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Basic Data Report for Drillhole WIPP 12 (Waste Isolation Pilot Plant – WIPP)

Sandia National Laboratories
D'Appolonia Consulting Engineers

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(Division 9731)

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1.0 ABSTRACT

WIPP 12 is a borehole drilled in eastern Eddy County, New Mexico, to investigate the stratigraphy, structure and lithology in the WIPP area. WIPP 12 was drilled in section 17, T22S,R31E, between November 9 and December 7, 1978. The hole was drilled to a depth of 2785.8 ft. It encountered from top to bottom, 16.2 ft of sand, 3 ft of Mescalero Caliche and 9.6 ft of the Gatuna Formation, all of Quaternary age; 138.2 ft of the Triassic Santa Rosa Formation, 483 ft of the Dewey Lake Red Beds, 326 ft of the Rustler Formation, 1771.5 ft of the Salado Formation, and 48.3 ft of the Castile Formation, all of Permian age. Cores or cuttings were obtained for the entire hole. A suite of geophysical logs, including neutron gamma and density curves, was run to the full depth of WIPP 12. The borehole demonstrated that the elevation of the top of the Castile is about 160' above the same horizon in ERDA 9.

The WIPP is a demonstration facility for the disposal of transuranic (TRU) waste from defense programs. The WIPP will also provide a research facility to investigate the interactions between bedded salt and high level wastes.

2.0 INTRODUCTION

The introduction describes background information on the WIPP and the investigations involving WIPP 12.

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 TRU waste resulting from this nation's defense programs over 30 years. After a period (5 years) of limited (pilot) operation, it is anticipated that the WIPP will allow for permanent disposal of defense TRU waste. The WIPP plans also include an underground research facility to examine, on a large scale, the interactions between bedded salt and high-level radioactive defense waste with its resultant thermal and radiation fluxes.

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 12

An anticlinal structure at the location of WIPP 12 was inferred in 1978 (see Ch. 4, Powers et al, 1978) on the basis of seismic reflection data (X Series, Hern et al, 1979). At the same time, faulting of the Rustler/Salado contact was inferred on the basis of seismic reflection data; borehole WIPP 18, 19, 21, and 22 were drilled to investigate the indications of shallow faulting (Sandia National Laboratories and U.S. Geological Survey, 1980a, b, c, d). These boreholes, together with P-5 (Jones, 1978), demonstrate the lack of structure at the Rustler/Salado contact in the same area where the Castile structure was inferred (P-5 and WIPP 12 share a drilling pad).

The principal question to be answered was whether the Castile structure existed and was significant enough to effect the proposed facility horizon over the northern part of Zone II. The elevation change from ERDA 9 to WIPP 12 was initially estimated (Appendix A) to be as much as 400 ft. Large elevation changes over this distance could seriously affect the

mining operations if the facility was located parallel to bedding. There was also a concern that the thickness of the beds for the facility would thin over the structure and be unsuitable for design purposes.

The borehole was designed to obtain maximum information from the lower Salado. The position of the top of the Castile was established for structural/design purposes. The lower Salado was cored to obtain additional samples from the rock units proposed for the facility. The borehole was logged extensively using geophysical tools, including an uphole velocity survey for further control on the seismic reflection data.

WIPP 12 was more recently (1981-82) deepened to provide information on the nature of the "disturbed zone" and to test for brine reservoirs in the Castile Formation. The basic data report for the deepening of WIPP 12 is being prepared by D'Appolonia Consulting Engineers.

3.0 GEOLOGIC DATA FOR BOREHOLE WIPP-12, EDDY COUNTY, NEW MEXICO

by M. H. Freeland and P. P. Dadourian[1]

3.1 Abstract

Borehole WIPP-12 is one of several exploratory wells drilled in eastern Eddy County, New Mexico, to evaluate the stratigraphy, structure and lithology of the rock units in and around the site proposed for the Waste Isolation Pilot Plant (WIPP). The drilling was done between November 9, 1978, and December 7, 1978.

The hole was drilled to a depth of 2785.8 feet (datum: kelly bushing) of which 1079.5 feet was cored. The lithologic descriptions include the following stratigraphic section:

Quaternary:	Holocene Deposits
	Mescalero Caliche
Triassic:	Santa Rosa Sandstone
Permian:	Dewey Lake Red Beds
	Rustler Formation
	Magenta Dolomite Member
	Culebra Dolomite Member
	Salado Formation
	Castile Formation

A suite of geophysical logs including gamma, neutron, density, temperature, acoustic and dip was run to provide data on lithology, structure and geochemistry. Gas chromatography was utilized to measure hydrocarbon content in the drilling mud. Based on preliminary analysis of the data by the individuals and companies listed in Table 1, the WIPP-12 stratigraphic section is interpreted as a sequence of siltstones, sandstones, mudstone and evaporites normal for the area. The top of the Castile Formation is structurally about 160 feet higher in WIPP-12 than in ERDA-9.

[1]D'Appolonia Consulting Engineers, Denver, Colorado

3.2 Introduction

Borehole WIPP-12 is an exploratory well drilled on a site proposed for the Waste Isolation Pilot Plant (WIPP) in eastern Eddy County, New Mexico (Figures 1 and 2). Objectives of the drilling program were: (1) determine lithologic and stratigraphic details of the rocks present under the site; (2) examine the structure of the rocks; (3) conduct downhole geophysical surveys to define rock and fluid properties; (4) obtain core samples for laboratory analysis; and (5) provide a data point for calibration of seismic records and construction of geologic cross sections through the WIPP site.

The drilling of WIPP-12 was done on behalf of the U. S. Department of Energy (formerly the U. S. Energy Research and Development Administration). Core and cuttings samples were examined and described by Bechtel National, Inc., and Fenix and Scisson geologists. All samples from WIPP-12 are stored in Carlsbad, New Mexico in Sandia National Laboratories' (Sandia) core storage facility. Sandia photographed all of the cores at two-foot intervals and copies were provided to Bechtel. Selected core samples were sent to San Francisco for physical analysis in the Bechtel rock mechanics laboratory. The drilling operations and related supporting services provided by supply and logging companies were supervised by Fenix and Scisson, Inc. Field stratigraphic columns, as well as descriptions of rock units and lithologic boundaries were made by geologists from Bechtel and from Fenix and Scisson, Inc.

The basic data pertaining to WIPP-12 tabulated herein, and additional supporting information and guidance were provided to the authors by Richard P. Snyder of the U S. Geological Survey, Denver, Colorado. Details of the location and drilling of WIPP-12 are summarized in Table 1, stratigraphic units of the geologic section are listed in Table 2, and the rocks are identified and described in detail in Table 3.

Table 3 is a descriptive lithologic log of WIPP-12. It was compiled from examination of rotary drill cuttings through a binocular microscope and visual examination of core at the drill site. The results of this examination are interpreted, and correlated and corrected for depth based upon selected geophysical logs presented in Figure 3 (the drilling time log in Figure 3 has not been corrected for depth).

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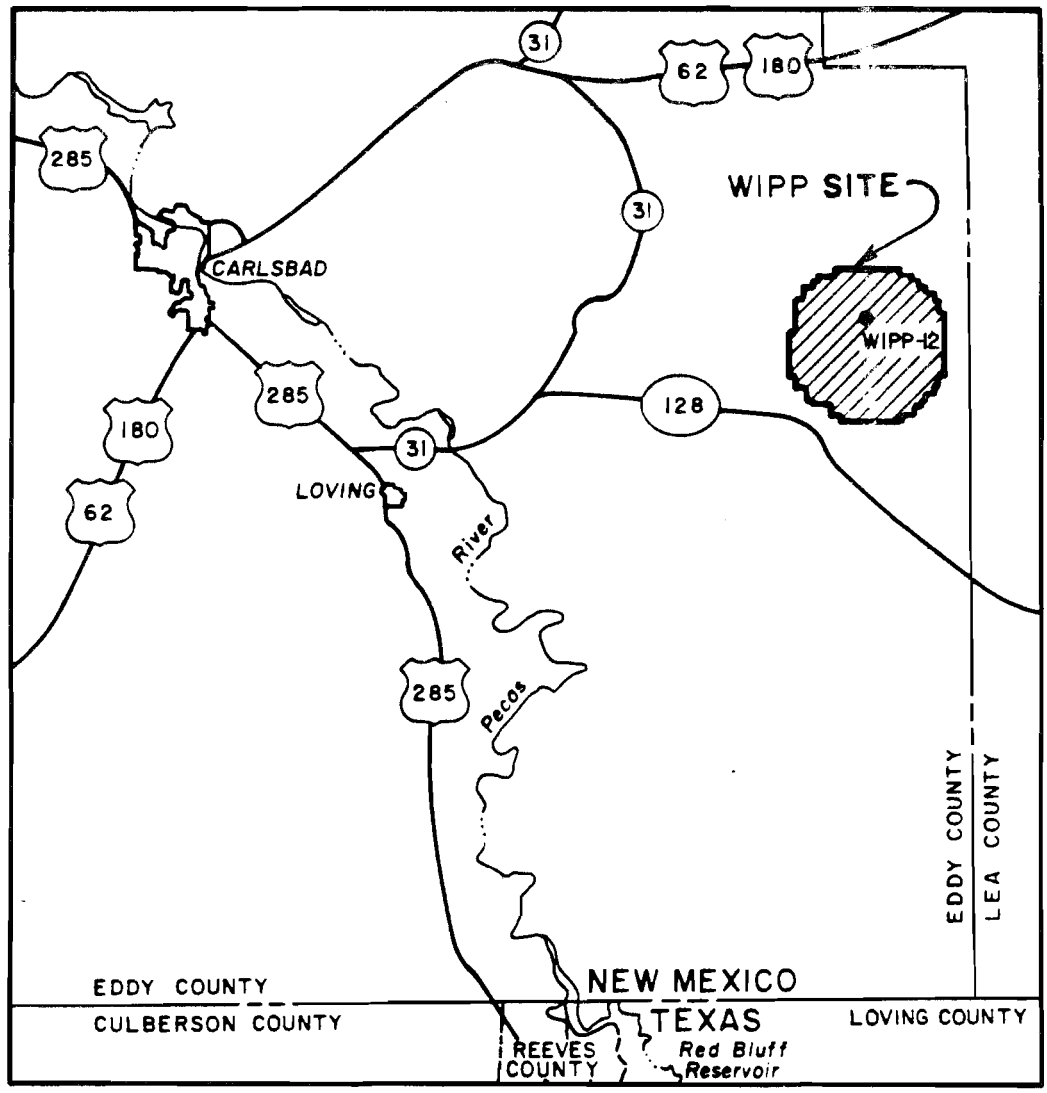

KEY MAP

FIGURE 1

LOCATION OF WIPP SITE AND BOREHOLE WIPP-12

PREPARED FOR

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

REFERENCE:
U.S. GEOLOGICAL SURVEY
DENVER, COLORADO
DATED: 1981

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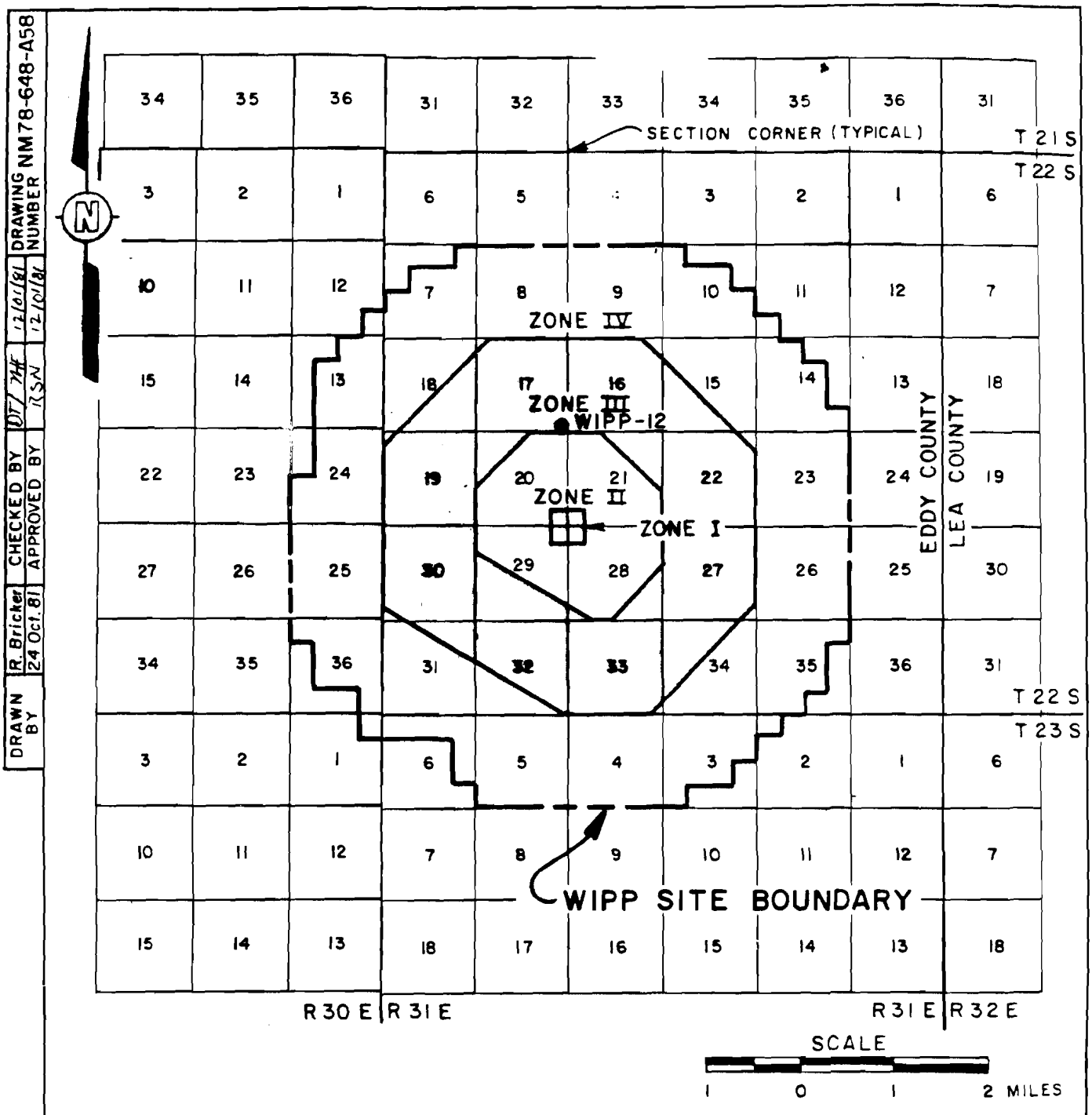

FIGURE 2

PLAN OF WIPP SITE
AND LOCATION OF BOREHOLE
WIPP-12

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3.3 Description of WIPP 12

Borehole WIPP 12 is located in Section 17, T22S, R31E, in eastern Eddy County, New Mexico. The borehole was drilled between November 9, 1978 and December 7, 1978, to a depth of 2785.8 feet as measured from KB (kelly bushing) at a land surface altitude of 3471.5 feet MSL (mean sea level). Details of the drilling chronology for WIPP-12 are presented in Table 1.

The stratigraphic section encompasses unconsolidated deposits and sedimentary rocks from Quaternary to Permian age. The rocks are primarily marine evaporites of Permian age with some younger continental rocks present in the upper portions of the section. The borehole stratigraphy is summarized in Table 2.

Cores were obtained at consecutive and nonconsecutive intervals to a depth of 2772.9 feet. The cores were marked according to the depths reported by the drillers, examined for geological details, photographed and stored. Cuttings were collected, examined and described for those intervals not cored.

A suite of geophysical logs was run to the full depth of WIPP-12. Selected logs including the neutron, gamma and density were used to: (a) augment and corroborate the lithologic descriptions of WIPP-12 compiled from examination of rotary drill cuttings and cores; and (b) provide depth determinations independent of the depths indicated by drill-rod measurements. Figure 3 is a compilation of lithologic and geophysical logs from borehole WIPP-12 (the drilling time log has not been corrected to geophysical log depth).

Gas and air bubbles were observed in the drilling mud, reaching pressures of 480 psi at the wellhead following completion of the drilling. Gamma-neutron and temperature logs were therefore used in March, 1979, to determine the origin of these gases. Though during drilling, an increase in production of formational N_2 was observed

from about 2426 feet to total depth (TD) (uncorrected), it was concluded on preliminary analysis (verbal communication, J. W. Mercer, Water Resources Division (WRD), Albuquerque, New Mexico) that the observed gas or air bubbles were the result of breakdown of the starches in the drilling fluid, not of formational anomaly.

The neutron logs show no unusual hydrogen (porosity) change, indicating the absence of gassy or dry zones. The density log shows no less-than-normal density fractures. A diplog was run for additional structural information on WIPP-12. Preliminary interpretation of the diplog by Dresser Atlas indicates the entire logged section from 1014 to 2783 feet generally dips to the southwest at an angle from less than one degree to about two degrees. No major deformations or other anomalous conditions were observed.

The drilling fluid was monitored for gas composition (Core Laboratories, Inc.) and the drill cuttings were inspected at regular intervals for gas and oil content and lithology. A gas chromatograph was used for detecting and measuring each hydrocarbon in the total gas. These data are on file at the U.S. Geological Survey offices in Denver.

A relative temperature log was run by the USGS from 1012.2 feet inside casing to 2782.2 feet. The temperature log utilized a high sensitivity of 0.2 degree Fahrenheit per inch of chart. No large deviation from normal gradient was observed on the log. Small changes from 0.2 to 0.3 degrees Fahrenheit were, however, observed from about 1500 to 1600 feet and attributed by the USGS to the frictional heat generated by the adjustment of clays subsequent to drilling. These data are on file at the USGS offices in Denver.

TABLE 1

ABRIDGED HISTORY OF BOREHOLE WIPP-12

LOCATION: Sec. 17, T22S, R31E
147.9 feet from the south line
83.91 feet from the east line

ELEVATION: GL (ground level) 3,471.5 feet
KB (kelly bushing) 3,483.7 feet

Datum for depth measurements given in Tables 1,2, and 3 and throughout this report is the kelly bushing (12.2 feet above ground level).

FIELD LITHOLOGIC LOG PREPARED BY: M. M. Bell, D. C. Dale, R. M. Beathard (Bechtel) S. L. Drellack, Jr., S. L. Gonzales, A. F. McIntyre (Fenix and Scisson)

GEOPHYSICAL LOGS RECORDED BY: Dresser Atlas and U.S. Geological Survey

MUD AND CUTTINGS ANALYSIS: Core Laboratories, Inc.

DEVIATION SURVEYS BY: Sperry Sun

DRILLING CONTRACTOR: Verna Drilling

DRILLING RECORD: Commenced drilling November 9, 1978, and completed drilling December 7, 1978 at a total depth of 2785.8 feet below KB.

Casing: 13 3/8" OD, 48# H-40 set and cemented 4 to 50.8 feet.

9 5/8" OD casing set and cemented to 1014 feet (24 joints of 32.30#, H-40 and 1 joint 36.00#, J-55).

Mud: 38-1015 feet: Cooper, Brine-Brine clay (10.1 lb. Brine, brine clay, soda ash, caustic soda, starch, Drispac).

1015-2785.5 feet: Cooper Hydropoly 10.0 lb. brine, starch, Drispac, soda ash, caustic.

TABLE 1
(Continued)

ABRIDGED HISTORY OF BOREHOLE WIPP 12

CORE NO.	DRILLER'S DEPTH INTERVAL (FEET)	CORRECTION FACTOR TOP OF CORE (FEET)	CORRECT DEPTH BELOW KB (FEET)	RPM	WEIGHT ON BIT (LBS)	CIRCULATING PRESSURE P.S.I.	CORE INTERVAL FEET CUT	CORE INTERVAL FEET RECOVERED	PERCENT RECOVERED
1	135.0-160.0	+1.7	136.7-162.0	65	9,000	400	25.3	25.3	100
2	160.0-185.0	+2.0	162.0-187.0	65	9,000	400	25.0	23.9	96
3	260.0-285.0	+4.2	264.2-289.2	65	14,000	400	25.0	24.8	99
4	285.0-310.0	+4.2	289.2-314.2	70	16,000	350	25.0	24.4	98
5	610.0-635.0	+4.7	614.7-639.7	65	16,000	250	25.0	21.3	85
6	635.0-680.0	+4.7	639.7-684.7	65	16,000	350	45.0	39.0	87
7	680.0-730.0	+4.7	684.7-734.7	65	16,000	350	50.0	51.0	102
8	800.0-830.0	0	800.0-830.0	60	14,000	250	30.0	29.8	99
9	830.0-846.0	0	830.0-846.0	40	8,000	100	16.0	12.5	78
10	935.0-985.0	-14	921.0-971.0	48	10,000	200	50.0	48.5	97
11	1100.0-1149.0	+6.7	1106.7-1155.7	80	16/18,000	400	49.0	35.7	73
12	1680.0-1730.0	0	1680.0-1730.0	65	14/16,000	400	50.0	50.0	100
13	2045.0-2095.0	0	2045.0-2095.1	65	14/16,000	400/500	50.1	50.1	100
14	2095.0-2146.0	+0.1	2095.1-2146.1	65	16,000	500	51.0	50.6	99
15	2146.0-2198.0	+0.1	2146.1-2198.1	65	16,000	450	52.0	52.5	101
16	2198.0-2249.0	+0.1	2198.1-2249.3	65	16,000	450	51.2	51.2	100
17	2319.0-2369.0	0	2319.0-2369.0	65	16,000	550	50.0	49.4	99
18	2369.0-2419.0	0	2369.0-2420.1	65	16,000	450	51.1	51.1	100
19	2419.0-2470.0	+1.1	2420.1-2470.6	65	16,000	450	50.5	49.8	99
20	2470.0-2520.0	+0.6	2470.6-2520.6	65	16,000	500	50.0	49.8	99
21	2520.0-2570.0	+0.6	2520.6-2571.4	65	16,000	300	50.8	50.8	100
22	2570.0-2621.0	+1.4	2571.4-2622.5	65	16,000	500	57.1	51.1	100
23	2621.0-2671.0	+1.5	2622.5-2672.5	65	16,000	500	50.0	49.5	99
24	2671.0-2721.0	+1.5	2672.5-2722.5	65	16,000	450	50.0	50.0	100
25	2721.0-2771.4	+1.5	2722.5-2772.9	65	16,000	450	50.4	50.4	100

All depths reported herein, unless otherwise noted, are measured from the drilling kelly bushing, set at 12.2 feet above ground level. Depths below ground level may be calculated by subtracting 12.2 feet from the reported depths.

Measurements in this document for WIPP-12 are reported in the inch-pound (English) system. These units are consistent with the units used in the field to record the original observations. The inch-pound system also facilitates comparison of WIPP-12 measurements with measurements made by surveyors in establishing the geographic coordinates of the boring, by drillers in determining well depth and drilling conditions, and by geophysical loggers in recording in-hole variations of rock properties with depth. If metric equivalents are desired, the following conversion factors are provided:

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 (lb)	0.4536	kilogram (kg)
pounds per square inch (psi)	0.006895	megapascal (MPa)

Depth measurements presented graphically in Figure 3 are given in both English and metric units.

3.3.1 Stratigraphy

WIPP-12 encountered a normal sequence of sedimentary clastic and evaporite rocks from Quaternary to Permian in age. The stratigraphic sequence is similar to that encountered in other boreholes in the WIPP site. An anticlinal structure in the lower Salado and upper Castile is confirmed by the drilling. Following is a description of the major factors of the rocks encountered in WIPP-12,

which is also summarized in Table 2. Detailed lithologic descriptions are presented in Table 3 and depicted graphically in Figure 3.

Quaternary System

The Quaternary System in WIPP-12 includes an unnamed deposit of eolian sand of Holocene age, the Mescalero caliche, and the Gatuna Formation of Pleistocene age. These deposits are encountered from 12.2 feet (= ground level) to 28.8 feet in WIPP-12. The eolian sands are ubiquitous and conceal the consolidated bedrock over much of the WIPP site.

Mescalero Caliche

From 16.2 to 19.2 feet below kelly bushing (KB), the bit penetrated a well-indurated illuvial deposit known informally as the Mescalero caliche. The Mescalero consists of white, chalky limestone which contains discrete grains of quartz suspended in a calcite matrix, and shattered sandstone fragments from the underlying Gatuna Formation.

Gatuna Formation

Pale-reddish sandstone representing the Gatuna Formation extends from 19.2 to 28.8 feet below KB. The sandstone is very fine to fine grained, calcareous and friable, and includes debris derived from older underlying red beds.

Triassic System

Santa Rosa Sandstone

From 28.8 to 167.0 feet below KB, a pale-red, grayish-orange, and light-gray, medium to coarse grained sandstone unit is believed to represent the basal part of the Santa Rosa sandstone. The rock resembles Santa Rosa outcrops in the area but may represent debris from the Santa Rosa that now forms the basal Gatuna Formation.

TABLE 2

STRATIGRAPHIC SUMMARY OF BOREHOLE WIPP-12[1]

ROCK UNIT	DEPTH INTERVAL IN FEET[2] (Below kelly bushing)
QUATERNARY	
Sand (Holocene-eolian)	0-16.2
Mescalero Caliche	16.2-19.2
Gatuna Formation	19.2-28.8
TRIASSIC	
Santa Rosa Formation	28.8-167.0
PERMIAN	
Dewey Lake Red Beds	167.0-640.0
Rusler Formation	640.0-966.0
Magenta Dolomite Member	703.9-727.0
Culebra Dolomite Member	822.0-846.8
Salado Formation	966.0-2737.5
Upper Member	966.0-1444.0
MB 101[3]	1084.5
MB 102	1116.0
MB 103	1130.0-1141.0
MB 104	1150.0
MB 105	1167.6
MB 106	1183.5
MB 107	1223.0
MB 108	1232.5
MB 109	1254.0-1278.0
MB 111	1324.0
MB 112	1338.0-1342.0
MB 113	1367.0
MB 114	1389.0
MB 115	1424.5
MB 116	1436.0
McNutt Member	1444.0-1798.0
Vaca Triste Sandstone Member	1444.0-1447.0
MB 117	1507.5
MB 118	1531.0
MB 119	1552.0-1556.5
MB 120	1575.0
MB 121	1588.0
MB 122	1596.0
Union Anhydrite	1617.0-1625.0
MB 123	1695.0-1700.8
MB 124	1708.0-1715.4
MB 126	1798.0

See footnotes at end of table.

TABLE 2
(Continued)

ROCK UNIT	DEPTH INTERVAL IN FEET[2] (Below kelly bushing)
PERMIAN (Continued)	
Lower Member	1798.0-2737.5
MB 127	1825.0
MB 128	1834.0
MB 129	1856.0
MB 130	1867.0
MB 131	1928.0
MB 132	1957.5
MB 133	1976.0
MB 134	2015.0-2025.0
MB 135	2040.0
MB 136	2071.6-2083.1
MB 138	2135.1
MB 139	2184.9
MB 140	2226.1-2238.1
MB 141	2290.0-2296.0
MB 142	2332.0-2344.0
MB 143	2381.5-2387.6
MB 144	2413.5-2423.9
Cowden Anhydrite	2445.5-2471.0
Castile Formation	2737.5-T.D.

[1]Depth is base of unit when single number is given.
[2]Depths to units taken from Density Log.
[3]MB = Marker Bed

Permian System

The Permian system in WIPP-12 includes, in the order encountered during drilling, the Dewey Lake Red Beds, the Rustler Formation, the Salado Formation, and a part of the Castile Formation.

Dewey Lake Red Beds

Extending from 167.0 to 640.0 feet below KB is a lithologically distinct, monotonous succession of reddish brown dolomitic siltstone and mudstone known as the Dewey Lake Red Beds; sparse interbeds of fine to coarse grained sandstone are found in the formation. Much of its reddish-brown rock is irregularly mottled greenish gray in splotchy, nodular and lenticular masses. Many bedding surfaces are sprinkled with plates of biotite. Veinlets of white, fibrous selenite are common in the lower part of the formation and their presence attests to the absence of circulating groundwater unsaturated with respect to calcium sulfate since vein formation.

Rustler Formation

The Rustler Formation, 640.0 to 966.0 feet below KB, is chiefly anhydrite and fine-grained clastic rocks with interbeds of dolomite and clayey halite. Clastic rocks in the upper and middle parts of the formation are structureless, unconsolidated clays and silts that are dissolution residues derived from clayey and silty halite. Clastics in the lower part of the formation are well indurated mudstone and clayey siltstone with halite cement. Gypsum rims the anhydrite immediately above and below the dissolution residues bounding the interbeds of dolomite.

The Rustler Formation contains two dolomite units which form two distinct stratigraphic units. These appear at 703.9 to 727.0 and 822.0 to 846.8 feet below KB, respectively. The upper unit is the Magenta Dolomite Member and the lower unit is the Culebra Dolomite Member. The Magenta Member is a

fine grained, silty dolomite with a platy (laminated) structure, composed of detrital dolomite and silt. The Culebra is thin-bedded, well crystallized dolomite of chemical origin that contains solution pits from which calcium sulfates (gypsum and anhydrite) have been leached. Both the Magenta and the Culebra are known to contain fluid at the WIPP site.

Salado Formation

The Salado Formation encountered between 966.0 and 2,737.5 feet below KB at WIPP-12 contains the salt beds of particular interest at the WIPP site. The Salado is chiefly halite but contains many intervals showing alternation of polyhalitic (or anhydritic) halite and argillaceous halite in beds ranging from a few inches to a few feet in thickness (Jones, 1960). Interbedded at irregular intervals are prominent beds of anhydrite, polyhalite, and siltstone, as well as many thin seams and partings of claystone. A few salt beds near the middle of the formation contain crystals and nodular masses of kainite, bloedite and, possibly, other uncommon potassium and magnesium minerals. The formation is apparently free of dissolution residues related to the removal of salt by groundwater. WIPP-12 is located on an anticlinal structure, and core from the lower Salado exhibits some evidence of deformation such as healed fractures and distorted and folded laminae.

The Salado Formation is divided into an unnamed upper unit, a middle unit known informally as the McNutt potash unit, and an unnamed lower unit. The three units are broadly similar in bedding characteristics, lithology and most other geologic details, but they differ in economic significance and in possible use for waste disposal experimentation.

Numerous marker beds are defined throughout the Salado. These beds are laterally persistent stratigraphic units composed of anhydrite

and/or polyhalite, and are used for correlation purposes. Many of these marker beds are difficult to observe in core or cuttings, but all are clearly observable in geophysical logs (Figure 3).

The upper unit of the Salado Formation is found from 966.0 to 1,444.0 feet below KB at WIPP-12. The unit is chiefly an alternation of reddish-orange, light-red, or white polyhalitic halite and brown, argillaceous halite in beds a few inches to a few feet thick. The upper unit also contains some beds of red to orange polyhalite and gray anhydrite as much as 10 feet thick. Two widely separated beds of clayey, halitic sandstone occur in the upper part of the unit. Thin seams or partings of gray and brown claystone underlie most of the polyhalite and anhydrite beds, and cap many beds of argillaceous halite.

The McNutt potash unit, from 1,444 to 1,798 feet below KB contains economically significant potash resources in New Mexico. The McNutt consists of alternating thin beds of white and reddish-orange to orange polyhalitic halite and gray to brown, argillaceous halite, separated at irregular intervals by beds of red polyhalite and gray anhydrite as much as eight feet thick. Thin seams or partings of gray to brown claystone are widespread capping beds of argillaceous halite or underlying the anhydrite and polyhalite beds. Thin beds of clayey, halitic siltstone occur in the upper part of the McNutt.

The lower unit of the Salado Formation, which is 1,798.0 to 2,737.5 feet below KB, includes the salt beds of interest for waste disposal purposes at the WIPP site. The unit contains irregular intervals of halite separated by thinner beds of red and orange polyhalite and gray anhydrite. The halite intervals in the upper part of the unit show a thin-bedded alternation of brown to gray argillaceous halite and orange to reddish-orange polyhalitic halite. The lower part is characterized by alternating beds of gray argillaceous halite and

gray anhydritic halite. Partings of brown and gray claystone cap some of the argillaceous halite beds, and underlie most of the polyhalite and anhydrite beds.

The halite in the lower unit contains the lowest amount of clastic constituents (clay and silt) in the Salado Formation. Additionally, much of this zone is free of polyhalite and other hydrous minerals. In much of the rock, crystals of halite are roughly equidimensional with well interlocked margins. Residual cores or halite relics (remnants of primary crystals) showing well developed growth lines are commonly observed in the crystalline halite. Halite relics suggest considerable long-term stability. These relics represent the form in which halite crystallized from Permian seawater 220 to 230 million years before present. Clearly, the evaporites in the lower Salado have been shielded from groundwater unsaturated with respect to sodium chloride.

Castile Formation

At 2,737.5 feet below KB, the salt beds of the Salado Formation give way downward to anhydrite of the Castile Formation. The Castile is the oldest formation encountered in WIPP-12 and extends to the bottom of the borehole at 2,785.5 feet below KB. The rock is gray, fetid, and dense and exhibits a faint laminated structure.

TABLE 3

LITHOLOGIC LOG OF BOREHOLE WIPP-12

[Depths reported are measured from kelly bushing and corrected from geophysical logs. Color designations are from the Rock Color Chart (Goddard et al, 1948)]

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Kelly bushing (KB at 3483.7) feet to ground level (GL) 3471.5 feet	0-12.2
Cellar	12.2-16.2
Caliche, moderate-pink (5R 7/4) to pale-red (5R 6/2); medium to very fine grained, rounded to subrounded, poorly sorted grayish-red (10R 4/2) sandstone; trace of hard siltstone.	16.2-19.2
Sandstone, grayish-red (10R 4/2), coarse to very fine grained, rounded to subrounded, poorly sorted, some subangular, very hard; trace of caliche between 22.2-27.2 feet; trace of hard, dark-reddish-brown (10R 3/4) siltstone	19.2-37.2
No samples available	37.2-52.2
Sandstone, grayish-red (10R 4/2) to moderate-brown (5YR 3/4), medium-grained, subrounded, mostly quartz grains; hard, dolomitic cement	52.2-60.2
Mudstone, moderate-red (5R 4/6) to dark-reddish-brown (10R 3/4), soft; moderate-red (5R 4/6) to dark-reddish-brown (10R 3/4) siltstone, trace of fine-grained, pale-blue-green (5BG 7/2) sandstone and siltstone	60.2-65.0
Sandstone, grayish-red (10R 4/2), to moderate-brown (5YR 3/4), medium-grained, subrounded, mostly quartz grains, hard, dolomitic cement; trace moderate-red (5R 4/6) to dark-reddish-brown (10R 3/4) mudstone	65.0-85.0
Siltstone, moderate-brown (5YR 3/4), hard, grading to very fine grained sandstone; very fine grained, greenish-gray (5GY 6/1) sandstone; trace of mudstone between 95.0-101.0 feet	85.0-101.0
Mudstone, dark-reddish-brown (10R 3/4) to grayish-red (10R 4/2), moderately hard, some fissile; moderately hard, dark-reddish-brown (10R 3/4) to	

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
grayish-red (10R 4/2) siltstone; rounded to subrounded, fine-grained, poorly sorted, moderately hard to hard, silica cemented, grayish-red (10R 4/2) to moderate-brown (5YR 3/4) sandstone between 107.0 and 127.0 feet; trace of moderately hard, greenish-gray (5GY 6/1) siltstone, grading to very fine grained sandstone.....	101.0-127.0
Sandstone, rounded to subrounded, fine-grained, poorly sorted, moderately hard to hard, silica cement, grayish-red (10R 4/2) to moderate-brown (5YR 3/4) sandstone; dark-reddish-brown (10R 3/4) to grayish-red (10R 4/2), moderately hard, trace greenish-gray (5GY 6/1), siltstone same as in unit 100.0-120.0 feet; trace light-bluish-gray (5B 7/1) sandstone between 101.0-119.0; trace fine-grained, moderately hard, greenish-gray (5GY 6/1) sandstone.....	127.0-136.7
Sandstone, moderate-reddish-brown (10R 4/6), some grayish-red (5R 4/2), medium to fine-grained, well sorted, rounded to subrounded, slightly calcitic, thin dispersed laminae throughout interval, horizontal to 18°; black (N1), possibly interbedded biotite; irregular, wavy, moderate-reddish-brown (10R 4/6) to grayish-red (10R 4/2) siltstone bands between 142.4-142.8, 143.3-143.5, 144.3-144.6, and 145.0-145.5 feet; siltstone band between 144.3-144.6 feet, greenish-gray (5GY 6/1) reduction spots up to 1.97 in. long; siltstone band between 145.0-145.5 feet has irregular, wavy, greenish-gray (5GY 6/1) laminae at top and bottom contacts.....	136.7-162.0
Sandstone, pale-reddish-brown (10R 5/4) to moderate-brown (5YR 4/4), fine to medium grained, well sorted, subrounded to rounded, faintly laminated at irregular intervals, laminae dip from 0-18° from many randomly scattered, slightly rounded dark-reddish-brown (10R 3/4) mudstone fragments ranging in size from 0.08 to 0.24 in., concentrated between 165.7-165.9 feet; fine-grained, pale-reddish-brown (10R 5/4) sandstone band at 167.6 feet, 0.7 feet thick with upper contact dipping approximately 25°.....	162.0-168.0
Mudstone, dark-reddish-brown (10R 3/4), interbedded with moderate-reddish-brown (10R 4/6) siltstone; bedding slightly wavy and irregular; few large (up to 4.33 in. long) grayish-green (10 GY 5/2) reduction spots; many	

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
cut and fill structures and desiccation features present; many randomly scattered, 1 mm to 4 mm in diameter, grayish-green (10 GY 5/2) reduction spots; 0.3 foot thick band of light-olive-gray (5Y 6/1) siltstone at 179.4 feet with small, thin medium-bluish-gray (5B 5/1) mudstone clasts; similar siltstone bands at 181.7, 182.2, 182.9 and 183.8 feet; zone of white (N9), very hard, massive, irregular fragments 0.39 in. to 0.79 in. across, subangular, magnesite (?) between 173.2-173.5 feet and at 179.4 feet.....	168.0-186.0
No core.....	186.0-187.0
Sandstone, dark-reddish-brown (10R 3/4), very fine grained, (some silty), hard, silica cement, biotitic; moderately hard, dark-reddish-brown (10R 3/4) siltstone; trace greenish-gray (5GY 6/1) sandstone; trace dark-reddish-brown (10R 3/4) mudstone.....	187.0-199.0
Siltstone, moderate-olive-brown (5Y 4/4) to dark-reddish-brown (10R 3/4), moderately hard, biotitic; moderately hard, moderate-olive-brown (5Y 4/4) to dark-reddish-brown (10R 3/4) mudstone; trace greenish-gray (5GY 6/1) siltstone and sandstone; trace of colorless vein selenite; hard, very fine-grained, moderate-olive-brown (5Y 4/4) sandstone at 209.0-254.0 feet, trace of very fine grained greenish gray (5GY 6/1) sandstone between 209.0-254.0 feet.....	199.0-254.0
Mudstone, dark-reddish-brown (10R 3/4), moderately hard with greenish-gray (5GY 6/1) reduction spots; moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4) siltstone; trace greenish-gray (5GY 6/1) mudstone.....	254.0-264.2
Mudstone same as in unit 254.0-264.2.....	264.2-266.5
Siltstone, moderate-reddish-brown (10R 4/6), interbedded with dark-reddish-brown (10R 3/4) mudstone; thin many randomly scattered, light-olive-gray (5Y 5/2) to greenish-gray (5GY 6/1) reduction spots; irregular band of light-olive-gray (5Y 6/1) siltstone between 267.8-268.0 feet with small, medium-bluish gray (5B 5/1) mudstone bands and clasts.....	266.5-268.0
Sandstone, dark-reddish-brown (10R 3/4) to grayish-red (10R 4/2), very fine grained, faintly banded in parts with darker, thin, wavy laminae and cut by 0.08 in. to 0.55 in. thick wavy selenite veins throughout;	

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
zone with 0.39 in to 1.18 in. long, dark-reddish-brown (10R 3/4) mudstone clasts between 274.3-274.4 feet; many dark-reddish-brown (10R 3/4) mudstone clasts and rounded fragments also at the base of unit; ten bands of colorless to white (N9) selenite, the thickest between 266.5-266.9 feet, 269.0-269.9 feet and 271.2-271.3 feet, all nearly horizontal;	268.0-275.5
Siltstone, moderate-reddish-brown (10R 4/6), interbedded with dark-reddish-brown (10R 3/4) mudstone with reduction spots and selenite banding throughout, the thickest selenite bands between 278.9-279.1 feet, 281.6-282.0 feet, and 287.2-287.6 feet, all nearly horizontal, some of the thinner selenite bands are dipping at angles from 0°-40°; few dark-reddish-brown (10R 3/4) mudstone clasts within the thicker selenite bands	275.5-289.0
No core	289.0-289.2
Siltstone, dark-reddish-brown (10R 3/4) to grayish-red (10R 4/2), hard; numerous hard greenish-gray (5GY 6/1),0.08 in. to 0.39 in. in diameter, reduction spots, parts grading toward dark-reddish-brown (10R 3/4) mudstone and irregular bands of dark-reddish-brown (10R 3/4) mudstone, horizontal, interbedded, 0.20 in. to 1.57 in. thick; gypsum (selenite) bands and some fractures filled with selenite spaced 0.2 to 1.3 feet apart, 0.08 in. to 2.76 in. thick, horizontal, slightly wavy, some branching into hairline and thin veinlets, translucent, fine to medium crystals; 0.20 in. thick fracture filled with gypsum dipping 63° at 290.0 feet; 0.24 in. to 0.39 in. thick fracture filled with gypsum, vertical to 80° dip between 304.0-306.0 feet; irregular, horizontal bands 0.16 in. to 0.63 in. thick, greenish-gray (5GY 6/1) siltstone between 292.5-294.3 feet and at 301.4 feet; numerous selenite bands, with consistant 21° dip, parallel, at 306.4-306.6 feet; fine-grained, rounded to subrounded, fairly well sorted, well consolidated, with irregular selenite bands, wavy, branching, generally horizontal with inconsistent dips, up to 18°, 0.04 in. to 0.39 in. thick; light-olive-gray (5Y 6/1) and greenish-gray (5GY 6/1), grading to grayish-red (10R 4/2), dark-reddish-brown (10R 3/4) and moderate-reddish-brown (10R 4/6) sandstone from 303.0-307.4 feet	289.2-313.6
No core	313.6-314.2

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Siltstone, grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4), hard, with few greenish-gray (5GY 6/1) reduction spots, some siltstone moderately hard to hard grading to mudstone from 320.0-330.0 feet; very fine-grained, rounded to subrounded, well sorted, slightly biotitic, hard, grayish-red (10R 4/2) to moderate-reddish-brown (10R 4/6) sandstone; trace moderately hard, dark-reddish brown (10R 3/4) mudstone.....	314.2-500.0
Siltstone, same as in unit from 310.0-500.0 feet; becoming coarser, some approaching very fine-grained sandstone; some cuttings with crystalline white (N9) translucent gypsum inclusions; gypsum inclusions from 520.0-530.0 feet; moderately hard, very fine-grained, moderate-reddish-brown (10R 3/4) sandstone, some poorly sorted with clear, subrounded, fine-to-medium grained quartz between 530.0-550.0 feet.....	500.0-550.0
Siltstone, approaching very fine-grained sandstone from 550-556 feet and 568-578 feet; trace transparent to translucent vein selenite.....	550.0-614.7
Siltstone, parts grading to mudstone, dark-reddish-brown (10R 3/4) to moderate-reddish-brown (10R 4/6); hard, greenish-gray (5GY 6/1) reduction spots throughout; numerous 1 mm to 2 mm wide selenite veins, most along low angle bedding planes or partings, some branching, selenite-filled fractures: dipping 50° at 613.0 feet; two dipping 50° at 620.0 feet and one dipping 26° at 622.2 feet.....	614.7-634.7
Siltstone, moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4), some grading toward mudstone; numerous thin selenite veins, irregular, some interconnecting, continuous and discontinuous; numerous greenish-gray (5GY 6/1) reduction spots, 0.08 in. to 0.39 in. in diameter, selenite veinlet dipping 48° at 639 feet; moderate-reddish-brown (10R 3/4), mudstone between 639.0-639.2 feet with irregular blebs of greenish-gray (5GY 6/1) mudstone.....	634.7-639.7
Siltstone, same as in unit 634.7-639.7.....	639.7-640.5
Anhydrite, light-olive-gray (5Y 6/1), very finely crystalline, mottled appearance caused by irregular veins and veinlets, some wavy, horizontal, discontinuous, 0.04 in. to 0.39 in. thick, of olive-black (5Y 2/1) gypsum; finely crystalline, white (N9) and olive-gray (5Y 4/1) to light-olive-gray (5Y 6/1)	

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
gypsum from 640.5-640.8 feet; zone of healed fractures with gypsum, vertical to 82° dip composed of numerous en echelon fractures 0.12 in. to 0.31 in thick between 641.2-644.4 feet and between 645.1-646.1 feet; fracture healed with gypsum, 0.59 in. thick 42° dip at 656.4 feet; chalky, white (N9) and olive-black (5Y 2/1) gypsiferous zone of anhydrite at 663.7-663.9 feet	640.5-663.9
Gypsiferous anhydrite, olive-black (5Y 2/1), to light-olive-gray (5Y 6/1), very finely crystalline with numerous, irregular, continuous, pale-brown (5YR 5/2), dark-yellowish-orange (10YR 6/6), and dark-reddish-brown (10R 3/4) laminae	663.9-671.0
Clay grayish-red (10R 4/2), to moderate-reddish-brown (10R 4/6), soft, some moderately hard	671.0-678.7
No core	678.7-684.7
Gypsum, dusky-yellowish-brown (10YR 2/2), fine to medium crystalline, mottled, trace remnant anhydrite	684.7-686.0
Gypsiferous anhydrite to slightly gypsiferous anhydrite, dark-yellowish-brown (10 YR 4/2), light-olive-gray (5Y 5/2) and light-bluish-gray (5B 7/1), very finely crystalline, some massive anhydrite, mottled, chicken wire and slightly banded appearance	686.0-690.2
Dolomitic gypsum, dark-yellowish-brown (10YR 4/2), dusky-yellowish-brown (10YR 2/2) with light-olive-gray (5Y 5/2); a light-olive-gray (5Y 5/2) gypsiferous dolomite band from 690 2-690.4 feet; gypsum is in numerous blebs less than 1 mm in diameter	690.2-691.7
Gypsiferous anhydrite to slightly gypsiferous anhydrite, dark-yellowish-brown (10 YR 4/2), light-olive-gray (5Y 5/2) and light-bluish-gray (5B 7/1), very finely crystalline, some massive anhydrite, mottled, chicken wire and slightly banded appearance	691.7-703.0
Dolomite, light-olive-gray (5Y 5/2), some light-olive-gray (5Y 6/1) laminated, small scale cross bedding, very numerous thin gypsum blebs from 703.0-705.4 feet; becomes clayey, no gypsum blebs, some very small sized pits from 705.4-706.6 feet with some light-olive-gray (5Y 6/1) laminae some very small sized pits to 703.5 feet;	

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
continuous and discontinuous, thin wavy gypsum veins, between 723.6-725.2 feet, predominantly along the wavy dolomite laminae but some "branches" cross dolomite laminae; laminae become very distorted and wavy with some folding and soft sediment deformation between 725.7-726.1 feet and from 726.7-727.0 feet.....	703.0-727.0
Gypsum, dark-yellowish-brown (10YR 4/2), dusky-yellowish-brown (10YR 2/2), mottled, medium crystalline; some wavy, discontinuous, thin translucent selenite veins.....	727.0-730.0
Gypsiferous anhydrite, light-olive-gray (5Y 6/1) with a light-bluish-gray tint (5B 7/1), very finely crystalline, mottled with chicken wire appearance.....	730.0-734.7
Gypsiferous anhydrite, same as in unit 730.0-734.7.....	734.7-736.0
Gypsum, white (N9), translucent to transparent and light-olive-gray (5Y 6/1), very finely crystalline; light-olive-gray (5Y 6/1) to olive-gray (5Y 4/1) anhydrite.....	736.0-755.5
Anhydrite, very finely crystalline, light-olive-gray (5Y 6/1) to olive-gray (5Y 4/1).....	755.5-764.0
Gypsum, white (N9), translucent to transparent and light-olive-gray (5Y 6/1); very finely crystalline, light-olive-gray (5Y 6/1) to olive-gray (5Y 4/1) anhydrite.....	764.0-800.0
Mudstone with gypsum; mud, dark-reddish-brown (10R 3/4) firm and pliable selenite crystals, veins and inclusions very numerous throughout, becoming the dominant constituant at 803.0-805.3 feet; thin selenite vein dipping 62° at 801.1 feet; selenite and argillaceous gypsum veins dipping 52°, and perpendicular to the veins at 801.0 feet and 801.9 feet; argillaceous gypsum vein dipping 30° at 802.1 feet; two undulating selenite veins dipping 40° and 11° at 803.0 feet; aggregate of coarse selenite and gypsum crystals from 803.6-804.2 feet.....	800.0-809.2
Gypsum, dark-yellowish-brown (10YR 4/2) to dusky-yellowish-brown (10YR 2/2), medium to coarsely crystalline; 5 mm wide healed fracture dipping 52° at 815.8 feet; grayish-red (10R 4/2) very argillaceous band with coarse crystals of gypsum from	

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
820.6-821.5 feet, top and bottom contacts dip approximately 17° and there is a mud parting at 816.4 feet that dips 22°; at the top of this argillaceous band are: a 0.39 in. thick healed fracture vein dipping 11°, a 1.18 in. thick, dense argillaceous light-olive-gray (5Y 5/2) very finely crystalline gypsum band, and a 2 cm thick band of grayish-red (10R 4/2) gypsum; gypsum is banded from 816.5-820.5 feet with a dip of approximately 20°; a small healed fracture dipping 56° at 818.7 feet; the gypsum banding becomes very contorted with a brecciated appearance and swarls of olive-gray (5Y 4/1) mud from 820.7-821.9 feet.....	809.2-822.0
Dolomite, light-olive-gray (5Y 6/1), very finely crystalline, very hard, pitted with vugs up to 0.39 in. in diameter; calcareous gypsiferous transition band at the top of 820.0-820.2-foot interval; 1.38 in. thick grayish-brown (5YR 3/2) to olive-gray (5Y 4/1) mud parting dipping 11° at 822.9 feet, with hard breccia-like inclusions of slightly dolomitic, argillaceous gypsum; several translucent gypsum inclusions (or filled vugs) 0.20 in. to several inches in size in the 823.7-825.7-foot interval and 832.1-832.8-foot interval with some interconnecting, irregular, discontinuous gypsum-filled fractures; a 0.79 in. thick clayey dolomite breccia-filled fracture dipping 60° at 827.4 feet.....	822.0-320.0
Dolomite, same as in unit 822.0-830.0 feet; irregular horizontal olive-black (5Y 2/1) mud parting at 833.1 feet.....	830.0-834.0
Dolomite, light-olive-gray (5Y 6/1), very finely crystalline, very hard, numerous pits; very small pits most common, tend to be concentrated in 0.39 in. thick horizontal bands, some pits/vugs up to 0.39 in. across, some filled with translucent gypsum; some irregular translucent gypsum inclusions up to to several inches in size, usually in irregularly shaped cavities associated with a branching network of gypsum-filled veins and fractures; small unfilled pits very numerous in 839.5-840.7-foot interval; horizontal to 10° dip, olive-gray (5Y 4/1) mud seam up to 0.12 in. thick at 834.4 feet, 837.7 feet, and 840.7 feet; breccia zone of dolomite fragments with translucent gypsum interstitial fill from 838.5-842.5 feet, becoming laminated with a 15° dip, between 838.5-839.3 feet.....	834.0-842.5

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
No core	842.5-846.0
Dolomite, same as in unit 834.0-842.5 feet	846.0-848.0
Gypsum, white (N9), some with light-olive-gray (5Y 6/1) tint, very finely crystalline; moderately hard, moderate-reddish-brown (10R 4/6) siltstone, some gypsiferous with few greenish-gray (5GY 6/1) reduction spots; trace translucent to transparent selenite; trace very finely crystalline anhydrite, light-olive-gray (5Y 6/1)	848.0-860.0
Anhydrite, light-olive-gray (5Y 6/1) to olive-gray (5Y 4/1), very finely crystalline; white (N9), gypsum, very finely crystalline; soft to moderately hard, moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4) siltstone; trace, argillaceous, translucent to transparent, moderate-reddish-brown (10R 4/6) selenite; trace soft to moderately hard, light-gray (N7), siltstone	860.0-880.0
Gypsum (Selenite), moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4), some translucent to transparent, very argillaceous; light-olive-gray (5Y 6/1), very finely crystalline anhydrite; trace moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4) siltstone	880.0-890.0
Sandstone, grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4), soft to moderately hard, very fine-grained, silica cement; trace of gypsum; trace of anhydrite; trace of translucent to transparent selenite	890.0-900.0
Sandstone, moderate-reddish-brown (10R 4/6) to grayish-red (5R 4/2), some medium-gray (N5) to medium-dark-gray (N4), moderately hard to hard, very fine-grained, silica cement; trace of gypsum	900.0-910.0
Sandstone, olive-gray (5Y 4/1), some medium-gray (N5) and some grayish-red (5R 4/2) to dark-reddish-brown (10R 3/4), hard to very hard, some moderately hard, very fine-grained, silica cement, biotitic; trace of gypsum	910.0-921.0
Siltstone, dark-greenish-gray (5GY 4/1) to greenish-black (5G 2/1), faint laminae, small surface pits scattered; several breaks or unfilled fractures dipping	

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
approximately 15°; unfilled fractures dipping 80° at 936.0-938.2 feet; 0.79 in. thick salt-filled vein dipping 14° at 938.1 feet, salt fill is translucent with moderate-reddish-brown (10R 4/6) tint; top of halite-filled fracture 1 mm wide and dipping 72° between 938.0-939.0 feet; 3 en echelon, thin salt filled fractures dipping 78° from 938.0-938.6 feet; 0.20 in. wide salt-filled fracture dipping 85° from 941.0-942.4 feet; several light-bluish-gray (5B 7/1) anhydrite inclusions 0.2 in. to 0.79 in. in size in 940.2-944.4-foot interval, these are usually in or close to fractures	921.0-962.9
Siltstone, dark-reddish brown (10R 3/4) to moderate-brown (5YR 3/4), laminated salt-filled fracture 4 mm wide with trace of anhydrite inclusions dipping 76° between 963.0-963.2 feet	962.9-963.6
Mudstone, dark-reddish-brown (10R 3/4); jagged contact of laminated mudstone clasts or load casting, upper contact dips 40°	963.6-964.3
Mudstone, dark-reddish-brown (10R 3/4) to moderate-brown (5YR 3/4), anhydritic, halitic; pitted surface in 964.5-966.0-foot interval; trace greenish-gray (5GY 6/1) mud at 964.4 feet	964.3-966.0
Halite, translucent with grayish-red (10R 4/2), moderate-reddish brown (10R 3/4) tint, finely to medium crystalline, argillaceous with dark-reddish brown (10R 3/4) mud, trace of pale-red (10R 6/2) to moderate-orange-pink (10R 7/4) anhydrite in irregular stringers; becoming clean, translucent with moderate-reddish-orange (10R 6/6) tint and less anhydritic at 974.0 feet; pale-red (10R 6/2) to moderate-orange-pink (10R 7/4) anhydrite band between 976.0-976.3 feet, with a very irregular top and a 0.1 thick moderate-reddish-brown (10R 4/6) halitic mud seam at the base; unit appears banded by 2.76 in. thick clean, translucent halite	966.0-969.5
No core	969.5-971.0
Halite, same as in unit 966.0-969.5, becoming finely crystalline and argillaceous at 986.5 feet to very argillaceous at 987.2 feet with moderate-reddish-brown (10R 4/6) to moderate-brown (5YR 4/4) mud	971.0-989.0

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, clear, translucent, with moderate-reddish-brown (10R 4/6) and moderate-reddish-orange (10R 6/6) tints, some dark-reddish-brown (10R 3/4) tint from interstitial mud, trace of light-olive-gray (5Y 6/1) to very-light-gray (N8), very finely crystalline.....	989.0-992.0
Sandstone, moderate-reddish-brown (10R 4/6), very fine-grained hard to slightly friable; halite, clear to translucent, with moderate-reddish-brown (10R 4/6) and moderate-reddish-brown (10R 6/6) tints, some dark-reddish-brown (10R 3/4) tint from interstitial mud; trace of light-olive-gray (5Y 6/1) to very-light-gray (N8), very finely crystalline halite.....	992.0-1002.0
Halite, clear to translucent, with moderate-reddish-brown (10R 4/6) and moderate-reddish-orange (10R 6/6) tints, some dark-reddish-brown (10R 3/4) tint from interstitial mud, trace light-olive-gray (5Y 6/1), pale-red (10R 6/2) to very-light-gray (N8), very finely crystalline.....	1002.0-1018.9
Poor sample, mostly cement.....	1018.9-1023.0
Clay, moderate-reddish-brown (10R 4/6), soft translucent to transparent halite.....	1023.0-1030.0
Halite, translucent to transparent, some argillaceous, moderate-reddish-brown (10R 4/6).....	1030.0-1050.0
Halite, translucent to transparent, some argillaceous, moderate-reddish-brown (10R 4/6); massive, moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6) polyhalite; very fine grained, soft to moderately hard, polyhalitic, halitic, grayish-red (10R 4/2) to moderate-reddish-brown (10R 4/6) sandstone; trace, of soft, moderate-reddish-brown (10R 4/6) clay.....	1050.0-1070.0
Halite, translucent to transparent, few pieces argillaceous, moderate-reddish-brown (10R 4/6) to moderate-reddish-orange (10R 4/6), some moderate-red (5R 4/6); polyhalite 1070.5-1072.0 feet and 1079.0-1082.0 feet.....	1070.0-1090.0
Halite, translucent to transparent, some argillaceous moderate-reddish-brown (10R 4/6): soft, "gumbo clay"; moderate-reddish-brown (10R 4/6), very fine grained, halitic, biotitic, moderately hard to hard, light-olive-gray (5Y 5/2), sandstone; trace polyhalite between 1098.0-1100.0 feet.....	1090.0-1106.7

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
No core	1106.7-1107.7
Halite, colorless to moderate-reddish-brown (10R 4/6), medium to coarsely crystalline with much moderate-reddish-brown (10R 4/6) and some medium-light-gray (N6) interstitial clay; few irregular stringers and masses of very fine crystalline, thin moderate-reddish-orange (10R 6/6) polyhalite between 1107.7-1110.0 feet; few thin scattered pits, cores slightly leached	1107.7-1110.7
Halite, colorless to moderate-reddish-orange (10R 6/6), finely to medium crystalline, banded every 0.2-0.5 feet, with thin 0.12 in. to 0.59 in. irregular, horizontal bands of very fine crystalline, moderate-reddish-orange (10R 6/6) polyhalite	1110.7-1114.5
Polyhalite, moderate-reddish-brown (10R 4/6), with some grayish-red (10R 4/2) banding, very fine crystalline, faintly laminated, contains many 1 to 20 mm diameter, irregular masses of clear halite; with irregular, 0.16 in. 0.39 inc. thick, medium-light-gray (N6), clay parting at base	1114.5-1116.0
Halite, colorless to moderate-reddish-orange (10R 6/6), finely to medium crystalline, with many thin irregular stringers of very finely crystalline, moderate-reddish-orange (10R 6/6) polyhalite	1116.0-1117.4
Halite, colorless to moderate-reddish-brown (10R 4/6) some moderate-reddish-orange (10R 6/6) tint, finely to medium crystalline, some coarsely crystalline; much moderate-reddish-brown (10R 4/6) interstitial clay and many thin irregular stringers and masses of moderate-reddish-orange (10R 6/6) polyhalite	1117.4-1130.0
Anhydrite, olive-gray (5Y 4/1) to medium-dark-gray (N4), with thin thick wavy horizontal laminae; irregular thin vugs with rough angular boundaries, some filled with halite between 1130.0-1131.0 and 1135.0-1138.7 feet; elongate and irregular vugs concentrated and localized in 0.08 in. wide, 0.31 in. long, dispersed irregular bands between 1135.0-1138.7 feet	1130.0-1147.4
No core	1147.4-1155.7

Note: Some interstitial clay and calcareous anhydrite in cuttings due to drilling additives.

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, translucent to transparent, clean; massive, moderate-reddish-orange (10R 6/6) to moderate-red (5R 4/6), moderate-reddish-brown (10R 4/6), few pieces light-brown (5YR 5/6) polyhalite located between 1166-1168. 1182-1184, and 1186.5-1190 feet; trace of soft, moderate reddish-brown (10R 4/6) clay	1155.7-1221.2
Polyhalite, massive, moderate-reddish-orange (10R 6/6) to moderate-red (5R 4/6) and moderate-reddish-brown (10R 4/6); halite, translucent to transparent, clean; trace very soft, moderate-reddish-brown (10R 4/6) clay; polyhalite, massive, moderate-reddish-brown (10R 4/6) from 1231.0-1234.0 feet	1221.2-1234.0
Halite, translucent to transparent, clean; very soft, moderate-reddish-brown (10R 4/6) clay	1234.0-1244.0
Halite, translucent, to transparent; very finely crystalline, grayish-orange (10YR 7/4), white (N9) anhydrite; trace of moderate-reddish-orange (10R 6/6) to moderate-red (5R 4/6) polyhalite, trace of very soft, moderate-reddish-brown (10R 4/6) clay	1244.0-1252.0
Anhydrite, light-gray (N7) to medium-light-gray (N6), some grayish-orange (10 YR 7/4), very finely crystalline; translucent to transparent halite; trace moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6) polyhalite	1252.0-1260.0
Halite, translucent to transparent; trace anhydrite, same as in unit 1252.0-1260.0 feet; trace very soft, moderate-reddish-brown (10R 4/6) clay	1260.0-1278.5
Halite, translucent to transparent, clean	1278.5-1288.5
Halite, translucent to transparent, clean; trace argillaceous halite with moderate-reddish-brown (10R 4/6) mud; trace of anhydrite, light-gray (N7) to medium-light-gray (N6), some grayish-orange (10YR 7/4), very finely crystalline	1288.5-1298.5
Halite, translucent to transparent, clean, trace polyhalite; massive to very finely crystalline, moderate-reddish-brown (10R 4/6) polyhalite; trace of anhydrite, light-gray (N7) to medium-light-gray (N6), some grayish-orange (10YR 7/4), very finely crystalline from 1308-1310 feet	1298.5-1310.0

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, translucent to transparent, clean; trace of polyhalite, massive to very finely crystalline, moderate-reddish-brown (10R 4/6), from 1313-1314 feet; trace of anhydrite, light-gray (N7) to medium-light-gray (N6)	1310.0-1320.0
Halite, translucent to transparent, argillaceous halite with moderate-reddish-brown (10R 4/6) mud from 1328-1330 feet	1320.0-1340.0
Halite, translucent to transparent; trace of moderate-reddish-brown (10R 4/6) polyhalite; trace of moderate-orange-pink (10R 7/4), very finely crystalline polyhalite	1340.0-1370.0
Halite, translucent to transparent, argillaceous halite with moderate-reddish-brown (10R 4/6) mud; trace moderate-orange-pink (10R 7/4), finely crystalline polyhalite	1370.0-1380.0
Halite, translucent to transparent, clean; very finely crystalline, moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6) polyhalite 1387-1389 feet	1380.0-1390.0
Halite, translucent to transparent, some argillaceous with moderate-reddish-brown (10R 4/6) mud; trace polyhalite from 1397-1398 feet	1390.0-1400.0
Halite, translucent to transparent, clean; small trace of opaque white (N9) anhydrite	1400.0-1410.0
Halite, translucent to transparent, some polyhalitic with moderate-orange-pink (10R 7/4) to grayish-orange-pink (10R 8/2) polyhalite; moderate-orange-pink (10R 7/4) to grayish-orange-pink (10R 8/2) polyhalite	1410.0-1420.0
Halite, translucent to transparent; very finely crystalline, moderate-orange-pink (10R 7/4), grayish-orange-pink (5 YR 7/2) and moderate-reddish-orange (10R 6/6) polyhalite from 1422.1-1426.4 feet	1420.0-1430.0
Halite, translucent to transparent; trace of white (N9), very finely crystalline to chalky anhydrite; polyhalite 1433-1435 feet	1430.0-1444.0

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Siltstone, moderate-reddish-brown (10R 4/6), some possibly halitic	1444.0-1447.0
Halite, translucent to transparent, some argillaceous halite with moderate-reddish-brown (10R 4/6) mud; trace of moderate-orange-pink (5YR 8/4) to moderate-reddish-orange (10R 6/6), very finely crystalline polyhalite 1454-1457 feet	1447.0-1470.0
Halite, translucent to transparent; trace argillaceous halite with moderate-reddish-brown (10R 4/6) mud; trace of dark-greenish-gray (5G 4/1) mud	1470.0-1480.0
Halite, transparent to translucent, clean; trace moderate-orange-pink (5YR 8/4) to moderate-reddish-orange (10R 6/6) polyhalite, very finely crystalline, 1483-1485 feet	1480.0-1490.0
Halite, transparent to translucent, clean; very finely crystalline, moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6) polyhalite 1495-1499 feet	1490.0-1500.0
Halite, transparent to translucent; polyhalite from 1505-1510 feet, massive to very finely crystalline, moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6)	1500.0-1510.0
Halite, transparent to translucent, clean; very finely crystalline, moderate-orange-pink (5YR 8/4) polyhalite 1528-1531 feet	1510.0-1531.0
Halite, translucent to transparent, slightly argillaceous, moderate-reddish-brown (10R 4/6) mud with grayish-red (10R 4/2) tint	1531.0-1540.0
Halite, translucent to transparent, some with a grayish-orange (10YR 7/4) tint; trace of moderate-reddish-brown (10R 4/6) polyhalite	1540.0-1550.0
Halite, translucent to transparent, clean; moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6) polyhalite 1551-1555.5, 1562-1564, 1572-1575, 1579-1580.5, 1585.5-1587, and 1594-1595.5 feet; trace of very finely crystalline, yellowish-gray (5Y 8/1) anhydrite	1550.0-1610.0

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, translucent to transparent, clean, some with a moderate-orange-pink (5YR 8/4) tint; moderate-orange-pink (10R 7/4) polyhalite; very finely crystalline, some chalky, very light-gray (N8) anhydrite from 1617-1625 feet	1610.0-1625.0
Halite, translucent to transparent, clean; traces of very finely crystalline, some chalky, very light-gray (N8) anhydrite and moderate-orange-pink polyhalite (5YR 8/4)	1625.0-1670.0
Halite, translucent to transparent, clean; trace dark-greenish-gray (5GY 4/1) mud; trace moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6), polyhalite	1670.0-1680.0
Halite, moderate-reddish-orange (10R 6/6), medium to coarsely crystalline, polyhalitic, numerous irregular blebs and stringers of polyhalite and/or anhydrite, moderate-reddish-orange (10R 6/6) and white (N9); few irregular 0.39 in. to 0.79 in. vugs; moderate-red (5R 4/6), slightly irregular polyhalite band from 1680.8-1680.0 feet	1680.0-1683.4
Halite, grayish-red (10R 4/2), pale-reddish-brown (10R 5/4), medium to coarsely crystalline with irregular blebs and stringers of moderate-reddish-orange (10R 6/6) to moderate-red (5R 4/6) polyhalite and moderate-reddish-brown (10R 4/6) clay	1683.4-1691.8
Halite, clear to white (N9) to moderate-reddish-orange (10R 6/6), medium to coarsely crystalline, polyhalitic; irregular blebs and stringers of pale-red (10R 6/2) to moderate-reddish-orange (10R 6/6); numerous irregular 0.39 in. to 1.97 in. fragments of angular to subrounded, medium-gray (N5) anhydrite from 1694.3-1695.0 feet	1691.8-1695.0
Polyhalite, light-olive-gray (5Y 6/1), massive to very finely crystalline, faintly laminated, massive bands in places of halite with translucent salt having a moderate-yellowish-brown (10YR 5/4) tint from 1695.1-1697.9 and 1699.1-1700.0 feet; stylolite or a horizontal dissolution horizon with 0.08 in. wide by 0.79 in. long vuggy vertical projections protruding upward; upper 2 feet anhydrite	1695.0-1700.8

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, translucent to transparent, clear, some grayish-orange (10YR 7/4) to yellowish-gray (5Y 7/2) tints, clean, medium to coarsely crystalline; several anhydrite bands, irregular wavy horizontal to low angle, 0.08 in. to 0.19 in. thick, slightly calcareous, very-light-gray (N8) to light-bluish-gray (5B 7/1)	1700.8-1710.0
Anhydrite, light-gray (N7), to medium-light-gray (N6), massive, aphanitic, horizontally laminated; halitic, translucent halite having a faint dark-yellowish-brown (10YR 4/2) tint, some halite pseudomorphs after gypsum, from 1710.0-1712.5 feet	1710.0-1712.5
Mud, olive-gray (5Y 4/1) with green tint, soft, slightly calcareous, numerous 0.20 in. polyhalite inclusions in top 0.2 feet; core over gauge, mud band is probably thin due to compression in core barrel	1712.5-1712.8
Polyhalite, moderate-reddish brown (10R 4/6), appears broken into 0.20 in. to 0.79 in. angular masses with slightly calcareous olive-gray (5Y 4/1) and green tint, mud filling the interstices	1712.8-1716.4
Halite, translucent to transparent with moderate-reddish-orange (10R 6/6), to moderate-reddish-brown (10R 4/6) tint, medium crystalline, some medium to coarsely crystalline, polyhalitic; dark-greenish-gray (5G 4/1) to medium-bluish-gray (5B 5/1) mud parting 0.20 in. thick and horizontal at 1721.2 feet; very irregular "V" shaped mud parting, filled with medium-bluish-gray (5B 5/1) and brownish-gray (5YR 4/1) muds; some thin vugs scattered, possibly dissolved out potassium salt(s)	1716.4-1726.5
Halite, some argillaceous halite and at least two magnesium minerals (bloedite-vanthoffite?), colors are mottled; predominantly clear to translucent with light brownish-black (5YR 2/1) tint, medium to coarsely crystalline halite from 1727.4-1728.4 feet; mottled moderate-reddish-orange (10R 6/6), pale-reddish-brown (10R 5/4) and some pale-red (10R 6/2), gritty, sucrosic appearance, magnesium mineral, some clear halite and some greenish-black (5G 2/1) interstitial mud; horizontal brownish-gray (5YR 4/1) mud parting at 1730.0 feet with some greenish-gray (5G 6/1) mud; parts or spots under gauge (dissolution of potash minerals), two irregular vertical 0.12 in. wide halite-filled healed	

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
fractures cutting through this mud and healed in the argillaceous halite below; finely crystalline, slightly polyhalitic and argillaceous with moderate-brown (5YR 3/4) mud from 1729.1-1730.0 feet	1726.5-1730.0
Halite, translucent to transparent, clear, some slightly argillaceous with dark-reddish-brown (10R 3/4) to grayish-red (10R 4/2) mud	1730.0-1740.0
Halite, transparent to translucent, clear, clean, with trace of polyhalite	1740.0-1750.0
Halite, transparent to translucent, clear, some slightly argillaceous, with dark-reddish-brown (10R 3/4) to grayish-red (10R 4/2) mud from 1755-1758 feet, halite	1750.0-1760.0
Halite, transparent to translucent, clean; trace of dark-greenish-gray (5G 4/1) mud 1767-1770 feet, some silty	1760.0-1780.0
Halite, translucent to transparent, very faint pale-reddish-brown (10R 5/4) tint, argillaceous, with pale-reddish-brown (10R 5/4) mud 1788-1790 feet	1780.0-1790.0
Halite, transparent to translucent, clean; moderate-reddish-orange (10R 6/6) polyhalite from 1796-1798 feet; trace dark-greenish-gray (5G 4/1) mud	1790.0-1800.0
Halite, transparent to translucent, some slightly argillaceous with dark-reddish-brown (10R 3/4) to grayish-red (10R 4/2) mud	1800.0-1820.0
Halite, transparent to translucent, clean; polyhalite, moderate-reddish-orange (10R 6/6) from 1822.5-1825.0 feet	1820.0-1830.0
Halite, transparent to translucent, some slightly argillaceous; trace moderate-reddish-orange (10R 6/6) polyhalite from 1834-1836.5 feet; trace of dark-greenish-gray (5G 4/1) mud	1830.0-1840.0
Halite, transparent to translucent, trace of moderate-reddish-orange (10R 6/6) polyhalite	1840.0-1850.0
Halite, transparent to translucent, moderate-reddish-orange (10R 6/6) polyhalite from 1854.5-1856.5 feet	1850.0-1860.0

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, transparent to translucent, moderate-reddish-orange (10R 6/6) and moderate-reddish-brown (10R 4/6) polyhalite	1860.0-1870.0
Halite, transparent to translucent, small trace moderate-reddish-orange (10R 6/6) polyhalite	1870.0-1880.0
Halite, transparent to translucent; trace of dark-reddish-brown (10R 3/4) clay	1880.0-1890.0
Halite, transparent to translucent, clean, moderate-reddish-orange (10R 6/6); moderate-reddish-brown (10R 4/6) polyhalite; trace of dark-reddish-brown (10R 3/4) and medium-dark-gray (N4) clay	1890.0-1900.0
Halite, transparent to translucent, clean, moderate-reddish-orange (10R 6/6); moderate-reddish-brown (10R 4/6) polyhalite from 1909.5-1910.0 feet	1900.0-1910.0
Halite, transparent to translucent, clean, moderate-reddish-orange (10R 6/6); moderate-reddish-brown (10R 4/6) polyhalite from 1910.0-1911.5 and 1928.5-1930.0 feet	1910.0-1930.0
Halite, same as in unit 1890.0-1900.0 feet, trace of medium-dark-gray (N4) clay	1930.0-1940.0
Halite, same as in unit 1890.0-1900.0 feet, but without clay	1940.0-1950.0
Halite, same as in unit 1930.0-1940.0 feet	1950.0-1970.0
Halite, polyhalite from 1974-1976 feet, trace, medium-dark-gray (N4) clay	1970.0-1980.0
Halite, transparent to translucent, clean, moderate-reddish-orange (10R 6/6) and reddish-brown (10R 4/6) polyhalite; trace medium-dark-gray (N4) clay	1980.0-1990.0
Halite, transparent to translucent, clean, moderate-reddish-orange (10R 6/6) polyhalite from 2000-2001.5 feet	1990.0-2001.5
Halite, translucent to transparent, clean; moderate-reddish-orange (10R 6/6) polyhalite	2001.5-2010.0
Halite, translucent to transparent, clean; some anhydritic with grayish-orange (10YR 7/4) to grayish-orange-pink (10R 8/2), very finely crystalline anhydrite; moderate-orange-pink (10R 7/4) polyhalite;	

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
soft but firm, olive-gray (5Y 4/1) to dark-greenish-gray (5GY 4/1) mud, some moderate-brown (5YR 3/4); very finely crystalline, halitic, grayish-orange (10YR 7/4) anhydrite, some granular, very-light-gray (N8)	2010.0-2015.5
Anhydrite, very-light-gray (N8), granular texture; halitic, some white (N9) and chalky; halite, transparent to translucent; trace of mud, soft but firm, olive-gray (5Y 4/1) to dark-greenish-gray (5GY 4/1), some moderate-brown (5YR 3/4)	2015.5-2025.0
Halite, translucent to transparent; anhydrite, very light-gray (N8), granular texture, halitic, some white (N9) and chalky	2025.0-2040.0
Halite, translucent to transparent, clear and predominantly clean, trace of moderate-brown (5YR 3/4) mud	2040.0 2045.0
Halite, translucent to transparent, medium to coarsely crystalline, slightly argillaceous with interstitial soft, medium-gray (N5) to medium-dark-gray (N4) clay; medium-gray (N5), 0.08 in. to 1.18 in. thick discontinuous, irregular clay band at 2045.3 feet; 0.04 in. to 0.24 in., medium-dark-gray (N4) clay-filled fracture dipping at 46°	2045.0-2046.4
Halite, translucent to transparent, coarsely to medium crystalline, some finely crystalline, very argillaceous, moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4) interstitial clay, few blebs and stringers of moderate-reddish-orange (10R 6/6) polyhalite; clean, medium crystalline, transparent to translucent halite 2048.8-2060.5 feet; clean with numerous blebs and stringers of polyhalite in finely to medium crystalline, translucent to transparent halite 2053-2054.1 feet, 2055.3-2055.8 feet, 2059.1-2060 feet and 2062-2064.1 feet	2046.4-2066.3
Halite, translucent to transparent, fine to medium crystalline, very polyhalitic; blebs and stringers of moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6), polyhalite, very concentrated from 2069.5-2071.5 feet; some interstitial, soft, medium-gray (N5) clay from 2068.1-2068.5 feet; coarsely crystalline, clean, translucent to transparent halite from 2071.5-2071.6 feet	2066.3-2071.6

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Polyhalite, olive-gray (5Y 4/1), very finely crystalline, some slightly gypsiferous, very numerous 0.25 in. to 2.5 in., very irregular moderate-reddish-orange (10R 6/6) polyhalite pseudomorphs; very concentrated, very polyhalitic, 0.04 in. or less, moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6), halite pseudomorphs	2071.6-2073.9
Polyhalite, olive-gray (5Y 4/1), very finely crystalline, numerous subrounded, irregular, 1.97 in. or less moderate-reddish-orange (10R 6/6) polyhalite pseudomorphs; horizontal, medium-gray (N5) clay parting at 2083.2 feet	2073.9-2083.4
Halite, translucent to transparent, clean, medium to finely crystalline, polyhalitic with some blebs and stringers of moderate-reddish-orange (10R 6/6) polyhalite	2083.4-2084.0
Polyhalite, olive-gray (5Y 4/1), very finely crystalline, some slightly gypsiferous; very irregular upper and lower contacts	2084.0-2084.1
Halite, translucent to transparent, argillaceous in parts with medium-gray (N5) tint, medium to coarsely crystalline, numerous blebs and stringers of moderate-reddish-brown (10R 4/6) to moderate-reddish-orange (10R 6/6) polyhalite	2084.1-2085.8
Halite, translucent to transparent, with moderate-reddish-orange (10R 6/6) tint, polyhalitic, finely crystalline	2085.8-2086.5
Halite, translucent to transparent, finely to medium crystalline, very argillaceous, grayish-red (10R 4/2) interstitial clay; few blebs and stringers of moderate-reddish-orange (10R 6/6) polyhalite; few blebs and stringers of very light-gray (N8) to white (N9) anhydrite, more prevalent from 2086.5-2087.0 feet	2086.5-2091.1
Halite, translucent to transparent with grayish-orange (10YR 7/4) tint, medium to coarsely crystalline; some disseminated blebs and stringers of moderate-reddish-orange (10R 6/6) polyhalite	2091.1-2095.1
Halite, translucent to transparent, with moderate-reddish-orange (10R 6/6) tint in parts caused by disseminated blebs of finely to medium crystalline polyhalite	2095.1-2096.1

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, translucent to transparent, with very-light-brownish-black (5YR 2/1) and some moderate-yellowish-brown (10YR 5/4) tints, finely crystalline, argillaceous moderate-brown (5YR 3/4) mud	2096.1-2101.0
Halite, translucent to transparent, medium crystalline with disseminated blebs and interstitial moderate-reddish-orange (10R 6/6) polyhalite throughout; infrequent rounded vugs (from fluid inclusions); becoming less polyhalitic from 2104.7-2105.5 feet	2101.0-2105.5
Halite, translucent to transparent with moderate-brown (5YR 3/4) to moderate-reddish-brown (10R 4/6) tint, finely to medium crystalline, argillaceous with moderate-brown (5YR 3/4) to moderate-reddish-brown (10R 4/6) mud; irregular mud parting with dark-greenish-gray (5G 4/1) and moderate-brown (5YR 3/4) muds (rough because of protruding salt crystals); several thin, very irregular mud "laminae" due to connecting linear mud-filled interstices	2105.5-2111.0
Halite, translucent to transparent, with moderate-brown (5YR 3/4) and moderate-reddish-orange (10R 6/6) tints, finely to medium crystalline, some parts with moderate-brown (5YR 3/4) mud; parts polyhalitic; irregular moderate-brown (5YR 3/4) mud seams and partings at 2114.9 and 2116.2 feet, one dipping 40° at 2116.6 feet and one dipping 40° (almost perpendicular to the mud seam at 2116.6 feet) at 2117.2 feet; numerous rounded vugs up to 0.12 in. in diameter from 2111.0-2115.0 feet	2111.0-2118.0
Halite, translucent to transparent with light moderate-reddish-orange (10R 6/6) tint; slightly polyhalitic	2118.0-2122.8
Halite, translucent to transparent with moderate-reddish-orange (10R 6/6) tint; moderate-reddish-brown (10R 6/6) to moderate-brown (5YR 3/4) mud partings at 2122.8 feet and 2124.8 feet; becoming polyhalitic, medium crystalline, and less argillaceous from 2127.1-2129.4 feet	2122.8-2130.6
Halite, translucent to transparent, clear with moderate-reddish-orange (10R 6/6) tints; disseminated blebs and interstitial polyhalite; rounded vugs up to 0.12 in. in diameter scattered throughout (from fluid inclusions), medium crystalline	2130.6-2134.6

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Anhydrite, medium-light-gray (N6) microcrystalline, faintly laminated	2134.6-2135.1
Mud, moderate-brown (5YR 3/4) with slight reddish-brown tint, soft but firm, halitic	2135.1-2135.3
Halite, translucent to transparent with moderate-brown (5YR 3/4) tint, finely crystalline, argillaceous	2135.3-2137.4
Halite, translucent to transparent with light-gray (N7) tint, medium crystalline, parts clean and medium to coarsely crystalline, parts argillaceous, medium-bluish-gray (5B 5/1) mud with green tint; discontinuous, irregular very-light-gray (N8) anhydrite stringers at 2144.5 feet and 2145.1 feet	2137.4-2145.6
No core	2145.6-2146.0
Halite, translucent to transparent with yellowish-gray (5Y 7/2) tint, medium to coarsely crystalline; few irregular stringers of very-light-gray (N8) to light-gray (N7) anhydrite	2146.0-2146.2
Halite, translucent to transparent with medium-light-gray (N6) to light-olive-gray (5Y 6/1) tint, finely to medium crystalline, argillaceous; slight trace of disseminated, moderate-reddish-orange (10R 6/6) polyhalite and very-light-gray (N8) anhydrite	2146.2-2150.8
Halite, translucent to transparent with moderate-reddish-orange (10R 6/6) tint, numerous disseminated blebs and stringers of moderate-reddish-orange (10R 6/6) polyhalite	2150.8-2153.5
Anhydrite, light-gray (N7) to medium-gray (N5), very finely crystalline, consists of numerous concentrated stringers of contrasting colors intermixed with numerous pseudomorphs of translucent to transparent halite; medium crystalline, translucent to transparent halite from 2154.4-2154.6 feet; medium crystalline, polyhalitic, translucent to transparent halite from 2154.6-2154.8 feet	2153.5-2155.5
Halite, translucent to transparent with medium-gray (N5) tint, finely crystalline, argillaceous; disseminated moderate-reddish-orange (10R 6/6) polyhalite blebs	2155.5-2155.7

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, translucent to transparent, milky, trace of disseminated blebs and stringers of moderate-reddish-orange (10R 6/6) polyhalite and very-light-gray (N8) anhydrite; irregular, horizontal, very-light-gray (N8) anhydrite band from 2160.9-2161.0 feet	2155.7-2161.0
Halite, translucent to transparent, alternating intervals of less than one foot of argillaceous, medium-gray (N5) polyhalite with blebs and stringers, moderate-reddish orange (10R 6/6) and some milky and finely to medium crystalline to clean, coarsely crystalline, translucent to transparent, halite from 2168.0-2168.5 feet	2161.0-2181.0
Halite, translucent to transparent with moderate-orange-pink (5YR 8/4) tint, numerous disseminated blebs and stringers of moderate-reddish-orange (10R 6/6) polyhalite	2181.0-2182.6
Anhydrite, very-light-gray (N8) to medium-gray (N5), very finely crystalline; translucent to transparent, grayish-orange (10YR 7/4) tinted halite from 2182.6-2183.4 feet and 2184.1-2184.9 feet	2182.6-2184.9
Halite, translucent to transparent, finely to coarsely crystalline. Alternating intervals from 1-6 feet thick, of blotchy argillaceous medium-gray (N5), polyhalite with blebs and stringers of moderate - reddish-orange-(10R 6/6) and milky halite	2184.9-2188.2
Halite, translucent to transparent with moderate-reddish-orange (10R 6/6) tint; medium crystalline, very concentrated disseminated blebs and stringers of moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6) polyhalite; wavy irregular 0.04 in. to 0.39 in. thick, light-gray (N7) anhydrite stringers at 2191.6 feet	2188.2-2191.6
Halite, translucent to transparent, finely to coarsely crystalline; as alternating intervals from 0.1 to 0.5 feet of blotchy argillaceous medium-gray (N5) polyhalite with blebs and stringers of moderate-reddish-orange (10R 6/6) and milky, disseminated polyhalite, medium to coarsely crystalline, translucent to transparent, some moderate-reddish-orange (10R 6/6) tinted halite from 2193.4-2196.2 feet	2191.6-2198.1
Halite, translucent to transparent with medium-light-gray (N6) tint, argillaceous; numerous disseminated blebs of moderate-reddish-orange (10R 6/6) polyhalite	2198.1-2200.6

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, translucent to transparent with pale-reddish-brown (10R 5/4) tint, medium crystalline; disseminated blebs and stringers of moderate-reddish-orange (10R 6/6) polyhalite	2200.6-2202.1
Halite, translucent to transparent with moderate-reddish-orange (10R 6/6) tint, medium to coarsely crystalline; numerous disseminated blebs and stringers of pale-red (10R 6/2) to moderate-reddish-orange (10R 6/6) polyhalite and and very-light-gray (N8) anhydrite	2202.1-2204.9
Halite, translucent to transparent, medium crystalline, milky with blebs and stringers of very-light-gray (N8) anhydrite	2204.9-2205.0
Anhydrite, very-light-gray (N8) and medium-gray (N5) at bottom 0.1 foot, very finely crystalline, horizontal contacts	2205.0-2206.0
Halite, translucent to transparent with pale-yellowish-orange (10YR 8/6) tint, finely crystalline, few disseminated blebs of moderate-reddish-orange (10R 6/6) polyhalite	2206.0-2207.0
Halite, translucent to transparent with dark-yellowish-brown (10YR 4/2) and medium-light-gray (N6) to yellowish-gray (5Y 7/2) tints, finely crystalline, parts approaching medium crystalline, trace of disseminated blebs of dark-yellowish-orange (10YR 6/6) to moderate-reddish-orange (10R 6/6) polyhalite increasing in the 2213.0-2214.0-foot interval	2207.0-2214.0
Halite, translucent to transparent, finely to medium crystalline, argillaceous; pale-brown (5YR 5/2) mud from 2214.0-2215.6 feet and with medium-light-gray (N6) mud 2215.6-2216.7 feet	2214.0-2216.7
Halite, translucent to transparent with medium-light-gray (N6) and faint dark-yellowish-orange (10YR 6/6) tints, finely to medium crystalline, parts (bands) with trace of medium-light-gray (N6) mud; trace of disseminated dark-yellowish-orange (10YR 6/6) polyhalite	2216.7-2223.0
Halite, translucent to transparent with dark-yellowish-orange (10YR 6/6) tint at 2223.0 feet, changing to a moderate-reddish-brown (10R 4/6) tint by 2224.5 feet, medium crystalline, polyhalitic, interstitial light-gray (N7) anhydrite	2223.0-2226.1

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Anhydrite, light-gray (N7), very finely crystalline, very faintly laminated, alternating bands of halitic anhydrite and dense anhydrite, halite pseudomorphs after gypsum in the halitic zones; 0.3 feet thick, soft but firm, medium-gray (N5) mud seam 2235.9-2236.2 feet; massive, dense anhydrite from 2236.2 to 2238.0 feet; 0.1 feet thick, soft but firm, medium-gray (N5) mud seam 2238.0-2238.1 feet.....	2226.1-2238.1
Halite, translucent to transparent with yellowish-gray (5Y 7/2) and pale-yellowish-orange (10YR 8/6) tint, some clear, finely to medium crystalline, argillaceous; medium-gray (N5) mud 2238.1-2238.6 feet; trace of dark-yellowish-orange (10YR 6/6) polyhalite 2240.7-2242.0 feet.....	2238.1-2242.1
Anhydrite, light-gray (N7), massive, dense, irregular upper contact with a 0.08 in. thick medium-light-gray (N6) mud seam at the base.....	2242.1-2242.2
Halite, translucent to transparent, mottled with moderate-brown (5YR 3/4) interstitial mud, and dark-yellowish-orange (10YR 6/6) finely crystalline polyhalite.....	2242.2-2244.5
Halite, translucent to transparent with pale-reddish-brown (10R 5/4) tint, medium crystalline; disseminated blebs and stringers of moderate-reddish-orange (10R 6/6) polyhalite.....	2244.5-2247.0
Halite, translucent to transparent, finely to medium crystalline, argillaceous; pale-brown (5YR 5/2) mud and medium-light-gray (N6) mud.....	2247.0-2249.0
*Note: Salt shows no sign of flowage; salt is equigranular, dips of contacts and mud partings are horizontal to 3°, no evidence of fractures. Halite pseudomorphs after gypsum "pointing upward" at bases of some halitic bands.	
Halite, mostly clear, some milky white, some moderate-reddish-orange (10R 6/6) tint; trace of moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6) polyhalite, trace of moderate-yellowish-brown (10 YR 5/4) 2260.0-2270.0 feet, trace of medium-dark-gray (N4) clay in lower 10 feet.....	2249.0-2280.0

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, mostly clear, some milky white, some moderate-reddish-orange (10R 6/6) tint; hard to soft dark-yellowish-orange (10 YR 6/6) to moderate-reddish-orange (10R 6/6) polyhalite	2280.0-2290.0
Polyhalite, pale-yellowish-orange (10YR 8/6) and moderate-reddish-brown (10R 4/6), soft to hard; white (N9) to clear halite; trace of medium-dark-gray (N4) and moderate-yellowish-brown (10YR 5/4) clay	2290.0-2296.0
Halite, mostly clear, some milky white, some moderate-reddish-orange (10R 6/6) tint; soft to hard, pale-yellowish-orange (10YR 8/6) and moderate-reddish-brown (10R 4/6) polyhalite	2296.0-2310.0
Halite, mostly clear, some milky white, some moderate-reddish-orange (10R 6/6) tint; moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6) polyhalite	2310.0-2319.0
Halite, transparent to translucent with light-olive-gray (5Y 5/2) to yellowish gray (5Y 7/2) tint from mud; some zones polyhalitic with a moderate-reddish-orange (10R 6/6) tint, finely crystalline, parts medium crystalline, recrystallized zones	2319.0-2323.0
Halite, transparent to translucent, clear with very-light-gray (N8) tint, medium crystalline, parts approaching coarsely crystalline, slightly argillaceous with pale-brown (5YR 5/2) to moderate-brown (5YR 3/4) interstitial and disseminated mud, some medium-gray (N5) mud, numerous rounded vugs up to 0.12 in. across scattered throughout (from bisected fluid inclusions); halite becomes translucent, milky white from 2331.6-2332.0 feet	2323.0-2332.0
Anhydrite, light-olive-gray (5Y 5/2) to light-olive-gray (5Y 6/1), very finely crystalline to massive, dense; core breaks (possibly along bedding planes) in top part at a 13° angle from horizontal; halitic in 2334.9-2336.5 and 2337.3-2341.0-foot intervals; 0.04 in. to 0.08 in. halite-filled healed fracture dipping 21° at 2335.5 feet. This healed fracture is cut or broken and off-set 0.1 foot. Several olive-gray (5Y 3/2) mud laminae in 2341.4-2341.9 foot interval; laminae are wavy and distorted with an average dip of 10°; anhydrite is light-gray (N7), very finely crystalline with an argillaceous or chalky appearance; bottom contact with halite is marbled with soft medium-light-gray (N6) mud and translucent halite and dips 19°	2332.0-2344.0

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, translucent to transparent with light-gray (N7) and yellowish-gray (5Y 7/2) tints, finely crystalline, trace of irregular very-light-gray (N8) anhydrite stringers, some dip 15°-25°; faint hint of a linear orientation of the slightly elongated halite crystals in the finely crystalline halite from 2344.3-2349.0 feet	2344.0-2350.0
Halite, translucent to transparent with light-gray (N7) and yellowish-gray (5Y 7/2) tints, medium crystalline, some containing traces of medium-light-gray (N6) mud; very-light-gray (N8) interstitial anhydrite from 2359.0-2368.4 feet; 1-3 mm-wide rounded vugs scattered throughout from fluid inclusions	2350.0-2368.4
No core	2368.4-2369.0
Halite, clear to milky white with grayish-orange (10YR 7/4) and light-gray (N7) to medium-dark-gray (N4) tint, medium to coarsely crystalline, equigranular, argillaceous; some disseminated blebs and stringers of very-light-gray (N8) to light-gray (N7) anhydrite	2369.0-2375.0
Anhydrite, light-gray (N7) to medium-gray (N5), some with grayish-orange (10YR 7/4) tint, very finely crystalline; grayish-orange (10YR 7/4) halite pseudomorphs up to 0.28 in. in diameter	2375.0-2376.6
Clay, medium-gray (N5), hard, horizontal	2376.6-2376.7
Halite, clear to milky-white with grayish-orange (10YR 7/4) and light-gray (N7) to medium-dark-gray (N4) tint, medium to coarsely crystalline, equigranular, argillaceous; irregular, discontinuous, 0.39 in to 1.97 in. thick, medium-gray (N5) anhydrite band at 2374.3 feet	2376.7-2378.7
Halite, clear to milky-white, transparent, coarsely crystalline, recrystallized	2378.7-2380.9
Halite, clear to milky-white with grayish-orange (10YR 7/4) and light-gray (N7) to medium-dark-gray (N4) tint, medium to coarsely crystalline, equigranular, argillaceous; continuous, irregular, thin light-gray (N7) anhydrite stringer at 2381.4 feet dipping 20°	2380.9-2381.5

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Anhydrite, light-gray (N7) to medium-gray (N5), some with grayish-orange (10YR 7/4) tint, very fine crystalline; 0.08 in. to 0.79 in., clear to milky white halite pseudomorphs, some as discontinuous bands, concentrated from 2381.9-2383.3 feet and sparse from 2383.3-2386.0 feet	2381.5-2387.6
Halite, clear to milky white with grayish-orange (10YR 7/4) and light-gray (N7) to medium-dark-gray (N4) tint, medium to coarsely crystalline, equigranular, argillaceous; some disseminated blebs and stringers, very-light-gray (N8) to light-gray (N7) anhydrite	2387.6-2391.9
Halite, grayish-orange (10YR 7/4), medium crystalline; disseminated blebs and stringers of very-light-gray (N8) anhydrite	2391.9-2392.4
Halite, clear to milky-white with grayish-orange (10YR 7/4) and light-gray (N7) to medium-dark-gray (N4) tint, medium to coarsely crystalline, equigranular, argillaceous; disseminated blebs and stringers of very-light-gray (N8) to light-gray (N7) anhydrite; remnant mud desiccation cracks, moderate-yellowish-brown (10YR 5/4) at 2395.5 feet	2392.4-2399.0
Halite, grayish-orange (10R 7/4), medium crystalline; disseminated blebs and stringers of very-light-gray (N8) anhydrite	2399.0-2400.9
Anhydrite, light-gray (N7) to medium-gray (N5), some with grayish-orange (10YR 7/4) tint, very finely crystalline; 0.08 in. to 0.39 in., clear to milky white, halite pseudomorphs, some as discontinuous bands, from 2400.9-2401.3 feet	2400.9-2401.6
Clay, medium-gray (N5), hard, horizontal	2401.6-2401.7
Halite, grayish-orange (10YR 7/4), medium crystalline; disseminated blebs and stringers of very-light-gray (N8) anhydrite	2401.7-2402.6
Halite, clear to milky-white with grayish-orange (10YR 7/4) and light-gray (N7) to medium-dark-gray (N4) tint, medium to coarsely crystalline, equigranular, argillaceous; disseminated blebs and stringers of very-light-gray (N8) to light-gray (N7) anhydrite; remnant mud desiccation cracks at 2305.0 feet	2402.6-2409.2

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, clear to milky white, translucent, slight medium-light-gray (N6) tint, coarsely crystalline	2409.2-2410.3
Halite, clear to milky white, translucent parts with slight yellowish-gray (5Y 8/1) tint, medium crystalline; numerous disseminated blebs and stringers, 0.12 in. or less thick of light-gray (N7) anhydrite; very concentrated, horizontal, light-gray (N7) anhydrite stringers from 2412.7-2412.8 feet	2410.3-2412.8
Halite, milky white, finely crystalline; disseminated blebs and stringers of light-gray (N7) anhydrite	2412.8-2413.5
Anhydrite, light-gray (N7) to medium-gray (N5), some with grayish-orange (10YR 7/4) tint, very finely crystalline; 0.12 in. to 0.79 in. thick, clear to milky white halite pseudomorphs mostly in discontinuous bands, from 2413.4-2413.7 feet	2413.5-2414.2
Halite, clear to milky white, parts with medium-light-gray (N6) tint, medium crystalline; trace of disseminated blebs and stringers of light-gray (N7) anhydrite	2414.2-2415.8
Anhydrite, light-gray (N7) to medium-gray (N5), some with grayish-orange (10YR 7/4) tint, very finely crystalline; 0.12 in. to 0.79 in. thick, clear to milky white, halite pseudomorphs mostly in discontinuous bands, top and bottom contacts are indistinct because of numerous clear halite pseudomorphs	2415.8-2416.7
Halite, milky-white, finely crystalline, disseminated blebs and stringers of light-gray (N7) anhydrite	2416.7-2417.5
Anhydrite, light-gray (N7) to medium-gray (N5), some with grayish-orange (10YR 7/4) tint, very finely crystalline; some discontinuous bands of clear to milky white, halite pseudomorphs 0.08 in. to 0.79 in. in diameter	2417.5-2419.1
Halite, milky-white, finely crystalline; disseminated blebs and stringers of light-gray (N7) anhydrite, dip is horizontal	2419.1-2419.5
Halite, translucent with very-light-gray (N8) tint, some translucent to opaque milky white, finely to medium crystalline; some of the milky white salt	

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
shows growth lines or hopper-type halite crystals, (primary halite crystals); transparent to translucent, medium to coarsely crystalline, recrystallized band from 2420.3-2420.6 feet with a discontinuous 0.08 in. to 0.16 in. thick very-light-gray (N8) anhydrite band or stringer; similar recrystallized halite zones with 0.08 in. to 0.39 in. thick anhydrite bands from 2420.8-2421.0 feet and 2421.5-2422.0 feet; rounded 0.04 in. to 0.12 in. vugs present but rare	2419.5-2422.0
Anhydrite, medium-light-gray (N6), very finely crystalline, faint wavy horizontal to low angle laminae, very halitic to 2423.5 feet, dense to 2423.9 feet	2422.0-2423.9
Halite, transparent to translucent, clear, with light-gray (N7) tint, medium crystalline; trace of very-light-gray (N8) irregular discontinuous anhydrite stringers	2423.9-2425.4
Halite, transparent to translucent, clear, light-gray (N7) tint, finely crystalline, trace of olive-gray (5Y 4/1) interstitial mud; becoming finely to medium crystalline at 2430.5 feet	2425.4-2431.0
Halite, translucent to transparent, clear, light-gray (N7) tint, coarsely to medium crystalline, recrystallized, medium-gray (N5) with green tint interstitial anhydrite; 0.04 in. to 0.16 in. wide rounded vugs	2431.0-2436.2
Halite, translucent to transparent, clear light-gray (N7) tint; alternating bands 0.1-0.4 feet thick of finely, medium and coarsely crystalline halite; some medium-gray (N5) with green tinted interstitial anhydrite; 0.04 in. to 0.16 in. wide rounded vugs; coarsely crystalline from 2441.5-2443.0 feet; anhydrite increasing toward bottom	2436.2-2445.5
Anhydrite, light-gray (N7) to medium-light-gray (N6), light-olive-gray (5Y 6/1) tint, very finely crystalline, laminated to very faintly laminated; upper contact dips 22°; halitic with distorted halite pseudomorphs in 2451.4-2458.0-foot intervals, laminated with very-light-gray (N8) magnesite, dipping 5-8° at 2460.0 feet, this lamination is very prominent in 2462.0-2463.5-foot intervals; some of these magnesite laminae are cut by thin halite-filled fractures which terminate at the anhydrite laminae; several halite-filled fractures up to 0.79 in. wide and 0.7 feet long, pinching out at both ends	2445.5-2463.9

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Anhydrite breccia in halite: anhydrite pieces are angular, laminated, the halite is transparent to translucent, clear, finely to medium crystalline	2463.9-2467.7
Magnesite (?) (and possibly anhydrite), very light gray (N8), faint laminae dipping as much as 11°, slightly chalky argillaceous texture, has fetid odor when broken	2467.7-2468.7
Anhydrite, light-gray (N7) to medium-gray (N5), some light-olive-gray (5Y 6/1), very finely crystalline, horizontal laminae; massive; 2.36 in. long by 1.18 in. wide, "saw tooth" shaped, light-gray (N7) magnesite from 2470.0-2470.1 feet and 0.39 in. thick, discontinuous horizontal band at 2471.0 feet; hard, numerous, very irregular, 0.04 in. to 0.79 in. thick, clear halite veins, medium-gray (N5) clay from 2470.6-2471.1 feet	2468.7-2471.0
Clay, medium-gray (N5), hard, as concentrated irregular, horizontal veinlets, 0.04 in. thick	2471.0-2471.1
Halite, colorless to milky white, transparent, medium-light-gray (N6) to medium-dark-gray (N4) tint, medium to coarsely crystalline, equigranular, argillaceous; disseminated stringers of very-light-gray (N8) anhydrite	2471.1-2476.6
Halite, colorless to milky white, transparent, medium to coarsely crystalline, recrystallized	2476.6-2478.0
Halite, colorless to milky white, transparent, with medium-light-gray (N6) to medium-dark-gray (N4) tint, medium to coarsely crystalline, equigranular, argillaceous; recrystallized, coarsely crystalline, 0.1-0.2 feet thick, irregular "blotchy" intervals of colorless to milky white halite at 2483.5, 2485.3, 2487.1, and 2494.6 feet; healed fracture at 2488.5 feet dipping 62°; disseminated stringers of very-light-gray (N8), anhydrite	2478.0-2495.2
Halite, colorless to milky white, finely to coarsely crystalline, disseminated stringers of very-light-gray (N8) anhydrite; very concentrated intervals of very-light-gray (N8) anhydrite stringers at 2495.2-2495.7 feet with medium-gray (N5) clay at base	2495.2-2500.0

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Anhydrite, light-gray (N7) to medium-gray (N5), some light-olive-gray (5Y 6/1), very finely crystalline, horizontal laminae; upper contact and some laminae dip 32°	2500.0-2500.5
Halite, colorless, translucent, coarsely crystalline; intermixed with medium-light-gray (N6) anhydrite	2500.5-2502.1
Anhydrite, light-gray (N7) to medium-gray (N5), and light-olive-gray (5Y 6/1), very finely crystalline, horizontal laminae	2502.1-2503.0
Halite, colorless to milky white, transparent, medium-light-gray (N6) to medium-dark-gray (N4) tint, medium to coarsely crystalline, equigranular, argillaceous; disseminated stringers of light-gray (N8) anhydrite	2503.0-2512.0
Halite, colorless to milky white, transparent, medium, mostly coarsely crystalline, recrystallized	2512.0-2515.8
Halite, colorless to milky white with yellowish-gray (5Y 7/2) tint, finely to medium crystalline, with disseminated, very-light-gray (N8) anhydrite stringers	2515.8-2516.0
Anhydrite, light-gray (N7) to medium-gray (N5) and light-olive-gray (5Y 6/1), very finely crystalline, recrystallized, irregular clear halite veins, medium-gray (N5)	2516.0-2517.5
Halite, colorless to milky white, transparent medium-light-gray (N6) to medium-dark-gray (N4) tint, medium to coarsely crystalline, equigranular, argillaceous; some disseminated stringers of very-light-gray (N8) anhydrite	2517.5-2518.3
No core	2518.3-2520.0
Halite, translucent to transparent with light-gray (N7) tint, finely to very finely crystalline, with a few 0.4 foot thick bands or zones of recrystallized medium to coarsely crystalline halite, which are clearer and more transparent; a few 0.04 in. to 0.16 in. wide rounded vugs in the finely to medium (not in the very finely to finely) crystalline zones	2520.0-2541.0
Halite, translucent to transparent, light-gray (N7) tint, portions clear, medium to coarsely crystalline	2541.0-2545.8

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, translucent to transparent, clear to milky white with light-gray (N7) tint, very finely to medium crystalline, portions recrystallized to coarsely crystalline bands 0.1-1.0 feet thick	2545.8-2570.6
Halite, transparent to translucent light-gray (N7) to medium-dark-gray (N4) tint, finely and medium crystalline bands 0.1-1.0 feet thick; recrystallized, clear to translucent coarsely crystalline bands, interstitial light-gray (N7) to medium-light-gray (N6) moderately hard mud; medium-light-gray (N6) mud parting dipping 29° at 2594.4 feet	2570.6-2594.6
Halite, translucent, milky-white, medium crystalline; some halite crystals show growth lines: hopper cubes	2594.6-2595.5
Anhydrite, very-light-gray (N8), discontinuous and irregularly laminated with translucent halite laminae dipping 17°	2595.5-2595.8
Halite, transparent to translucent, light-gray (N7) to medium-dark-gray (N4) tint, several thin bands of translucent milky white halite	2595.8-2596.0
Anhydrite, light-olive-gray (5Y 6/1), very finely crystalline, parts halitic, horizontal laminae	2596.0-2597.0
Halite, transparent to translucent light-gray (N7) to medium-dark-gray (N4) tint several thin bands of translucent milky white halite; no halite crystals showing growth lines; medium-light-gray (N6) with green tinted, 0.39 in. thick mud seam at the top (base of anhydrite) and as argillaceous mud in the bottom 0.3 feet of this section	2597.0-2598.0
Anhydrite, light-olive-gray (5Y 6/1), very finely crystalline, parts halitic, horizontal laminae	2598.0-2598.3
Halite, transparent to translucent, light-gray (N7) to medium-dark-gray (N4) tint, finely and medium crystalline bands 0.1-1.0 feet thick; some recrystallized, clear to translucent coarsely crystalline bands, interstitial light-gray (N7) to medium-light-gray (N6), a few milky white crystals from 2598.3-2598.6 feet show growth lines, hopper cubes	2598.3-2606.1
Anhydrite, very-light-gray (N8), discontinuous and irregularly laminated with translucent halite dipping at 17°; 0.39 in. thick medium-light-gray (N6) mud parting at base which dips approximately 7°	2606.1-2606.7

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, light-gray (N7) to medium-light-gray (N6), finely to medium crystalline, slightly argillaceous and anhydritic, thin coarsely crystalline halitic bands throughout; band of very halitic, light-gray (N7) anhydrite at 2608.8-2609.1 feet	2606.7-2613.5
Anhydrite, very-light-gray (N8), discontinuous and irregularly laminated with translucent halite dipping at 5°	2613.5-2614.4
Halite, clear to milky white, grading to very-light-gray (N8) towards base, medium crystalline	2614.4-2615.0
Anhydrite, very-light-gray (N8) and light-gray (N7), slightly mottled, faintly and discontinuously banded with less than 0.04 in. thick medium-light-gray (N6) laminae, very finely crystalline; 0.1 feet thick, medium-light-gray (N6); discontinuous, irregular mud parting at base of unit	2615.0-2615.9
Halite, light-gray (N7) to medium-light-gray (N6), finely to medium crystalline, slightly argillaceous; contains thin, irregular bands of clear to very-light-gray (N8) coarsely crystalline halite	2615.9-2619.3
Halite, colorless to milky white, transparent, medium-gray (N5) tint, finely to medium crystalline; argillaceous, equigranular; few horizontal, irregular 0.04 in. to 0.39 in. thick, very-light-gray (N8) anhydrite stringers	2619.3-2635.3
Halite, colorless to milky white, transparent, medium crystalline trending to finely crystalline; some crystal growth lines, primary crystals	2635.3-2635.7
Halite, colorless to milky white, transparent, medium-gray (N5) tint, finely to medium crystalline; argillaceous; few horizontal, irregular 0.04 in. to 0.39 in. thick very-light-gray (N8) anhydrite stringers	2635.7-2636.0
Anhydrite, medium-light-gray (N6) and light-olive-gray (5Y 6/1) intermixed with numerous 0.12 in. to 0.79 in. thick generally discontinuous bands of colorless to milky white halite pseudormorphs after gypsum	2636.0-2638.4

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, colorless to milky white, transparent with medium-gray (N5) tint, finely to medium crystalline; argillaceous, few horizontal, irregular 0.04 in. to 0.39 in. thick very-light-gray (N8) anhydrite stringers	2638.4-2639.1
Anhydrite, light-gray (N7) and light-olive-gray (5Y 6/1) cryptocrystalline with horizontal, wavy laminae, less than 0.04 in. thick	2639.1-2641.2
Anhydrite, medium-light-gray (N6) and light-olive-gray (5Y 6/1) intermixed with numerous, 0.12 in. to 0.79 in. thick, generally discontinuous bands of colorless to milky white halite pseudormorphs after gypsum	2641.2-2642.2
Halite, colorless to milky white, transparent, with medium-gray (N5) tint, finely to medium crystalline; argillaceous, few horizontal, irregular 0.04 in. to 0.39 in. thick, very-light-gray (N8) anhydrite stringers 2642.2-2643.3	2642.2-2645.0
Anhydrite, light-gray (N7) and light-olive-gray (5Y 6/1) cryptocrystalline with horizontal, wavy laminae less than 0.04 in. thick	2645.0-2645.4
Halite, colorless to milky white, transparent with medium-gray (N5) tint, fine to medium crystalline; argillaceous	2645.4-2649.4
Halite, colorless to milky white, transparent, medium to coarsely crystalline, recrystallized	2649.4-2650.3
Anhydrite, medium-light-gray (N6) and light-olive-gray (5Y 6/1), intermixed with numerous, 0.12 in. to 0.79 in. thick generally discontinuous bands of colorless to milky white halite pseudormorphs after gypsum	2650.3-2652.0
Halite, colorless to milky white, transparent, medium to coarsely crystalline, recrystallized; horizontal, irregular, 0.04 in. to 0.08 in., very-light-gray (N8), anhydrite stringers	2652.0-2654.0
Anhydrite, light-gray (N7) and light-olive-gray (5Y 6/1) cryptocrystalline; horizontal, thin wavy laminae; 0.08 in. to 0.39 in., irregular, colorless to milky white, halite pseudomorphs after gypsum	2654.0-2655.0

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, colorless to milky white, transparent, medium to coarsely crystalline, recrystallized	2655.0-2655.5
Halite, colorless to milky white, slight medium-light-gray (N6) tint in parts, finely to medium crystalline, numerous, irregular, 0.04in to 0.08 in. thick stringers and 0.12 in. to 1.57 in. thick blebs of very-light-gray (N8) anhydrite	2655.5-2657.7
Halite, colorless to milky white, transparent, medium-gray (N5) tint, finely to medium crystalline; argillaceous, concentrated, irregular, 0.04 in. to 0.39 in. thick, very-light-gray (N8), intercrystalline, anhydrite blebs and stringers at 2661.0-2666.0 feet	2657.7-2666.0
Halite, transparent, clear to translucent, light-gray (N7) to medium-gray (N5) tint, some translucent milky white, banded in zones 0.1 to over 1.0 feet thick, varying in translucency and shades of gray tint, predominantly finely and medium crystalline, but contains some very finely crystalline and some recrystallized, clear, clean, coarsely crystalline zones; slight to moderate amount of light-gray (N7) to medium-light-gray (N6) interstitial clay and anhydrite; translucent milky white zones with halite crystals showing growth lines (hopper cubes) of unrecrystallized primary halite from 2668.1-2668.8, 2669.8-2670.0, 2679.5-2679.8, and 2703.9-2704.2 feet and several thinner zones and thin bands scattered randomly; several very finely crystalline, very-light-gray (N7) anhydrite bands and irregular stringers up to 0.12 in. thick dipping 3-4 degrees 2670.4-2670.8 feet with a 0.20 in. thick medium-gray (N5) mud seam at the base; irregular very-light-gray (N7) halitic anhydrite band from 2703.7-2703.9 feet; a 0.79 in. thick anhydrite band at 2706.0 feet with a thin medium-gray (N5) mud seam at the base; anhydrite band dipping 4-6 degrees from 2715.1-2715.3 feet same as unit 2703.7-2703.9 feet; an irregular wavy linear feature, possibly a healed (with transparent halite) fracture 0.39 in. wide and dipping 84 degrees from 2692.4 to 2694.3 feet; another similar feature describing an arc through the core from 2694.4 to 2695.0 feet is 0.2 in. wide, partly highlighted with irregular anhydrite stringers, the bottom 0.1 foot of this halite healed fracture is filled with very-light-gray (N7) anhydrite, fracture may be similar to mud crack	2666.0-2716.1

LITHOLOGIC DESCRIPTION	DEPTH INTERVAL (IN FEET)
Halite, transparent to translucent, light-gray (N7) to medium-gray (N5) tint, parts translucent milky white, finely to medium crystalline, banded by the above characteristics; white halite crystals in the milky white zones show growth bands (hopper cubes), primary halite crystals from 2722.8-2723.2, 2723.9-2724.3, 2725.9-2726.3, 2726.6-2726.9, 2729.0-2730.7, 2730.2-2730.4, 2731.5-2731.9, 2732.4-2732.7, 2733.8-2734.8, and 2736.9-2737.5 feet; minor to locally moderate amounts of medium-gray (N5) interstitial mud; numerous irregular, continuous and discontinuous, horizontal to very low angle, stringers and halitic bands of very-light-gray (N7) anhydrite scattered throughout interval, up to 0.4 feet thick; 0.4 foot thick; anhydrite band from 2732.7-2733.1 feet	2716.1-2737.5
Anhydrite, light-olive-gray (5Y 6/1) to light-gray (N7), very finely crystalline, dense, faint bands and (or) laminated dipping 0 to 3°, locally dipping as much as 16° at 2763.8 feet; core gives off a fetid odor when broken	2737.5-2767.5
Anhydrite, very-light-gray (N8) to light-gray (N7), faint light-olive-gray (5Y 6/1) tint, very finely crystalline to dense, white (N9) and chalky, trace of firm olive-gray (5Y 4/1) to dark-greenish-gray (5G 4/1) mudstone	2767.5-2785.8

4.0 HYDROLOGICAL DATA

No fluid-bearing zones in the Salado Formation were known to be penetrated during this drilling program, and no hydrological tests were performed in either the Rustler or Salado Formations.

Following the well completion, the borehole was filled with drilling fluid and capped. A pressure gage was routinely attached after it was noted that pressure had built up in the casing. Table 4 shows the surface pressures as monitored over a period of about 6 months. Though the pressures at WIPP 12 and 13 reached seemingly high levels, the volume of gas and fluid produced were very small. The gas, as analyzed by S.J. Lambert, is nearly identical with the atomosphere. It is slightly enriched in nitrogen and slightly depleted in oxygen. WIPP 13 gas was indistinguishable from air. There is no apparent connection with the brine reservoir found in deepening WIPP 12 (D'Appolonia, in preparation). Temperature logging, as cited in Chapter 3, does not indicate any source of significant fluids from the Salado as a cause for the pressure. The conclusion of brine breakdown, as noted in Chapter 3, is the most reasonable explanation of the pressure.

Table 4

Pressure Readings

Date	WIPP 1 1 Time	WIPP 1 1 psi	WIPP 12 Time	WIPP 12 psi	WIPP 13 Time	WIPP 13 psi	Temp. Est. oF
6-25-80			1100	469			
7-01-80	0940	6	0905	472	0945	86	90
7-07-80	1030	5	1015	466	1025	118	85
7-17-80	1430	6	1415	464	1425	212	105
7-22-80	1215	6	1200	462	1205	240	95
7-29-80	1015	6	1005	460	1010	254	85
8-06-80	0955	6	0945	458	0950	260	80
8-13-80	0740	6	0730	454	0735	264	70
8-20-80	0825	6	0815	456	0820	280	70
8-22-80:	WIPP 12 bled off - repaired weld - while open - blew Air about 30 seconds - then fluid estimate 1-1/4 bbl. - Re-shut-in at 1130 hours 8-22-80						
8-25-80	1320	6	1310	126	1315	306	95
9-03-80:	WIPP 12 suspect - still leaking:						
	0905	6	0855	266	0900	296	80
9-06-80:	WIPP 12 only -		0845	300 - bled off - repaired weld			
9-06-80:	WIPP 12 only -		1145	0 - re-shut-in			
9-08-80	0800	6	0745	86	0750	312	70
9-17-80	0800	6	0745	268	0750	328	70
9-22-80	1115	6	1105	327	1110	326	80
9-25-80 -	Bled off to run logs -						
			0745	344	0750	326	60
9-29-80	1330	6	1335	128	1340	10	70
10-06-80	0930	6	0920	242	0925	104	65
10-13-80	0900	6	0845	308	0915	180	65
10-20-80	0905	6	0855	342	0900	210	60
10-27-80	1005	6	0955	378	1000	224	50
11-04-80	0925	6	0915	396	0920	232	60
11-10-80	0940	6	0930	408	0935	238	65
11-20-80	1015	6	1005	422	1010	258	50
12-01-80	1225	18	1215	442	1220	288	52
12-04-80:	Steve Lambert, SNL - wellhead samples at WIPP 12 and 13						
12-08-80	0805	16	0755	432	0800	314	38
12-16-80	1340	16	1325	454	1330	338	65

5.0 REMARKS

WIPP 12 clearly confirmed the presence of an elevation change from ERDA 9, but the actual 160 ft was quite different from the estimates based on siesmic reflection data. Uphole velocity surveys confirm higher velocities at WIPP 12, which tend to exaggerate the structure. In addition, the borehole velocity records indicate that the original interpretation had jumped up one wavelet in being carried across the flank of the structure. Further indications of velocity variations have come from subsequent gravity surveys (Barrows, in preparation).

The structure over WIPP 12 does not appear to be significant for operations at the facility horizon in the northern part of Zone II. Excavations at that level are about to begin; these will demonstrate the presence or lack of significant local structural disturbance over the half mile north of ERDA 9. The core and logs indicate reasonable thickness of the proposed horizon, though some apparent increase in the number of clay seams or partings in the lower member of the Salado.

The anticlinal structure at WIPP 12 is now included in the "disturbed zone" of the northern part of the site (Barrows et al, in preparation). The origin of the "disturbed zone" and relationship to brine reservoirs is covered in Barrows, et al (in preparation).

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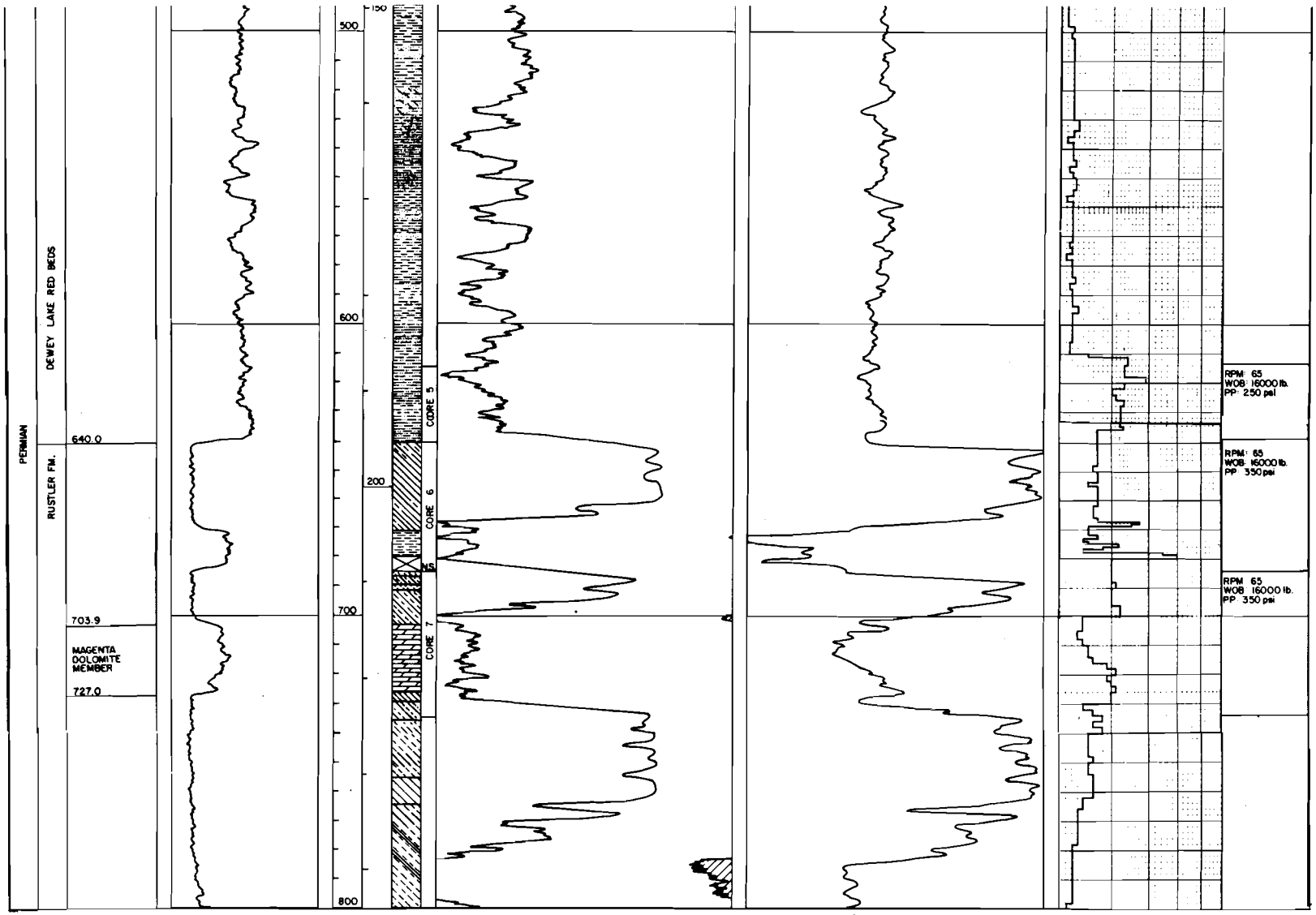

PERMIAN
DEWEY LAKE RED BEDS
RUSTLER FM.
640.0
703.9
MAGENTA DOLOMITE MEMBER
727.0
500
600
700
800
150
200
CORE 5
CORE 6
CORE 7
RPM: 65
WOB: 16000 lb.
PP: 250 psi
RPM: 65
WOB: 16000 lb.
PP: 350 psi
RPM: 65
WOB: 16000 lb.
PP: 350 psi

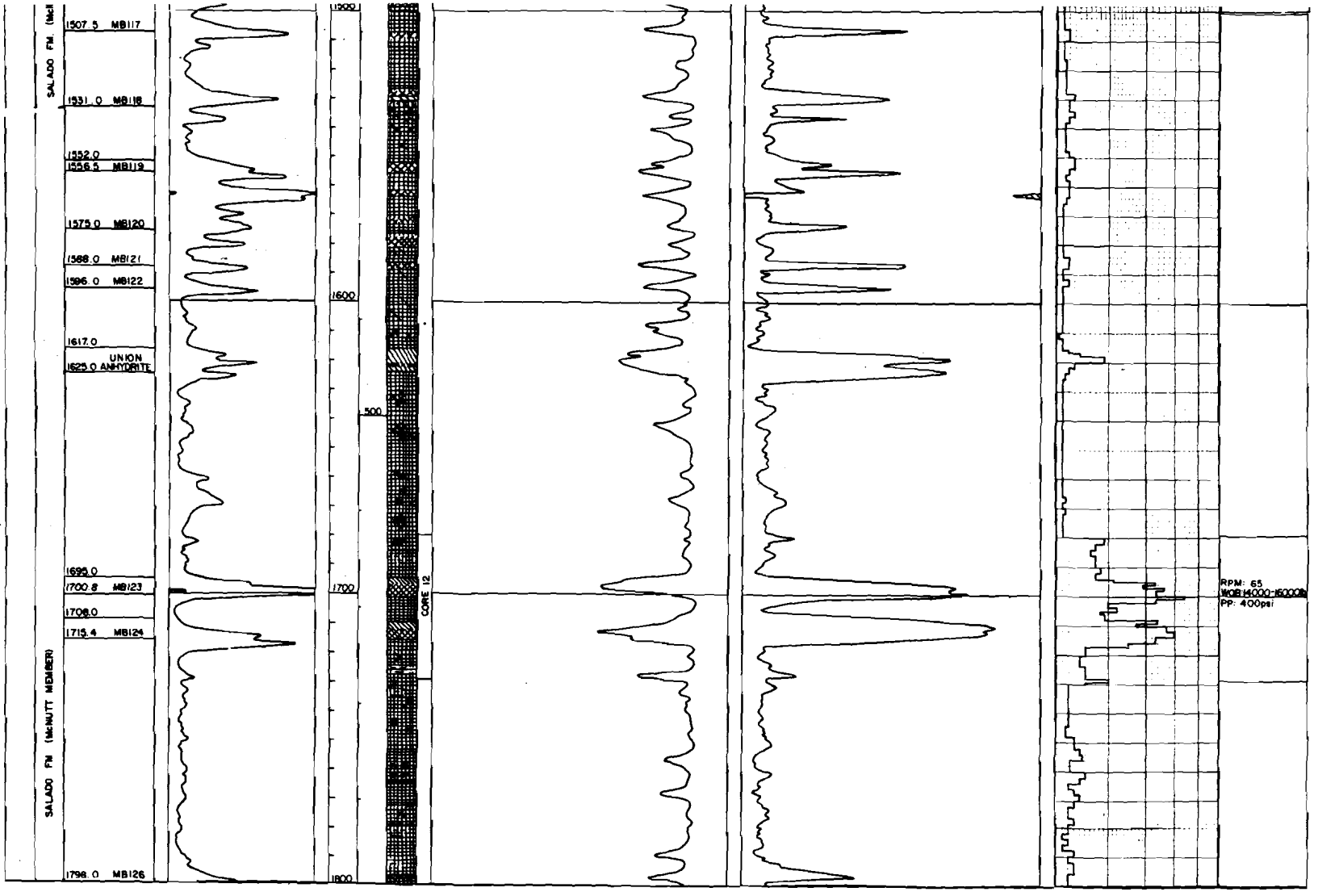
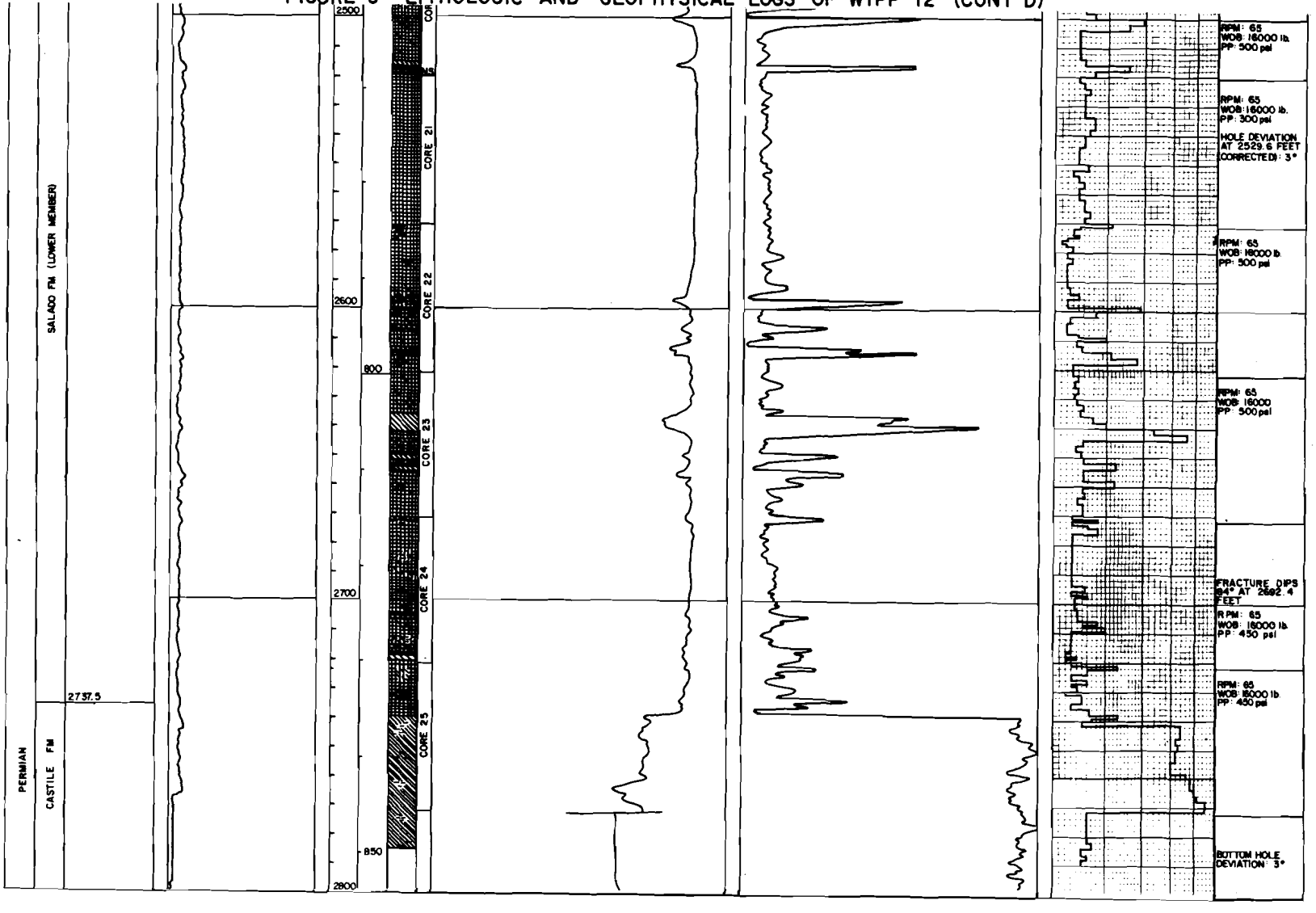

SALADO FM. (McN
1507.5 MB117
1531.0 MB118
1552.0
1556.5 MB119
1575.0 MB120
1588.0 MB121
1596.0 MB122
1617.0
1625.0 UNION ANHYDRITE
1695.0
1700.8 MB123
1708.0
1715.4 MB124
SALADO FM (McNUTT MEMBER)
1798.0 MB126
1500
1600
1700
1800
500
CORE 12
RPM: 65
WOB:14000-16000lb
PP: 400psi

FIGURE 3 LITHOLOGIC AND GEOPHYSICAL LOGS OF WIPP-12 (CONT'D)



APPENDIX AB

JUSTIFICATION and FIELD OPERATIONS PLAN

compiled by

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Division 9731
Sandia National Laboratories

INTRODUCTION TO APPENDIX AB

JUSTIFICATION and DRILLING AND TESTING PLAN

Separate documents for the statement of work and field operations plan were not prepared. This Appendix is a combination of the two purposes. It includes a document (S-22-V-02) prepared by Bechtel, Inc., dated November 6, 1978, titled: Exploratory Drill Hole WIPP 12, Technical Specification. This is the basic justification and operations plan. Additional information regarding predicted structure at WIPP 12 is included in the letter dated October 11, 1978, from J.L. Hern to D.W. Powers.

Following drilling, pressure build-up was noted (Chapter 4.0). Sampling specifications are given in the memorandum from S.J. Lambert to R.D. Statler, dated March 6, 1979, Subject: Specifications for Fluid Sampling at Well Heads. The basic testing to understand the pressure build-up are given in the memorandum from D.W. Powers to R.D. Statler, dated March 9, 1979, Subject: Testing of WIPP 12, General Scope of Work.

These documents provide details of background information and program options as understood at the time of initiation. The reader is cautioned, therefore, that the details of the program may have been altered as information became available and that preliminary interpretative 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. The approvals and permits obtained from various agencies prior to drilling are kept on file but are not included here.

ITEM Q

TABLE OF CONTENTS

NO.	DATE	DESCRIPTION	BY	CHK'D	DESIGN SUPV	ENG'R	PEM
0	11-6-78	ISSUED FOR APPROVAL	DJR			DJR	

ORIGIN			JOB NO. 12484 -002	
BECHTEL INC SF	BECHTEL	U.S. DEPARTMENT OF ENERGY WASTE ISOLATION PILOT PLANT EXPLORATORY DRILL HOLE WIPP-12 TECHNICAL SPECIFICATION	DOCUMENT NO. S-22-V-02	REV. 0

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1.0 GENERAL

This specification covers the technical requirements for the exploratory drill hole WIPP-12. The hole location is indicated on Attachment 1.

2.0 SCOPE OF WORK

The work to be performed under this technical Specification consists of drilling and intermittently coring hole WIPP-12 to an estimated depth of 3000 feet below ground surface. The hole will be geophysically logged and casing will be set and cemented into the top of salt (Salado Fm). The primary objectives for drilling the WIPP-12 hole include:

1. Confirmation of suspected anticlinal structure at location of a seismic reflection anomaly.

2. Confirmation of continuity and attitude of bedding with respect to repository (mine) design.

3. Determination of lithology, stratigraphy and structure for geologic correlation with other drill hole information.

4. Obtaining core samples of selected intervals including repository horizons for laboratory rock testing and for assessing the rock properties.

5. Examination of the hydrologic characteristics of the core obtained from the suspected water bearing zones.

3.0 LOCATION

3.1 General

The WIPP-12 drill hole will be on the site of the Waste Isolation Pilot Plant (WIPP), located approximately 25 miles east of Carlsbad, New Mexico.

The WIPP site is located in Section 20, 21, 28, and 29, T225, R313, Eddy County, New Mexico. The WIPP-12 drill hole will be located approximately one mile north of the ERDA-9 drill hole. The location was established on the basis of Bechtel/Sandia seismic reflection survey data which revealed a suspected anticlinal structure at or below the base of the Salada Fm. For purposes of exploring this feature, a hole location near the center of the suspected structure is proposed. The location of the drill hole in the field will be based on scaling from a map location. A horizontal tolerance of 100 ± feet will be adequate for field location. The approximate hole location is shown on the attached map.

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The as-built location (geographic coordinates) of WIPP-12 will be surveyed after completion so as to be known within one foot with respect to existing section boundaries (New Mexico Coordinate System). The field hole location and elevation shall be determined by a licensed surveyor.

3.2 Surface Elevation

A datum point at ground surface at WIPP-12 shall be established to within ± 0.1 ft. with respect to the nearest National Geodetic Survey first-order levelling survey marker.

This datum point shall serve as a reference for depths measured in the WIPP-12 hole.

4.0 QUALITY REQUIREMENTS

4.1 This specification covers services that impact the design of structures that have safety-related functions in a Waste Isolation Plant. The Contractor shall have a Quality Assurance program in conformance with the applicable requirements of ANSI N45.2, as modified by NRC Regulatory Guide 1.28.

4.2 The notation "Q-Item" has been placed on the first page of this specification to alert all affected personnel to this quality assurance program requirement.

4.3 The documented quality assurance program, applicable to the services to be performed in the field and in the home office of the contractor, shall include, but not be limited to:

a) A program plan covering all contractor's tasks
b) Organization, including project task assignments
c) Qualification of personnel
d) Identification, control and storage of project documents and records
e) Calibration

f) Use of procedures conforming to applicable specifications and standards, unless otherwise approved by Bechtel.

g) The requirement and control for passing applicable quality assurance requirements onto sub-tier contractor/suppliers.

4.4 Pertinent records of field activities shall be maintained and reported as work progresses, and shall be verified as complete. Specific requirements are noted throughout this specification. Any unusual circumstances encountered during field activities shall be recorded and reported. Checks of field

activities shall be performed while the work is in progress to ensure compliance with technical and quality requirements specified.

4.5 In the event that Contractor employs any other organization to perform any portion of this contract work to which a Quality Assurance program is applicable, as specified by Section 3.1 above, all of the Quality Assurance requirements of 3.0 of this specification shall be binding upon the subordinate organization.

4.6 The Contractor, including any lower-tier organizations engaged by it, shall be subject to surveillance inspection and audit by Bechtel. Surveillance inspection or audit by Bechtel shall not relieve the Contractor of the responsibility for complying with the requirements of the procurement documents.

4.7 Measures shall be established to ensure that conditions adverse to quality are promptly identified, the cause of the condition is determined, and corrective action is taken to preclude repetition.

In cases where conditions are discovered that have an impact on the validity of previously recorded test data associated with the condition, there shall be a written report submitted to Bechtel with a statement of the corrective action taken to ensure the validity of test data and to correct previously reported data.

4.8 The Contractor shall maintain copies of all documentation required and any other quality assurance records that furnish evidence of the quality of services and activities affecting quality until all work required by the procurement documents has been delivered and final payment has been received. Such documentation and quality assurance records shall be available for Bechtel review and evaluation during te period of contract performance. The Contractor may be required to retain, for a limited time, certain non-permanent records that are not transmitted to Bechtel. Record identification and retention time for these non-permanent records will be covered in the procurement documents.

4.9 The Contractor shall furnish Bechtel's field representative with a daily log sheet(s) covering the activities he is responsible for with notation verifying that the work performed complies with the requirements of the quality control program.

4.10 Contractor shall not dispose of any of his non-permanent records until Bechtel has been advised in writing which items are to be discarded.

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Contractor will then be advised to discard the item or to ship it to a permanent storage site named at that time.

5.0 DRILLING REQUIREMENTS

5.1 General

The hole will be drilled and cored at selected intervals in two stages to an estimated depth of 3000 ft. Procedures to be followed in completing the WIPP-12 drill hole are provided below.

5.2 Stage I (0 to 1000 ± ft.)

The hole will be drilled and cored to an anticipated approximate depth of 1000 ± feet below the ground surface.

Intervals to be cored and their respective approximate depths are:

(a) Dewey Lake Fm., 250 to 300 ft 50 ± ft.

(b) Dewey Lake/Rustler contact 600 ft. to 650 ft. (50 ± ft.)

(c) Magenta member of the Rustler Fm., 675 to 725 ft. (50 ± ft.)

(d) Culebra member of the Rustler Fm., 770 ft. to 840 ft. (50 ± ft.)

(e) Rustler/Salado contact, 925 ft. to 975 ft. (50 ± ft.)

5.2.1 Casing

The hole will be cased to about 50 ± ft. below the top of the salt using appropriately sized steel casing to allow completion of the hole to the estimated depth of 3000 feet.

5.2.2 Cementing

Cementing of the casing is to be accomplished so as to isolate water bearing zones from one another so that fluids from them do not cross-flow along the annulus of the casing. Bond logs and tracer testing will be utilized to verify the integrity of the cement behind the casing. The Contractor shall provide documentation as to the cement mix used and that the cementing of the casing was properly performed by providing signed bond logs and tracer test record.

5.3 Stage II (1000 ± to 3000 ± ft.)

The hole will be continued by drilling and intermittent coring to the estimated final depth of 3000 feet below the ground surface.

Anticipated depth intervals to be cored are tabulated below:

From (ft.)	To (ft.)	Coring (ft.)
1090	1140	50
1670	1720	50
2030	2080	50
2100	2250	150
2430	2480	50
2600	2750	150
2850	2900	50

Owing to the exploratory nature of this program and the fact that geologic conditions in this hole are imprecisely known, the number and actual depth intervals may vary from those indicated above. Actual core intervals will be as directed by Bechtel.

At the completion of drilling and coring of each stage a sweep of geophysical logs, including a deviation survey, will be run in the WIPP-12 drill hole. Refer to 6.0 Geophysical Logging for quality assurance documentation.

6.0 CORE AND CUTTINGS SAMPLING

6.1 Coring

Each of the above core intervals in both Stage I and Stage II will be continuously cored. The core should be at least 3-5/8 inches in diameter. Cores should be clearly labeled to identify the site, boring number, the core interval and the top and bottom of the core. Labeling should be placed on the end of the box as well as the lid. The Contractor will be responsible for labeling core boxes.

Maximum core recovery is highly desirable to improve the knowledge of the rock characteristics. Depth intervals of coring and drilling should be determined to within an accuracy of ± 1.0 ft. The Contractor will be responsible for providing documentation verifying the hole depth intervals of coring and drilling.

6.2 Core Handling, Storage and Transporting

Rock cores should be stored and transported in durable boxes with suitable dividers to prevent shifting of core. Core samples should be transported with care

6/78

necessary to avoid breakage or disturbance.

Cores shall be wrapped in approximately 10 mil clear plastic sheets for protection prior to placing in boxes. Plastic wrapping material or containers as directed by Bechtel to preserve core test samples to be used for fluid content determination or rock strength test should be provided. The Contractor shall transport the boxed core from the drill site to the Sandia Laboratories core storage building in Carlsbad, New Mexico. Core storage shall be coordinated with Sandia Carlsbad Office and Bechtel.

6.3 Cuttings Sampling

In the portions of the hole that is drilled (not cored), drill cuttings representatives of the formations being penetrated shall be collected by the Contractor. The cuttings shall be collected at intervals of ten feet, washed, except when drilling in salt, and placed in bags. Each sample shall be labeled by the Contractor to identify the site, boring number and drilled interval.

The cuttings samples shall be tied in bundles of 100 feet each, boxed, labeled and transported to the core storage in Carlsbad by the Contractor.

7.0 CORE PHOTOGRAPHS

Color photographs of the rock cores will be taken by a photography furnished by Sandia Laboratories under the direction of the Contractor. The Contractor shall furnish a temporary enclosure for conducting the photography, including the required lighting and work tables, similar to that provided by the Contractor on previous WIPP - series holes. The Contractor shall provide the photographer laborer/technician assistance as may be required. Scheduling of the Sandia photographer by the Contractor will be coordinated with Bechtel. The Contractor through Sandia shall provide Bechtel with one set of color prints of the same size as previously obtained of WIPP cores; corresponding negatives will also be furnished to Bechtel.

8.0 GEOPHYSICAL LOGGING

Geophysical logs will be run at the conclusion of drilling in Stage I and II.

Geophysical logs will be run to provide information for:

a. Identification of lithology encountered
b. Stratigraphic control
c. Verification of core depths

d. Identification of fluid bearing zones
e. Determination of elastic properties of rocks

Geophysical logging will include focus resistivity, gamma-neutron, velocity, density, caliper, temperature, cement bond and tracer tests, and directional survey. The Contractor will be responsible for providing signed documentation verifying that the geophysical logging was performed in a proper manner in accordance with instructions provided by Bechtel.

9.0 U.S. GEOLOGICAL SURVEY

Arrangements have been made by DOE and Bechtel for the USGS to have a geologist on site observing the WIPP-12 drilling operations. The USGS geologist may make recommendations to Bechtel with respect to drill data aquisition. the USGS in coordination with Bechtel may select certain core samples for testing by the USGS.

Release of core samples for testing by the program participants will be coordinated by Bechtel.

10.0 HOLE COMPLETION

After reaching final depth and geophysical logging has been completed, the hole shall be filled with drilling mud or other fluids approved and the casing capped with a temporary, removable cap.

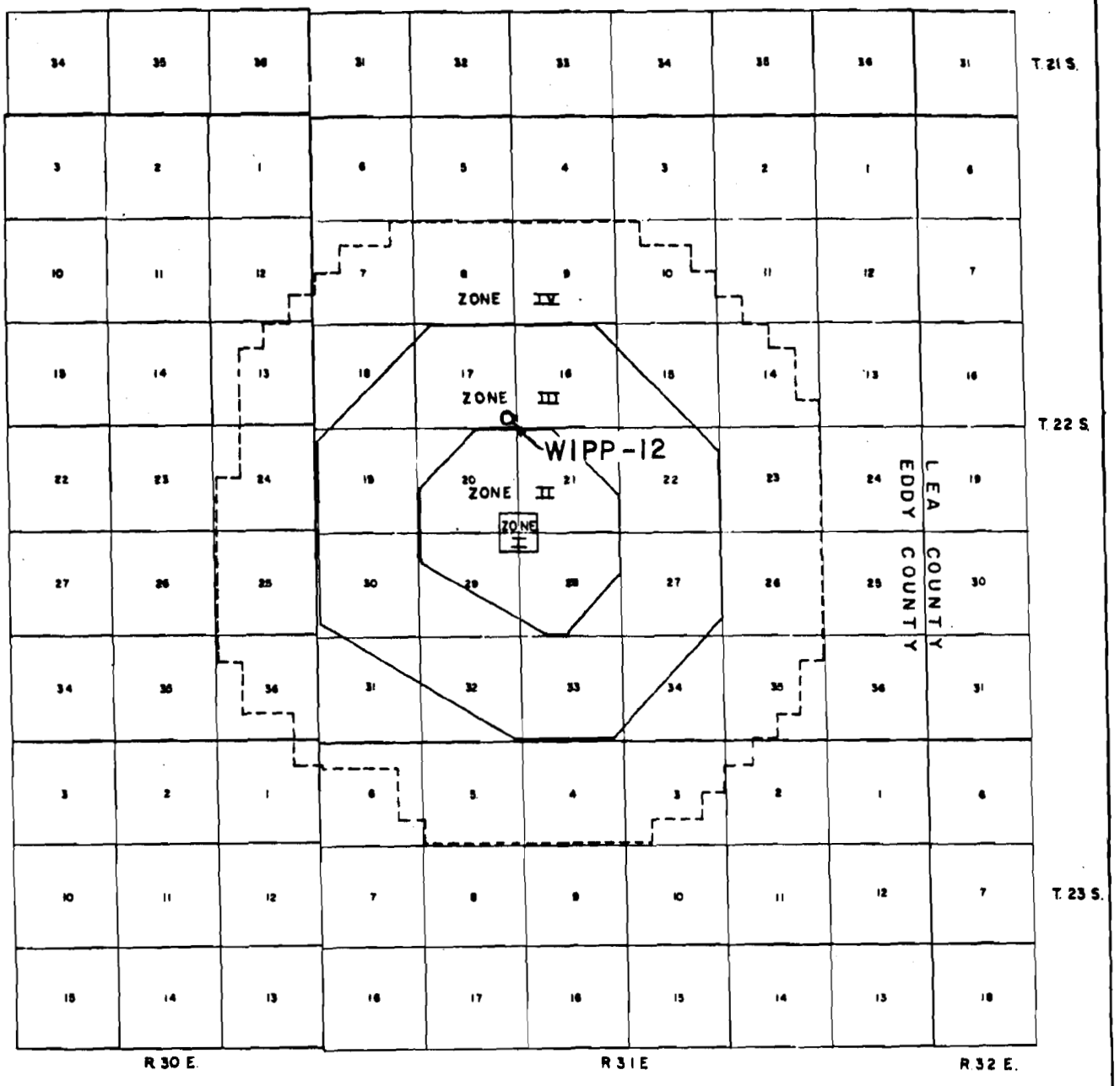
11.0 CONTRACTOR'S REPORTS

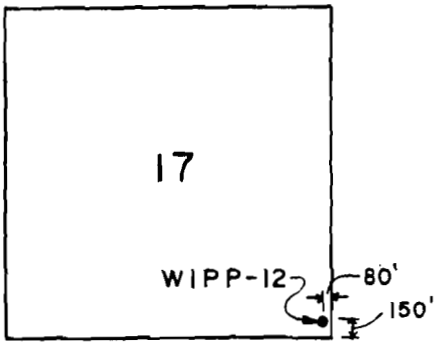
11.1 Daily Log Sheet:

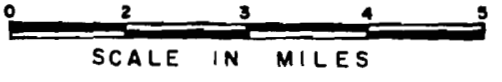
The Contractor's daily log sheet shall include the following items:

a) Key parameters employed for that day's drilling
b) Weather conditions.
c) Major equipment on site.
d) Number of Contractor's personnel on site.
e) Verification of performing quality control program.
f) Notation of nonconformances, with Bechtel's approval.
g) Estimated percentage of work completed during that day. Estimated percentage of work completed to date. Estimated percentage of work to go.

h) Brief note covering any accidents, injuries, equipment breakdowns or other problems.







WIPP SITE

LOCATION MAP

PROPOSED WIPP-12 DRILL HOLE

ATTACHMENT 1

G. J. LONG & ASSOCIATES, INC.
1765 STEBBINS DRIVE HOUSTON, TEXAS 77043 713-461-9931

11 October 1978

Dr. Dennis W. Powers
Sandia Laboratories
Department 5311
Albuquerque, New Mexico 87115

Dear Dr. Powers:

Per a request made at the meeting held in Carlsbad, New Mexico on 4 October 1978, I submit an estimated depth to the Top of Castile at the WIPP No. 12 drill site. I understand this site is located slightly northwest of the SE corner of Sec. 17, T22S-R31E.

From available seismic data it is estimated that the Top of Castile will be reached at a depth of 2494' (± 25'). This value is assuming a site elevation of 3470'. Another way of stating the projected Top of Castile is to say it will be approximately 400' high to the ERDA No. 9 bore hole.

If you have any questions or want additional information on this matter please contact me at your earliest convenience.

Yours very truly,

John L. Hern

JLH:bmc

cc: Mr. R. D. Statler
Mr. C. L. Jones
Mr. D. L. Roberts

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date: March 6, 1979

to: R. D. Statler, 1133

from: S. J. Lambert, 4511

subject: Specifications for Fluid Sampling at Well Heads

Recently discovered buildup of pressure at well heads, particularly in WIPP 12, may have resulted from geological processes which could have implications regarding the long term safety of the proposed WIPP repository. Collection and analyses of aqueous solutions and gaseous phases from these shut in wells may provide insight into the nature and origin of these pressure buildups. For aqueous solutions at least two liters should be sampled and preserved in polyethylene bottles as well as 4 ounces to be preserved in glass bottles. For gaseous phase samples at least 2000 cc at standard temperature and pressure should be collected in vessels constructed so that no material other than glass comes in contact with the sample. It is recommended that gaseous samples be collected in four vessels, each containing 500 cc. Before collection of the sample these vessels will have been evacuated. These gas sampling vessels shall be closed by means of a stop cock with either a teflon seal or a ground glass seal lubricated by an inert stop cock grease of low vapor pressure. Through a comparison with the result of the analyses of these collected samples with components known to be present in the natural geological environment or components added during the drilling or subsequent preservation of the hole the origins of these pressure buildups might be deduced. Each sample vessel should be labeled with the location, date, time of day, and estimated or measured well head pressure at the time of collection. In addition, any abnormal sampling conditions, such as the inadvertent inclusion of a hydrocarbon phase in addition to the aqueous or gaseous phases should be noted.

SJL:4511:bl

APPROVED: L. R. Hill, 4511

Copy to:
W. P. Armstrong, DOE, Albuquerque
J. W. Mercer, USGS, Water Resources Division, Albuquerque
W. E. Hale, USGS, Water Resources Division, Albuquerque
C. L. Jones, USGS, Special Projects Branch, Denver
W. S. Twenhofel, USGS, Special Projects Branch, Denver
4510 W. D. Weart
4511 L. R. Hill
4511 D. W. Powers
4511 S. E. Schaffer
4511 K. L. Robinson

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date: March 9, 1979

to: R. D. Statler, 1133

Dennis W. Powers

from: D. W. Powers, 4511

subject: Testing of WIPP 12, General Scope of Work

This memorandum briefly describes the objectives, data needs, and background of possible testing of WIPP 12.

Objective: The immediate objective of testing WIPP 12 is to determine if gases or fluids are entering the WIPP 12 borehole and to further determine the nature, volume, and origin of such gases or fluids. The ultimate objective of such testing is to determine operating difficulties or long-term risk from any such gas or fluid.

Data Needs: The immediate data need is to determine if fluid or gas is entering the borehole. Measurement of the pressure at the surface will give an initial indication, but will not be very useful until a horizon is identified as the source. Sampling of fluid or gas will also be necessary, and may be done at the surface if flow is sufficient. The memorandum from S.J. Lambert to R.D. Statler, dated March 6, 1979, and entitled: Specifications for Fluid Sampling at Well Heads, gives details of the methodology necessary to obtain suitable samples.

When gas or fluid entry has been determined and well-head sampling attempted or completed, further testing of the borehole can be undertaken. The producing horizon or horizons will need to be identified, probably through geophysical logging. A sensitive indicator of the horizons may be temperature of the fluid in the borehole; other detection devices may be appropriate depending on the composition of the fluid or gas.

Reservoir analysis through appropriate drill stem tests can be attempted if the reservoir is not depleted through previous testing and logging. Downhole samples are desired to confirm well head sampling; the sampling may be designed later if appropriate.

An accurate analysis of mud composition and density will be needed to determine contamination of samples and to allow continued well head monitoring of pressure build-up, if any, after the above reservoir tests. Mud logs taken during drilling should be re-examined for any indications of fluid or gas entry.

In summary, the following are needed:

1. well-head pressure
2. well-head samples
3. horizon identification
4. reservoir test for size, and pressure, and physical properties
5. reservoir samples
6. mud analyses for composition and density
7. monitoring of long-term pressure

Decision Points: The decision points are:

1. if well-head monitoring indicates pressure build-up, sample and proceed with borehole measurements and analyses;
2. if reservoir is known to be exhausted, cease testing.

Support Requirements: Division 1133, Sandia, is requested to provide field engineering assistance to meet the needs listed above. USGS Water Resources Division and Special Projects Branch are expected to provide technical advice as appropriate to meet the objectives, and may recommend and use special tools at their disposal.

Background: Preliminary evidence indicates some pressure build-up in WIPP 12. Pressure build-up may be due to several geological processes important to operational and long-term safety of the WIPP. Samples and borehole tests will be necessary to analyze such effects, if any.

Experience in the northern Delaware Basin indicates that small fluid or gas pockets do exist in the evaporite sequence that will bleed into boreholes with resulting pressure build-up. While experience also indicates that the Salado Fm will generally contain mostly brine or nitrogen gas, larger pockets of these substances is reason for caution in operation of mines. Instances of these fluids or gases should be carefully studied for composition, origin, and size to guide mining operation.

Of further concern, however, are the few instances of fluids or gases which are from larger reservoirs or which are particularly hazardous (such as H_2S). Experience again indicates that these occurrences are from the Castile Fm rather than the Salado Fm penetrated by WIPP 12. However, that experience does not prove that such an occurrence will not be found in the Salado Fm; the build-up of pressure in WIPP 12 should be carefully checked to assure that it is not due to a larger reservoir or particularly hazardous gases.

The present indications of pressure build-up in WIPP 12 should be placed in proper perspective. Many boreholes in the evaporite sequence will show small, temporary build-up due to small fluid or gas pockets, and WIPP 12 is likely to be little different. But because of the association of this borehole with the WIPP site, due caution will be exercised to determine the nature of the build-up so its importance may be ascertained.

Approved Leslie R. Hill
L. R. Hill, Supervisor
Division 4511

DWP:4511:dp

Copy to:
W. P. Armstrong, WPO, DOE/ALO
D. L. Roberts, Bechtel, San Francisco, CA
W. E. Hale, USGS, WRD, Albuquerque
J. W. Mercer, USGS, WRD, Albuquerque
W. S. Twenhofel, USGS, SPB, Denver, CO
C. L. Jones, USGS, SPB, Denver, CO
4510 W. D. Weart
4511 L. R. Hill
4511 L. J. Barrows
4511 S. J. Lambert
4511 K. L. Robinson
4511 S. E. Shaffer
4540 M. L. Kramm
4511 D. W. Powers

APPENDIX C

HOLE HISTORY

compiled by

R. D. Statler
Division 7133
and
P. D. Seward
Division 7135
Sandia National 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 witn 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

TE: 1-16-79

LE No.: WIPP #12	W. O. No.:	I. D. No.:
R: Bechtel	TYPE HOLE: Exploratory	
ATION: New Mexico	COUNTY: Eddy	AREA: WIPP
FACE COORDINATES: ** 149.41' FSL, 82.81' FEL		GROUND ELEVATION: **
ON LOCATION:	SPUDDED: 11-9-78	COMPLETED: 12-7-78

CULATING MEDIA: Salt base mud

of COMPRESSORS & SIZE:

BORE HOLE RECORD			CASING RECORD							
ROM	TO	SIZE	I. D.	WT./FT.	WALL	GRADE	CPL'G	FROM	TO	CU. FT. CMT.
0'	4'	Excav.		(5' x 5' cellar)				0'	4'	Dirt
5.2'	50.8'	18"	12.715"	48.00#		H-40	ST&C	12.7'	50.8'	81
).8'	1015'	12-1/4"		(See page 2 for 9-5/8" casing)				12.7'	1013.7'	476
)15'	2790'	7-7/8"								

AL DEPTH: 2790' MANDREL DEPTH PLUGS:

GING DATA: Page 4 SURVEYS PAGE: CORING PAGE: 5

TOM HOLE COORDINATES: 198.98' FSL, 34.32' FEL @ 2783' REFERENCE: Dresser Atlas

NON-OPERATIONAL TIME		OPERATIONAL DELAY TIME		WORKING TIME	
up & down gov't Mat	1.72 days	Equipment Repair	0.70 days	Drilling Time	4.33 days
ed	____ days	Coring	0.14 days	Trip Time	1.59 days
& Run Mandrel	____ days	Lost Circ.	____ days	Single Shot Survey Time	0.09 days
ng	2.66 days	Fishing	____ days	Open Hole	4.50 days
Down Drill Pipe	0.30 days	W.O. Equipment	0.18 days	Total	10.51 days
g	0.29 days	Mix & Condition mud	0.24 days	Total Suspended Time	____ days
nt	1.13 days	Shut Down for	____ days	Non-Operational Time	16.03 days
g	9.82 days	Seismic Survey	0.78 days	Operational Delay Time	2.04 days
11 Out Shoe	0.11 days		____ days	Working Time	10.51 days
L	16.03 days	TOTAL	2.04 days	TOTAL ELAPSED TIME	28.58 days

RKS: * Site prep items.

** Brass monument location: 147.90' FSL, 83.11' FEL, Sec. 17, T22S, R31E.
Elevation 3471.53'.

E: Depths shown are from kelly bushing
elevation 12.2' above ground level
except for cellar.

Rig No.	Name	Type	
14	Verna Drilling Co.	Wilson Mogul	28.58 days
			____ days
			____ days
			____ days
			____ days

S:it C-2

WIPP #12
HOLE HISTORY

10-20-78	Construction Enterprise excavated a 5' x 5' x 4' deep cellar and lined with boards.
10-25-78	Completed a 400' x 300' pad with the cellar 150' from the south edge and 42' from the east edge.
11-3-78	Drilled 18" hole from 4' to 38.6' using Link dry hole auger. Set 1 joint of 13-3/8" O.D., 48#, H-40 casing at 38.6'.
11-4-78	Cemented annulus to cellar using 81 ft^3 of Southeast ready mix grout.
11-8-78	Moved in Verna Drilling Company's rig #14 and rigged up. Mixed up salt base mud.
	NOTE: Depths reported are from kelly bushing elevation (KB) 12.2' above ground level elevation (GL) unless otherwise noted.
11-9-78	Made up 7-7/8" drilling assembly and drilled from 50.8' to 135' and pulled out of hole. Made up 7-13/16" x 4-1/4" diamond core bit and cut core #1 from 135' to 160', recovered 25.25'. Cut core #2 from 160' to 185', recovered 23.85'. Reamed core hole and drilled 7-7/8" hole from 185' to 227'.
11-10-78	Drilled 7-7/8" hole from 227' to 260'. Cut core #3 from 260' to 285', recovered 24.8'. Cut core #4 from 285' to 310', recovered 24.4'. Reamed core hole and drilled 7-7/8" hole from 310' to 490'.
11-11-78	Drilled 7-7/8" hole from 490' to 610'. Cut core #5 from 610' to 635', recovered 21.3'. Cut core #6 from 635' to 680'.
11-12-78	Recovered 39' in core #6. Cut core #7 from 680' to 730', recovered 51'. Reamed core hole and drilled 7-7/8" hole from 730' to 800'.
11-13-78	Cut core #8 from 800' to 830', recovered 29.8'. Cut core #9 from 830' to 846', recovered 12.5'. Reamed core hole and drilled 7-7/8" hole from 846' to 935'.
11-14-78	Cut core #10 from 935' to 985', recovered 48.5'. Reamed core hole and drilled 7-7/8" hole from 985' to 1015'. Ran Dresser Atlas logs.
11-15-78	Completed Dresser Atlas logs and ran USGS logs. Made up 10-5/8" hole opener and opened 7-7/8" hole from 50.8' to 69'.
11-16-78	Opened 7-7/8" hole to 10-5/8" from 69' to 287'.
11-17-78	Opened 7-7/8" hole to 10-5/8" from 287' to 556'. Made trip for bit at 419' and reamed 360' of out of gauge hole.
11-18-78	Opened 7-7/8" hole to 10-5/8" from 556' to 718'.
11-19-78	Opened 7-7/8" hole to 10-5/8" from 718' to 1015'. Made up 12-1/4" hole opener and opened 10-5/8" hole from 50.8' to 187'.

11-20-78 Opened 10-5/8" hole to 12-1/4" from 187' to 638'. Made trip for bit at 630', cleaned out bridge at 293' and washed to 500'.

11-21-78 Opened 10-5/8" hole to 12-1/4" from 638' to 1015'. Pulled out of hole and found tight hole from 700' to 500'. Ran Dresser Atlas caliper log and Sperry-Sun directional survey. Made trip to condition mud for casing.

11-22-78 Ran 9-5/8" O.D. casing as follows:

No. Joints	WEIGHT	GRADE	FROM	TO
24	32.30#	H-40	1013.68'	46.54'
1	36.00#	J-55	46.54'	-6.20'

Centralizers were placed at 993', 931' and 813'. A Dowell guide shoe was on bottom and a flapper type float shoe at 972'. Cemented annulus using Dowell with 1000 gallons of mud flush and 500 gallons of water ahead of 50 sacks of RFC cement and 300 sacks of class "C" cement with 2% salt. Displaced cement with 79.3 barrels of water and circulated 90 sacks of cement to surface. Cement in place at 0645 hours. Total slurry volume was 476 ft^3.

11-23-78 Waited on cement to 0800 hours. Cut off 9-5/8" O.D. casing at ground level and welded the 13-3/8" O.D. casing to the 9-5/8". Welded a 10" series 900 slip on flange to the 9-5/8" casing and installed blow out equipment.

11-24-78 Tested blow out equipment and installed a Grant rotating head. Made up 7-7/8" drilling assembly and tagged cement at 967' inside the casing. Drilled out float collar and cement.

11-25-78 Drilled out cement and guide shoe. Drilled 7-7/8" hole from 1015' to 1100'. Cut core #11 from 1100' to 1139', recovered 35.7'. Reamed core hole and drilled 7-7/8" hole from 1139' to 1179'.

11-26-78 Drilled 7-7/8" hole from 1179' to 1680'. Cut core #12 from 1680' to 1704'.

11-27-78 Completed core #12 from 1704' to 1730', recovered 50'. Reamed core hole and drilled 7-7/8" hole from 1730' to 1932'.

11-28-78 Drilled 7-7/8" hole from 1932' to 2045'. Cut core #13 from 2045' to 2080'.

11-29-78 Completed core #13 from 2080' to 2095', recovered 50.1'. Cut core #14 from 2095' to 2146', recovered 50.6'. Cut core #15 from 2146' to 2198', recovered 52.5'.

11-30-78 Cut core #16 from 2198' to 2249', recovered 51.15'. Reamed core hole and drilled 7-7/8" hole from 2249' to 2319'.

12-1-78 Cut core #17 from 2319' to 2369', recovered 49.4'. Cut core #18 from 2369' to 2419', recovered 50.1'.

12-2-78 Cut core #19 from 2419.5' to 2470', recovered 49.8'. Cut core #20 from 2470' to 2520', recovered 49.8'.

12-3-78 Cut core #21 from 2520' to 2570', recovered 50.8'. Cut core #22 from 2570' to 2621', recovered 51.10'. Cut core #23 from 2621' to 2671'.

12-4-78 Recovered 49.5' on core #23. Cut core #24 from 2671' to 2721', recovered 50'. Cut core #25 from 2721.3' to 2760'.

12-5-78 Completed core #25 from 2760' to 2771.4', recovered 50.4'. Reamed core hole and drilled 7-7/8" hole from 2771.4' to 2790'. Ran Dresser Atlas logs.

12-6-78 Completed logging. Ran Seismic Reference Service seismic surey. Laid down drill pipe.

12-7-78 Rigged down blow out equipment. Released rig at 1200 hours. Cut off the 9-5/8" O.D. casing at 6" below ground level and welded on a lock cap.

DEVIATION SURVEYS

DATE	DEPTH-FT.	DEVIATION-DEGRESS
11-10-78	260	3/4
	435	1
11-26-78	1483	1-1/2
11-27-78	1826	2-3/4
11-28-78	1946	2-1/2
11-30-78	2263	3-1/2
12-3-78	2539	3
12-5-78	2790	3

BIT RECORD

RUN NO.	SIZE	MAKE	TYPE	DEPTH OUT	FEET DRILLED	ROTATING HOURS
1	7-7/8"	Security	S33	610	559	29
2	7-7/8"	Security	S33	1015	405	17-1/4
3	10-3/8"	Security	Hole Opener	419	368	25-3/4
3				718	299	34-1/4 New Cutters
3				1015	297	18-1/4 New Cutters
4	12-1/4"	Security	Hole Opener	630	579	22-1/2
4				1015	385	13-3/4 New Cutters
5	7-7/8"	Security	S33	1680	665	18-3/4
6	7-7/8"	Security	S33	2790	1110	39

CORE BIT

1	7-13/16"	Varel	MT	2771	1071	143

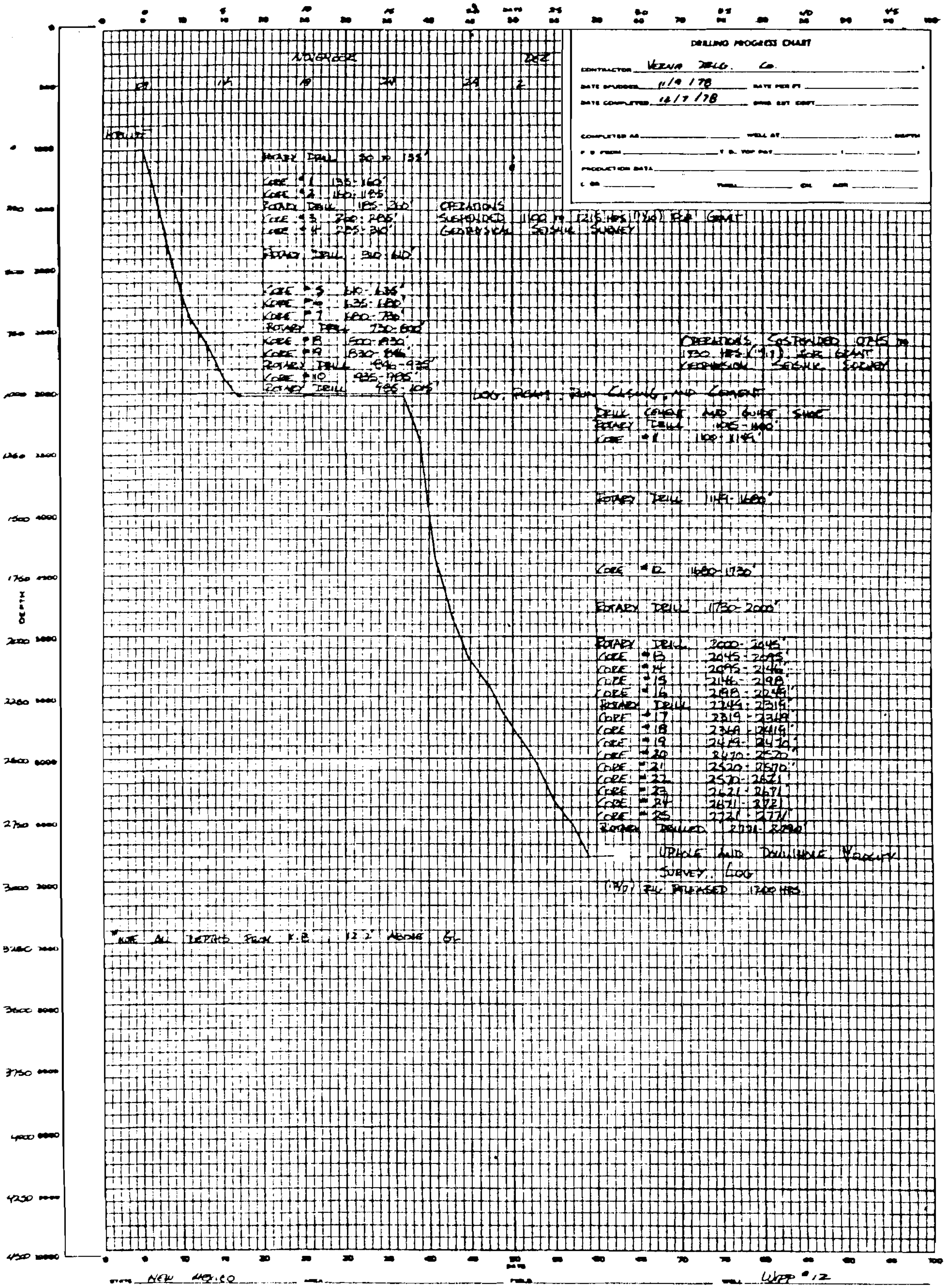
LOG INDEX SHEET

TYPE LOG	DATE	RUN NO.	DEPTH DRILLER	DEPTH LOGGER	LOGGED FROM	LOGGED TO
DRESSER ATLAS LOGS						
BHC Acoustilog	11-14-78	1	1015	1018	0	1012
	12-6-78	2	2790	2789	1012	2783
Cement Bond	12-5-78	2	2790	2786	0	1030
Compensated Densilog & Neutron	11-14-78	1	1015	1019	0	1017
	12-5-78	2	2790	2786	1017	2785
Dual Laterolog & Micro Laterlog	11-15-78	1	1015	1018	53	1017
	12-6-78	2	2790	2786	1017	2785
Temperature	11-15-78	1	1015	1018	0	1000
	12-5-78	1	2790	2786	850	2786
Diplog	12-6-78	1	2790	2786	1014	2783
Directional Survey	12-6-78	1	2790	2786	1014	2783
SEISMIC REFERENCE SERVICE LOG						
Seismic Survey	12-6-78	1	2790	2789	40	2783

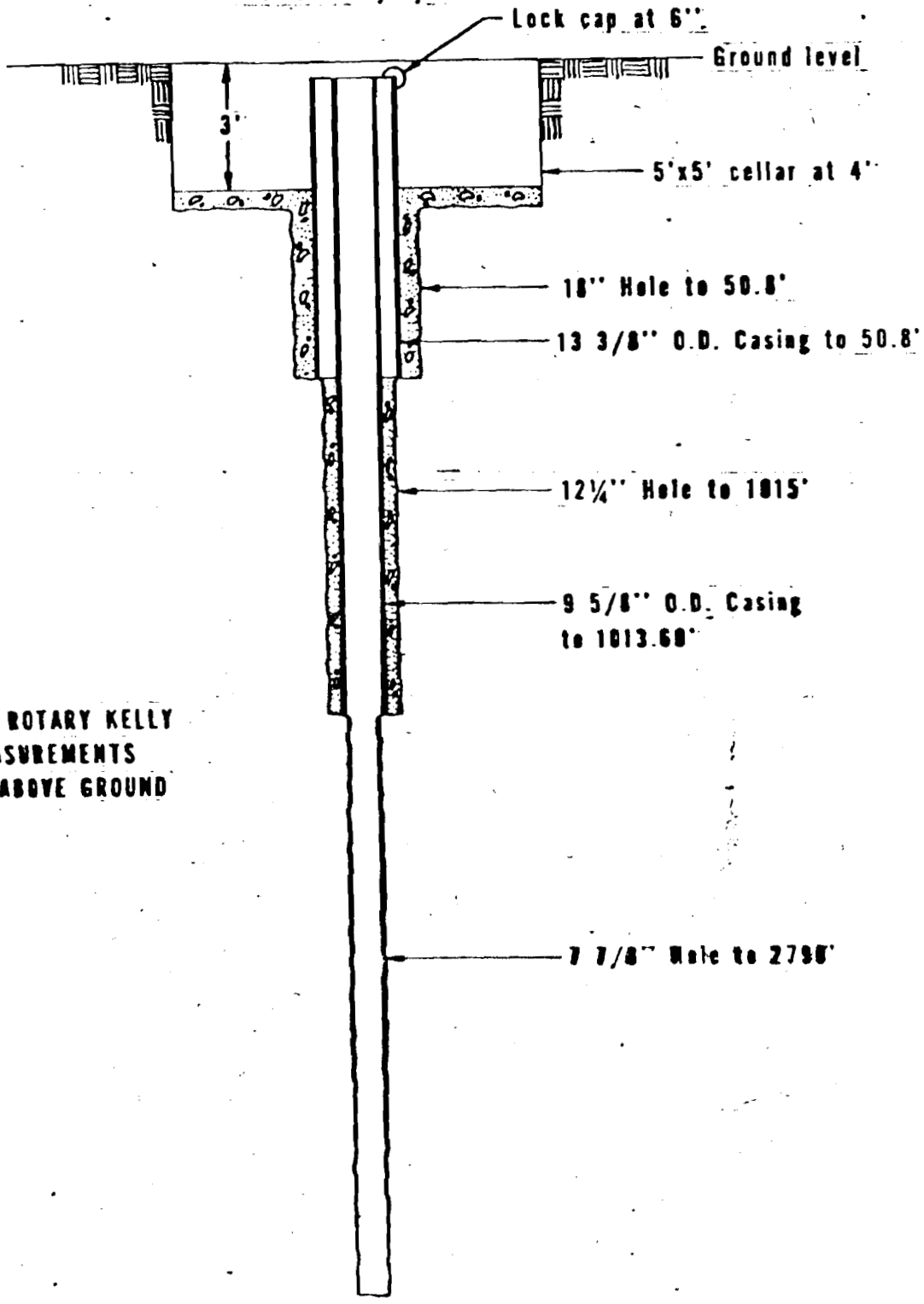
NOTE: Logs furnished F&S/Mercury.

COMPILED BY: A. [illegible]

PROGRESS CHART WIPP #12



WIPP #12
AS BUILT HOLE CONDITIONS
AS OF 12/7/78



DEPTHS ARE ROTARY KELLY BUSHING MEASUREMENTS 12.28 FEET ABOVE GROUND LEVEL

NOT TO SCALE

WIPP #12
HOLE HISTORY

DAILY CORE LOGGING RECORD

Date 11-9-78 DUTY GEOLOGIST Bud McIntyre

LOG HEADINGS:

Company Fenix & Scisson

Well Number WIPP No. 12

Field ---------- County Eddy State New Mexico

Location 83.91 FEL 147.90 FSL

Section 17 Township 22S Range 31E

Permanent Datum GL Elevations: K.B. 3483.73'

Drilling Measured From KB D.F. NA

G.L. 3471.53'

INTERVAL	FEET	RPM	WEIGHT ON BIT	CIRCUL. PRESS. P.S.I.	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BO NUM
135	160	65	9000	400	25	25.25	101	1-10
160	185	65	9000	400	25	23.85	95.4	11-2

DAILY CORE LOGGING RECORD

Date 11-10-78 DUTY GEOLOGIST J. L. Gonzales

LOG HEADINGS:

Company Fenix & Scisson

Well Number WIPP No. 12

Field ---------- County Eddy State New Mexico

Location 83.91 FEL 147.9 FSL

Section 17 Township 22S Range 31E

Permanent Datum GL Elevations: K.B. 3483.73'

Drilling Measured From KB D.F. NA

G.L. 3471.53'

INTERVAL	FEET	RPM	WEIGHT ON BIT	CIRCUL. PRESS. P.S.I.	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BO NUM
260	285	65	14000	400	25	24.8	99.2	21-3(
285	310	70	16000	350	25	24.4	97.6	31-4(
				C-10				

DAILY CORE LOGGING RECORD

Date 11-11-78 DUTY GEOLOGIST Drellack

LOG HEADINGS:

Company Fenix & Scisson

Well Number WIPP No. 12

Field ---------- County Eddy State New Mexico

Location 83.91 FEL 147.90 FSL

Section 17 Township 22S Range 31E

Permanent Datum GL Elevations: K.B. 3483.73'

Drilling Measured From KB D.F. NA

G.L. 3471.53'

INTERVAL	FEET	RPM	WEIGHT ON BIT	CIRCUL. PRESS. P.S.I.	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BO NUM
610	635	65	16000	250	25	21.3	85.2	41-5
635	680	65	16000	350	45	39.0	64.4	51-6
				C-11				

DAILY CORE LOGGING RECORD

Date 11-12-78 DUTY GEOLOGIST Drellack

LOG HEADINGS:

Company Fenix & Scisson

Well Number WIPP No. 12

Field ---------- County Eddy State New Mexico

Location 83.91 FEL 147.90 FSL

Section 17 Township 22S Range 31E

Permanent Datum GL Elevations: K.B. 3483.73'

Drilling Measured From KB D.F. NA

G.L. 3471.53'

NTERVAL	FEET	RPM	WEIGHT ON BIT	CIRCUL. PRESS. P.S.I.	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BOX NUMB
680	730	65	16000	350	50	51	102	65-85
				C-12				

DAILY CORE LOGGING RECORD

Date 11-13-78 DUTY GEOLOGIST Gonzales - Drellack

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NTERVAL	FEET	RPM	WEIGHT ON BIT	CIRCUL. PRESS. P.S.I.	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BOX NUMI
800	830	60	14000	250	30	29.8	99.3	86-97
830	846	40	8000	100	16	12.5	78.1	98-10

Org.	Bldg.	Name	Rec'd by	Org.	Bldg.	Name	Rec'd by