brown (10R 3/4) mudstone (30 percent); trace of very calcareous, very fine grained, pale-reddish-brown (10R 5/4) sandstone	420.0-430.0
Siltstone (90 percent), same as above; mudstone (10 percent) same as above	430.0-440.0
Siltstone (80 percent), same as above; mudstone (20 percent), same as above	440.0-450.0
Siltstone, dark-reddish-brown (10R 3/4), firm to moderately hard	450.0-460.0
Siltstone (90 percent), same as above; mudstone (10 percent), same as unit at 420.0-430.0 feet	460.0-470.0
Siltstone, same as above	470.0-510.0
Siltstone, same as above; trace of white (N9) gypsum	510.0-520.0
Anhydrite, pale-yellowish-brown (10YR 6/2) to light-olive-gray (5Y 6/1), massive to very finely crystalline, brittle	520.0-530.0
Anhydrite (90 percent), same as above; dark-reddish-brown (10R 3/4) to moderate-reddish-brown (10R 4/6) mudstone (10 percent)	530.0-540.0
Anhydrite (70 percent), same as above, some becoming darker toward a dark-yellowish-brown (10YR 4/2); chalky, very finely crystalline, very light gray (N8) gypsum (20 percent); mudstone (10 percent), same as unit at 530.0-540.0 feet	540.0-550.0
Gypsum (50 percent), same as above; anhydrite (30 percent), same as above; mudstone (20 percent), same as above	550.0-560.0
Gypsum (70 percent), same as above; anhydrite (30 percent), same as above	560.0-565.0
Gypsum (90 percent), same as above; anhydrite (10 percent), same as above; selenite vein in anhydrite	565.0-570.0
Dolomite, light-olive-gray (5Y 6/1) and olive-gray (5Y 4/1), silty, thinly laminated; broken and shattered by numerous fractures dipping 60°-80° and displacing bedding planes 0.5-1.0 cm	570.0-581.0
Dolomite, light-olive-gray (5Y 6/1) and olive-gray (5Y 4/1), thinly laminated, dipping 20°-30°; liberally dotted with solution pits from 584.3 to 584.8 feet; contains network of gypsum veinlets 1 mm wide by 1-5 cm long, dipping 60°-70°; few gypsum-filled fractures offset bedding planes from 1 to 2 mm	581.0-584.8
Gypsum, dark-yellowish-brown (10R 4/2) to dusky-yellowish-brown (10R 2/2); very finely crystalline; sparse, silty, wavy laminae dipping 30°-40°, contains gypsum veinlets and gypsum-filled fractures	584.8-590.0

Table 3.--Lithologic log for borehole WIPP-13--Continued

Lithologic description	Depth interval Feet
Anhydrite, dark-yellowish-brown (10YR 4/2) and olive-gray (5Y 4/1), massive, nodular structure, very finely crystalline, gypsiferous and sparingly argillaceous; network of gypsum-filled fractures, most dipping about 10°------	590.0-595.0
Anhydrite, light-olive-gray (5Y 6/1) to olive-gray (5Y 4/1), very finely crystalline, very hard, brittle, somewhat gypsiferous----------	595.0-625.0
Gypsum (70-80 percent), clear to white (N9), very finely crystalline; anhydrite (20 percent), same as above----------	625.0-650.0
Anyhdrite (90 percent), olive-gray (5Y 4/1) to light-olive-gray (5Y 6/1), very finely crystalline, very hard; chalky, very finely crystalline, very light gray (N8) gypsum (10 percent)----------	650.0-656.0
Gypsum, medium-dark-gray (N4) to medium-gray (N5), very finely crystalline, argillaceous and in places silty; contains veins of selenite, 2-20 mm thick, dipping 60°-70°; nodules of light-olive-gray (5Y 6/1) to brownish-gray (5Y 4/1), laminated dolomite between 661.0 and 661.4 feet----------	656.0-661.4
Gypsum, brownish-black (5YR 2/1) and dark-yellowish-brown (10YR 4/2), very finely crystalline, argillaceous, veins of selenite, 2-5 mm thick, dipping 20°-70°; single, silt-filled fracture, 1 cm thick dipping 50° at 665.4 feet----------	661.4-669.0
Gypsum, brownish-black (5YR 2/1), very finely crystalline; contains large irregular pods and masses of medium-dark-gray (N4) to medium-gray (N5), silty gypsum; irregular bands and laminae of dark-reddish-brown (10R 3/4) mudstone at 676.2-680.5 feet; veins of gypsum, 1-15 mm thick dipping 50° cut the mudstone bands and laminae----------	669.0-680.5
Mudstone, dark-reddish-brown (10R 3/4); contains angular clasts of brownish-black (5YR 2/1) gypsum from 681.0 to 682.4 feet and a conjugate set of gypsum veins, 2-20 mm thick dipping 20°-50°----------	680.5-687.6
Gypsum, brownish-black (5YR 2/1); very finely crystalline; contains numerous crisscrossing veins of gypsum and 1 band of dark-gray (N3) siltstone at 687.6 feet----------	687.6-689.0
Anhydrite, light-olive-gray (5Y 6/1) and olive-gray (5Y 4/1) to light-bluish-gray (5B 7/1), very finely crystalline; network of gypsum veins, ranging from hairline to 1 cm in thickness, dipping 30°-70°----------	689.0-693.8
Siltstone, olive-black (5Y 2/1) and yellowish-gray (5Y 8/1); contains network of gypsum veins----------	693.8-695.1
Anhydrite, light-olive-gray (5Y 6/1), very finely crystalline; contains network of gypsum veins----------	695.1-704.3
Dolomite, light-olive-gray (5Y 6/1), very finely crystalline; fractured, dotted with lense-shaped solution pits, 1-20 mm wide, contains a seam of moderate-yellowish-brown, silty dolomite at 704.3-705.2 feet----------	704.3-709.0

Table 3.--Lithologic log for borehole WIPP-13--Continued

Lithologic description	Depth interval Feet
Dolomite, light-olive-gray (5Y 6/1), very finely crystalline, highly fractured, and contains numerous solution pits, as much as 3 mm wide; contains interbedded laminae of light-brown (5YR 6/4) siltstone, 1-20 mm thick-----	709.0-722.0
Dolomite, light-olive-gray (5Y 6/1), very finely crystalline, argillaceous, fractured, dotted with solution pits-----	722.0-726.9
Mudstone, medium-gray (N5), soft, fissile-----	726.9-727.0
No core-----	727.0-729.0
Mudstone (60 percent), medium-dark-gray (N4), very soft; contains soft, chalky, white (N9) to very light gray (N8), some moderately hard, finely crystalline, yellowish-gray (5Y 8/1) and very light gray (N8) gypsum (40 percent); trace of vein selenite-----	729.0-735.0
Gypsum, predominantly white (N9), chalky, soft; some fine to medium crystalline, very light gray (N8); contains veins of selenite-----	735.0-740.0
Gypsum (80 percent), predominantly very light gray (N8), very light olive gray (lighter than 5Y 6/1) and white (N9), finely crystalline; trace of chalky, very finely crystalline, light-gray (N7) to light-olive-gray (5Y 6/1) anhydrite (20 percent)-----	740.0-750.0
Mudstone (60 percent), dark-reddish-brown (10R 3/4), very soft; colorless, argillaceous halite (20 percent); gypsum (20 percent), same as above; trace of anhydrite, same as above-----	750.0-760.0
Anhydrite (60 percent), light-olive-gray (5Y 6/1), very finely crystalline, trace of dark-yellowish-brown (10YR 4/2); finely crystalline, very light gray (N8) gypsum (40 percent); trace of very finely crystalline, gypsiferous anhydrite; trace of dark-reddish-brown (10R 3/4) siltstone-----	760.0-770.0
Siltstone (70 percent), moderate-brown (5YR 3/4) to dark-reddish-brown (10R 3/4), very halitic, argillaceous in part; anhydrite (20 percent), same as above; gypsum (10 percent), same as above; trace of vein selenite-----	770.0-780.0
Siltstone, same as above, very halitic, argillaceous-----	780.0-785.0
Siltstone (80 percent), same as above; trace of firm, olive-gray (5Y 4/1) siltstone; light-olive-gray (5Y 6/1) anhydrite (20 percent); trace of very light gray (N8) gypsum-----	785.0-790.0
Siltstone (80 percent), dark-reddish-brown (10R 3/4); friable, moderate-brown (5YR 3/4) siltstone (10 percent); anhydrite (10 percent), same as above-----	790.0-800.0
Siltstone, predominantly olive-gray (5Y 4/1), same as above, some dark-reddish-brown (10R 3/4) to moderate-brown (5YR 3/4), same as above-----	800.0-810.0
Mudstone (80 percent), medium-dark-gray (N4) with olive-gray (5Y 4/1) tint, soft; firm to soft, medium-dark-gray (N4) with olive-gray (5Y 4/1) tint siltstone (20 percent)-----	810.0-820.0

Table 3.--Lithologic log for borehole WIPP-13--Continued

Lithologic description	Depth interval Feet
Mudstone, medium-dark-gray (N4) with olive-gray (5Y 4/1) tint, soft----------	820.0-827.0
Mudstone, dark-gray (N3), fissile; contains blebby and lenticular masses of light-bluish-gray (5B 5/1) to medium-gray (N5) anhydrite from 845.0 to 845.7 feet, 5 mm in diameter; wavy, irregular laminae of olive-gray(5Y 6/1) anhydrite from 845.5 to 845.7 feet; halite-filled veins, 0.5-15 mm thick cut the rock between 828.8 and 845.7 feet----------	827.0-845.7
Mudstone, dark-reddish-brown (10R 3/4), contains horizontal clayey laminae as much as 1 mm thick; narrow seams of argillaceous anhydrite 2 cm wide from 846.5 to 846.6 feet----------	845.7-846.6
Mudstone, dark-reddish-brown (10R 3/4), sprinkled with euhedral halite crystals----------	846.6-848.0
Halite, translucent, medium-crystalline, sprinkled through mud matrix----------	848.0-848.7
Anhydrite, moderate-red (5R 4/6), wavy, irregular band----------	848.7-849.0
Halite, moderate-reddish-brown (10R 4/6), fine- to medium-crystalline, argillaceous with inclusions of moderate-brown (5YR 3/4) clay----------	849.0-853.0
Mudstone, dark-reddish-brown (10R 3/4), soft to firm; random fractures, 2 mm wide, filled with halite----------	853.0-853.7
Halite, moderate- to dark-reddish-brown (10R 4/6 to 10R 3/4), medium-crystalline, argillaceous and polyhalitic----------	853 7-859.0
Halite, colorless to moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline----------	859.0-861.3
Polyhalite, pale-red (10R 6/2), very finely crystalline, sinuous to irregular upper and lower boundaries----------	861.3-861.6
Mudstone, dark-reddish-brown (10R 3/4), soft, halitic----------	861.6-861.8
Halite, clear with slight moderate-reddish-orange (10R 6/6) tint, finely crystalline to medium crystalline, sparingly argillaceous at 0.5-foot intervals----------	861.8-872.0
Halite, moderate-reddish-brown (10R 4/6), finely crystalline, argillaceous; contains a parting of dark-reddish-brown (10R 3/4) mudstone at 872.6 feet, dipping 30°----------	872.0-873.2
Halite, clear with slight moderate-reddish-orange (10R 6/6) tint, medium-crystalline; contains clayey inclusions near base; a 2-4 mm band of moderate-reddish-brown (10R 4/6), finely crystalline polyhalite at 875.8 feet------	873.2-875.9
Mudstone, dark-reddish-brown (10R 3/4), halitic----------	875.9-876.1
No core----------	876.1-878.0
Halite (85 percent), translucent to white (N9); grayish-red (5R 4/2) to dark-reddish-brown (10R 3/4) mudstone (10 percent); medium-gray (N5) mudstone (5 percent)----------	878.0-890.0

Table 3.--Lithologic log for borehole WIPP-13--Continued

Lithologic description	Depth interval (ft)
Halite (90 percent), translucent to white (N9), some moderate-reddish-brown (10R 4/6), argillaceous; moderate-reddish-brown (10R 4/6) siltstone (10 percent)----------	[illegible]
Halite (95 percent), same as above; siltstone (5 percent), same as above-------	9[illegible]
Halite, same as above; trace of medium-gray (N5) siltstone----------	91[illegible]
Halite, same as above; trace of moderate-reddish-brown (10R 4/6) siltstone-----	92[illegible]
Halite, same as above; trace of grayish-red (10R 4/2) siltstone----------	93[illegible]
Halite, same as above; trace of moderate-reddish-brown (10R 4/6) siltstone-----	94[illegible]
Halite, same as above; trace of moderate-reddish-brown (10R 4/6) siltstone-----	950.0-96[illegible]
Halite (95 percent), same as above; siltstone (5 percent), same as above; trace of very finely crystalline, moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6) polyhalite----------	[illegible]
Polyhalite (80 percent), same as above; halite (10 percent), same as above; moderately hard, very fine grained, grayish-red (10R 4/2) sandstone (10 percent); trace of very finely crystalline, very light gray (N[illegible] to light-gray (N7) anhydrite----------	[illegible]
Polyhalite (85 percent), same as above; halite (10 percent), same as above; sandstone (5 percent), same as above----------	[illegible]
Halite (90 percent), translucent to white (N9); polyhalite (10 percent), same as above; trace of grayish-red (10R 4/2) siltstone----------	[illegible]
Halite, same as above; trace of polyhalite, same as above----------	[illegible]
Halite (90 percent), same as above; polyhalite (10 percent), same as above----------	[illegible]
Polyhalite (60 percent), same as above; halite (30 percent), same as above; very fine grained, grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4) and moderate-reddish-brown (10R 4/6) sandstone (10 percent), trace of medium-dark-gray (N4) siltstone; trace of very finely crystalline, very light gray (N8) to light-gray (N7) anhydrite----------	[illegible]

4.0 HYDROLOGICAL DATA

No hydrological data were obtained from WIPP 13.

5.0 REMARKS

The objective of drilling WIPP 13 to test the resistivity anomaly was attained through this program. The location is again useful for testing disturbances within the Castile Formation as interpreted from seismic reflection data. The borehole is being deepened for that program at this time; a report of the results will be published later.

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Powers, D. W., Lambert, S. J., Shaffer, S-E., Hill, L. R., and Weart, W. D., editors, 1978, Geological Characterization Report, Waste Isolation Pilot Plant (WIPP) Site, Southeastern New Mexico: Vol. I & II, SAND78-1596, Sandia Laboratories, Albuquerque, NM.

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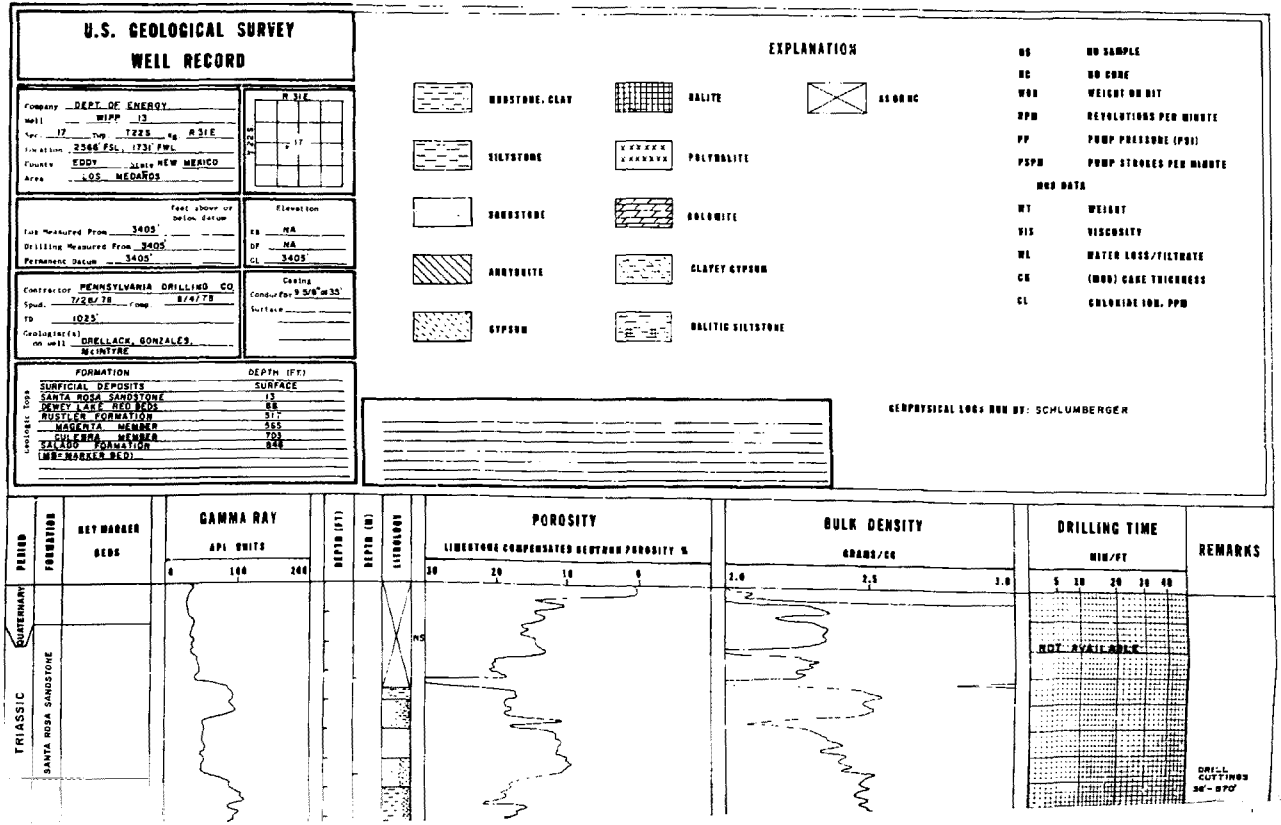
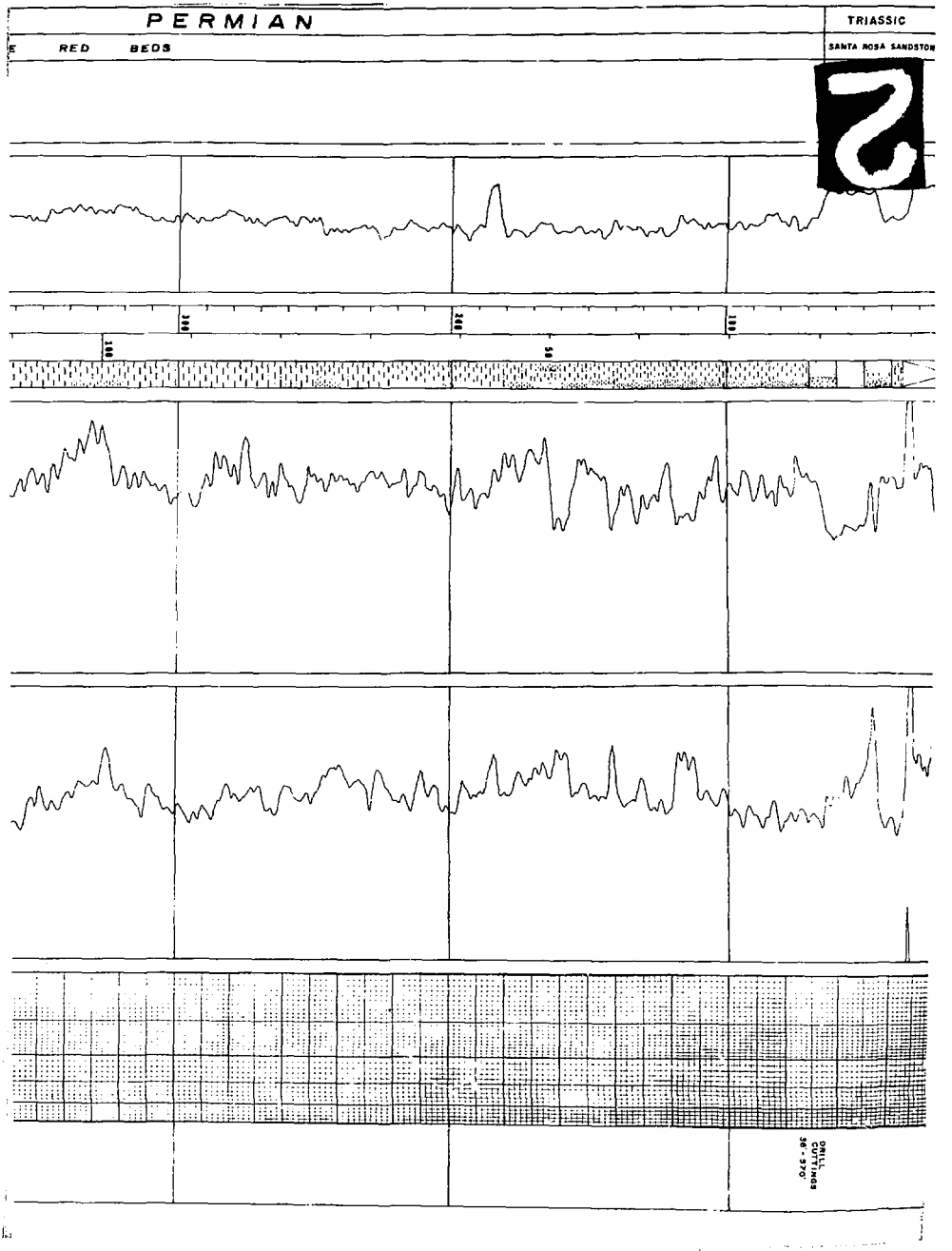
Figure 2.—Lithologic and geophysical logs of borehole WIPP-13

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RED BEDS
TRIASSIC
SANTA ROSA SANDSTON
?
DRILL CUTTINGS 50 - 570

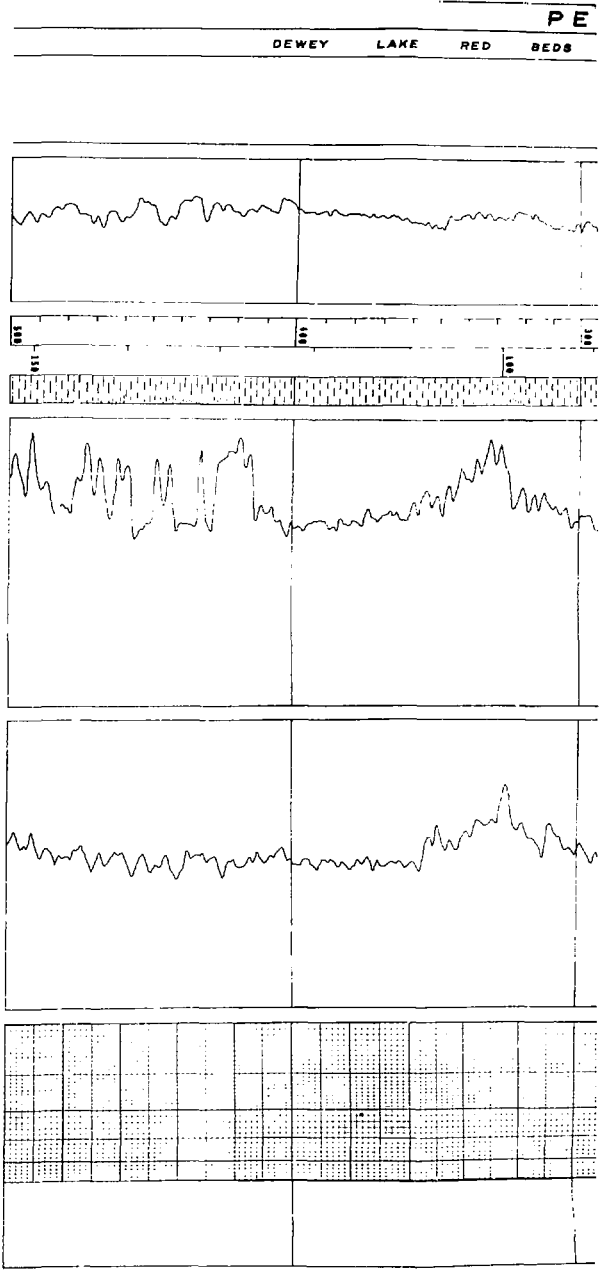
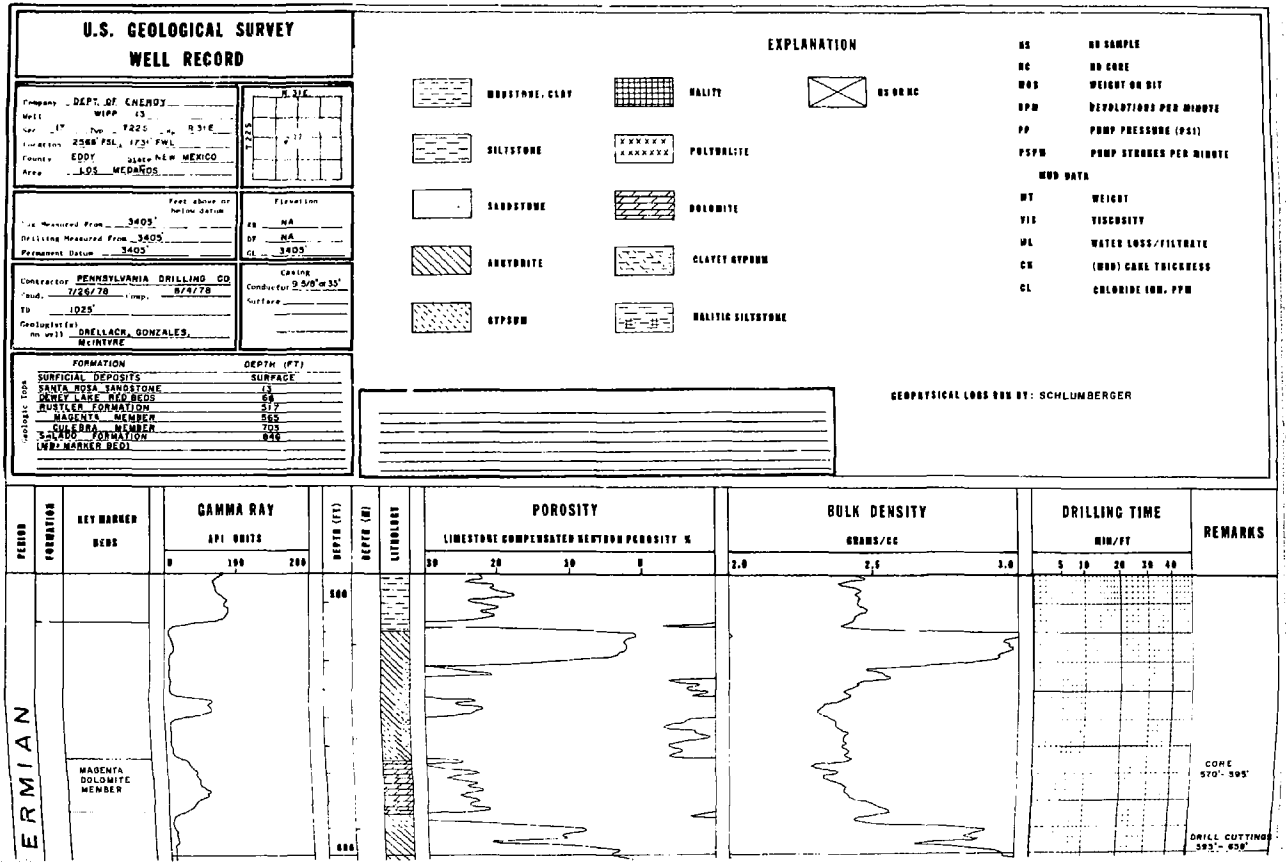
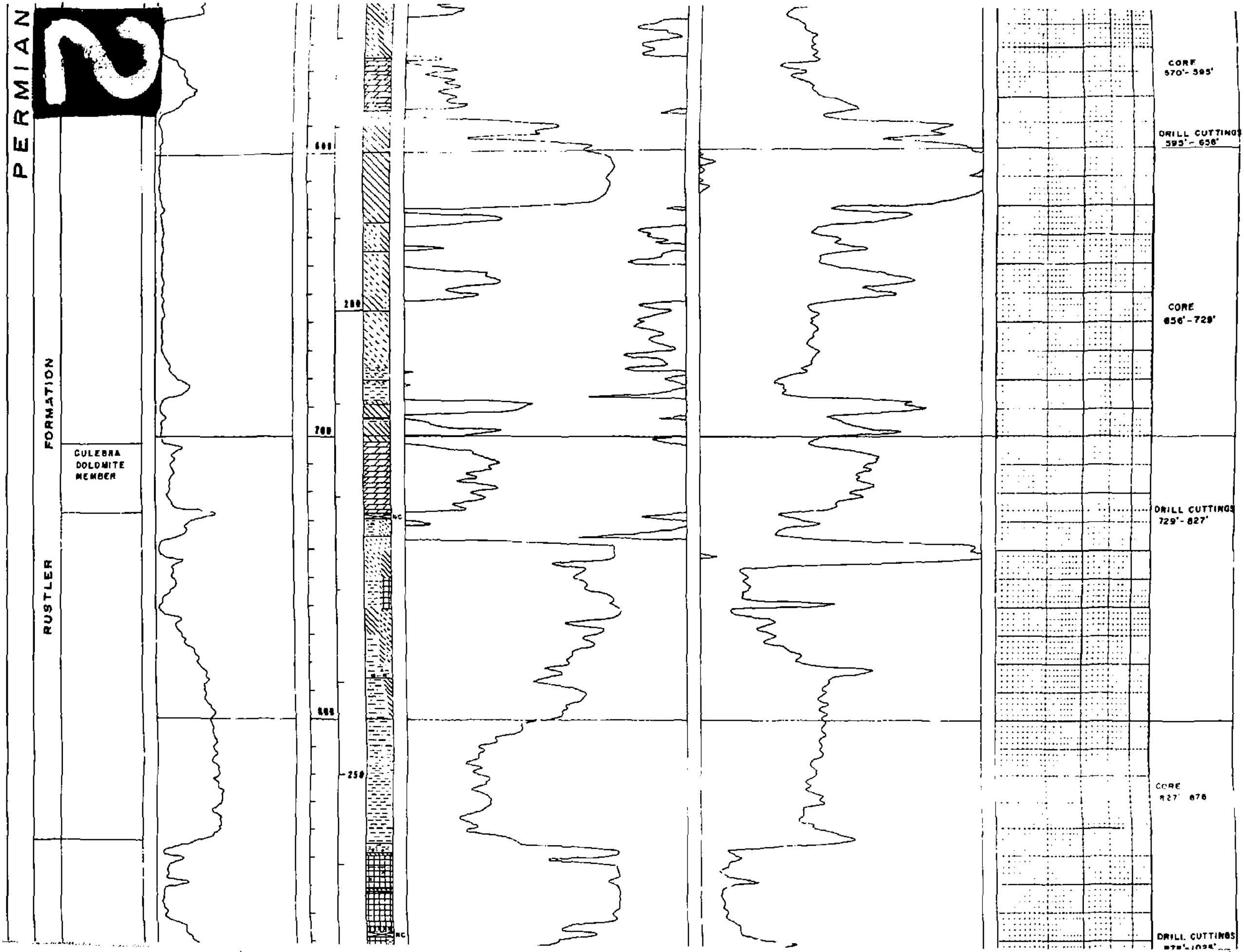
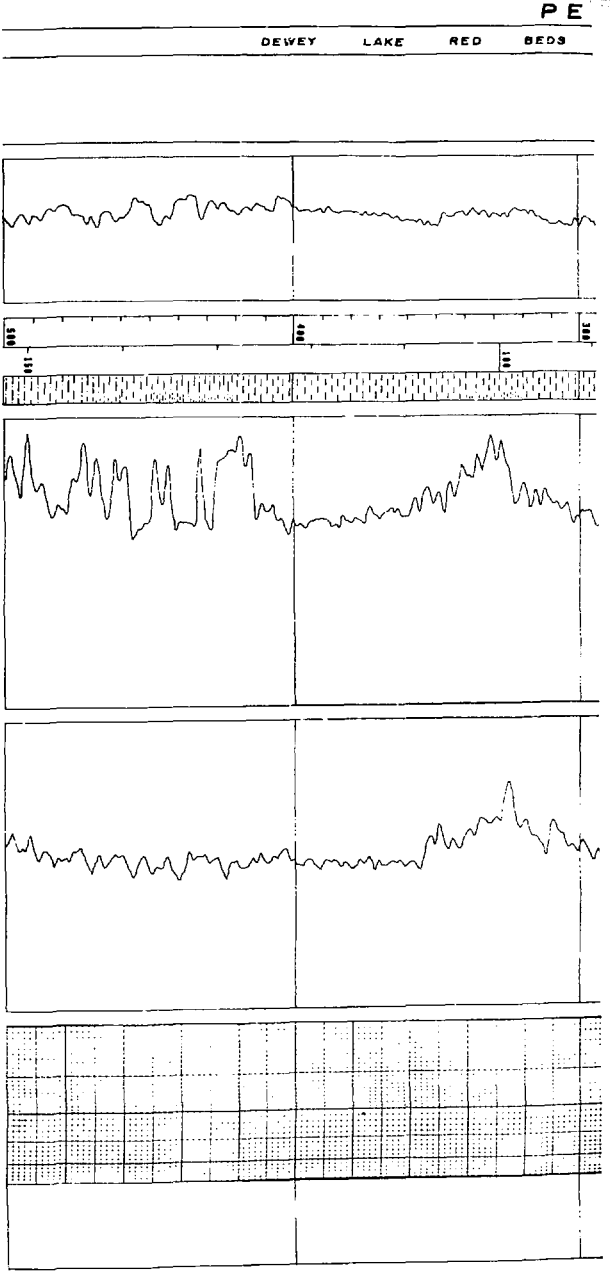

PE
DEWEY
LAKE
RED
BEDS

Figure 2.—Lithologic and geophysical logs of borehole WIPP-13





PERMIAN
2
RUSTLER FORMATION
CULEBRA DOLOMITE MEMBER
600
200
700
800
250
CORE 570'- 595'
DRILL CUTTINGS 595' - 656'
CORE 656'-729'
DRILL CUTTINGS 729'- 827'
CORE 827' 878
DRILL CUTTINGS


PE
DEWEY
LAKE
RED
BEDS

APPENDIX A

JUSTIFICATION

by

D. W. Powers
Division 4511
Sandia Laboratories

INTRODUCTION TO APPENDIX A, JUSTIFICATION

Appendix A consists of two documents, a memo from D. W. Powers to R. D. Statler, dated 6/12/78 and entitled "WIPP 13" and a memo from D. W. Powers to R. D. Statler, dated 6/30/79 and entitled "WIPP 13, Scope of Work, Revised." This document provides details of background information and program options as understood at the time of initiation. The reader is cautioned, therefore, that details of the program may have been altered as information became available and that preliminary interpretive hypotheses or ideas guiding the program formulation may need revision based on information presented in this report. Later interpretive reports may deal with such items.

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date: June 12, 1978

to: R.D. Statler 1133

from: D.W. Powers 5311

subject: WIPP 13

Objective: to determine the nature of a resistivity anomaly in section 17, T22S, R31E, through a drilling and logging program, and to further assess the effects of the anomaly, if any, upon the WIPP. The center of the anomaly is located about 2800' FNL and 1750' FWL; the data are found in a report to Sandia Laboratories by C.L. Elliot on December 29, 1977, titled: Evaluation of the Proposed Los Medanos Nuclear Waste Disposal Site by Means of Electrical Resistivity Surveys, Eddy & Lea Counties, New Mexico.

Method: one drill hole is expected to provide information to assess the resistivity anomaly. The hole will be drilled to below the 101 marker bed near the top of the Salado Fm or the equivalent depth of about 1025'. Logging of the hole is to provide information on the acoustic velocities, formation resistivities, porosity, density, natural radioactivity, hole deviation, and formation attitudes.

Details: the specific hole location will be surveyed after completion of a detailed resistivity study of the apparent anomaly. WIPP 13 should be nearly all rotary drilling with some provision for taking a limited amount of NX size core. The conditions for coring are the following:

a) if disturbance of the stratigraphy appears unusual, core may be required to confirm or deny this possibility.
b) if the stratigraphy appears normal, coring of the usual wet zones or aquifers is to be undertaken to support conversion of the hole for hydrologic purposes.

Under these circumstances, not more than 150' total of core should be anticipated. Logging undertaken by commercial concerns should include compensation for hole effects. The USGS/WRD should independently plan to log the resulting hole for hydrologic purposes and cross-documentation with nearby potash (P) holes.

Quality Items: the quality items concerning this hole include hole location, coring, logging, and items affecting any hydrologic program.

The hole location will be established on the basis of the resistivity measurements in the field, and should be known areally ± 10' relative to the nearest readily accessibly permanent corner marker and ± 1' vertically relative to the nearest readily accessible NGS permanent marker.

Continuous coring will be required through hydrologically important zones or unusual stratigraphy, though 100% core recovery is not required. All core taken should be marked to the nearest foot relative to measurements of drilling pipe, and should be sealed in heavy plastic as in ERDA 9. Further core handling procedures have previously been established and are adequate.

Logging done by commercial firms should be in accordance with industry standards. Logging of the hole requires gamma ray, sonic or acoustic, neutron, density, electric, directional or deviation, and dip logs. Gamma ray should be calibrated to the industry standard ranging to 200 API units. The neutron log should be compensated and indicate neutron porosity ranging from -15 to 45% against a limestone matrix standard. The density log should be compensated and requires a range from about 1 to 3 gm/cc. The borehole log indicating formation resistivity (R_t) will need small scaling since formation resistivites may exceed 40,000 ohm-m. The sonic or acoustic log must be borehole compensated and capable of measuring velocities from about 4000-25,000 ft/sec (interval transit times of about 240-40 microseconds). The dipmeter log is to show dips to the nearest degree at least, and is to be corrected for tool orientation. Depths measured by logging tools should be accurate to 1 foot per thousand feet depth. A trained logging engineer is required to perform the logging task.

Preparation of the hole for hydrologic purposes will require quality programs in accordance with the following memorandum: Rationale and Procedures for Establishing WIPP Hydrology Holes for Scientific Data Collection, Summer 1978, dated May 11, 1978, from S.J. Lambert to R.D. Statler.

Hole plugging quality programs may be deferred for the moment since the hole is likely to remain open for some time or be re-entered. Ultimate hole plugging may follow the program outlined in the memorandum: WIPP 18 through 22 Drill Holes, Plugging Plan, dated March 28, 1978, from C.W. Gulick to R.D. Statler.

Field Support: Division 5311 will depend on Division 1133 for support in obtaining permits, carrying out the drilling and logging programs, and supplying field support. Support from the USGS/WRD for logging and hydrologic investigations is requested, as is support from the Special Projects Division in examining the stratigraphy. Field support for hydrologic programs will also be obtained from other hydrologic consultants to Sandia Division 5311.

Decision Points: if the detailed resistivity survey confirms the anomaly, WIPP 13 will then be located and drilled. The total depth of the hole is expected to be about 1025', deep enough to confirm the stratigraphy in the upper Salado Fm or determine that abnormalities persist into the Salado. Other decision points during the drilling float based on the observed stratigraphy:

a) if the stratigraphy is normal, coring of the normal hydrologic zones will take place. Ordinarily a hole in section 17 might be expected to encounter normal stratigraphy with depths to the Magenta, Culebra, and top of Salado of approximately 600', 730', and 860', respectively. Marker bed 101 should be about 980' deep.

b) if the stratigraphy is abnormal or collapsed, coring may take place to confirm the abnormality.

With normal stratigraphy, the hole will be converted for hydrologic monitoring after reaching total depth and logging of the hole. If the stratigraphy is abnormal, the hole will be logged at total depth, and may be readied for testing of zones within the hole that indicate possible fluids. If the stratigraphy is indicating solution collapse very near the surface, the hole may be drilled to perhaps 500' to ascertain that a localized surficial feature is not present. If the hole continues to show such abnormal features to that depth, it is anticipated that the hole will be abandoned temporarily, and the location will be reoccupied at a later date with a drilling rig sufficient to handle any circumstance. If stratigraphic problems are not indicated, at the proper depths the decision will be made to core for hydrologic purposes.

Background: Resistivity surveys of the entire withdrawal area were undertaken using a gradient array in 1977. The resulting interpretation of that data indicated a

resistivity anomaly in section 17 based on good quality data. Several other anomalies, based on data of poorer quality, were found; these were primarily within zone IV or outside of zone IV. One of these poorer anomalies was located near WIPP 19 as well.
The area of the resistivity anomaly in section 17 is also marked by an apparent seismic anomaly, near the top of the Salado Fm, which is similar to the apparent seismic anomaly near WIPP 19. The interpretation of that anomaly was not borne out by a drilling program, and therefore the seismic evidence in section 17 is suspect for the top of the Salado.
WIPP 13 is mainly a test of the resistivity method. If a solution collapse feature of significance is found, further testing will be carried out under a more elaborate plan at a later date.

Approved: Leslie R. Hill
L.R. Hill, Supervisor
Division 5311
Nuclear Waste Technology

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5342 Archives (2)
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5311 D.W. Powers (2)

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date June 30, 1978

to R. D. Statler, 1133

from D. W. Powers, 5311

subject WIPP 13, Scope of Work, Revised

Objective: To determine the nature of a resistivity anomaly in section 17, T22S, R31E, through a drilling and logging program, and to further assess the effects of the anomaly, if any, upon the WIPP. The center of the anomaly is located about 2800' from the north line and 1750' from the west line; the data are found in a report to Sandia Laboratories by C.L. Elliot on December 23, 1977, titled: Evaluation of the Proposed Los Medanos Nuclear Waste Disposal Site by Means of Electrical Resistivity Surveys, Eddy & Lea Counties, New Mexico.

Method: One drill hole is expected to provide information to assess the resistivity anomaly. The hole will be drilled to below the 101 marker bed near the top of the Salado Fm or the equivalent depth of about 1025'. Logging of the hole is to provide information on the acoustic velocities, formation resistivities, porosity, density, natural radioactivity, and formation attitudes.

Details: The specific hole location will be surveyed after completion of a detailed resistivity study of the apparent anomaly, and the determination is made that the resistivity anomaly persists. WIPP 13 should be nearly all rotary drilling with some provision for taking a limited amount of core at least NX in size. Coring will be undertaken if disturbance of the stratigraphy appears unusual. Such disturbance may be recognized if the bedding indicates brecciation, or if expected beds are encountered more than about 50' above or below projected intercepts. If the stratigraphy appears normal, coring of important marker zones such as the Magenta, Culebra, and top of Salado may be undertaken to provide further evidence of normality.

Under these circumstances, not more than about 150' total of core should be anticipated. Logging undertaken by commercial concerns shall include compensation for hole effects. The USGS/Water Resources Division, Albuquerque, should independently plan to log the resulting hole for cross-documentation with nearby potash (P) holes.

Quality Items: The quality items concerning this hole include hole location, coring, and logging.

The hole location shall be established on the basis of the resistivity measurements in the field, and shall be determined areally + 10' relative to the nearest readily accessibly permanent corner marker and + 1' vertically relative to the nearest readily accessible NGS permanent marker.

Continuous coring shall be required through important stratigraphic markers or unusual stratigraphy, though 100% core recovery is not required. All core taken will be marked to the nearest foot relative to measurements of drilling pipe, and will be sealed in heavy plastic as in ERDA 9. Further core handling instructions have previously been established and are adequate when appropriately modified for hole number and size (see WIPP 11 Drilling Program, Schedule, and Test Plan, Appendix A, from R.D. Statler to Distribution, January 26, 1978).

Borehole geophysical logging is required to supply information on stratigraphy, formation density, porosity, formation resistivity, and formation attitude. Logging done by commercial firms should be in accordance with industry standards. Logging of the hole requires gamma ray, sonic or acoustic, neutron, density, electric, directional or deviation, and dip logs. Gamma ray shall be calibrated to the industry standard ranging to 200 API units. The neutron log shall be borehole compensated and indicate neutron porosity ranging from -15 to 45% against a limestone matrix standard. The density log shall be borehole compensated and requires a range from about 1 to 3 gm/cc. The borehole log indicating formation resistivity (R_t) will need small scaling since formation resistivities may exceed 40,000 ohm-m. The sonic or acoustic log must be borehole compensated and capable of measuring velocities from about 4000-25,000 ft/sec (interval transit times of about 240-40 microseconds). The dipmeter log is to show dips to the nearest degree at least, and is to be corrected for tool orientation. Depths measured by logging tools should be accurate to 1 foot per thousand feet depth. A trained logging engineer is required to perform the logging task.

Hole plugging quality programs may be deferred for the moment since the hole is likely to remain open for some time or be re-entered. Ultimate hole plugging may follow the program outlined in the memorandum: WIPP 18 through 22 Drill Holes, Plugging Plan, dated March 28, 1978, from C.W. Gulick to R.D. Statler.

Field Support: Division 5311 will depend on Division 1133 for support in obtaining permits, carrying out the drilling and logging programs, establishing QC procedures, and supplying field support. Support from the USGS/WRD for logging is requested, as is support from the Special Projects Division in examining the stratigraphy.

Decision Points: If the detailed resistivity survey confirms the anomaly, WIPP 13 will then be located and drilled. The total depth of the hole is expected to be about 1025', deep enough to confirm the stratigraphy in the upper Salado Fm or determine that abnormalities persist into the Salado. Other decision points during the drilling float based on the observed stratigraphy:

a) If the stratigraphy is normal, coring of three stratigraphic markers (Magenta, Culebra, top of Salado) will take place. Ordinarily a hole in section 17 might be expected to encounter normal stratigraphy with depths to the Magenta, Culebra, and top of Salado of approximately 600', 730', and 860', respectively. Marker bed 101 should be about 980' deep.

b) If the cuttings and/or drilling rates indicate that marker beds are absent or displaced more than about 50' from expected stratigraphic positions, or breccia is encountered, core will be taken to determine the nature of the abnormality.

If the stratigraphy is abnormal, the hole will be logged at total depth, and may be readied for testing of zones within the hole that indicate possible fluids. If the stratigraphy is indicating solution collapse very near the surface, the hole will be drilled to total depth of about 1025' to ascertain that a localized surficial feature is not present. If the hole continues to show such abnormal features to that depth, it is anticipated that the hole will be abandoned temporarily, and the location will be reoccupied at a later date with appropriate equipment and a test plan designed to thoroughly evaluate the anomaly.

Background: Resistivity surveys of the entire withdrawal area were undertaken using a gradient array in 1977. The resulting interpretation of that data indicated a resistivity anomaly in section 17 based on good quality data. Several other anomalies, based on data of poorer quality, were found; these were primarily within zone IV or outside of zone IV. One of these poorer anomalies was located near WIPP 19 as well. The area of the resistivity anomaly in section 17 is also marked by an apparent seismic anomaly, near the top of the Salado Fm, which is similar to the apparent seismic anomaly near WIPP 19. The interpretation of that anomaly was not borne out by a drilling program, and therefore the seismic evidence in section 17 is suspect for the top of the Salado. WIPP 13 is mainly a test of the resistivity method. If a solution collapse feature of significance is found, further testing will be carried out under a more elaborate plan at a later date.

Previous Version of Memorandum: This memorandum supersedes a memorandum, subject: WIPP 13, dated June 12, 1978, from D.W. Powers to R.D. Statler. The hydrologic data and testing indicated in the previous memo is secondary to this borehole; because of a strong conflict in methods for exploring the resistivity anomaly and obtaining hydrologic information, the requirement for hydrologic testing has been dropped from this [illegible] as a quality item.

Approved: _____
L.R. Hill, Supervisor
Division 5311
Nuclear Waste Technology

[illegible]rmf

APPENDIX B

DRILLING AND TESTING PLAN

by

R. D. Statler
Division 1133
and
P. D. Seward
Division 1135
Sandia Laboratories

INTRODUCTION TO APPENDIX B, DRILLING AND TESTING PLAN

The drilling and testing plan is the translation of technical objectives contained in documents in Appendix A into field engineering terms. Changes or amendments are included as well. The approvals and permits obtained from various agencies prior to drilling are kept on file but are not included here.

July 26, 1978

Field Operations Program of Sandia Labs
WIPP Site Investigations
Resistivity Anomaly

Exploratory Well: WIPP 13

Los Medanos Area: Section 17, Township 22S, Range 31E

Eddy County, New Mexico

PURPOSE: To determine the nature of a resistivity anomaly and to gather information with which to further assess the effects, if any, upon the WIPP.

Prepared by R. D. Statler
R. D. Statler, Supervisor
Division 1133
Field Engineering Projects

Approved by L. R. Hill
L. R. Hill, Supervisor
Division 5311
Nuclear Waste Technology

Approved by J. W. McKiernan
J. W. McKiernan, Supervisor
Division 5342
Nuclear Waste Programs

Sandia Laboratories

July 26, 1978

Distribution

R. D. Statler - 1133

Site Investigations for WIPP 13

The attached document contains the Field Operations Plan for conducting WIPP 13. Drilling, logging, coring, and cementing procedures are included for your use and information. Revisions and additions shall be added to this document as required and appropriate distribution made.

RDS:rj

Distribution:
C. L. Jones, USGS, Special Projects Division, Denver, CO
J. W. Mercer, USGS/WRD, Albuquerque, NM
G. O. Bachman, USGS/WRD, Albuquerque, NM
R. Taft, DOE/NVOO, Las Vegas, NV
D. Schueler, DOE/ALO
J. Cross, F&S, Las Vegas, NV
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1133 C. W. Gulick
1135 P. D. Seward
1135 J. E. Magruder
5310 Archives (2)
5311 L. R. Hill
5311 S. J. Lambert
5311 D. W. Powers
5312 H. C. Walker
5342 J. W. McKiernan
5342 R. Hogan
9517 F. L. McFarling (2)
1133 R. D. Statler (3)

TABLE OF CONTENTS

INTRODUCTION

This document contains design criteria for an exploratory well, WIPP 13, to determine the nature of a resistivity anomaly and to gather information with which to further assess the effects, if any, upon the WIPP. It describes the operational plan for conducting the field activities required to meet specified objectives. It includes procedures with drawings, specifications, and instructions necessary for good quality control of essential features. The Sandia Quality Assurance Program Plan for WIPP Site Evaluation is expected to cover activities associated with this field program.

I. FIELD OPERATIONS PROGRAM CRITERIA

The following memorandum has been accepted as the design criteria for the WIPP Site Investigations of the Nash Draw, therefore, it is being reproduced in its entirety for use in the conduct of this project.

Sandia Laboratories

Albuquerque New Mexico
Livermore California

date June 30, 1978

to R. D. Statler, 1133

from D. W. Powers, 5311

subject WIPP 13, Scope of Work, Revised

TO AVOID DUPLICATION, COMPLETE TEXT IS REPRODUCED IN APPENDIX A.

IV. FIELD OPERATIONS PLAN

A. Organization

Technical direction will originate within Sandia Division 5311. Field operations, managed by Bob Statler, Sandia Division 1133, will be conducted by W. E. Cunningham, Fenix & Scisson. Drilling contract and associated support service contracts will be let and administered by FS as arranged for by Federal Agency Order through Nevada Operations Office, DOE.

Identification of marker beds, core logging and other geologic interpretations will be provided by duty geologist.

Quality control and inspection will be conducted by designated experts. Quality assurance program will be administered by F. L. McFarling and Tim Jones, Sandia Division 9517.

Industrial Safety Program will be administered by specialists from Fenix & Scisson, Las Vegas.

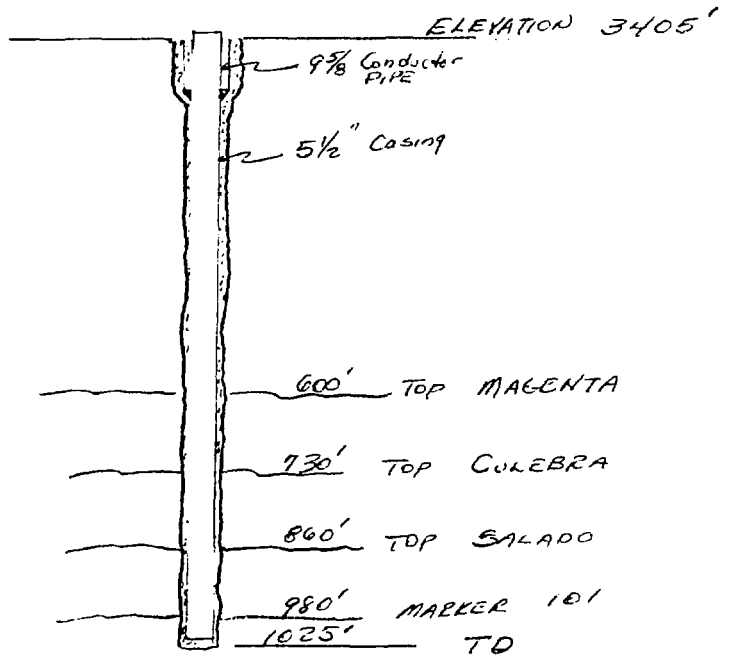
Administrative assistance, logistical support of Sandia Programs will be provided by P. D. Seward and J. E. Magruder, Sandia Division 1135.

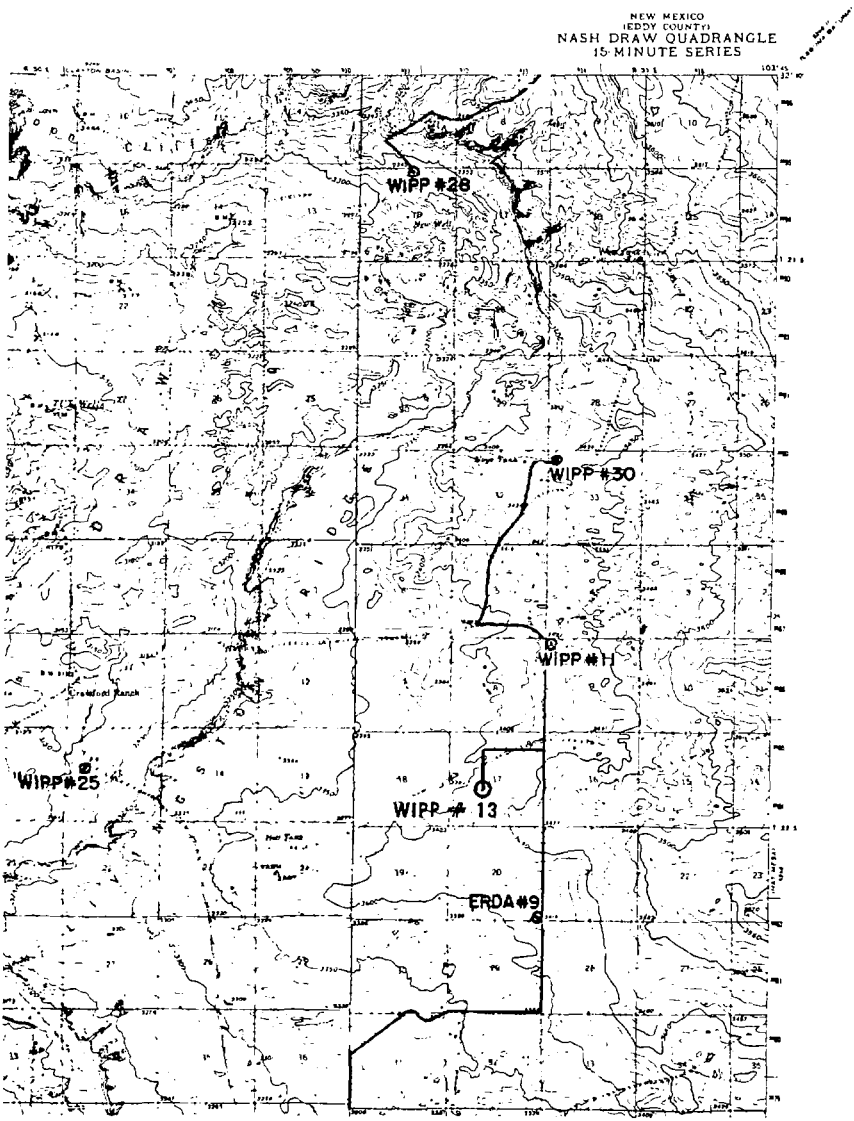
B. Supporting Data

Geology

The geology of the immediate site of the resistivity anomaly is not known and the stratigraphy may prove unusual. The following prognosis is based on projections from nearby holes assuming normal stratigraphy:

Ground Elevation	3405'	(above sea level)
Top of Magenta Dolomite	600'	Depth
Top of Culebra Dolomite	730'	"
Top of Top of Salado Salt	860'	"
Marker Bed 101	980'	"
Expected Total Depth	1025'	"




NEW MEXICO
(EDDY COUNTY)
NASH DRAW QUADRANGLE
15-MINUTE SERIES
WIPP #28
WIPP #30
WIPP #11
WIPP #25
WIPP # 13
ERDA #9

C. Drilling Parameters and Expected Drilling Requirements

It should be recognized that the stratigraphy may be unusual, therefore, the drilling program may be adjusted to provide for abnormalities. If the conditions are found to be relatively normal, the following program is expected to be employed and be known as Plan "A":

A-1. Level and prepare a surface location of 100' x 200' minimal size using approximately 6" caliche base.

A-2. Machine auger a conductor hole of sufficient depth and diameter to permit installation and cementing of a 30-40' x 9-5/8" O.D. conductor pipe.

Construct a timber-cribbed cellar which will be compatible with appropriate well-head safety equipment and other associated drilling equipment.

A-3. Move in rig, rig up, rotary drill a 7-7/8" hole to approximately 590' which should be approximately 10' above the Top of Magenta Dolomite, using a circulating medium best suited for coring in this formation and then pick up appropriate coring equipment to produce nominal 3-1/2" diameter core over 50' interval. All core to be logged, marked, and handled according to procedures outlined in Section III.A.

A-4. Resume rotary drilling of 7-7/8" diameter hole to approximately 720' which should be approximately 10' above projected depth of Culebra Dolomite. Then take 3-1/2"± diameter core over 50' interval.

A-5. Resume rotary of 7-7/8" diameter hole to approximately 850' which should be approximately 10' above projected depth of Rustler Salado contact. Then take 3-1/2"± diameter core over 50' interval.

A-6. Resume rotary drilling sufficiently through an acceptable marker bed to permit good logging of contact. Presumably this will be the 101 marker bed at about 980' and total depth is expected at about 1025'.

A-7. When rotary drilling, take drill cuttings at 10' intervals, log, mark, and retain for storage in 100' bundles.

A-8. After reaching total depth, condition hole and make ready for geophysical logging by commercial service as well as USGS-WRD.

A-9. Geophysical logs to be run are to provide information on acoustic velocities, formation resistivities, porosity, density, natural radioactivity, hole deviation and formation attitudes. The actual commercial logs selected to produce the above information will be established at a later time after a better understanding of the hole conditions is known. Procedures for logging program will be found in Section III.B.

A-10. Run a string of 5-1/5", 15.5, J-55 casing with combination float shoe and centralizers to total depth and cement to surface following procedures described in Section IV.D.

A-11. Clean up pad area, fill in pits and leave hole temporarily abandoned pending subsequent reoccupation for hydrological testing.

As stated previously, the drilling program may be adjusted from Plan A to provide for a study of abnormalities. If the drilling program reveals abnormal stratigraphy, the progress of Plan A may be revised to begin taking core at an earlier interval to confirm or deny suspicions.

F. Discussion of Potential Hazards

Drilling this hole may well produce unusual fluids and/or gas pockets. Preparations should be included for monitoring and flaring combustible gases.

III. FIELD OPERATING PROCEDURES FOR QUALITY CONTROL REQUIREMENTS

Portions of this field activity are considered of such a significance that quality control measures have been established and these are subject to independent audit by Sandia Laboratory Quality Assurance personnel as well as NRC Field Audit Team. These activities are:

A. Measurement of Surface Location and Elevation

B. Core Logging and Handling and Storage

C. Geophysical Logging

D. Casing and Cementing.

The above activities will be monitored in detail or reviewed by designated quality control experts whose education, knowledge and/or experience makes him qualified to assure adherence to operating procedures or to ascertain or certify that desired objectives have been met.

When designated, this individual shall take appropriate measures to negotiate with pertinent officials to whatever extent necessary to secure acceptable results.

A. Measurement of Surface Location and Elevation

The general location will be established by Division 5311 following a review of resistivity surveys, surface features, accessibility and other geo-political considerations. A preliminary land survey shall be conducted by a Registered Land Surveyor to establish access routes and set stakes for drill location and pad boundaries. Dimension of the location will be established with nearest section boundaries and nearest marked section corners to provide data necessary for obtaining land use permits. Drawings or sketches suitable for construction use shall be submitted. After pad construction is complete and at the time of hole spudding, a concrete monument with a brass cap will be set in the immediate vicinity of the borehole such that it can be used as the datum point for all borehole vertical measurements. Once this monument is established, this monument and its lateral relation to borehole axis is to be surveyed by a Registered Land Surveyor to establish the vertical elevation within ±1' of the nearest NGS monument and the lateral coordinates within ± 1' with respect to nearest section boundaries and recoverable section corners.

Copies of all field notes utilized in conducting the "as-built" survey, as well as a written description of techniques and instruments utilized in making the survey shall be submitted along with survey drawings carrying the stamp of the responsible surveyor.

July 2[illegible], 197[illegible]

L. Core Logging and Handling and Storage

A duty geologist will log and measure core as it is removed from core barrel. When drill cuttings are required, duty geologist will see they they have been taken, washed and dried. They should then be tied in 100' bundles, boxed, and marked with well identity, and interval taken. Cuttings will then be taken to core storage in Carlsbad along with core.

A record should be kept showing date and tour, sequence of core interval, depth of interval, footage of core recovered, and percentage. If significant intervals are missing, the depth and interval of missing core should be recorded as well as any determinable physical properties of the formation. Rig operating conditions such as RPM, weight on bit, circulating pressure should also be kept.

For sake of consistency, a routine has been established for handling and marking core at the drill pad as follows:

1. Coring contractor and roustabouts will lay barrel down and open barrel. The duty geologist will supervise removal from core barrel and placement in troughs in the order they come out of barrel for inspection and measurement. Troughs are marked orange or red indicating top end and black indicating down direction.

2. If core is suitable for marking, each major piece should be marked with a waterproof, black-ink arrow pointing in the direction the hole is advancing. If core is not suitable for marking, the sleeve is to be marked on [illegible] with [illegible] black marking pen.

3. Log, identify and measure all core pieces, mark to the nearest foot relative to measurements of drill pipe, express to closest 1/10th of foot. Note: all depth measurements are from the top side of the kelly bushing unless otherwise specified.

4. [illegible] sleeve and seal and insert into boxes. Tape boxes and mark outside of box with hole identity and depth of core interval.

5. Transport the boxed core to [illegible] and delivery to [illegible].

6. The duty geologist will be responsible for [illegible] markings [illegible] of all core [illegible] drill pad location to core storage [illegible] entries into the Daily Core Logging Record (sample follows) as to quantities and [illegible].

Page ____ of ____

DAILY CORE LOGGING RECORD

Date _____ DUTY GEOLOGIST _____

LOG HEADINGS:

Company _____

Well Number WIPP No. _____

Field _____ County _____ State New Mexico

Location _____

Section _____ Township _____ Range _____

Permanent Datum _____ Elevations: K.B. _____

Drilling Measured From _____ D.F. _____

G.L. _____

CORE NO.	INTERVAL	FEET	RPM	WEIGHT ON BIT	CIRCUL. PRESS. P.S.I.	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BOX NUMBER

C. Geophysical Logging

1. Prior to logging, a Sandia representative will meet with the logging engineer, present "Instructions to Logging CO" as shown on following pages, and discuss:

   a. The entire logging program and any special requirements

   b. Hole conditions that may cause problems

   c. Zones of special interest.

2. The equipment will be "warmed up" for the adequate amount of time and tools will le checked to see that they are functioning properly upon arrival at the location.

3. Rm, Rmf, and Rmc will be measured on mud samples. Estimated values are not acceptable. The service company should run the sample through a mud press.

4. Proper scales will be used on each log.

5. All Sidewall and Compensated Neutron logs and all density porosity curves l be run on limestone matrix over the zones of interest, regardless of the lithology.

6. Equipment will be tested while running in hole.

7. Before and after log calibrations will be shown for all curves.

8. Panel calibrations will be shown for all density and neutron logs, integration checks will be shown for all integrated Acoustic logs.

9. In addition to caliper rings the caliper will be [illegible] "tool full open" and caliper rings.

10. A minimum 200 feet repeat must be shown.

11. Overlap previous runs by at least 100 ft.

12. All headings information will be completely filled out.

13. Logging facility [illegible] Completed by qualified Sandia representative.

FENIX & SCISSON
LOG QUALITY REPORT

F-11

Hole _____ Log Date _____ Current Date _____

Log _____ Run # _____ Engr. _____

Field Print ☐ Final Print ☐ Log Analyst _____

CHECK ALL BOXES – ACCEPTABLE YES OR UNACCEPTABLE NO
Sections not applicable to a particular service, Leave Blank.

	YES	NO
A. HEADING		
1. Correct Heading Used	☐	☐
2. Heading Data Properly Completed	☐	☐
3. Equipment Used Section Completed	☐	☐
4. Equipment Data Section Completed	☐	☐
5. Scale Changes Noted on Heading	☐	☐
6. Are all abnormal conditions explained in the remarks section	☐	☐
B. CALIBRATIONS AND SCALES		
1. Scales Correct for Area	☐	☐
2. Scales Labelled	☐	☐
3. Scale Changes Labelled	☐	☐
4. Zeroes Recorded	☐	☐
5. Before Log Calibrations	☐	☐
6. After Log Calibrations	☐	☐
7. Repeat Section Recorded	☐	☐
8. Repeat Section Acceptable	☐	☐
C. VALIDITY OF LOG		
1. Curves Functioning Correctly	☐	☐
2. Do Log values fall within reasonable limits	☐	☐
3. Curves on Depth	☐	☐
4. Logging Speed Indicated	☐	☐
5. Logging Speed Correct	☐	☐
D. APPEARANCE		
1. Printing or Typing Neat	☐	☐
2. Printing or Typing Accurate	☐	☐
3. Grid and Pen Traces	☐	☐
4. Splices Straight and Clean	☐	☐
5. Film Correctly Processed	☐	☐
6. General Print Quality	☐	☐

REMARKS: Code Remarks with the proper Section Number. For Example: Remarks concerning before log calibrations would be coded B-5.

FENIX & SCISSON, INC.

Page _____ of _____

INSTRUCTIONS TO LOGGING COMPANY

Date _____ Logging Company _____
Logging Engineer _____
Witnessed By _____

Log Headings:

Company Fenix & Scisson, Inc.

Well Number WIPP No. _____

Field _____ County _____ State New Mexico

Location _____

Section _____ Township _____ Range _____

Permanent Datum _____ Elevations: K.B. _____

Log Measured From _____ D.F. _____

Drilling Measured From _____ G.L. _____

Hole Status:	SIZE	FROM	TO		SIZE	FROM	TO
Casings				Borehole			

Type Fluid in Borehole _____ Fluid Level _____

Density _____ pH _____

Viscosity _____ Fluid Loss _____

Purpose of Logging Program, Zones of Special Interest, Critical Hole Conditions, Remarks, Etc. _____

Number of Prints: Field 10 Final 10

Invoice To : Fenix & Scisson, Inc.
1502 W. Stevens Street
Carlsbad, New Mexico 88220

Fenix & Scisson, Inc.
Instructions to Logging Company

Page _____ of _____

Log No. _____

(a) Vertical Depth Scales 2-inches/100-feet and 5-inches/100-feet
(b) Horizontal Logging Scales _____
(c) Logging Speed Desired _____
(d) Interval to be Logged _____
(e) Zones of Special Interest _____

(f) Special Instruction _____

****

Log No. _____

(a) Vertical Depth Scales 2-inches/100-feet and 5-inches/100-feet
(b) Horizontal Logging Scales _____
(c) Logging Speed Desired _____
(d) Interval to be Logged _____
(e) Zones of Special Interest _____

(f) Special Instruction _____

****

Log No. _____

(a) Vertical Depth Scales 2-inches/100-feet and 5-inches/100-feet
(b) Horizontal Logging Scales _____
(c) Logging Speed Desired _____
(d) Interval to be Logged _____
(e) Zones of Special Interest _____

(f) Special Instruction _____

D. Casing and Cementing

1. Inspect casing to be run. Sand blast if necessary to remove severe rust flakes. Pits of rust without flakes may actually enhance bonding.

2. Condition hole, ream if necessary to remove tight places.

3. Condition fluid until mostly free of cuttings.

4. Install a combination float shoe.

5. Stand casing with centralizer. Utilize logs to determine location as well as routine spacing of 60-90 feet apart.

6. Begin pumping and displace well fluid with mud flush, then set, and cement slurry. Use 70-30 poz mix, salt to saturation, and 2% bentonite gel.

7. Displacement rate approximately 2-1/2 barrels per minute.

8. Bump plug with approximately 500 psi over pumping-mixing rate. Mix 1000 psi, close in head.

9. WOC 48 hours.

10. Nipple up after 36 hours.

NOTE: Observe regulations issued by State Engineer; in particular, requirement that "casing shall not be installed or cemented without prior notification to the State Engineer Office."

IV. REPORTS

Distribution Instructions:

A. Daily Reports
F&S, Carlsbad, shall provide to Sandia, Carlsbad, a copy of the daily report. Sandia, Carlsbad, will telefax weekdays to D. Schueler, DOE/ALO, and L. R. Hill, 5311, Albuq., who will mail copies to McFarling, 9517, Seward, 1135, and Statler, 1133. A copy of the daily report is to be kept by Sandia, Carlsbad.

B. Hole History
Compiled by F&S, Carlsbad, and Las Vegas, NV. Send copy to R. M. Statler, 1133, for Sandia, Albuquerque, distribution.

C. Geophysical Logs
F&S, Carlsbad, shall obtain nine copies of field prints and make general distribution, to include the following:

1 - Sandia, Carlsbad
1 - C. Jones, USGS, Spec. Proj. Div., Denver, CO
1 - J. Mercer, USGS/WRD, Albuq., NM
1 - G. O. Bachman, USGS/WRD, Albuq., NM
1 - D. W. Powers - 5311, SLA
- - F&S, Carlsbad

F&S, Carlsbad, shall order 19 Final copies for distribution as follows:

1 - F&S, Carlsbad
1 - F&S, Las Vegas
1 - Sandia, Carlsbad
1 - C. Jones, USGS, Spec. Proj. Div., Denver, CO
1 - G. O. Bachman, USGS/WRD, Albuq., NM
1 - R. J. Lambert, 5311, SLA
1 - D. W. Powers, 5311, SLA
- - 5310 Archives, w/original, tapes and film
1 - State Engineer, Roswell, NM
- - [illegible]
- - [illegible]

[illegible]

Drillers Logs, Bit Records, Drill Fluid Recaps
[illegible]

APPENDIX C

HOLE HISTORY

by

R. D. Statler
Division 1133
and
P. D. Seward
Division 1135
Sandia Laboratories

INTRODUCTION TO APPENDIX C, HOLE HISTORY

The hole history is a document provided soon after completion of the borehole, and it summarizes the relevant information on the daily log kept by the contractor. The hole history is not edited to ensure conformance in every detail with later information developed for previous chapters. Further information may be obtained as necessary through examination of the original daily time logs.

FENIX & SCISSON, INC.

HOLE HISTORY DATA

DATE: 10-27-78

HOLE No.: WIPP #13	W.O. No.:	I.D. No.
USER: Sandia Lab.	TYPE HOLE: Exploratory	
LOCATION: New Mexico	COUNTY: Eddy	AREA: WIPP
SURFACE COORDINATES: **		GROUND ELEVATION: **
RIG ON LOCATION	SPUDDED: 7-26-78	COMPLETED: 8-6-78
CIRCULATING MEDIA: Air to 36', salt base mud to 1025'.		
No. of COMPRESSORS & SIZE		

BORE HOLE RECORD			CASING RECORD							
FROM	TO	SIZE	I.D.	WT. FT.	WALL	GRADE	CPL'G	FROM	TO	CU FT CMT
* 0'	5'	Excav.			(5' x	5' Cellar)		0'	5'	Dirt
* 5'	36'	16"	8.921"	36"		J-55	ST&C	0'	36'	27
36'	1025'	7-7/8"								

TOTAL DEPTH: 1025' | MANDREL DEPTH | PLUGS:

JUNK: NONE

LOGGING DATA: Page: 2 | SURVEYS PAGE | CORING PAGE: 3

BOTTOM HOLE COORDINATES: | REFERENCE

NON-OPERATIONAL TIME		OPERATIONAL DELAY TIME		WORKING TIME	
Move Rig us & down	0.46 days	Equipment Repair	0.38 days	Drilling Time	3.06 days
Secured	2.00 days	Coring	____ days	Trip Time	0.56 days
Ball & Run Mandrel	____ days	Lost Circ.	____ days	Single Shot Survey Time	0.05 days
Logging	0.46 days	Fishing	____ days		____ days
Surveys	____ days	W.C. Equipment	____ days	Total	3.67 days
Casing	____ days	Ream Tight Hole	0.83 days	Total Suspended Time	____ days
Cement	____ days	Mix & Condition Mud	0.29 days	Non-Operational Time	6.97 days
Coring	3.85 days		____ days	Operational Delay Time	1.50 days
Lay Down Drill Pipe	0.20 days		____ days	Working Time	3.67 days
TOTAL	6.97 days	TOTAL	1.50 days	TOTAL ELAPSED TIME	12.14 days

REMARKS: * Site prep items. Time breakdown for Pennsylvania Drilling Company.

** Brass monument location: 2563.67' FSL, 1727.36' FWL, Sec.17, T22S, R31E. Elevation 3405.43'.

Rig No.	Name	Type	
1	Penn. Drilling Co.	Failing 2000	12.14 days
			____ days
			____ days
			____ days
			____ days

WDS:lkm

WIPP #13
HOLE HISTORY

7-24-78	Excavated a 5' x 5' cellar 5' deep and lined with boards. Link Rat Hole, Inc. drilled a 16" hole from 5' to 36' with an auger rig. Set 1 joint (40.64') of 9-5/8" O.D., 36#, J-55 casing at 36' and cemented annulus with 27 ft^3 of ready mix grout. Left cement in the bottom of the cellar.
7-25-78	Cut off 9-5/8" O.D. casing at ground level and welded on a slip on flange. Moved in Pennsylvania Drilling Company's rig #1.
7-26-78	Rigged up and mixed salt base mud. Drilled 7-7/8" hole from 36' to 154'.
7-27-78	Drilled 7-7/8" hole from 154' to 440'. Deviation surveys were $1/2^{o}$ at 188' and 335'.
7-28-78	Drilled 7-7/8" hole from 440' to 570'. Stuck drill pipe on trip out of the hole at 410' and worked free. Found tight places at 350', 300', 250' and 225'. Made up 7-13/16' x 4-1/4" core bit and ran in hole, could not get past 80'. Deviation survey was $15/16^{o}$ at 532'.
7-29-78	Made trip with bit and conditioned hole. Made up core bit, reamed and washed from 80' to 515', torque was building up. Pulled out of hole and installed a new 7-7/8" rock bit. Reamed and washed to 570'. Ran core barrel back in the hole to 532', washed and reamed to 570'. Cut 7-13/16" core #1 from 570' to 581', recovered 11'.
7-31-78	Cut core #2 from 581' to 590', recovered 9'. Cut core #3 from 590' to 595', recovered 5'. Made up 7-7/8" bit and ran in hole. Reamed core hole and drilled 7-7/8" hole from 595' to 606'.
8-1-78	Drilled 7-7/8" hole from 606' to 656'. Made up 7-13/16" core bit and ran in hole. Hit ledge at 616', reamed and washed to bottom. Cut core #4 from 656' to 669', recovered 12.6'. Cut core #5 from 669' to 672'.
8-2-78	Completed core #5 from 672' to 689', recovered 20.4'. Cut core #6 from 689' to 709', recovered 20'.
8-3-78	Cut core #7 from 709' to 722', recovered 13'. Cut core #8 from 722' to 729', recovered 5'. Ran 7-7/8" bit in the hole, reamed core hole and drilled from 729' to 807'. Deviation survey was 1^{o} at 701'.
8-4-78	Drilled 7-7/8" hole from 807' to 827'. Made up core barrel and cut 7-13/16" core #9 from 827' to 853', recovered 26'. Cut core #10 from 853' to 878', recovered 22.9'.
8-5-78	Reamed core hole and drilled 7-7/8" hole from 878' to 1025'. Ran USGS and Schlumberger logs.
8-6-78	Rig secured from 8-5-78 to 8-6-78. Rigged down. Hole completed.

LOG INDEX SHEET

TYPE LOG	DATE	RUN NO.	DEPTH DRILLER	DEPTH LOGGER	LOGGED FROM	LOGGED TO
SCHLUMBERGER LOGS						
Dipmeter - Basic Data	8-5-78	1	1025	1025	36	1024
Dipmeter Arrow Plot	8-5-78	1	1025	1025	36	1024
Dual Laterolog Micro-SFL	8-5-78	1	1025	1020	35	1008
Compensated Neutron-Formation Density	8-5-78	1	1025	1022	0	1021
Borehole Compensated Sonic	8-5-78	1	1025	1019	0	1008
Directional Survey	8-5-78	1	1025	1025	36	1024

NOTE: Logs Furnished F & S/Mercury.

BIT RECORD

BIT NO.	MAKE	SIZE	TYPE	DEPTH OUT	FEET DRILLED	ROTATING HOURS	REMARKS
1	Security	7-7/8"	S3J	570	534	4-1/4	
2	Security	7-7/8"	S3J	656	61	12-1/4	
2	Rerun					2-1/4	Rear
2	Rerun			827	98	7-1/4	
2	Rerun			1025	147	7-3/4	
			CORE BIT				
1	Diamond	7-13/16"		595	25	13-3/4	
1	Rerun			729	73	34-1/4	
1	Rerun			878	51	12	

WIPP #13
HOLE HISTORY
PAGE 3

DAILY CORE LOGGING RECORD

Date 7-28-78 DUTY GEOLOGIST Bud McIntyre

LOG HEADINGS:

Company Fenix & Scisson

Well Number WIPP No. 13

Field East of Carlsbad County Eddy State New Mexico

Location Nash Draw

Section 17 Township 22 South Range 31 East

Permanent Datum 3405.4' Elevations: K.B. 3409.7'

Drilling Measured From 3405' D.F.

G.L. 3405'

RE NO.	INTERVAL	FEET	RPM	WEIGHT ON BIT	CIRCUL. PRESS. P.S.I.	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BOX NOS.
1	570	581	60	14,000	200/300	11	11	100%	1-6

DAILY CORE LOGGING RECORD

Date 7-31-78 DUTY GEOLOGIST Bud McIntyre/Sigmund Drellack

LOG HEADINGS:

Company Fenix & Scisson

Well Number WIPP No. 13

Field East of Carlsbad County Eddy State New Mexico

Location Nash Draw

Section 17 Township 22 South Range Range 31 East

Permanent Datum 3405.4' Elevations: K.B. 3409.7'

Drilling Measured From 3405' D.F.

G.L. 3405'

RE NO.	INTERVAL	FEET	RPM	WEIGHT ON BIT	CIRCUL. PRESS. P.S.I.	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BOX NUMBERS
2	581	590	50/60	14,000	200	9	9	100%	1-4
3	590	595	50/60	14,000	200	5	5	100%	1-2

DAILY CORE LOGGING RECORD

Date 8-1-78 DUTY GEOLOGIST Bud McIntyre

LOG HEADINGS:

Company Fenix & Scisson

Well Number WIPP No. 13

Field East of Carlsbad County Eddy State New Mexico

Location Nash Draw

Section 17 Township 22 South Range 31 East

Permanent Datum 3405.4' Elevations: K.B. 3409.7'

Drilling Measured From 3405' D.F.

G.L. 3405'

RE NO.	INTERVAL	FEET	RPM	WEIGHT ON BIT	CIRCUL. PRESS. P.S.I.	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BOX NUMBER
4	656	669	80/60	15,000	200/300	13	12.6	100%	1-5

DAILY CORE LOGGING RECORD

Date 8-2-78 DUTY GEOLOGIST Bud McIntyre

LOG HEADINGS:

Company Fenix & Scisson

Well Number WIPP No. 13

Field East of Carlsbad County Eddy State New Mexico

Location Nash Draw

Section 17 Township 22 South Range 31 East

Permanent Datum 3405.4' Elevations: K.B. 3409.7'

Drilling Measured From 3405' D.F.

G.L. 3405'

RE NO.	INTERVAL	FEET	RPM	WEIGHT ON BIT	CIRCUL. PRESS. P.S.I.	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BOX NUMBE
5	669	689	80/60	14,000	200/300	20	20.4	100%	1-9
6	689	709	65	14,000	200/300	20	20	100%	1-9

DAILY CORE LOGGING RECORD

Date 8-3-78 DUTY GEOLOGIST Bud McIntyre

LOG HEADINGS:

Company Fenix & Scisson

Well Number WIPP No. 13

Field East of Carlsbad County Eddy State New Mexico

Location Nash Draw

Section 17 Township 22 South Range 31 East

Permanent Datum 3405.4' Elevations: K.B. 3409.7'

Drilling Measured From 3405' D.F.

G.L. 3405'

RE NO.	INTERVAL	FEET	RPM	WEIGHT ON BIT	CIRCUL. PRESS. P.S.I.	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BOX NUMBE
7	709	722	65	14,000	200/300	13	13	100%	1-5
8	722	729	65	14,000	200/300	7	5	71%	1-3

DAILY CORE LOGGING RECORD

Date 8-4-78 DUTY GEOLOGIST Bud McIntyre/Sigmund Drellack

LOG HEADINGS:

Company Fenix & Scisson

Well Number WIPP No. 13

Field East of Carlsbad County Eddy State New Mexico

Location Nash Draw

Section 17 Township 22 South Range 31 East

Permanent Datum 3405.4' Elevations: K.B. 3409.7'

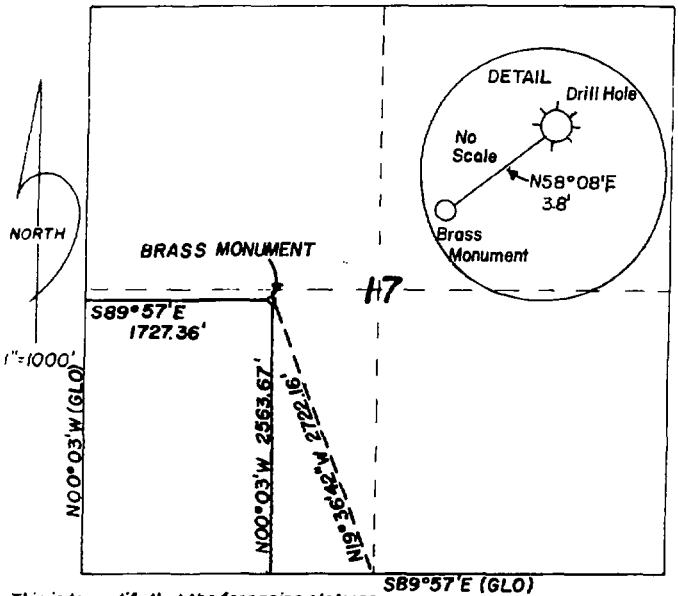
Drilling Measured From 3405' D.F.

G.L. 3405'

CORE NO.	INTERVAL	FEET	RPM	WEIGHT ON BIT	CIRCUL. PRESS. P.S.I.	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BOX NUMBER
9	827	853	60	14,000	200	26	26	100%	1-12
10	853	878	60	14,000	300	25	22.9	81%	1-10

SURVEY MONUMENT "AS BUILT"
"WIPP 13"
SECTION 17, TOWNSHIP 22 S, RANGE 31 E N.M.P.M.
EDDY COUNTY, NEW MEXICO

ELEVATION OF BRASS MONUMENT 3405.43'
2563.67' FS L & 1727.36' FWL

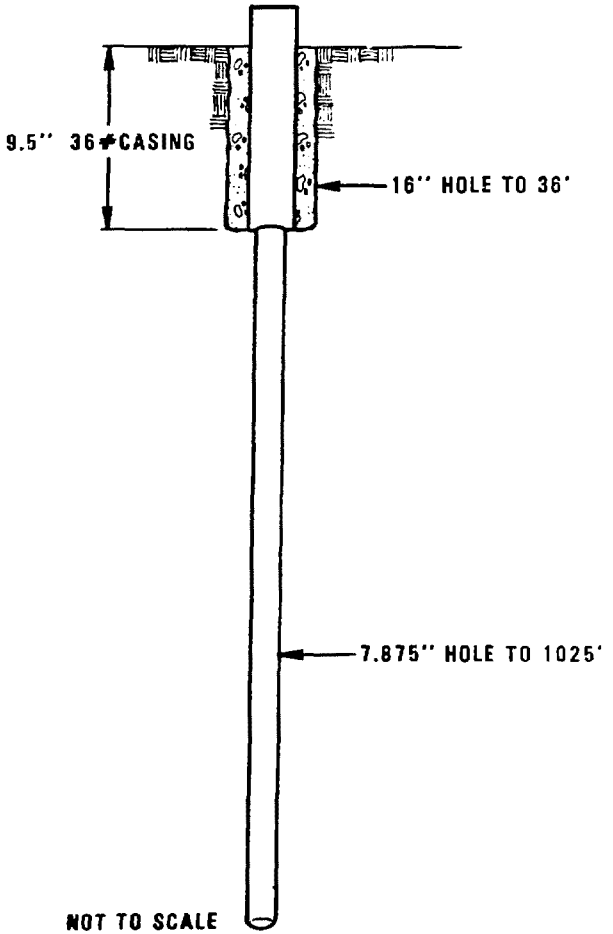


This is to certify that the foregoing plat was made from field notes of a bonafide survey made by me and is true and correct to the best of my knowledge and belief.

Dan R. Reddy
N.M.P.E. & L.S. # 5412

DAN R. REDDY
NEW MEXICO
5412
LAND SURVEYOR
REGISTERED PROFESSIONAL ENGINEER

WIPP #13
AS BUILT HOLE CONDITIONS
AS OF 10/27/78



APPENDIX D

LOGS

by

S-E. Shaffer
Division 4511
Sandia Laboratories

WIPP 13 Logs[1]

Log	Company	ELSI#[2]	Top of Logged Interval[3] (feet)	Bottom Logged Interval (feet)	Date
BHC Sonic Log	Schlumberger	W7131X	Surf.	1008	8/05/78
Compensated Neutron Formation Density	Schlumberger	W7131S	Surf.	1021	8/05/78
Continuous Directional Log	Schlumberger	W7495Y	36	1024	8/05/78
4-Arm High Resolution Continuous Dipmeter	Schlumberger	W7131Y	36	1024	8/05/78
Dual Laterolog Micro-SFL	Schlumberger	W7131W	35	1008	8/05/78

[1]Original data is retained in Sandia WIPP Central File, Division 4542, Sandia Laboratories, Albuquerque, NM, 87185.

[2]Order number for logs available through West Texas Electric Log Service, Inc. (ELSI), 105 West Wall Avenue, Midland, TX.

[3]Depths measured from ground surface; elevation officially 3405.4 above MSL.