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Basic Data Report for Drillholes H-14 and H-15 (Waste Isolation Pilot Plant-WIPP)

Jerry W. Mercer, Richard P. Snyder

Prepared by
Sandia National Laboratories
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BASIC DATA REPORT

for

DRILLHOLES H-14 and H-15
(Waste Isolation Pilot Plant-WIPP)

Jerry W. Mercer
Engineering Projects Division
Sandia National Laboratories
Albuquerque, NM 87185

with a section on Geologic data by
Richard P. Snyder
US Geological Survey
Denver, CO 80225

1.0 ABSTRACT

Drillholes H-14 and H-15 were drilled to investigate data gaps in the hydrologic hole distribution at the WIPP site. One data gap existed on the southwestern quarter of the site (H-14) and the other existed on the eastern side of the site (H-15). To alleviate this problem, H-14 and H-15 were drilled and cored into the lower member of the Rustler Formation. In addition to the information gained on the Culebra Dolomite Member, the holes yielded hydraulic and/or stratigraphic information on the Forty-niner, Magenta Dolomite, and Tamarisk Members of the Rustler Formation in an area where no such information was available. Hydraulic tests were also conducted on the lower part of the Dewey Lake Redbeds in H-14.

The geologic units penetrated in H-14 are surficial deposits (0-6.5 feet) of Holocene age, the Gatuna Formation (6.5-40 feet) of Pleistocene age, the Dewey Lake Redbeds (40-359 feet) and the Rustler Formation (359-589+ feet) of Permian age. There was no evidence of halite currently in place in the drilled or cored portion of the Rustler Formation (17 feet into the unnamed lower member).

The geologic units penetrated in H-15 are surficial deposits (0-18 feet) of Holocene age, the Gatuna Formation (18-42 feet) of Pleistocene age, the Triassic Dockum Group (42-168 feet), the Dewey Lake Redbeds (168-692 feet) and the Rustler Formation (692-900+ feet) of Permian age. There was no evidence of halite currently in place in the drilled or cored portion of the Rustler Formation (17 feet into the unnamed lower member).

A suite of geophysical logs was run on the drillholes and was used to identify different lithologies and aided in the interpretation of the hydraulic tests.

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2.0 INTRODUCTION

This report describes the data collected during the drilling of exploration drillholes H-14 and H-15. Chapter 2 gives background information on the selection and siting of the drillholes while chapters 3 and 4 give the geologic data. Consistent with the usual format of a basic data report, individual technical sections are by separate authors.

2.1 Purpose of WIPP

The DOE is developing the WIPP for underground disposal of transuranic waste from defense-related programs. The site selected for this facility is in eastern Eddy County, about 25 miles east of Carlsbad, NM.

The underground disposal facility of the WIPP will be placed at a depth of approximately 2150 feet in the bedded salts of the Permian Salado Formation, which is contained in an evaporite sequence >3200 feet thick. After a period of "pilot" operation in a waste-retrievable mode, it is expected that the WIPP will be converted into a permanent disposal facility. The WIPP also includes an underground research facility for in situ experiments related to interactions between bedded salt and defense wastes.

Sandia National Laboratories, as scientific advisor to the DOE, supports the WIPP project in site characterization, including continuing evaluation of geologic and hydrologic processes that may affect the WIPP site both now and in the future.

2.2 Purpose of Drillholes H-14 and 15

H-14: A large gap was present in the hydrologic hole distribution in the southwest quarter of the WIPP site with no monitoring points for the Culebra Dolomite between the Zone II boundary and the WIPP site boundary to the southwest. A new well in this region was desirable for three reasons:

1) The permeability of the Culebra decreases by one to two orders of magnitude between H-3 and H-4/P-15, with a notable decrease in fracture-flow /double-porosity effects. The extent of the H-3 fracture system to the southwest also needed to be determined.

2) The recent modeling of the H-3 multipad pumping test indicates a channeling of regional flow across the southwest quarter of the site to the southeast. A hole in this vicinity would allow confirmation/refinement of the permeability and location assumed for the flow channel.

3) The Culebra water at H-2 appears to be anonymously fresh (i.e., low total dissolved solids). Another hole in the approximate vicinity of H-2 would provide information on the extent of the H-2 low-TDS zone.

The old P-1 pad in the southwest quarter of section 29, T22S, R31E, was an optimal location for the proposed hole. The pad lies very near the intersection of lines connecting H-2 with H-4 and H-3 with P-15. It is nearer the high-permeability zone at H-3 than the low-permeability zone at H-4/P-15, providing greater likelihood of finding relatively high permeability than would a more southerly location.

In addition to the information gained on the Culebra, a hole at this location would allow characterization of the hydraulic properties of the Forty-niner, Magenta, and Tamarisk Members of the Rustler Formation in an area where no such information was available.

H-15: Another large gap in the hydrologic hole distribution existed on the eastern side of the WIPP site. Two wells were present in the southeastern quarter of the site, DOE-1 and H-11 (and P-18 just east of the site), but none in the east-central part of the site and only H-5 to the northeast, at the extreme corner of the site. A new well on the eastern side of the site is desirable for three reasons:

1) the permeability on the eastern side of the site had been assumed to be very low, based primarily on measurements made at H-5 and P-18. The Culebra permeability is much higher, however, at DOE-1 and H-11, farther to the south. Confirmation of the assumed low permeability, or definition of a transition zone or boundary between DOE-1 and H-5, would greatly increase confidence in the conceptual hydrologic model of the site. The New Mexico Environmental Group (EEG) had repeatedly recommended a hole to the east for just this reason.

2) in addition to sparse permeability data on the eastern side of the site, modeling had also had to contend with a lack of hydraulic head and water-quality data to the east. An additional data point to the east would greatly aid in model calibration.

3) the proposed hole would provide the first point to the east at which effects of the shafts on Culebra hydrology might be measured. This would greatly aid the calibration of the regional Culebra model.

The old P-2 pad in the northeast quarter of section 28, T22S, R31E, was an optimal location for this hole. The pad lies midway between the shafts and the eastern site boundary. It is close enough to wells such as WIPP-21, H-3, and DOE-1 to make a large-scale interference test feasible, and yet far enough away to provide a distinct and useful permeability/head/water quality data point.

3.0 GEOLOGIC DESCRIPTION OF DRILLHOLE H-14

By

R. P. Snyder
(U. S. Geological Survey)

3.1 Abstract

Drillhole H-14, located about 1.4 miles southwest of the center of the WIPP (Waste Isolation Pilot Plant) site in southeast New Mexico, penetrated a typical stratigraphic section for this area. There was no evidence of halite in the drilled and cored part of the Upper Permian Rustler Formation (17 ft into the lower unnamed member). The Culebra Dolomite Member of the Rustler, directly overlying the lower unnamed member, is highly fractured. This suggests that halite beds, present a few feet below the Culebra Member in holes to the east of H-14, have been removed by dissolution.

3.2 Introduction

Drillhole H-14 is one of a series of exploratory holes drilled for the site characterization hydrologic studies at and near the WIPP (Waste Isolation Pilot Plant) site. Continuous cores were taken through the Magenta and Culebra Dolomite Members of the Rustler Formation and across their upper and lower contacts to aid in the interpretation of the hydrologic data. The intervening Tamarisk Member was not cored.

The drilling was performed under the direction of SNL (Sandia National Laboratories) on behalf of the WIPP Project Office of the DOE (U. S. Department of Energy). Description of the cuttings and core was the responsibility of the USGS (U. S. Geological Survey).

3.3 Description of Drillhole H-14

Drillhole H-14 is located in eastern Eddy County, New Mexico (fig. 1), in the SW 1/4, sec. 29, T. 22 S., R. 31 E. (fig. 3.1). The drilling and coring were done during September and October 1986, to a depth of 589 ft, measured from a surface elevation of 3345.6 ft above MSL (mean sea level). An abridged hole history is given in table 3.1, and the stratigraphic summary of the hole in table 3.2. Cuttings and core were examined at the drill site, and a detailed lithologic log is given in table 3.3.

Two intervals of the hole were cored, from 422.0 to 451.2 ft and fromm 535.5 to 574.0 ft. The upper 40 ft of the hole was augered; from 40 to 422.0 ft, 451.2 to 535.5 ft, and 574.0 to 589.0 ft, a rock bit was used and cuttings were collected, generally at 10-ft intervals.

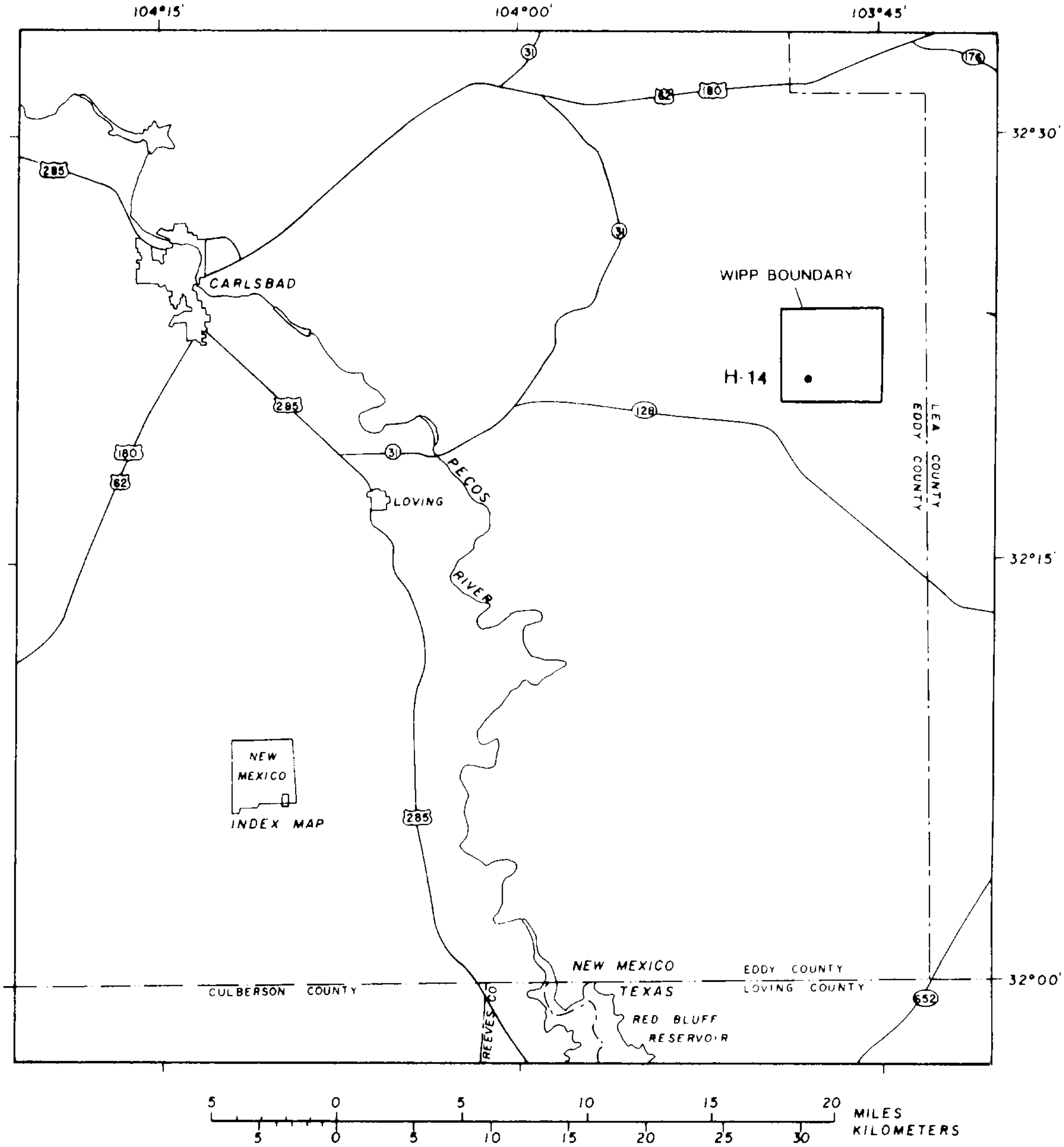


Figure 3.1 Index map showing location of drillhole H-14

A suite of geophysical logs was run, and includes 1) a gamma log, 2) a neutron log, and 3) a gamma-gamma density log. These logs are used to identify different lithologies, and especially to differentiate between anhydrite and gypsum. Figure 3.2 shows these logs along with the lithologic column as interpreted from cuttings, cores, and geophysical logs.

All measurements related to the drill site are in English units. If metric units are desired, the following conversion factors should be used:

Multiply English unit	By	To obtain metric unit
mile (mi)	1.6093	kilometer (km)
foot (ft)	0.3048	meter (m)
inch (in)	25.4	millimeter (mm)

3.4 Lithology and stratigraphy

Drillhole H-14 was spudded in pad-fill material and in loose sand of Holocene age to a depth of 6.5 ft. The hole penetrated 33.5 ft of the Pleistocene Gatuna Formation; a fine- to medium-grained, poorly sorted, pale-red to pinkish-gray sandstone that becomes conglomeratic downward.

Directly underlying the Gatuna at the drill site is approximately 320 ft of the Dewey Lake Redbeds, the uppermost rocks of Late Permian age in the area. The redbeds are composed of interbedded dark-reddish-brown and moderate-reddish-orange siltstones and claystones, and a few thin beds of sandstone. Drill cuttings indicate fibrous-gypsum veins occur from about 220 ft (180 ft below the top of the redbeds) to the base of the formation (359.5 ft, from drill cuttings).

The Rustler Formation, also of Late Permian age, underlies the Dewey Lake Redbeds and consists of five members. In descending order, they are: the Forty-niner Member, the Magenta Dolomite Member, the Tamarisk Member, the Culebra Dolomite Member, and an unnamed lower member. Drillhole H-14 penetrated the Rustler at 359.5 ft below GL (ground level) based on inspection of drill cuttings , and bottomed at 589 ft below GL in the unnamed member also based on drill cuttings.

The Forty-niner Member generally consists of two anhydrite or gypsum beds, or combinations of these, separated by a claystone unit. Interpreting the lithology using core, cuttings, and geophysical logs, the Forty-niner consists of the following rock types in descending order: 13 ft of anhydrite, 6 ft of gypsum, 4 ft of anhydrite, 10 ft of gypsum, 13.5 ft of interbedded claystone and siltstone, 8 ft of anhydrite, and 8 ft of gypsum.

The Magenta Dolomite Member, 25.6 ft thick, is laminated to very thinly bedded and crossbedded, very fine to fine-grained, and contains a few thin beds of gypsum. Laminations in the lower few feet are very wavy.

The Tamarisk Member is lithologically similar to the Forty-niner Member, and consists of two calcium sulfate units separated by a fine-grained clastic unit. Again, using a combination of core, cuttings, and geophysical logs, the lithology of the Tamarisk Member is interpreted to consist of the following: 28 ft of gypsiferous anhydrite, 5 ft of anhydrite, 21 ft of gypsum, 28 ft of siltstone and claystone, 8 ft of anhydrite, and 7 ft of gypsum.

The Culebra Dolomite Member thickness is estimated to be about 27 ft. Poor core recovery and the inability of the geophysical logging tools to go deeper than 568 ft made it necessary to estimate the thickness. In Drillhole P-1, less than 100 ft from H-14, geophysical logs indicated a thickness of 27 ft for the Culebra Member (Jones, 1978). The Culebra Member is a microcrystalline, dense, massive bedded, pale-yellowish-brown dolomite. Numerous vugs and fractures in the unit cause poor core recovery. The Culebra in H-14 lies at depths from 544.9 to about 572 ft. No samples were collected from 572 to 574 ft.

Cuttings collected from 574 to 589 ft indicate that the upper part of the unnamed lower member in the bottom 15 ft of H-14 probably consists of anhydrite, gypsum, and claystone. Neither cuttings nor core indicate that there is any halite present in the Rustler Formation down to total depth of the hole.

Table 3.1.--Abridged history of Drillhole H-14

LOCATION: sec. 29, T. 22 S., R. 31 E.
372.2 ft from south line (FSL)
562.4 ft from west line (FWL)

ALTITUDE: (LAND SURFACE): 3345.6 feet (MSL). Datum for depth measurements in drilling and logging operations.

CORE DESCRIPTION BY: R. P. Snyder, U. S. Geological Survey; J. W. Mercer, Sandia National Laboratories.

DRILLING CONTRACTOR: Pennsylvania Drilling Co.

DRILLING RECORD: Augered 12-1//4 in. hole to 39 ft, 39 ft of 8-5/8 in. OD surface pipe set September 25, 1986.
Drilled and cored hole to 589 ft, September 26 to October 21, 1986.
Hole cased with 5-1/2 in. OD casing to 532 ft.
Open hole 4-3/4 in. from 532 to 589 ft.

Core no.	Depth Interval from	Depth Interval to	Interval cored	Interval recovered	Percent recovered
1	422.0	432.0	10.0	10.0	100.0
2	432.0	441.2	9.2	9.2	100.0
3	441.2	451.2	10.0	10.0	100.0
4	535.5	540.7	5.2	5.2	100.0
5	540.7	550.7	10.0	8.2	82.0
6	550.7	560.7	10.0	4.7	47.0
7	560.7	567.7	7.0	0.4	5.7
8	567.7	574.0	6.3	1.7	27.0

Table 3.2.---Stratigraphic summary of Drillhole H-14

Rock unit	Depth Interval[1] in feet
Quaternary deposits	
Holocene deposits[2]	0.0- 6.5
Pleistocene rocks	
Gatuna Formation	6.5- 40.0
Upper Permian Rocks	
Dewey Lake Redbeds	40.0-359.5
Rustler Formation	359.5-589.0+
Forty-niner Member	359.5-422.4
Magenta Dolomite Member	422.4-448.0
Tamarisk Member	448.0-544.9
Culebra Dolomite Member	544.9-572?
unnamed lower member	572 ?-589+

[1]Footages from core depths.

[2]Includes artificial fill for drill pad, Holocene sand, and Mescalero caliche.

Table 3.3.--Lithologic log for Drillhole H-14

[Color designations from Rock-Color Chart (Goddard, and others, 1948); no recovery designates intervals where no sample was recovered during coring operations].

Lithologic description	Depth Interval (feet)
No description, augered material indicates drill pad material and loose sand to 6.5 ft; projection from Drillhole P-1 used for placing base of Gatuna Formation at 40 ft............................	0.0 - 40.0
CUTTINGS FROM 40.0 TO 422.0 FT	
Siltstone and mudstone, dark-reddish-brown (10R 3/4); siltstone ranges from 30 to 70 percent, claystone from 70 to 30 percent, minor amount of light-olive-gray (5Y 5/2) siltstone; greenish-gray (10Y 4/2) reduction spots, 1- to 3-mm in diameter begin at approximately 100 ft; occasional fragments of greenish-gray (10Y 4/2) siltstone ranging from 0.5 to 1 percent of cuttings begin at approximately 150 ft; trace to 1.0 percent fibrous-gypsum crystals from 220 ft downward, increasing to 1 to 2 percent between 260-270 ft; 5 percent grayish-orange-pink (5YR 7/2), fine grained siltstone from 241 to 245 ft..	40.0 - 359.5
Siltstone and claystone, similar to unit above; very light gray (N8) anhydrite and gypsum; geophysical logs and cuttings indicate top of the Forty-niner Member of the Rustler Formation is at 359.5 ft............................	359.5 - 392.5
Claystone and siltstone, dark-reddish-brown (10R 3/4) to very dusky red (10R 2/2)................	392.5 - 406.0
Anhydrite and gypsum, very light gray (N8)............	406.0 - 422.0
CORE FROM 422.0 TO 451.2 FT	
Gypsum, dark-gray (N3) to medium-gray (N5) crystals as large as 1 mm; horizontal veins of recrystallized gypsum 1 mm thick; basal contact sharp and horizontal......................	422.0 - 422.4

Dolomite, light-olive-gray (5Y 6/1), very fine grained, very thinly bedded, laminations of dark-gray (N3) gypsum; unit grades downward to anhydrite similar to unit from 422.0 to 422.4 ft.......... 422.4 - 423.2

Gypsum, similar to unit from 422.0 to 422.4 ft, horizontal fibrous-gypsum veins as thick as 3 mm.......... 423.2 - 423.8

Dolomite, pale-yellowish-brown (10YR 6/2) and light-brownish-gray (5YR 4/1), laminated to very thinly bedded, small sets of cross-bedding, bedding horizontal to sub-horizontal; unit contains 1- to 5-mm-diameter vugs filled with recrystallized gypsum from 426.9 to 427.5 ft, several horizontal fibrous-gypsum veins 0.5- to 4-mm-thick from 427.7 to 428.7 ft; rock broken and contains gypsum crystals as large as 1 cm at 426.9 ft; basal contact horizontal and grades into unit below.......... 423.8 - 428.8

Gypsum, similar to unit from 422.0 to 422.4 ft.......... 428.8 - 429.0

Dolomite, similar to unit from 423.8 to 428.9 ft; some thin beds of dolomite contain gypsum crystals as large as 1 mm.......... 429.0 - 430.7

Dolomite, olive-gray (5Y 4/1), laminated to very thinly bedded, silty.......... 430.7 - 432.5

Dolomite, similar to unit from 423.8 to 428.8 ft; clayey layer 0.1 ft thick at 441.1 ft; thin (0.5 to 1 mm) horizontal, fibrous-gypsum veins spaced 4 mm to 2 cm apart from 438.7 to 443.0 ft, veins increase in number and thickness (3 mm) from 443.0 to 446.1 ft, veining parallel to bedding; laminations wavy from 444.9 to 447.1 ft; laminations in lower 0.4 ft dip 20 degrees; broken, laminated dolomite rehealed with clayey matrix at 446.2 ft; basal contact gradational with unit below.......... 432.5 - 447.5

Interbedded gypsum and dolomite, colors similar to units above.......... 447.5 - 448.0

Gypsum, light-olive-gray (5Y 6/1), some crystals as large as 3 mm; dark-gray (N3) clots of gypsum crystals as large as 4 mm disseminated throughout unit.......... 448.0 - 451.2

CUTTINGS FROM 451.2 TO 535.5 FT

Anhydrite and gypsum, pale-yellowish-brown (10YR 6/2) and light-brownish-gray (5YR 4/1) microcrystalline; minor, clear, fibrous-gypsum increases downward.......................... 451.2 - 535.5

CORE FROM 535.5 TO 574.0 FT

Anhydrite and gypsum, medium-dark-gray (N4), medium-gray (N5), and brownish-gray (5YR 4/1), crystalline to microcrystalline, crystals as large as 1 mm; thinly bedded to massive; thin, black (N1) carbonaceous laminations at various intervals; secondary gypsum crystals from 535.9 to 536.2 ft; lower 1.6 ft contains numerous 2- to 8-mm-thick, black (N1) and clear gypsum bands; basal contact sharp and horizontal................................ 535.5 - 543.0

Anhydrite, grayish-black (N2) and black (N1), crystalline, crystals as large as 2 mm, laminated to very thinly bedded, some laminations wavy; gypsum-healed fracture at 543.5 ft dipping 80 degrees; secondary gypsum crystals, 1- to 2-mm-long along sharp, nearly horizontal basal contact............................ 543.0 - 544.9

Silty dolomite, pale-yellowish-brown (10YR 6/2) and light-olive-gray (5Y 6/1), thinly bedded to laminated; upper 0.1 ft grayish-black (N2); uppermost 0.3 ft fissile and carbonaceous, numerous vugs and gypsum-filled vugs; clot of gypsum crystals, 1 cm in diameter at 545.7 ft.. 544.9 - 546.1

No recovery.. 546.1 - 547.9

Dolomite, pale-yellowish-brown (10YR 6/2) and pale-brown (5YR 5/2), massive; numerous vugs less than 1 mm in diameter, clot of recrystallized gypsum, 1- to 2-cm in diameter at 548.2 ft; minor laminations in lower 0.6 ft of unit........... 547.9 - 550.7

Dolomite, pale-yellowish-brown (10YR 6/2), microcrystalline, dense, massive bedding; zones of vugs at 0.5-ft intervals; dark-yellowish-brown (10YR 4/2) clay laminations at 553.3 and 553.4 ft; clayey interval from 554.3 to 554.5 ft.................................. 550.7 - 555.4

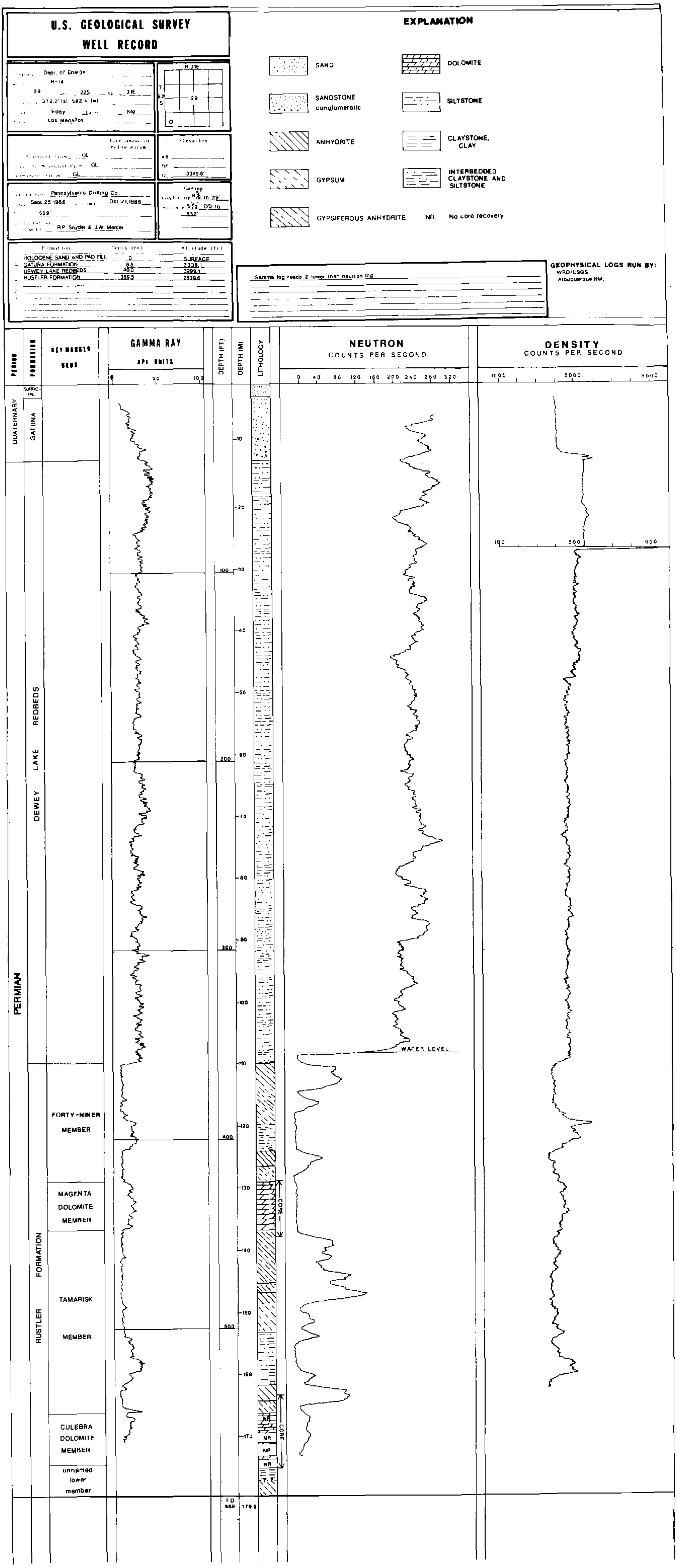
No recovery......................................	555.4 - 560.7
Dolomite, similar to unit 550.7 to 555.4 ft......................................	560.7 - 561.1
No recovery......................................	561.1 - 567.7
Dolomite, similar to interval from 550.7 to 555.4 ft; lower 1.2 feet recovered from outer core barrel and may not be sequential...............	567.7 - 569.4
No recovery......................................	569.4 - 574.0

CUTTINGS FROM 574.0 TO 589.0

Anhydrite and gypsum, similar to unit from 451.2 to 535.5 ft, minor dark-reddish-brown (10R 3/4) claystone decreases from 579.0 to 589.0 ft......................................	574.0 - 589.0

Total Depth 589.0 ft

Figure 3.2--Lithologic and geophysical logs of drill hole H-14



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4.0 GEOLOGIC DESCRIPTION OF DRILLHOLE H-15

By

R. P. Snyder
(U. S. Geological Survey)

4.1 Abstract

Drillhole H-15, located about 1.0 mile east of the center of the WIPP (Waste Isolation Pilot Plant) site in southeastern New Mexico, penetrated a typical stratigraphic section for this area. No halite was observed in the Rustler Formation in the core and cuttings, nor was any indicated from interpretation of the geophysical logs. The Culebra Dolomite Member of the Rustler Formation, overlying the lower unnamed member, was not fractured to any great extent. This suggests that there may be halite in the upper part of the lower unnamed member, possibly only a short distance below the 900-ft total depth of the drill hole.

4.2 Introduction

Drillhole H-15 is one of a series of exploratory holes to be used to study the hydrology at and near the WIPP (Waste Isolation Pilot Plant) site. Continuous cores were taken through the Magenta and Culebra Dolomite Members of the Rustler Formation (Upper Permian) and across the upper and lower contacts to aid in the interpretation of the hydrologic data.

The drilling was under the direction of Sandia National Laboratories (SNL) on behalf of the WIPP Project Office of the U. S. Department of Energy (DOE). Logging of the cuttings and core was done at the site by the U. S. Geological Survey (USGS) personnel.

4.3 Description of Drillhole H-15

Drillhole H-15 is located in eastern Eddy County, New Mexico, in the NE 1/4 sec. 28, T. 22 S., R. 31 E. (fig. 4.1). The drilling and coring were done during October and November 1986, to a depth of 900 ft, measured from a surface elevation of 3480.2 ft above MSL (mean sea level). An abridged hole history is given in table 4.1, and the stratigraphic summary of the hole in table 4.2. Cuttings and core were examined at the drill site, and a detailed lithologic log is given in table 4.3.

Two intervals of the hole were cored, from 744.0 to 774.2 ft and from 855.0 to 890.8 ft. The upper 40 ft of the hole was augered; from 40 to 744.0 ft, 774.2 to 855.0 ft, and 890.8 to 900.0 ft, a rock bit was used and cuttings were collected, generally at 10-ft intervals.

A suite of geophysical logs was run, and includes 1) a gamma log, 2) a neutron log, and 3) a gamma-gamma density log. These logs are used to identify different lithologies, and especially to differentiate between anhydrite and gypsum. Figure 4.2 shows these logs along with the lithologic column as interpreted from cuttings, cores, and geophysical logs.

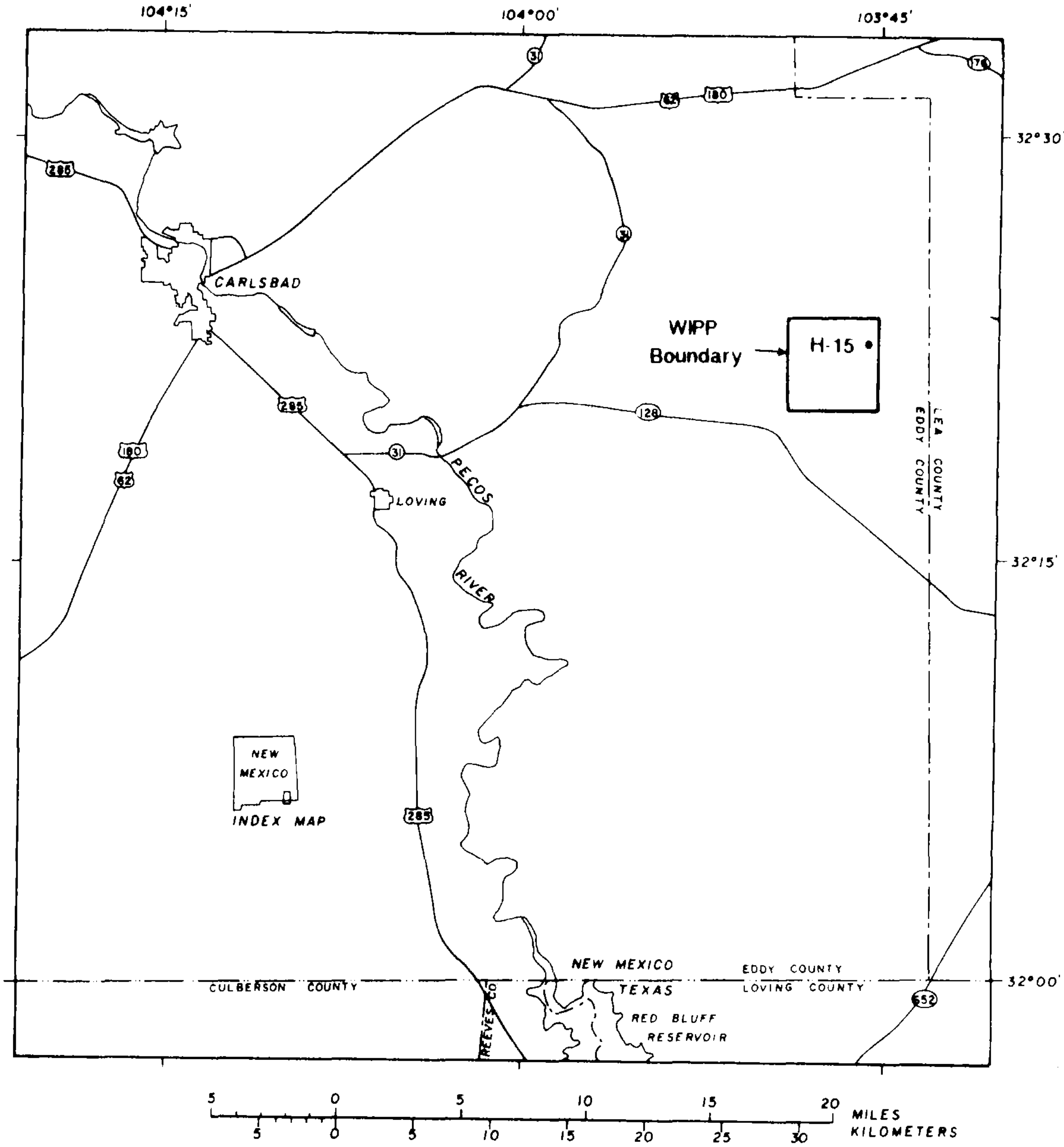


Figure 4.1 Index map showing location of drillhole H-15

All measurements related to the drill site are in English units. If metric units are desired, the following conversion factors should be used:

Multiply English unit	By	To obtain metric unit
mile (mi)	1.6093	kilometer (km)
foot (ft)	0.3048	meter (m)
inch (in)	25.4	millimeter (mm)

4.4 Lithology and stratigraphy

Drillhole H-15 was spudded in pad-fill material and in loose sand of Holocene age to a depth of 3 ft. The hole then penetrated 7 ft of very light gray caliche, the informal Mescalero caliche (middle Pleistocene) of Bachman (1976). From 10 to 42 ft lies the Pleistocene Gatuna Formation, a fine- to medium-grained, poorly sorted, pale-red to pinkish-gray sandstone that becomes conglomeratic downward.

Unconformably underlying the Gatuna is approximately 126 ft (42 to 168 ft) of the Dockum Group, undifferentiated, of Late Triassic age. The Dockum Group rocks are micaceous, fine- to coarse-grained sandstone and conglomerate.

From 168 to 691.5 ft (523.5 ft thick) is the uppermost Late Permian formation, the Dewey Lake Redbeds, consisting of interbedded dark-reddish-brown and moderate-reddish-orange siltstone and claystone, along with a few thin sandstone layers. The redbeds are characterized by numerous greenish-gray alteration spots and zones. There are numerous, variously oriented fractures, and veins filled by fibrous-gypsum beginning at 250 ft (82 ft below top of formation) and continuing to the base of the Dewey Lake..

The Rustler Formation, also of Late Permian age, underlies the Dewey Lake Redbeds and consists of five members. In descending order they are: the Forty-niner Member, the Magenta Dolomite Member, the Tamarisk Member, the Culebra Dolomite Member, and an unnamed lower member. Drillhole H-15 penetrated the Rustler at 691.5 ft below GL (ground level), based on inspection of drill cuttings and bottomed at 900 ft below GL in the unnamed member also based on drill cuttings.

The Forty-niner Member generally consists of two anhydrite or gypsum beds, or combinations of these, separated by a claystone unit. Interpreting the lithology using core, cuttings, and geophysical logs, the Forty-niner consists of the following rock types in descending order: 18 ft of anhydrite, 14 ft of gypsum, 10 ft of interbedded siltstone and claystone, 3 ft of gypsum, 6 ft of anhydrite, and 5 ft of gypsum.

The Magenta Dolomite Member, 24.6 ft thick, is laminated to very thinly bedded and crossbedded, very fine to fine grained, and contains a few thin beds of gypsum. There is evidence of soft-sediment deformation in the lowest foot, and laminations are very wavy in the lower few feet.

Geophysical logging did not extend below about 805 ft, not deep enough to log the entire Tamarisk Member. Logs from drillhole P-2

(Jones, 1978), less than 100 ft from H-15, were used to reconstruct the probable lithologies and depths and thicknesses of the Tamarisk Member in drillhole H-15. The Tamarisk consists (descending) of 11 ft of gypsiferous anhydrite, 10 ft of anhydrite, 22 ft of gypsiferous anhydrite, 22 ft of gypsum, 11 ft of siltstone and claystone, 9.5 ft of gypsum for a total of about 85.5 ft.

The Culebra Dolomite Member, from 858.5 to 885.3 ft (26.8 ft thick), is a light-gray and pale-yellowish-brown, microcrystalline, laminated to massive bedded dolomite. Numerous vugs ranging from less than 1 mm to less than 10 mm are disseminated throughout the member. The upper 0.5 ft of the member is dusky-yellowish-brown, carbonaceous claystone.

Only 7.8 ft of the unnamed lower member was cored (883.0-890.8 ft). The rock consists of 2.3 ft of laminated, plastic, calcium-sulfate-cemented, black claystone, 1.3 ft of grayish-red silty claystone, 2.4 ft of grayish-red gypsum, and 1.8 ft of dark-reddish-brown claystone to a total cored depth of 890.8 ft. From this depth to 900 ft, total depth of the hole, geophysical logs from Drillhole P-2 (Jones, 1978) indicate about 3 ft of claystone and 6 ft of gypsum.

Table 4.1.--Abridged history of Drillhole H-15

LOCATION: sec. 28, T. 22 S., R. 31 E.
88.6 ft from north line (FNL)
174.5 ft from east line (FEL)

ALTITUDE: LS (Land Surface): 3480.2 feet (MSL). Datum for depth measurements in drilling and logging operations.

CORE DESCRIBED BY: R. P. Snyder, U. S. Geological Survey
J. W. Mercer, Sandia National Laboratories.

DRILLING CONTRACTOR: Pennsylvania Drilling Company

DRILLING RECORD: Augered 12-1//4-in. hole and set 39 ft of 8-5/8 in. OD surface pipe September 29, 1986.
Commenced drilling 7-7/8 in. hole October 24, 1986.
Cased hole to 853 ft with 5-1/2 in. OD casing.
Reached total depth of 900 ft on November 14, 1986.
Open hole 4-3/4 in. from 853 to 900 ft.

Core no.	Depth Interval from	Depth Interval to	Interval cored	Interval recovered	Percent recovered
1	744.0	754.2	10.2	10.2	100.0
2	754.2	764.2	10.0	10.0	100.0
3	764.2	774.2	10.0	10.0	100.0
4	855.0	865.0	10.0	9.5	95.0
5	865.0	875.0	10.0	9.9	99.0
6	875.0	880.8	5.8	5.9	101.7
7	880.8	890.8	10.0	9.5	95.0

Table 4.2.--Stratigraphic summary of Drillhole H-15

Rock unit	Depth Interval[1] in feet
Quaternary deposits	
Pad-fill and Holocene sand	0.0- 10.0
Pleistocene rocks	
Gatuna Formation	10.0- 42.0
Upper Triassic Rocks	
Dockum Group, undifferentiated	42.0-168.0
Upper Permian Rocks	
Dewey Lake Redbeds	168.0-692.0
Rustler Formation	692.0-900.0+
Forty-niner Member	692.0-748.0
Magenta Dolomite Member	748.0-773.0
Tamarisk Member	773.0-858.5
Culebra Dolomite Member	858.5-885.3
unnamed lower member	885.3-900.0+

[1] Depths from core log, augmented by geophysical logs

Table 4.3.--Lithologic summary of Drillhole H-15

[Color designations from Rock-Color Chart, Goddard, and others, (1948). No recovery indicates no sample was recovered during coring operations].

Lithologic description	Depth Interval (feet)
Pad fill and sand	0 - 3
Caliche, very light gray (N8)	3 - 10
CUTTINGS FROM 40.0 TO 744.0 FT	
Sandstone, dark-reddish-brown (10R 3/4), coarse-grained, micaceous; minor grayish-green (10GY 4/2) sandstone increasing in lower 10 ft	10 - 80
Siltstone and sandstone, dark-reddish-brown (10R 3/4), minor grayish-green (10G 4/2) sandstone and siltstone increasing to 5 to 10 percent from 100 to110 ft; no sandstone in lower 10 ft	80 - 120
Claystone and minor siltstone and sandstone (10R 3/4; 1 to 5 percent grayish-green (10G 4/2) claystone, siltstone, and sandstone	120 - 140
Claystone and siltstone, dark-reddish-brown (10R 3/4); trace to 5 percent grayish-green (10G 3/4) claystone (reduction zones and spots)	140 - 250
Claystone and siltstone, similar to unit above, 5 to 10 percent light-olive-gray (5Y 6/1), fine-grained sandstone; minor fibrous gypsum	250 - 260
Claystone and siltstone, similar to unit from 140 to 250 ft, better cemented than above units	260 - 310
Claystone and siltstone, similar to unit from 140 to 250 ft; minor fibrous gypsum and white (N9) gypsum, 1 to 5 percent, increasing to 5 to 10 percent in lower 30 ft; light-olive-gray (5Y 6/1), fine-grained sandstone from 460 to 470 ft	310 - 590

Claystone and siltstone, similar to unit above except for nearly total lack of fibrous gypsum	590 - 690
Siltstone, 95 percent, similar to unit from 310 to 590 ft, grayish-orange-pink (10R 8/2) and (5YR 7/2), and very light gray (N8) anhydrite and gypsum, 5 percent	690 - 710
Siltstone, as above, 80 pecent; anhydrite and gypsum, as above, 20 percent	710 - 715
Anhydrite and gypsum, as above, 95 percent; siltstone, as above, 5 percent	715 - 725
Anhydrite and gypsum, as above, 90 percent; claystone, similar to unit from 140 to 250 ft, 10 percent increasing to 20 percent in lower 5 ft	725 - 735
Anhydrite and gypsum, 40 percent; siltstone, 40 percent; and claystone, 20 percent; all similar to units above	735 - 744

CORE FROM 744.0 TO 774.4 FT

Gypsiferous anhydrite, medium-gray (N5), microcrystalline, massive, three horizontal fibrous-gypsum veins 2- to 3-mm-thick; basal contact sharp	744.0 - 745.3
Gypsiferous anhydrite, as above, alternating with light-olive-gray (5Y 5/2) dolomite; dolomite very fine grained, laminated to very thinly bedded; numerous 1- to 4-mm-thick, horizontal fibrous-gypsum veins; basal contact at gypsiferous anhydrite is sharp	745.3 - 748.0
Dolomite, light-olive-gray (5Y 6/1 and 5Y 5/2), very fine grained, laminated to very thinly bedded and crossbedded; soft-sediment deformation in lower 0.2 ft; basal contact sharp	748.0 - 749.0
Clayey dolomite, light-olive-gray (5Y 6/1), laminated in upper 0.1 ft and lower 0.3 ft, massive from 749.1 to 750.0 ft; lower 0.1 ft contains numerous 1- to 6-mm oval, gypsum-filled vugs; basal contact sharp	749.0 - 750.3
Dolomite, similar to unit from 748.0 to 749.0 ft, numerous 1- to 3-mm gypsum-filled vugs; some carbonaceous laminae; clayey in lower 0.2 ft; lower contact gradational	750.3 - 751.5

Dolomite, pale-brown (5YR 5/2), moderate-brown (5YR 4/4) and light-olive-gray (5Y 5/2), laminated to thinly bedded, crossbedded in part, very sandy and poorly cemented in upper 4.5 ft, very clayey and sandy in lower 3.1 ft; laminations cause breakage of core in lower foot; numerous 1- to 3-mm-diameter vugs in upper 4.5 ft; some layers recemented by gypsum; basal contact sharp........................	751.5 - 759.1
Dolomite, light-olive-gray (5Y 6/1) and olive-gray (5Y 4/1), laminated to thinly bedded and crossbedded, nearly horizontal; well cemented; clay laminae at 760.0, 760.1, and 760.7 ft; horizontal, fibrous-gypsum veins, 1- to 2-mm thick from 768.6 to 769.9 ft, some follow crossbedding; numerous wavy laminae of gypsum gypsum and carbonaceous material from 769.9 to 771.9 ft; laminated dolomite, anhydrite, and anhydrite clots from 771.9 to 772.6 ft; soft-sediment deformation at 771.9 ft; fibrous-gypsum healed fracture 4 mm thick, dipping 67 degrees from 767.1 to 767.6 ft; basal contact moderately sharp............................	759.1 - 772.6
Gypsiferous anhydrite, similar to unit from 744.0 to 745.3 ft; numerous 1- to 3-mm-thick, horizontal fibrous-gypsum veins.....................	772.6 - 774.4

CUTTINGS FROM 774.4 TO 854.0 FT

Dolomite, light-olive-gray (5Y 6/1), 90 percent; dark-reddish-brown (10R 3/4), 7 percent; anhydrite and gypsum, light-olive-gray (5Y 6/1), 3 percent; minor fibrous gypsum......................	774.4 - 790
Anhydrite and gypsum, 40 percent; siltstone, 30 percent; dolomite, 30 percent; minor fibrous gypsum; similar to unit above.......................	790 - 800
Anhydrite and gypsum, 90 percent; siltstone, 5 percent; dolomite, 5 percent; minor fibrous gypsum; similar to unit from 774.4 to 790 ft.........	800 - 810
Anhydrite and gypsum, 98 percent; siltstone and dolomite, 2 percent; minor fibrous gypsum; similar to unit from 774.4 to 790 ft........................	810 - 840
Anhydrite and gypsum, 75 percent; siltstone and claystone, 25 percent; similar to unit from 774.4 to 790 ft....................................	840 - 850

Claystone, 70 percent; anhydrite and gypsum, 30 percent; similar to unit from 774.4 to 790 ft....	850	-	854
No recovery..	854	-	855

CORE FROM 855 TO 890.8 FT

Gypsum, medium-gray (N5) to grayish-black (N2) and very light gray (N8), microcrystalline, massive to laminated in part; upper 0.2 ft nodular; carbonaceous-filled fractures (dipping 60 degrees at 856.8, horizontal at 856.7, and 5 degrees at 855.2 and 855.6 ft); laminations of recrystallized gypsum from 855.2 to 855.6 ft dip 25 degrees; basal contact is sharp and jagged and dips less than 5 degrees.......	855	-	858.5
Carbonaceous mudstone, dusky-yellowish-brown (10YR 2/2), contorted laminae, silty in lower 0.1 ft, contorted gypsum-filled laminations in lower 0.1 ft; basal contact sharp, dips 5 degrees..	858.5	-	859.0
Gypsum, medium-light-gray (N6), microcrystalline, interbedded and interlaminated with dark-yellowish-brown (10YR 4/2) dolomite; dolomite increases downward; nodules of gypsum 1- to 6-mm in diameter; basal contact gradational over 0.2 ft......................	859.0	-	860.8
Clayey dolomite, pale-yellowish-brown (10YR 6/2), thinly bedded; dark-yellowish-brown (10YR 4/2) horizontal laminations from 861.0 to 861.2 ft; numerous 1- to 6-mm-diameter gypsum-filled vugs at 861 ft; 1- to 2-mm-diameter vugs from 861.3 to 861.6 ft.................	860.8	-	861.6
No recovery..	861.6	-	862.1
Clayey dolomite, similar to unit from 860.8 to 861.6 ft..	862.1	-	862.7
Dolomite, pale-yellowish-brown (10YR 6/2), minor 5-mm-diameter vugs; two hairline fractures rehealed by gypsum dip 50 degrees and 80 degrees; basal contact sharp.................	862.7	-	864.5
Clayey dolomite, similar to unit from 860.8 to 861.6 ft; basal contact gradational over 0.1 ft..	864.5	-	865.1

Dolomite, yellowish-gray (5Y 6/2), 1- to 2-mm-diameter vugs throughout unit, a few as large as 10 mm; horizontal, dark-gray (N3) clay seam at 868.3 ft; two minor clay seams at 868.8 and 869.5 ft; gypsum-filled vug, 6 mm in diameter, at 868.0 ft, basal contact fairly sharp	865.1 - 870.3
Dolomite, pale-yellowish-brown (10YR 6/3); zones of 1- to 10-mm-diameter vugs and very pale yellowish brown (10YR 7/2) clay laminae in upper 5.2 ft cause rock to break into 0.1- to 0.4-ft lengths; open fractures dip 80 degrees at 873.5 and 874.8 ft; in lower 0.3 ft, a mudstone-filled, horizontal parting intersects vertical mudstone-filled fracture just below a 0.1-ft-thick clay bed; basal contact gradational over 0.1 ft interval	870.3 - 877.1
Dolomite, pale-yellowish-brown (10YR 6/2), 2-mm to 30-cm-thick zones of 1- to 2-mm-diameter vugs, alternate with non-vuggy zones; clay-filled partings and laminae at various intervals; thicker laminae often exhibit irregular, pod-like upper surface and smooth, horizontal lower surface; partially-healed, high-angle fractures from 878.5 to 879.6 ft; numerous gypsum-filled, hairline fractures throughout unit; basal contact gradational over 0.1 ft interval	877.1 - 881.3
Dolomite, similar to unit from 865.1 to 870.3 ft; several gypsum-filled vugs as large as core (2.1 in.); lower 0.6 ft laminated with clayey dolomite; basal contact sharp and irregular	881.3 - 882.5
Clayey dolomite, laminated pale-yellowish-brown (10YR 6/2) and grayish-black (N2), laminae dip less than 5 degrees; rock fractured and rehealed; fragments in upper 0.2 ft turned in various orientations before rehealing; rock exhibits 1- to 2-mm-vertical displacements across fractures from 882.7 to 882.9 ft; basal 0.1 ft similar to upper 0.2 ft; basal contact moderately sharp	882.5 - 883.0
Mudstone, black (N1), laminated, plastic, calcium sulfate cement; poorly cemented; gypsum and fibrous-gypsum veins oriented from horizontal to 65 degrees; basal contact sharp	883.0 - 885.3

Mudstone, grayish-red (10R 4/2), partly silty; blades and veins of fibrous gypsum; calcium sulfate cement; unit ranges from poorly to well-cemented; 0.1- to 0.3-ft-thick interlayered gypsum beds; basal contact sharp.................... 885.3 - 886.6

Gypsum, grayish-red (10R 4/2), clayey layers at 888.3 and 888.7 ft partially eroded and very gypsiferous; moderate-red (5R 4/6) splotches and rinds around gypsum nodules in upper 0.8 ft; numerous nearly horizontal, anastomosing fibrous-gypsum veins................................ 886.6 - 889.0

Mudstone, dark-reddish-brown (10R 3/4), partially well-cemented by calcium sulfate as nodules, rosettes, and interstitial cement; grayish-green (5G 5/2) clay layer less than 0.1 ft thick at top of unit; contains fibrous-gypsum crystals; gypsum bed less than 0.1 ft thick at base.................................... 889.0 - 889.9

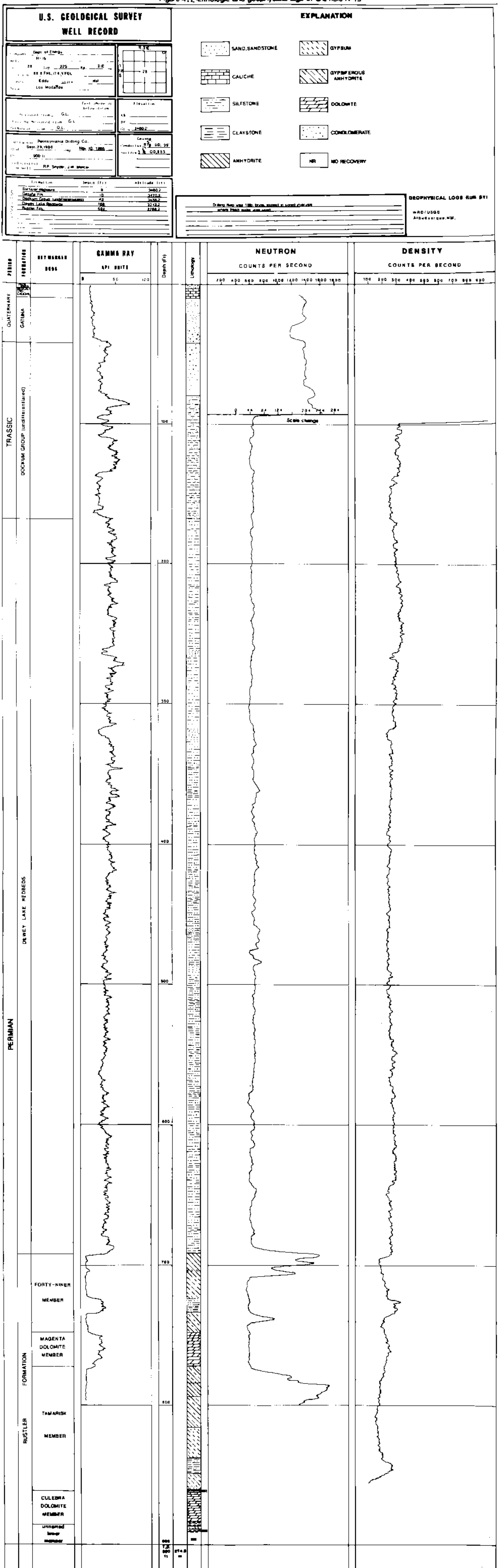
No recovery... 889.9 - 890.4

Mudstone, similar to unit from 889.0 to 889.9 ft; unit contains 2 discontinuous bands of gypsum.. 890.4 - 890.8

NO RECOVERY OF CUTTINGS FROM 890.8 TO 900.0 FT

Total Depth 900.0 ft

Figure 4.2 Lithologic and geophysical logs of drill hole H-15



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APPENDIX A

FIELD OPERATIONS PLAN AND HOLE JUSTIFICATION
FOR DRILLHOLES H-14 AND H-15

FIELD OPERATIONS PLAN OF SANDIA NATIONAL LABORATORIES

WIPP SITE INVESTIGATIONS

HYDROLOGIC TEST HOLES H-14 and H-15

Hydrologic Test Holes: H-14 and H-15

Purpose: To define work necessary for drilling and completing two hydrologic test holes to further define the hydraulic gradients and to obtain additional information on hydraulic parameters and chemical quality of fluids encountered in the Rustler Formation; in particular the Culebra Dolomite Member.

Prepared by: R. D. Statler (for) 9/12/86
J. W. Mercer, 7133

Reviewed by: R. D. Statler 9/12/86
R. D. Statler, 7133

Richard L. Beauheim 9/12/86
R. L. Beauheim, 6331

APPROVED BY: Allen R. Lappin 9/12/86
A. R. Lappin, 6331

G. R. Romero 9-12-86
G. R. Romero, QA, 6330

Allen R. Lappin for WDW 9/12/86
W. D. Weart, 6330
WIPP Project Manager

INTRODUCTION

This document contains plans, procedures, and specifications for the drilling and testing of two hydrologic exploratory drill holes, H-14 and H-15, to be drilled at the Waste Isolation Pilot Plant site near Carlsbad, New Mexico. The drill location for the H-14 exploratory hole is on the existing P-1 drill pad located in the southwest quarter of section 29, T.22 S., R.31 E. and the location of the H-15 exploratory hole is on the existing P-2 drill pad located in the northeast quarter of section 28, T.22 S., R.31 E. in Eddy County.

The H-14 and H-15 drilling program will involve drilling and selected coring from the surface through the Culebra Dolomite Member of the Rustler Formation. The total depth of these test holes will be approximately 590 feet for H-14 and 915 feet for H-15. Formation tests will be conducted at selected locations in H-14 during the drilling operations. Geophysical logging will also be conducted. The core will be logged, photographed, packaged and retained in the WIPP core library.

1. Field Operations Criteria

This operations plan is based on a hole-justification statement written by R. L. Beauheim, 6331. It is reproduced in its entirety herein.

Justification for Holes

H-14: A large gap exists in our hydrologic hole distribution in the southwest quarter of the WIPP site. We have no monitoring points between the Zone II boundary and the WIPP site boundary to the southwest. A distance of approximately two miles separates our southwesternmost wells in Zone II, H-2 and H-3, from our well closest to the southwest site boundary, H-4 and P-15. A new well in this region is desirable for three reasons:

1) The permeability of the Culebra decreases by one to two orders of magnitude between H-3 and H-4/P-15, with a notable decrease in fracture-flow/double-porosity effects. We need to determine how far the H-3 fracture system extends to the southwest.
2) The recent modeling of the H-3 multipad test indicates a channeling of regional flow across the southwest quarter of the site to the southeast. A hole in this vicinity will allow confirmation/refinement of the permeability assumed for this flow channel.
3) The Culebra water at H-2 appears to be anomalously fresh (i.e., low TDS). Another hole in the approximate vicinity of H-2 may provide information on the extent of the H-2 low-TDS zone.

In addition to the information gained on the Culebra, a hole in the southern part of the WIPP site would allow characterization of the hydraulic properties of the Forty-niner, Magenta, and Tamarisk Members of the Rustler Formation in an area where no such information is available.

The old P-1 pad is an optimal location for the proposed hole. The pad lies very near the intersection of lines connecting H-2 with H-4 and H-3 with P-15. It is nearer the high-permeability zone at H-2/H-3 than the low-permeability zone at H-4/P-15, providing greater likelihood of finding relatively high permeability than would a more southwesterly location. Good stratigraphic control proved by the P-1 drilling will allow the Rustler dolomites and contacts to be cored with a minimum of excess coring. This location would also satisfy the EEG, who have indicated that their top priority for a new hole is a location between H-3 and H-4.

H-15: Another large gap in our hydrologic hole distribution exists on the eastern side of the WIPP site. We have two well locations in the southwestern quarter of the site, at DOE-1 and H-11 (and P-18 in Zone IV), but none in the east-central part of the site and only H-5 to the northeast, at the extreme corner of the site. A new well on the eastern side of the site is desirable for three reasons:

1) the permeability on the eastern side of the site has been assumed to be very low, based primarily on measurements made at H-5 and P-18. The Culebra permeability is much higher, however, at DOE-1 and H-11, farther to the south. Confirmation of the assumed low permeability, or definition of a transition zone or boundary between DOE-1 and H-5, would greatly increase confidence in our conceptual hydrologic model of the site. The EEG has repeatedly recommended a hole to the east for just this reason.

2) in addition to sparse permeability data on the eastern side of the site, modeling has also had to contend with a lack of head and water-quality date to the east. An additional data point to the east would greatly aid in model calibration.

3) the proposed hole would provide the first point to the east at which effects of the shafts on Culebra hydrology might be measured. This would greatly aid the calibration of the regional Culebra model.

The old P-2 pad is an optimal location for the proposed hole. The pad lies midway between the shafts and the eastern site boundary. It is close enough to wells such as WIPP-21, H-3, and DOE-1 to make a large-scale interference test feasible, and yet far enough away to provide a distinct and useful permeability/head/water/quality data point. Good stratigraphic control provided by the P-2 drilling will allow the Rustler dolomites and contacts to be cored with a minimum of excess coring.

2. Field Operations Plan

2.1 Organization and responsibilities

2.1.1 The technical program for drilling and testing in this operation is the responsibility of Earth Sciences Division 6331. R. L. Beauheim, 6331, and J. W. Mercer, 7133, are responsible for the hydrologic and geological programs. Field decisions affecting the technical objectives will be made with full concurrence of the responsible parties and Division 6331.

2.1.2 The U.S. Geological Survey (Regional Geology and Water Resources Division) will assist in cuttings and core descriptions and are expected to provide their expertise and recommendations throughout the program.

2.1.3 The direction of the field operations described in this plan is the responsibility of J.W. Mercer, Division 7133.

2.1.4 The quality level of this program is categorized as QA Level II (major). Appropriate Quality Assurance measures on work preformed by Division 7133 will conform to the following documents:

a. Engineering Projects Division 7133
Quality Plan Sandia National Laboratories:
dated February 14, 1986

b. Quality Assurance Program Plan
Organization 6000 Energy Programs
Sandia National Laboratories: 6000 QAPP Revision D

c. Waste Isolation Pilot Plant, WIPP
Supplemental Quality Assurance Features
Sandia National Laboratories: QAP 1-2
dated November 15, 1986, Revision D

Where conflicts exists, the WIPP QA plan takes precedence over all other plans.

2.2 Drilling and Testing Program

Because the drilling and testing programs are somewhat different for the two hydrologic exploratory holes, they are listed separately. It should also be recognized that the stratigraphy and/or hydrologic conditions may be unusual; therefore, the drilling and testing programs may have to be adjusted in the field to provide for abnormalities.

2.2.1 Hydrologic Exploratory Hole H-14

1. Rehabilitate existing P-1 drill pad and dig and line mud pits.
2. Move in auger rig, drill 12-1/4 inch ± hole from 0 to 40 feet±. Set 8-5/8 inch outside diameter casing and cement annulus to surface.
3. Implement a rig to rotary drill a nominal 7-7/8 inch hole using the rotary method and air or brine as a circulating medium. Usage of additives to the drilling fluid will be documented.
4. Rig up and run-in-hole with a 7-7/8 inch bit and drill from 40 feet ± to a depth of 420 feet or just above the Magenta Dolomite Member of the Rustler Formation. Cuttings should be taken, identified, and bagged at intervals of 10 feet plus or minus 2 feet as a record of rock types penetrated.
5. Pick up coring equipment for taking a minimum 2-1/4 inch diameter core using a ten foot long split inner tube core barrel. Continuously core from 420 feet ± through the Magenta dolomite to a depth of about 450 feet.

6. Using 7-7/8 inch bit, ream core hole from 420 feet to 450 feet; then drill from 450 feet to 535 feet or just above the Culebra Dolomite Member of the Rustler Formation. Circulate hole in preparation for logging.

7. Run geophysical logs. The logging program is required to provide information on acoustic velocities, porosity, density, natural radioactivity, and formation resistivities. See section 3.4 on geophysical logging.

8. Upon completion of logging, pick up 7-7/8 inch bit and run-to-bottom and circulate hole in preparation for hydrologic testing.

9. Demobilize rotary drill rig and move off hole (rig will be moved to drill H-15).

10. Mobilize and rig up workover rig to conduct hydrologic tests.

11. Run hydrologic tests based on evaluation of core and geophysical logs. Emphasis is to be placed on the Magenta dolomite and the Forty-niner and Tamarisk Members of the Rustler Formation. See Section 3.3 for Hydrologic Testing.

12. After completion of hydrologic testing demobilize work-over rig and associated equipment.

13. Mobilize rotary drilling rig and move over existing hole (after rig has completed H-15).

14. Pick up 7-7/8 inch bit and run-in and condition hole to a depth of about 535 feet in preparation for running casing.

15. Inspect and install 5-1/2 inch outside diameter casing (industry standard) to programmed depth. Install centralizers in optimum position usually 60 feet to 90 feet apart.

16. Select a 70-30 poz mix cement slurry mixed with salt to saturation and 2% bentonite gel. Circulate a minimum of 50% excess above volume calculated to fill annulus. See Section 3.5 on cementing procedures.

17. Wait on cement for 24 hours.

18. Rig up and run-in-hole with 4-1/2 inch (nominal) bit to drill out cement, float, and guide shoe.

19. Pick up coring assembly to take nominal 2-1/4 inch core using a 10-foot long split tube-inner barrel. Begin to continuously core from about 535 feet through the Culebra dolomite to a depth of about 565 feet.

20. If after coring a minimum of 5 feet of the Culebra, the coring penetration rate shows a marked decrease which is sustained while one foot of core is cut, stop core run at that point.

21. Run hydrologic tests of the upper Culebra with a single packer set at the bottom of the casing or in the lower Tamarisk if a good packer seat is available. See Section 3.3 for Hydrologic Testing.

22. Pick up coring assembly and continue coring. Additional hydrologic tests <u>may</u> be performed as coring progresses if penetration rates and core indicate changes in Culebra hydrologic properties. Additional tests <u>will</u> be performed when the Culebra has been completely cored.

23. Pick up 4-1/2 inch (nominal) bit and clean out hole to 565 feet and then rotary drill to 590 feet to provide "rat hole" below the Culebra dolomite.

24. If determined appropriate, run geophysical logs from 535 feet to 590 feet.

25. Rig down drill rig and associated equipment and install removable well head.

2.2.2 Hydrologic Exploratory Hole H-15

1. Rehabilitate existing P-2 drill pad and dig and line mud pits.
2. Move in auger rig, drill 12-1/4 inch ± hole from 0 to 40 feet±. Set 8-5/8 inch outside diameter casing and cement annulus to surface.
3. Implement a rig to rotary drill a nominal 7-7/8 inch hole using the rotary method and air or brine as circulating medium. Usage of additives to the drilling fluid will be documented.
4. Rig up and run-in-hole with a 7-7/8 inch bit and drill from 40 feet± to a depth of 745 feet or just above the Magenta Dolomite Member of the Rustler Formation. Cuttings should be taken, identified and bagged at intervals of 10 feet plus or minus 2 feet as a record of rock types penetrated.
5. Pick up coring equipment for taking a minimum 2-1/4 inch diameter core using a ten foot long split inner tube core barrel. Continuously core from 745 feet ± through the Magenta dolomite to a depth of about 775 feet.
6. Using a 7-7/8 inch bit, ream core hole from 745 feet to 775 feet; then drill from 775 feet to about 855 feet or just above the Culebra Dolomite Member of the Rustler Formation. Circulate hole in preparation for logging.
7. Run geophysical logs. The logging program is required to provide information on acoustic velocities, porosity, density, natural radioactivity, and formation resistivities. See Section 3.4 on geophysical logging.

8. Upon completion of logging, pick up 7-7/8 inch bit and run-to-bottom and circulate hole in preparation for running casing.

9. Inspect and install 5-1/2 inch outside diameter casing (industry standard) to programmed depth. Install centralizers in optimum position, usually 60 feet to 90 feet apart.

10. Select a 70-30 poz mix cement slurry mixed with salt to saturation and 2% bentonite gel. Circulate a minimum of 50% excess above volume calculated to fill annulus. See Section 3.5 on cementing procedures.

11. Wait-on-cement for 24 hours.

12. Rig up and run-in-hole with 4-1/2 inch (nominal) bit to drill out cement, float, and guide shoe.

13. Pick up coring assembly to take nominal 2-1/4 inch core using a 10-foot long split tube inner barrel. Continuously core from about 855 feet through the Culebra dolomite to a depth of about 885 feet.

14. Pick up 4-1/2 inch (nominal) bit and clean out hole to 885 feet and then rotary drill to 915 feet to provide "rat hole" below Culebra dolomite.

15. If determined appropriate, run geophysical logs from 855 feet to 915 feet.

16. Rig down drill rig and associated equipment and install removable well head.

3. Field Operating Procedures for Quality Control Requirements.

Portions of this field activity are considered to be of sufficient significance that quality control measures have been established.

3.1 Surface Location and Depth Measurement Procedure of Sandia National Laboratories -- WIPP Site Investigations

3.1.1 Introduction

This procedure is prepared by the Engineering Projects Division 7133 for use in Sandia National Laboratories WIPP Program. The objective is to establish the methods and techniques to be used in measurements of the surface locations and well depths of exploratory holes H-14 and H-15.

3.1.2 Scope of Work

Establishing the surface locations and making depth measurements as drilling progresses are to be done as part of the exploratory program of drilling H-14 and H-15.

3.1.3 Organization

Sandia National Laboratories is conducting this field work under technical direction from Earth Sciences Division 6331. The Sandia Engineering Projects Division 7133 will manage the field operations.

3.1.4 Operations

3.1.4.1 Surface Location Measurements

The general location will be established by Division 7133. A preliminary land survey shall be conducted by a Registered Land

Surveyor to establish access routes and set stakes for drill locations. After pad rehabilitation is complete, a concrete monument with a cap will be set in the immediate vicinity of the borehole at ground level such that it can be used as the datum point for all borehole vertical measurements. Once this monument is established, this monument and its lateral relation to borehole axis is to be surveyed by a Registered Land Surveyor to establish the vertical elevation within ±1' of the nearest NGS monument and the lateral coordinates within ±1' with respect to nearest section boundaries and recoverable section corners. Copies of all field notes utilized in conducting the "as-built" survey, as well as a written description of techniques and instruments utilized in making the survey shall be submitted along with survey drawings carrying the stamp of the responsible surveyor.

3.1.4.2 Depth Measurements

The nature of the drilling of exploratory wells H-14 and H-15 requires unusual accuracy in determining the depth of the core intervals and the depths for hydrologic testing. The depths shall be referenced to the concrete monument at ground level and the measurement procedures should be developed with a known accuracy and following standard API.

3.2 Coring Operations Procedure of Sandia National Laboratories - WIPP Site Investigations

3.2.1 Introduction

This procedure is prepared by the Engineering Projects Division 7133 for use in Sandia National Laboratories' WIPP Program. The objective is to establish the methods and techniques to be used in coring operations in order to obtain reliable samples in a uniform manner.

3.2.2 Scope of Work

The coring operation is to be done as a part of exploratory drilling of hydrologic test holes H-14 and H-15. Coring operation will consist of taking approximately 60 feet of 2-1/4 inch core from selected intervals in each test hole. Core is to be removed from the core barrel, logged, measured, cleaned, marked, photographed, packaged, transported, and stored according to the procedures presented in this document.

3.2.3 Organization

Sandia National Laboratories is conducting this field work under technical direction from Earth Science Division 6331. The Sandia Field Engineering Division 7133 will manage the field operations. USGS will provide the duty geologist for logging and identifying the core and supervision of core handling in the field.

Sandia National Laboratories will provide core photography and arrange for core storage.

3.2.4 Operations

3.2.4.1 Coring

Conventional coring with a ten foot long split inner tube core barrel to produce a nominal 2-1/4 inch core is required. Other equipment and material such as drill-collars and stabilizers, drilling fluid (air or mud) should be utilized according to best judgment to match the formation and produce optimum core recovery.

Select and use drilling weight, rotary speed and circulation rates that will produce optimum core recovery.

The duty geologist shall maintain a daily record which shows date, tour and operating personnel, sequence of core interval, depth of core interval, drilling time of core interval, drilling weight, rotary speed and circulation rate, and type circulating fluid using the Core Logging Record (sample follows).

3.2.4.2 Removal from Barrel

Core should be removed from core barrel as gently as possible to cause minimum alteration of the core.

As the core is removed, it will be placed in troughs in the order coming out of the barrel. Troughs will be marked with red at top end and black at bottom indicating down direction.

3.2.4.3 Logging (USGS)

If core is suitable for marking, each major piece should be marked with a visible waterproof ink arrow pointing in the

SANDIA NATIONAL LABORATORY
DAILY CORE LOGGING RECORD

Date ______________________ Duty Geologist ______________________

LOG HEADINGS :

Company ______________________

Well Number ______________________

Field ______________________

County ______________________ State ______________________

Location ______________________

Section __________ Township __________ Range __________

Permanent Datum: ground level (G.L.) Elevations: G.L. __________

drill floor (D.F.) D.F. __________

kelley bushing (K.B.) K.B. __________

NO.	INTERVAL FEET	*RPM	*WEIGHT ON BIT	*CIRCUL. PRES. (PSI)	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BOX NUMBER

* RPM, WEIGHT ON BIT, AND CIRCULATION PRESSURE optional depending on rig type

direction the hole is advancing. Each core piece should be measured, identified and logged indexing each foot with footage expressed to the closest 1/10 of a foot. Depths should be reconciled from measurements of the drill pipe to the nearest foot taken from ground-level unless otherwise specified. Any lost recovery should be logged at the bottom of each core interval unless known to be otherwise and so explained on the core log.

3.2.4.4 Cleaning

Core will be wiped or brushed to remove soft mud cake and excess mud as soon as possible following removal from the core barrel. A rag dampened in drilling fluid or brine will be used to wipe the core. If core is accidentally washed with fresh water, it will be noted in the log, stating intervals exposed and time of occurrence.

3.2.4.5 Photography (Sandia and Duty Geologist)

After core has been logged, labeled, and cleaned, it will be carefully moved to the core/photo shed and prepared for photography. Core may be wetted with brine to enhance photo coverage. Core should be positioned by the duty geologist to promote coverage of pertinent features such as fractures, bedding plane, color, or any other significant characteristics. Each photo should have a title block showing well number, date, core interval and photo number.

3.2.4.6 Preservation (Duty Geologist)

After core has been photographed, it will be wiped dry and preserved for transportation and storage in the following method: Core pieces will be separated into lengths appropriate to fit into the core boxes. Pieces will be placed into plastic sleeves of appropriate length or wrapped and taped with plastic sheet if applicable. When using sleeves, use a hot iron sealing tool, seal both ends of plastic sleeve after squeezing all air possible from sleeve. Place sleeved or wrapped core into box and tape shut. When core intervals are missing, spacers marked with missing footage figures may be inserted in the box as necessary to preserve sequence. Boxes should be labeled in sequence with name of agency, well number, date, core number and depth of core pieces in the box.

3.2.4.7 Core Photos (Final Prints)

Sandia National Laboratories will arrange for core photography as described previously in paragraph 3.2.4.5. 8-1/2" x 11" prints will be made and distributed as follows:

1-set USGS, Regional Geology, Denver, Attn: R. P. Snyder

2-set Sandia Division 6331, ABQ, Attn: R. L. Beauheim

1-set Sandia Division 6331, ABQ, WIPP Central File

2-sets WIPP Project Office/TSC, Carlsbad, NM

1-set Sandia Division 7133, Attn: J. W. Mercer

3.3 Hydrologic Testing Procedures of Sandia National Laboratories - WIPP Site Investigations

3.3.1 Introduction

This procedure is prepared by the Engineering Projects Division 7133 for use in Sandia National Laboratories WIPP Program, in particular to test selected intervals in H-14. The objective is to establish methods and techniques to be used in hydrologic testing in order to obtain reliable data in a uniform manner.

3.3.2 Scope of Work

The hydrologic testing operation is to be conducted to obtain hydraulic properties of selected intervals, in particular, the zones in the Rustler Formation. The prime objectives of the testing program are to obtain data necessary to evaluate and measure certain hydraulic parameters. These are:

- hydraulic conductivity
- transmissivity
- hydraulic potential or head

It is understood that because of the very low anticipated permeabilities and unknown hole conditions, all these parameters may not be obtained from each individual zone.

The hydrologic tests will all be similar to a conventional drill stem test, but may include pressure pulse, slug-withdrawal or slug-injection tests if core or geophysical logs show they may be more appropriate.

Each test is anticipated to take a minimum of 12 hours to as much as 72 hours. The duration of each test will depend on the quality and amount of data required to achieve test objectives and overcome unknown downhole test conditions.

3.3.3 Organization

Sandia Laboratories is conducting the field work under the technical direction of Earth Sciences Division 6331. The Sandia Field Engineering Division 7133 will manage field operations.

3.3.4 Operations

3.3.4.1 The results of the logging and coring program for hydrologic exploration hole H-14 will identify the selected intervals to be tested.

3.3.4.2 When the selected test intervals have been cored and identified, run gamma log and caliper to identify potential packer seats.

3.3.4.3 Run the drill stem-test hardware using either a single or straddle inflatable packer sized for 7-7/8" drill hole and attached to 2-3/8" tubing. The packer assembly will include transducer probes capable of measuring pressures and temperatures below, above and within the test interval. The pressure data will be transmitted to a surface data acquisition system where it will be monitored and recorded. The data will be used to adjust flow schedules if necessary.

3.3.4.4 Set up and operate the test assembly with the capability of running a 12- to 72-hour DST. Prior to opening the test interval to the tubing, the water in the tubing will be swabbed out. The shortest time schedule for flow and shut-in periods will be determined by the Sandia field test director based on the real-time evaluation of the reservoir's performance. A minimum of two flow and buildup periods will be required.

If after the second flow period, there is either minimal or very little flow, or conversely, if there is significant flow, the testing times may be varied according to the judgment of the Sandia field test director. The flow schedule can be regulated by a sliding sleeve integral within the packer.

3.3.4.5 If the results of the DST are unsatisfactory; i.e. when reasonable estimates of conductivity and head cannot be achieved, then a pressure pulse test (very low conductivity), or a slug-withdrawal (rising head) (moderate to high conductivities) will be conducted.

Pressure Pulse Test - Conductivity is calculated from the pressure time history of an applied pressure-pulse. After the zone is isolated, the tubing shall be swabbed as nearly dry as practicable. The shut-in valve shall be opened to depressurize the test interval and then closed immediately, creating an applied pressure-pulse on the test interval. Pressure increase with time shall be recorded downhole. Duration of these tests will vary depending on test interval permeabilities.

Slug-withdrawal (rising head) - Upon completion of the DST, the test interval shall be shut-in and the tubing shall be evacuated by swabbing. After pressure in the test interval has stabilized, the shut-in tool will be opened and the pressure rise with time monitored.

During all testing, quantity and quality of water removed shall be documented.

3.4 Borehole Geophysical Logging Operations Procedure of Sandia National Laboratories - WIPP Site Investigation

3.4.1 Introduction

This procedure is prepared by the Sandia National Laboratories Engineering Projects Division 7133 for use in Sandia's WIPP Site Investigation. The objective is to establish standard routines and methods for borehole geophysical logging in order to assure qualified data in a reliable manner.

To insure accuracy and quality of all work done, the logging company shall provide a description of their calibration and quality standards prior to award of the logging contract. For these tools requiring calibration standard source, it must be traceable to the API standards or a recognized natural physical constant.

3.4.2 Scope of Work

Geophysical logging of boreholes in the WIPP Site Investigations may include a wide variety of individual logging services. Logging services may be provided by several different commercial firms utilizing different types of tools and techniques. Services may be purchased directly by Sandia National Laboratories or through the Drilling Engineering firms.

The scope of logging services may change for specific intervals depending on the test horizon conditions. The logging services may be changed at the discretion of the field operations director.

3.4.3 Organization

Sandia Laboratories is conducting this field work with technical direction from Earth Sciences Division 6331. Field operations are managed by Sandia Engineering Projects Division 7133.

3.4.4 Operations

3.4.4.1 The logging services will consist of all or part of the following:

Natural Gamma Ray Log - Measures the natural radiation from the wall rock formations, recorded in API Gamma Ray Units versus depth of the hole.

4-Arm Caliper Log - Measures variations in the borehole diameter and is recorded in inches for diameter versus depth; used to select packer seats as well as estimating hole volumes.

Density Log - Measures formation density and is compensated for borehole effects using a gamma source and records bulk density in grams/cc and formation porosity in percent versus depth.

Neutron Log - Measures density of hydrogen atoms using a neutron source and is compensated for borehole effects, usually referenced to limestone standard; used for porosity and hydrogen for concentrations. Recorded as porosity percent versus depth.

Borehole Compensated Sonic Velocity - Measures acoustic properties of borehole wall rock compensated for borehole diameter changes. Recording is of interval transit time in microseconds/foot versus depth; used to measure porosities and detect fractures.

Acoustic Televiewer - Measures acoustic properties of borehole wall and converts attenuation of sonic signal to "picture" of borehole wall; used to identify and measure fractures and their orientation on borehole walls.

Dual Laterolog - Measures laterally focused resistivity at two depths of penetration from the borehole wall. Records in ohmmeters versus depth; used to obtain true rock resistivities and can be used as a qualitative measure of permeability.

Temperature Log - Measures temperature of borehole fluid and records in degrees fahrenheit versus depth; used to detect possible abnormalities of temperature that may indicate fluid or gas entry into borehole.

Directions/Deviation - Uses a compass and photographic accessories to determine deviation of the boreholes from vertical and the direction of the deviation.

3.4.4.2 Prior to selecting a logging service, a Sandia representative will prepare the form "Instructions o Logging Company" for the specific logs to be run (sample instructions form follows).

3.4.4.3 Prior to logging, a qualified representative of Sandia Labs will meet with the logging service company's logging engineer. He will present the "Instructions . . .: and discuss:

a) the entire logging program and special requirements,

b) hole conditions that may cause problems, and

c) zones of special interest.

3.4.4.4 During the pre-log conference, the Sandia representative will discuss and request the following to be done:

- The equipment will be "warmed up" for the adequate amount of time and tools will be checked to see that they are calibrated as appropriate and functioning properly upon arrival at the location.
- Rm, Rmf, and Rmc will be measured on mud samples if electrical logs are to be run. Estimated values are not acceptable. The service company should run the sample through a mud press.

SANDIA NATIONAL LABORATORY
INSTRUCTIONS TO LOGGING COMPANY

Date ______________________ Logging Company ______________________

Prepared By ______________________ Logging Engineer ______________________

Witnessed By ______________________

Log Headings:

Company ______________________

Well Number ______________________

Field ______________________

County ______________________ State ______________________

Location ______________________

Section ______________ Township ______________ Range ______________

Permanent Datum: ground level (G.L.) Elevations: G.L. ______________

drill floor (D.F.) D.F. ______________

kelley bushing (K.B.) K.B. ______________

Hole Status

	SIZE	FROM	TO		SIZE	FROM	TO
Casings	____	____	____	Borehole	____	____	____
	____	____	____		____	____	____
	____	____	____		____	____	____

Fluid Status

Type Fluid in Borehole ________ Fluid Level ________ Fluid Loss ________

Density ____________ pH ____________ Viscosity ____________

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

____

____

____

Number of Prints: Field ____________ Final ____________

Send to : Sandia National Laboratories
P. O. Box 5800, Division 7133 Attn. Jerry W. Mercer
Albuquerque, New Mexico 87185

Log Number * ____________________

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

(f.) Special Instructions ____________________

Log Number * ____________________

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

(f.) Special Instructions ____________________

Log Number * ____________________

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

(f.) Special Instructions ____________________

---

* Logs do not need to be run in this sequence

- All Sidewall and Compensated Neutron logs and all density porosity curves will be run on limestone matrix over the zones of interest, regardless of the lithology.
- Equipment will be tested while running in hole.
- Before-and-after log calibrations will be shown for all curves.
- Panel calibrations will be shown for all density and neutron logs; integration checks will be shown for all integrated acoustic logs.
- In addition to caliper rings, the caliper calibration should show "tool full open" and casing readings.
- A minimum 200 feet repeat must be shown.
- Overlap previous runs by at least 200 feet.
- All headings information will be completely filled out.
- In addition, all open-hole commercial logs shall be digitized and recorded on magnetic tape.

3.4.4.5 The Sandia logging representative will be present and observe the logging operation to the extent necessary to assure objectives have been met. He should complete a "Log Quality Report" (sample follows) following the operation and, along with a copy of "Instructions to Logging Company", forward to Sandia Engineering Projects Division 7133.

LOG QUALITY REPORT

Hole ______________________ Log Date ______________________ Current Date ______________________

Log ______________________ Run # ______________________ Engr. ______________________

Field Print ☐ Final Print ☐ Log Analyst ______________________

CHECK ALL BOXES – ACCEPTABLE **YES** OR UNACCEPTABLE **NO**

Sections not applicable to a particular service, Leave Blank.

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

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

3.4.5 Records

3.4.5.1 "Instruction to Logging Company"

Sandia representative should prepare instructions for the logging company, and provide ten copies to Sandia Field Engineering Division 7133. Distribution should be made as follows:

1	Logging Company
1	Sandia Representative - observing log operations
1	Sandia Carlsbad Hole File
2	TSC Records Center, Carlsbad
1	Sandia WIPP Central Files (SCWF)
1	Sandia Division 7133, ABQ.
1	Sandia Division 6331, ABQ.
1	USGS, Regional Geology, Denver Attn: R. P. Snyder
1	USGS/WRD, ABQ, Attn: J. Hudson

3.4.5.2 Log Quality Report

Sandia representative should prepare the Log Quality Report and distribute as follows:

3	Original and 2 copies to Sandia Engineering Projects Division 7133, ABQ, who will be responsible for forwarding to WIPP Central File
2	Sandia Earth Science Division 6331, ABQ Attn: R. L. Beauheim, D. J. Borns
1	Sandia Carlsbad Hole File

3.4.5.3. Geophysical Logs (Final Prints)

Fifteen final copies of logs and two copies of library magnetic tapes of the logs shall be ordered and distributed as follows:

2 TSC Records Center, Carlsbad

1 USGS, Regional Geology, Denver,
Attn: R. P. Snyder

1 USGS/WRD, ABQ Attn: J. Hudson

3 Sandia Division 6331, ABQ,
Attn: A. R. Lappin, D. J. Borns, R. L. Beauheim

2 Sandia Division 7133, ABQ, Attn: J. W. Mercer

2 Sandia WIPP Central File, ABQ
2 copies logs & 2 copies tapes

1 Sandia Carlsbad Hole File

1 State Engineer, Roswell, NM

1 USGS Area Geologist, Roswell, NM

1 West Texas Electric Log Service

3.5 Cementing Operations Procedure of Sandia National Laboratory, WIPP Site Investigation

3.5.1 Observe regulations issued by New Mexico State Engineer for casing wells through known aquifers. State Engineer's office should be notified in advance of intention to case.

3.5.2 Condition the hole, ream if necessary to remove tight places. Run a caliper log as necessary to calculate the proper amount of cement and help in selecting the appropriate positioning of centralizers.

3.5.3 Inspect the casing to be run. Sandblast if necessary to remove severe rust flakes. Install centralizers in optimum position, usually 60-90' apart. Install combination float collar and guide shoe.

3.5.4 Run the casing string and land at preselected depth.

3.5.5. Select a 70-30 poz mix cement slurry mixed with salt to saturation and 2% bentonite gel. Weight the slurry as necessary to match density of drilling fluids in the hole.

3.5.6 Install an appropriate cementing head, rig up the mixing and pumping units. Begin pumping to displace the drilling fluids with a suitable mud flush followed by a suitable spacer and an appropriate volume of cement slurry to equal at least 150% of the calculated annulus volume of
the hole. Continue pumping at about 2-1/2 bpm until acceptable returns have been observed at the surface. Displace top plug with water and then bump plug with about 500 psi (maximum of 1000 psi) over displacing pressure. Check float and if it is holding, close in cementing head and W.O.C. for 24 to 48 hours. Maintain tension in the casing string while cement is setting.

3.5 7 Run a casing pressure test before drilling out the plug. Apply a pressure of about 600 psi and hold for 30 minutes and observe. If a pressure drop of 100 psi or more is observed, take corrective measures and repeat the test.
If a pressure drop is less, cementing job is considered complete. Pick up the appropriate size bit and proceed to drill out the plug and continue with the program as directed.

4. REPORTS

4.1 Daily Report

Sandia, Carlsbad, will telefax the daily report on weekdays to Division 6331 and Division 7133 in Albuquerque. A copy of the daily report will be kept on file in the Sandia Carlsbad office.

4.2 Daily Time Log

A Daily Time Log will be maintained by Sandia. Two copies will be provided to the Sandia, Carlsbad office. Sandia, Carlsbad office will maintain a file of the log.

4.3 Hole History

A Hole History of the drilling activities will be prepared by Sandia from the daily time logs and other pertinent records. A reproducible copy of this history is to be sent to Division 7133, ABQ, following completion of field activities for subsequent distribution.

4.4 Miscellaneous Records

A variety of records are kept and will be useful in historical preparation. These are to be kept on file in Carlsbad while the program is active and on completion, a copy forwarded to Division 7133, for placement in the WIPP central file. They include:

Driller Logs, Bit Records, Drilling Fluid, Recaps, Equipment Certification, Drilling History Chart, and Cost Records.

APPENDIX B

ABRIDGED HOLE HISTORY
FOR DRILLHOLES H-14 AND H-15

HYDROLOGIC DRILLHOLE H-14
ABRIDGED HOLE HISTORY

The following hole history was abstracted from the daily drilling records.

Note: Depths will be from ground level unless otherwise reported. Drilled two shifts from 0800 hrs to 0400 hrs (20 hrs/day).

9-22-86 Commenced site preparation extending existing pad to 100 ft by 100 ft to accommodate drilling operations. Levelled ground and compacted caliche on pad to a minimum 6-inch depth. Drilled 12-1/4 inch hole from surface to 39.5 feet using Abbott Bros. dry hole auger. Set and aligned one joint of 8-5/8 inch OD, 28 lb/ft (H-40), surface casing at 39 feet. Cemented annulus with 27 cubic feet of ready-mix grout.

9-23-86 Excavated pit to set steel tanks for use as mud pits. Moved in Pennsylvania Drilling Co. Rig #1.

9-24-86 Cut off surface conductor pipe near ground level. Used winch truck to set steel tank for mud pit. Started rigging up Pennsylvania Drilling Co. Rig # 1.

9-25-86 Completed rigging up flow lines and filled pits with 10 lb/gal saturated brine. Held safety meeting. Made up 7-7/8 inch drilling assembly, tripped in hole, and broke tower at 2000 hrs. Drilled 7-7/8 inch hole from 39.5 ft to 110 feet using saturated brine water as circulation fluid. Tripped out drill pipe and bit.

9-25-86 Tripped in hole with drill pipe and 7-7/8 inch bit to continue drilling from 110 ft to 230 ft using brine water as circulation fluid. Tripped out drill pipe and bit. Secured rig for the weekend.

9-27-86 No activity

9-28-86 No activity

9-29-86 Tripped in hole with drill pipe and bit to continue drilling 7-7/8 inch hole from 230 ft to 309 ft. Drilling slow, possible "junk" in the hole. Tripped out with drill pipe and bit.

9-30-86 Tripped in hole with drill pipe and bit to continue drilling 7-7/8 inch hole from 309 feet. Drilled very rough so tripped pipe, teeth worn on bit and metal fragments lodged in teeth. Called Star Tool, arrived on site with 7-inch magnet at 1600 hrs. "Fished" with magnet, retrieved several pieces of metal (looked like thread protector maybe off surface casing). Tripped magnet, made up drilling assembly, tripped in hole, and drilled 7-7/8 inch hole from 309 ft to 339 ft.

10-1-86 Tripped in hole with drill pipe and bit to continue drilling 7-7/8 inch hole from 339 ft to 422 ft. Drilling rate indicates must have cleaned hole of all "junk". Tripped out drill pipe and bit, ran magnet in in preparation for coring. No "junk" was picked up on magnet.

10-2-86 Ran temporary string of 4-1/2 inch steel casing to accommodate wire-line coring operation. Pump problems, replace pressure line. Picked up 10-foot split-inner tube coring assembly with a 3-7/8 inch OD diamond core head to cut a 2-1/4 inch diameter core. Tripped in hole with coring assembly and wire-line pipe to 422 ft. Circulated hole and cut core # 1 from 422 ft to 432 ft using saturated brine water as circulation fluid. While pulling inner barrel, backed off shoe and left core inside wire-line pipe. Went back in and recovered 10 feet of core. Cut core # 2 from 432 ft to 441.2 ft. Recovered 9.2 ft of core. Cut core # 3 from 441.2 ft to 451.2 ft and recovered 10.0 feet of core. Completed coring operations and tripped out with wire-line pipe and coring assembly.

10-3-86 Pulled temporary 4-1/2 inch casing. Picked up drill pipe and 7-7/8 inch bit and reamed core hole from 422 ft to 451.2 ft. Continued drilling 7-7/8 inch hole from 451.2 ft to 527 ft using saturated brine as circulation fluid. Tripped out drill pipe and bit. Secured rig for the weekend.

10-4-86 No activity

10-5-86 No activity

10-6-86 Tripped in hole with drill pipe and bit to 527 ft, some fill. Washed out fill and continued drilling 7-7/8 inch hole from 527 ft to 533 ft. Circulated hole in preparation for geophysical logging. Tripped out with drill pipe and bit. USGS on site at 1300 hrs to run logs. Geophysical logs run included gamma ray, caliper, gamma-gamma density, and neutron porosity. Completed logging at 1630 hrs. Dresser-Atlas on site to run logs. Geophysical logs run by Dresser included neutron-gamma ray, BHC acoustilog, dual laterolog, and compensated densilog. Rigged down Dresser at 0230 hrs.

10-7-86 Picked up drill pipe and 7-7/8 inch bit and tripped in hole to clean out in preparation for hydrologic testing. Found about 4 ft of fill. Circulated hole and tripped out drill pipe and bit. Rigged up Lynes hydrologic test tool and tripped in hole for testing, running test tool on 2-3/8 inch tubing. DST of the Tamarisk claystone was conducted over the interval from 494.5 ft to bottom of the hole at 533 ft. Well on test at 1719 hrs . **

* Note: The test data for these and all subsequent tests are included in Stensrud et al. (1987), while the test analyses are included in Beauheim (1987).

10-8-86 Continued DST of Tamarisk claystone.

10-9-86 Deflated packer and reset packer at 1019 hrs 8 feet deeper at 502.5 ft. Continued DST test at Tamarisk claystone. Terminated DST test at 1510 hrs tripped hydrologic test tool.

10-10-86 Dressed and rigged up Lynes hydrologic test tool to conduct hydrologic tests of the Magenta Dolomite Member of the Rustler Formation. Tripped in hole with test tool and set packers straddling the interval from 420 ft to 448.5 ft. Conducted DST of Magenta starting at 1216 hrs.

10-11-86 Continued DST of the Magenta Dolomite.

10-12-86 Continued DST of the Magenta Dolomite.

10-13-86 Terminated testing of the Magenta Dolomite at 0810 hrs. Deflated straddle packers on Lynes test tool and moved up hole to test Forty-niner claystone. Reset straddle packers and inflated them isolating the interval from 381 ft to 409.5 ft. Conducted DST of the Forty-niner claystone beginning at 1245 hrs.

10-14-86 Continued DST of the Forty-niner claystone until 1450 hrs. Terminated test and deflated packers. Moved test tool up the hole to test Forty-niner anhydrite. Reset packers isolating an interval from 356 ft to 384.5 ft. Conducted DST beginning at 1515 hrs.

10-15-86 Continued Forty-niner DST until 0810 hrs when they were terminated. Deflated packers on Lynes test tool and moved up the hole to test lower Dewey Lake Redbeds. Reset straddle packers isolating an interval from 327.5 ft to 356 ft. Conducted DST beginning at 0844 hrs.

10-16-86 Completed DST of the lower Dewey Lake Redbeds at 0830 hrs. Deflated packers and tripped out with Lynes test tool completing this series of DST's. Picked up drill pipe with 7-7/8 inch bit and ran into hole to circulate at 533 ft. Circulated hole. Found about 4 ft of fill since testing had begun on 10-7-86. Continued to circulate hole in preparation for running casing. Tripped out drill pipe and bit.

10-17-86 Rigged up to run casing. Ran 17 joints, 553.11 ft of 5-1/2 inch OD, J-55, 15.5 lb/ft, ST&C casing. Landed casing and set at 532 ft (BGL). Combination guide shoe and float collar on bottom of last joint. Ran centralizers on top of joints no. 2, 6, 10, and 14. Rigged up Dowell cementing company and made up Dowell circulating head and pumped until broke circulation. Commenced cementing with 25 barrels of CW-7 (chemical wash), then RFC (regulated fill) Class A Thixotropic followed by 70-30% Poz mix. Slurry mixed at 14.6 to 14.9 lbs/gal; pumped at 2.5 bbl/min. Released plug and displaced with fresh water; cement back to surface. Shut-in circulating head with cement in place at 1214 hrs. Waited on cement to set. Secured rig.

10-18-86 No activity

10-19-86 No activity

10-20-86 Cut off 5-1/2 inch casing and retrieved circulation head. Rigged up flow line and associated equipment. Tripped in hole with drill pipe and 4-3/4 inch bit to drill out cement. Evacuate hole of drilling fluid with compressed air from 529 ft. Changed out drilling fluid to fresh water traced with an organic tracer (trimetafluorobenzoic acid). Drilled out plug, float collar, cement, and guide shoe to a depth of 535.5 ft. Circulated out hole to clean and tripped out with drill pipe and bit. Rigged up coring assembly using 10-foot split-inner tube core barrel and 3-7/8 inch OD diamond coring head to take 2-1/4 inch core. Tripped in hole with coring assembly and wire-line pipe to cut core from 535.5 ft. Cut core # 4 from 535.5 ft to 540.7 ft using traced fresh water as circulation fluid. Started to pull inner barrel, but barrel hung up in wire-line pipe about 5 joints from the surface. Worked and freed inner barrel. Recovered 5.2 ft of core. Ran in hole with inner barrel and hung up again at same place. Pulled wire-line pipe and found a bad joint.

10-21-86 Replaced 4 joints of wire-line pipe and resumed coring operations. Cut core # 5 from 540.7 ft to 550.7 ft and recovered 8.2 ft of core. Tripped out with wire-line pipe and core barrel. Rigged up Lynes hydrologic test tool to conduct hydrologic tests of the upper Culebra Dolomite Member of the Rustler Formation. Tripped in hole with test tool and set packer at the bottom of the casing leaving the interval from 532 ft to 550.7 ft open for testing. DST and rising-head slug tests were conducted beginning at 1303 hrs. Testing concluded at 1820 hrs. The packer was deflated and the test tool was tripped out of the hole. Tripped in hole with wire-line pipe and coring assembly to resume coring. Cut core # 6 from 550.7 ft to 560.7 ft and recovered 4.7 ft of core. Cut core # 7 from 560.7 ft to 567.7 ft and recovered 0.4 ft of core. Rock appears to be fractured.

10-22-86 Continued coring operation and cut core # 8 from 567.7 ft to 574 ft and recovered 1.7 ft of core. Completed coring and tripped wire-line pipe and core barrel in preparation of running hydrologic tests on the entire Culebra Dolomite Member. Rigged up Lynes hydrologic test tool and tripped in hole to set packer at bottom of casing to test interval from 532 ft to bottom of hole at 574 ft. Set packer at 1224 hrs. Conducted series of DSTs and rising-head slug tests. Concluded testing at 2000hrs and tripped out with test assembly.

10-23-86 Picked up drill pipe with 4-3/4 inch bit to ream core hole. Reamed core hole from 532 ft to 574 ft and drilled "rat" hole from 574 ft to 589 ft (total depth). Circulated hole to clean out and tripped out laying down drill pipe. Commenced rigging down. Demobilized rig and moved out. Equipped hole with removable cap on well casing. Drilling operations at H-14 completed.

11-6-86 Rigged up USGS loggers over H-14 to run geophysical logs of the section of borehole from 532 ft to total depth of 589 ft. Unable to get below 570 ft because the hole had bridged. Logs run included gamma ray, gamma-gamma density, and neutron porosity. Logging completed at 1530 hrs.

DRILLING AND WELL COMPLETION RECORD
OF HYDROLOGIC DRILLHOLE H-14

* all depths below ground level

WELL NAME: Hydrologic Drillhole H-14

LOCATION: Section 29, Township 22 South, Range 31 East

SURFACE COORDINATES: Brass Monument is 564.7 feet from West Line (FWL) and 369.5 feet from South Line (FSL). Drillhole is N32 W 5 from brass monument at a location of 562.4 feet from West Line (FWL) and 372.2 feet from South Line (FSL).

ELEVATION: Ground Elevation; 3345.48 ft MSL

DRILLING RECORD:

Start Date- Commenced drilling on September 25, 1986, and completed on October 23, 1986, at a depth of 589 feet below ground level (BGL)

Circulation Media- Saturated brine water until reached the Culebra at 532 ft then used traced fresh water to total depth of 589 ft.

Rig and Subcontractor- Failing 2000, Pennsylvania Drilling Company, Carlsbad, NM

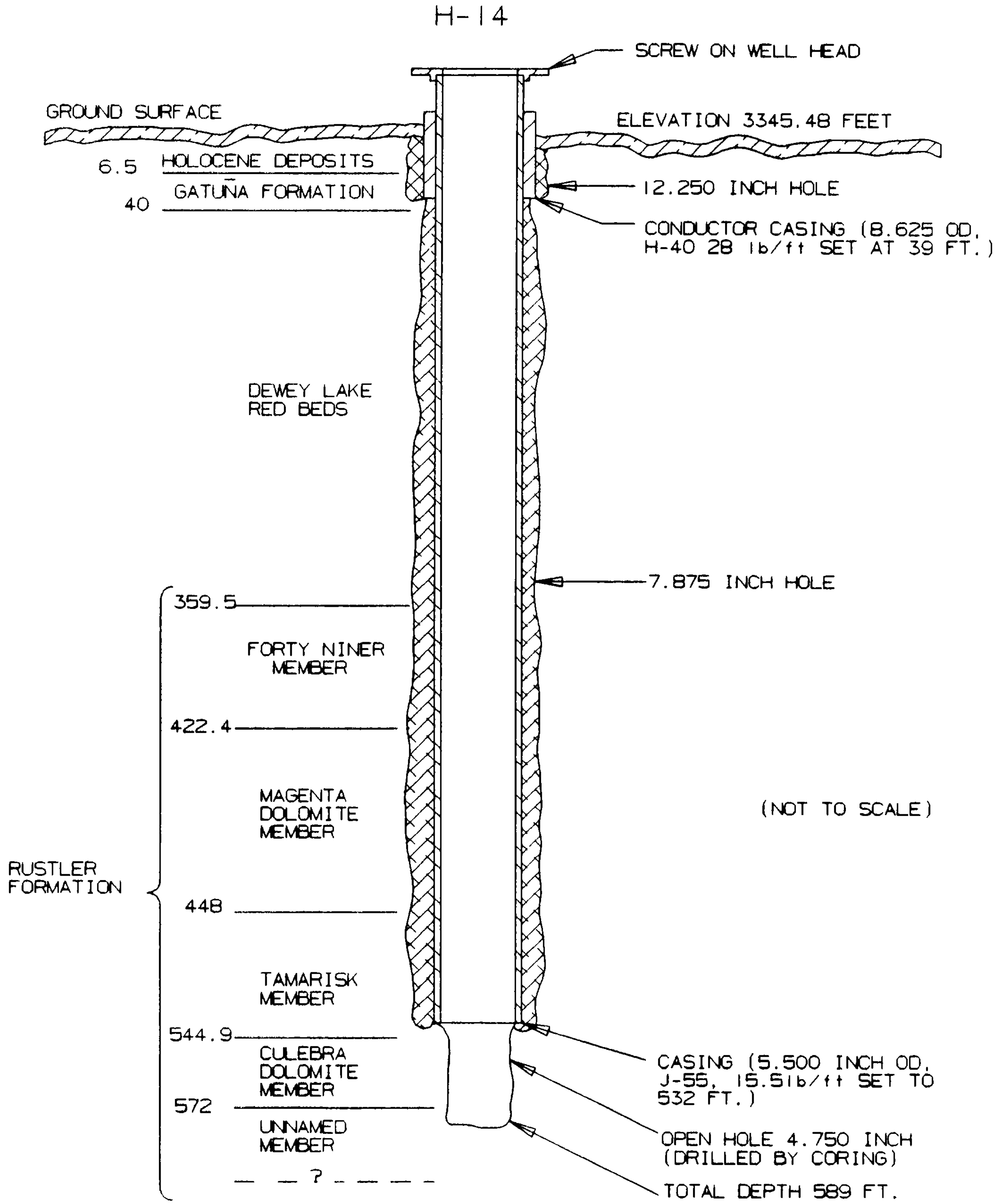
Drillhole Record-

Size (inches)	From (feet)	To (feet)
12-1/4	0	39
7-7/8	39	532
4-3/4	532	589

Casing Record-

Size (inches)	WT/FT (pounds)	From (feet)	To (feet)
8-5/8	(H-40) 28	0	39
5-1/2	(J-55) 15.5	0	532

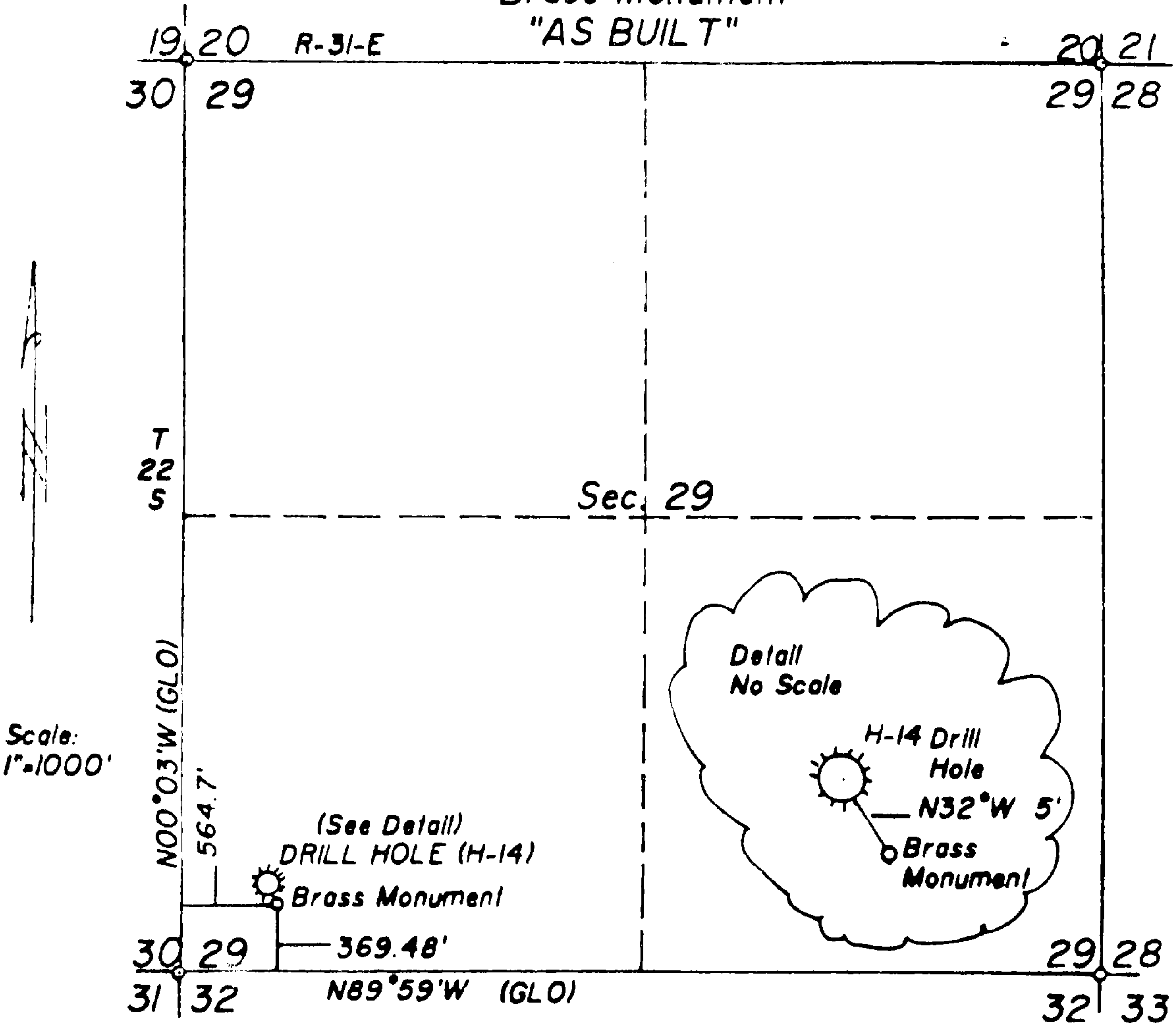
* 4-3/4-inch open hole from 532 feet to the total depth of 589 feet



H-14 HYDROLOGIC TEST HOLE AS BUILT CONDITIONS AFTER COMPLETION ON OCTOBER 23, 1986.

Plat of Survey

"H-14"
Brass Monument
"AS BUILT"



Brass MONUMENT Location:
564.7 Feet From West Line
369.5 Feet From South Line
Sec. 29, T-22-S, R-31-E N.M.P.M.
Eddy County, New Mexico
Elevation- 3345.48

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

NEW MEXICO
5412
REGISTERED PROFESSIONAL

DATE: AUGUST 24, 1987
PREPARED FOR: SANDIA LABORATORIES

Dan R. Reddy
DAN R. REDDY NM PE&LS 5412

As Built Survey
H-14
Sec. 29

T 22 S
R 31 E

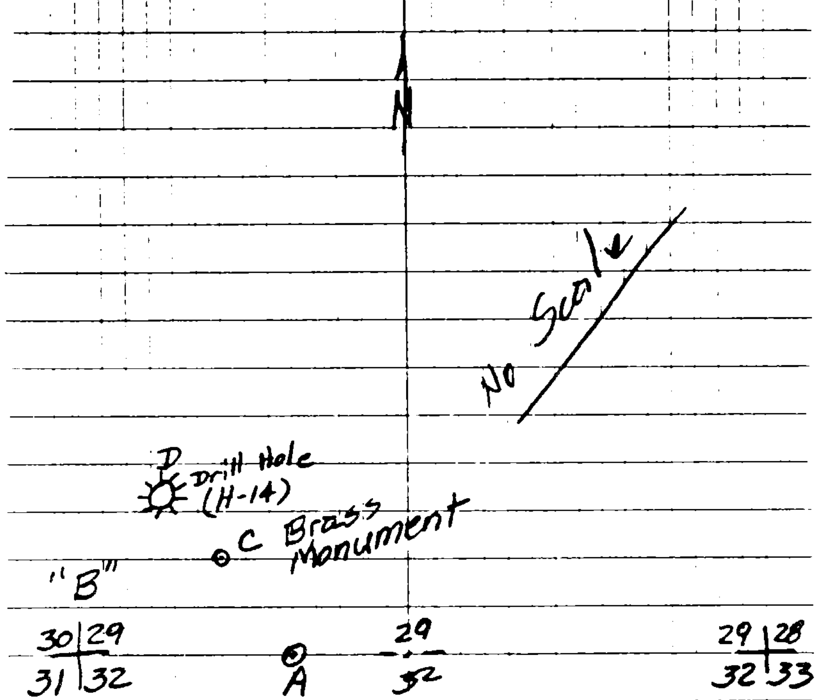
Aug 5, 1982

Dan R. Reddy
and
David R. Reddy

Sta	Dist	horiz Angle	vert Angle	Comment	
A-B	974.37		neg		
A C	551.94		do		
BAC		42°01'			
C B	674.43		do		
BCD		91°00'			
C D	5'				

Sta	B.S.	H.I.	F.S.	Elev.	Comment
H-349	4.03	50.39		3346.36	NGS Sta
Brass monument H-14	4.99	50.47	4.91	3345.48	
H-349			4.12	3346.35	ok NGS Sta

3/3


N
No Scale
D Drill Hole (H-14)
C Brass Monument
"B"
30 29
31 32
A
29
32
29 28
32 33

HYDROLOGIC DRILLHOLE H-15
ABRIDGED HOLE HISTORY

The following hole history was abstracted from the daily drilling records.

Note: Depths will be from ground level unless otherwise reported. Drilling two shifts from 0800 hrs to 0400 hrs (20 hrs/day).

9-23-86 Commenced site preparation extending existing pad to 100 ft by 100 ft to accommodate drilling operations. Levelled ground and compacted pad with minimum of 6 inches of caliche.

9-29-86 Drilled 12-1/4 inch hole from surface to 39.5 feet using Abbott Bros. dry hole auger. Set and aligned one joint of 8-5/8 inch OD (H-40), 28 lb/ft, surface casing at 39 ft. Cemented annulus with 27 cubic feet of ready-mix grout.

9-30-86 Cut off surface conductor pipe near ground level. Excavated pit and used winch truck to set steel tank for mud pit.

10-23-86 Moved in Pennsylvania Drilling Co. Rig # 1 from H-14. Started rigging up over H-15.

10-24-86 Completed rigging up flow lines and filled pits with 10 lb/gal saturated brine. Held safety meeting. Made up 7-7/8 inch drilling assembly, tripped in hole, and broke tower at 1030 hrs. Drilled 7-7/8 inch hole from 39.5 ft to 140 feet using saturated brine water as circulation fluid. Tripped out drill pipe. Secured rig for the weekend.

10-25-86 No activity

10-26-86 No activity

10-27-86 Tripped in hole with drill pipe and 7-7/8 inch bit, circulated hole. Pump problems, tear down and repair pump. Resumed drilling 7-7/8 inch hole from 140 ft to 250 ft. Circulated hole and tripped out drill pipe and bit.

10-28-86 Tripped in hole with drill pipe and bit to continue drilling 7-7/8 inch hole from 250 ft to 388 ft. Using brine water as circulation fluid. Circulated hole and tripped out with drill pipe and bit.

10-29-86 Tripped in hole with drill pipe and bit to continue drilling 7-7/8 inch hole from 388 ft to 490 ft.

10-30-86 Tripped out drill pipe and replaced bit. Vacuumed out mud pits. Tripped in hole with drilling assembly and continued drilling 7-7/8 inch hole from 490 ft to 650 ft. Circulated hole and tripped out with drill pipe and bit.

10-30-86 Rotary control valve problems, repaired and replaced air cylinder. Tripped in hole with drill pipe and bit to continue drilling 7-7/8 inch hole from 650 ft to 735 ft. Tripped out drill pipe and bit. Secured rig for the weekend.

11-1-86 No activity

11-2-86 No activity

11-3-86 Tripped in hole with drill pipe and bit. Continued drilling 7-7/8 inch hole from 735 ft to 744 ft (core point). Tripped out drill pipe and bit in preparation for coring. Run temporary string of 4-1/2 inch steel casing to 744 ft to accommodate wire-line coring operations.

11-4-86 Rigged up wire-line coring assembly. Picked up 10-foot split-inner tube core barrel with 3-7/8 inch OD diamond core head to cut 2-1/4 inch diameter core. Tripped in hole with core barrel and wire-line pipe to 744 feet. Cut core #1 from 744 ft to 754.2 ft using saturated brine water as circulating fluid. Recovered 10.2 ft of core. Cut core # 2 from 754.2 ft to 764.2 ft. Recovered 10 ft of core. Light plant went down, repaired and continued coring core # 3 from 764.2 ft to 774.2 ft. Recovered 10.0 ft of core. Tripped out wire-line pipe and coring assembly. Pulled temporary casing.

11-5-86 Picked up and ran in hole with drill pipe and 7-7/8 inch bit and reamed core hole to 7-7/8 in diameter from 744 ft to 774.2 ft. Continued to drill 7-7/8 inch hole from 774.2 ft to 844 ft. Pump problems, tripped out drill pipe and bit.

11-6-86 Repaired pump. Tripped in hole with drill pipe and bit to continue drilling 7-7/8 inch hole from 844 ft to 854 ft (casing depth). Circulated hole to clean out. Tripped out with drill pipe and bit in preparation for geophysical logging. Dresser Atlas loggers on site at 1000 hrs to run geophysical logs. Geophysical logs run included gamma ray, caliper, densilog, BHC acoustilog, compensated neutron, and dual laterolog. Rigged down Dresser Atlas and rigged up USGS. USGS logging at 1945 hrs. Geophysical logs run included gamma ray, neutron porosity, gamma-gamma density, and caliper. Completed logging operations at 2230 hrs. Rigged up to run casing.

11-7-86 Ran 21 joints, 868.86 ft of 5-1/2 inch OD, J-55, 15.5 lb/ft, ST&C, casing and set at 853 feet BGL. Ran a combination guide shoe and float collar on the bottom of the last joint. Ran centralizers on top of joints # 2, 5, 9, 13, and 18. Made up Dowell circulating head and broke circulation. Commenced cementing operations with 15 barrels CW-7 (chemical wash) followed by RFC-Class A (Thixotropic) cement, followed by 70-30 poz mix cement. Slurry mixed at 14.0 to 14.2 lb/gal; pumped at 2.5 bbl/min. Released plug and displaced with fresh water; cement back to surface. Shut-in circulating head. Rigged down Dowell. Waited on cement.

11-8-86 No Activity

11-9-86 Cut off 5-1/2 inch casing and retrieved cementing head. Rigged up flow line. Tripped in hole with drill pipe and 4-3/4 inch bit to drill out cement and float collar. After bit was on bottom, evacuated hole of brine with air compressor. Changed out drilling fluid from brine to fresh water spiked with an organic tracer (trimetafluorobenzoic acid). Drilled out plug, float collar, cement, and guide shoe to a depth of 855 feet. Circulated clean and tripped out with drill pipe and bit to pick up core barrel. Tripped in hole with wire-line pipe and 10-foot split-inner tube core barrel to cut 2-1/4 inch diameter core. Began cutting core # 4 from 855 ft to 865 ft using traced fresh water as circulation fluid. Recovered 9.5 ft of core. Cut core # 5 from 865 ft to 875 ft and recovered 9.9 ft of core. Cut core # 6 from 875 ft to 880.8 ft and recovered 5.9 ft of core.

11-10-86 Continued coring. Cut core # 7 from 880.8 ft to 890.8 ft and recovered 9.5 ft of core. Tripped out laying down wire-line pipe. Picked up drill pipe and 4-3/4 inch bit to ream core hole. Reamed core hole to 4-3/4 inches from 853 ft to 891 ft using traced fresh water as circulation fluid. Circulated hole clean and tripped out drill pipe and bit.

11-11-86 Rigged up Lynes hydrologic test tool and tripped in hole to set packer at bottom of casing to test interval from 853 ft to bottom of the hole at 891 ft.

Set the packer at 1524 hrs and conducted a series of DST's and rising head slug tests.**

** Note: Data and analyses of hydrologic tests can be found in Stensrud et al. (1987) and Beauheim (1987).

11-12-86 Well on test.

11-13-86 Concluded hydrologic tests and deflated packer at 0820 hrs. Tripped out with packer and hydrologic test tool. Secured rig.

11-14-86 Picked up 4-3/4 inch bit and drill pipe to clean out well. Cleaned out well to 891 ft and drilled "rat hole" to 900 ft using traced fresh water as circulation fluid. H-15 total depth at 900 ft. Tripped out laying down drill pipe. Secured rig.

11-15-86 No activity.

11-16-86 No activity.

11-17-86 Rigged down and demobilize rig.

11-18-86 Rigged up USGS to run geophysical logs. Logged hole from 853 ft to total depth of 900 ft. Logs ran include gamma ray, caliper, neutron porosity, and gamma-gamma density. Logging completed at 1200 hrs. Equipped hole with removable well head (cap on casing). Operations on H-15 complete.

DRILLING AND WELL COMPLETION RECORD OF HYDROLOGIC DRILLHOLE H-15

* all depths below ground level

WELL NAME: Hydrologic Drillhole H-15

LOCATION: Section 28, Township 22 South, Range 31 East

SURFACE COORDINATES: Brass Monument is 92.6 feet from North Line (FNL) and 170.6 feet from East Line (FEL). Drillhole is N43 20 W of brass monument at a distance of 5.4 ft.

ELEVATION: Ground Elevation; 3480.2 ft MSL

DRILLING RECORD:

Start Date- Commenced drilling on October 24, 1986, and completed on November 14, 1986, at a depth of 900 feet below ground level (BGL)

Circulation Media- Saturated brine water until reached the Culebra at 853 ft then used traced fresh water to total depth of 900 ft.

Rig and Subcontractor- Failing 2000, Pennsylvania Drilling Company, Carlsbad, NM

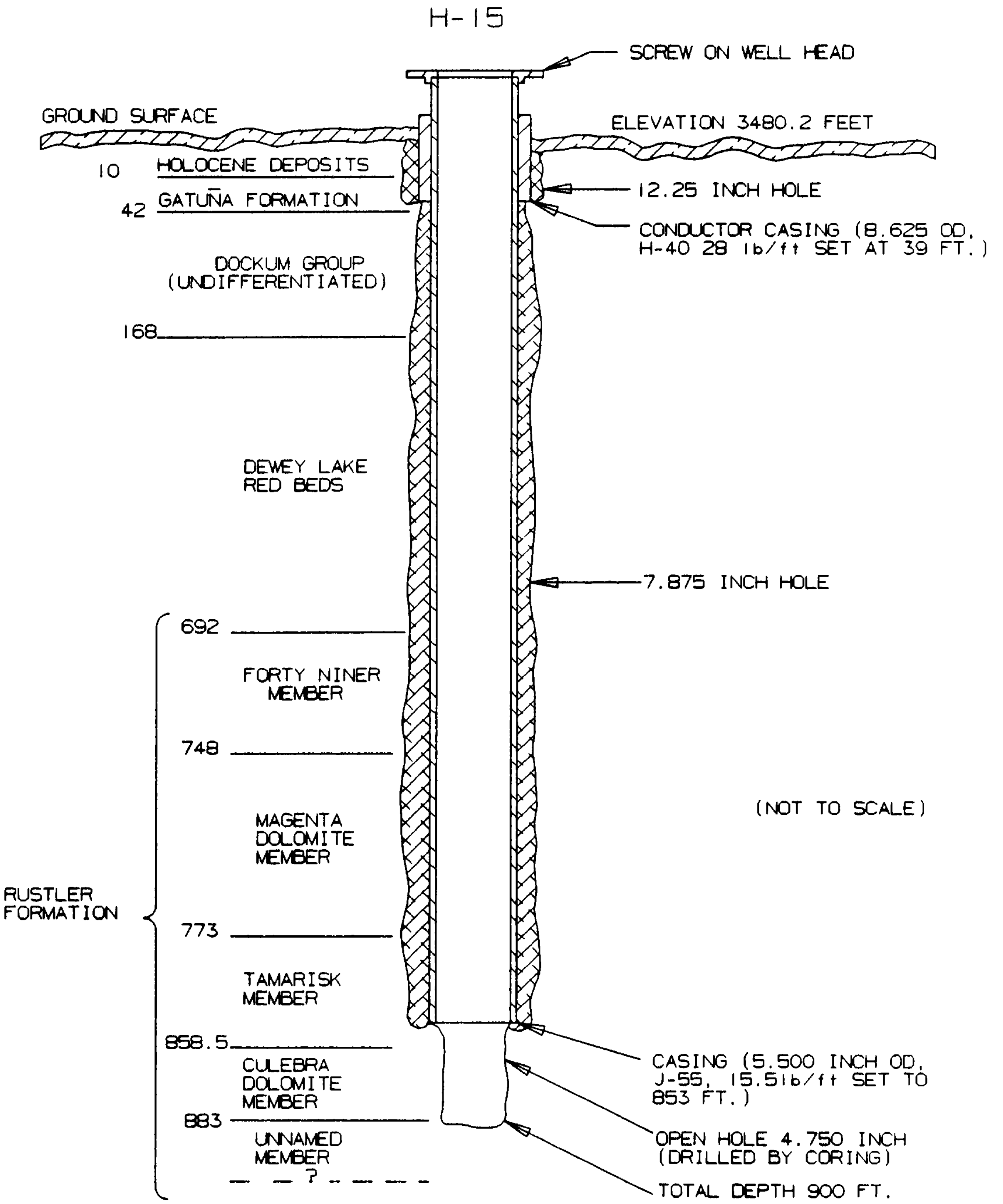
Drillhole Record-

Size (inches)	From (feet)	To (feet)
12-1/4	0	39
7-7/8	39	853
4-3/4	853	900

Casing Record-

Size (inches)	WT/FT (pounds)	From (feet)	To (feet)
8-5/8	(H-40) 28	0	39
5-1/2	(J-55) 15.5	0	853

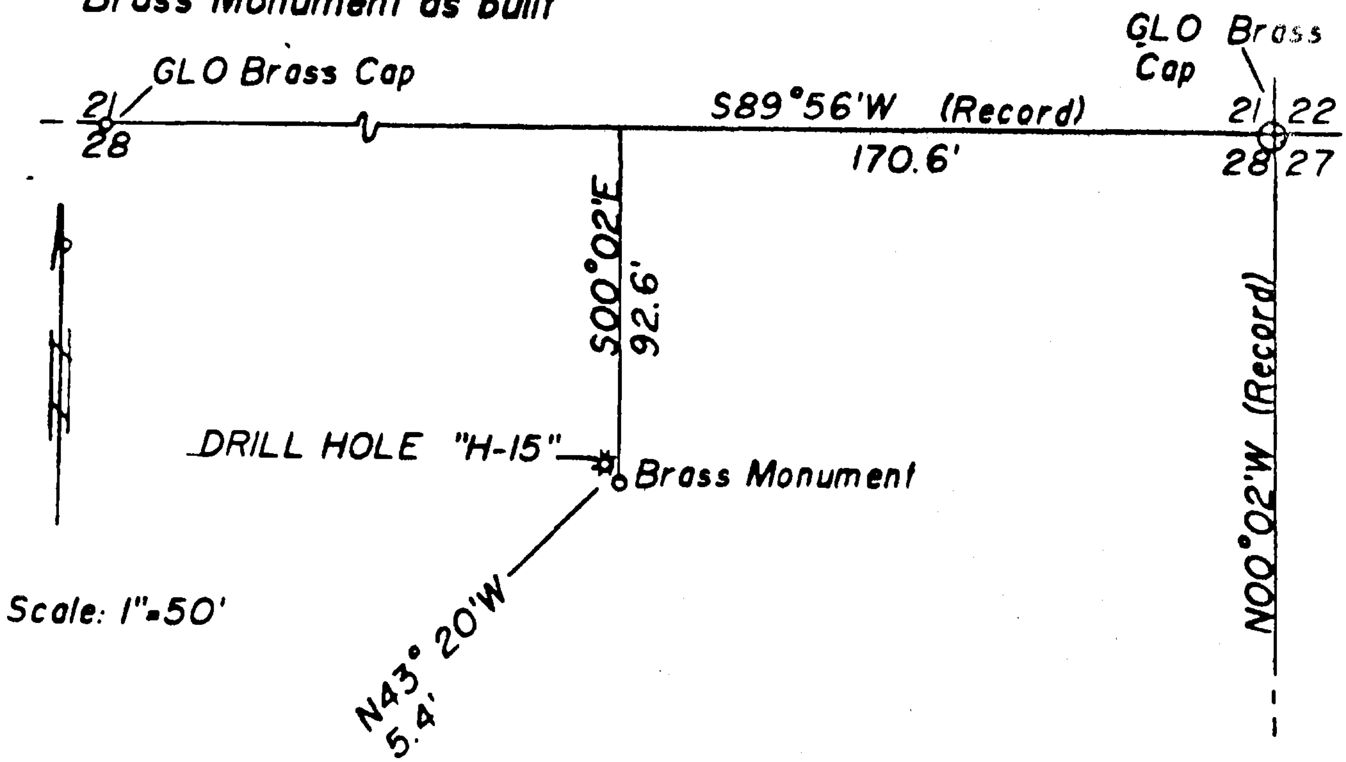
* 4-3/4-inch open hole from 853 feet to the total depth of 900 feet



H-15 HYDROLOGIC TEST HOLE AS BUILT CONDITIONS AFTER COMPLETION ON NOVEMBER 14, 1986.

Plat of Survey

"Brass Monument as built"



LOCATION:
92.6 feet from North Line
170.6 feet from East Line
Section 28
Township 22 South
Range 31 East
Eddy County, New Mexico
Elevation: 3480.2 M.S.L.

CERTIFICATION:

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

Dan R. Reddy 10/10/86

DAN R. REDDY NM PROFESSIONAL ENGINEER AND LAND SURVEYOR 5412

PREPARED FOR: SANDIA LABS

Horizontal Survey 1/5
&
Level loop
to
Sandia Labs

H-15 Sec 28
T22S
R31E
10/8/86

Eddy Co.

DRR cool
WPR &
cloudy

H-15 92.6 FNL
170.6 FEL

2/5

STA	B.S. (+)	H I	F.S (−)	Elev	Remarks
K 349	8.08	12.37		3404.29	Bench Mark
T.P. 1	8.68	16.99	4.06	08.31	Top of pavement
T.P. 2	9.84	25.31	1.52	15.47	do
T.P. 3	8.98	33.80	1.49	23.82	do
T.P. 4	7.46	39.97	1.29	32.51	do
T.P. 5	9.76	48.38	1.35	38.62	do
T.P. 6	10.82	58.84	0.36	48.02	do
T.P. 7	8.19	67.00	0.03	58.81	do
T.P. 8	12.33	79.10	0.23	68.77	Top of Screwdriver
T.P. 9	7.50	88.02	1.58	77.52	Top of Rock
Brass monument	3.56	84.78	3.80	3481.22	B.M set by [illegible]
T.P. 10	1.50	78.01	7.27	79.51	T.P. 9
T.P. 11	2.60	68.36	12.25	66.76	T.P. 8
T.P. 12	0.52	59.32	10.56	58.80	T.P. 7
T.P. 13	0.78	48.84	11.26	47.06	T.P. 6
T.P. 14	1.51	40.15	10.20	39.64	T.P. 5
T.P. 15	1.62	34.14	7.63	32.52	T.P. 4
T.P. 16	1.79	26.60	9.33	24.81	T.P. 3
T.P. 17	1.59	18.05	10.14	16.96	T.P. 2
T.P. 18	4.50	13.78	8.77	07.28	T.P. 1
K 349			8.[illegible]	~~34.0826~~ 3404.26	B.M.

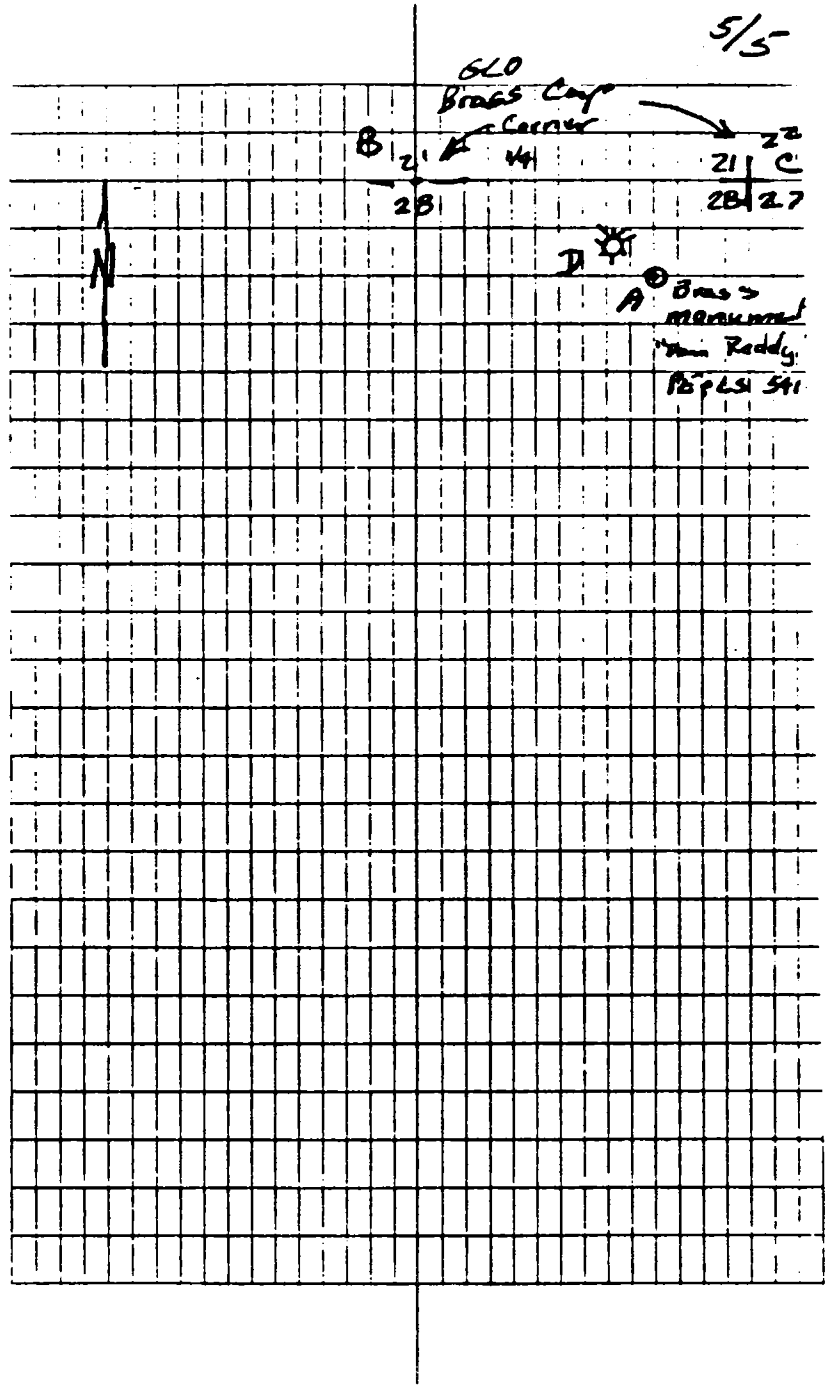
Closure 0.03 low OK

3/5

3480.22

4/5

Sta	Slope Dist	Horiz Angle	Vert ∠	Horiz Distance	
AB	2475.35		90°56'36"	2475.01	
AC	194.21		88°33'51"	194.15	
BAC		149°21'42"			
CB	2644.49		90°56'18"	2644.19	
ACD		01°31'48"			
CD	195.6		neg		


5/5
GLO
Brass Cap
Corner
B
21
28
1/4
21
C
28
27
N
D
A
Brass
monument
Reddy

REFERENCES

Beauheim, R. L., 1987. Interpretations of Single-Well Hydraulic Tests Conducted At and Near the Waste Isolation Pilot Plant (WIPP) Site, 1983-1987, SAND87-0039. Sandia National Laboratories, Albuquerque, NM.

Stensrud, W.A., M.A. Bame, K.D. Lantz, J.B. Palmer, and G.J. Saulnier, Jr., 1987. WIPP Hydrology Program, Waste Isolation Pilot Plant , Southeastern New Mexico, Hydrologic Data Report #5, SAND87-7125. Sandia National Laboratories, Albuquerque, NM.

APPENDIX C

PERMITS AND MISCELLANEOUS DOCUMENTS

STATE OF NEW MEXICO

STATE ENGINEER OFFICE

ROSWELL

S. E. REYNOLDS
STATE ENGINEER

DISTRICT II
909 E. 2nd STREET
P.O.BOX 1717
ROSWELL, NEW MEXICO 88201

September 17, 1986

FILES: 0-08-1469 (H-14)
0-08-1470 (H-15)

Sandia National Laboratories
PO Box 5800
Albuquerque, New Mexico 87185

Attn: Jerry W. Mercer

Dear Mr. Mercer:

Enclosed are your copies of the above numbered Notices of Intention to Drill Exploratory Hole for your files.

Yours truly,

Art Mason

Art Mason
Field Engineering Unit

AM/tmg
Encl.
cc Santa Fe

IMPORTANT – READ INSTRUCTIONS ON BACK BEFORE FILLING OUT THIS FORM

NOTICE OF INTENTION TO DRILL EXPLORATORY HOLE

Eddy
County

Date Received September 12, 1986 File No. 0-08-1469

1. Name Sandia National Laboratories

   Mailing Address P. O. Box 5800

   City and State Albuquerque, New Mexico 87185 - Attn: Div. 7133

2. Hole is to be drilled under contract for U. S. Department of Energy (self or company)

   and is to be known as the H-14.

3. The hole is to located ~350 feet from the South Line and ~550 feet from the West Line of Section 29 Township 22S, Range 31E, N.M.P.M., on land owned by U. S. Government of .

4. Drilling will commence on or about September 19, 1986.

5. Description of Hole: Depth to be drilled 585 feet. It is our intention to:

   a. ☐ complete this hole as follows without cementing casing and to plug this hole immediately after completion of drilling in accordance with the rules and regulations of all appropriate regulatory agencies.

   b. ☒ cement casing and retain hole completed as follows:

Diameter of hole	Casing Size	Casing New/Used	Casing API Grade	Casing Wt/Foot	Interval From	Interval To	Mud or Cement Type	Mud or Cement Sacks
12 1/4	8 5/8	New	H-40	28#	0	40	Batch	To Surf.
7 7/8	5 1/2	New	J-55	15.5#	0	535	70-30 poz Salt resist.	To Surf.
4 1/2	Open Hole				535	585		

6. Location of hole is confidential ____; not confidential X.

7. Logs of hole are confidential ____; not confidential X.

8. Additional statements or explanations: Part of overall hydrologic investigations at the WIPP Site on the Rustler formation; in particular the Culebra Dolomite.

Jerry W. Mercer, depose and say that I have carefully read the foregoing statement and each and all of the items contained therein, and that the same are true to the best of my knowledge and belief.

Jerry W. Mercer
Jerry W. Mercer
Engineering Projects Div. 7133

The above proposed casing, cementing, and plugging program has been ~~reviewed by~~ me, in my capacity as a duly appointed representative of the New Mexico State Engineer, and to the best of my knowledge and belief will be adequate to insure that waters and other minerals will be permanently confined to the zones in which they are encountered. (See reverse side of form for specific State Engineer regulations regarding the drilling of this hole).

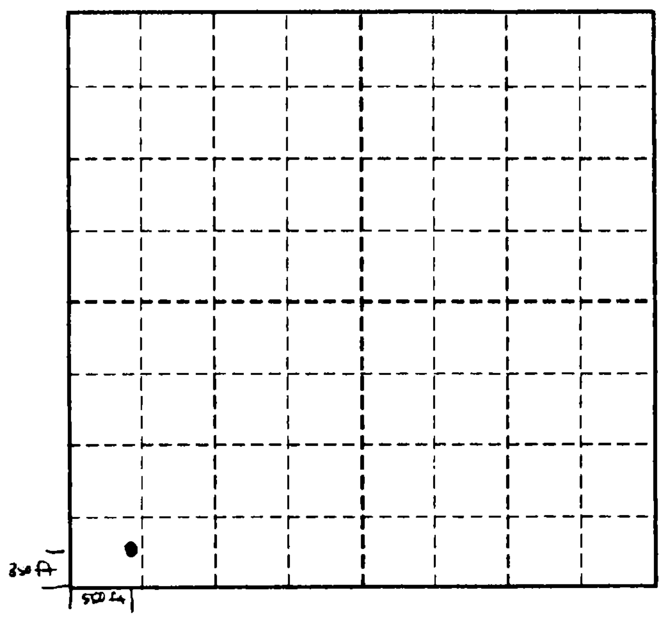
Art Mason
Art Mason, Field Engineering Unit

Date September 17, 1986

1. Drilling of hole shall be subject to compliance with the New Mexico Statutes and all rules and regulations of the State Engineer.
2. Casing shall not be installed or cemented without prior notification of the State Engineer office.
3. Hole shall not be plugged without prior notification of the State Engineer office.
4. Log of hole and plugging record shall be filed with the State Engineer office as soon as hole is completed.

LOCATE HOLE AS ACCURATELY AS POSSIBLE ON FOLLOWING PLAT:

Section(s) 29, Township 22 S., Range 31 W. N.M.P.M.
Elevation 3345



INSTRUCTIONS

This form shall be executed, preferably typewritten, in triplicate.

Each of the triplicate copies must be properly signed.

A separate notice must be filed for each hole drilled.

Sections 1-4 – Fill out all blanks fully and accurately.

Section 7 – Estimate time reasonably required to commence drilling. **Drilling shall not commence until the Engineer is notified.**

Forms should be filed with the Field Engineer, Box 1717, Roswell, New Mexico 88201

May 1972

IMPORTANT – READ INSTRUCTIONS ON BACK BEFORE FILLING OUT THIS FORM

NOTICE OF INTENTION TO DRILL EXPLORATORY HOLE

Eddy
County

Date Received September 12, 1986 File No. 0-08-1470

1. Name Sandia National Laboratories

Mailing Address P. O. Box 5800

City and State Albuquerque, New Mexico 87185 - Attn: Div. 7133

2. Hole is to be drilled under contract for U. S. Department of Energy (self or company)

and is to be known as the H-15.

3. The hole is to located ~100 feet from the North Line and ~170 feet from the East Line of Section 28 Township 22 S. Range 31 E. N.M.P.M., on land owned by U. S. Government of .

4. Drilling will commence on or about September 25, 1986.

5. Description of Hole: Depth to be drilled 915. It is our intention to:

a. ☐ complete this hole as follows without cementing casing and to plug this hole immediately after completion of drilling in accordance with the rules and regulations of all appropriate regulatory agencies.

b. ☒ cement casing and retain hole completed as follows:

Diameter of hole	Casing Size	Casing New/Used	Casing API Grade	Casing Wt/Foot	Interval From	Interval To	Mud or Cement Type	Mud or Cement Sacks
12 1/4	8 5/8	New	H-40	28#	0	40	Batch	To Surf.
7 7/8	5 1/2	New	J-55	15.5#	0	855	70-30 poz Salt resist.	To Surf.
4 1/2	Open	Hole			855	915		

6. Location of hole is confidential ______ ; not confidential X.

7. Logs of hole are confidential ______ ; not confidential X.

8. Additional statements or explanations: Part of overall hydrologic investigations at the WIPP site on the Rustler Formation; in particular the Culebra Dolomite

I, Jerry W. Mercer, depose and say that I have carefully read the foregoing statement and each and all of the items contained therein, and that the same are true to the best of my knowledge and belief.

Jerry W Mercer
Jerry W. Mercer
Engineering Projects Div. 7133
Sandia National Laboratories

The above proposed casing, cementing, and plugging program has been reviewed by me, in my capacity as a duly appointed representative of the New Mexico State Engineer, and to the best of my knowledge and belief will be adequate to insure that waters and other minerals will be permanently confined to the zones in which they are encountered. (See reverse side of form for specific State Engineer regulations regarding the drilling of this hole).

Art Mason
Art Mason, Field Engineering Unit

Date September 17, 1986

1. Drilling of hole shall be subject to compliance with the New Mexico Statutes and all rules and regulations of the State Engineer.

2. Casing shall not be installed or cemented without prior notification of the State Engineer office.

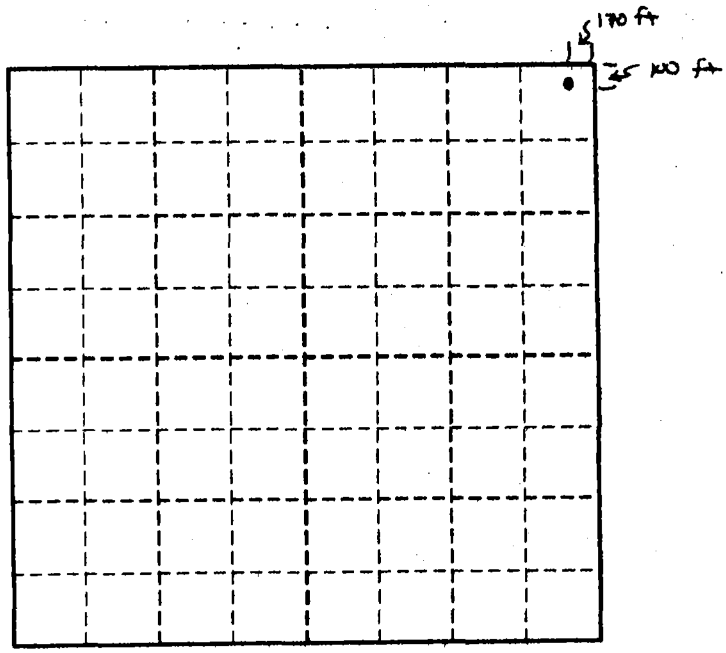
3. Hole shall not be plugged without prior notification of the State Engineer office.

4. Log of hole and plugging record shall be filed with the State Engineer office as soon as hole is completed.

LOCATE HOLE AS ACCURATELY AS POSSIBLE ON FOLLOWING PLAT:

Section(s) 28, Township 22 S., Range 31 E. N.M.P.M.

Elevation 3478



INSTRUCTIONS

This form shall be executed, preferably typewritten, in triplicate.
Each of the triplicate copies must be properly signed.

A separate notice must be filed for each hole drilled.

Sections 1-4 – Fill out all blanks fully and accurately.

Section 7 – Estimate time reasonably required to commence drilling. **Drilling shall not commence until the Engineer is notified.**

Forms should be filed with the Field Engineer, Box 1717, Roswell, New Mexico 88201

Sandia National Laboratories

Albuquerque, New Mexico 87185

date: October 3, 1986

to: Record

from: Jerry W. Mercer, 7133

Jerry W Mercer

subject: Technical and Safety Briefing at H-14 hydrologic exploration hole.

A meeting was held at H-14 drill site on September 25, 1986 at 1755 hours prior to breaking tower. The purpose of the meeting was to discuss the technical objectives of the hole and to outline safety procedures. Jerry Mercer gave an overview of the technical objectives which indicated the holes are part of the overall network of holes to test the Culebra Dolomite member of the Rustler. Good quality samples and core were stressed as the main objectives of the drilling operation. The hole will be drilled with brine water as a circulating agent until such time as it may cause the potential loss of the hole Mud use will be evaluated at this time.

The safety part of the meeting stressed three (3) major points?

1. WIPP site safety requirements

2. Availability of medical facilities at the WIPP site

3. Pennsylvania Drilling Company Safety Plan

The WIPP site safety requirements were reviewed and included location of fire extinguishers, use of occupational safety equipment such as hard hats, safety shoes, and safety glasses (when appropriate).

The availability of medical facilities at the site and their use were discussed. The contractor was informed that medical help such as ambulance etc. was available at the WIPP site. In case of an accident beyond minor first-aid the site security should be notified.

The Pennsylvania safety plan was reviewed and discussed. Emphasis was placed on making the drill site as safe as possible. The need of periodic safety meetings was stressed.

Those in attendance included:

Jay L. Trotte	Pennsylvania Drilling
Gary R. Hieter	Pennsylvania Drilling
Ronald L. Wolf	Pennsylvania Drilling
Rodolfo G. Rodriguez	Pennsylvania Drilling
Maxwell Crass	Pennsylvania Drilling
Steve Kovacs	Pennsylvania Drilling
Rick Beauheim	Sandia National Laboratories
Jerry Mercer	Sandia National Laboratories
Wayne Stensrud	Intera Technologies

JWM:7133:nr

Copy to:
Ray Nations, DOE
Dick Crawley, DOE
6332 Fred Yost
7133 Bob Statler
6331 Al Lappin
6331 Rick Beauheim
Pennsylvania Drilling

Sandia National Laboratories

Albuquerque, New Mexico 87185

Date: October 24, 1986

To: Record

From: Jerry W. Mercer

Subject: Technical and Safety Briefing at the H-15 hydrologic test hole near the WIPP site

A technical and safety briefing was given at the H-15 site on October 24, 1986 at 0930 hours, prior to the beginning of drilling operations. Jerry Mercer gave an overview of the technical objectives of the drill hole indicating that, in general, they were the same as the objectives for H-14 which had just been completed. Collection of good quality samples and core were stressed.

The safety of the drilling operations was again stressed. The three major points discussed included:

1. WIPP site safety requirements

2. Availability of medical facilities at the WIPP site

3. Pennsylvania Drilling Company Safety Plan

The WIPP site safety requirements were reviewed emphasing placement of fire extinguishers, use of occupational safety equipment such as hard hats, safety shoes, and safety glasses (when appropriate). It was also discussed that caution should be used when pulling out on the paved road when leaving the drilling site as this road is well traveled.

The availability of medical facilities at the WIPP site and their use was reviewed. The contractor was informed that a medical technician was available and so was the use of an ambulance.

Because Pennsylvania Drilling Company is using the Safe Operation Procedures for Drilling published by International Association of Drilling Contractors (IADC) as a guideline, the applicable sections were reviewed. Drill crews were reminded that it was their job as well to make the drilling site as safe as possible. There was no known drilling hazards outside of normal operations expected at this location.

Copy to:

Ray Nations, DOE
Dick Crawley, DOE
6332 Fred Yost
7133 Bob Statler
6331 Al Lappin
6331 Rick Beauheim
Pennsylvania Drilling
File

SANDIA NATIONAL LABORATORY
INSTRUCTIONS TO LOGGING COMPANY

Date OCTOBER 6, 1986 Logging Company DRESSER - ATLAS

Prepared By JERRY W MERCER Logging Engineer GERALD VAUGHN

Witnessed By Jerry W Mercer

Log Headings:

Company DEPARTMENT OF ENERGY

Well Number H - 14

Field WIPP SITE

County EDDY State NEW MEXICO

Location ~ 350 FSL AND ~ 550 FWL (SURVEYED LOCATION WILL BE PROVIDED LATER

Section 29 Township 22S Range 31E

Permanent Datum: ground level (G.L.) Elevations: G.L. ~ 3347

drill floor (D.F.) D.F. ____

kelley bushing (K.B.) K.B. ____

Hole Status

	SIZE	FROM	TO		SIZE	FROM	TO
Casings	8 5/8"	0	39.5 FT	Borehole	12 1/4"	0	39.5 FT
					7 7/8"	39.5	533 FT

Fluid Status

Type Fluid in Borehole BRINE Fluid Level WILL BE FULL DURING LOGGING Fluid Loss NA

Density 10 lb/gal pH — Viscosity —

Purpose of Logging Program, Zones of Special Interest, Critical Hole Conditions, Remarks, Etc. Purpose is to obtain stratigraphic and hydrologic data to the top of the Culebra Fm. The logs will be used for stratigraphic correlation and hydrologic analyses. All logs to be recorded on same depth

Number of Prints: Field 10 Final 15

Send to : Sandia National Laboratories
P. O. Box 5800, Division 7133 Attn. Jerry W. Mercer
Albuquerque, New Mexico 87185

Log Number *1 - DUAL LATEROLOG

(a.) Vertical Depth Scales 2-inches/100 feet and 5-inches/100feet
(b.) Horizontal Logging Scales Dresser Standard
(c.) Logging Speed Desired ~ 30 FT/MIN
(d.) Interval to be Logged Total depth to surface casing
(e.) Zones of Special Interest total hole
Gamma 0 - 100 API

(f.) Special Instructions Drill crew will insure the hole is full of fluid during logging

---

Log Number *2 - GAMMA-RAY COMPENSATED NEUTRON

(a.) Vertical Depth Scales 2-inches/100 feet and 5-inches/100feet
(b.) Horizontal Logging Scales Dresser Standard (Limestone -15 to 45%)
(c.) Logging Speed Desired ~ 30 FT/MIN
(d.) Interval to be Logged TOTAL HOLE
(e.) Zones of Special Interest TOTAL HOLE

(f.) Special Instructions GAMMA - 0 - 100 API
CALIPER 6" - 16"
Neutron -15 - 45% on Limestone
Drill crew will keep hole full of fluid during logging operations

---

Log Number *3-COMPENSATED DENSILOG W/GAMMA

(a.) Vertical Depth Scales 2-inches/100 feet and 5-inches/100feet
(b.) Horizontal Logging Scales Density 2.0 - 3.0 with 1.0 - 2.0 BKUP
(c.) Logging Speed Desired ~ 30 FT/MIN
(d.) Interval to be Logged TOTAL DEPTH TO SURFACE CASING
(e.) Zones of Special Interest TOTAL HOLE

(f.) Special Instructions GAMMA 0 - 100 API
CALIPER 6" - 16"
Density 2.0 - 3.0 w/ 1.0 - 2.0 BKUP
Drill crew will insure hole is full of fluid during logging operations

---

* Logs do not need to be run in this sequence

Log Number * 4 - BHC - ACOUSTILOG

(a.) Vertical Depth Scales 2-inches/100 feet and 5-inches/100feet
(b.) Horizontal Logging Scales 40 - 140 us/FT WITH 140 - 240 BKUP
(c.) Logging Speed Desired ≈ 40 FT/MIN
(d.) Interval to be Logged Total Depth to Surface casing
(e.) Zones of Special Interest Total hole

(f.) Special Instructions Acoustic 40-140 us/FT w/ 140-240 BKUP
Gamma 0 - 100 API

Drill crew will insure hole is full of fluid during logging operations

— END OF LOGS —

Log Number *

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

(f.) Special Instructions

Log Number *

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

(f.) Special Instructions

---

* Logs do not need to be run in this sequence

SANDIA NATIONAL LABORATORY
INSTRUCTIONS TO LOGGING COMPANY

Date NOVEMBER 6, 1986 Logging Company Dresser - Atlas

Prepared By Jerry W Mercer Logging Engineer Alexander

Witnessed By Jerry W Mercer

Log Headings:

Company DEPARTMENT OF ENERGY

Well Number H-15

Field WIPP

County EDDY State NM

Location BRASS MONUMENT WHICH IS 5.4 FT SE OF Hole ~~92.6 FNL & 170.6 FEL~~

Section 28 Township 22S Range 31E

Permanent Datum: ground level (G.L.) Elevations: G.L. 3480.2

drill floor (D.F.) D.F. NA

kelley bushing (K.B.) K.B. NA

Hole Status

	SIZE	FROM	TO		SIZE	FROM	TO
Casings	8 5/8"	0	39.5	Borehole	12 1/4"	0	39.5 FT
					7-7/8"	39.5 FT	854

Fluid Status

Type Fluid in Borehole Brine Fluid Level Surface Fluid Loss —

Density — pH — Viscosity —

Purpose of Logging Program, Zones of Special Interest, Critical Hole Conditions, Remarks, Etc. Purpose is to obtain stratigraphic and hydrologic data to top of Culebra MBR OF RUSTLER Fm The logs will be used for stratigraphic correlation and hydro analyses. All logs to be recorded on same depth. Fast breaks should be readable

Number of Prints: Field 10 Final 15

Send to : Sandia National Laboratories
P. O. Box 5800, Division 7133 Attn. Jerry W. Mercer
Albuquerque, New Mexico 87185

Log Number *1 - DUAL LATEROLOG

(a.) Vertical Depth Scales 2-inches/100 feet and 5-inches/100feet
(b.) Horizontal Logging Scales Dresser-Atlas standard
(c.) Logging Speed Desired ~ 30 feet/minute
(d.) Interval to be Logged Total depth to bottom of surface casing
(e.) Zones of Special Interest Total hole

(f.) Special Instructions Gamma 0 - 100 API
Resistivity 0.2 - 2000 OHM/m
w/ 2000 - 20000 BKUP
Drill crew will insure hole remains full of fluid during logging operations

---

Log Number * 2 - COMPENSATED NEUTRON W/GAMMA

(a.) Vertical Depth Scales 2-inches/100 feet and 5-inches/100feet
(b.) Horizontal Logging Scales Dresser-Atlas standard (Limestone -15-45%)
(c.) Logging Speed Desired ~ 30 FT/MIN
(d.) Interval to be Logged Total hole
(e.) Zones of Special Interest Total hole

(f.) Special Instructions Gamma 0 - 100 API
Caliper 6" - 16"
Neutron porosity -15% to 45%
Drill crew will insure hole is full of fluid during logging operations

---

Log Number * 3 - COMPENSATED DENSILOG W/GAMMA

(a.) Vertical Depth Scales 2-inches/100 feet and 5-inches/100feet
(b.) Horizontal Logging Scales Density 2.0 - 3.0 w/ 1.0 - 2.0 BKUP
(c.) Logging Speed Desired ~ 30 feet/minute
(d.) Interval to be Logged total depth to bottom of surface casing
(e.) Zones of Special Interest TOTAL HOLE

(f.) Special Instructions GAMMA 0 - 100 API
Caliper 6" - 16"
Density (gm/cm^3) 2.0 - 3.0 w/ 1.0 - 2.0 BKUP
Drill crew will insure hole remains full of fluid

---

* Logs do not need to be run in this sequence

Log Number * 4 - BHC ACOUSTILOG w/ GAMMA

(a.) Vertical Depth Scales 2-inches/100 feet and 5-inches/100feet
(b.) Horizontal Logging Scales 40 - 140 µs/ft with 140 - 240 BKUP
(c.) Logging Speed Desired ~ 40 feet/minute
(d.) Interval to be Logged Total Depth of hole
(e.) Zones of Special Interest Total hole

(f.) Special Instructions Acoustic 40 - 140 µs/ft w/ 140 - 240 BKUP
Gamma 0 - 100 API

Drill crew will insure hole is full of fluid

- END OF LOGS -

Log Number *

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

(f.) Special Instructions

Log Number *

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

(f.) Special Instructions

---

* Logs do not need to be run in this sequence

LOG QUALITY REPORT

Hole H-14 Log Date 10/6/86 Current Date 10/6/86

Log NEUTRON-GAMMA Run # 1 Engr. Vaughn

Field Print [✓] Final Print [ ] Log Analyst Jerry W Mercer

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

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

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

LOG QUALITY REPORT

Hole H-14 Log Date 10/6/86 Current Date 10/6/86

Log COMPENSATED DENSILOG W/GAMMA Run # 1 Engr. Vaughn

Field Print ☑ Final Print ☐ Log Analyst Jerry W Mercer

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

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

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

LOG QUALITY REPORT

Hole H - 14 Log Date 10/6/86 Current Date 10/6/86

Log BHC - ACOUSTILOG Run # 1 Engr. Vaughn

Field Print [✓] Final Print [ ] Log Analyst Jerry Mercer

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

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

	YES	NO	Remarks
A. HEADING			
1. Correct Heading Used	✓		
2. Heading Data Properly Completed	✓		
3. Logging Data Section Completed	✓		
4. Equipment Data Section Completed	✓		
5. Scale Changes Noted on Heading	✓		
6. Are all abnormal conditions explained in the remarks section	✓		
B. CALIBRATIONS AND SCALES			
1. Scales Correct for Area	✓		
2. Scales Labelled	✓		
3. Scale Changes Labelled	✓		
4. Zeroes Recorded	✓		
5. Before Log Calibrations	✓		
6. After Log Calibrations			B6 - Afterlog calibrations not on print
7. Repeat Section Recorded	✓		
8. Repeat Section Acceptable	✓		
C. VALIDITY OF LOG			
1. Curves Functioning Correctly	✓		
2. Do Log values fall within reasonable limits	✓		
3. Curves on Depth	✓		
4. Logging Speed Indicated	✓		
5. Logging Speed Correct	✓		
D. APPEARANCE			
1. Printing or Typing Neat	✓		
2. Printing or Typing Accurate	✓		
3. Grid and Pen Traces	✓		
4. Splices Straight and Clean	✓		
5. Film Correctly Processed	✓		
6. General Print Quality	✓		

LOG QUALITY REPORT

Hole H - 14 Log Date 10/6/86 Current Date 10/6/86

Log DUAL LATEROLOG Run # 1 Engr. Vaughn

Field Print ☑ Final Print ☐ Log Analyst Jerry W Mercer

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

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

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

Remarks:

C

C-2 correct resistivity to other logs

LOG QUALITY REPORT

Hole: H-15 Log Date: 11/6/86 Current Date: 11/6/86

Log: NEUTRON-GAMMA Run #: 1 Engr.: Alexander

Field Print: ✓ Final Print: [ ] Log Analyst: J.W. Mercer

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

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

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

Remarks:

C-3 Curves on Neutron off 1 ft

LOG QUALITY REPORT

Hole H-15 Log Date 11/6/86 Current Date 11/6/86

Log COMPENSATED DENSILOG w/ GAMMA Run # 1 Engr. Alexander

Field Print [✓] Final Print [ ] Log Analyst J.W Mercer

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

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

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

LOG QUALITY REPORT

Hole H-15 Log Date 11/6/86 Current Date 11/6/86

Log BHC- ACOUSTILOG Run # 1 Engr. Alexander

Field Print ☑ Final Print ☐ Log Analyst J.W Mercer

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

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

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

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LOG QUALITY REPORT

Hole H-15 Log Date 11/6/86 Current Date 11/6/86

Log DUAL LATEROLOG W/GAMMA Run # 1 Engr. Alexander

Field Print ✓ Final Print Log Analyst J.W. Mercer

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

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

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

APPENDIX D

LIST OF GEOPHYSICAL LOGS RUN

The following geophysical logs for H-14 are incorporated in this appendix by reference

Type of Log	Date	Depth Driller	Depth Logger	Interval Logged
(Logged by the US Geological Survey)				
Natural Gamma	10-06-86	533 ft	533 ft	0-- 530 ft
Natural Gamma (Deepened)	11-06-86	589 ft	570 ft	0-- 570 ft
Gamma-Gamma Density	10-06-86	533 ft	531 ft	0-- 531 ft
Gamma-Gamma Density(Deepened)	11-06-86	589 ft	568 ft	0-- 568 ft
Neutron	10-06-86	533 ft	531 ft	0-- 531 ft
Neutron (Deepened)	11-06-89	589 ft	568 ft	0-- 568 ft

*logs available from the US Geological Survey, Albuquerque,NM

Type of Log	Date	Depth Driller	Depth Logger	Interval Logged
(Logged by Dresser Atlas)				
Compensated Neutron-Gamma Ray	10-06-86	533 ft	532 ft	10--530 ft
Compensated Densilog-Gamma Ray	10-06-86	533 ft	534 ft	37--531 ft
BHC Acoustilog Gamma Ray	10-06-86	533 ft	531 ft	38--524 ft
Dual Laterolog Gamma Ray	10-06-86	533 ft	531 ft	38--530 ft

Note: The deepened part of the hole from 532 ft to 589 ft was not logged by Dresser Atlas. Logs are available for review at Sandia National Labs, PO Box 5800, Albuquerque, New Mexico.

The following geophysical logs for H-15 are incorporated in this appendix by reference

Type of Log	Date	Depth Driller	Depth Logger	Logged Interval
(Logged by the US Geological Survey)				
Natural Gamma	11-06-86	854 ft	854 ft	0-- 854 ft
Natural Gamma (Deepened)	11-18-86	900 ft	900 ft	800---900 ft
Gamma-Gamma Density	11-06-86	854 ft	854 ft	96- 854 ft
Gamma-Gamma Density(Deepened)	11-18-86	900 ft	900 ft	800--900 ft
Neutron	11-06-86	854 ft	854 ft	0-- 854 ft
Neutron (Deepened)	11-18-89	900 ft	900 ft	800---900 ft

*logs available from the US Geological Survey, Albuquerque,NM

Type of Log	Date	Depth Driller	Depth Logger	Interval
(Logged by Dresser Atlas)				
Compensated Neutron-Gamma Ray	11-06-86	854 ft	853 ft	0--851 ft
Compensated Densilog-Gamma Ray	11-06-86	854 ft	856 ft	42---850 ft
BHC Acoustilog Gamma Ray	11-06-86	854 ft	856 ft	42---849 ft
Dual Laterolog Gamma Ray	11-06-86	854 ft	853 ft	42---850 ft

Note: The deepened part of the hole from 854 ft to 900 ft was not logged by Dresser Atlas. Logs are available for review at Sandia National Labs, PO Box 5800, Albuquerque, New Mexico.

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