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Basic Data Report for Drillhole WIPP 22 (Waste Isolation Pilot Plant - WIPP)

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Sandia Laboratories
United States Geological Survey

Basic Data Report

for

Drillhole

WIPP 22

(Waste Isolation Pilot Plant - WIPP)

SAND79-0278

Compiled by

Sandia Laboratories

(Division 4511)

and

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1.0 ABSTRACT

WIPP 22 is an exploratory borehole whose objective is to determine the nature of the near-surface formations after seismic information indicated a possible fault. The borehole is located in section 20, T.22S., R.31E., in eastern Eddy County, New Mexico, and was drilled between March 14 and 30, 1978. The hole was drilled to a depth of 1448 feet and encountered, from top to bottom, surficial Holocene deposits (6', including artificial fill for drill pad), the Mescalero caliche (7'), the Santa Rosa Sandstone (68'), the Dewey Lake Red Beds (492'), the Rustler Formation (311'), and the upper portion of the Salado Formation (565'). Cuttings were collected at 10-foot intervals. A suite of geophysical logs was run to measure acoustic velocities, density, and radioactivity. On the basis of comparison with other geologic sections drilled in the area, the WIPP 22 section is a normal stratigraphic sequence and it does not show structural disruption.

The WIPP is to demonstrate (through limited operations) disposal technology for transuranic defense wastes. The WIPP will also provide facilities to research interactions between high-level waste and salt.

2.0 INTRODUCTION

The introduction describes background information on the Waste Isolation Pilot Plant (WIPP) and the investigations at WIPP 18, 19, 21, and 22.

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).

2.2 The Purpose of WIPP Boreholes 18, 19, 21, 22

Seismic reflection data (see X series in Bern et al., 1978) over the mile immediately north of ERDA 9 was acquired in late 1977. Early in 1978, preliminary interpretation of the data from line X-2 (Figure 1) indicated faulting of the upper Castile Formation. The fault line, as interpreted in the Castile, was extrapolated upward into poorly defined reflectors in the Rustler Formation (Figure 2). The possibility of a fault in the Rustler was investigated because of potential hydrologic connections into or through the evaporites.

In addition, anomalously low resistivity was measured (Elliot, 1977) in the area where WIPP 19 was drilled. The anomaly, though of lesser areal size and intensity than those previously measured over known "breccia pipes," has a pattern similar to the resistivity anomalies associated in these "breccia pipes." These coincident features required further investigation.

Boreholes WIPP 18, 19, 21, and 22 (WIPP 20 was unnecessary and was never drilled) were positioned to test the most probable location of the inferred fault and to bracket that location for added certainty (Figure 2). WIPP 18 was located north of the inferred fault. WIPP 19 was to intersect the fault in the lower Rustler or upper Salado. WIPP 22 was drilled so that the inferred fault might be intersected in the upper Rustler or Dewey Lake Redbeds. WIPP 21 was located farther south, between ERDA 9 and WIPP 22, to test for southward dip of the Rustler interpreted from the seismic reflection records.

For this evaluation, the displacement was to be identified primarily from comparison of stratigraphic thickness and position of marker beds identified on borehole geophysical logs. WIPP 19 was cored from surface to total depth as the borehole which might intercept the fault if it existed in the Rustler Formation.

Basic geologic data in this report may be used for many purposes. The geologic interpretation of borehole data relating to the inferred fault and resistivity anomaly will be a separate document.

Additional details regarding the background and justification for WIPP 18, 19, 21, and 22 are in Appendix A.

Figure 1. Shot point map of line X-2 north of ERDA 9.

Figure 2. Seismic reflection line X-2 north of ERDA 9.
 Top: Uninterpreted. Bottom: Preliminary interpretation
 displaying features investigated by WIPP 18, 19, 21, 22.

3.0 GEOLOGIC DATA FOR BOREHOLE WIPP 22

By

C. L. Jones¹ and G. L. Gonzales²

3.1 Abstract

Borehole WIPP 22 is an exploratory well drilled in eastern Eddy County, New Mexico, to explore for a possible fault indicated by seismic testing in near-surface rocks. The rocks penetrated include the Mescalero caliche of Pleistocene age, the Santa Rosa Sandstone of Triassic age, and the Dewey Lake Red Beds, the Rustler Formation, and the upper part of the Salado Formation, all of Permian age. Correlated geologic and geophysical logs of WIPP 22 give stratigraphic, lithologic, and physical details of the near-surface rocks. The drilling results establish the presence of a normal representative geologic section unbroken by faulting.

3.2 Introduction

Borehole WIPP 22 is one of a series of exploratory wells drilled near the center of the proposed site for a Waste Isolation Pilot Plant (WIPP) in eastern Eddy County, New Mexico (Figure 3) on behalf of the WIPP project office of the U.S. Department of Energy (DOE). The exploratory drilling was undertaken to search for a fault inferred from a seismic reflection survey record to cut the near-surface formations with a possible minimum of 100-150 feet of stratigraphic displacement.

Basic data concerning the geologic section in WIPP 22 are tabulated herein. The tabulation includes details of the location and the drilling of the borehole, stratigraphic details of the geologic section, and a lithologic description of the drill cuttings. The lithology of geologic section is interpreted and correlated with selected geophysical logs on Figure 3.

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Figure 3: Index map showing location of borehole WIPP 22.

All measurements related to WIPP 22 are reported in the inch-pound system. The system is used to facilitate the comparison of original measurements and observations by surveyors in establishing the geographic coordinates of the borehole, by drillers in reporting sample depth, and by geophysical loggers in recording inhole variations in rock properties with depth. If metric equivalents of the inch-pound system are required, the following conversion factors are provided:

<u>Multiply English unit</u>	<u>By</u>	<u>To obtain metric unit</u>
foot (ft)	0.3048	meter (m)
inch (in)	25.4	millimeter (mm)
inch (in)	2.54	centimeter (cm)
pounds (lb)	0.4536	kilogram (kg)
pounds per square inch (lb/in ²)	0.006895	megapascal (MPa)

3.3 Description of WIPP 22

Borehole WIPP 22 is located in eastern Eddy County, New Mexico, in the SE 1/4 Section 20, T.22S., R.31E. The borehole was drilled between May 8 and 23, 1976, to a depth of 1450 feet measured from a land-surface altitude of 3425.83 feet above MSL (mean sea level). Table 1 gives further details concerning the drilling of WIPP 22.

Conventional rotary-drilling procedures were used to drill WIPP 22. Salt-base mud containing starch, drispac, and other additives was used as the drilling fluid. Cuttings were collected at 10-foot intervals by the driller and were washed at the drill site prior to examination through a binocular microscope. A lithologic description of the cuttings was prepared by S. L. Drellack, Jr., and J. L. Gonzales of Feris & Scisson, Inc.

On completion of drilling, a suite of wireline geophysical logs was run the full depth of WIPP 22 under open-file fluid-filled conditions. The logging was done to facilitate the recognition and correlation of rock units, to assure identification of major lithologies (dolomite, anhydrite, polyhalite, and other evaporites), and to provide depth determinations independent of that indicated by drill-pipe measurements.

The geophysical logs included (1) a gamma-ray curve that recorded variations in the distribution of potassium and other radioactive elements, (2) a neutron-porosity curve that essentially recorded variations in rock density (Figure 3).

3.4 Geologic Data

The geologic section in WIPP 22 includes continental sediments of Quaternary and Triassic age, and marine red beds and evaporites of Permian age. The Quaternary, Triassic, and Permian units are listed in Table 2, and are briefly described in descending order.

The Quaternary sediments consist of unconsolidated dune sand of Holocene age, and a well-lithified calcareous soil, known locally as the Mesclero caliche, of Pleistocene age. The two rock units account for the upper 13 feet of section in WIPP 22.

Rocks underlying the Quaternary units, at 13-81 feet below land surface, represent the lower part of the Santa Rosa Sandstone of Triassic age. This part of the Santa Rosa consists of brown, reddish-brown, and grayish-red siltstone and sandstone. The rocks have a dolomitic cement and are somewhat micaceous.

Rocks belonging to the Permian System are represented by the Dewey Lake Red Beds, the Rustler Formation, and the upper part of the Salado Formation. The Dewey Lake Red Beds, at 81-574 feet below the surface, are a monotonous sequence of chiefly reddish-brown siltstones, with subordinate mudstone and sandstone. The underlying Rustler Formation at 574-885 feet below the surface, is chiefly anhydrite and siltstone, with subordinate dolomite, clayey halite, and unconsolidated silt derived from dissolution of clayey halite. The underlying upper part of the Salado Formation, at 885-1450 feet below the surface, is chiefly halite and argillaceous halite, with thin interbeds of anhydrite, polyhalite, and siltstone.

Insofar as has been demonstrated by drilling, the geologic section in WIPP 22 is unbroken by faulting, and there are no missing rock units, anomalous thicknesses, or structural discontinuities. In fact, the section is representative for the near-surface formations at the WIPP site,

and it is similar lithologically, stratigraphically, and structurally to that in other exploratory wells drilled in the area (see, for example, Jones 1978). The drilling results do not confirm the interpretations from seismic records of the faulting of near-surface formations at WIPP 22.

Table 1.--Abridged history of borehole WIPP-22

LOCATION: sec. 20, T. 22 S., R. 31 E.
2,544.45 feet from south line
10.94 feet from east line

ALTITUDE: LS (land surface) 3,425.83 feet. Datum for all depth measurements.

LITHOLOGIC DESCRIPTION OF CUTTINGS PREPARED BY: S. L. Drellack, Jr., and J. L. Gonzales (F&S),
May 8-23, 1978.

DRILLING CONTRACTOR: Boyles Bros. Drilling Co.

DRILLING RECORD: Commenced drilling on May 8, 1978, and completed on May 23, 1978, at
1,450 feet below LS.

Drilled 8 3/4-inch hole to 20 feet, and set 7-inch outside-diameter casing at
20 feet. Packed annulus with dirt.

Drilled 6 1/8-inch hole to 1,450 feet.

On completion of drilling, suite of wireline geophysical logs was run, and
hole capped pending decision on further work.

Table 2.--Geologic section in borehole WIPP-22

Rock unit	Thickness Feet	Depth interval ¹ Feet
Quaternary rocks		
Holocene deposits ²	6	0- 6
Mescalero caliche	7	6- 13
Triassic rocks		
Santa Rosa Sandstone	68	13- 81
Permian rocks		
Dewey Lake Red Beds	492	81- 574
Rustler Formation	311	574- 885
Dissolution residue	11	603- 614
Magenta Dolomite Member	24	630- 654
Dissolution residue	11	717- 728
Culebra Dolomite Member	22	742- 764
Dissolution residue	6	767- 773
Salt interval	108	777- 885
Salado Formation	565	885- 1,450
Upper member	480	883- 1,363
³ MB 101	3	1,000- 1,003
³ MB 102	1	1,036- 1,037
³ MB 103	14	1,049- 1,063
³ MB 104	1	1,071- 1,072
³ MB 105	1	1,086- 1,087
³ MB 106	1	1,102- 1,103
³ MB 107	1	1,142- 1,143
³ MB 108	1	1,150- 1,151
³ MB 109	22	1,172- 1,196
³ MB 111	1	1,242- 1,243
³ MB 112	2	1,259- 1,261
³ MB 113	1	1,285- 1,286
³ MB 114	1	1,307- 1,308
³ MB 115	2	1,342- 1,344
³ MB 116	2	1,353- 1,355
McNutt potash unit	87	1,363- 1,450
Vaca Triste Sandstone Member ⁴	4	1,363- 1,367
³ MB 117	1	1,426- 1,427
Maximum depth recorded-----		1,440

¹Depth recorded on Compensated Neutron-Formation Density log²Includes artificial fill for drill pad.³Marker Bed.⁴Of Adams, 1944.

Table 3.--Descriptive log of cuttings for WIPP-22

[Color designation from Rock-Color Chart (Goddard and others, 1948). Depth interval refers to depth reported by driller]

Lithologic description	Depth interval feet
Dune sand, unconsolidated, eolian (includes fill for drill pad)-----	0- 6
Caliche, grayish-pink (5R 8/2) to white (N9); dotted with very fine sand grains-----	6- 13
Siltstone, moderate-brown (5YR 3/4) and pale-reddish-brown (10R 5/4)-----	13- 20
Siltstone (90 percent) moderate-brown (5YR 3/4); moderate-brown (5YR 3/4), very fine grained sandstone (10 percent)-----	20- 40
Siltstone (35 percent), pale-yellowish-brown (10YR 6/2), well-cemented; moderate-brown (5YR 3/4) siltstone (35 percent); moderate-brown (5YR 4/4), very fine grained sandstone (30 percent)-----	40- 50
Siltstone (95 percent), grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4), micaceous; grayish-red (10R 4/2), very fine grained sandstone (5 percent)-----	50- 60
Sandstone, dark-reddish-brown (10R 3/4), subangular to subrounded; dolomitic cement-----	60- 70
Sandstone (50 percent), dark-reddish-brown (10R 3/4), very fine grained, slightly micaceous; dolomitic cement, subrounded; moderate- reddish-brown (10R 4/6), fine-grained, subrounded sandstone (30 percent); pale-yellowish-brown (10YR 6/2), very fine grained sandstone (20 percent)-----	70- 80
Siltstone (40 percent), dark-reddish-brown (10R 3/4); grayish-yellow- green (5GY 7/2) siltstone (40 percent), dolomitic cement; dark- reddish-brown (10R 3/4), very fine grained sandstone (20 percent), dolomitic cement-----	80- 90
Siltstone (50 percent), dark-reddish-brown (10R 3/4); moderate-reddish- brown (10R 4/6) siltstone (50 percent); trace of dark-reddish-brown (10R 3/4) mudstone-----	90-100
Mudstone (60 percent), dark-reddish-brown (10R 3/4); moderate-reddish- brown (10R 4/6) siltstone (30 percent); pale-yellowish-brown (10YR 6/2) siltstone (10 percent)-----	100-110
Siltstone, dark-reddish-brown (10R 3/4), dolomitic cement; trace of pale-yellowish-brown (10YR 6/2) siltstone and very fine grained sandstone-----	110-130
Siltstone (60 percent), dark-reddish-brown (10R 3/4), dolomitic cement; greenish-gray (5G 6/1) siltstone (40 percent)-----	130-150
Sandstone, moderate- to dark-reddish-brown (10R 4/6-10R 3/4), very fine grained; trace of dark-reddish-brown (10R 3/4) siltstone-----	150-160

Table 3.--Descriptive log of cuttings for WIPP-22--Continued

Lithologic description	Depth interval Feet
Siltstone (70 percent), dark-reddish-brown (10R 3/4); dark-reddish-brown (10R 3/4), very fine grained sandstone (30 percent)-----	160-170
Siltstone (80 percent), dark-reddish-brown (10R 3/4), dolomitic; pale-yellowish-brown (10YR 6/2) siltstone (20 percent), dolomitic cement-----	170-190
Siltstone, dark-reddish-brown (10R 3/4), dolomitic cement-----	190-200
Siltstone (90 percent), dark-reddish-brown (10R 3/4); dark-reddish-brown (10R 3/4), very fine grained sandstone (10 percent); trace of very light gray (x8) siltstone-----	200-210
Siltstone, dark-reddish-brown (10R 3/4); contains white (N9) selenite-----	210-230
Siltstone (65 percent), dark-reddish-brown (10R 3/4); pale-yellowish-brown (10YR 6/2), very fine grained sandstone (5 percent); colorless to white (N9) selenite (5 percent); dark-reddish-brown (10R 3/4) mudstone (5 percent)-----	230-240
Siltstone, dark-reddish-brown (10R 3/4), biotitic; contains some selenite-----	240-250
Siltstone, dark-reddish-brown (10R 3/4), peppered with grayish-green (5G 5/2) reduction spots, biotitic; some colorless to white (N9) selenite; trace of light-gray (W7) siltstone-----	250-260
Siltstone, same as unit at 250-260 feet, no light-gray (W7) siltstone-----	260-270
Siltstone, dark-reddish-brown (10R 3/4), peppered with grayish-green (5G 5/2) reduction spots, biotitic; some colorless to white (N9) selenite; trace of dark-reddish-brown (10R 3/4), very fine grained sandstone-----	270-290
Siltstone (90 percent), dark-reddish-brown (10R 3/4), peppered with grayish-green (5G 5/2) reduction spots, biotitic; some colorless to white (N9) selenite; dark-reddish-brown (10R 3/4) mudstone (10 percent)-----	290-300
Siltstone, dark-reddish-brown (10R 3/4), peppered with grayish-green (5G 5/2) reduction spots, slightly biotitic; trace of dark-reddish-brown (10R 3/4) mudstone and white (N9) selenite-----	300-310
Siltstone, same as unit at 300-310 feet; trace of light-gray (W7) siltstone-----	310-320
Siltstone, dark-reddish-brown (10R 3/4), peppered with grayish-green (5G 5/2) reduction spots, slightly biotitic; trace of dark-reddish-brown (10R 3/4) mudstone and white (N9) selenite-----	320-330
Siltstone, same as unit at 320-330 feet; trace of dusky-yellowish-green (5GY 5/2) siltstone-----	330-340
Siltstone (90 percent), dark-reddish-brown (10R 3/4), peppered with grayish-green (5G 5/2) reduction spots; white (N9) to colorless selenite (10 percent)-----	340-350
Siltstone (80 percent), dark-reddish-brown (10R 3/4), peppered with grayish-green (5G 5/2) reduction spots; white (N9) to colorless selenite (10 percent); greenish-gray (5G 6/1) siltstone (10 percent)-----	

Table 3.--Descriptive log of cuttings for NIPP-22--Continued

Lithologic description	Depth interval Feet
Siltstone (90 percent), dark-reddish-brown (10R 3/4), peppered with grayish-green (5G 5/2) reduction spots; colorless to white (W9) selenite (10 percent); trace of greenish-gray (5G 6/1) siltstone-----	380-410
Siltstone, moderate- to dark-reddish-brown (10R 4/6-10R 3/4), peppered with grayish-green (5G 5/2) reduction spots and some white (W9) selenite-----	410-440
Siltstone (95 percent), same as unit at 410-440 feet; pale-reddish-brown (10R 5/4), very fine grained sandstone (5 percent)-----	440-450
Siltstone, same as unit at 440-450 feet; trace of pale-reddish-brown (10R 5/4), very fine grained sandstone-----	450-460
Siltstone (75 percent), moderate- to dark-reddish-brown (10R 4/6-10R 3/4), peppered with grayish-green (5G 5/2) reduction spots; pale-yellowish-green (10GY 7/2), very fine grained sandstone (25 percent)-----	460-470
Siltstone (90 percent), moderate- to dark-reddish-brown (10R 4/6-10R 3/4), peppered with grayish-green (5G 5/2) reduction spots; pale-yellowish-green (10GY 7/2), very fine grained sandstone (10 percent)-----	470-480
Siltstone (95 percent), moderate- to dark-reddish-brown (10R 4/6-10R 3/4), peppered with grayish-green (5G 5/2) reduction spots; pale-reddish-brown (10R 5/4), very fine grained sandstone (5 percent); trace of white (W9) selenite-----	480-490
Siltstone, moderate- to dark-reddish-brown (10R 4/6-10R 3/4), peppered with grayish-green (5G 5/2) reduction spots; some colorless to white (W9) selenite and trace of pale-yellowish-green (10GY 7/2) siltstone-----	490-500
Siltstone, moderate- to dark-reddish-brown (10R 4/6-10R 3/4), peppered with grayish-green (5G 5/2) reduction spots; trace of colorless to white (W9) selenite, dark-reddish-brown (10R 3/4) mudstone, and grayish-green (10GY 5/2) siltstone-----	500-530
Siltstone (95 percent), moderate- to dark-reddish-brown (10R 4/6-10R 3/4), peppered with grayish-green (5G 5/2) reduction spots; colorless to white (W9) selenite (5 percent); trace of pale-reddish-brown (10R 5/4), very fine grained sandstone-----	530-540
Siltstone, dark-reddish-brown (10R 3/4), peppered with grayish-green (5G 5/2) reduction spots; trace of white (W9) selenite and grayish-green (5G 5/2) siltstone-----	540-570
Siltstone (40 percent), dark-reddish-brown (10R 3/4), peppered with grayish-green (5G 5/2) reduction spots; light-olive-gray (5Y 6/1), very finely crystalline anhydrite (30 percent); white (W9), very finely crystalline gypsum (30 percent)-----	570-580
Anhydrite (70 percent), light-olive-gray (5Y 6/1) to medium-light-gray (W6), very finely crystalline; white (W9), very finely crystalline gypsum (20 percent); dark-reddish-brown (10R 3/4) siltstone (10 percent)-----	580-590

Table 3.--Descriptive log of cuttings for WIPP-22--Continued

Lithologic description	Depth interval Feet
Anhydrite (80 percent), gypsum (20 percent), same as unit at 580-590 feet; trace of dark-reddish-brown (10R 3/4) siltstone-----	590-600
Anhydrite (75 percent), light-olive-gray (5Y 6/1) to medium-light-gray (N6), very finely crystalline; white (N9), very finely crystalline gypsum (20 percent); dark-reddish-brown (10R 3/4) siltstone (5 percent)-----	600-620
Anhydrite (90 percent), olive-gray (5Y 4/1) to medium-light-gray (N6), very finely crystalline; white (N9), very finely crystalline gypsum (10 percent)-----	620-630
Dolomite (90 percent), olive-gray (5Y 4/1) to grayish-green (10GY 5/2), very fine grained; white (N9), very finely crystalline gypsum (10 percent); trace of selenite-----	630-640
Dolomite (80 percent), gypsum (20 percent), same as unit at 630-640 feet; trace of anhydrite and dark-reddish-brown (10R 3/4) siltstone-----	640-650
Dolomite (95 percent); gypsum (5 percent), same as unit at 640-650 feet-----	650-660
Anhydrite (50 percent), olive-gray (5Y 4/1) to medium-light-gray (N6), very finely crystalline; white (N9), very finely crystalline gypsum (40 percent); olive-gray (5Y 4/1) to grayish-green (10GY 5/2), very fine grained dolomite (10 percent)-----	660-670
Anhydrite (45 percent), olive-gray (5Y 4/1) to medium-light-gray (N6), very finely crystalline; dolomite (25 percent) and gypsum (25 percent), same as unit at 660-670 feet; dark-reddish-brown (10R 3/4) siltstone (5 per- cent)-----	670-680
Anhydrite (50 percent), gypsum (15 percent) and dolomite (5 percent), same as unit at 670-680 feet; trace of dark-reddish-brown (10R 3/4) siltstone-----	680-700
Gypsum (50 percent), white (N9), very finely crystalline; light-olive- gray (5Y 6/1) to medium-light-gray (N6) anhydrite (50 percent); trace of moderate-reddish-brown (10R 4/6) siltstone-----	700-730
Gypsum (60 percent), white (N9), very finely crystalline; medium-light- gray (N6), very finely crystalline anhydrite (30 percent); light-brownish- gray (5YR 5/1) to brownish-gray (5YR 4/1), very finely crystalline dolomite (10 percent)-----	730-740
Gypsum (60 percent), anhydrite (30 percent), and dolomite (30 percent), same as unit at 730-740 feet-----	740-750
Dolomite (95 percent), light-olive-gray (5Y 5/2), very finely crystalline; white (N9), very finely crystalline gypsum (5 percent); trace of selenite-----	750-760
Dolomite, light-olive-gray (5Y 5/2), very finely crystalline; trace of white (N9) gypsum-----	760-780

Table 3.--Descriptive log of cuttings for WIPP-22--Continued

Lithologic description	Depth interval Feet
Anhydrite (50 percent), medium-light-gray (N6), very finely crystalline; white (N9) gypsum (40 percent); dark-reddish-brown (10R 3/4) siltstone (5 percent); light-olive-gray (5Y 5/2), very finely crystalline dolomite (5 percent)-----	780-790
Anhydrite (40 percent), same as unit at 780-790 feet; colorless halite (20 percent); moderate-reddish-brown (10R 4/6) siltstone (30 percent); white (N9) gypsum (10 percent); trace of olive-gray (5Y 3/2) clay-----	790-800
Halite (90 percent), colorless; white (N9) gypsum (10 percent); trace of anhydrite and moderate-reddish-brown (10R 4/6) siltstone-----	800-810
Siltstone (95 percent), dark-reddish-brown (10R 3/4); colorless halite (5 percent); trace of dark-reddish-brown (10R 3/4), very fine grained sandstone and white (N9) gypsum-----	810-820
Sandstone (95 percent), dark-reddish-brown (10R 3/4), very fine grained; dark-reddish-brown siltstone and white (N9) gypsum (5 percent)-----	820-830
Sandstone (95 percent), dark-reddish-brown (10R 3/4) and light-olive-gray (5Y 5/2) to olive-gray (5Y 3/2), very fine grained; dark-reddish-brown (10R 3/4) siltstone and white (N9) gypsum (5 percent)-----	830-840
Sandstone (90 percent), grayish-red (10R 4/2), pale-blue (5B 6/2) and moderate-reddish-brown (10R 4/6), very fine grained; white (N9) gypsum and moderate-reddish-brown (10R 4/6) siltstone (10 percent)-----	840-850
Sandstone, same as unit at 840-860 feet; trace of light-olive-gray (5Y 6/1), very finely crystalline anhydrite-----	860-870
Gypsum (50 percent), white (N9), very finely crystalline; light-olive-gray (5Y 6/1), very finely crystalline anhydrite (30 percent); pale-red (5R 6/2) and grayish-red (10R 4/2) siltstone (20 percent); trace of medium-gray (N5) clay-----	870-880
Gypsum (25 percent), anhydrite (25 percent), and siltstone (25 percent), same as unit at 870-880 feet; sandstone (25 percent), same as unit at 860-870 feet; trace of medium-gray (N5) clay-----	880-890
Halite (90 percent), clear to moderate-reddish-brown (10R 4/6); white (N9), very finely crystalline gypsum (5 percent); dusky-yellowish-brown (10YR 2/2) sandstone and moderate-reddish-brown (10R 4/6) siltstone (5 percent); trace of medium-gray (N5) clay-----	890-900
Halite (95 percent), colorless to moderate-reddish-brown (10R 4/6); white (N9) gypsum and dusky-yellowish-brown (10YR 2/2) and moderate-reddish-brown (10R 4/6) siltstone (5 percent)-----	900-910
Halite, same as unit at 900-910 feet; trace of dusky-yellowish-brown (10YR 2/2) and moderate-reddish-brown (10R 4/6) siltstone-----	910-920

Table 3.--Descriptive log of cuttings for WIPP-22--Continued

Lithologic description	Depth interval Feet
Halite (95 percent), same as unit at 910-920 feet; medium-blue-gray (5B 5/1) siltstone (5 percent)-----	920-950
Halite (70 percent), same as unit at 920-950 feet; moderate-reddish-brown (10R 4/6), grayish-blue-green (5AG 5/2), and pale-reddish-brown (10R 5/4), very fine grained sandstone (30 percent); trace of white (M9) gypsum-----	950-960
Halite (95 percent), sandstone (5 percent), same as unit at 950-960 feet; trace of white (M9) gypsum-----	960-980
Halite, same as unit at 960-980 feet-----	980-1,000
Halite (85 percent), colorless to white (M9); moderate-reddish-brown (10R 4/6), very fine grained sandstone (5 percent); moderate-reddish-orange (10R 6/6) siltstone (5 percent); moderate-reddish-orange (10R 6/6) to pale-reddish-brown (10R 5/4), very finely crystalline polyhalite (5 percent)-----	1,000-1,010
Halite (50 percent), colorless to white (M9); moderate-reddish-orange (10R 6/6) to pale-reddish-brown (10R 5/4), very finely crystalline polyhalite (20 percent); moderate-reddish-brown (10R 4/6) and moderate-reddish-orange (10R 6/6), very fine grained sandstone (15 percent); moderate-reddish-brown (10R 4/6) and moderate-reddish-orange (10R 6/6) siltstone (15 percent)-----	1,010-1,020
Polyhalite (50 percent), moderate-reddish-orange (10R 6/6) to pale-reddish-brown (10R 5/4), very finely crystalline; colorless to white (M9) halite (40 percent); moderate-reddish-brown (10R 4/6) siltstone (10 percent)-----	1,020-1,030
Halite (60 percent), colorless to white (M9); moderate-reddish-orange (10R 6/6) to pale-reddish-brown (10R 5/4), very finely crystalline polyhalite (35 percent); medium-blue-gray (5B 5/1), and moderate-reddish-brown (10R 4/6) siltstone (5 percent)-----	1,030-1,040
Halite (95 percent), colorless to white (M9); medium-blue-gray (5B 5/1) and moderate-reddish-brown (10R 4/6) siltstone (5 percent); trace of polyhalite-----	1,040-1,045
Halite, clear to very light gray (M8), slightly argillaceous-----	1,045-1,050
Anhydrite, yellowish-gray (5Y 3/1) to light-olive-gray (5Y 6/1), finely to medium-crystalline, granular; moderate-reddish-orange (10R 6/6) polyhalite and clear halite-----	1,050-1,060
Anhydrite, light-olive-gray (5Y 6/1) finely crystalline-----	1,060-1,070
Halite, predominantly clear to very light gray (M8); trace of moderate-reddish-orange (10R 6/6) polyhalite-----	1,070-1,080
Halite, clear, slightly argillaceous-----	1,080-1,090

Table 3.--Descriptive log of cuttings for WIPP-22--Continued

Lithologic description	Depth interval Feet
Halite, same as unit at 1,070-1,080 feet; trace of moderate-reddish-orange (10R 6/6) polyhalite-----	1,090-1,100
Halite, predominantly clear, some very light gray (N8); trace of polyhalite----	1,100-1,110
Halite (90 percent), same as unit at 1,100-1,110 feet; polyhalite (10 percent)---	1,110-1,130
Halite, clear and very light gray (N8); trace of polyhalite and anhydrite-----	1,130-1,140
Halite, (90 percent), clear; moderate-reddish-orange (10R 6/8) to moderate-reddish-brown (10R 4/6) polyhalite (10 percent)-----	1,140-1,160
Halite, clear; trace of polyhalite-----	1,160-1,180
Halite, clear-----	1,180-1,190
Halite (60 percent), clear; yellowish-gray (5Y 8/1), very finely crystalline anhydrite (30 percent) very light yellowish gray (5Y 8/1) to white (N9) to pinkish-gray (5YR 8/1) gypsum (10 percent)-----	1,190-1,200
Halite (50 percent), clear; gypsum (20 percent), same as unit at 1,190-1,200 feet; yellowish-gray (5Y 8/1), very finely crystalline anhydrite (30 percent)-----	1,200-1,210
Halite, clear; trace of anhydrite and polyhalite-----	1,210-1,220
Halite, clear; trace of polyhalite-----	1,220-1,230
Halite (90 percent), clear; polyhalite (10 percent)-----	1,230-1,240
Halite, same as unit at 1,230-1,240 feet; trace of polyhalite-----	1,240-1,260
Halite (70 percent), clear; moderate-reddish-orange (10R 6/6) polyhalite (30 percent)-----	1,260-1,270
Halite, clear; trace of polyhalite, same as above-----	1,270-1,280
Halite (80 percent), clear; moderate-reddish-orange (10R 6/6) polyhalite (20 percent)-----	1,280-1,290
Halite (90 percent), clear; moderate-reddish-orange (10R 6/6), very finely crystalline polyhalite (10 percent)-----	1,290-1,300
Halite, clear, slightly argillaceous; trace of polyhalite, same as above-----	1,300-1,320
Halite, clear; trace of polyhalite-----	1,320-1,340
Halite, clear-----	1,340-1,350
Halite, clear, some slightly argillaceous; trace of polyhalite and anhydrite---	1,350-1,360
Halite (90 percent), clear; moderate-orange-pink (10R 7/4) to moderate-reddish-orange (10R 6/6) polyhalite (10 percent)-----	1,360-1,370
Halite, clear-----	1,370-1,380
Clay (50 percent), moderate-brown (5YR 4/4) to moderate-reddish-brown (10R 4/6); clear halite (50 percent)-----	1,380-1,390
Halite, clear, slightly argillaceous-----	1,390-1,400
Halite, clear to white (N9)-----	1,400-1,430
Halite, clear; trace of polyhalite-----	1,430-1,450

4.0 HYDROLOGIC DATA

No hydrologic test data have been obtained to date from WIPP 22, and there are no plans at present to convert these boreholes for hydrologic testing.

5.0 REMARKS

The immediate objective of testing for stratigraphic continuity of the Rustler Formation and upper Salado was reached through drilling of the complementary boreholes WIPP 18, 15, 21, 22. As a consequence, the seismic reflection data down to the upper Salado are treated with extreme caution; the apparent reflectors are generally considered unreliable for this area. Later generations of seismic reflection data ("Y" series, Hern et al., 1978; "GG" series, Bell and Murphy, 1979), synthetic seismograms, and review of field data contribute to understanding of the seismic data in this particular area. Interpretive reports will deal with this aspect.

Trenches were dug through the Mesuadero caliche in the road at the projected surface trace of the inferred fault. The caliche was examined by the USGS for displacements, but none were observed. This examination and caliche data are not reported explicitly for this problem, but the information is available in more general form (Bachman, USGS, in preparation).

6.0 BIBLIOGRAPHY

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RUSTLER

FORMATION

DEWEY

Year	1990	1991	1992	1993	1994	1995
1990	1991	1992	1993	1994	1995	1996

[illegible]

QUESTIONS

APPENDIX A

JUSTIFICATION

INTRODUCTION TO APPENDIX A, JUSTIFICATION

Appendix A consists of relevant portions of two related documents:

- 1) memorandum from D. W. Powers to L. R. Hill, dated 2/15/78, "Stratigraphic Test Holes," and
- 2) memorandum from D. W. Powers to L. R. Hill, dated 3/15/78, "Shallow Cores for Testing Displacement of Pleistocene Sediments."

These documents provide 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.

date: February 15, 1978

to L.R. Hill 5311

Dennett W. Powers

from D.W. Powers 5311

subject: Stratigraphic Test Holes

Objective: to determine the depth of the top of the Salado Formation rather precisely over a half-mile interval beginning about a half-mile north of ERDA 9, section 20, T22S, R31E. In addition, the stratigraphy of the beds above the Salado will be evaluated, and some core from the upper part of the Salado Formation may be taken. One of the holes may be established as a hydrology hole.

Method: 3-5 drill holes may be required along seismic reflection line X-2. If necessary, 2 drill holes may be located along or near line X-5. Extensive logging will be required to support stratigraphic inferences, and some of the holes may be cored extensively.

Details: WIPP 18 should be rotary drilled to the top of the Salado at an expected depth of about 1100'. The logs required are sonic, gamma ray, neutron, microlaterolog, and diplog. In addition, determination of the seismic velocity through downhole measurements will probably be required. The USGS/WRD should plan to log this hole to provide continuity between commercial logs on this, and other holes, and the USGS/WRD logs on the potash holes, particularly P-5. WIPP 18 should be located at vibrating point (VP) 179 of X-2.

WIPP 19 should be cored from "grassroots" to the top of the Salado at an expected depth of about 900'. Logs should be run as on 18, with the exception of the seismic velocity log. The location is at VP 191 of X-2. Core in this hole may help to locate the depth of faults more precisely, and help determine the character of any fault (including fluid movement). If the stratigraphy is relatively undisturbed through normal aquifer zones, the hole may be cased for hydrologic studies.

This hole is located to intersect both possible faults to aid projections toward the surface, and should intersect the top of the Salado immediately south of the fault zone on the hanging wall. This borehole should, with WIPP 18, provide boundaries for the zone of apparent displacement.

WIPP 20 should be drilled to a depth of about 700' (contingent on the depths indicated in WIPP 18), and then cored to a depth of about 1500'. Logs should be similar to WIPP 19. The location is at VP 187 of X-2. The core will indicate the depth of faults, and the nature of the fault plane(s). Solutioning of salt may be determined by examination of core within the Salado.

This hole is located in the zone showing greatest probable disturbance. It may be the last of the test holes necessary around this anomaly.

WIPP 21 may be drilled to a depth of about 1200-1300' to obtain additional data on the disturbed zone. Logs are similar to WIPP 19. The location is at VP 185 of X-2. Some core may be required to determine the effects of faulting and any dissolution of salt. The location and need for this hole are tentative.

An alternative location (WIPP 23) for this hole is at VP 110 on line X-5. This area shows about 100' difference in depth to top of Salado when compared with hole F-82 about one-quarter mile north. In addition, apparent faulting of the top of the Salado occurs at about VP 120.

WIPP 22 may be drilled to the top of the Salado at a depth of about 900'. The logs would be the same as for WIPP 19. The location is VP 195 along X-2. This location is tentative, and may be used only if WIPP 19 is more disturbed than expected. This location might be an alternative for conversion to hydrologic purposes.

An alternate location (WIPP 24) is near F-82 to confirm information on the top of the Salado in that hole.

Background: interpretation of the recently acquired seismic reflection data in the WIPP area indicates a possible northwest trending fault through this area. The displacement on the fault, if properly interpreted, may be 100-250'. There is a need to confirm or reject this interpretation in order to further assess the study area as suitable for the WIPP. This drilling program is expected to provide appropriate data.

Field Support: support for engineering programs is requested from Division 1133. Geologic field support is expected through the USGS and F&S.

DWP:5311:dp

Distribution:

1133 R.D. Statler (3)
1135 P.D. Seward
5310 W.D. Weart
5311 D.W. Powers (2)
5311 Archives (2)

date: March 15, 1978

to: L.R. Hill 5311

from: D.W. Powers 5311

subject: Shallow cores for testing displacement of Pleistocene sediments

Objective: to provide core of significant stratigraphic horizons from very shallow depths north of ERDA 9 to test for displacement.

Method: use normal soil coring techniques to provide generally continuous core from above the caliche to a depth of 5-15 feet into the uppermost Permian or Triassic sediments. Contacts of the caliche and any Gatuna are most significant; other traceable horizons may be useful as well. Surveying of the drilling locations will provide the lateral and vertical control necessary to establish possible displacement.

Location: the location of interest for these 10-12 coreholes is between vibrating points (VP) 191 and 195 of seismic line X-2. The locations are in section 20, T22S, R31E, and are between about 2500 and 3000' north of the south boundary of the section. The line of holes will probably be located west of the access road through section 20 to avoid caliche disturbed by construction.

Timing: shallow coring will be initiated as soon as practicable after WIPP 19 has drilled the redbed section. This will allow further refinements to the location of initial shallow cores.

Background: This program is directed at further delineation of the zone north of ERDA 9 where possible faulting has been interpreted on the basis of recent seismic reflection data. If the drilling of WIPP 18 and 19 disproves such faulting, this program for shallow core drilling will not be necessary. If WIPP 18 and 19 indicate the presence of faulting, this program will help determine how recently such faulting has been active.

Field Support: support in establishing the contracting, surveying, and other field engineering is requested from Division 1133. Geologic field support is expected from the USGS, F&S, and the New Mexico Bureau of Mines and Mineral Resources (Dr. John Hawley).

DWP:5311:dp

Distribution:

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APPENDIX B

DRILLING AND TESTING PLAN

compiled 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.

Date February 27, 1978

Albuquerque, New Mexico
Livermore, California

To Distribution

R. D. Statler

From: R. D. Statler - SLA 1133

Subject: WIPP Nos. 18 thru 22, Drilling Program Schedule and Coring Plan

The attached document describes the plans and program for drilling up to five exploratory holes designated as WIPP 18, 19, 20, 21, and 22. It is expected these holes will begin during March 1978 and be completed by the end of May 1978, presuming necessary clearances and permits can be quickly obtained.

RDS:rj

Distribution:

DOE/ALO D. Davis
USGS Denver C. Jones
USGS Albuquerque J. Mercer
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1135 J. E. Magruder
5311 L. R. Hill
5311 D. W. Powers (3)
5311 S. J. Lambert
5311 Archives (2)
5342 J. W. McKiernan
9512 F. L. McFarling
1133 R. D. Statler (5)

WIPP 18, 19, 20, 21 22
OPERATIONAL PROCEDURE, CORING & TEST PLANS

- A. OBJECTIVE (Ref Memo of Record, D. W. Powers, 5311, dtd 2/15/78)
To determine depth of the top of Salado formation precisely over a half-mile interval within the mile immediately north of ERDA 9. To evaluate the stratigraphy in the overlying beds above the Salado and possibly establish a hydrological test well.

B. SCHEDULING SEQUENCE

WIPP 18 will be initiated first by rotary drilling to the top of Salado. After a suite of logs are run, the hole will be plugged to surface and abandoned. Expect to begin mid-March and be complete in about one week.

WIPP 19 will be set up second to take continuous core from "grass-roots" to the top of Salado. After a suite of logs have been run and evaluated, the hole may be opened and then casing stood and cemented for subsequent conversion into a hydrological test well. If hole not considered suitable, it will be plugged to surface and abandoned.

WIPP 20 will be drilled third to a depth of about 700' (contingent on evaluation of results from WIPP 18 and 19) and then a continuous core taken to a depth of about 1500'. After suite of logs taken, hole will be plugged to surface and abandoned.

WIPP 21 may be drilled to a depth of 1200-1300' to obtain additional data if information from 18, 19 and 20 is considered incomplete. Suite of logs will be run and several hundred feet of core may be taken. Hole will then be plugged to surface and abandoned. Location may be moved to an alternate site along seismic line X-5.

WIPP 22 may be drilled to the top of Salado. After suite of logs, hole will be evaluated and either plugged or set up as hydrologic test well.

C. ORGANIZATION

Technical direction will originate within Sandia Division 5311 under Dennis Powers. 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 F&S 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 Charlie Jones, USGS-Special Projects, Jerry Mercer, USGS-WRD, and Joe Gonzales, F&S.

Quality Assurance Program will be administered by F. L. McFarling and Jim 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.

D. FIELD OPERATIONS

1. Sites selected and archaeological survey conducted. Land survey made. BLM permits obtained. "Notice of Intention to Drill Exploratory Well" filed with NM State Engineer's office.

2. Award dirt contract. Construct 3/4 mile of 12' wide access road, 6" thick caliche base, five each 100' x 100' drill pads around drill site stake.

3. Begin WIPP, 18 as follows:

WIPP 18, 19, 20, 21 22
OPERATIONAL PROCEDURE, CORING & TEST PLANS

A. OBJECTIVE (Ref Memo of Record, D. W. Powers, S311, dtd 2/15/78)

To determine depth of the top of Salado formation precisely over a half-mile interval within the mile immediately north of ERDA 9. To evaluate the stratigraphy in the overlying beds above the Salado and possibly establish a hydrological test well.

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WIPP 20 will be drilled third to a depth of about 700' (contingent on evaluation of results from WIPP 18 and 19) and then a continuous core taken to a depth of about 1500'. After suite of logs taken, hole will be plugged to surface and abandoned.

WIPP 21 may be drilled to a depth of 1200-1300' to obtain additional data if information from 18, 19 and 20 is considered incomplete. Suite of logs will be run and several hundred feet of core may be taken. Hole will then be plugged to surface and abandoned. Location may be moved to an alternate site along seismic line X-5.

WIPP 22 may be drilled to the top of Salado. After suite of logs, hole will be evaluated and either plugged or set up as hydrologic test well.

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D. FIELD OPERATIONS

1. Sites selected and archaeological survey conducted. Land survey made. BLM permits obtained. "Notice of Intention to Drill Exploratory Well" filed with NM State Engineer's office.
2. Award dirt contract. Construct 3/4 mile of 12' wide access road, 6" thick caliche base, five each 100' x 100' drill pads around drill site stake.
3. Begin WIPP 18 as follows:

WIPP 18, 19, 20, 21 22
OPERATIONAL PROCEDURE, CORING & TEST PLANS

A. OBJECTIVE (Ref Memo of Record, D. W. Powers, 5311, dtd 2/15/78)

To determine depth of the top of Salado formation precisely over a half-mile interval within the mile immediately north of ERDA 9. To evaluate the stratigraphy in the overlying beds above the Salado and possibly establish a hydrological test well.

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WIPP 19 will be set up second to take continuous core from "grass-roots" to the top of Salado. After a suite of logs have been run and evaluated, the hole may be opened and then casing stood and cemented for subsequent conversion into a hydrological test well. If hole not considered suitable, it will be plugged to surface and abandoned.

WIPP 20 will be drilled third to a depth of about 700' (contingent on evaluation of results from WIPP 18 and 19) and then a continuous core taken to a depth of about 1500'. After suite of logs taken, hole will be plugged to surface and abandoned.

WIPP 21 may be drilled to a depth of 1200-1300' to obtain additional data if information from 18, 19 and 20 is considered incomplete. Suite of logs will be run and several hundred feet of core may be taken. Hole will then be plugged to surface and abandoned. Location may be moved to an alternate site along seismic line X-5.

WIPP 22 may be drilled to the top of Salado. After suite of logs, hole will be evaluated and either plugged or set up as hydrologic test well.

C. ORGANIZATION

Technical direction will originate within Sandia Division 5311 under Dennis Powers. 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 F&S as arranged for by Federal agency order through Nevada Operations Office, DOE.

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D. FIELD OPERATIONS

1. Sites selected and archaeological survey conducted. Land survey made. BLM permits obtained. "Notice of Intention to Drill Exploratory Well" filed with NM State Engineer's office.
2. Award dirt contract. Construct 3/4 mile of 12' wide access road, 6" thick caliche base, five each 100' x 100' drill pads around drill site stake.
3. Begin WIPP 18 as follows:

3. (Continued)

WIPP 18 (located adjacent to seismic shot point 179 of X-2).

- a. Set nominal diameter conductor pipe to permit use of rotary bit to make a 6" ± diameter hole to total depth.
- b. Rotary hole to top of Salado salt; collect drill cuttings every 10'; use drilling fluids to match formation.
- c. Run commercial logs as follows:
 - (1) BHC Sonic
 - (2) Dual Induction
 - (3) Micro-Laterolog
 - (4) Compensated Neutron
 - (5) Formation Density
 - (6) Gamma
 - (7) Continuous Dip Meter

d. Plug hole to surface using 50/50 PoZ mix, Class "C" cement.

d. Rig down.

4. WIPP 19 (located adjacent to shot point 191 of line X-2)

- a. Move in rig and associated equipment for taking continuous core from "grass-roots" to the top of Salado.
- b. Dry punch hole and extract first core using Pitcher Sampler. Continue using until formation appears competent enough to begin using wire line rotary diamond coring procedures. Estimated to be 7-10'.
- c. Pick up 3-1/4" x 2-1/4" diamond core bit with split barrel and take continuous core to approximately 30'.

4. (Continued)
 - d. Pick up 8-3/4" bit and ream hole to approximately 30'. Set 8-5/8"+ O.D. conductor pipe, cement to surface. Install appropriate well head equipment to protect from gas pockets.
 - e. Pick up 3-1/4" x 2-1/4" diameter core bit and take continuous core to total depth.
 - f. Open hole as necessary to accommodate taking commercial logs with 4-5/8" diameter tool.
 - g. Call out and run same suite of logs as for WIPP 18.
 - h. If logs shows bore-hole fluids of interest, hole may be cased with 5-1/2" casing, cemented to surface and set up for hydrological test well.
 - i. If no fluids of interest, plug hole to surface as WIPP 18.
 - j. Rig down.
5. WIPP 20 (located adjacent to shot point 187 of X-2)
 - a. Move in rig and associated equipment for alternating between rotary drilling and diamond coring.
 - b. Pick up 8-3/4" bit and rotary to approximately 30'. Set 8-5/8"+ conductor pipe, cement to surface. Install appropriate well head equipment to protect from gas pockets.
 - c. Pick up nominal 6" diameter rotary bit and rotary to an approximate depth of 700', taking cuttings every 10'. Actual depth will depend on review of findings from WIPP 18 and 19.

5. (Continued)
- d. Pick up 3-1/4" x 2-1/4" diameter core bit and take continuous core to a depth of about 1500'.
- e. Open hole as necessary to accommodate use of commercial logging tool 4-5/8" diameter.
- f. Call out and run same suite of logs as for WIPP 18.
- g. Plug hole to surface as in WIPP 18.
- h. Rig down.
6. WIPP 21 & 22 (location to be determined after review of WIPP 18, 19, 20)
 - a. Move in rig and associated equipment for alternating between rotary drilling and diamond coring. Take cutting every 10'.
 - b. Pick up 8-3/4" bit and rotary to approximately 30'; set 8-5/8" O.D. conductor pipe, cement to surface. Install appropriate well head equipment to protect from gas pockets.
 - c. Pick up nominal 6" diameter rotary bit and drill to 900-1200'. Selected 2-1/4" cores may be taken.
 - d. Open hole and condition to accommodate commercial logging tool 4-5/8" diameter.
 - e. Either hole may be selected as hydro test well if significant fluids are encountered while drilling. If so, prepare hole to run 5-1/2" casing and cement to surface.
 - f. If not set up as hydro well, plug to surface and abandon.
 - g. Rig down.

E. CORE HANDLING PROGRAM

Cores with 2-1/4" nominal diameter are to be taken. One from ground surface to the total depth. It is recognized that formations may be encountered which are soft and/or rubblized; therefore, particular attention must be paid to rate of rotation, penetration and drilling fluid properties to assure as complete a recovery as possible.

A split core barrel is to be utilized to ease the removal of core from the barrel and to lessen the possibility of damaging or mixing core components.

A duty geologist will log and measure core as it is removed from core barrel. Core will then be sealed within plastic sleeving and packaged in standard cardboard boxes. If core is soft and/or badly rubblized, additional cushioning material will be placed around core within box. Boxes will then be marked with hole identity and core interval. Core will then be carefully loaded in a transport vehicle by contractor personnel as supervised by duty geologist, and taken to core storage in Carlsbad.

A coring 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 photograph core and 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 water-proof black ink arrow, pointing in the direction the hole is advancing. If core is not suitable for marking, the above is to be marked on sleeving using an indelible, water-proof black marking pen.

3. Log, identify and measure all core pieces, express to closest 1/10th of foot. Note; All depth measurements are from the top side of the Kelly Bushing unless otherwise specified.

4. Move troughs to core shed and separate into appropriate lengths. Sleeve and seal and insert into boxes. Tape boxes and mark outside of box with hole identity and depths of core interval.

5. Transport boxed core to core storage taking particular care in handling and delivery to avoid core damage.

F. LOGGING PROGRAM

The original records and 10 copies of all logs should be delivered to F&S, Carlsbad. F&S will distribute as follows:

USGS-WRD, Albuq. - J. W. Mercer (1)
USGS-Spec. Proj., Denver - C. Jones (1)
F&S, Carlsbad - W. Cunningham (2)
5311 D. W. Powers (Orig. & 1)
5311 S. J. Lambert (1)
5311 Archives (2)
F&S Carlsbad (2)

G. PLUGGING AND ABANDONMENT

1. Notice of intention to plug must be filed with appropriate agencies including State Engineer, since all wells are believed to be within a Water District as declared by the State Engineer of New Mexico.

2. Plugging should be in manner to confine water in the separate strata originally containing them.

3. A length of 4" steel tubing approximately 20' long will be placed in the freshly poured plug with 4' protruding above the ground surface. The identity of the well, i.e., WIPP 18, as well as the location: X feet FEL, X feet FSL, Section, Township and Range, shall be welded or stamped in the tubing.

RDStatler:rj

SEC 17

SEC 16

PROPOSED WIPP-12

WIPP-18 #1

660'

WIPP-21

220'

WIPP-20 #3

445'

WIPP-19 #2

440'

WIPP-22

3/4 mi

SEC 20

T225, R31E

S-C 21

2640

ERDA-9

SEC 29

Bound Line

SEC 28

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date February 27, 1978

to Distribution

R. D. Statler/rj

from R. D. Statler - 1133

subject WIPP Nos. 18 thru 22, Drilling Program Schedule and Coring Plan

Ref: Memo, R. D. Statler to Distribution, dtd 2/27/78, same
subject

Please attach the enclosed chart to the subject memo.

rj

Distribution:

DOE/ALO D. Davis
USGS Denver C. Jones
USGS Albuquerque J. Mercer
F&S Las Vegas R. E. Ashlock
F&S Carlsbad W. E. Cunningham

1130 H. E. Viney
1135 P. D. Seward
1135 J. E. Magruder
5311 L. R. Hill
5311 D. W. Powers (3)
5311 S. J. Lambert
5311 Archives (2)
5342 J. W. McKiernan
9512 F. L. McFarling
1133 R. D. Statler (5)

ACCESS ROAD AND DRILL HOLE LOCATIONS WIPP DRILL HOLE NOS. 18, 19, 20, 21, AND 22

Section 20, Township 22S
Range 31 E, N.M.P.M.
Eddy County, New Mexico

Scale: 1"=400'

DRILL HOLE NO.	ELEVATION
WIPP # 18	3455.57
WIPP # 19	3452.80
WIPP # 20	3450.30
WIPP # 21	3444.33
WIPP # 22	3425.57

SHOT POINT NO.	ELEVATION
180	3455.21
179	3450.6
165	3445.0
167	3439.0
151	3432.3
195	3425.6
215	3411.85

Top of Post Elevation:
Ground Elev at S.P. 170 is 3474.19'
Ground Elev at S.P. 215 is 3409.31'

Shot Point = 215, X-2
Set Steel Frame Post
Stamping "S.P. 215, Line 2"
3411.85' A

CERTIFICATION

I, Charles W. Molzen, do hereby certify that the foregoing plat was made under my direction and supervision and is a true representation of a survey on the ground, to the best of my knowledge and belief.

Charles W. Molzen
Charles W. Molzen, N.E. 112, S. 10, 2002

MOLZEN-CORBIN & Assoc.
Consulting Engineers
Cedarburg, New Mexico
Chart Number 1305 Date 12/21/52

Curt May 18, 1978

ALBUQUERQUE AREA OFFICE
Livermore, California

TO W. E. Cunningham - F&S, Carlsbad

R. D. Statler

FROM R. D. Statler - 1133, SLA

Subject Land-Use Permit for Relocating Drill Sites for WIPP 20 and 21

On this date we have received verbal permission from BLM to relocate the hole locations of WIPP 20 and 21.

You are authorized to proceed with the necessary dirt work to prepare drill pads for WIPP 21, 1000' due south of WIPP 22, and for WIPP 20, 770' due south of WIPP 22.

You are also authorized to resume drilling of WIPP 22 and then proceed with the program as outlined in my memorandum to you dated May 17, 1978, subject, Stratigraphic Hole Drilling Plans.

RDS:1133:rj

Copy to:

C. Jones, USGS, Special Projects Branch, Denver, CO

J. Mercer, USGS-WRD, Albuquerque, NM

1135 P. D. Seward

5311 D. W. Powers

1133 File (2)

DATE May 23, 1978

TO W. E. Cunningham - F&S, Carlsbad

R. D. Statler/rj

FROM R. D. Statler - 1133, SLA

SUBJECT Land-Use Permit for Relocating Drill Sites for WIPP 20 and 21

Ref: Memo, Statler to Cunningham, dtd 5/18/78, same subject

This memorandum is to correct the Southerly dimension on the WIPP 21 drill location as quoted in the referenced memorandum. The attached survey plat gives the correct location.

PDS:1135:rj

Copy to:

C. Jones, USGS, Special Projects Branch, Denver, CO

J. Mercer, USGS-WRD, Albuquerque, NM

G. Bachman, USGS-WRD, Albuquerque, NM

1135 P. D. Seward

5311 D. W. Powers

1133 File (2)

DRILL HOLE LOCATION

DRILL HOLE NO. WIPP#21

SECTION 20, TOWNSHIP 22 S, RANGE 3 E, N.M.P.M.

EDDY COUNTY, NEW MEXICO

GROUND ELEVATION AT HOLE: 3417.05'

MOLZEN-CORBIN & ASSOCIATE

CONSULTING ENGINEERS

CARLSBAD, NEW MEXICO

DATE: MAY 19, 1978

Sandia Laboratories

date May 23, 1978

Albuquerque, New Mexico
Livermore, California

to W. E. Cunningham - F&S, Carlsbad

R. D. Statler/rj

from R. D. Statler - 1133, SLA

subject Land-Use Permit for Relocating Drill Sites for WIPP 20 and 21

Ref: Memo, Statler to Cunningham, dtd 5/18/78, same subject

This memorandum is to correct the Southerly dimension on the WIPP 21 drill location as quoted in the referenced memorandum. The attached survey plat gives the correct location.

PDS:1135:rj

Copy to:

C. Jones, USGS, Special Projects Branch, Denver, CO

J. Mercer, USGS-WRD, Albuquerque, NM

G. Bachman, USGS-WRD, Albuquerque, NM

1135 P. D. Seward

5311 D. W. Powers

1133 File (2)

DRILL HOLE LOCATION

DRILL HOLE NO. WIPP#21

SECTION 20, TOWNSHIP 22S, RANGE 31E, N.M.P.M.

EDDY COUNTY, NEW MEXICO

GROUND ELEVATION AT HOLE: 3417.05'

MOLZEN-CORSIN & ASSOCIATE

CONSULTING ENGINEERS

CARLSBAD, NEW MEXICO

DATE: MAY 19, 1978

PAD AND
 DRILL HOLE LOCATION
 DRILL HOLE NO. WIPP # 21
 SECTION 20, TOWNSHIP 22S, RANGE 31E, N.M.P.M.
 EDDY COUNTY, NEW MEXICO

MOLZEN-CORBIN & ASSOC.

CONSULTING ENGINEERS

CARLSBAD, NEW MEXICO

DATE: MAY 19, 1978

APPENDIX C

SOLE HISTORY

compiled by

R. D. Statler

Division 1133

and

D. 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.

DATE: 10-16-78 (Rev. #1)
6-29-78

DATE: 6-29-78

HOLE NO.: WIPP #22	W. O. NO.:						I. D. NO.:			
USER: Sandia Lab.	TYPE HOLE: Exploratory									
LOCATION New Mexico	COUNTY: Eddy	AREA:								
SURFACE COORDINATES: * 2546.95' FSL, 13.44' FEL, Sec.20, T2S, R31E										
GROUND ELEVATION: *	PAD ELEVATION:	TOP CASING ELEVATION:								
RIG ON LOCATION:	SPUDDED: 5-8-78	COMPLETED: 5-24-78								
CIRCULATING MEDIA: Salt base mud.										
MAIN RIG & CONTRACTOR				NO. OF COMPRESSORS & CAPACITY:						
BORE HOLE RECORD				CASING RECORD						
FROM	TO	SIZE	I.D.	WT./FT.	WALL	GRADE	CPL'G.	FROM	TO	CU. FT. CMT.
0'	20'	8-3/4"	7" (O.D.)			USED		0'	20'	NONE
20'	1450'	6-1/8"								
TOTAL DEPTH: 1450' GL	AVERAGE MANDREL DEPTH.			FROM REFERENCE ELEVATION #						
JUNK & PLUGS LEFT IN HOLE:										
SURVEYS PAGE:		CORING PAGE:			CU. FT. CMT. TOTAL IN PLUGS, ETC:					
LOGGING DATA: Page 2										
BOTTOM HOLE COORDINATES: NONE								REFERENCE:		
RIGS USED					(Site Prep Rigs *)					
RIG NO.	NAME		TYPE		CLASS	DAYS OPERATING	SECURED W CREW	SECURED W/O CREW	TOTAL DAYS ON LOC.	
3625	Boyles Bros.		Failing 2000			5.31	1.10	9.50	15.91	
REMARKS: Sample Description: Page 3 * Brass monument location: 2542.70' FSL, 15.19' FEL, T2S, R31E. Elevation 3425.83'. 										
PREPARED BY: WDS/lkm C-2 TIME BREAKDOWN ON NEXT PAGE										

FENIX & SCISSON, INC.
HOLE HISTORY DATA

DATE: 6-29-78

HOLE NO.: WIPP #22	W. D. NO.:	I. D. NO.:
USER: Sandia Lab	TYPE HOLE: Exploratory	
LOCATION: New Mexico	COUNTY: Eddy	AREA:
SURFACE COORDINATES: 2544.66' FSL, 11.35' FEL, Sec. 20, T 22S, R 31 E		
GROUND ELEVATION: 3426.95'	PAD ELEVATION:	TOP CASING ELEVATION:
RIG ON LOCATION:	SPUDED: 5-8-78	COMPLETED: 5-24-78

CIRCULATING MEDIA: Salt base mud

MAIN RIG & CONTRACTOR

NO. OF COMPRESSORS & CAPACITY:

BORE HOLE RECORD

CASING RECORD

FROM	TO	SIZE	I. D.	WT./FT.	WALL	GRADE	CPL'G.	FROM	TO	CU. FT. CNT.
0'	20'	8-3/4"	7" (O.D.)			USED		0'	20'	NONE
20'	1450'	6-1/8"								

TOTAL DEPTH: 1450' GL AVERAGE MANDREL DEPTH: FROM REFERENCE ELEVATION ?

JUNK & PLUGS LEFT IN HOLE:

SURVEYS PAGE: CORING PAGE: CU. FT. CNT. TOTAL IN PLUGS, ETC:

LOGGING DATA: Page 2

BOTTOM HOLE COORDINATES: NONE REFERENCE:

RIGS USED

RIG NO.	NAME	TYPE	CLASS	DAYS OPERATING	SECURED W/ CREW	SECURED W/O CREW	TOTAL DAYS ON LOC.
3625	Boyles Bros.	Falling 2000		5.31	1.10	9.50	15.91

REMARKS:

Sample Description: Page 3

PREPARED BY: WDS/lc

C-3

TIME BREAKDOWN ON NEXT PAGE

WIPP #22
HOLE HISTORY

5-8-78 Moved in Boyles Bros. rig #3625 and rigged up. Drilled 8-3/4" hole from 0' to 20' using salt base mud. Set 7" O.D. casing at 20' and packed around the top. Drilled 6-1/8" hole from 20' to 400'. Mixed mud with loss circulation materials at 202', 100% returns.

5-9-78 Drilled 6-1/8" hole from 400' to 700'. Changed out bit at 532'.

5-10-78 Drilled 6-1/8" hole from 700' to 1045'. Changed out bit at 787'. Conditioned mud to log and laid down drill pipe. Ran Schlumberger logs.

5-11-78 Completed Schlumberger logs. Ran USGS logs.

5-22-78 Rig secured from 5-11-78 to 5-22-78. Drilled 6-1/8" hole from 1045' to 1342'.

5-23-78 Drilled 6-1/8" hole from 1342' to 1450'. Ran Schlumberger logs.

5-24-78 Ran USGS logs. Rigged down. Hole completed.

BIT RECORD

<u>BIT NO.</u>	<u>MAKE</u>	<u>SIZE</u>	<u>TYPE</u>	<u>DEPTH OUT</u>	<u>FEET DRILLED</u>	<u>ROTATING HOURS</u>
1	Rerun	8-3/4		20	20	1/2
2	Security	6-1/8	S3J	532	512	20-3/4
3	Hughes	6-1/8	OSC3J	787	255	20
4	Security	6-1/8	S3J	1045	258	7
5	Security	6-1/8	S3J	1450	405	19-1/2

WIFF #22
HOLE HISTORY

LOG INDEX SHEET

<u>TYPE LOG</u>	<u>DATE</u>	<u>RUN NO</u>	<u>DEPTH DRILLER</u>	<u>DEPTH LOGGER</u>	<u>LOGGED FROM</u>	<u>TO</u>
<u>SCHLUMBERGER LOGS</u>						
Dual Laterolog Micro-SFL	5-11-78	1	1045	1034	22	1032
	5-23-78	2	1450	1450	10	1448
Compensated Neutron- Formation Density	5-10-78	1	1045	1034	20	1033
	5-23-78	2	1450	1450	0	1448
Borehole Compensated Sonic	5-11-78	1	1045	1034	10	1029
	5-23-78	2	1450	1449	10	1447
Dipmeter-Computed	5-10-78	1	1045	1034	20	1032
	5-23-78	2	1450	1452	20	1452
Dipmeter-Basic Data	5-10-78	1	1045	1034	20	1032
	5-23-78	2	1450	1452	20	1452

NOTE: Logs furnished F&S/Mercury.

SURVEY MONUMENT "AS BUILT"

WLEP 22

SECTION 20, TOWNSHIP 22S, RANGE 31E, N.M.P.M.
EDDY COUNTY, NEW MEXICO

ELEVATION OF BRASS MONUMENT 3425.83'

2542.70' FSL @ 15.19' FEL

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

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

APPENDIX D

LOGS

compiled by

**S-E. Shaffer
Division 4511
Sandia Laboratories**

WIPP 22 Logs¹

Log	Company	ELSI# ²	Top of Logged Interval ³ (feet)	Bottom Logged Interval (feet)	Date
BBC Sonic Log	Schlumberger	W7108Z	10	1029	5/11/78
Compensated Neutron Formation Density	Schlumberger	W7108X	20	1033	5/10/78
Dual Laterolog Micro-SFL	Schlumberger	W7108Y	10	1448	5/23/78
4-Arm High Resolution Continuous Dipmeter	Schlumberger	W7108W	20	1032	5/10/78

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

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

³Depths measured from ground surface; elevation officially 3425.57' above MSL.