DOE/WIPP 01-3210

Basic Data Report
For Drillhole C-2737
(Waste Isolation Pilot Plant - WIPP)

Dennis W. Powers
Consulting Geologist
140 Hemley Road
Anthony, TX 79821

March 2002

Basic Data Report
For Drillhole C-2737
(Waste Isolation Pilot Plant - WIPP)

Dennis W. Powers
Consulting Geologist
140 Hemley Road
Anthony, TX 79821

1.0 Abstract

C-2737 was drilled to provide hydrological monitoring of the Culebra Dolomite and Magenta Dolomite Members of the Permian Rustler Formation near the surface facilities of the Waste Isolation Pilot Plant (WIPP). C-2737 is, in effect, a replacement for H-1, which was plugged and abandoned as C-2737 was being completed. C-2737 is located in the northeast quarter of section 29, T22S, R31E, in eastern Eddy County, New Mexico. C-2737 was drilled to a total depth of 710 ft below the ground surface. Below surface dune sand and the Berino soil, C-2737 encountered in order the Mescalero caliche, Gatuña Formation, Santa Rosa Formation, Dewey Lake Formation, and the Rustler Formation. Three intervals were cored: the upper Dewey Lake; the Magenta Dolomite and uppermost Tamarisk Member; and the lowermost Tamarisk, Culebra Dolomite, and upper Los Medaños Member of the Rustler Formation. There was no halite in the upper Los Medaños Member. Geophysical logs were acquired after reaching TD.

Water was encountered in the upper Dewey Lake, and the drilling method was subsequently changed from air to brine for both coring and rotary drilling. Fiberglass casing was placed in the hole, with screens across the Culebra and Magenta Dolomites. The annulus across the Culebra and Magenta intervals was filled with sand, and the intervals were separated by bentonite. Bentonite was placed on top of the upper sand pack, and the annulus was cemented to the surface above. After initial well development, a packer was placed in the casing to separate the Magenta and the Culebra, and water levels for both intervals are being monitored.

Table of Contents

Table of Contents, cont.

Table of Figures & Tables

2.0 Introduction

C-2737 was drilled in the northeast quarter of Section 29, T22S, R31E, in eastern Eddy County, New Mexico (Figure 2-1). It is located 527.3 ft from the east line (fel) and 1513.3 ft from the north line (fnl) of the section (Figure 2-2). This location places the drillhole approximately over the center of the area being developed as panels for waste disposal. C-2737 is used to monitor ground water levels in both the Culebra and Magenta Dolomite Members of the Rustler Formation.

Most drillholes at WIPP have been described after completion to provide an account of the geology, hydrology, or other basic data acquired during drilling and immediate completion of the drillhole. In addition, the basic data report provides an account of the drilling procedures and activities that may be helpful to later interpretations of data or for further work in the drillhole, including test activities and eventual plugging and abandoning activities. The basic data report also provides a convenient means of reporting information about administrative activities necessary to drill the hole.

2.1 Purpose of WIPP

The WIPP is a US Department of Energy facility disposing of transuranic and mixed waste, byproducts of US defense programs, under permits issued respectively by the US Environmental Protection Agency and the New Mexico Environment Department. The WIPP is located about 25 miles east of Carlsbad, New Mexico, in eastern Eddy County (Figure 2-1). Disposal panels are being excavated in the Permian Salado Formation at a depth of about 2150 ft below ground level.

2.2 Purpose of C-2737

C-2737 was designed and located to provide a long-term monitoring point for water levels of the Magenta and Culebra Dolomites as a replacement for drillhole H-01 (Figure 2-1; Appendix A).

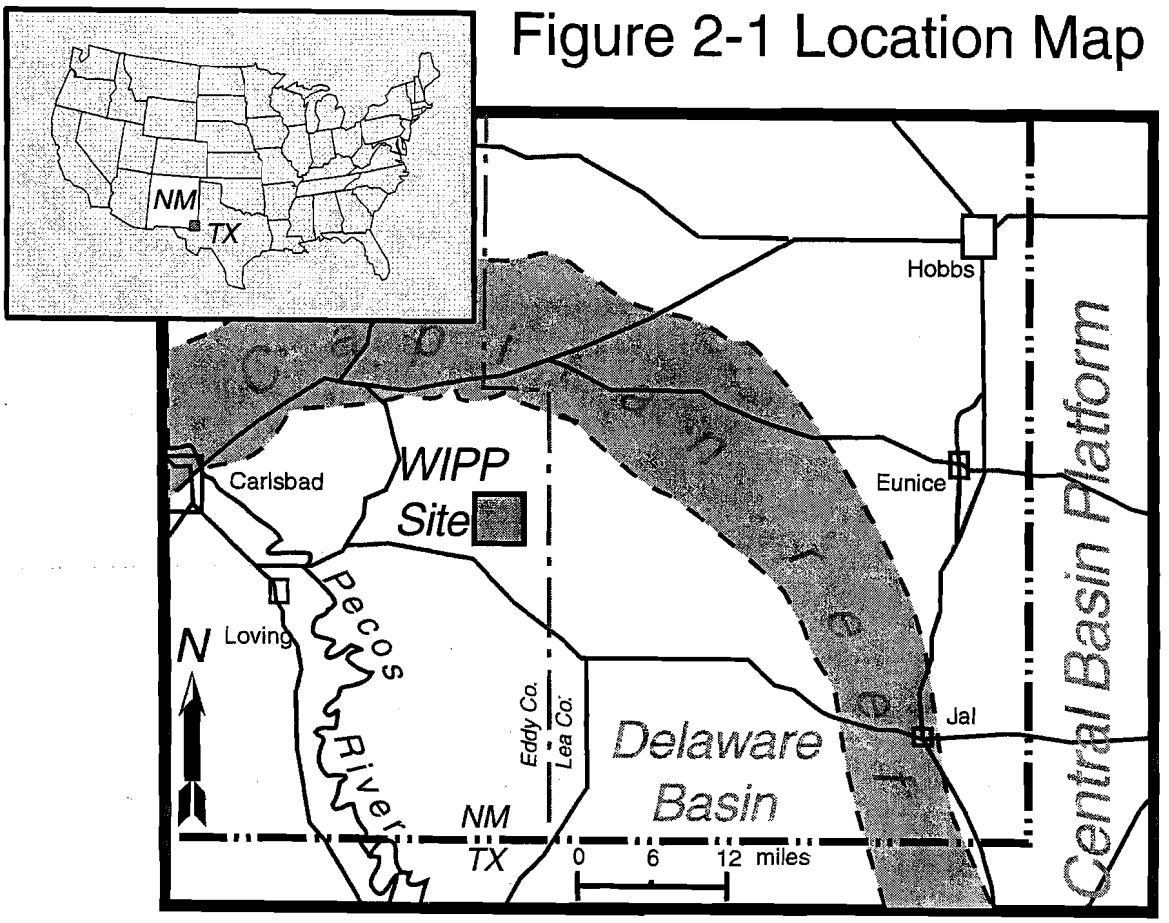
Water levels for the Magenta in H-01 rose relatively steadily about 3.1 ft/yr from early 1994 to July, 1997. From about July 1997 to April 1998, water levels in the Magenta rose about 85 ft above previous levels, and Magenta water levels continued to fluctuate by tens of feet in the following two years. At the same time, Culebra water levels monitored in H-01 during these times show modest changes, such as the drop (about 10 ft) in response to the Water Quality Sampling Program (WQSP) activities at H-03 in May 1995 and pumping tests of other WQSP wells in 1996. H-01 was inspected, and it was discovered that the casing had holes in it at depths of about 40 ft. As a result, H-01 was removed from the groundwater monitoring program, and it was plugged and abandoned on February 26, 2001 (Jones, 2001).

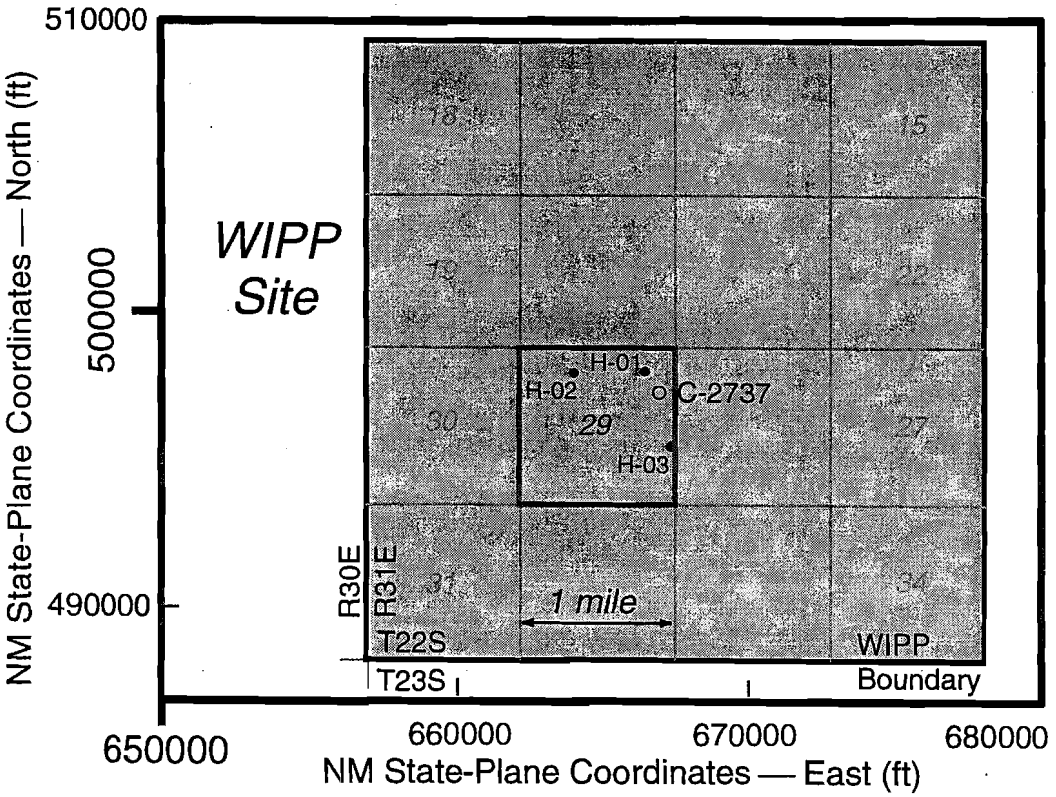
C-2737 was located in the vicinity of H-01, above areas where future waste disposal panels will be excavated (Figure 2-2). That provides the additional prospect of monitoring water levels over the waste panels during construction and after closure (Beauheim, 2000, in Appendix A).

2.3 Other Background

C-2737 was drilled and completed by the West Texas Water Well Service, 3432 W. University, Odessa, TX, under contract #3737 from Westinghouse Government Environmental Services Company (Appendix A). Coring was done by Johnny Wood, Diamond Oil Well Drilling Co., Inc., P.O. Box 7843, Midland, TX. Geophysical logging was conducted by Raymond Federwisch, Geophysical Logging Services, 6250 Michele Lane, Prescott, AZ, as part of the West Texas Water Well Service contract. Geological support was provided by Dennis W. Powers under contract #4739 from Westinghouse TRU Solutions. Archeological clearances obtained from the US Bureau of Land Management were based on field work and reports by Pecos Archeological Consultants, P.O. Box 1771, Carlsbad, NM (Appendix D). Mike Stapleton of the New Mexico Office of the State Engineer witnessed hole completion activities. C-2737 is part of the Groundwater Monitoring Program directed by the Environmental Monitoring Department, Westinghouse TRU Solutions LLC.

Figure 2-1 Location Map





C-2737 Fig 1 location.ai

Figure 2-2 Plat Map of C-2737 Location

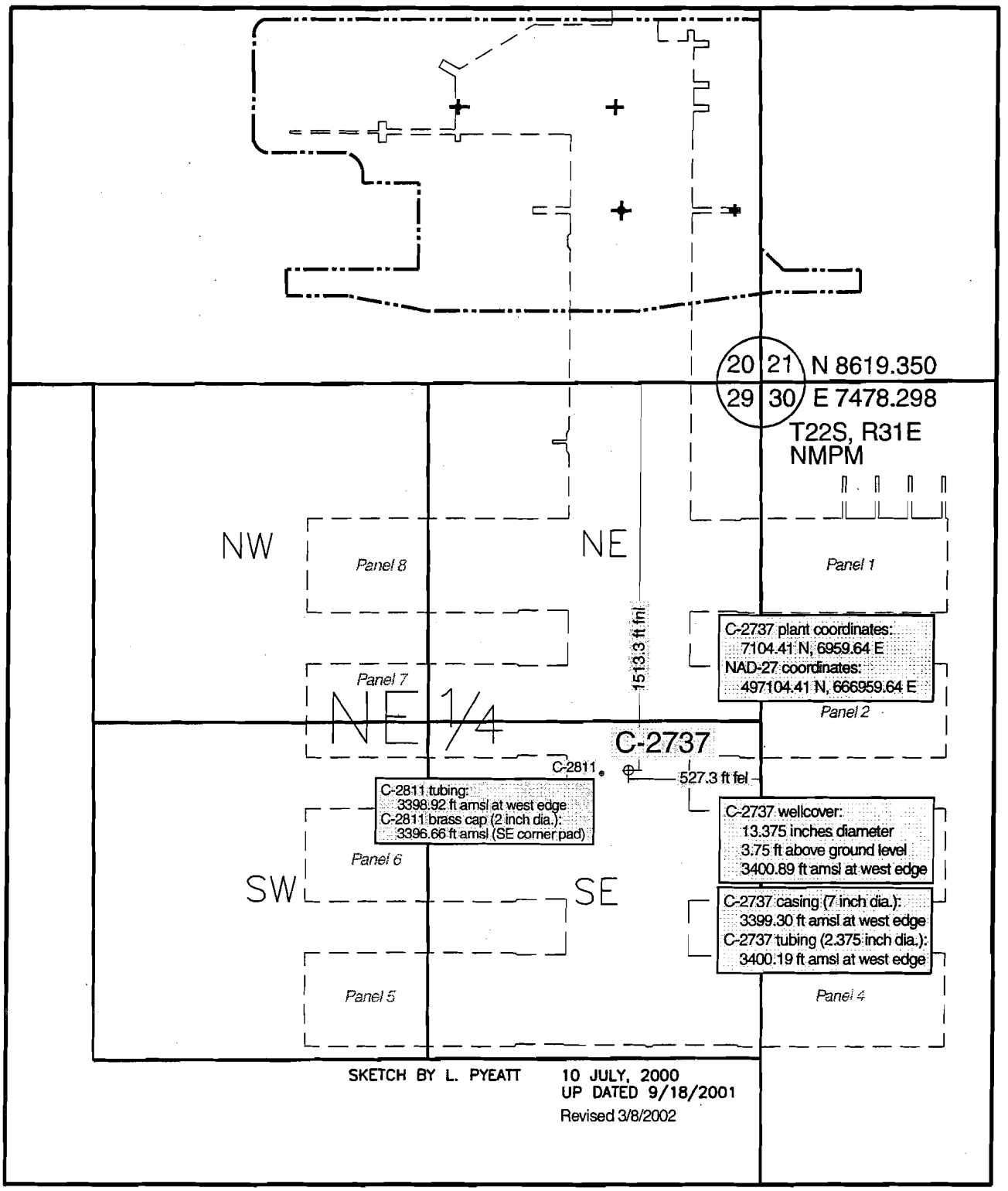


Figure 2-2.ai

As possible, C-2737 was to be drilled and cored using air to circulate cuttings out of the drillhole. Groundwater was encountered at shallow depths, and it was necessary to use brine for all subsequent drilling and coring. Following completion of C-2737, a drillhole designated C-2811 was drilled at the west side of the drillpad (Figure 2-2) and completed to monitor water levels and permit sampling of the shallow groundwater.

In keeping with practice at the WIPP site, the basic data for C-2737 are reported in the inch-pound or English system; metric equivalents are given in one figure. The following conversion factors for metric equivalents may be useful:

MULTIPLY ENGLISH UNIT	BY	TO OBTAIN METRIC UNIT
foot (ft)	0.3048	meter (m)
inch (in)	25.4	millimeter (mm)
inch (in)	2.54	timeter (cm)
pounds (lb)	0.4536	kilogram (kg)

2.4 C-2737 Drillhole Statistics

The basic information about drilling and completion of C-2737 are presented here in tabular form for ease of reference. Appendix B includes details based on daily drilling logs.

Table 2-1. Summary of Drilling and Well Completion Records For Hydrologic Drillhole C-2737

WELL NAME: C-2737

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

SURFACE COORDINATES: The well is located 1513.3 ft from the North line (fnl) and 527.3 ft from the East line (fel) of Section 29. The NM State Plane (NAD 27) coordinates are 497104.41 N, 666959.64 E. (Figure 2-2 shows the survey plat.)

ELEVATION: All depths used in reporting data here are reported below ground level (bgl), which is 3397.14 ft above mean sea level (amsl). The primary datum for the well is 3400.89 ft amsl for the west edge of the wellcover. Figure 2-3 shows the as-built configuration of C-2737.

DRILLING RECORD:

Dates: Began drilling February 14, 2001; drillhole reamed to total depth (710 ft) on March 4, 2001. Geophysical logging was conducted on March 5, 2001. Drillhole prepared for casing, cased, and cemented March 4 through March 8, 2001. C-2737 well development began March 9, 2001; test pump was removed on March 13, 2001 and rig was moved off the drillpad. (On March 12, 2001, the rig was used to drill and case C-2811 to 80 ft bgl on the west side of the drill pad to monitor shallow ground water.)

Circulation Fluid: C-2737 was drilled to 90.7 ft bgl with circulating air. Because of water encountered at shallow depths, the remainder of C-2737 was drilled, cored, and reamed using brine as a circulating medium. Flowzan biopolymer was added to the brine to improve circulation.

Cored Intervals: 4.0-inch core was taken from the following intervals:

181.0-231.0 ft bgl: upper Dewey Lake Fm

561.0-588.3 ft bgl: Magenta Dolomite Member and upper Tamarisk Member

665.0-710.0 ft bgl: lower Tamarisk Member, Culebra Dolomite Member, upper Los Medaños Member

Rig and Drilling Contractor: Gardner-Denver 1500; West Texas Water Well Service, 3432 W. University, Odessa, TX

Drillhole Record:

Size (inches)	From (ft bgl)	To (ft bgl)
18	0	30
12.25	30	710

Casing Record:

Size (inches)	Weight/ft (pounds)	From (ft bgl)	To (ft bgl)
13.375		~0	30
7.0	fiberglass	+2.16	710

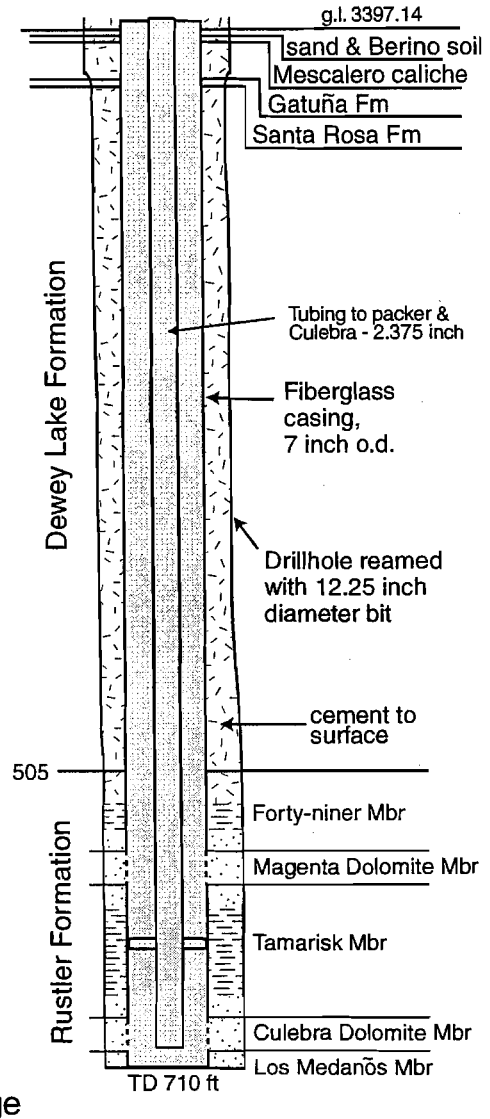
Coring Record:

Core Run No.	Depth Interval (ft) From	To	Interval (ft) Cored	Recovered	Recovered %
1	181	199	18	9.3	52
2	199	209	10	10	100
3	209	231	22	22	100
4	561	588.3	27.3	25.75	94
5	665	682	17	16.8	99
6	682	696.5	14.5	5	34
7	696.5	710	13.5	13.5	100
		Totals	**122.3**	**102.35**	**84**

Figure 2-3
C-2737
As-built Diagram

(3/8/2002)

General Stratigraphy and Configuration



Surface Configuration and Elevations

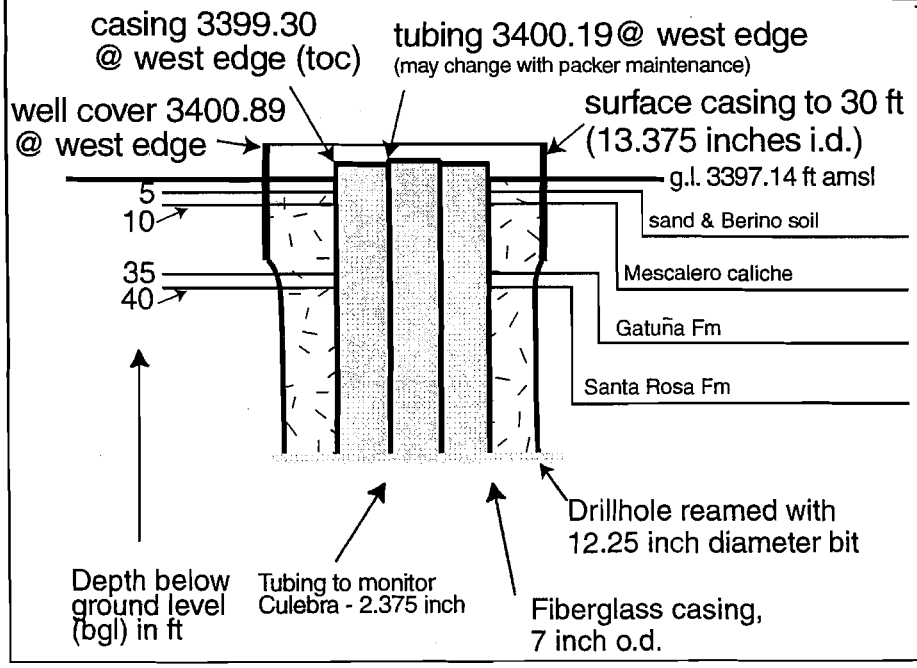


Figure 2-3.ai

3.0 Geological Data

3.1 General Geological Background

The geology and hydrology of formations at the WIPP site and surroundings have been intensively investigated since 1975, and the information and interpretations have been reported in numerous documents. The most thorough compilation is certainly the Compliance Certification Application (CCA) submitted in 1996 by the US Department of Energy to the US Environmental Protection Agency. Some salient features of the broader geological history are relevant to understanding the geology and hydrology at C-2737.

The Delaware Basin (Figure 2-1) was a large structural feature that controlled deposition through much of the Paleozoic. By late Permian, the basin was restricted, and evaporite minerals dominated. The basin filled with sediments, and it no longer significantly affected sedimentation. Near the end of the Permian, circulation with the ocean improved, and some of the Rustler Formation, for example, was deposited in saline water rather than brine. As the Permian ended and Triassic began, continental environments prevailed, and significant redbeds were deposited. Although surrounding areas accumulated variable thicknesses of later Mesozoic and Cenozoic age sediments, the WIPP area appears to have mainly been subject to erosion during an extended period. Some basin tilting from mid- to late Cenozoic exposed the evaporite beds to faster solution and erosion, and weathered material began to accumulate. The Pecos River drainage became integrated through the region during this period, and more recent deposits reflect such a sedimentary environment as well as sources of sediment from outside the local area. Although the region continues to be subject to some dissolution of evaporites and erosion, large areas have remained geologically stable for about the last half million years, resulting in the formation and preservation of pedogenic calcrete (caliche) deposits.

3.2 Geological Data From C-2737

C-2737 encountered a normal stratigraphic sequence in the central part of the WIPP site area from ground level to total depth (Table 3-1; Figure 3-1). Units encountered ranged from unconsolidated surficial sands to the upper part of the Los Medaños Member of the Permian Rustler Formation. No unusual structural, sedimentological, or diagenetic features were found during investigation using cuttings, cores, and geophysical logs. Shallow groundwater was encountered during drilling to about 97 ft bgl, and drilling methods were modified to use brine. The shallow groundwater is discussed briefly in section 4.0.

The geologic units encountered in C-2737 are described from total depth to the surface, in the order in which they were deposited rather than in the order in which they were encountered in the drillhole. Cores and cuttings were described in the field using drilling records for depth control; the difference between geophysical logs and drilling depths is slight. Geologic logs detailing observations of cuttings and cores are included in Appendix C.

3.2.1 Permian Rustler Formation

The Rustler was not completely drilled, as C-2737 penetrated the upper four members and about 12 ft of the lowermost member. The contact between the Rustler and the overlying Dewey Lake Formation is at 505 ft bgl and total depth (TD) was 710 ft. In the vicinity of C-2737, the Rustler is about 315 ft thick (Holt and Powers, 1988).

3.2.1.1 Los Medaños Member

The Los Medaños Member of the Rustler Formation was named by Powers and Holt (1999) based on the rocks described in shafts at the WIPP site. For the area around WIPP, studies of the Rustler have commonly referred to this interval as the unnamed lower member of the Rustler. The upper 12 ft of the Los Medaños was cored in C-2737.

From TD to 707 ft, about 3 ft of the upper part of an anhydrite (referred to as A-1 by Holt and Powers, 1988) ranges from structureless to laminar and thin bedded, and somewhat wavy, at the top. Some small gypsum prisms indicate bottom-grown

Table 3-1
Geology at Drillhole C-2737

System/ Period/Epoch		Formation or unit	Member	Depth below surface (ft)[1]
Cenozoic	Holocene	Surface dune sand and Berino soil[2]		Surface to ~ 5 ft
	Pleistocene	Mescalero caliche		~ 5 to ~ 10 ft
	Miocene-Pleistocene	Gatuña Fm		~ 10 to ~ 35 ft
Triassic		Santa Rosa Fm[3]		~ 35 to 40 ft
		Dewey Lake Fm[4]		40 ft to 505 ft
Permian		Rustler Fm	Forty-niner	505 to ~ 561 ft
			Magenta Dolomite	~ 561 to 584.3 ft
			Tamarisk	584.3 to 675 ft
			Culebra Dolomite	675 to 698
			Los Medaños[5]	698 to TD (710 ft)

[1]Depths are based on measurements during drilling and coring and confirmed (± 1 ft) by geophysical logging.

[2]Drillpad construction disturbed surficial materials. Units and depths are based on cuttings and exposures in wall of mud pit adjacent to drillhole.

[3]The Santa Rosa Fm is part of the Dockum Group. These rocks have also been referred to as Triassic undifferentiated.

[4]The Dewey Lake Fm has been considered part of the Permian System in the past. Recent work (Renne et al, 1996) indicates that lithologically equivalent rocks in Texas are mostly Lower Triassic, with some Upper Permian at the base.

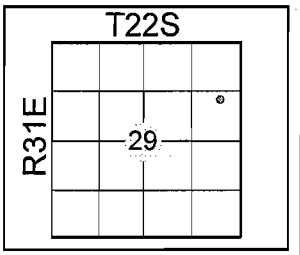
[5]The Los Medaños Member was named by Powers and Holt (1999) to replace the informal unit "unnamed lower member" of the Rustler Formation.

textures. A zone at about 709.5 ft bgl is light red and fine grained; although the natural gamma log doesn't reach the bottom of the hole for confirmation, this zone is likely polyhalite (Figure 3-2A). Other drillholes to the south and east of the C-2737 location also show some polyhalite in the bed. The upper boundary of the polyhalite is inclined. The upper contact of the anhydrite is relatively flat, suggesting that the inclined boundary is either an irregular diagenetic boundary or the polyhalite reflects local depositional mounding of the gypsum. Such mounded features are expressed in several anhydrite beds of the Salado Formation (e.g., Jarolimek, et al., 1983; Holt and Powers, 1990).

The upper 9.4 ft (from 707-697.6 ft) of the Los Medaños is mainly silty claystone, with lesser argillaceous siltstone and a zone of sandy siltstone. Holt and Powers (1988) refer to this zone as M-2/ H-2, reflecting regional facies relationships between mud flat facies (M-2) in the area of C-2737 to halite pan deposits (H-2) to the east (Powers and Holt, 2000). There is no halite in this bed at C-2737. An anhydrite about 0.1 ft is present at 699.0 ft bgl. No thin bedding or sedimentary structures such as ripples are apparent on the surface of M-2 cores. Sharper contacts between beds are present at 705.1 ft, 703.7 ft, and at 699.1 and 699.0 (both contacts on the thin anhydrite). The sharp bedding contact at 705.1 ft indicates a primary depositional surface (Figure 3-2B).

Figure 3-1
Well Record C-2737

Company: Westinghouse TRU Solutions LLC
Well: C-2737
Section: 29□ Twp: T22S□ Rge: R31E
Location: 1513.3 ft from north line (fnl)
527.3 ft from east line (fel)



Reference point
Log measured from: ground level (gl)
Drilling measured from: gl
Permanent Datum: gl

Elevation
KB:
DF:
GL: 3397.14 ft amsl

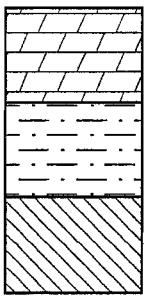
Drilling contractor: West Texas Well Water Service
Coring contractor: Diamond Oil Well Drilling Co.
Geophysical logs: Raymond Federwisch
Geophysical Logging Services (AZ)
Geologist: Dennis W. Powers
Spud date: February 14, 2001
Completion date: March 13, 2001
Total depth (TD): 710 ft bgl (driller log)

Casing Record
Conductor: 30 ft
13.375 inch steel
Casing: 7 inch o.d.
fiberglass to TD
Screened intervals:
562.0-587.0 ft
675.5-700.5 ft

Geophysical Logs
Date: March 5, 2001
Micro/Laterolog: 0-710 ft
Gamma/Fluid:□ 0-710 ft
Caliper:□ 0-710 ft
Density/Neutron: 0-710 ft

Type fluid in hole: Brine
Res mud: 0.5 ohm-m.
Res mud filtrate:
0.5 ohm-m.
Max. Rec. Temp.:
23°C

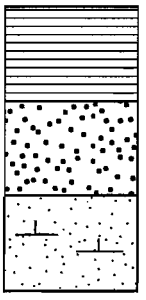
General Lithologic Symbols Used



Dolomite

Mudstone/siltstone

Anhydrite



Claystone

Coarse sandstone

Sandstone w/caliche

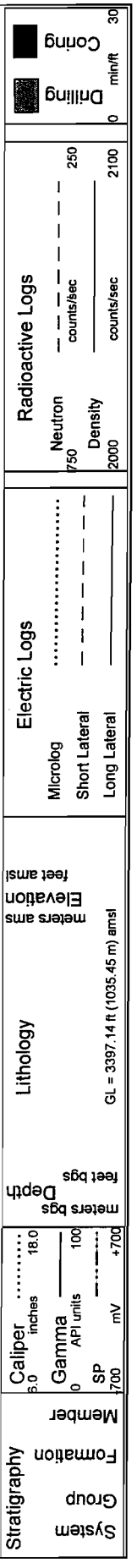


Figure 3-1 Log Title & Header page.ai

Figure 3-1, continued

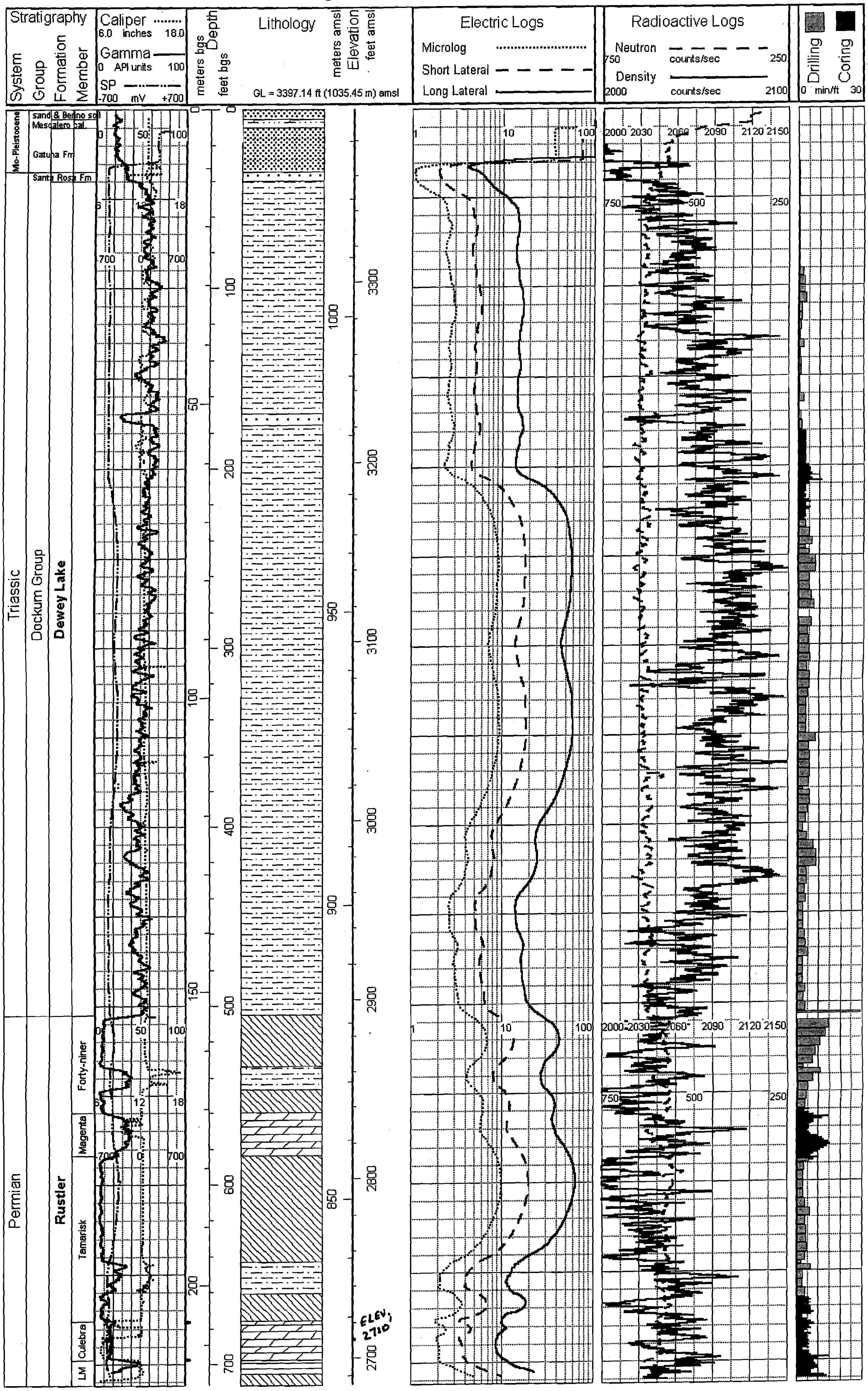
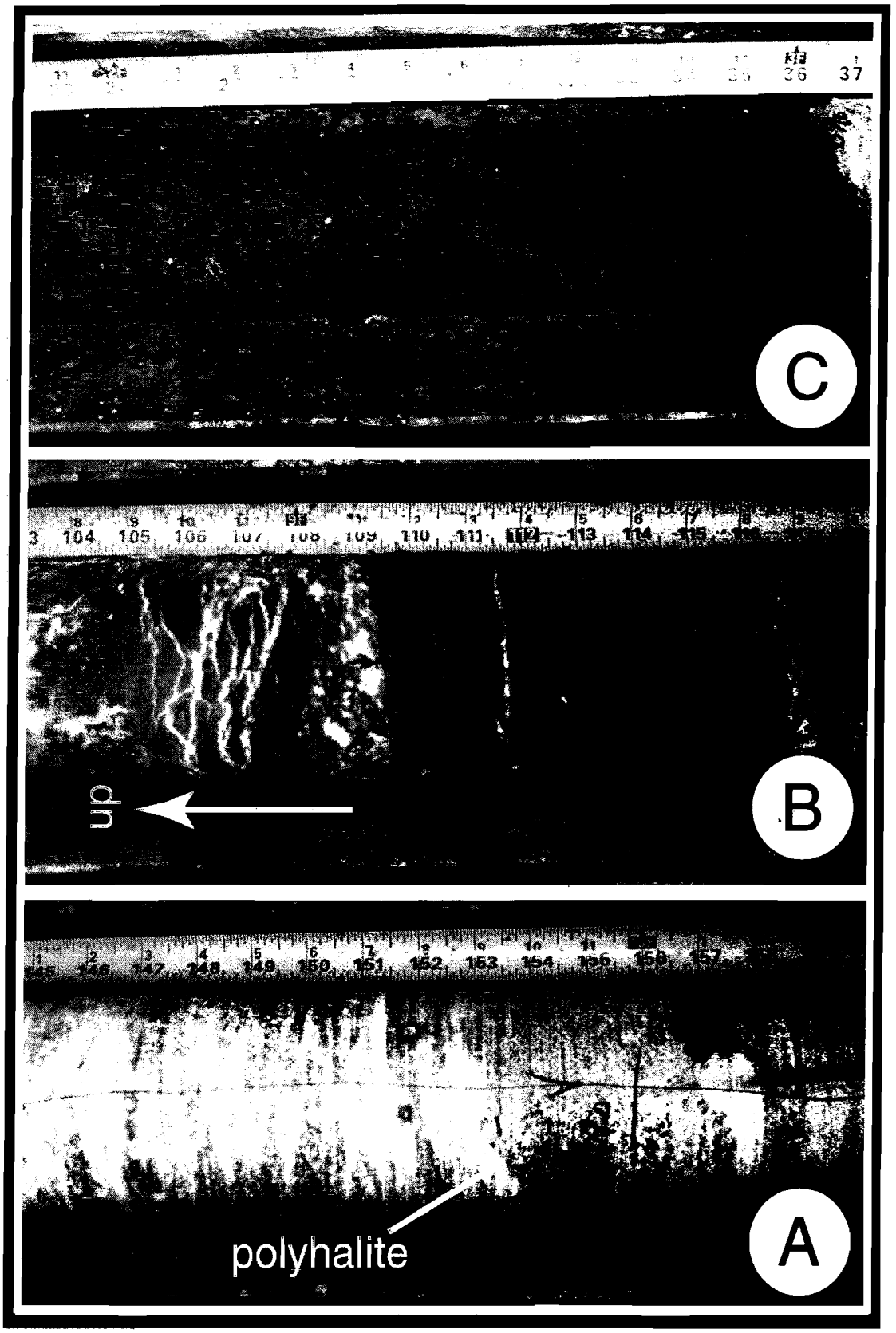


Figure 3-2 Los Medaños Member Cores



From 707 ft to about 702 ft, reddish siltstone dominates, with colors ranging from 10R4/6 (red; Munsell Soil Color Chart, 1971 ed.) to 10R4/4 (weak red) and 10R3/4 (dusky red). There are lesser gray areas (5Y5/2, olive gray) in this interval. Gypsum is mostly coincident with the reddish brown, and the gypsum is mainly as horizontal to sub-horizontal fibrous fracture fillings. Cores from the more argillaceous zones display nearly surface textures that resemble horizontal tabular clasts that Powers and Holt (2000) called smeared intraclasts; they interpret these features as indicating synsedimentary dissolution of halite. At about 703.5 ft, a wedge-shaped greenish-gray block occurs in the reddish-brown siltstones just above a similar zone of greenish-gray siltstone. Given the local sharp contact at 703.7 ft, I interpret this as an intraclast carried a short distance before being incorporated into reddish-brown siltstone.

From about 702 ft to 697.6 ft, black claystone dominates. This zone includes the thin anhydrite at 699, but there is little gypsum. Below the gypsum, the claystone is 5Y3/1 (very dark gray) and appears somewhat purplish to the eye; above the gypsum, it is 7.5YRN2.5/ (black). Most of the black claystone exhibits large smeared intraclast textures (Figure 3-2C). Immediately below the Culebra Dolomite, however, the outlines of clasts on the core surface are more angular. As in the shafts and some other cores, this zone appears more disrupted by the influx of fresher water leading to deposition of the Culebra.

In the limited extent of the core, the upper contact with the Culebra is sharp, and the Culebra does not appear to be disrupted by post-depositional movement into the underlying claystone. Because no halite was observed in this interval, the casing was placed to TD without cement at the base.

3.2.1.2 Culebra Dolomite Member

From cored intervals, the Culebra extends from 675.0 to 697.6 ft bgl, a thickness of 22.6 ft (Figure 3-3). The geophysical log depths are very similar. In nearby holes of the H-19 complex, the Culebra ranges from about 23-25 ft thick (Mercer et al., 1998); Holt and Powers (1988) found a range of 20-30 ft thickness in cores described from the WIPP project. The Culebra thickness and attitude are consistent with this area. Core recovery from the Culebra was variable, and significant core loss in the stratigraphic interval from about 686-692 ft bgl is fairly common for this area (Mercer et al., 1998). There is uncertainty about the stratigraphic position of some of the recovered core in the interval cored from 682-696.5 ft. Most of the core was assigned to the top of the cored interval because the rock was consistent with the previous core and because the lower part of the zone is known to be difficult to core.

The Culebra is a light gray (10YR7/2) gypsiferous dolomite. It is fine grained, laminar to thin bedded, and it characteristically displays zones of pores that range areally from open to filled with silt to filled with gypsum/anhydrite (Holt and Powers, 1988; Powers and Holt, 1990; Holt, 1997).

The basal dolomite was sampled from 697.6 to 696.5 ft bgs. It is fine grained and moderately well indurated. Pores are small (< 0.04 inch; < 1 mm). Very fine vertical cracks are observable, and some of the porous zones exhibit slight collapse. On the scale of the core diameter (4 inches), the basal Culebra does not exhibit local, early deformation apparent in some cores and shafts.

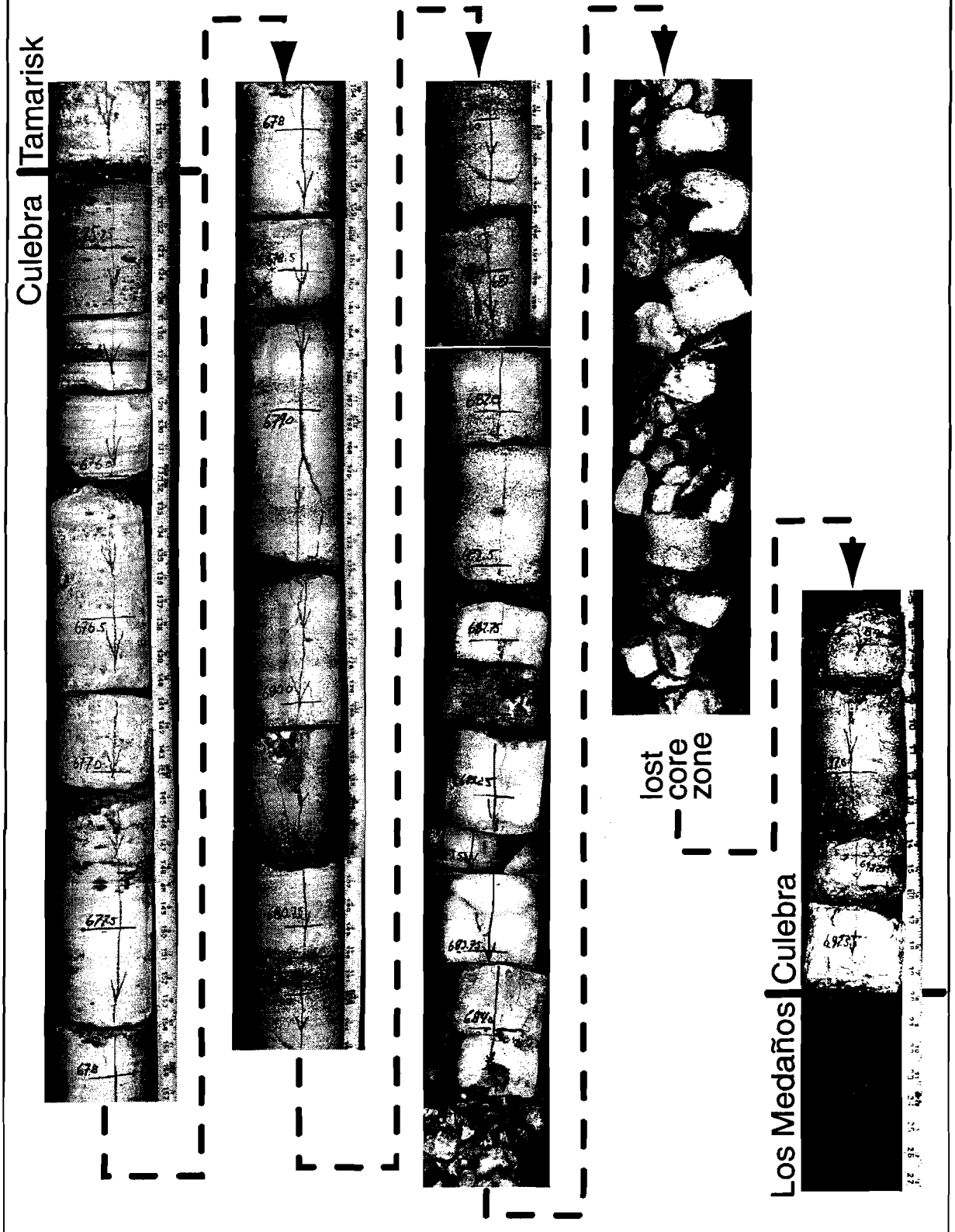
The interval from 696.5–685.3 ft bgl is believed to have been little sampled, with some core rubble probably representing the zone. These pieces of rubble show reddish-brown staining of fracture surfaces and pores that are large and generally open.

The core attributed to the interval from 678.8–685.3 ft bgl is well indurated, hard dolomite with faint bedding, one inch high zones of small pores (0.04–0.12 inch; 1–3 mm) parallel to bedding, and scattered larger pores (0.4 inch; 1 cm). The small pores range from open to filled with silty sediment. The larger vugs are either open or filled with gypsum. This interval also includes gypsum-filled, vertical to subvertical fractures, with apertures of about 0.04–0.08 inch (1–2 mm).

A thin (0.4 inch; 1 cm) organic-rich claystone separates dolomites from about 678.6–678.7 ft bgl.

Dolomite in the interval from 678.7–677.3 shows vague indications of bedding at about 0.5 inch scale. Pores are scattered and range from about 0.04–0.40 inch (1 mm – 1 cm). Vertical

Figure 3-3 Culebra Core Features



microfractures range from about 1–6 inches high and have apertures of the order of about 0.0004 inch (0.01 mm). The fractures appear to be filled with silt or clay.

The uppermost dolomite of the Culebra from 677.3–675.0 is light gray (10YR7/2), gypsiferous, and microcrystalline. It is laminar to thinly bedded (~ 0.04–0.4 inch; 1 mm – 1 cm), with dark brown organic-rich laminae and about 0.5 inch of waxy claystone at the upper contact. The upper contact with the anhydrite of the Tamarisk Member is sharp. Pores in the upper 6 inches range from 0.04-0.4 inch; most are open or have silty dolomite filling and only a few have gypsum fillings. The lower 6 inches of this interval shows some probable collapse of porosity, with porosity connecting remnant vugs.

Holt (1997) subdivided the Culebra into 4 informal units. The lowermost (CU-4) is normally about 4.5-5.8 ft thick in cores from the H-19 complex (Mercer et al., 1998), and it is represented in C-2737 by only 1.1 ft of core. CU-3 (3.3–3.7 ft at H-19) and CU-2 (4.6–5.8 ft at H-19) are represented, at best, by some rubble in core run 6. The core from 675–685.3 is more intact and represents most or all of CU-1, which ranges from 9.7–10.5 ft thick at the H-19 complex (Mercer et al., 1998).

3.2.1.3 Tamarisk Member

The basal 10 ft and upper 4 ft of the Tamarisk were cored; the remainder of the unit is described on the basis of cuttings and geophysical logs. The Tamarisk comprises three basic subunits: a lower anhydrite, a middle mudstone to halite, and an upper anhydrite. Powers and Holt (2000) labeled these A-2, M-2/H-2, and A-3, respectively, and showed that the lateral gradation from mudstone M-2 to halite H-2 reflects lateral changes in deposition. C-2737 is located in the mudflat or M-2 facies of these beds.

The basal anhydrite (A-2) of the Tamarisk is 16 ft thick (675–659 ft bgs). Above the contact with the Culebra, the unit is softer and partly gypsum. Laminae are slightly wavy to crenulated from 675 to about 667 ft bgs; bedding is much less apparent about 667 ft. The basal laminae may be algal. The lower 2 ft of A-1 display a faint nodular texture between laminae, and a more distinctive nodular zone, about 1 inch thick, occurs at 672.4 ft bgl. The lower part of A-2 shows some prismatic textures on the core surface that may be pseudomorphs after gypsum growth textures.

The Tamarisk mudstone (M-3/H-3 of Holt and Powers, 1988) is 16 ft thick (659–643 ft bgs) at C-2737. A harder drilling zone at 647 ft is about 1 ft thick, and it is equivalent stratigraphically to anhydrite found in nearby drillholes, such as H-3b3 (Holt and Powers, 1988). The basal mudstone is general gray from about 657–659 ft bgs. From 657–647 ft bgs, the mudstone is generally light brown. Above the anhydrite at 647 ft, the cuttings showed dark reddish brown mudstone and siltstone.

The upper Tamarisk anhydrite (A-3) is 58.7 ft thick (643–584.3 ft bgs) at C-2737. Cuttings from 588.3–643 ft bgs show gray to white anhydrite in very small chips. The upper 4 ft of the bed was cored, revealing white to dark gray (N4/) anhydrite and gypsum. The lower part of the core is generally laminar to thinly bedded, and the bedding becomes more wavy and possibly stromatolitic in the upper 1–1.5 ft. The rock has a spotted appearance due to approximately equant crystals of dark anhydrite. The contact with the Magenta Dolomite Member is sharp and slightly wavy; the contact is at the first significant laminated carbonate (Figure 3-4A: white dashed line).

The Tamarisk stratigraphy and thickness are consistent with other drillholes and shafts in the area (Holt and Powers, 1988). M-2 is a few feet thicker, and A-2 a few feet thinner, than in some of the surrounding drillholes. Holt and Powers (1988) and Powers and Holt (2000) report thinning of A-2 by erosion at two WIPP shafts and complete erosion of A-2 at drillhole WIPP 19; M-2 has compensating greater thickness where A-2 is eroded. C-2737 is likely at a similar location.

2.1.1.4 Magenta Dolomite Member

The Magenta was cored through 23.3 ft (561–584.3 ft bgl) at C-2737 (Figure 3-5). The upper contact was not displayed in the core, but the geophysical log indicates that the contact is very near the upper coring point.

Figure 3-4 Basal Magenta Cores

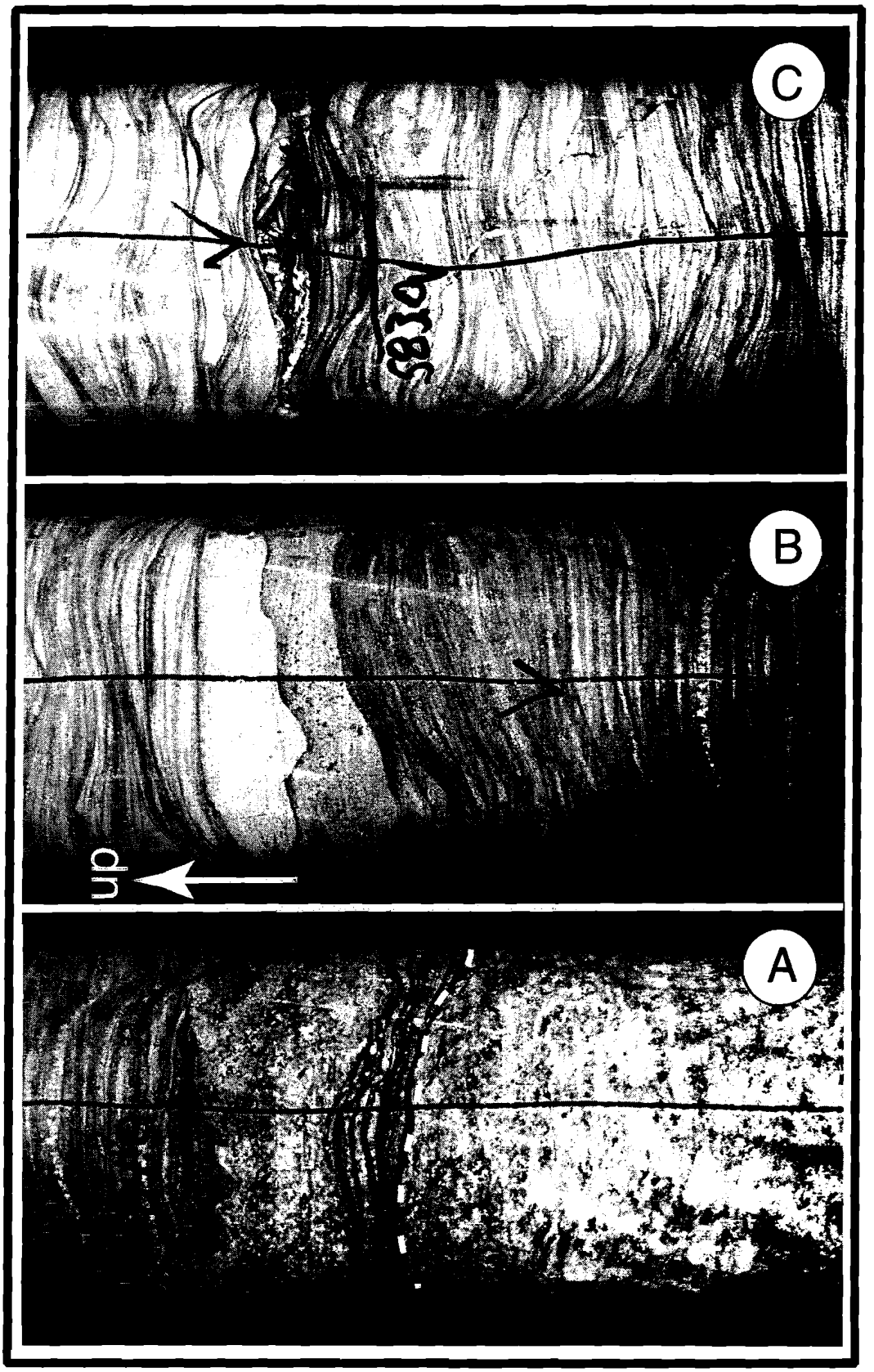
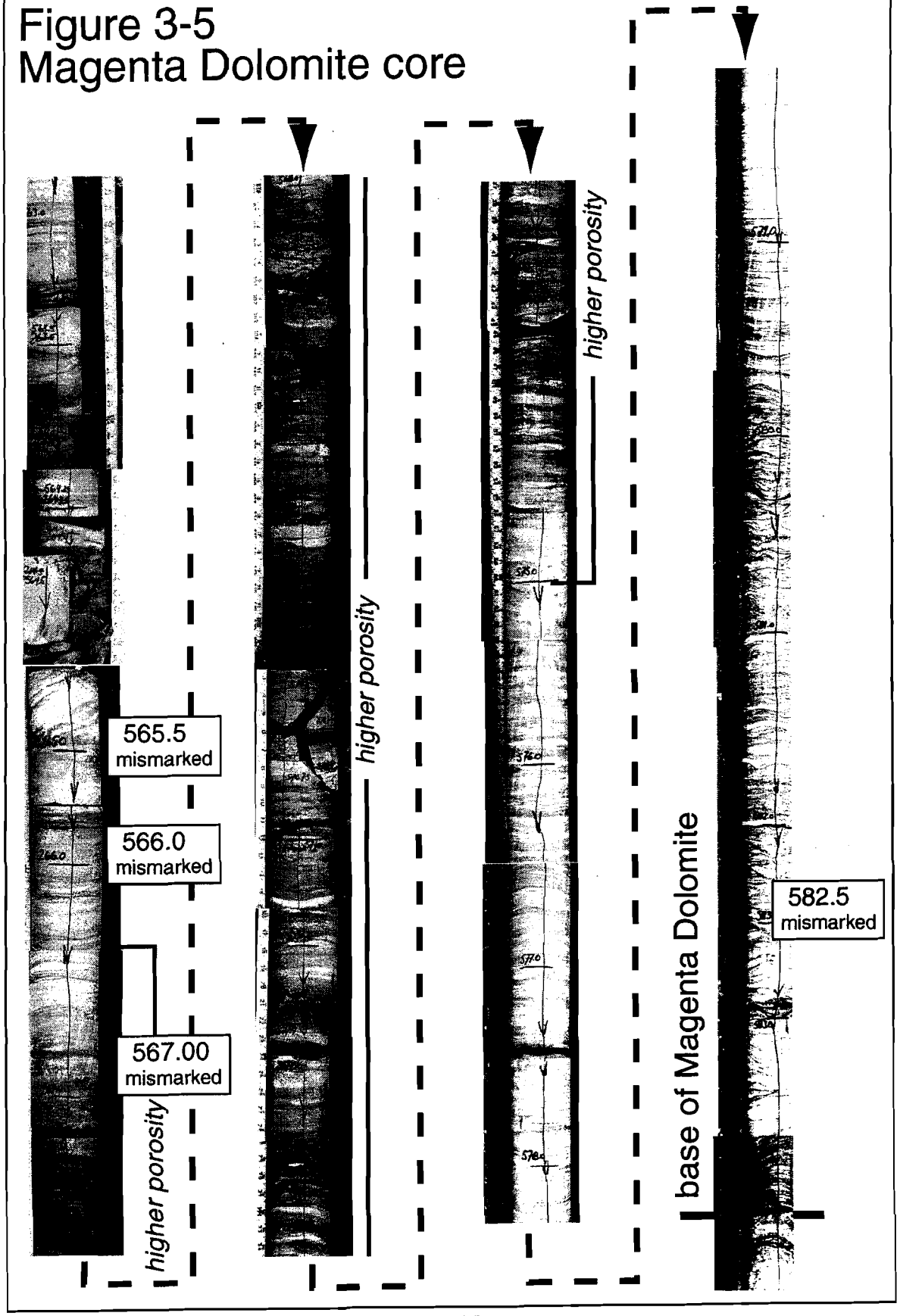


Figure 3-5
Magenta Dolomite core



The Magenta consists of dolomite and gypsum, and it is commonly light gray (5Y7/2) to olive gray (5Y5/2) in core. The reddish-purple color for which it is named occurs in outcrop and apparently is a consequence of weathering. The dominant characteristic of the Magenta in core, outcrop, or shaft is strong wavy to laminar bedding, with wave amplitudes commonly about 0.5–1 inch (Figure 3-4). Wavy bedding amplitude is generally less than about 0.25 inch in the middle of the unit, from 579.8– ~570 ft bgl. Some small ripple bedding is evident in the middle and upper part of the unit. Near the base of the Magenta, small domal features indicate stromatolites, and these are consistent with well exposed algal features in the air intake shaft (Powers and Holt, 1990). Less common features include a small flame structure at 583.3 ft bgl and a thin (< 1 inch) breccia band and gypsum at 582.9 ft (Figure 3-4C). The breccia is likely to be an intraformational conglomerate in view of the undisturbed overlying thin laminae, but slabbing may be necessary for more detail. Some thin laminae from 566.6–572 ft bgl are sandy, and some of the wavy laminae in this zone preferentially washed out during drilling. Thin white gypsum bands parallel to bedding occur between 580 and 582 ft. Gypsum in these bands are about perpendicular to bedding.

Porosity is very low below ~ 575 ft, as indicated by rapid drying of the core. Porosity appears to be higher from about 575–566.5 ft (Figure 3-5), as indicated visually and by slow drying of the core surface. There are rare open pores about 0.5 inch in the sandy laminae from 566–572 ft. One fracture, about 30° from vertical, was observed from about 572–570.5 ft bgl.

The Magenta is typical in thickness, composition, and sedimentary features. The observations regarding a higher porosity zone from about 575–566.5 ft indicate that, like the Culebra, hydraulic properties for the Magenta are likely not vertically uniform.

3.2.1.5 Forty-niner Member

The Forty-niner at C-2737 is 56 ft thick (561–505 ft bgl), and it was described on the basis of cuttings and geophysical logs through the interval. Like the Tamarisk, the Forty-niner consists of upper and lower anhydrites with a middle unit that ranges from mudstone at C-2737 to halite east of the WIPP site area. Powers and Holt (2000) informally designated these units as A-4, M-4/H-4, and A-5, and they attributed the mudstone (M-4) to halite (H-4) lateral relationship to depositional facies.

A-4, the lower unit, is gray to white anhydrite with some gypsum. The unit is 14.5 ft thick (561–546.5 ft bgl). M-4 is 12.5 ft thick (546.5–534 ft bgl). Cuttings from the basal part of M-4 are gray (N6/) mudstone, and this part of the mudstone is apparently harder based on slower drilling. The upper 11 ft of M-4 is reddish brown (2.5YR4/4) claystone and mudstone. A-5, the upper unit, is gray to white, well indurated anhydrite that becomes gypsiferous below about 527 ft. A-4 is 29 ft thick (505–534 ft bgl).

3.2.2 Permo-Triassic Dewey Lake Formation

The Dewey Lake Formation has most commonly been assigned to the Permian System (e.g., Hills and Kottlowski, 1983), although there is no direct evidence, either paleontological or radiometric, of age in the vicinity of the WIPP. More recently, Renne et al. (1996) obtained radiometric (Ar-Ar) ages from ash beds near the base of lithologically equivalent red beds (Quartermaster Formation) in the Texas panhandle. These ages show that the basal Quartermaster is Permian, but most of the formation is early Triassic in age. Although lithologic contacts are not inherently isochronous, the particular relationships of evaporite to red bed suggest that the Dewey Lake is mainly Triassic in age (e.g., Powers and Holt, 1999). Lucas and Anderson (1993) have asserted that the Quartermaster, and Dewey Lake, are Permian in age, but more recent direct evidence supersedes their discussion.

At C-2737, the Dewey Lake is 465 ft thick (505–40 ft bgl), and it is composed mainly of dark reddish brown (2.5YR3/4) to reddish brown (2.5YR4/4) mudstone, siltstone, and fine grained sandstone. Light brownish gray (2.5Y6/2) reduction spots are a common characteristic of the Dewey Lake. Most of the Dewey Lake is described on the basis of cuttings, drilling rates, and geophysical log characteristics. The interval from 181–231 ft bgl

was cored to obtain samples across a stratigraphic zone in which natural cement minerals change, affecting geohydrologic characteristics (Holt and Powers, 1988; Powers, 1997, in prep.).

During core run 1 (181–199 ft bgl), about half the core was lost during drilling. The loss was attributed to the upper part of the run, although it's not possible to determine if all core lost was at the beginning of the run. The core recovered comprises a series of fining upward cycles of sandstone, siltstone, and mudstone from about 1–3 ft thick. The basal sandstone of these cycles is very fine to fine grained, subround, poor to moderately sorted, with one bed of fine to medium sand at 191 ft. The sandstone is generally laminar or thin-bedded, and there is some low angle cross-bedding, especially at 191 ft. The siltstones or mudstones above sandstones in these fining upward cycles are laminar to thin bedded, and mica is common.

Above about 202 ft, the rocks are moderately calcareous and there are a few subhorizontal fractures that are partially filled with gypsum. Below 202 ft, carbonate is very limited, fractures are filled with gypsum, and there appears to be gypsum cements (Figure 3-6). The cores below 202 ft are noticeably better indurated than the rocks above 202 ft. This cement change is observable in other cores from the area (Powers, in prep.), and it was reported in the air intake shaft (Holt and Powers, 1988).

Fractures in the core are either parallel to bedding planes or within about 30° of vertical. Subhorizontal fractures filled with gypsum have separations up to about 0.5 inches. High angle fractures can have apertures up to 0.5 inch, but many apertures are 0.25 inch or less.

As C-2737 was being drilled to the coring point at 181 ft bgl, drilling rates varied noticeably with thin (< 1 ft) harder drilling zones vertically spaced generally about 1 to 10 ft.

Geophysical logs from C-2737 can be interpreted to indicate different basic sedimentary regimes as well as porosity conditions. The following information follows the basic template developed for a study of the Dewey Lake hydrogeology (Powers, in prep.). The natural gamma log responds mainly to differing concentrations of uranium, thorium, and potassium. In siliciclastic sedimentary rocks, lower natural gamma typically indicates higher content of sand, and higher natural gamma indicates higher clay mineral content (Doveton, 1986). Borehole resistivity logs (micro-, short, and long lateral) respond to the resistivity of the formation and pore fluids over differing depths in the formation. High resistivity generally indicates low porosity and/or low fluid content. Low resistivity indicates pores filled with fluids that are more conductive. Brines, saline water, and oil are relatively conductive, while fresh water is less conductive than other fluids. The micro-lateral and short lateral logs show conditions close to the borehole and influences of drilling fluid. The long lateral log should be responding to formation conditions. The Dewey Lake resistivity logs are clearly related to natural mineral cements.

Three general depositional regimes can be distinguished on natural gamma logs of the Dewey Lake. From 505–390 ft bgl, the Dewey Lake shows general interbedding of siltstone and sandy siltstone or silty sandstone at roughly 20 ft vertical intervals. Cuttings revealed that very fine sandstone is more abundant in this interval than in higher parts of the formation. From about 390–130 ft bgl, the natural gamma log tends to show overall "fining upward" as well as smaller (20–50 ft) fining upward cycles. Geophysical logs in some boreholes in the area of C-2737 also indicate cycles as small as about 10 ft. Such cycles are commonly associated with fluvial deposits, and outcrops of the Dewey Lake along Livingston Ridge also show these features. From 170–175 ft bgl, the natural gamma log reveals a unit with much lower radioactivity. Although cuttings didn't show a change, cores from other drillholes (Powers, in prep) and outcrops show that this interval is a well-sorted, medium sandstone with very little clay content. The upper interval (130–40 ft bgl) indicates general coarsening upwards and somewhat simpler alternations of grain size. Outcrops along the Maroon Cliffs in northern Nash Draw are consistent with the logs and cuttings of this upper interval.

On the basis of the resistivity (lateral) logs (Figure 3-1), the Dewey Lake can be divided into three intervals that correspond in some areas to the

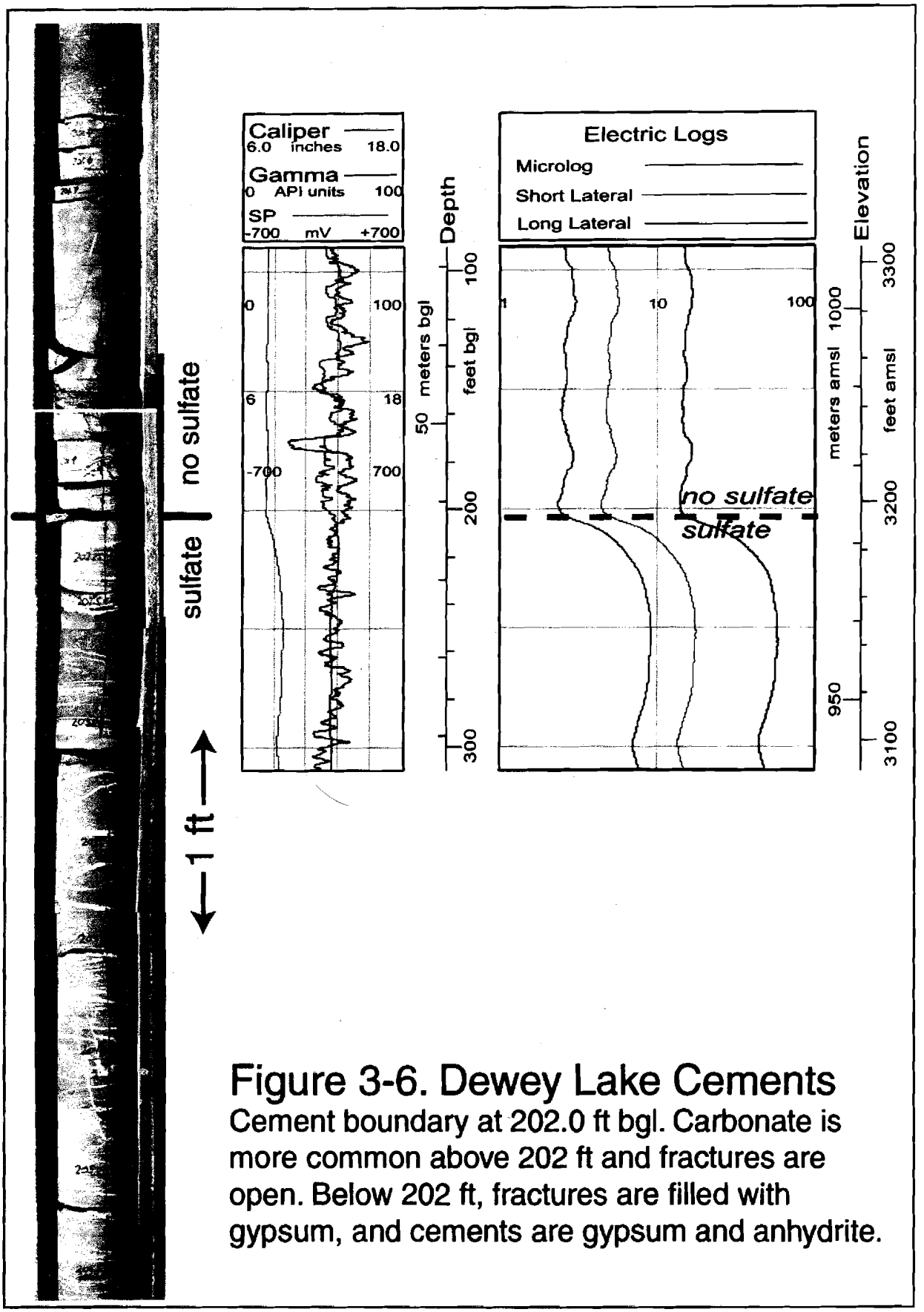


Figure 3-6. Dewey Lake Cements

Cement boundary at 202.0 ft bgl. Carbonate is more common above 202 ft and fractures are open. Below 202 ft, fractures are filled with gypsum, and cements are gypsum and anhydrite.

natural gamma intervals. From 505–400 ft bgl, the resistivity is relatively low (higher conductivity) for all three resistivity logs, indicating some invasion of the sidewall and greater porosity with an uncertain degree of saturation. This interval corresponds well to the interbedded interval defined from natural gamma logs. From 400–205 ft bgl, the resistivity logs indicate much higher resistivity, corresponding to lower porosity and less intergranular saturation. From 205–40 ft bgl, resistivity is uniformly low, showing higher conductivity associated with higher porosity and increased pore fluids. These three intervals are observable in resistivity logs in many drillholes around the area of C-2737. The main difference from drillhole to drillhole is the stratigraphic position of the resistivity increase, which is about 205 ft bgl in C-2737 logs. The difference between depths for changes in the core and log depths for the cement and resistivity changes (202 ft bgl and 205 ft bgl, respectively, is consistent with the precision for each measurement.

The resistivity logs for C-2737 do show the same broad patterns as logs for other drillholes in the area. Details are not available for C-2737 because of the sampling rate.

3.2.3 Triassic Santa Rosa Formation

C-2737 is located in an area where erosion has removed most of the Santa Rosa Formation and all of the overlying upper Triassic formations. Cuttings interpreted as Santa Rosa Formation are weak red (7.5YR5/4) silty sandstone with fine to medium grains. Some of the sediment eroded from the Santa Rosa is redeposited as part of the Gatuña Formation, making it difficult to differentiate the formations by cuttings. Initial problems with depth recording instruments also render the depths obtained during drilling to about 70 ft bgl less reliable. Cuttings from augering to set the surface conductor casing and geophysical logs are helpful. The Santa Rosa is interpreted to occur from about 35–40 ft bgl.

3.2.4 Miocene-Pleistocene Gatuña Formation

Based on the cuttings from augering to set the surface conductor casing and exposures in the mud pit excavated adjacent to the drill pad, the Gatuña is interpreted from 35–10 ft bgl. The Gatuña is reddish-brown (2.5YR5/4) sandstone with subround to subangular, very fine to very coarse grains. About 1-2% of the grains is opaques. Toward the top of the Gatuña, the formation is increasingly calcareous with some probable carbonate linings or ped structures. Some gray staining along surfaces is probably MnO_2 from pedogenic processes. The formation is porous and mottled due to pedogenic processes, and the color becomes more increasingly pink to white vertically approaching the overlying Mescalero caliche. The Gatuña generally increases in thickness to the west, and the depositional edge of the formation at the WIPP site is in the same general area where the Santa Rosa pinches out because of erosion that preceded Gatuña deposition (Powers and Holt, 1993).

Although the Gatuña ranges in age from at least 13.5 to about 0.5 million years old (Powers and Holt, 1993), the deposit at the WIPP site is of unknown age. From general relationships along Livingston Ridge, Powers and Holt (1993) infer that thin upland deposits of the Gatuña, such as at C-2737, probably represent younger portions of the unit range.

3.2.5 Pleistocene Mescalero caliche

The Mescalero is an informal soil stratigraphic unit defined by Bachman (1973). It is widespread in southeastern New Mexico, and it is a continuous stratigraphic unit at the WIPP site. Uranium-disequilibrium ages indicate the Mescalero formed as a pedogenic unit between about 570,000 (± 100,000) and about 420,000 (± 60,000) years ago (Rosholt and McKinney (1980). The age is further bounded by the Lava Creek B ash, about 600,000 years old, which underlies the Mescalero at one location along Livingston Ridge (Izett and Wilcox, 1982).

At C-2737, the Mescalero is about 5 ft (10-5 ft bgl) thick. From cuttings and from exposures in the adjacent mud pit, the Mescalero shows evidence of pedogenic processes such as nodule, ped, and laminae development. Not only is the unit strongly calcareous, the upper portion of the unit is locally

plugged and subhorizontal laminae are partially developed at the upper surface. Bachman and Machette (1970) classified six useful stages of pedogenic calcrete development, ranging from I as the least developed to VI morphologies showing multiple generations of calcrete development. [Pedogenic calcrete is preferred by many geologists and pedologists because of the wide variation in use of the term "caliche."] The Mescalero is generally at stage V in the vicinity of WIPP, as it is at C-2737.

3.2.6 Pleistocene Berino soil and surficial sands

The Berino is a yellowish-red (2.5YR5/6) sandstone that is friable and argillaceous. Sand grains are very fine to medium. The cuttings are not a clear indication of thickness, but the mudpit exposure indicates less than 1 ft thickness. It is very porous. Pinkish gray mottling observed in cuttings are probably mixed from the Mescalero, as the mudpit and field observations in the area show a sharp contact between this unit and Mescalero, with no color mottling. The Berino soil is not a geologic unit; it is a pedogenic unit defined by the soil scientists in the area (Chugg et al., 1971). Although originally thought to be a soil B horizon associated with the Mescalero, uranium-disequilibrium ages indicate formation of the Berino at about 330,000 (± 75,000) years ago. Although Powers (1993) agreed with Bachman (1980) that the Berino probably represented a remnant B horizon for the Mescalero, the Berino most likely developed separately. The Berino is inset into the Mescalero in "flowerpots" that developed in the Mescalero. These local dissolution features are commonly lined with carbonate laminae that cross-cut calcrete features (indicating later development) and the Berino set into the "flowerpots is sharply differentiated from the laminar carbonate lining. The uranium-disequilibrium ages are also enough different between calcrete and Berino to indicate different periods of development.

The surface sand across much of the WIPP site is eolian, and the sand grains are generally fine to medium and moderately well sorted. The sand is not indurated. The dunes across the WIPP site are partially stabilized by vegetation; the thickness at the drill pad of about 4 ft is a result of leveling the area and redistributing sand that is variable in thickness.

4.0 Preliminary Hydrological Data for C-2737

C-2737 was drilled specifically to monitor water levels from the Culebra and Magenta Dolomite Members of the Rustler Formation. Groundwater was also encountered at shallow depths, in the upper Dewey Lake Formation. Preliminary information can be reported based on initial drilling and observations, effective through February, 2002.

C-2737 was completed with screened intervals across both the Culebra and Magenta. The configuration of the well (Figure 4-1) for monitoring changes slightly whenever the packer separating the intervals requires maintenance.

4.1 Shallow Groundwater in the Upper Dewey Lake Formation

On February 15, 2001, West Texas Water Well Service encountered some difficulties removing cuttings from C-2737 using compressed air. At a depth of about 90.7 ft, the driller recommended placing temporary casing inside the conductor pipe to improve the flow of air and cuttings. Drilling was shut down about 9 am (MST). The drillpipe and bit were wet at the bottom, and the driller reported seeing water entering the drillhole. Fluid levels were observed from 9:40 am until 1:01:00 pm (2/15/2001). Fluid level observations are reported in Table 4-1, and the recovery is plotted in Figure 4-2.

Fluid temperatures were measured with a VWR Scientific thermometer (cat. # 61016-208) with 1 °C gradations, yielding a fluid temperature of 19 °C on a field sample. Fluid density was measured with a Cole-Parmer hydrometer (cat. # 08291-10) with 0.005 g/cc gradations. The fluid density was estimated to be between 1.000 and 1.005 g/cc.

Figure 4-1
C-2737 Completion Configuration

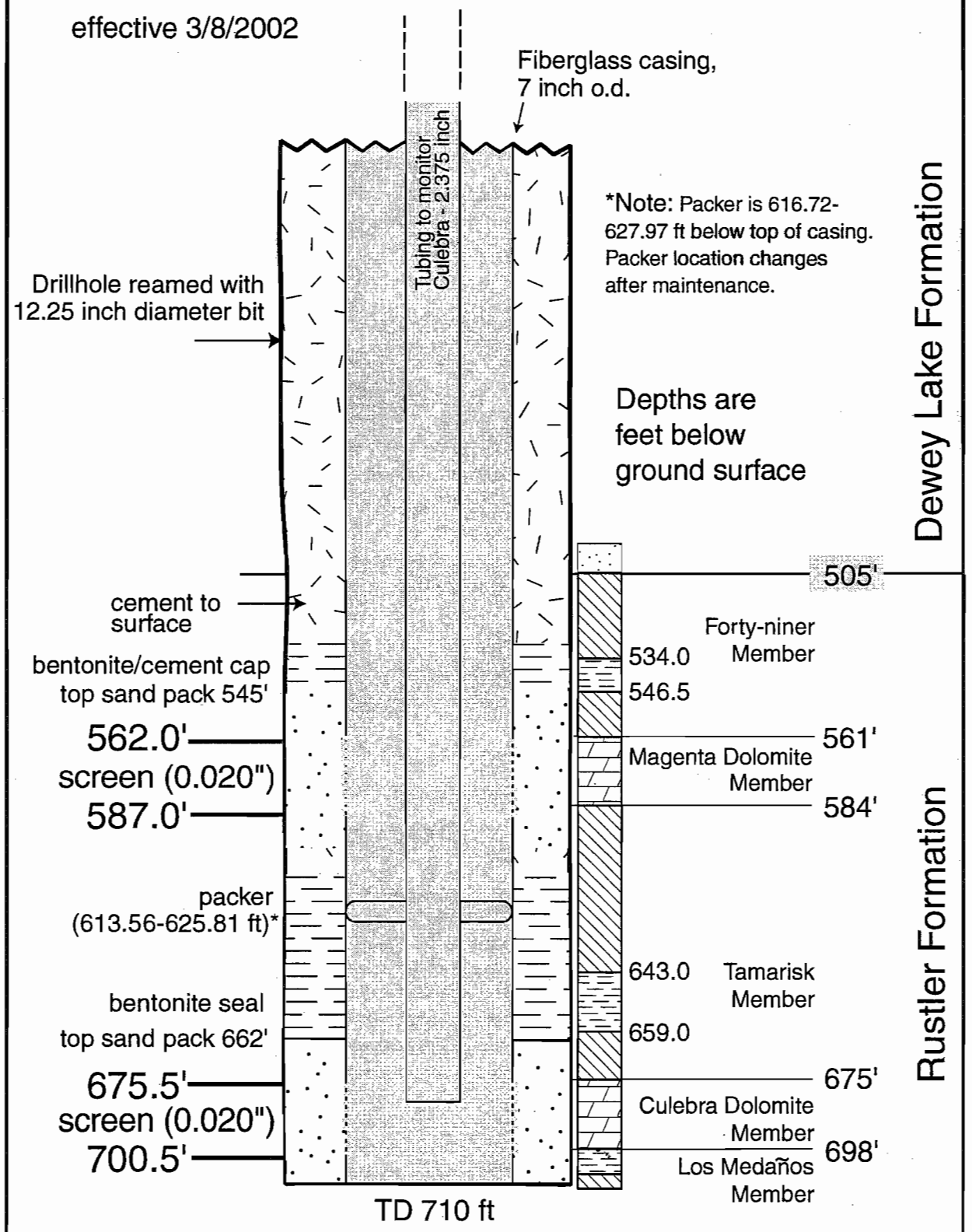


Figure 4-1.ai

Table 4-1 Fluid Levels Observed in the Upper Dewey Lake Formation

Time	Depth to Water ft below grnd level	Time	Depth to Water ft below grnd level
9:40	76.40	10:48:45	66.50
9:49	74.00	10:53:40	66.00
10:05:15	72.00	10:59:00	65.50
10:08:45	71.50	11:04:30	65.00
10:12:15	71.00	11:15:45	64.00
10:15:40	70.50	11:31:45	63.00
10:19:15	70.00	11:49:45	62.00
10:23:05	69.50	12:16:35	61.00
10:31:00	68.50	12:42	60.50
10:39:30	67.50	13:01:00	60.25

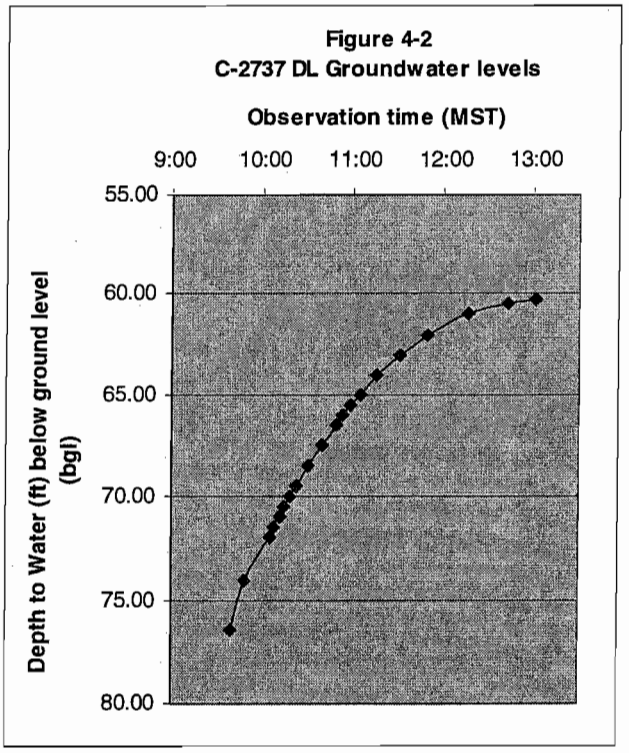
Notes: Times were taken from one watch; where seconds were not noted, time is about + or - 30 seconds. Depths were noted using tape marked to 0.01 ft and an electric indicator of water. Reference point was part of the drilling equipment, 2.75 ft above ground level.

Drilling personnel estimated fluid was entering at about 60 ft bgl, and the last measured fluid level was about 57.50 ft bgl. Other measurements of fluid levels, mainly of drilling fluid, during drilling varied.

Following the completion of C-2737, a separate monitoring hole (C-2811) was drilled on the west side of the drillpad to a depth of 80 ft bgl and was completed for observation of shallow groundwater.

This shallow groundwater is likely related to the shallow groundwater found under the WIPP site facilities, perching on upper Dewey Lake horizons (Powers, 1997). During drilling, numerous "hard zones" were encountered that greatly slowed drilling. Although samples are not available to determine the composition of these "hard zones," they may affect vertical fluid flow in these units, causing perching for an undetermined period of time. Further investigations of the water levels and chemistry should assist in determining the relationship between water at this location and at other areas of the Dewey Lake.

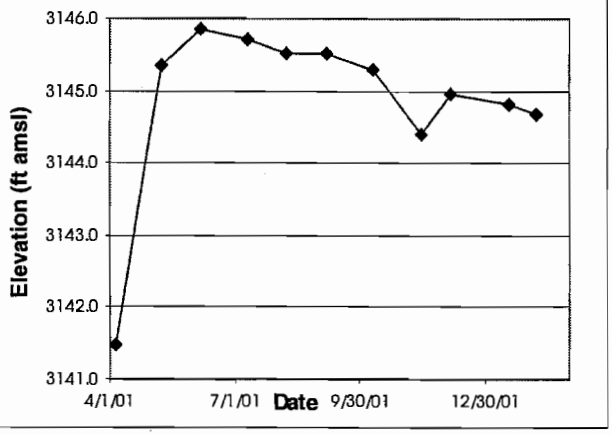
Initial laboratory analyses (sample collected 2/19/01) provided major components as: specific gravity: 1.01; TDS: 2590 ppm; Na: 123 ppm; Ca: 301 ppm; Mg: 231 ppm; S (as sulfate): 276 ppm; Cl: 1110 ppm (personal communication from Wayne Stensrud, 9/19/01).



4.2 Initial Results from the Magenta Dolomite

Since the packer was placed in C-2737 to separate the Culebra and Magenta, water levels for the Magenta have been monitored through the annulus between tubing and the casing. Initial monthly results seem to indicate that the water levels, uncorrected for specific gravity, have recovered to between 3145 and 3146 ft amsl (Figure 4-3; data from Jones, 2002).

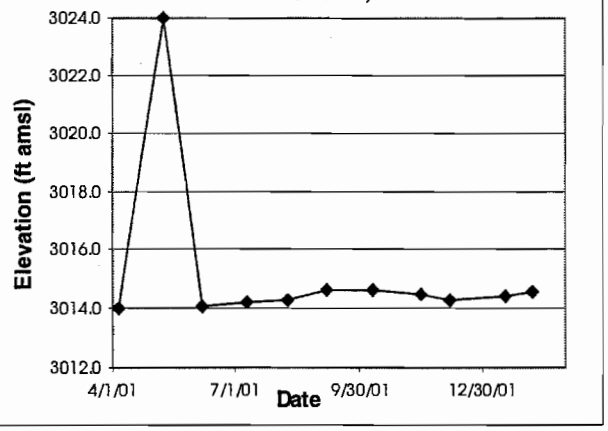
Figure 4-3
Magenta Water Levels, C-2737



4.3 Initial Results from the Culebra Dolomite

Since the packer was placed in C-2737 to separate the Culebra and Magenta, water levels for the Culebra have been monitored through the tubing, below the packer. Initial monthly results seem to indicate that the water levels, uncorrected for specific gravity, have recovered to slightly above 3114 amsl (Figure 4-4; data from Jones, 2002).

Figure 4-4
Culebra Water Levels, C-2737



5.0 Significance/Discussion

Drillhole C-2737 provides a groundwater monitoring point that replaces H-01, now plugged and abandoned. The location over the waste panels provides a datum that is expected to be more representative of the Culebra in the waste panel area than the H-01 location (Appendix A). In addition, the materials used in completing C-2737 are expected to be stable over a lengthy monitoring period, in contrast to steel casing in monitoring wells drilled before 1995. Newer monitoring wells provide construction experience for groundwater surveillance wells that may be drilled in the future.

The uppermost Los Medaños does not include halite at C-2737. This is consistent with previous halite margins for this unit and a depositional origin for mudstone-halite facies. The lowermost part of the casing was not cemented because of there was no halite in the core.

Culebra core recovery was poor through the zones generally believed to be more transmissive. This is a common problem, not one that is specific to C-2737. Although no specific testing was undertaken, it is likely that this zone is also the most transmissive for the C-2737 location by analogy to past experience. The caliper log (Figure 3-1) through this zone of the Culebra is unusual: the diameter is about 6.5-7 inches, although the hole had been reamed to 12.25 inches. In other holes, the caliper through this zone is more likely to show an enlarged diameter.

The Magenta core showed surface porosity and different rates of drying during logging that suggest a zone about 12 ft thick that may have higher transmissivity than the remainder of the unit. These characteristics can be further examined as part of developing a geohydrologic conceptual model of the Magenta. The neutron log and the long lateral resistivity log are consistent with this macroscopic observation. Detailed plotting of the raw neutron log data may provide additional definition. Like the Culebra, the more porous zone shows a reduced caliper log.

The Dewey Lake cores, as projected, bracketed the change in natural mineral cements that appears elsewhere to modify the vertical movement of fluids in the upper Dewey Lake. The long lateral resistivity

log markedly responded to this change, and even the caliper log maps the boundary. Above the sulfate-cemented zone that starts at 202 ft bgl, the caliper log is erratic. Below that zone, the caliper log is much more uniform. The zone immediately above 202 ft bgl is not known to be saturated, but no hydraulic testing was performed.

The upper part of the Dewey Lake, however, did yield water inflow to the drillhole. The depth of the saturated zone isn't determined by hydraulic testing. Long lateral resistivity increases fairly uniformly below the surface conductor casing (30 ft bgl) to a depth of about 55 ft bgl and then increases very slightly from about 60 ft to 202 ft bgl. This suggests that the main part of the inflow comes from above about 60 ft bgl. Drillhole C-2811 will provide additional information about this shallow groundwater.

6.0 Acknowledgements

Drafts of this document were reviewed by Ron Richardson, Rey Carrasco, and Wayne Stensrud, and their comments improved the final report. Gil Gillespie (West Texas Water Well Service) provided electronic files of drilling and coring rates used in Figure 3-1, and the drillers and hands were very helpful in providing access for sampling during drilling. Ray Federwisch (Century Geophysical Logging) explained the electronic files that were provided to develop Figure 3-1. Chris Mahoney checked certain files and figures and provided data files for sections.

7.0 References Cited

Bachman, G.O., 1973, Surficial features and late Cenozoic history in southeastern New Mexico: US Geological Survey Open-file Report USGS-4339-8, 32 p.

Bachman, G.O., 1980, Regional geology and Cenozoic history of Pecos region, southeastern New Mexico: US Geological Survey Open-file Report 80-1099.

Bachman, G.O., and Machette, M.N., 1977, Calcic soils and calcretes in the southwestern United States: US Geological Survey Open-file Report 77-794, 163 p.

Beauheim, R.L., 2000, memorandum to J. Plum, Subject: Regulatory drivers for replacing H-1, dated July 3, 2000: Sandia National Laboratories, Albuquerque, NM, 3 p. (included in Appendix A of this report)

Chugg, J.C., Anderson, G.W., Kink, D.L., and Jones, L.H., 1971, Soil survey of Eddy area, New Mexico: US Department of Agriculture, 82 p plus figures.

Doveton, J.H., 1986, Log analysis of subsurface geology : John Wiley & Sons, New York, NY, 273 p.

Hills, J.M., and Kottlowski, F.E. (coordinators), 1983, Southwest/southwest mid-continent region: American Association of Petroleum Geologists, Correlation Chart Series.

Holt, R.M., 1997, Conceptual model for transport processes in the Culebra Dolomite Member, Rustler Formation: SAND97-0194, Sandia National Laboratories, Albuquerque, NM.

Holt, R.M., and Powers, D.W., 1988, Facies variability and post-depositional alteration within the Rustler Formation in the vicinity of the Waste Isolation Pilot Plant, southeastern New Mexico: WIPP DOE 88-004, US Department of Energy, Carlsbad, NM, 88221

Holt, R.M., and Powers, D.W., 1990, Geotechnical activities in the air intake shaft (AIS): DOE/WIPP 90-051, US Department of Energy, Carlsbad, NM.

Izett, G.A., and Wilcox, R.E., 1982, Map showing localities and inferred distribution of the Huckleberry Ridge, Mesa Falls and Lava Creek ash beds in the western United States and southern Canada: US Geological Survey, Miscellaneous Investigations Map I-1325, Scale 1:4,000,000.

Jarolimek, L., Timmer, M.J., and Powers, D.W., 1983, Correlation of drill and shaft logs, Waste Isolation Pilot Plant (WIPP) project, southeastern New Mexico: TME 3179, US Department of Energy, Albuquerque, NM.

Jones, S.B., 2001, Transmittal of water level data for March 2001: letter to D. Kessel, Sandia National Laboratories, dated March 20, 2001; Westinghouse TRU Solutions LLC DA: 01:01724; UFC: 5480.00.

Jones, S.B., 2002, Transmittal of water level data for February 2002: letter to D. Kessel, Sandia National Laboratories, dated February 18, 2002; Westinghouse TRU Solutions LLC DA: 02:01717; UFC: 5480.00.

Lucas, S.G., and Anderson, O.J., 1993, Stratigraphy of the Permian-Triassic boundary in southeastern New Mexico and west Texas, *in* Hawley, J.W., and others, eds., Geology of the Carlsbad Region, New Mexico and West Texas: 44th NMGS Fall Field Conference Guidebook, New Mexico Geological Society, Socorro, NM, p. 219-230.

Mercer, J.W., Cole, D.L., and Holt, R.M., 1998, Basic data report for drillholes on the H-19 hydropad (Waste

Isolation Pilot Plant–WIPP): SAND 98-0071, Sandia National Laboratories, Albuquerque, NM.

Powers, D.W., 1993, Surficial units and inferences of stability, Sand Point Site, Eddy County, New Mexico: NMBM OFR 0418 D, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM (dated 03/23/93).

Powers, D.W., 1997, Geology of piezometer holes to investigate shallow water sources under the Waste Isolation Pilot Plant, *in* Intera, 1997, Exhaust Shaft Hydraulic Assessment Data Report, DOE/WIPP 97-2219, US Department of Energy, Carlsbad, NM.

Powers, D.W., in prep, Perching horizons in the Permo-Triassic Dewey Lake Formation near the Waste Isolation Pilot Plant, southeastern New Mexico: interim report in preparation for Westinghouse TRU Solutions.

Powers, D.W., and Holt, R.M., 1990, Sedimentology of the Rustler Formation near the Waste Isolation Pilot Plant (WIPP) site, *in* Powers, D.W., Holt, R.M., Beauheim, R.L., and Rempe, N., eds., 1990, Geological and hydrological studies of evaporites in the northern Delaware Basin for the Waste Isolation Pilot Plant (WIPP): Guidebook 14, Geological Society of America (Dallas Geological Society), p. 97-106.

Powers, D.W., and Holt, R.M., 1993, The upper Cenozoic Gatuña Formation of southeastern New Mexico, *in* Hawley, J.W., and others, eds., Geology of the Carlsbad Region, New Mexico and West Texas: 44th NMGS Fall Field Conference Guidebook, New Mexico Geological Society, Socorro, NM, p. 271-282.

Powers, D.W., and Holt, R.M., 1999, The Los Medaños Member of the Permian Rustler Formation: *New Mexico Geology*, v. 21, no. 4, p. 97-103.

Powers, D.W., and Holt, R.M., 2000, The salt that wasn't there: mudflat facies equivalents to halite of the Permian Rustler Formation, southeastern New Mexico: *Journal of Sedimentary Research*, v. 70, no. 1, p. 29-36.

Renne, P.R., Steiner, M.B., Sharp, W.D., Ludwig, K.R., and Fanning, C.M., 1996, $^{40}Ar/^{39}Ar$ and U/Pb SHRIMP dating of latest Permian tephras in the Midland Basin, Texas: American Geophysical Union, EOS, Transactions, v. 77, p. 794.

Rosholt, J.N., and McKinney, C.R., 1980, Uranium series disequilibrium investigations related to the WIPP site, New Mexico, Part II: Uranium trend dating of surficial deposits and gypsum spring deposit near WIPP site, New Mexico: US Geological Survey Open-file Report 80-879, p. 7-16.

Appendix A

Field Operations Plan/Scope of Work/Justification

The memorandum from R.L. Beauheim (Sandia National Laboratories) to Jody Plum (Carlsbad Area Office) has been reproduced here (courtesy of R.L. Beauheim) as part of the justification leading to the location and drilling of C-2737 as a replacement for H-01. There may be slight reformatting differences in this version in converting the electronic file for the data report.

The statement of work included in the appendix was used to develop the contract documents for drilling C-2737. It was provided courtesy of Ron Richardson (Westinghouse TRU Solutions LLC). Similar fonts were substituted for those used in the original file.

Sandia National Laboratories

Operated for the U.S. Department of Energy by

Sandia Corporation

LOCKHEED MARTIN

Nuclear Waste Management Program
Waste Isolation Pilot Plant

4100 National Parks Highway
Carlsbad, NM 88220
Department 6822, MS1395
Phone: (303) 984-4192
Fax: (505) 234-0061
Internet: rlbeauh@sandia.gov

Date: July 3, 2000
From: Rick Beauheim, 6822, MS1395
To: Jody Plum, CAO
Subject: Regulatory Drivers for Replacing H-1

The regulatory drivers for water-level monitoring at WIPP are contained in 40 CFR §191 and 40 CFR §264. 40 CFR §191.14(b) states "Disposal systems shall be monitored after disposal to detect substantial and detrimental deviations from expected performance. This monitoring shall be done with techniques that do not jeopardize the isolation of the wastes and shall be conducted until there are no significant concerns to be addressed by further monitoring." 40 CFR §264.99(e) states "The owner or operator must determine the ground-water flow rate and direction in the uppermost aquifer at least annually." The WIPP Hazardous Waste Facility Permit describes how the requirements of 40 CFR §264.99(e) are to be met in Permit Module V – Ground-Water Detection Monitoring:

"V.G. Ground-Water Surface Elevation Determination
V.G.1. DMP Ground-Water Surface Elevation Determination
V.G.2. Regional Ground-Water Surface Elevation Determination
The Permittees shall determine the ground-water surface elevation on a monthly basis for each well completed in the Culebra Member of the Rustler Formation in the WIPP Ground-Water Level Monitoring Program, as specified in Permit Attachment L, Section L-4c(1).

V.H. Ground-Water Flow Determination
The Permittees shall determine the ground-water flow rate and direction in the Culebra Member of the Rustler Formation at least annually, as required by 20 NMAC 4.1.500 (incorporating 40 CFR §264.98(e)). The Permittees shall use ground-water surface elevation data specified in Permit Condition V.G. to determine ground-water flow."

Note that Section V.G. has two components: monitoring of the DMP wells (WQSP-1 through 6) and monitoring of the other wells in the monitoring network. The monitoring performed under V.G.2. is critical to meeting the requirements of Section V.H. The six WQSP wells completed to the Culebra are pumped twice a year for water-quality samples. This causes the water levels in these wells to be in a continual state of fluctuation, and prevents the data from these wells being used to determine the ground-

water flow rate and direction as required in Section V.H. The requirements of Section V.H. are in fact met by the monitoring performed under Section V.G.2. Thus, maintenance of an adequate network of wells apart from the DMP (WQSP) wells is essential in meeting our regulatory requirements.

This raises the question of what constitutes an adequate network of wells. In a homogeneous medium, three wells along the northern WIPP boundary and three wells along the southern boundary might be adequate to define ground-water flow direction and velocity across the site. The Culebra, however, is not a homogeneous medium. The transmissivity of the Culebra varies over six orders of magnitude on the WIPP site in a nonsystematic way. This causes both flow direction and velocity to be highly variable and location-specific. In order to understand flow patterns on the WIPP site, many more wells are needed than simply three upgradient and three downgradient.

The existing well network currently includes 26 monitoring locations on the WIPP site (including the six WQSP wells) and three other wells within 2000 ft of the site (Figure 1). All but the WQSP wells and H-19 will have to be plugged and abandoned within the next 10-15 years because maintenance costs are proving prohibitive, as demonstrated most recently by H-1. If some of these wells are not replaced, WIPP will be unable to meet its regulatory requirement to determine the ground-water flow rate and direction in the Culebra. Sandia believes that some smaller number of wells, probably between 10 and 20, properly positioned would provide an adequate long-term monitoring network. We had an activity planned for FY00 to identify the number and locations of wells needed, but were forced to postpone that activity because of budgetary problems. We hope to perform that activity in FY01.

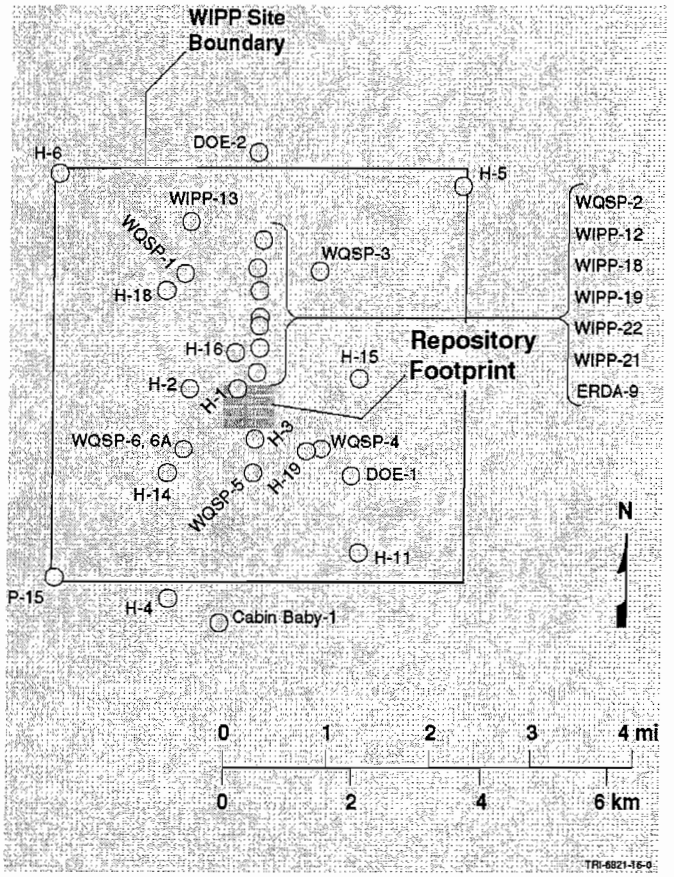


Figure 1. Wells within or near the WIPP site boundary.

In the meantime, we are faced with the loss of H-1. H-1 is unique in that it is the only well located directly above the waste-storage panels. As such, much of the information on Culebra properties (hydraulic head and transmissivity) used in PA to model radionuclide releases to the Culebra through intrusion boreholes has been based on data from H-1. In the future, evaluation and potential modeling of the effects of any changes observed by the monitoring program in Culebra water levels will require knowledge of the Culebra head above the waste panels. No other existing wells are suitable for this purpose. H-3 is only 600 ft south of the waste panels, but the Culebra transmissivity decreases by two orders of magnitude between H-3 and H-1, so H-3 is not interchangeable with H-1. ERDA-9 is 800 ft north of the panels, where the Culebra transmissivity is even lower.

In addition, the primary cause of changes in Culebra water levels near the center of the site has historically been leakage into the shafts. The Culebra has been grouted in the Waste, Exhaust, and Air-Intake Shafts numerous times over their lifetimes, with varying degrees and durations of success. Deterioration/ failure of the grout is quickly observed in the wells closest to the shafts: H-16 to the west, H-1 to the southwest, ERDA-9 to the southeast, and WIPP-21 to the northeast. Because we have had these wells to pinpoint the locus of the water-level changes, we have been able to explain the changes observed at more distant wells such as H-2, H-3, WIPP-22, WIPP-19, etc. unambiguously. As the performance of the shafts will remain of concern during both the operational and post-closure phases of WIPP, wells close to the shafts should be maintained.

Thus, having a well to replace H-1 is critical. A location over the center of the waste panels is preferable to the existing H-1 location near the northern edge of the panels because it will provide data more representative of the Culebra over the entire panel area. In this location, a well can also effectively monitor shaft conditions. By putting a new well over the center of the panels, and maintaining H-19, WQSP-4, and WQSP-5, we can probably eliminate not only H-1, but also ERDA-9, H-3, and DOE-1.

We cannot continue to plug and abandon wells without installing some new wells if we are to meet our regulatory requirements. The prudent course is to install new wells gradually, perhaps one or two a year, while plugging and abandoning four or five a year. In this way, we always have an adequate monitoring network and have steady costs, instead of suddenly coming to a point where we need to spend $10 million on new wells in one year. H-1 is a well that clearly needs to be replaced. We should proceed with that replacement without delay.

cc: R.A. Nelson, CAO
C.A. Zvonar, CAO
D. Mercer, CAO
G.T. Basabilvazo, CAO
H.E. Johnson, CAO
S.B. Jones, WID
R.G. Richardson, WID
B.A. Howard, SNL
M.K. Knowles, SNL
S.W. Wagner, SNL

Statement of Work
for
Water Well Drilling Spec
to support
Westinghouse Government Environmental Services Company
Waste Isolation Division
Waste Isolation Pilot Plant
Purchase Requisition 3737 Number Rev.1
09/20/00

1.0 Introduction and Background

The Waste Isolation Pilot Plant is a research and development facility designed to demonstrate the safe disposal of transuranic wastes in bedded salt 2150 feet below the ground surface.

The site began receiving waste in March 1999. Detection monitoring of the ground water near the WIPP has confirmed that no contamination of the underlying strata has occurred. The well to be drilled will be used to collect ground water elevation data from the Magenta and Culebra members of the Rustler formation.

Multiple ground water bearing strata may be encountered during drilling. The Dewey Lake Redbeds are the upper-most strata where water may be found. Ground water in the Dewey Lake formation is generally considered to be minimal. Lenticular, discontinuous zones of saturation within the WIPP boundaries, may occur between 150 and 250 feet below ground surface. The Dewey Lake is primarily made up of mudstone and sandstone with open fractures where ground water is present. Ground water produced from the Dewey Lake is usually suitable for livestock and other agricultural uses. Nitrate content may make it unsuitable for human consumption.

The Rustler formation contains two other significant water-bearing strata. First, is the Magenta dolomite, normally encountered approximately 550 to 600 feet below ground surface. The Magenta is fractured dolomite media approximately 25 feet thick, yielding less than one gallon of water per minute of brackish to brine quality water. The second is the Culebra, normally encountered between 650 and 700 feet below ground surface in fractured dolomite media and will produce waters that are brackish to brine in character. The Culebra may yield <1 gallon per minute, to more than 30 gallons per minute, depending on the fracture pattern of the rock.

2.0 Scope of Work

The scope of work to be performed will be to drill a single, dual completion well. The well will be drilled using the hydraulic air rotary method. The well will be a dual completion to monitor water-bearing zones in the Magenta and Culebra members of the Rustler formation. The purpose of the well will be to monitor water level fluctuations at a point directly over the underground waste panels.

Summaries of work items that are included in this statement of work are as follows:

- Mobilization of equipment to the WIPP site
- Well pad construction
- Well drilling and Construction
- Well development

3.0 Technical Tasks and QA Requirements

3.1 Mobilization

Mobilization will occur in a reasonable time to allow the vendor to move equipment and personnel to the site of construction and rig up over the proposed well site. Drilling will commence as soon as reasonably possible after mobilization is complete.

3.2 Well Pad Construction

The vendor will be responsible for constructing an access road to the well pad approximately 700 feet in length and 14 feet wide and a 150 X 150 foot well pad at the site of the proposed well. The well pad and access road will be constructed of a minimum of 12 inches of compacted caliche. A culvert will be placed in the access road at the intersection of the access road and the existing pavement to accommodate storm runoff water. The WIPP will furnish the Caliche for the construction however the contractor will be responsible for supplying water needed for compaction and the materials necessary to construct the culvert. Water sources are available near the WIPP site however arrangements must be made through the City of Carlsbad for access.

3.3 Well Drilling and Construction

Drilling will be accomplished by the hydraulic air rotary method. Safety devices such as shrouds, canopies, balouеey lines, directional pipes or the best available technology will be used to direct well cuttings and water discharged from the well bore away from the drilling crew and other personnel working on site. Well completions will be in the Magenta and Culebra members of the Rustler formation. Completion depths are expected to range from 550-600 feet below ground surface (BGS) for the Magenta and 650 to 700 feet for the Culebra total depth will be dependent upon actual conditions encountered while drilling.

Foaming agents may be used in the event drill cuttings become too heavy to remove from the well bore.(HOLD POINT) Should inflow of water become too great to lift out of the borehole with the aid of foaming agents 10# brine may be used with the approval of the WID representative. The vendor will submit MSDS forms to the WID representative for approval of any foaming agent or saturated brine the vendor proposes to use as a drilling fluid prior to bringing the foaming agent or brine onto the WIPP Land Withdrawal Area. Documentation that the trucks hauling brine to the WIPP have been cleaned by steam cleaning or sandblasting will be furnished to, and approved by, the WID representative prior to unloading the brine at the WIPP.

Cuttings will be discharged into a lined pit. The pit will be of sufficient size to collect all cutting samples and will be lined with a minimum 6 mil. thick plastic liner. The pit may be constructed with a burm in the center or two smaller pits may be constructed in anticipation of the use of brine as a circulation fluid. The second pit will be used for mixing and circulating the drilling fluid into the hole and the primary pit will be used for cuttings and expended circulation fluid. In the event that brine is discharged into the pit, excess brine will be recovered from the pit and properly disposed of at the contractor's expense. Cuttings will be disposed of in place by folding the liner to the inside of the pit and covering the pit with sufficient surface material to ensure that the pit is completely contained.

Cutting samples will be taken periodically during the drilling process. The WID representative will determine the frequency that cutting samples will be taken, however, the minimum samples collected will be as follows:

- One sample in the surficial sands at approximately 6-10 feet BGS
- One sample in the Gatuna (Santa Rosa Sandstone) if present, at 10-40 feet BGS
- One sample at the top of the Dewey Lake, usually occurring between 40 and 100 feet BGS.

- Beginning 20 feet below the top of the Dewey Lake and every 20 feet thereafter to the bottom of the Dewey Lake, with the exception of coring intervals.
- There-after one cutting sample will be taken at each change in strata.

The WID representative shall have the authority to require that the sample interval be increased or decreased.

Cutting samples will be placed into sampling bags. A chain of custody form will be filled out and each bag will be labeled with the following information:

- Date and time the cutting sample was collected
- Well Number
- Depth below ground surface that the cutting sample was collected
- The name of the person collecting the sample
- The name of the formation where the sample was collected
- The sample number

The bags containing the cutting samples will be turned over to the WID representative for proper disposition. In addition, a description of the drill cuttings being excavated from the well bore will be kept in the driller's log under the heading "Other Considerations" every 20 feet throughout the drilling process.

3.4 **Coring** (Hold Point)

Coring will proceed when the WID representative gives notice to proceed. Notice to proceed may be given verbally. Three different intervals will be cored during the drilling process.

- The Dewey Lake will be cored from 180 to 230 feet BGS.
- The Magenta will be cored through the entire interval.
- The Culebra will be cored through the entire interval of the formation and to a depth 10 feet below the Culebra interval.

Core samples will be a minimum of 3.00 inches in diameter. The following information will be entered into the driller's log:

- The time and date the core sample was taken.
- The percent recovery of the sample.
- The length of the core
- The depth interval where the core sample was taken
- A complete physical description of the materials observed within the core sample.

Core samples will be placed under chain of custody and turned over to the WID representative. Core samples will be used to determine the exact location of the Magenta and Culebra intervals and serve as archival evidence of the physical characteristics of the intervals sampled. After coring of each interval is complete the interval will be reamed to 12-1/4 inches including the sump interval below the Culebra.

3.5 Surface Casing

The surface casing will provide protection against damage from natural or manmade sources to the inner casing of the well bore.

The vendor shall drill an 18 inch hole 30 feet deep and install a 14 inch O.D. standard oil field casing of H-40, 63 lb/ft schedule 40 or equal and grout the surface casing to the surface to seal the annulus. The surface casing will extend 2 feet above the ground surface. Below the 30-foot level the borehole size will be 12-1/4 inches in diameter. The vendor shall notify the WID representative when each cutting sample collection or coring interval is reached.

Upon completion of the drilling, coring, and reaming process the following geophysical logs will be ran:

- Borehole deviation survey
- Caliper log
- Natural Gamma log with 0-100 api not to exceed 0-200 api
- Neutron log
- Density log
- Dual lateral log
- Micro lateral log

In the event ground water is encountered in the Dewey Lake formation a Bore Hole Video log will be run to assess the extent of fractures in the water bearing interval.

3.6 Casing and Screen Specifications

The casing and screen material will be of fiberglass reinforced epoxy. The outside diameter shall be 7 inches with a minimum wall thickness of .500 inches. The casing and screen material shall meet the following specifications:

- Fiberglass casing shall be installed from the surface to total depth.
- The minimum tensile strength shall be 42,000 lbs., with a minimum internal pressure rating of 540 psi.
- The casing will be manufactured with an integral coupling design with an O-ring seal with tapered threads to withstand the rigors of installation and use without leakage. A 4 thread per inch design shall be used.

- The threaded joint shall have a minimum rated tensile strength of that of the casing.
- Casing shall be made available, at a minimum, in 5,10 and 20 foot lengths, with the manufactured length variable by not more than +/- 0.25 inches.
- Documentation of leach testing shall be available for products accepted as well as sorption/ desorption testing documentation. These tests are required to ensure inert qualities of the product.
- The casing outside walls shall be rough or sand impregnated to enhance bonding with grout used for annular seals.
- All fittings, adapters and flanges, used in conjunction with the casing shall conform to the casing manufacturers thread pattern; wall thickness and resin base and must comply with the manufacture specifications.
- Casing shall have an approximate ratio of 70% fiberglass to 30% resin by weight +/-5%.
- Casing screens shall meet the same specifications as casing with the exception of tensile strength. Tensile strength of the screen joint(s) shall be a minimum of 30,000lbs.
- Screen slots shall be inward tapered to prevent clogging of the screen openings.
- The slotted screen opening shall be mill slotted 0.020 inches.

3.7 **Installation** (Hold point)

The New Mexico Office of the State Engineer shall be notified 48 hours prior to the anticipated installation of the casing. No casing installation, gravel packing, or grouting activities shall take place until a representative of the State Engineers office is on site or has responded negatively to an invitation to witness such activities.

The casing shall be lowered into the borehole with the drilling rig utilizing clamps, elevators, or other mechanical devices. Centralizers will be placed one on the screen section, two on the first joint of casing above the screen, and after at 40 foot intervals.

If at anytime the estimated weight of the casing string exceeds the rated tensile strength of the casing specification the joint will be pinned.

If any casing with a thread design other than that specified above is proposed by the vendor and accepted by WID, each joint outer thread shall be taped with a minimum of 2 mils of Teflon tape. Each joint inside threads shall be coated with Teflon based-pipe dope to ensure a leak free coupling.

Halite deposits may be present in the formation immediately below the Culebra formation. To prevent groundwater quality from being altered by solutes, the following precautions will be taken. A ten-foot blank section of casing, capped at the bottom end, will be attached to the bottom of the lower screen section to serve as a sump. The screen and casing will be suspended in the well bore so as to relieve sufficient weight stress to prevent damage to the screen slot openings.

If the presence of halite has been determined or is suspected from inspection of the core samples taken below the Culebra formation, the sump will be sealed. The annulus around the sump section will be grouted to within one foot of the bottom of the screen slots by the tremie pipe method.

If no halite is detected from inspection of the core taken from the sump area, the annulus around the sump will be gravel packed.

3.8 **Gravel Packing** (Hold point)

Gravel packing nor grouting of the well will commence until the results of the gamma log are interpreted to determine the distance of the claystone interface above the Culebra interval. The WID representative will determine the actual gravel packing and grouting conditions based on the results of the gamma log. The specification given below is based on ideal conditions.

Gravel packing material will be of 8/16-test or 0.04-grain size silica sand. Documentation will be provided giving guarantee that the gravel pack material is free of contaminates that could alter the natural state of ground water quality. Gravel packing will be accomplished by the tremie pipe method. The screened interval will be gravel packed to a depth 10 feet above the top of the screen slots followed by five feet of fine grained sand and five feet of bentonite slurry to form a barrier between the casing grout and the gravel packing around the screen.

3.9 Grouting

Grouting will be accomplished by the tremie pipe method. Grout will consist of a mixture of Portland neat cement or equal (ASTM C150) and no more than seven gallons of clean water per bag (one cubic foot or 94 pounds) of cement will be used. Additives will conform to ASTM C494 and percent mixtures and ratios will be proposed as part of the bidding process. Additives to accelerate drying time will be proposed as part of the bidding process. Consideration when proposing such additives will be given to the ability of the specified casing to withstand heat of hydration and the effects of such additives on the collapse pressure rating of the casing.

The casing will be grouted to within 20 feet of the lower portion of the upper screen section. Five feet of bentonite slurry and five feet of fine-grained sand will be placed on top of the grout, followed by #8/16 or 0.040 silica sand to a point 10 feet above the top of the upper screen section. Five feet of fine-grained sand and five feet of bentonite slurry shall be placed above the gravel pack. The casing will then be grouted to the surface.

3.10 Well Development

The method of well development shall be over-pumping. The vendor shall furnish the manpower and equipment necessary to accomplish this task. Over-pumping shall be accomplished by pumping the well with both formations open at a rate to exceed the delivery of fluid to the well bore by the formation, followed by a period of recovery. Delivery to the well bore from both formations is expected to be less than 10 gpm. Alternative means to develop the well other than over-pumping shall be proposed by the vendor during the bidding process.

4.0 Reports, Data, and Deliverables

4.1 Daily Driller's Report

A daily Driller's report shall be prepared and submitted to the WID representative at the beginning of each working day. The report shall contain the following:

- The names of all workers present on the rig
- Safety meeting topics
- Number of operating hours
- Unusual occurrences, such as down time and the reason(s)
- Depth drilled during the work day

4.2 Driller's Log

During drilling operations the vendor shall prepare and submit to the WID representative at the end of each workweek a log of all activities. The driller's log shall contain but not be limited to the following:

- The reference point for all depth measurements.
- The depth at which each change of formation occurred
- The depth at which each water bearing strata was encountered
- An estimated yield of water to the bore hole form each water bearing formation encountered
- The depth at which each stratum was encountered
- The thickness of each stratum
- The identification of the material of which each stratum is composed
- The depth interval from which each water and formation sample was taken
- The depth at which hole diameters (bit sizes) change
- The depth to the static water level and changes in static water level
- Total depth of completed well
- Depth or location of any lost drilling fluids, drilling materials, or tools
- The depth of the surface seal
- The nominal hole diameter of the well bore above and below the casing seal.
- The amount of cement (number of sacks) installed for the seal,
- The depth and description of the well casing

- Visitors to the well site (people who are not part of the Driller's crew) and their time of arrival and departure from the drilling site.

4.2 Job Hazard Analysis

At the time the bid proposal is submitted the vendor shall also submit a comprehensive Job Hazard Analysis (JHA). The JHA shall list all hazards that could potentially cause injury to personnel, the cause, and the precautions taken by the vendor to assure that the hazard has been mitigated through safe work practices. An example of a JHA is attached.

5.0 Other Conditions

5.1 Site Environmental Protection

The vendor shall make every effort to protect the environment at the site. Protection of the environment consists of, but is not limited to, the protection of vegetation, and biological residents in the area of the site and the prevention of damage, or removal of any archaeological artifacts. Prevention of the introduction of any harmful or hazardous material into the environment shall be a top priority of the vendor. No contract for drilling of this well will commence work until all NEPA surveys and permits are in place.

5.2 Vendor Responsibilities

The vendor shall prevent contamination and entrance of foreign matter into the well bore at all times during work. The vendor shall prevent damage to the environment both on and around the well pad and will prevent damage or contamination to endanger life or habitat, including leakage of fluids from equipment. The WID reserves the right to inspect the vendor's equipment prior to mobilization in order to confirm that the equipment poses no threat to human health or safety or the environment.

5.3 Safety

The U. S. Department of Energy and the Waste Isolation Division of the Westinghouse Government Environmental Services Company, take extraordinary measures to ensure the safety and well being of its employees and subcontractors. The vendor shall be responsible for maintaining these high standards of safety while performing work under contract to the WIPP. Safety inspections may be performed during the course of the contract. Stop work orders may be issued if a gross violation of safety protocol is observed. If such an order is issued the vendor is expected to correct the violation at once prior to resuming work. Down time for such a violation shall not be charged back to Westinghouse or the DOE.

Appendix B
Abridged hole history

Note: The abridged drillhole history provided here has been compiled mainly from the daily records produced by personnel of West Texas Water Well Service (WTWWS) and provided to Ron Richardson (Westinghouse TRU Solutions LLC). The information has been reformatted and has been modestly edited. *Additions to the record from notes by Dennis Powers or other personnel are in italics.* All times reported in the abridged drillhole history are in CST (Central Standard Time) as recorded by WTWWS because they operate from Midland, TX. Any additional notes included here *(in italics)* with times recorded as MST (Mountain Standard Time) at the site have been converted to CST. Geologic logs (main body of text) have times as MST, and times in the geologic logs commonly vary slightly from driller's log after allowing for the hour time difference.

2-13-01 Arrived at location at 16:10 CST (see note above). Rig up at site. Secured rig at 18:30. 30' of 13 3/8" surface casing had been previously set. Secured rig and departed site at 18:50.

2-14-01 Arrived at location at 08:10. Continued rigging up. Installed diverter. Supervised digging of pits. Located water source and filled water truck. Porta potty delivered. Installed mist pump on rig. Started rig at 14:10 and discovered hydraulic leak in hose (split). Contained and cleaned up spilled hydraulic oil. Located replacement hose in Carlsbad. Installed and tested new hose. Started rig at 17:10 and made final preparation for drilling. Drilled 7 7/8" diameter *(with air)* to total depth of 34.9' at 17:55. Secured rig and departed site at 18:20.

2-15-01 Arrived at location at 07:15. Measured water level. No water in hole. Installed drill collar at 08:05 *at 72'; adjusted geolograph.* Started drilling *with air* at 08:12. Called for core contractor at 08:25. Installed 2nd collar at 08:45. Corrected geolograph. Conferred with geologist. Touched off T.D. at 09:00. Reset geolograph. Started drilling at 72' at 09:15. Shut down at 09:30 – drilled to 90.7'. Trouble cleaning out cuttings; cause unknown at this time. Worked with diverter to insure proper operation. Considered installing smaller surface pipe inside current surface pipe to facilitate better clean out. Called for materials. Tripped out of hole at 10:15 and discovered water on drill pipe. This was the cause of inability to properly clean-out hole. Called and cancelled materials to reduce size of surface casing. Measured water level in hole at 76.4' at 10:40. Geologist took continuing measurements of rising water level. Waited on WIPP personnel to decide course of action. Decision was made to continue drilling on brine. Advised WIPP personnel that drilling would commence Monday after arrangements were made to convert to brine drilling. Started preparing rig for brine drilling at 15:00. Removed diverter. Replaced liner under rig. Removed compressor lines. Removed geolograph. Secured rig for the weekend. Left for Odessa at 16:30.

2-16-01 No drilling activity. Delivered auxiliary mud pump to location.

2-17-01 No drilling activity.

2-18-01 No drilling activity.

2-19-01 Arrived at location at 08:30. WIPP representatives checked water level at 59.4'. Requested quote on 80' monitor well on same location with 20' 2" screen. Prepared for drilling with brine. Dug trough to pit and installed top pipe. Set-up bits and reamers. Brine arrived on location at 11:20. Started drilling 12 ¼" at 30' at 11:40. *Added liquid Flowzan biopolymer to drilling fluid.* Added collar at 48' at 12:10. Resumed drilling at 12:25. Shutdown for lunch at 13:00. Repaired and relined trough to pit. Resumed drilling at 13:55. Reached 100' depth at 14:45 and began sampling. Added

collar at 15:00. Added collar at 104' at 15:20. Started auxiliary mud pump at 110' at 15:30. Took samples at 120' at 15:50. Added drill pipe at 133' at 16:10. Added drill pipe at 162.47' at 17:04. Core point at 180' depth at 17:43. Tripped out of hole and secured rig. Left location at 18:20.

2-20-01 Arrived at location at 07:30. Tripped into hole. Water level estimated at 50' bgl. At total depth at 08:10. 10' fill. Circulated. Tripped out at 08:30. Out of hole at 08:45 and set up to core. Second load of brine arrived on location at 09:15. Core set-up completed at 09:20. Started down hole at 09:24, making up core tooling. Started coring at 181' at 10:25. Cored 15' at 11:23. Pressure building at depth of 199' at 11:34. Began to trip out of hole. Core tool out at 11:52. Removed 9' of core (drilled 18') 12:15. 50% recovery. Core sample condition – poor. Started core tool assembly down hole at 12:30. Added drill pipe at 12:57. Started coring at 199' at 13:09. Cored 10' at 14:14. Tripped out for recovery. Core recovery 100%. Core condition – good. Began coring again at 209' at 15:22. At total depth of 231' for this core zone at 17:00. Began to trip out at 17:05. Recovered 100% of 22' of core. Core condition – excellent. Removed core tooling at 18:15. Secured rig and left location at 18:20.

2-21-01 Arrived at location at 07:15. Set-up for drilling. Battery dead on rig. Started with mud pump battery. Alternator problem. Static water level at 100.5'. Started down hole at 08:15. Started drilling at 181' at 08:40. Third brine load of 150 barrels arrived at 08:55 (making 450 barrels total). Added drill pipe. Replaced packing in mud pump. Fourth brine load of 150 barrels arrived at 09:15 (600 barrels total). Resumed drilling at 09:25. Drilled to 225' at 10:52. Added drill pipe. Resumed drilling at 11:20. Bit tripped out at 13:05 *from depth of 247'*. Changed to button bit due to slow drilling conditions. Resumed drilling at 14:20. Drilled to 281' at 18:20. Slow drilling. Tripped out and secured rig. Left site at 18:35.

2-22-01 Arrived at location at 07:40. Attempted to check water level – WIPP supplied meter would not function. Began tripping into hole. Reached bottom at 08:15 and circulated. Started drilling at 281' at 08:18. Added drill pipe at 09:05. Resumed drilling at 288.7' at 09:12. Added drill pipe at 319.16' at 11:45. Resumed drilling at 11:55. Added drill pipe at 350' at 14:25. Resumed drilling at 14:40. Drilled to 380' at 17:34. Circulated and tripped out to clean reamers. Tripped back into hole with collars only. Secured rig. Left location at 18:20.

2-23-01 Arrived at location at 07:30. Water level estimated at 60' – 80' bgl. Six ft. fill overnight. Tripped down to 382'. Started drilling at 08:25. At depth of 395' at 09:45. At depth of 400' at 10:08. Shut down and tripped out for bit change at 12:50. Changed back to toothed bit. Resumed drilling at 14:00. At depth of 442' at 15:15. Added drill pipe. Resumed drilling at 15:25. Added drill pipe at 17:20. At depth of 500' at 18:45. Stopped drilling. Tripped out of hole at 19:45. Secured rig and left location.

2-24-01 Arrived at location at 07:10. Eight ft. overnight fill. Began tripping into hole. At bottom at 07:53. Started circulating. Started drilling at 500' at 08:00. At depth of 505' at 08:20. Circulating. Resumed drilling at 08:40. Hit anhydrite formation at 506' at 08:53. Reached approx. depth of 507' at 09:20. Could not drill further. Formation very hard. Pulled out for bit change. Changed to chisel tooth button bit. Circulated with polymer for weekend. Pulled alternator from rig. Secured rig for weekend. Left location at 10:45.

2-25-01 No drilling activity.

2-26-01 Arrived at location at 08:35. Hole did not appear to take water over weekend. Eighty-nine ft. static water level. Installed new alternator on rig. Started down hole with new bit at 09:40. Began drilling at 507' at 10:22. At depth of 516' at 12:40. At depth of 520' at 13:40. At first core depth of 561' at 18:27. Began tripping out. Left location at 19:10.

2-27-01 Arrived at location at 07:10. Tripped to T.D. of 561'. Circulated prior to coring. Began tripping out at 08:09. Added core tooling to bit set-up. Began tripping in with core tooling at 09:00. Began coring at 561' at 09:30. Coring at 573' at 11:00. Coring at 578' at 11:50. Coring at 588' at 14:49. Cored at 588' 3" at 14:55. Core appeared to jam. Rough drilling. Decided to pull out and not risk core. Circulated. Began pulling out of hole at 15:04. Recovered 25.9' of core at 15:30. Lost core appeared to be from broken area. Formation not stable enough to recover core in one area. Left location at 16:00.

2-28-01 Arrived at location at 07:30. Tripped to 561', core depth, with 7 7/7" bit. Circulated prior to coring. Began drilling out cored area at 08:30. Reached bottom of cored depth of 588' at 09:30. Core Engineer arrived at 10:00. Drilled to 660' at 14:30. Drilled to 665' depth, second core depth, at 14:50. Circulated. Began to trip out at 15:00. Added core tooling to bit set up. Tripped in. Began coring at 665' at 16:30. Cored first 17' at 18:30. Pulled out and set core tooling on top of surface casing at 19:15. Left location at 19:30.

3-01-01 Arrived at location at 07:15. Core barrel at surface. Began removing core. Recovered 16.8' of 17' cored. Began tripping back down hole. Started coring again at 682' at 09:06. Cored 14.5' to total depth of 696.5' at 10:36. Circulated. Began to trip out to retrieve core at 10:49. Recovered 5' out of 14.5' cored at 11:45. Broken formation. Tripped to core depth at 13:15. Lost circulation. Core barrel plugged. Worked to unplug core barrel. Core barrel unplugged at 14:30. Began coring again at 696.5'. Cored 13.5' to 710' at 16:30. Began to trip out. Recovered 13.5' (100%) of core at 17:35. Core condition – excellent. Removed core tooling. Tripped in to collars. Left location at 18:15.

3-02-01 Arrived at location at 07:10. Installed 12 ¼" bit to drill out from 561' to T.D. of 710'. Reamed down hole on trip down to clean up. Started reaming at 561' at 09:25. Reamed to 620' at 18:00. Hard formation to ream. Very slow. Began tripping out. Left location at 18:35.

3-03-01 Arrived at location at 07:20. Began tripping into hole. Began reaming at 620' at 08:00. Reamed to 690' at 18:00. Began to trip out. Encountered mud ring on way out. Left location at 19:10.

3-04-01 Arrived at location at 07:10. Began to trip in. Reamed in last four joints of drill pipe due to mud ring encountered. Began reaming at 08:20. Reamed to total depth of 710' at 11:15. Began circulating. Ended circulation at 11:45. Began to trip out. Out of hole at 13:20. Left location.

3-05-01 Arrived at location at 09:30. Set up for logging. Tripped down hole with logging tool to verify hole still open. Hole open to 710'. Began logging at 11:45. Logging completed at 14:50. Prepared for casing. Set up slick line. Hauled fresh water – 5 loads. Moved casing to location. Moved gravel to rig. Discovered centralizers didn't fit casing. Ordered new centralizers for delivery in the morning. Hung collars. Delivered logs to WIPP personnel. Left location at 18:05. Problems with logs found that evening. Conferred with Dennis and Raymond concerning discrepancies. Discovered logging software error that changed actual depth by 5'. This corrected log to actual depth. Raymond to send new logs.

3-06-01 Arrived at location at 07:05. Tripped down hole reaming lower 160' in preparation for casing. At T.D. of 710' at 08:20. Began circulation with fresh water. Chamferred casing. Setting up top case. Brought in 10T pulling unit to handle super sacks of gravel. Conferred with Dennis to establish zones. Calculated lengths and volumes based on established zones. Began to trip out at 10:40. Out of hole at 11:15. Began installing Tremie pipe at 11:23. Tremie pipe installed at 12:30. Lunch. Began running casing at 12:50. Casing to T.D. at 15:10. Setting up grout pump. Started pumping fresh water down Tremie pipe at 15:30. Pumped 55 barrels at 16:45. Went for water at 16:49. Pumped 2 loads down Tremie. Total 3. Started pumping gravel at 18:15. Went for light tower. Gravel at 662' at 18:50. Went for 4th load of water at 19:15. Pumped bentonite. Trouble pumping. Plugged Tremie pipe and had to pull to clear. Bentonite to depth. Second gravel zone to depth at 02:00. Left location at 02:15.

3-07-01 Arrived at location at 10:50. Went for load of water. Prepared for cementing. Measured depth to gravel at 545'. Mixed bentonite/cement slurry for cap over gravel at 12:15. Pumped cap over gravel at 12:25. Allowed to sit. Cement arrived at 15:05. Started pumping cement at 15:13. Second load arrived at 15:45. Got return of cement at surface with approximately 11 yards cement at 16:20. Left location at 17:10.

3-08-01 Arrived at location at 07:00. Cement settled 13'. Cleaned up location. Maintained rig. Repaired hydraulic hose. Picked up motor at Jal at 11:00. Began installing 25 GPM pump and column pipe to bottom of well at 13:00. Completed installation at 18:00. Left location.

3-09-01 Arrived at location at 07:30. Developed well through over-pumping until 13:30. Well makes 2 GPM brinish water.

3-10-01 No drilling activity.

3-11-01 No drilling activity.

3-12-01 Arrived at location at 08:00. Developed C-2737 well for additional 7 hours. [Drilled C-2811.] Left location at 18:30.

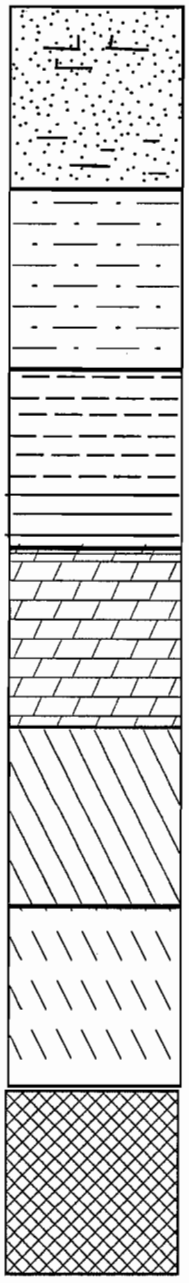
3-13-01 Arrived at location at 07:00. Pulled test pump from C-2737. Moved equipment in 2 trips; off location at 18:30.

Appendix C
Geologic Logs

Note: The original field descriptions and graphic logs were prepared at the scale indicated in the header for the log. For publication purposes, the figures were reduced to 86% of the original size, and the scale indicated will be incorrect. The vertical footage log is reduced proportionally and will still be correct.

General Key to Symbols Used in Geologic Logs

Lithology Symbols



calcareous Sandstone
silty

Siltstone
with sandstone and mudstone

Mudstone

Claystone

Dolomite

Anhydrite

Gypsum

Polyhalite

Bedding & Sedimentary Features

Sharp bedding contact (< 1 cm)

Gradational contact, over several cm

Ripples, small cross-bedding

Troughs, erosional surfaces

Moderate soft-sediment deformation

Convoluted bedding

f — Fracture

Abbreviations

hz: hard zone of drilling

add jt: drill pipe (~ 30' length) added to drilling string

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel	
DRILLING DATE:	EXCAVATION DATE:	NORTHING: 497105.07 NMSP
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Auger	EASTING: 666959.84 NMSP
DRILL MAKE/MODEL:		COLLAR ELEVATION: 3400.89 ft amsl
HOLE DIAMETER: 18 (IN) HOLE DEPTH: 30 (FT)	DRILLING CREW:	
LOGGED BY: Dennis W. Powers	DATE: 2/22/2001	SCALE: 1 inch = 10 ft SHEET 1 OF 1

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
NA	NA	NA	5, 10, 15, 20, 25		Sandstone, very fine to medium grain size, argillaceous, friable, yellowish-red (2.5YR5/6), zones with pinkish gray mottling (7.5YR7/2). Very porous. Sandstone, fine to medium grain size, very calcareous, friable to well indurated, pinkish gray (5YR7/2) to reddish brown (2.5YR7/2). Clast and ped structures outlined by carbonate. Some mottling. Very porous. Sandstone, fine to medium grain size, very calcareous, moderately well indurated, reddish brown (2.5YR5/4). Some gray MnO_2? Subangular to subround grains. With depth, becomes finer (some silt and clay) and less indurated. Sandstone, reddish brown (2.5YR5/4), fine to very coarse grain size, ~ 1-2% opaque grains. Subangular to subround grains. Very calcareous, poorly indurated to friable. Possible carbonate linings on ped (?) structures. Surface conductor casing set to ~ 30 ft, in Gatuña Fm.	Surficial dune sand and Berino soil above Mescalero caliche. Also observed in wall of driling pit. Mescalero caliche from ~5 - ~ 10 ft. Gatuña Fm from ~ 10 ft to bottom of auger hole.

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel	
DRILLING DATE: 2/14/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Rotary with air	EASTING: 666959.84 NMSP
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl
HOLE DIAMETER: 7.875 (IN)	HOLE DEPTH: 30-90 (FT)	DRILLING CREW: West Texas Water Well Service
LOGGED BY: Dennis W. Powers	DATE: 2/14/2001-2/15/2001	SCALE: 1 inch = 10 ft SHEET 1 OF 14

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
NA	NA	NA	30		see previous page for description of cuttings 0-30 feet.	Begin 1645 pm MST Cuttings only.
					Gatuña Formation (Mio-Pleistocene)	
					Sandstone, silty, medium reddish brown; fine to medium, subangular to subround grains, mainly quartz; very calcareous.	
			35			34.9 ft, end 1655 MST 2/15
					Sandstone, similar to above, brown.	Hole dry 0645 MST begin drilling 0706
					Santa Rosa Formation (Triassic)	
			40		Sandstone, similar to above, weak red (7.5R5/4:Munsell)	
					Siltstone and claystone, red (2.5YR5/8), with some small reduction spots.	
			45		From ~ 47 ft depth, hard drilling zones (hz) marked by weak red cuttings are interbedded with soft, red siltstone and claystone.	Locations not precise-geolograph corrected at 62.5 ft when next joint added
			50		hz	
			55		hz	
					From ~ 60 ft, dominated by reddish brown siltstone and claystone, similar to ~ 40 ft, with thin hard zones 0.1-1.0 ft thick at irregular intervals.	Sample depths to 62.5 ft not correct.
			60		hz	62.5 ft at 0740 MST
			65		hz	
			70			Stop 0805 MST at 72 ft to adjust geolograph
			75		hz	Stop using geolograph
					hz	
			80		hz	80 ft at 0819 MST
					hz	
			85			90.7 ft at 0826 MST. added jt
			90			Returns poor, stopped drilling. Pulled pipe & bit to run temporary casing; found water in hole. Shut down, monitored water level to 1301; will resume on 2/19/01 using brine.
			95			
			100			

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel		
DRILLING DATE: 2/19/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP	
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Rotary with brine	EASTING: 666959.84 NMSP	
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl	
HOLE DIAMETER: 12.25 (IN)	HOLE DEPTH: 90-170 (FT)	DRILLING CREW: West Texas Water Well Service	
LOGGED BY: Dennis W. Powers	DATE: 2/19/2001	SCALE: 1 inch = 10 ft	SHEET 2 OF 14

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
NA	NA	NA	90		Siltstone and very fine sandstone, dark reddish brown, with greenish gray reduction spots. Very slightly calcareous. Thin (~ 0.1-0.3 ft) hard zones (hz) are encountered at irregular intervals. Cuttings show trace to some mica.	Ream 12.25 in hole to 90.7; begin drilling new hole from 90.7 at 1320 MST. Brine includes liquid Flowzan biopolymer.
			95		hz	
			100		hz Sample 99-100 ft no cuttings ~ 100-104 ft	100 ft at 1348 MST 104 ft at 1400 MST; add jt
			105		cuttings size increased from ~105 ft, especially in hz hz	
			110			110 ft at 1427 MST
			115		hz	115 ft at 1438 MST
			120		hz Sample 119-120 ft hz Thin layers of green sandstone @ 120 ft	120 ft at 1449 MST
			125		Sandy siltstone and silty sandstone from ~ 123 ft. Sandstone is generally gray to grayish green (2.5YR6/4: yellow to 10YR7/4: very pale brown), fine to medium, subangular to subrounded, moderately well sorted, with trace opques. Siltstone and mudstone is dark reddish brown (10R4/3: weak red).	125 ft at 1458 MST
			130			130 ft at 1505 MST 133 ft at 1507 MST; add jt
			135		hz	
			140		Sample 139-140 ft	140 ft at 1528 MST
			145		hz hz	145ft at 1536MST
			150		hz Sample 149-150 ft	150 ft at 1544 MST
			155			155 ft at 1551 MST
			160		hz Sample159-160 ft	160 ft at 1537 MST 162.47 ft at 1559 MST; add jt
			165			165 ft at 1612 MST
						170 ft at 1618 MST

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel	
DRILLING DATE: 2/19/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Rotary with brine	EASTING: 666959.84 NMSP
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl
HOLE DIAMETER: 12.25 (IN)	HOLE DEPTH: 170-181 (FT)	DRILLING CREW: West Texas Water Well Service
LOGGED BY: Dennis W. Powers	DATE: 2/19/2001	SCALE: 1 inch = 10 ft SHEET 3 OF 14

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
NA	NA	NA	170		cont from sheet 3	
			175			175 ft at 1625 MST
			180		Sample at 180 ft	180 ft at 1635 MST Stop at 181 ft at 1638 MST 2/19/01

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel	
DRILLING DATE: 2/20/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Core with brine	EASTING: 666959.84 NMSP
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl
HOLE DIAMETER: 6.75 (IN)	HOLE DEPTH: 181-212 (FT)	DRILLING CREW: West Texas Water Well Service
LOGGED BY: Dennis W. Powers	DATE: 2/20/2001	SCALE: 1 inch = 4 ft SHEET 4 OF 14

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
NA	NA	NA	180			Fluid level estimated at 50 ft bgl. Set up for coring. Began coring from 181 at 0920 MST.
1	9.3 ft (52%)	23 breaks; lengths from 0.2 to 1.1 ft	182, 184, 186, 188, 190, 192, 194, 196, 198	f/f	Mudstone (to siltstone) and interbedded sandstone, dark reddish brown (2.5YR3/4) to reddish brown (2.5YR4/4) with variable diameter light brownish gray (2.5Y6/2) spots. SS are very fine to fine, with one bed of fine-medium (@191), subround, moderately calcareous, poor to moderately sorted; argillaceous; moderate to low porosity, but less in mudstone intervals. Some low-angle cross-bedding, especially @ 191 ft, generally laminar or thin-bedded. Some near-horizontal to higher angle fractures in ss, partially gypsum-filled. Mudstones are laminar to thin-bedded, some wavy. Subhorizontal fractures in finer grained units tend to have more gypsum filling. Two gypsum-filled narrow fractures @ ~60° @ 191 ft. Mica is common. SS and mudstones (to siltstones) form small (1-2 ft) thick fining upward cycles.	Run 1 core graphed as if all lost core is at top of cored interval. No way to determine interval of loss.
2	10.0 ft (100%)	18 breaks from 0.1 to 1.3 ft; RQD better below gypsum	200, 202, 204, 206, 208	f, f	Sandstone to mudstone (or siltstone) fining upward cycles about 1-3 ft thick below about 199 ft.	end core run 1 @ 199 ft @ 1030 MST
					calcareous cement / gypsum cement 202.3 ft	
					Soft sediment deformation of sandstone laminae @ about 202.8 ft. Mostly subhorizontal gypsum-filled separations up to ~ 0.5 inch thick from 202.3 ft. Less common high-angle fractures with separations ~ 0.125 inch or less.	
3			210			end core run 2 @ 209 ft @ 1320 MST

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel		
DRILLING DATE: 2/20/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP	
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Core with brine	EASTING: 666959.84 NMSP	
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl	
HOLE DIAMETER: 6.75 (IN)	HOLE DEPTH: 212-231 (FT)	DRILLING CREW: West Texas Water Well Service	
LOGGED BY: Dennis W. Powers	DATE: 2/20/2001	SCALE: 1 inch = 4 ft	SHEET 5 OF 14

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
3	22.0 ft (100%)	Only 1 natural break; other breaks to fit boxes	212 214 216 218 220 222 224 226 228 230 232		Core run 3 is similar to lower part of core run 2. Gypsum veins are more abundant, commonly 0.1-0.3 ft long, with wider apertures. High angle fractures are generally 0.25-0.50 inches, with slight sigmoidal fibrous texture. Greater porosity 226.5-228.5 ft; convoluted bedding @ 228.2 and 229 ft.	Continue core run 3. end core run 3 @ 231 ft @ 1555 MST shut down for day

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel	
DRILLING DATE: 2/21-22/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Rotary with brine	EASTING: 666959.84 NMSP
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl
HOLE DIAMETER: 12.25 (IN)	HOLE DEPTH: 230-310 (FT)	DRILLING CREW: West Texas Water Well Service
LOGGED BY: Dennis W. Powers	DATE: 2/21-22/2001	SCALE: 1 inch = 10 ft SHEET 6 OF 14

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
NA	NA	NA	230		Siltstone and mudstone, dark reddish brown, with some very fine sandstone; some fibrous gypsum. Non-calcareous.	Ream 12.25 in hole to 231; begin drilling new hole from 231 at 1037 MST.
			235			
					Sample 240 ft	240 ft at 1122 MST
			240			
			245			245 ft at 1154 MST stop @ 247 ft @ 1202, change bit; start 1320
			250			250 ft at 1338 MST
					Little gypsum in cuttings from ~ 255-265 ft.	
			255			255 ft at 1429 MST; add jt
					Sample 260 ft	260 ft at 1502 MST
			260			
			265			
						270 ft at 1559 MST
			270			
			275		Little gypsum in cuttings from ~ 275-295 ft; finer cuttings, small volume.	275 ft at 1630 MST
					Sample 280 ft	280 ft at 1709 MST
			280		Siltstone and mudstone, as above, little sandstone from from 275 ft; greenish gray flakes common.	stop @ 281 ft @ 1718 begin 2/22/01 @ 281 ft
			285			
					Sample 290 ft	290 ft at 0816 MST
			290			
			295		Thin hard zone at 297 ft, begin to see gypsum in cuttings	
					Sample 300 ft	300 ft at 0907 MST
			300			
			305		From 231 to 310 ft, the rock is generally homogeneous, with variable zones of gypsum, little sandstone below 275 ft.	
					Sample 310 ft	310 ft at 1006 MST

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel	
DRILLING DATE: 2/22-23/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Rotary with brine	EASTING: 666959.84 NMSP
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl
HOLE DIAMETER: 12.25 (IN)	HOLE DEPTH: 310-390 (FT)	DRILLING CREW: West Texas Water Well Service
LOGGED BY: Dennis W. Powers	DATE: 2/22-23/2001	SCALE: 1 inch = 10 ft SHEET 7 OF 14

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
NA	NA	NA	310		Siltstone and mudstone, dark reddish brown (2.5YR3/4) wet, with light brownish gray (10YR6/2) reduction spots and trace white fibrous gypsum. Very little sandstone. Cuttings as flakes, possibly indicating fine laminae. Non-calcareous.	Drilling from 310 at 1006 MST.
			315			add jt 1043 MST
			320		Sample 320 ft	320 ft at 1100 MST
			325		More mudstone and claystone, less siltstone from 325 ft, little gypsum.	
			330		Not enough cuttings for sample 330 ft	330 ft at 1154 MST
			335		Little gypsum in cuttings from ~ 255-265 ft.	
			340		Not enough cuttings for sample 340 ft	340 ft at 1238 MST
			345		As above, trace gypsum from 345 ft.	
					Sample 345-350 ft	
			350		Thin hard zone at 350 ft, more siltstone from 350 ft.	350 ft at 1320 MST; add jt, resume 1332 MST
			355		Little gypsum in cuttings from ~ 275-295 ft; finer cuttings, small volume.	
			360		Sample 360 ft	360 ft at 1430 MST
			365		Siltstone and mudstone, as above, little sandstone from from 275 ft; greenish gray flakes common.	
			370		Sample 370 ft Soft, gummy gypsum, continues mudstone with siltstone as at 350 ft.	370 ft at 1531 MST
			375			
			380		Mainly mudstone and claystone, little gypsum from ~ 380 ft. Not enough cuttings for sample 380 ft	380 ft at 1629 MST stop @ 382 ft for day
			385			begin 382 ft @ 0725 MST 2/23/01
					Not enough cuttings for sample 390 ft	390 ft at 0814 MST

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel		
DRILLING DATE: 2/23/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP	
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Rotary with brine	EASTING: 666959.84 NMSP	
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl	
HOLE DIAMETER: 12.25 (IN)	HOLE DEPTH: 390-470 (FT)	DRILLING CREW: West Texas Water Well Service	
LOGGED BY: Dennis W. Powers	DATE: 2/23/2001	SCALE: 1 inch = 10 ft	SHEET 8 OF 14

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
NA	NA	NA	390		Very few cuttings. Mainly soft mudstone and claystone, no gypsum.	
			395			395 ft at 0842 MST
					Drilling rate increases @ 398 ft Small sample 400 ft @ 0908 MST	
			400			400 ft at 0905 MST
			405			405 ft at 0919 MST
			410		Small sample 410 ft @ 0944 MST	410 ft at 0942 MST
						add jt 0952-1005 MST
			415		Hard drilling @ 414.5 ft, more hard zones (hz) below; some siltstone in mudstone, trace gypsum, trace very fine sandstone.	415 ft at 1021 MST
				hz		
			420	hz		420 ft at 1104 MST
				hz		stop @ 425 ft @ 1150; change bit
			425			425 ft at 1258 MST
			430		Sample 430 ft @1324 MST	430 ft at 1321 MST
					Siltstone, sandy siltstone, and claystone, with some clear gypsum. Dark reddish brown. some reduction	
			435	hz	spots. Better cuttings returns with different bit improves sampling and description, but basic lithology same as above.	435 ft at 1345 MST
			440		Very fine sandstone and gypsum more abundant from ~ 440 ft.	added jt
			445			445 ft at 1427 MST
			450		Sample 450 ft @ 1445 MST	450 ft at 1442 MST
			455			455 ft at 1457 MST
					Mainly mudstone and claystone, little gypsum from ~ 380 ft.	
			460	hz		460 ft at 1512 MST
			465	hz		465 ft at 1532 MST
					Sample 470 ft @ 1554 MST	470 ft at 1552 MST

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel	
DRILLING DATE: 2/23/01 & 2/26/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Rotary with brine	EASTING: 666959.84 NMSP
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl
HOLE DIAMETER: 12.25 (IN)	HOLE DEPTH: 470-550 (FT)	DRILLING CREW: West Texas Water Well Service
LOGGED BY: Dennis W. Powers	DATE: 2/23/2001 & 2/26/01	SCALE: 1 inch = 10 ft SHEET 9 OF 14

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
NA	NA	NA	470		Siltstone, sandy siltstone, and claystone, dark reddish brown, with greenish-gray reduction spots. Trace to some gypsum. some very fine sandstone, increasing slightly with depth.	add jt at 470 ft
			475			475 ft at 1620 MST
			480			
			485			485 ft at 1650 MST
			490		Sample 490 ft @ 1707 MST Less sandstone from ~ 492 ft depth	490 ft at 1705 MST
			495		Sample 495 ft @ 1729 MST Some pasty white gypsum (~2%) in cuttings from ~ 497 ft.	495 ft at 1727 MST
			500		Sample 500 ft @ 1745 MST	500 ft at 1745 MST, circulate, lay down pipe begin @ 500 ft @ 0658 MST
			505		Dewey Lake Fm Rustler Fm Anhydrite, gray to white, hard, microcrystalline, from 505 to 506 ft. Harder drilling begins 505-505.5, cuttings show increased gypsum and anhydrite several minutes later.	add jt 505', 0720 MST 507 ft at ~0820 MST shut down restart @ 507'
			510		Sample 510 ft includes Dewey Lake Fm cuttings	
			515			515 ft at 1128 MST
			520		Sample 520 ft @1233 MST	520 ft at 1233 MST
			525		easier drilling, more gypsiferous from ~ 527 ft	525 ft at 1330 MST
			530			530 ft at 1413 MST
			535		Claystone & mudstone, reddish brown (2.5YR4/4); very soft, cuttings poor	535 ft at 1450 MST added jt 1457-1502 MST
			540		Sample 540 ft @ 1534 MST	540 ft at 1531 MST
			545		slightly harder drilling from 545 ft; cuttings with gray (N6/) mudstone. Sample 546 ft @ 1617 MST Gypsum and anhydrite, gray to white, hard chips to soft white paste from 546.5 ft.	545 ft at 1609 MST
			550			550 ft at 1634 MST

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel	
DRILLING DATE: 2/26/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Rotary with brine	EASTING: 666959.84 NMSP
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl
HOLE DIAMETER: 12.25 (IN)	HOLE DEPTH: 550-561 (FT)	DRILLING CREW: West Texas Water Well Service
LOGGED BY: Dennis W. Powers	DATE: 2/26/2001	SCALE: 1 inch = 10 ft SHEET 10 OF 14

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
NA	NA	NA	550		Anhydrite, gray to white, hard chips to soft white paste.	add jt at 470 ft
			555			
			560		sample 560 ft at 1622 MST start coring 2/27/01 2 561 ft.	560 ft at 1620 MST stop drilling 561 ft @ 1724 MST
			565			

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel	
DRILLING DATE: 2/27/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Core with brine mud	EASTING: 666959.84 NMSP
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl
HOLE DIAMETER: 6.75"/4.0" core	HOLE DEPTH: 561-588.3 (FT)	DRILLING CREW: West Texas Water Well Service
LOGGED BY: Dennis W. Powers	DATE: 2/27/2001	SCALE: 1 inch = 4 ft SHEET 11 OF 14

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
NA	NA	NA	560		contact Forty-niner Member	Began coring @ 561ft.
					approximate Magenta Dolomite Member	
			562			Footage assigned as if all lost core is at top of cored interval. There are several surfaces showing rotation within core barrel in upper 10 ft and more breakage. Cannot rule out loss at base of core.
			564			
			566		Dolomite and gypsum, commonly light gray (5Y7/2) to olive gray (5Y5/2). Shows strong wavy bedding associated with some algal growth, especially near base, and some small ripple bedding in middle & upper part. Wavy bedding amplitude generally ~ 0.05-0.1 ft from 584.3-579.8. amplitude very low (~0.02 ft) from 579.8-570.0. Amplitude increases some to top of core.	
			568			
			570		30^0 from vertical	
			572		Thin slightly sandy-sandy laminae from 566.5-572.0 ft. Core shows some wavy laminae preferentially washed out. Rare small (~ 0.5 inch) pores may be from dissolved gypsum or washed out siltstone.	
			574			
4	drilled 27.3 ft, recoverd 25.75 ft (95% recovery)	24 breaks, more frequent in upper 15 ft.,RQD best in lower 15 ft.	576		Porosity very low below ~ 575.0 ft, indicated by rapid core drying. Higher porosity zone from ~ 575.0-566.5 ft. May be somewhat higher @ top of core as well.	
			578			
			580		Thin white gypsum bands parallel to bedding, spaced ~ 2-4 inches, between 580.0-582.0 ft. Fibrous gypsum ~ perpendicular to bedding.	
			582		Thin (< 1 inch) breccia band & gypsum @ 582.9 ft. May be synsedimentary, as overlying wavy beds are unfractured. Small flame structure @ 583.3 ft.	
			584		Anhydrite and gypsum, white to dark gray (N 4/); broadly laminar to thinly bedded, becomes more wavy and possibly stromatolitic in upper 1-1.5 ft. Nearly equant crystals of dark anhydrite give spotted appearance to rock.	
			586			
			588			Stop coring 588.3 ft @ change in coring conditions; end drilling 2/27/01
			590			
			592			

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel		
DRILLING DATE: 2/28/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP	
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Rotary with brine	EASTING: 666959.84 NMSP	
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl	
HOLE DIAMETER: 7.875 (IN)	HOLE DEPTH: 588.3-665 (FT)	DRILLING CREW: West Texas Water Well Service	
LOGGED BY: Dennis W. Powers	DATE: 2/28/2001	SCALE: 1 inch = 10 ft	SHEET 12 OF 14

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
NA	NA	NA	585		bottom cored interval 588.3 ft	changed rotary bit to 7 7/8 inch, ream cored interval and continue drilling
			590		Gray to white anhydrite, small chips as cuttings, mixed with reddish brown mud from rest of hole	
			595			
			600		Sample 600 ft @ 0900 MST	
			605			
			610			
			615			615 ft at 0957 MST added jt, begin drilling @ 1010 MST
			620		Sample 620 ft @ 1031MST	620 ft at 1029 MST
			625			625 ft at 1046 MST
			630		Sample 630 ft @ 1115 MST	630 ft at 1113 MST
			635			635 ft at 1137 MST
			640		Sample 640 ft @1204 MST easier drilling 643 ft,	640 ft at 1202 MST added jt 1230-1237
			645		Mudstone & siltstone, dark reddish brown Sample 645 ft @1226 MST thin hard zone @ 647 ft; anhydrite? Mudstone becomes light brown below 647 ft.	
			650		Sample 650 ft @1251 MST	650 ft at 1249 MST
			655		hard zone @ 657 ft; soft & gray from 657-659 ft	655 ft at 1306 MST
			660		Sample 660 ft @ 1326 MST Gypsum and anhydrite, cuttings mixed with grayish brown soft mudstone.	660 ft at 1323 MST
			665		Sample 665 ft @ 1344 MST	665 ft at 1343 MST

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel	
DRILLING DATE: 2/28/01-3/1/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Rotary with brine	EASTING: 666959.84 NMSP
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl
HOLE DIAMETER: 6.75/4.0" core	HOLE DEPTH: 665-697 (FT)	DRILLING CREW: West Texas Water Well Service
LOGGED BY: Dennis W. Powers	DATE: 3/1/2001	SCALE: 1 inch = 4 ft SHEET 13 OF 14

RUN NUMBER	RECOVERED LENGTH	ROD	DEPTH ( )FT	LITHOLOGY	DESCRIPTION	REMARKS
5	recovered 16.8 ft of 17.0 cored (99%)	665-675: 10 breaks, top piece 29 inches, bottom piece 24 inches	665		Anhydrite, white (7.5 YR N8/), with laminae of gray (7.5 YR N5/) argillaceous & organic-rich anhydrite; becomes gypsiferous toward base (679-681 ft). Laminae are poorly visible from 665-667.5, increase in abundance and visibility toward bottom. Lower 2 ft are laminated from ~ 1 mm to 1-2 cm. Laminae are slightly wavy to crenulated, probably algal in lower part. Gypsiferous parts have faint nodular appearance between laminae in lower 2 ft. Possible 3 cm nodular zone @ 672.4 ft. Basal contact is sharp.	began coring @ 1530 MST @ 665 ft.
			667			
			669			
			671			
			673			
			675			coring rate increased at 674.8 ft.
		675-682: 12 breaks, 9 inches max length	677		Dolomite, light gray (10YR7/2), gypsiferous, microcrystalline. 675-677.3: laminar to thin beds (1 mm-~ 1 cm), with dark brown organic-rich laminae and 1 cm waxy claystone at upper contact. Upper 6 inches with pores from 1 mm to 1 cm, mainly open or with silty dolomite; a few pores have gypsum fillings. Lower 6-8 inches shows some probable porosity collapse, with porosity connecting remnant vugs.	
			679			
			681		677.3-678.7: vague cm-scale bedding, scattered pores of 1mm-1 cm size; vertical microfractures generally 3-20 cm long, may be filled with silt; aperture ~ 0.01 mm. 1 cm organic claystone at 678.7 ft.	stop coring 1718 MST @ 682 ft; end drilling 2/28 begin coring @ 682 ft, 0803 MST 3/1
			683		678.8-684.2 : harder dolomite, faint bedding, 2-3 cm zones of small pores (1-3 mm) at 10-20 cm spacing, appear open or sediment-filled. Vertical to subvertical fractures filled with gypsum, aperture 1-2 mm. Larger pores (1 cm) are few and filled with gypsum or open, become gypsum to silt filled toward base of zone.	
			685			
6	recovered ~ 5 ft of 14.5 cored (34%)	about 3 ft (upper part) is intact. Lower part is rubble, with low recovery	687		Rubble recovered shows fracture surfaces with oxidized material on surface, pores that are large and generally open.	Coring run 6 ended when rate of advance ~0. Depths on core that were marked were assigned to top of interval based on rock recovered at base of run 5 and experience that Culebra tends to brecciate from ~ 10 ft below the top
			689	poor recovery		
			691			
			693			
			695		Basal dolomite sample is moderately well indurated, has zones of small (< 1mm) pores, very fine vertical cracks, possible slight collapse in porous zones.	
			697			

C-2737 Basic Data Report

HOLE ID: C-2737	LOCATION: sec 29, T22S, R31E, 1513.3 fnl, 527.3 fel	
DRILLING DATE: 2/28/01-3/1/01	EXCAVATION DATE:	NORTHING: 497105.07 NMSP
DRILLING DIRECTION: Vertical Downward	DRILL METHOD: Rotary with brine	EASTING: 666959.84 NMSP
DRILL MAKE/MODEL: Gardner-Denver 1500		COLLAR ELEVATION: 3400.89 ft amsl
HOLE DIAMETER: 6.75/4.0" core	HOLE DEPTH: 697-710 (FT)	DRILLING CREW: West Texas Water Well Service
LOGGED BY: Dennis W. Powers	DATE: 3/1/2001	SCALE: 1 inch = 4 ft SHEET 14 OF 14

RUN NUMBER	RECOVERED LENGTH ( )	RQD	DEPTH ( ) FT	LITHOLOGY	DESCRIPTION	REMARKS
7	recovered 13.5 ft of 13.5 cored (100%)	3 breaks in Los Medanos Mbr & at contact 4 breaks in Culebra	697 699 701 703 705 707 709 711		Culebra Dolomite Member Los Medaños Member Black (7.5 YR N2.5/) Very dark gray (5Y3/1) Dusky red (10R3/4) Weak red (10R4/4) Claystone, slightly silty, with some argillaceous siltstone. Most of claystone shows smeared intraclast textures. Gypsum mainly as horizontal to subhorizontal fibrous fracture fillings in lower half to third of unit. Upper contact is sharp, lower contact slightly gradational over ~ 0.5 inch. Sandy siltstone 704.0-704.5 ft. Red (10R4/6) with some olive gray (5Y5/2) Anhydrite, white to light red from probable polyhalite, especially at 709.5 ft. Lower 1 ft appears structureless. Rest of unit shows laminar to thin bedding, somewhat wavy. Small possible gypsum growth textures.	began coring @ 1530 MST @ 665 ft. coring rate increased at 674.8 ft. Coring run 7 ended @ 710 ft @ 1535 MST drillhole TD 710 ft.

Appendix D
Archeological clearance report

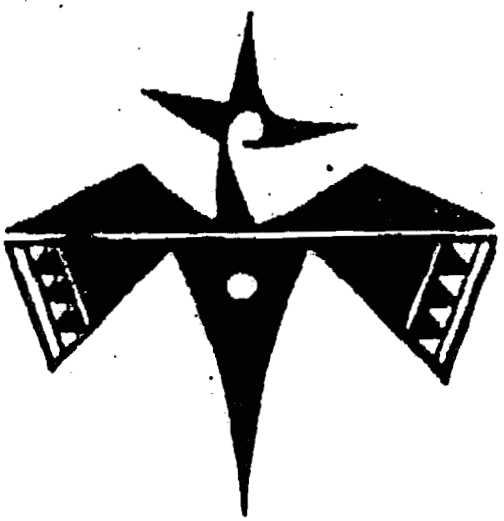
PECOS

ARCHEOLOGICAL

CONSULTANTS

P.O. BOX 1771

CARLSBAD, NM 88221



Archeological Clearance Report for
WESTINGHOUSE WASTE ISOLATION DIVISION'S
Proposed Replacement H-1 Replacement Well to be Constructed for the
WASTE ISOLATION PILOT PLANT PROJECT
Situated on U.S. Department of Energy Lands in Eddy County, N.M.
Pecos Archeological Consultants Report No. 20029
Westinghouse P.O. No. 3728
NMCRIS No. 71137

ABSTRACT

On May 25, 2000, Pecos Archeological Consultants (BLM Cultural Use Permit No. 6-2920-00, State Blanket Survey Permit No. 00-024) undertook an archeological inventory for the well pad of a replacement water well scheduled to be impacted by the Westinghouse Waste Isolation Division. This project will be situated on public lands in Eddy County, New Mexico. These lands occur in Section 29, T22S, R31E, NMPM, Eddy Co., N.M. A total of 5.74 acres Department of Energy Lands were investigated. The project was conducted in 4 man-hours by Robert J. Martin. No cultural resources were recorded as occurring within the impact zone of the project area. Due to the absence of such remains in the project area, Pecos Archeological Consultants are recommending clearance for this project, as planned.

INTRODUCTION

On May 5, 2000, Pecos Archeological Consultants was requested by Mr. Doug Lynn, Land Use Manager representing Westinghouse's Wast Isolation Dividion, to perform the archeological survey for a drill location, located on Department of Energy in Eddy County, New Mexico. This land is administered by the United States Department of Energy will be impacted by construction of a well pad. Consequently, federal law requires that an intensive archeological inventory be performed to identify what cultural resources might be impacted by such construction prior to granting clearance for the project. Therefore, Pecos Archeological Consultants undertook this survey on August 25, 2000. Fieldwork for this project was performed by Robert J. Martin. The following is a report of the field activities and findings resulting from the survey:

SURVEY METHODOLGY

Pecos Archeological Consultants conducted this survey by physically examining the entire impact zone which will result from the planned construction. Pedestrian inspection along parallel transects was accomplished across the drill location. These transects were spaced 15 meters apart; however, established transects were departed from to examine nearby areas of high site probability. All prominent deflations and denuded areas were given special attention. Skies were mostly sunny on the day of field work. Surface visiblity in the region, which, due to the drought-dessicated nature of vegetation/floral cover, ranged between 45-85% of the ground under dry soil conditions, made this the most practical methodology for effectively sampling the impact zone which will result from this project as planned.

ENVIRONMENT

The project area will be located approximately 35 miles Southeast of Carlsbad, New Mexico on lands located near the Waste Isolation Pilot Plant. The landform is typically undulating to rolling and characterized low, duned ridges and coppice duned areas, and attendant deflation basins. Microrelief for the proposed construction area is to 1.0 meters as seen in the forms of dunes; however microrelief can range to 5 meters in the general area of the WIPP. Local soils in the region consist of loamy blow sands that are over loamy, sandy paleosols; these, in turn lie over caliche. The soils are included with fragmented caliche and occasionally with rough-textured cherts and quartzites that are Ogallalan in origin. Virtually none of the Ogallalan material is suitable for aboriginal lithic tool manufacture. These soils remain, despite wind erosion, fairly well consolidated and could cover subsurface archeological remains. Drainage is accomplished primarily by internal means. Elevation in the project area is approximately 3990 ft above sea level.

The environmental zone in which the project area occurs is called the Lower Sonoran Desert Life Zone. The most common plant varieties in the region are shin oak *(Quercus havardii)*, mesquite *(Prosopis juliflora)*, yucca (*Yucca glauca*), prickly-pear cactus (*Opuntia macrocentra*), and various grasses, including sand burr (*Cenchrus insertus*). Some of the common faunal types in area are mule deer (*Odocoileus hemionus*), pronghorn antelope (*Antilocapra americana*), jackrabbit (*Lepus* sp.), cottontail rabbit (*Silvilagus* sp.), coyote (*Canis latrans*), as well as other small mammals, birds and reptiles.

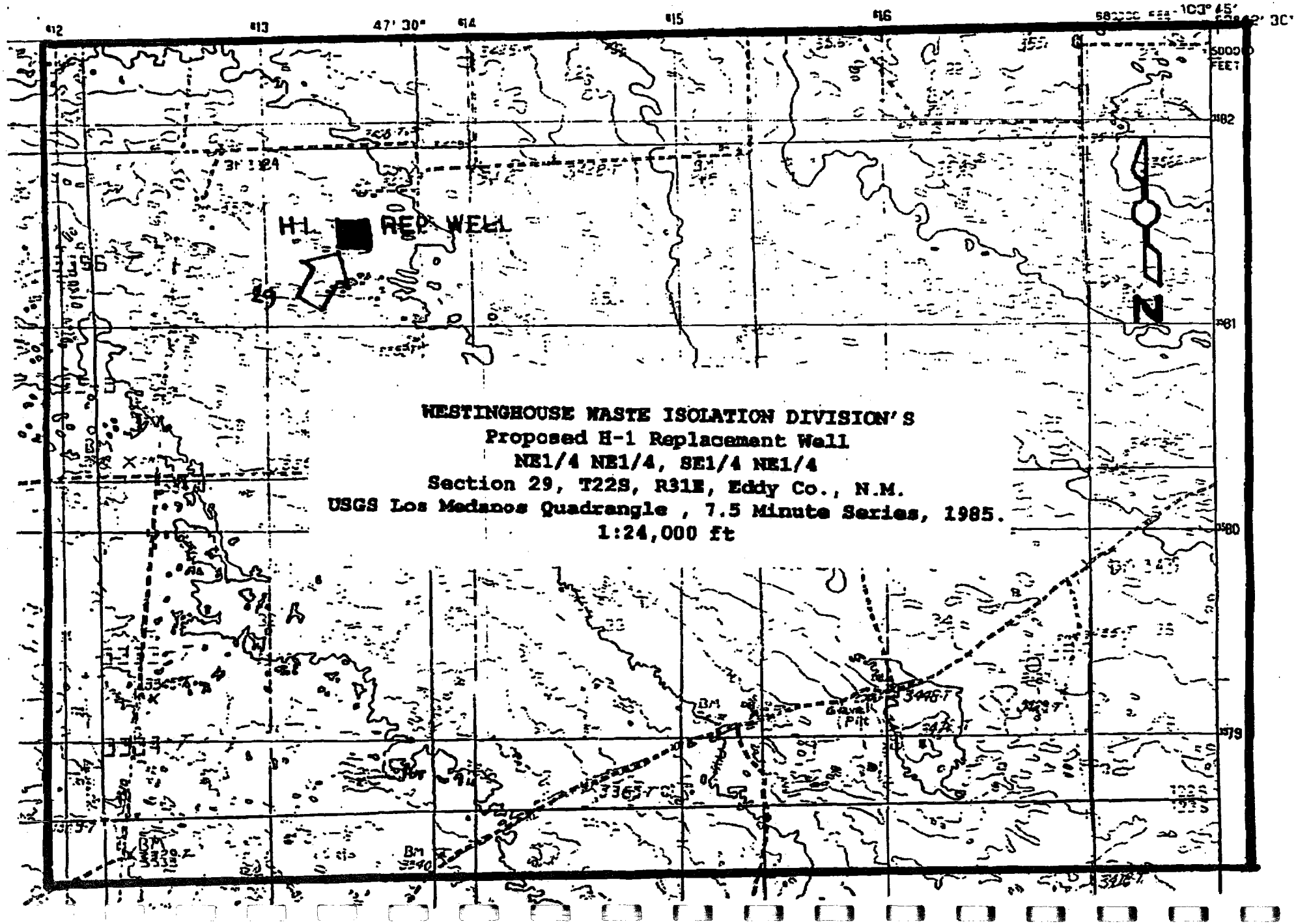
LOCATIONAL DATA

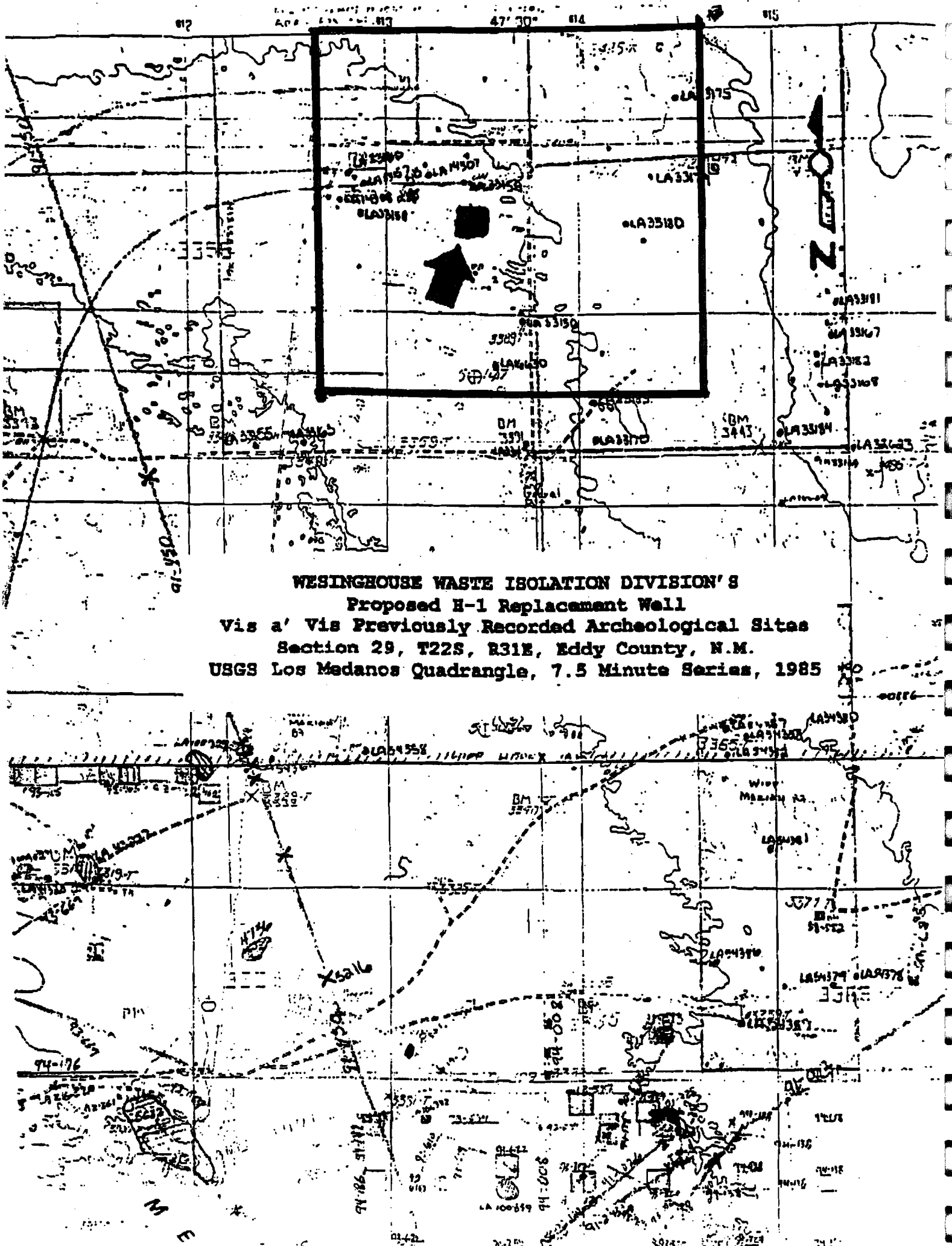
Westinghouse Waste Isolation Division's proposed well pad will measure 500 ft X 500 ft, or an area of 5.74 acres. It will be situated in the:

NE1/4 NE1/4, section 29, T22S, R31E, NMPM, Eddy Co., N.M.
SE1/4 NE1/4, section 29, T22S, R31E, NMPM, Eddy Co., N.M.

Map Reference: USGS Los Medanos Quadrangle, 7.5 Minute Series, 1985.

LOS MEDAÑOS QUADRANGLE
NEW MEXICO-EDDY CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)





WESINGHOUSE WASTE ISOLATION DIVISION'S
Proposed H-1 Replacement Well
Vis a' Vis Previously Recorded Archeological Sites
Section 29, T22S, R31E, Eddy County, N.M.
USGS Los Medanos Quadrangle, 7.5 Minute Series, 1985

ARCHEOLOGICAL RESOURCES

Prior to fieldwork for this project, Pecos Archeological Consultants performed a literature search to determine if any archeological sites had already been recorded in the vicinity of the project area. Current BLM maps, files, and the National Register of Historic Places were consulted in this endeavor. The following previously-recorded archeological sites are located within 1/4 mile of the project area: LA 33159 and LA 14307. These sites were not encountered as a result of field work for this project

Observed Archeological Resources:

No archeological remains were recorded as a result of field work for this project.

RECOMMENDATIONS

Due to the absence of cultural resources in the project area, Pecos Archeological Consultants are recommending clearance for this project. as planned. This recommendation is made on the basis of an intensive surface inspection of the project area. Should additional, purely subsurface remains occur in the impact zone, they would not be detected without extensive subsurface test excavation. Of course, approval for our recommendations and final clearance for the project must he granted by the appropriate government agency.

Attachment C

LAND USE REQUEST
Approval Contingency
For
LUR #000705A

During the construction phase of this project, there is a likelihood of encountering cultural artifacts. Prior to the initiation of construction, all subcontract construction personnel will be apprised of requisite protocol in the event artifacts are encountered. This includes, at a minimum, an immediate "stop work" order, with subsequent notification of the Land Use Coordinator. A notice to proceed will be issued after a thorough investigation is conducted.

Signed: Douglas C. Lynn, WID Land Use Coordinator

Douglas C. Lynn 03-07-03

Appendix E
Geophysical logs

C-2737 Basic Data Report

Geophysical logging of C-2737 was completed by Geophysical Logging Services, 6250 Michele Lane, Prescott, AZ 86305 on March 5, 2001. The operator was Raymond Federwisch.

The heading on the paper copy of the log reports the following logs, all conducted from ground level to a depth of 710 ft:

Microlog
Dual Lateral
Neutron
Density
Gamma
Caliper
Deviation
Fluid.

An electronic file of data from Geophysical Logging Services is being placed in records in an (Microsoft) Excel 97 format.

Appendix F
Photo logs

Frame numbers are presented chronologically: the Canon Eos Rebel winds the film from the cassette and takes frame 24 first and frame 1 last.

C-2737 Basic Data Report

PHOTOGRAPH LOG SHEET

FRAME Roll 2001-04	DATE	LOCATION	DESCRIPTION OF SUBJECT (include individual/group names, direction, etc. as appropriate)	PHOTOGRAPHER (Initials and Dept.)
24	2/19/01	C-2737	**Drilling rig, West Texas Water Well Services; Gardner-Denver 1500**	DW Powers (Consulting Geologist)
23	2/19/01	C-2737	**Drilling rig, West Texas Water Well Services; Gardner-Denver 1500; crew**	DW Powers (Consulting Geologist)
22	2/19/01	C-2737	**Drilling rig, West Texas Water Well Services; Gardner-Denver 1500; crew**	DW Powers (Consulting Geologist)
21	2/19/01	C-2737	**Drilling rig, West Texas Water Well Services; Gardner-Denver 1500; pit; crew**	DW Powers (Consulting Geologist)
20	2/20/01	C-2737	**Core, Run 1, (Dewey Lake Formation) overlapping frame: 197.5-199.0 ft depth**	DW Powers (Consulting Geologist)
19	2/20/01	C-2737	**Core, Run 1, (Dewey Lake Formation) overlapping frame: 196.5-198.3 ft depth**	DW Powers (Consulting Geologist)
18	2/20/01	C-2737	**Core, Run 1, (Dewey Lake Formation) overlapping frame: 195.6-197.2 ft depth**	DW Powers (Consulting Geologist)
17	2/20/01	C-2737	**Core, Run 1, (Dewey Lake Formation) overlapping frame: 193.9-195.8 ft depth**	DW Powers (Consulting Geologist)
16	2/20/01	C-2737	**Core, Run 1, (Dewey Lake Formation) overlapping frame: 192.8-194.4 ft depth**	DW Powers (Consulting Geologist)
15	2/20/01	C-2737	**Core, Run 1, (Dewey Lake Formation) overlapping frame: 191.5-193.2 ft depth**	DW Powers (Consulting Geologist)
14	2/20/01	C-2737	**Core, Run 1, (Dewey Lake Formation) overlapping frame: 190.3-191.8 ft depth**	DW Powers (Consulting Geologist)
13	2/20/01	C-2737	**Core, Run 1, (Dewey Lake Formation) overlapping frame: 190.2-191.1 ft depth**	DW Powers (Consulting Geologist)
12	2/20/01	C-2737	**Core, Run 2, (Dewey Lake Formation) overlapping frame: 207.5-209.0 ft depth**	DW Powers (Consulting Geologist)
11	2/20/01	C-2737	**Core, Run 2, (Dewey Lake Formation) overlapping frame: 206.4-208.0 ft depth**	DW Powers (Consulting Geologist)
10	2/20/01	C-2737	**Core, Run 2, (Dewey Lake Formation) overlapping frame: 205.3-206.8 ft depth**	DW Powers (Consulting Geologist)
09	2/20/01	C-2737	**Core, Run 2, (Dewey Lake Formation) overlapping frame: 203.9-205.6 ft depth**	DW Powers (Consulting Geologist)
08	2/20/01	C-2737	**Core, Run 2, (Dewey Lake Formation) overlapping frame: 202.6-204.2 ft depth**	DW Powers (Consulting Geologist)

Camera: Eos Canon Rebel **Film Speed: ISO 200** **Exposures: 24**

C-2737 Basic Data Report

PHOTOGRAPH LOG SHEET

FRAME Roll 2001-04	DATE	LOCATION	DESCRIPTION OF SUBJECT (include individual/group names, direction, etc. as appropriate)	PHOTOGRAPHER (Initials and Dept.)
07	2/20/01	C-2737	Core, Run 2, (Dewey Lake Formation) overlapping frame: 201.1-202.7 ft depth	DW Powers (Consulting Geologist)
06	2/20/01	C-2737	Core, Run 2, (Dewey Lake Formation) overlapping frame: 200.0-201.6 ft depth	DW Powers (Consulting Geologist)
05	2/20/01	C-2737	Core, Run 2, (Dewey Lake Formation) overlapping frame: 199-200.6 ft depth	DW Powers (Consulting Geologist)
04	2/20/01	C-2737	Drilling rig, West Texas Water Well Services; Gardner-Denver 1500; crew	DW Powers (Consulting Geologist)
03	2/20/01	C-2737	Drilling rig, West Texas Water Well Services; Gardner-Denver 1500; crew	DW Powers (Consulting Geologist)
02	2/20/01	C-2737	Drilling rig, West Texas Water Well Services; Gardner-Denver 1500; core ops	DW Powers (Consulting Geologist)
01	2/20/01	C-2737	Drilling rig, West Texas Water Well Services; Gardner-Denver 1500; core ops	DW Powers (Consulting Geologist)

Camera: Eos Canon Rebel **Film Speed: ISO 200** **Exposures: 24**

C-2737 Basic Data Report

PHOTOGRAPH LOG SHEET

FRAME Roll 2001-05	DATE	LOCATION	DESCRIPTION OF SUBJECT (include individual/group names, direction, etc. as appropriate)	PHOTOGRAPHER (Initials and Dept.)
24	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 229-231 ft depth	DW Powers (Consulting Geologist)
23	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 228.2-230.3 ft depth	DW Powers (Consulting Geologist)
22	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 227.2-229.3 ft depth	DW Powers (Consulting Geologist)
21	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 225.9-227.9 ft depth	DW Powers (Consulting Geologist)
20	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 224.7-226.7 ft depth	DW Powers (Consulting Geologist)
19	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 223.9-225.9 ft depth	DW Powers (Consulting Geologist)
18	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 222.9-223.8 ft depth	DW Powers (Consulting Geologist)
17	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 221.9-223.7 ft depth	DW Powers (Consulting Geologist)
16	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 218.9-222.7 ft depth	DW Powers (Consulting Geologist)
15	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 220.0-221.7 ft depth	DW Powers (Consulting Geologist)
14	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 219.3-221.1 ft depth	DW Powers (Consulting Geologist)
13	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 218.5-220.2 ft depth	DW Powers (Consulting Geologist)
12	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 217.8-219.5 ft depth	DW Powers (Consulting Geologist)
11	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 216.8-218.5 ft depth	DW Powers (Consulting Geologist)
10	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 215.9-217.6 ft depth	DW Powers (Consulting Geologist)
09	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 215.2-216.8 ft depth	DW Powers (Consulting Geologist)
08	2/20/01	C-2737	Core, Run 3, (Dewey Lake Formation) overlapping frame: 214.3-216.0 ft depth	DW Powers (Consulting Geologist)

Camera: EOS Canon Rebel **Film Speed: ISO 200** **Exposures: 24**

PHOTOGRAPH LOG SHEET

FRAME Roll 2001-05	DATE	LOCATION	DESCRIPTION OF SUBJECT (include individual/group names, direction, etc. as appropriate)	PHOTOGRAPHER (Initials and Dept.)
07	2/20/01	C-2737	**Core, Run 3, (Dewey Lake Formation) overlapping frame: 213.5-215.1 ft depth**	DW Powers (Consulting Geologist)
06	2/20/01	C-2737	**Core, Run 3, (Dewey Lake Formation) overlapping frame: 212.8-214.4 ft depth**	DW Powers (Consulting Geologist)
05	2/20/01	C-2737	**Core, Run 3, (Dewey Lake Formation) overlapping frame: 212.0-213.6 ft depth**	DW Powers (Consulting Geologist)
04	2/20/01	C-2737	**Core, Run 3, (Dewey Lake Formation) overlapping frame: 211.1-212.7 ft depth**	DW Powers (Consulting Geologist)
03	2/20/01	C-2737	**Core, Run 3, (Dewey Lake Formation) overlapping frame: 210.1-211.7 ft depth**	DW Powers (Consulting Geologist)
02	2/20/01	C-2737	**Core, Run 3, (Dewey Lake Formation) overlapping frame: 209-210.6 ft depth**	DW Powers (Consulting Geologist)
01	2/20/01	C-2737	**Core, Run 3, (Dewey Lake Formation) overlapping frame: 209-210.3 ft depth**	DW Powers (Consulting Geologist)

Camera: EOS Canon Rebel **Film Speed: ISO 200** **Exposures: 24**

C-2737 Basic Data Report

PHOTOGRAPH LOG SHEET

FRAME Roll 2001-08	DATE	LOCATION	DESCRIPTION OF SUBJECT (include individual/group names, direction, etc. as appropriate)	PHOTOGRAPHER (Initials and Dept.)
24	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 588.3-586.5 ft depth	DW Powers (Consulting Geologist)
23	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 587.1-585.1 ft depth	DW Powers (Consulting Geologist)
22	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 585.7-583.6 ft depth	DW Powers (Consulting Geologist)
21	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 584.3-583.2 ft depth	DW Powers (Consulting Geologist)
20	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 583.7-580.7 ft depth	DW Powers (Consulting Geologist)
19	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 581.4-579.3 ft depth	DW Powers (Consulting Geologist)
18	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 580.0-578.0 ft depth	DW Powers (Consulting Geologist)
17	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 578.5-576.5 ft depth	DW Powers (Consulting Geologist)
16	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 577.0-575.0 ft depth	DW Powers (Consulting Geologist)
15	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 575.6-573.6 ft depth	DW Powers (Consulting Geologist)
14	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 574.2-572.3 ft depth	DW Powers (Consulting Geologist)
13	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 572.9-571.0 ft depth	DW Powers (Consulting Geologist)
12	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 571.6-569.9 ft depth	DW Powers (Consulting Geologist)
11	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 570.2-568.5 ft depth	DW Powers (Consulting Geologist)
10	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 569.0-567.2 ft depth	DW Powers (Consulting Geologist)
09	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 567.9-566.0 ft depth*	DW Powers (Consulting Geologist)
08	2/27/01	C-2737	Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 566.7-565.1 ft depth*	DW Powers (Consulting Geologist)

Camera: Canon Eos Rebel **Film Speed: 200 ISO** **Exposures: 24**

PHOTOGRAPH LOG SHEET

FRAME Roll 2001-08	DATE	LOCATION	DESCRIPTION OF SUBJECT (include individual/group names, direction, etc. as appropriate)	PHOTOGRAPHER (Initials and Dept.)
07	2/27/01	C-2737	**Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 565.1-563.7 ft depth***	DW Powers (Consulting Geologist)
06	2/27/01	C-2737	**Core, Run 4, (Magenta Dol., Rustler Fm) overlapping frame: 564.3-562.8 ft depth***	DW Powers (Consulting Geologist)
05	2/27/01	C-2737	**Core, Run 4, (Magenta Dol., Rustler Fm), full length shot 588.3 (foreground) - 562.8 ft**	DW Powers (Consulting Geologist)
04	2/27/01	C-2737	**Core, Run 4, (Magenta Dol., Rustler Fm), upper core porous (wet) zone above 574 ft**	DW Powers (Consulting Geologist)
03	2/27/01	C-2737	**Core, Run 4, (Magenta Dol., Rustler Fm), closeup of Tam-Mag transition @ 584 ft**	DW Powers (Consulting Geologist)
02	2/27/01	C-2737	**Core, Run 4, (Magenta Dol., Rustler Fm), closeup basal Magenta, 584-583.4 ft**	DW Powers (Consulting Geologist)
01	2/27/01	C-2737	**Core, Run 4, (Magenta Dol., Rustler Fm), closeup of basal Magenta, 582.7-583.5 ft**	DW Powers (Consulting Geologist)
			***Descriptions marked with an asterisk are frames where core was marked incorrectly. Corrected cores are photographed in Roll 2001-09**	

Camera: Canon Eos Rebel **Film Speed: 200** **Exposures: 24**

C-2737 Basic Data Report

PHOTOGRAPH LOG SHEET

FRAME Roll 2001-09	DATE	LOCATION	DESCRIPTION OF SUBJECT (include individual/group names, direction, etc. as appropriate)	PHOTOGRAPHER (Initials and Dept.)
24	2/27/01	C-2737	Core, Run 5, (Rustler Formation), remarked core: 565.1-563.3 ft depth*	DW Powers (Consulting Geologist)
23	2/27/01	C-2737	Core, Run 5, (Rustler Formation), remarked core: 564.3-562.8 ft depth*	DW Powers (Consulting Geologist)
22	2/27/01	Nash Draw	Laguna Tres, salt hoppers underwater (out of focus)	DW Powers (Consulting Geologist)
21	2/27/01	Nash Draw	Laguna Tres, salt hopper underwater (clear) on salt with silt	DW Powers (Consulting Geologist)
20	2/27/01	Nash Draw	Laguna Tres, high point of salt in shallow water, looking west	DW Powers (Consulting Geologist)
19	2/27/01	Nash Draw	Laguna Tres, white salt hoppers (rafts) that sank to bottom of shallow water	DW Powers (Consulting Geologist)
18	2/27/01	Nash Draw	Laguna Tres, reflection on brine	DW Powers (Consulting Geologist)
17	2/27/01	Nash Draw	Laguna Tres, sunken salt rafts (~ 1 inch) collected in wave trains (penny scale)	DW Powers (Consulting Geologist)
16	2/27/01	Nash Draw	Laguna Tres, shrinkage polygons ~ 1-2 ft across in shallow brine, dissolved edges	DW Powers (Consulting Geologist)
15	2/27/01	Nash Draw	Like 16, closer view, brown halite of underlying layer exposed at edges	DW Powers (Consulting Geologist)
14	2/27/01	Nash Draw	Laguna Tres, shrinkage polygons 1-2 ft exposed on high salt, dissolved edges	DW Powers (Consulting Geologist)
13	2/27/01	Nash Draw	Laguna Tres, poorly organized ripples or waves of halite	DW Powers (Consulting Geologist)
12	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 681.7-680.5 ft depth	DW Powers (Consulting Geologist)
11	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 681.2-680.0 ft depth	DW Powers (Consulting Geologist)
10	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 680.5-679.4 ft depth	DW Powers (Consulting Geologist)
09	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 679.9-678.8 ft depth	DW Powers (Consulting Geologist)
08	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 679.3-678.3 ft depth	DW Powers (Consulting Geologist)

Camera: Canon Eos Rebel **Film Speed: 200 ISO** **Exposures: 24**

PHOTOGRAPH LOG SHEET

FRAME Roll 2001-09	DATE	LOCATION	DESCRIPTION OF SUBJECT (include individual/group names, direction, etc. as appropriate)	PHOTOGRAPHER (Initials and Dept.)
07	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 678.6-677.5 ft depth	DW Powers (Consulting Geologist)
06	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 678.1-677.0 ft depth	DW Powers (Consulting Geologist)
05	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 677.5-676.4 ft depth	DW Powers (Consulting Geologist)
04	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 676.8-675.8 ft depth	DW Powers (Consulting Geologist)
03	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 676.3-675.0 ft depth	DW Powers (Consulting Geologist)
02	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 676.7-674.6 ft depth	DW Powers (Consulting Geologist)
01	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 675.2-674.2 ft depth	DW Powers (Consulting Geologist)
			*Descriptions marked with an asterisk are frames where core was rephotographed after markings were corrected. Substitute for some frames in Roll 2001-08.	

Camera: Canon Eos Rebel **Film Speed: 200** **Exposures: 24**

C-2737 Basic Data Report

PHOTOGRAPH LOG SHEET

FRAME Roll 2001-10	DATE	LOCATION	DESCRIPTION OF SUBJECT (include individual/group names, direction, etc. as appropriate)	PHOTOGRAPHER (Initials and Dept.)
24	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 675.2-674.1 ft depth	DW Powers (Consulting Geologist)
23	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 674.5-673.4 ft depth	DW Powers (Consulting Geologist)
22	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 673.8-672.7 ft depth	DW Powers (Consulting Geologist)
21	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 672.9-672.0 ft depth	DW Powers (Consulting Geologist)
20	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 672.3-671.1 ft depth	DW Powers (Consulting Geologist)
19	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 671.6-670.6 ft depth	DW Powers (Consulting Geologist)
18	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 670.8-669.6 ft depth	DW Powers (Consulting Geologist)
17	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 670.2-669.0 ft depth	DW Powers (Consulting Geologist)
16	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 669.4-668.2 ft depth	DW Powers (Consulting Geologist)
15	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 668.7-667.5 ft depth	DW Powers (Consulting Geologist)
14	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 667.8-666.9 ft depth	DW Powers (Consulting Geologist)
13	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 667.3-666.1 ft depth	DW Powers (Consulting Geologist)
12	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 666.6-665.4 ft depth	DW Powers (Consulting Geologist)
11	3/01/01	C-2737	Core, Run 5, (Rustler Formation) overlapping frame: 665.9-665.0 ft depth	DW Powers (Consulting Geologist)
10	3/01/01	C-2737	Core, Run 6, (Rustler Formation), lower rubble from ~ 696.5-684.2	DW Powers (Consulting Geologist)
09	3/01/01	C-2737	Core, Run 6, (Rustler Formation), upper rubble from ~ 696.5-684.2	DW Powers (Consulting Geologist)
08	3/01/01	C-2737	Core, Run 6, (Rustler Formation), upper rubble, core: 684.2-686.5 ft depth	DW Powers (Consulting Geologist)

Camera: Canon Eos Rebel **Film Speed: 200 ISO** **Exposures: 24**

PHOTOGRAPH LOG SHEET

FRAME Roll 2001-10	DATE	LOCATION	DESCRIPTION OF SUBJECT (include individual/group names, direction, etc. as appropriate)	PHOTOGRAPHER (Initials and Dept.)
07	3/01/01	C-2737	**Core, Run 6, (Rustler Formation) overlapping frame: 683.7-682.7 ft depth**	DW Powers (Consulting Geologist)
06	3/01/01	C-2737	**Core, Run 6 (Rustler Formation) overlapping frame: 682.8-681.8 ft depth**	DW Powers (Consulting Geologist)
05	3/01/01	C-2737	**Core, Run 7, (Rustler Formation) overlapping frame: 710.0-709.0 ft depth**	DW Powers (Consulting Geologist)
04	3/01/01	C-2737	**Core, Run 7, (Rustler Formation) overlapping frame: 709.3-708.1 ft depth**	DW Powers (Consulting Geologist)
03	3/01/01	C-2737	**Core, Run 7, (Rustler Formation) overlapping frame: 708.3-707.2 ft depth**	DW Powers (Consulting Geologist)
02	3/01/01	C-2737	**Core, Run 7, (Rustler Formation) overlapping frame: 707.5-706.2 ft depth**	DW Powers (Consulting Geologist)
01	3/01/01	C-2737	**Core, Run 7, (Rustler Formation) overlapping frame: 706.6-705.5 ft depth**	DW Powers (Consulting Geologist)

Camera: Canon Eos Rebel **Film Speed: 200** **Exposures: 24**

C-2737 Basic Data Report

PHOTOGRAPH LOG SHEET

FRAME Roll 2001-11	DATE	LOCATION	DESCRIPTION OF SUBJECT (include individual/group names, direction, etc. as appropriate)	PHOTOGRAPHER (Initials and Dept.)
24	3/01/01	C-2737	Core, Run 7, (Rustler Formation) overlapping frame: 706.5-705.3 ft depth	DW Powers (Consulting Geologist)
23	3/01/01	C-2737	Core, Run 7, (Rustler Formation) overlapping frame: 705.9-704.6 ft depth	DW Powers (Consulting Geologist)
22	3/01/01	C-2737	Core, Run 7, (Rustler Formation) overlapping frame: 705.2-703.9 ft depth	DW Powers (Consulting Geologist)
21	3/01/01	C-2737	Core, Run 7, (Rustler Formation) overlapping frame: 704.4-703.2 ft depth	DW Powers (Consulting Geologist)
20	3/01/01	C-2737	Core, Run 7, (Rustler Formation) overlapping frame: 703.6-702.4 ft depth	DW Powers (Consulting Geologist)
19	3/01/01	C-2737	Core, Run 7, (Rustler Formation) overlapping frame: 702.9-701.7 ft depth	DW Powers (Consulting Geologist)
18	3/01/01	C-2737	Core, Run 7, (Rustler Formation) overlapping frame: 702.2-700.9 ft depth	DW Powers (Consulting Geologist)
17	3/01/01	C-2737	Core, Run 7, (Rustler Formation) overlapping frame: 701.4-700.1 ft depth	DW Powers (Consulting Geologist)
16	3/01/01	C-2737	Core, Run 7, (Rustler Formation) overlapping frame: 700.6-699.4 ft depth	DW Powers (Consulting Geologist)
15	3/01/01	C-2737	Core, Run 7, (Rustler Formation) overlapping frame: 698.6-699.8 ft depth	DW Powers (Consulting Geologist)
14	3/01/01	C-2737	Core, Run 7, (Rustler Formation) overlapping frame: 697.9-699.1 ft depth	DW Powers (Consulting Geologist)
13	3/01/01	C-2737	Core, Run 7, (Rustler Formation) overlapping frame: 698.3-697.2 ft depth	DW Powers (Consulting Geologist)
12	3/01/01	C-2737	Core, Run 7, (Rustler Formation) overlapping frame: 697.5-696.5 ft depth	DW Powers (Consulting Geologist)
11	3/01/01	C-2737	Core, Run 7, (Rustler Formation) view of 710 (foreground) to top of core	DW Powers (Consulting Geologist)
10	3/01/01	Nash Draw, Laguna Cuatro	South side, IMC 5 headframe	DW Powers (Consulting Geologist)
09	3/01/01	Nash Draw, Laguna Cuatro	North side, laminar silty halite in low spots, hammer scale	DW Powers (Consulting Geologist)

Camera: Canon Eos Rebel **Film Speed: 200 ISO** **Exposures: 24**

PHOTOGRAPH LOG SHEET

FRAME Roll 2001-11	DATE	LOCATION	DESCRIPTION OF SUBJECT (include individual/group names, direction, etc. as appropriate)	PHOTOGRAPHER (Initials and Dept.)
08	3/01/01	Nash Draw, Laguna Cuatro	North side, laminar silty halite closeup, hammer scale	DW Powers (Consulting Geologist)
07	3/01/01	Nash Draw, Laguna Cuatro	North side, sunset	DW Powers (Consulting Geologist)
06	3/01/01	Nash Draw, Laguna Cuatro	North side, silty halite in shallow area, shoreline, hammer scale	DW Powers (Consulting Geologist)
05	3/01/01	Nash Draw, Laguna Cuatro	North side, halite overgrowing sunken raft halite, shallows	DW Powers (Consulting Geologist)
04	3/01/01	Nash Draw, Laguna Cuatro	North side, narrow halite ripples at edge of water overgrown by capillary halite	DW Powers (Consulting Geologist)
03	3/01/01	Nash Draw, Laguna Cuatro	North side, narrow halite ripples at edge of water overgrown by capillary halite	DW Powers (Consulting Geologist)
02	3/01/01	Nash Draw, Laguna Cuatro	North side, white halite zone probably formed during seiche from west (view to south)	DW Powers (Consulting Geologist)
01	3/01/01	Nash Draw, Laguna Cuatro	North side, halite overgrowths in very shallow water. Slightly out of focus.	DW Powers (Consulting Geologist)

Camera: Canon Eos Rebel Film Speed: 200 Exposures: 24

Appendix G
Additional Completion Information

C-2737 Basic Data Report

Dennis W. Powers, Ph. D.

Consulting Geologist

February 28, 2002

Memorandum for the record

Re: Some completion data for drillhole C-2737

During a telephone conversation today with Gil Gillespie (West Texas Water Well Service, 3432 W. University, Odessa, TX 79764), we discussed some of the completion data for drillhole C-2737 not immediately available from other sources. This is a summary of those items, and they will be included as appropriate in the basic data report for C-2737.

Fiberglass Casing

The fiberglass casing used in C-2737 has the following characteristics:
Threaded connections
Outside diameter (o.d.) of 7 inches
Thickness of wall: minimum 0.5 inch
Length: 29.5 ft
Manufacturer: Centron Fiberglass

Screened Intervals

The fiberglass casing used for screens had tapered slots (wider to inside of pipe) 0.02 inch (0.508 mm) wide. The screened casing is also 29.5 ft long, with 25 ft of slots in the lower part (the upper 4.5 ft doesn't have slots).

There are 19 lengths minus 3 ft stickup above ground to the first screened casing:
(29.5 x 19 = 560.5 ft; 560.5 - 3.0 ft = 557.5 ft)
The Magenta screen casing is from 557.5 to 587.0 (557.5 + 29.5 = 587.0), and the screen interval is from 562.0 to 587.0 (557.5 + 4.5 unslotted length = 562.0)

Below the Magenta, 2 full length casings, a 20 ft casing, and a 5 ft casing were added:
587.0 + 29.5 + 29.5 + 20 + 5 = 671 ft.

The Culebra screen casing runs from 671 to 700.5 (671 + 29.5 = 700.5), and the screen interval is from 675.5 to 700.5 ft (671 + 4.5 unslotted length = 675.5).

A 10 ft casing sits below the Culebra screen for a total casing depth of 710.5 ft.

Gravel Pack

The sand used behind the screened intervals was obtained from Oglebay-Norton Industrial Sand, and the grain size is 1.39-1.42 mm (0.055-0.056 inch) diameter.

Bentonite

The bentonite used to seal the gravel packs and separate the intervals is a pelletal bentonite hole plug material obtained from Baroid Industries.

Distribution: G. Gillespie (West Texas Water Well Services); Ron Richardson (Westinghouse TRU Solutions); Rick Beauheim (Sandia National Laboratories)

140 Hemley Road, Anthony, TX 79821
Telephone: (915) 877-3929E-mail: dwpowers@htg.net *FAX: (915) 877-5071*

Thomas C. Turney
State Engineer

Roswell Office
1900 WEST SECOND STREET
ROSWELL, NM 88201

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER

Trn Nbr: 192470
File Nbr: C 02737

Sep. 27, 2000

DOUGLAS C. LYNN
U.S. DEPT. OF ENERGY, WIPP
P.O. BOX 3090
CARLSBAD, NM 88221-3090

Greetings:

Enclosed is your copy of the 72-12-1 Permit which has been approved. Your attention is called to the Specific and the General Conditions of Approval of this permit.

In accordance with General Condition C, a well record shall be filed in this office within ten (10) days after completion of drilling. The well record is proof of completion of the well. IT IS YOUR RESPONSIBILITY TO ASSURE THAT THE WELL LOG BE FILED WITHIN 10 DAYS OF DRILLING THE WELL.

This permit will expire on or before 09/26/2001, unless the well has been drilled and the well log filed in this office.

Sincerely,

Theresa Grandjean

for Mike Stapleton
(505) 622-6467

Enclosure

cc: Santa Fe Office

wr_01app

File Number: C-2737

Received: August 18, 2000

NEW MEXICO STATE ENGINEER OFFICE
APPLICATION TO APPROPRIATE UNDERGROUND WATERS
IN ACCORDANCE WITH SECTION 72-12-1 NEW MEXICO STATUTES

1. APPLICANT

Name: U,S. Department of Energy, Waste Isolation Pilot Plant **Work Phone:** (505) 234-8739 or 234-7349

Contact: Harold Johnson Home Phone: N/A

Address: P.O. Box 3090

City: Carlsbad State: NM Zip: 88221-3090

2. LOCATION OF WELL (E thru H optional)

A. NE 1/4 SE 1/4 NE 1/4 Section: 29 Township: ~~23S~~ 22 S Range: 31E N. M. P. M. in Eddy County.

B. X = 497,105.23 N feet, Y = 666,959.89 E feet, N.M. Coordinate System EAST Zone in the _____ Grant.
U.S.G.S. Quad Map _____

C. Give State Engineer File Number if existing well: unknown

D. On land owned by: U.S. Department of Interior, Bureau of Land Management

E. Tract No. _____, Map No. _____ of the _____

F. Lot No. _____, Block No. _____ of Unit/Tract _____ of the _____ Subdivision recorded in _____ County.

G. Latitude: _____ Longitude: _____

H. Other: _____

3. USE OF WATER (check use applied for)

N/A One household, non-commercial trees, lawn and garden not to exceed a total of one acre.

N/A Livestock watering.

Note: If any of the following items are marked, give the name and nature of business or use under item 5 of the additional statements or explanations section.

N/A More than one household, non-commercial trees, lawns and gardens not to exceed a total of one acre.

N/A Drinking and sanitary purposes and the irrigation of non-commercial trees, shrubs and lawns not to exceed one acre in conjunction with a commercial operation.

N/A Prospecting, mining or drilling operations to discover or develop natural resources.

N/A Construction of public works, highways and roads

"SEE ATTACHMENT"

WR Filed: _____

Trn Desc: _____ File Number: C-2737

Log Due Date: 09-26-2001 Trn Number: 192470

Form: wr-01

NEW MEXICO STATE ENGINEER OFFICE
APPLICATION FOR PERMIT TO USE UNDERGROUND WATERS
IN ACCORDANCE WITH SECTION 72-12-1 NEW MEXICO STATUTES

GENERAL CONDITIONS OF APPROVAL (Continued)

I The permittee shall utilize the highest and best technology available to ensure conservation of water to the maximum extent practical.

SPECIFIC CONDITIONS OF APPROVAL

6 The well shall be plugged upon completion of the permitted use, and a plugging report shall be filed with the State Engineer within 10 days.

B The well shall be drilled by a driller licensed in the State of New Mexico in accordance with Section 72-12-12 New Mexico Statutes Annotated. A licensed driller shall not be required for the construction of a driven well; provided, that the casing shall not exceed two and three-eighths (2 3/8) inches outside diameter (Section 72-12-12).

D The casing shall not exceed 7 inches outside diameter except under specific conditions in which reasons satisfactory to the State Engineer are shown.

G If artesian water is encountered, all rules and regulations pertaining to the drilling and casing of artesian wells shall be complied with.

LOG This permit will automatically expire unless the well C 02737 is completed and the well record filed on or before 09/26/2001.

ACTION OF STATE ENGINEER

This application is approved for the use indicated, subject to all general conditions and to specific conditions listed above.

Witness my hand and seal this 26 day of Sep A.D., 2000

Thomas C. Turney, State Engineer

By: Mike Stapleton

Trn Desc: C 02737 File Number: C 02737
Log Due Date: 09/26/2001 Trn Number: 192470
Form: wr-01

NEW MEXICO STATE ENGINEER OFFICE
APPLICATION FOR PERMIT TO USE UNDERGROUND WATERS
IN ACCORDANCE WITH SECTION 72-12-1 NEW MEXICO STATUTES

GENERAL CONDITIONS OF APPROVAL (A thru I)

A The maximum amount of water that may be appropriated under this permit is 3 acre-feet in any year.

B The well shall be drilled by a driller licensed in the State of New Mexico in accordance with Section 72-12-12 New Mexico Statutes Annotated. A licensed driller shall not be required for the construction of a driven well; provided, that the casing shall not exceed two and three-eighths (2 3/8) inches outside diameter (Section 72-12-12).

C Driller's well record must be filed with the State Engineer within 10 days after the well is drilled or driven. Well record forms will be provided by the State Engineer upon request.

D The casing shall not exceed 7 inches outside diameter except under specific conditions in which reasons satisfactory to the State Engineer are shown.

E If the well under this permit is used at any time to serve more than one household or livestock in a commercial feed lot operation, or for drinking and sanitation purposes in conjunction with a commercial operation, the permittee shall notify the State Engineer Office in writing.

F In the event this well is combined with other wells permitted under Section 72-12-1 New Mexico Statutes Annotated, the total outdoor use shall not exceed the irrigation of one acre of non-commercial trees, lawn, and garden, or the equivalent outside consumptive use, and the total appropriation for household and outdoor use from the entire water distribution system shall not exceed 3 acre-feet in any year.

G If artesian water is encountered, all rules and regulations pertaining to the drilling and casing of artesian wells shall be complied with.

H The amount and uses of water permitted under this Application are subject to such limitations as may be imposed by the courts or by lawful municipal and county ordinances which are more restrictive than applicable State Engineer Regulations and the conditions of this permit.

NEW MEXICO STATE ENGINEER OFFICE
APPLICATION TO APPROPRIATE UNDERGROUND WATERS
IN ACCORDANCE WITH SECTION 72-12-1 NEW MEXICO STATUTES

4. WELL INFORMATION (Change, Repair, Drill, Test, Supplement)

Name of well driller and driller license number:
TBD

Approximate depth 700 feet; Outside diameter of casing 7.0 inches.

___ Change Location of existing well or replacement well

___ Repair or Deepen:
___ Clean out well to original depth
___ Deepen well from _____ to _____ feet
___ Other _____

X Drill and test a well for Well is intended for monitoring only use

___ Supplemental well

5. ADDITIONAL STATEMENTS OR EXPLANATIONS:
Well is intended for monitoring only

ACKNOWLEDGEMENT FOR NATURAL PERSONS

I, Douglas C Lynn (Please Print) affirm that the foregoing statements are true to the best of my knowledge and belief, By: Douglas C Lynn

Signature Signature

Eddy County, NM
Com. exp. 2-19-03

Mary Ann Walker

Trn Desc: _____
Log Due Date: 09-26-2001
Form: wr-01

File Number: C-2737
Trn Number: 192470

STATE ENGINEER OFFICE/INTERSTATE STREAM COMMISSION – ROSWELL

OFFICIAL RECEIPT NUMBER 2- 11076 DATE Sept. 26, 2000 FILE NO. SEE COMMENTS

TOTAL RECEIVED: $ 360 . 00 RECEIVED: three hundred sixty & no/100---------- DOLLARS CHECK NO 78349 CASH: ☐

FROM: WIPP BANK NAME: Carlsbad National Bank

RECEIVED BY: (Signature) C. Bing (TITLE) clerk spec.

INSTRUCTIONS: Indicate the number of actions to the left of the appropriate type of filing. Complete the receipt information. **Original** to payor; **pink** copy to ASD; **yellow** copy to Water Rights - Santa Fe, and **goldenrod** copy for District file. If you make a mistake, void original and all copies and submit to ASD along with valid receipts.

A. Ground Water Rights Filing Fees

____	1. Declaration of Water Right	$ 1.00
____	2. Application to Appropriate; Domestic, Stock, Other Use	$ 5.00
____	3. Application for Test, Exploratory, or Observation Well	$ 5.00
____	4. Application to Change Location Domestic Well	$ 5.00
____	5. Application to Repair or Deepen	$ 5.00
____	6. Application to Dewater	$ 5.00
____	7. Application to Appropriate Irrig., Mun., Ind., or Com. Use	$25.00
____	8. Application to Combine Wells and/or Use	$25.00
____	9. Application for Supplemental Well	$25.00
____	10. Application to Change Location of Non-72-12-1 Well	$25.00
____	11. Application to Change Place or Purpose of Use	$25.00
____	12. Application to Change Location of Well and Place and/or Purpose of Use	$50.00
____	13. Application for Extension of Time	$25.00
____	14. Certificate and License (PCW, PBU)	$25.00
____	15. Application for Plan of Replacement	$25.00
____	16. Other (As per Art. 6-2 of Rules and Regulations) Specify: _____ _____	$25.00
____	17. Application to Change Point of Diversion and Place and/or Purpose of Use from Surface to Ground Water	$50.00
____	18. Change of Ownership	$ 2.00

B. Surface Water Rights Filing Fees

____	1. Declaration of Water Right	$ 1.00
____	2. Declaration of Livestock Dam	$ 1.00
____	3. Application to Change Point of Diversion	$25.00
____	4. Application to Change Place and/or Purpose of Use	$50.00
____	5. Application to Change Point of Diversion and Place and/or Purpose of Use	$50.00
____	6. Notice of Intent to Appropriate	$25.00
____	7. Application to Appropriate	$25.00
____	8. Application for Extension of Time	$50.00
____	9. Certificate of Construction (PCW)	$25.00
____	10. License to Appropriate (PBU)	$25.00
____	11. Application to Enlarge of Amend	$25.00
____	12. Other (As per 72-2-6.J NMSA 1978) (Specify: _____)	(VAR)
____	13. Application to Change Point of Diversion and Place and/or Purpose of Use from Ground to Surface Water	$50.00
____	14. Change of Ownership	$ 2.00

C. Miscellaneous Fees

____	1. Application to Construct Flood-Control Dam. Same as #5 below	
____	2. Application for Well Driller's License	$50.00
____	3. Application for Renewal of Well Driller's License	$20.00
____	4. Application to Amend Well Driller's License	$ 5.00
____	5. Review of Plans for Safety of Dams ($10.00 + $2.00/$1,000 of estimated construction cost)	(VAR)

D. Reproduction of Documents 20¢/copy, $3.00/map $_____

E. Certification $_____

F. Other (Specify - not for Filing Fees) $_____

COMMENTS

Use of future declarations and various drillings. Listing to be kept in the Carlsbad Basin Secretary's office