GW - 32

REPORTS

YEAR(S):

1986 - GW + SOIL INVESTIGATION

File Copy
Submitted 2/3/86

ATTACHMENT B-1

GROUND WATER AND SOILS INVESTIGATION

CINIZA REFINERY

NEAR GALLUP, NEW MEXICO

FOR SHELL OIL COMPANY

Dames & Moore

Dames & Moore

6400 Uptown Boulevard N.E., Suite 398-W, City Centre
Albuquerque, New Mexico 87110
(505) 883-5885

March 11, 1981

Shell Oil Company
Box 7, Route 3
Gallup, New Mexico 87301

Attention: Mr. Mitchell Sapp

Gentlemen:

This letter transmits three (3) copies of our final report, "Ground Water and Soils Investigation, Ciniza Refinery, Near Gallup, New Mexico, For Shell Oil Company". This work was performed under Purchase Order No. CR-2149.

The report provides a significant part of the information required to develop a closure plan and post-closure plan for a hazardous waste land treatment facility as prescribed under RCRA.

We have appreciated the opportunity to perform these services for Shell Oil Company. Please contact us if there are any questions.

Yours very truly,

DAMES & MOORE

William E. Mead

William E. Mead
Partner

WEM:lj

Attachment

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

PLATE NUMBER	
1	SITE MAP
2	REGIONAL GEOLOGY MAP
3-A	GRADATION CURVE - COMPOSITE SOIL SAMPLE, TEST PITS LF-1 and LF-2
3-B	GRADATION CURVE - COMPOSITE SOIL SAMPLE, TEST PITS LF-3 , LF-4 and OW-4
4-A	INFILTROMETER TEST - LAND TREATMENT AREA - SITE LF-2
4-B	INFILTROMETER TEST - LAND TREATMENT AREA - SITE LF-4
4-C	INFILTROMETER TEST - LAND TREATMENT AREA - SITE OW-4
5-A	CROSS SECTIONS A - A' AND B - B'
5-B	CROSS SECTION C - C'
6	WATER TABLE CONTOUR MAP - JANUARY 5, 1981

EXECUTIVE SUMMARY

The following summarizes our conclusions from this investigation:

1. The Ciniza Refinery property is underlain by a sandstone aquifer which dips less than three degrees to the northwest and ranges in depth from about 70 feet near the south limit of the main refinery complex to about 143 feet near the northwest property boundary. This is the uppermost (or "near-surface") continuous aquifer at the site and it contains ground water under artesian confinement. Clay and weathered shale overlie the aquifer. The shale contains some discontinuous sandy intervals.

2. Five of the seventeen observation wells drilled under this project show some evidence of chromium or lead contamination. Four of these wells are completed in the near-surface aquifer. Fluoride is several times background in most of the wells. It is possible that the contamination detected in one or more of these cases occurred during sample collection.

3. The land treatment area is underlain by about 100 feet of clay and shale above the near-surface aquifer. The piezometric surface of the confined aquifer lies approximately 71 feet above the top of this unit. In our opinion, the aquifer is sufficiently protected from potential contamination originating in the land treatment area to warrant seeking an exemption from the RCRA ground-water monitoring requirement.

4. Recommendations are presented in this report for future ground water quality monitoring in the general plant area and for monitoring the

unsaturated zone at the land treatment site.

GROUND WATER AND SOILS INVESTIGATION

CINIZA REFINERY

NEAR GALLUP, NEW MEXICO

FOR SHELL OIL COMPANY

1.0 INTRODUCTION

This report presents the results of our investigations at the Ciniza Refinery of Shell Oil Company near Gallup, New Mexico, relative to ground-water conditions in the general vicinity of the plant and soil conditions in the area to be used for treating solid waste. Field work was commenced on October 27, 1980 and completed on January 6, 1981.

2.0 PURPOSE AND SCOPE OF WORK

The purpose of the work described herein was to provide data necessary for compliance with the Interim Status permitting requirements of the Resources Conservation and Recovery Act of 1976 (RCRA), and included the following objectives:

1. To characterize the geohydrologic regime in the plant area and its immediate vicinity.
2. To evaluate the extent of ground-water contamination, if any, at the site and the degree to which it may be attributable to plant operation.

3. To assess the background physical and chemical characteristics of the soils and/or rock material in the area used for land treatment of solid waste.
4. To assist Shell Oil Company in achieving compliance with the RCRA Interim Status Standards.

The scope of work undertaken to fulfill the above objectives comprised essentially Phases I and II of the four-phase program described in our original proposal dated October 2, 1980, and included:

1. The drilling of 17 observation wells.
2. The collection of ground-water samples and measurement of the water table.
3. The excavation of five test pits in the land treatment area.
4. The collection of bulk and in-situ soil samples from the test pits.
5. The laboratory analysis of ground-water and soil samples for selected physical and chemical parameters.
6. Assistance to Shell Oil Company in preparing a description of the land treatment area and a preliminary plan for monitoring and sampling this area during waste disposal activities.
7. Preparation of a report describing the results of these investigations.

3.0 SITE DESCRIPTION

The Ciniza Refinery is located in Sections 28 and 33 of T.15N., R.15W, and in Section 4 of T.14N., R.15W., N.M.P.M. Drainage is north and west toward the South Fork of the Puerco River, a westward-flowing

intermittent stream.

The western two-thirds of the property is nearly flat with a slight northwestward topographic gradient. The eastern one-third is dominated by a bedrock bluff which is 60 to 100 feet higher than the adjacent flatland. The base of the bluff is at approximate elevation 6,900 feet (ASL). The general features of the site and the principal plant facilities are shown on Plate 1.

Geologically, the site occupies the northeast flank of the Zuni Uplift region of the Colorado Plateau. The flatlands have been mapped as Quaternary alluvium and the bedrock bluff has been identified as the Sonsela Sandstone of the Chinle Formation (Shomaker). The regional geology is depicted on Plate 2.

4.0 METHODS OF INVESTIGATION

4.1 FIELD INVESTIGATIONS

4.1.1 Land Treatment Area

Shell Oil Company treats certain plant wastes such as the API separator emulsion and leaded tank sludge by mixing with natural soils. Laboratory analyses of selected constituents in these wastes are provided in Appendix B-3.

An area on the plant property comprising approximately 7.9 acres and divided into three equal plots has been delineated for the initial phase of this land treatment operation and is shown on Plate 1.

Five test pits were dug by backhoe at representative locations in the land treatment area. The purpose of the pits was to obtain samples of the uppermost several feet of natural soils in order to analyze their chemical and physical characteristics. The pits were designated as LF-1 through LF-4, and OW-4. In four of the pits, bulk samples were cut from a clean pit wall at depth intervals of 0 to 1 foot, 1 to 2 feet, and 2 to 3 feet. In OW-4, samples were collected also from depths of 3 to 4 feet, 4 to 5 feet and 5 to 6 feet. The samples were placed in plastic-coated cloth bags and shipped to Santa Fe for analysis.

In addition to bulk samples, in-situ samples were obtained at four of the pit locations using the Dames & Moore sampler. Relatively undisturbed drive samples six inches in length were collected from a depth of 6 to 12 inches in pits LF-1, LF-2 and LF-4, and from 18 to 24 inches of depth in pit OW-4. The samples were sealed at the site and shipped to the laboratory.

Infiltration capacity measurements in the surficial soils were obtained near three of the pit locations (LF-2, LF-4, OW-4) by means of double ring infiltrometer tests. In these tests, two concentric metal cylinders, 12 inches and 9½ inches in diameter respectively, were driven approximately four inches below the ground surface. A buffer pond of water was established in the section between the cylinders and maintained during the test. Water was then added to the inner cylinder and the rate of water level decline recorded over time. In order to maintain an approximately constant head during the test, the original water level was periodically restored by adding measured quantities of water. Measurements were continued until the rate of infiltration stabilized.

4.1.2 Ground-Water Investigation

Seventeen observation wells were drilled by percussion methods to investigate the near-surface geology and ground-water hydrology at the site. Permits to drill these wells were issued by the New Mexico State Engineer. Original plans envisioned as many as 20 to 25 wells being drilled. However, fewer wells were found to be necessary to adequately describe the hydrogeologic conditions. The wells ranged in depth from 45 to 163 feet and were drilled either at 8 or 10 inches in diameter. A total of 1,505 feet of drilling was completed. Four-inch diameter PVC casing was installed in each well and included a perforated section at the desired depth interval. Approximately two feet of PVC casing were allowed to extend above ground level and the bottom end of the casing was plugged. The annular space between the PVC casing and the wall of the boring was packed with gravel opposite the perforations and for a distance of several feet above the top of the perforations to allow for settlement. A Quick-Gel bentonite seal was emplaced above the gravel pack for an interval that varied from 5 to 15 feet among the several wells. The bentonite was followed either by sand concrete or by cement grout which extended to the ground surface. Grout emplacement was achieved by using a tremie pipe. Most of the wells which penetrated the sandstone artesian aquifer were inspected by a representative of the State Engineer's office during the grout emplacment.

A protective steel casing 8-5/8 inches in diameter fitted with a locking cap was installed over the above-ground extension of the PVC casing in each well and was cemented in place.

The completed well was flushed clean of drilling mud and cuttings to permit the inflow of fresh ground water. Measurements of water level, water temperature and electrical conductivity were obtained at the time of well completion. The water level in each well also was recorded at frequent intervals during the remainder of the field program. Records of all wells were submitted to the State Engineer on the prescribed forms.

Collection of ground-water samples for analysis was normally delayed until the water table had stabilized. A Kemmerer-type PVC water sampler was utilized which could be opened at any desired depth below the water table. Samples were collected near the water table and transferred to either polyethylene or tinted glass bottles. Containers of the latter type were used for samples to be analyzed for hydrocarbons.

Various methods were utilized to preserve or buffer the water samples against changes in composition during the period between collection and laboratory analysis.

Samples requiring determinations of TDS, pH, Cl, SO_4 and F were packed in ice for shipment. Sulfuric acid was added to samples collected for nitrate analysis. Samples to be tested for Se, Fe, Cr, As, Ca, Na and Mn were buffered with concentrated nitric acid to a pH less than 2.0. Analysis for CN required that a pH of at least 12 be maintained in the sample, which was achieved by adding NaOH in controlled amounts.

4.2 LABORATORY INVESTIGATIONS

4.2.1 Land Treatment Area

Samples from the top foot of soil at the five sampling locations in the land treatment area were individually analyzed for pH, TOC, EP

toxicity (inorganic), and total metals in the EP toxicity series. EP toxicity tests for potentially hazardous inorganic constituents were run in accordance with RCRA specifications for As, Ba, Cd, Cr, Cr^{+6}, Pb, Hg, Se and Ag.

Soil from a depth of 12 to 24 inches and from 24 to 36 inches at each of the five sampling locations was tested for the same parameters as the top 12 inches, with the exception of pH.

At the center pit location, the samples collected from 3 to 4 feet, 4 to 5 feet and 5 to 6 feet of depth were analyzed for total chromium.

A portion of the sample from the top foot of soil at locations LF-1 and LF-2 was combined into a composite bulk sample and analyzed for grain size distribution (sieve analysis), N, P, cation exchange capacity and sodium adsorption ratio. A composite also was prepared from the top foot of soil at locations LF-3, LF-4 and OW-4 and similarly tested.

Finally, the in-situ soil samples obtained from 6 to 12 inches of depth in LF-1, LF-2 and LF-4, and from 18 to 24 inches in depth in OW-4 were tested in the laboratory for hydraulic conductivity (permeability) and moisture content.

4.2.2 Ground-Water Investigation

A suite of parameters was chosen for the chemical analysis of ground water which was judged to be adequate to determine its overall quality within the confines of the Shell property. In selecting these parameters, consideration was given to constituents which have been present in relatively high concentrations in the effluents discharged

to the evaporation ponds as indicated from previous analyses of the pond effluent.

The parameters tested were as follows:

pH	CN	Fe	Na
TDS	F	Cr	Mn
Cl	NO_3	As	Pb
SO_4	Se	Ca	

Water samples from wells constructed in the immediate area of the refinery and product storage tanks were analyzed additionally for immiscible hydrocarbons such as grease and oil which possibly could have reached the water table from surface spills of diesel oil, fuel oil or gasoline.

5.0 RESULTS

5.1 LAND TREATMENT AREA

5.1.1 Soil Characteristics - Physical

The land treatment area is underlain by silty clay which extends below the five-foot depth of excavation in four of the five test pits and to a depth of about 25 feet in the center test pit (OW-4). The upper three to four feet of clay contains closely spaced herbaceous roots and dessication cracks. Logs of the test pits are presented in Appendix A-1. Gradation curves representing composites of the upper one foot of soil are shown on Plates 3-A and 3-B.

Below 25 feet of depth, the clay grades to variably decomposed sandy shale which extends nearly to 100 feet. From 90 to 100 feet the

shale becomes calcareous and at 100 feet, a fine-grained sandstone is encountered.

The water table in OW-4 stabilized at about 29 feet below ground.

In parts of the land treatment area devoid of dessication cracks, the infiltration capacity of the surficial soils is estimated to be on the order of 1 to 3 inches per hour or 5 to 20×10^{-4} centimeters per second (cm/sec). These estimates are based on infiltrometer tests conducted at three locations (LF-2, LF-4 and OW-4). The test results are shown on Plates 4-A through 4-C and in Table 1-A.

Based on laboratory permeability tests, the vertical hydraulic conductivity in the upper two feet of soil is on the order of 2.2×10^{-5} cm/sec and the moisture content averages 9.8 percent (Table 1-A).

5.1.2 Soil Characteristics - Chemical

The results of chemical analysis of the soils in the land treatment area are given in Tables 1-A and 1-B. These analyses represent background conditions. Copies of the laboratory reports are presented in Appendix B-1.

The pH of the top foot of soil ranged from 8.4 to 8.9 at the five sampled locations. Total organic carbon in this depth interval ranged from 4,700 to 4,800 micrograms per gram (ug/gm). Two soil composites from the top foot possessed an average cation exchange capacity of 43.3 milli-equivalents per hundred grams (meq/100gm) and a sodium adsorption ratio ranging from 9.5 to 18.4. Nitrogen content varied from 420 to 540 ug/gm and phosphorus content was 180 ug/gm in the top foot of soil.

In the second and third foot of soil, the total organic carbon content was 4,700 ug/gm in all but one sample (LF-3 from 2 to 3 feet).

TABLE 1-A

SUMMARY OF SOILS ANALYSES

LAND TREATMENT AREA

SAMPLE LOCATION	NITROGEN (ug/gm)[1]	PHOSPHORUS (ug/gm)	CEC[2]	SAR[3]	SIEVE ANALYSIS	K_F[5] (cm/sec)	K_L[6] (cm/sec)	MC[7]
Composite								
LF-1 + LF-2								
0-12"	420	180	43.9	9.5	[4]			
Composite								
LF-3 + LF-4 + OW-4								
0-12"	540	180	42.8	18.4	[4]			
LF-1								
6-12"							1.9×10^{-5}	10.2
LF-2								
Surface						4×10^{-4}		
6-12"							1.6×10^{-5}	9.3
LF-4								
Surface						18×10^{-4}		
6-12"							2.2×10^{-5}	9.1
OW-4								
Surface						9×10^{-4}		
18-24"							3.2×10^{-5}	10.1

[1] Micrograms/gram

[2] Cation exchange capacity in meq/100 grams

[3] Sodium adsorption ratio

[4] See Plate 3

[5] Field infiltration capacity

[6] Laboratory permeability (vertical)

[7] Moisture Content (% of dry weight)

TABLE 1-B

SUMMARY OF SOILS ANALYSES

LAND TREATMENT AREA

(in milligrams/liter except as noted)

SAMPLE LOCATION	pH[1]	TOC[2]	As	Ba	Cd	Cr	Cr^{+6}	Pb	Hg	Se	Ag
LF-1											
0-12"	8.6	4800									
EP Toxicity			<0.01	<10	0.002	<0.001	<0.01	<0.001	<0.0004	0.01	<0.01
(RCRA limits)			(5)	(100)	(1)	(5)	(5)	(5)	(0.2)	(1)	(5)
Total Metals [3]			20	980	0.2	34	<1	26	0.04	<1	7.8
12-24"	-	4700									
EP Toxicity			<0.01	<10	0.001	<0.001	<0.01	0.003	<0.0004	<0.01	<0.01
Total Metals			50	970	0.2	34	1	27	<0.04	<1	<1.0
24-36"	-	4700									
EP Toxicity			<0.01	<10	0.001	<0.001	<0.01	0.002	<0.0004	<0.01	<0.01
Total Metals			50	860	0.2	34	<1	24	0.05	<1	2.2
LF-2											
0-12"	8.4	4800									
EP Toxicity			<0.01	<10	0.001	<0.001	<0.01	0.001	<0.0004	<0.01	<0.01
Total Metals			40	970	0.2	29	<1	28	<0.04	<1	2.0
12-24"	-	4700									
EP Toxicity			<0.01	<10	0.002	<0.001	<0.01	<0.001	<0.0004	<0.01	<0.01
Total Metals			50	1,100	0.3	39	1	26	0.1	<1	1.4
24-36"	-	4700									
EP Toxicity			<0.01	<10	<0.001	<0.001	<0.01	0.002	<0.0004	<0.01	<0.01
Total Metals			50	940	0.1	36	<1	23	<0.04	<1	<1.0
LF-3											
0-12"	8.9	4700									
EP Toxicity			<0.01	<10	0.002	<0.001	<0.01	<0.001	<0.0004	<0.01	<0.01
Total Metals			40	1,000	0.4	34	1	26	<0.04	<1	<1.0
12-24"	-	4700									
EP Toxicity			<0.01	<10	0.002	<0.001	<0.01	<0.001	<0.0004	<0.01	<0.01
Total Metals			50	970	0.2	45	<1	24	0.9	<1	<1.0
24-36"	-	4800									
EP Toxicity			<0.01	<10	0.002	<0.001	<0.01	0.001	<0.0004	<0.01	<0.01
Total Metals			40	870	0.2	40	<1	26	0.04	<1	<1.0
LF-4											
0-12"	8.7	4800									
EP Toxicity			<0.01	<10	0.001	<0.001	<0.01	<0.001	<0.0004	<0.01	<0.01
Total Metals			50	880	0.2	36	<1	29	<0.04	<1	2.7
12-24"	-	4700									
EP Toxicity			<0.01	<10	<0.001	<0.001	<0.01	<0.001	<0.0004	<0.01	<0.01
Total Metals			50	1,000	0.1	33	<1	23	0.09	<1	<1.0
24-36"	-	4700									
EP Toxicity			<0.01	<10	0.002	<0.001	<0.01	0.002	<0.0004	<0.01	<0.01
Total Metals			50	880	0.2	23	2	28	0.05	<1	<1.0
OW-4											
0-12"	8.5	4800									
EP Toxicity			<0.01	<10	0.001	<0.001	<0.01	0.003	<0.0004	<0.01	<0.01
Total Metals			40	930	0.2	30	<1	29	<0.04	<1	<1.0
12-24"	-	4700									
EP Toxicity			<0.01	<10	<0.001	<0.001	<0.01	0.003	<0.0004	<0.01	<0.01
Total Metals			50	970	<0.1	34	<1	23	0.05	<1	3.2
24-36"	-	4700									
EP Toxicity			<0.01	<10	<0.001	<0.001	<0.01	<0.001	<0.0004	<0.01	<0.01
Total Metals			50	890	0.3	29	<1	25	<0.04	<1	<1.0
36-48"						20[4]					
48-60"						20[4]					
60-72"						30[4]					

[1] Standard units

[2] Total organic carbon in micrograms/gram

[3] Total metals in all cases are reported in micrograms/gram

[4] micrograms/gram

In the fourth, fifth and sixth foot of soil at the center pit location, total chromium was 20 to 30 ug/gm.

5.2 GROUND-WATER INVESTIGATION

5.2.1 Site Geology

The property is underlain by the Chinle Formation. According to the drillers' logs for Water Supply Wells 1 and 2, the Chinle is about 730 feet thick at the site. Samples from the observation wells show that the upper 10 to 50 feet has weathered extensively and consists of reddish-brown silty clay or silty fine sand. The silty clay occurs in the vicinity of the evaporation ponds, and the silty fine sand occurs in the main plant area and near OW-11.

The silty fine sand in the main plant area is believed to be the weathered equivalent of the Sonsela Sandstone which has been mapped by others as the geologic unit comprising the bluff area. The Sonsela Sandstone here is an erosional remnant and does not extend below the ground surface beyond the bluff.

Unweathered bedrock consists of interbedded shale and sandstone. The uppermost bedrock unit is reddish-brown silty shale with some fine sand, which grades gray or brown with depth. It ranges up to about 110 feet thick. A discontinuous two-foot sandstone lense was found in this unit in some borings. Underlying the shale is a gray to brown fine- to coarse-grained sandstone, which henceforth will be referred to as the "near-surface aquifer". It can be easily traced in the observation wells and ranges from 12 to 30 feet thick. Below the near-surface aquifer is gray or reddish-brown silty shale with some fine

sand. None of the observation wells completely penetrated this unit.

The strike of the bedrock ranges from North 33° East to North 48° East and the bedrock dips between 1.4 and 2.7 degrees toward the northwest in the direction of the San Juan structural basin. Logs of the observation wells are provided in Appendix A-2. Cross sections through the plant area are shown on Plates 5-A and 5-B.

5.2.2 Site Ground-Water Hydrology

5.2.2.1 Physical Characteristics

For purposes of this report, only the hydrogeologic conditions to a depth of about 150 feet need to be considered. The near-surface San Sc La aquifer, which was described in the previous section, occurs within 150 feet of the ground surface in the plant vicinity and would be the first aquifer to receive any contamination emanating from plant activities or other surface sources.

Ground water occurs under both artesian and water table conditions in the plant vicinity. Artesian conditions exist in the near-surface aquifer northwest of the plant where ground water rises more than 100 feet (OW-2) above the aquifer. The amount of rise decreases toward the southeast (up dip) and at OW-11, the water table was about 10 feet above the top of the aquifer on January 5, 1981. The area of direct recharge for the near-surface aquifer is estimated to be more than one-half mile south of the plant area.

In the shale which overlies the near-surface aquifer, water table conditions exist, as at OW-3, OW-7 and OW-24. Recharge to the weathered shale is maintained principally by surface infiltration and perhaps to

some degree by upward leakage from the near-surface aquifer.

Plate 6 shows the site ground-water elevations measured on January 5, 1981. These data are also summarized in Table 2. The ground-water table is influenced by local topography and the bedrock attitude. It is highest immediately beneath the plant, which is located on a topographic high. From the plant, the ground-water table slopes toward the northwest at one to two degrees (about 0.02 feet/foot), which is approximately the same as the dip of the bedrock. The slope decreases beneath the evaporation ponds to less than one degree (less than 0.02 feet/foot) toward the northwest. Based on the average gradient of the water table and estimates of shale permeability calculated from limited water level recovery data, the rate of ground-water movement is on the order of 0.4 feet/year, to the northwest.

5.2.2.2 Chemical Characteristics

The ground wat ılyzed chemically for selected natural OW-24 not even close to the Tonsela, + /n. Creek. s for potential contaminants from th The results of these analyses are g

Well OW-11, th eved to represent approximate backgrou ted levels of fluoride appear to e: ty. Chromium is above background ran; he drinking water standard. Lead is close to the drinking water standard in OW-12, OW-13, OW-20 and OW-24. In OW-17, lead is ten times the standard. Now Storage wells

OW-17 and OW-20 appear to be contaminated wells. Some trace of contamination also may be present in OW-12, OW-13 and OW-24. These

TABLE 2

SUMMARY OF WELL DATA

NAME	COORDINATES [1] NORTH	WEST	GROUND [1] ELEVATION	TOTAL DEPTH (ft)	DATE COMPLETED	AQUIFER [3][4] INTERVAL (ft)	DEPTH OF [2] WATER TABLE (ft)	ELEVATION WATER TABLE (ft)
OW-1	3190	5150	6868	99.5	11/10/80	86-98	6.4	6861.6
OW-2	5985	5125	6871	163	10/31/80	143-162.5	31.2	6839.8
OW-3	5855	4220	6876	67	11/04/80	-	34.4	6841.6
OW-4	4960	3565	6881	102	11/07/80	100-102	29.2	6851.8
OW-5	4325	2970	6882	92	11/12/80	82-92	16.2	6865.8
OW-7	3875	3740	6872	70	11/18/80	-	6.7	6865.3
OW-9	2215	3445	6873	60	11/21/80	23-46	0.6	6872.4
OW-10	2710	3470	6872	68	11/25/80	34-63	1.7	6870.3
OW-11	1365	1455	6923	150	12/30/80	30-40	20.2	6902.8
OW-12	4490	1540	6939	145	12/15/80	104-143	47.3	6891.7
OW-13	4790	970	6914	108	12/10/80	70-104	23.2	6890.8
OW-14	4245	495	6923	45	12/17/80	39-45	25.8	6897.2
OW-16	3800	1365	6942	55	12/02/80	47-50	26.8	6915.2
OW-17	3885	1195	6941	50	1/03/81	40-42	31.8	6909.2
OW-18	3955	1020	6932	82	12/04/80	61-82	-	?
OW-20	2965	410	6961	83	12/19/80	70-82	50.2	6910.8
OW-24	5475	3875	6878	65	1/02/81	-	32.5	6845.5
				1,505				

[1] Estimated - survey required

[2] Last measurement Jan.5, 1981

[3] Depth underlined is maximum depth of well

[4] Does not include zones of sandy shale below

TABLE 3

SUMMARY OF GROUND-WATER CHEMICAL ANALYSES
(in milligrams per liter except as noted)

OBSERVATION WELL	pH[1]	TDS	Cl	SO_4	CN	F	NO_3	Se	Fe	Cr	As	Ca	Na	Mn	Pb	TEMP. (C^o)	EC[4] (umhos)	HC[5]
OW-1	7.8	776	28	167	<0.1	0.55	0.5	<0.01	0.07	0.007	<0.01	7.6	270	0.04				
OW-2	7.6	856	39	16	<0.1	1.6	0.1	0.01	1.1	0.003	<0.01	20	390	0.2		11	1180	
OW-3	7.7	876	36	79	<0.1	1.4	<0.1	<0.01	1.8	0.007	<0.01	3.4	370	0.003		11.5	1280	
OW-4	8.1	741	57	188	<0.1	1.0	0.2	<0.01	0.1	0.005	<0.01	14	230	0.07				
OW-5	(well incorrectly completed for collection of ground water sample)																	
OW-7	8.7	717	21	166	<0.1	0.37	<0.1	<0.01	0.3	0.003	<0.01	34	270	0.02		12	1050	
OW-9	7.8	1060	56	391	<0.1	0.8	0.5	<0.01	0.02	0.004	<0.01	19	350	0.02		12.5	1575	
OW-10	7.6	1030	79	331	<0.1	0.64	0.3	0.01	0.6	0.002	<0.01	17	360	0.03		10	1474	
OW-11	7.8	935	88	196	<0.1	0.20	1.8	<0.01	0.3	0.003	<0.01	11	380	0.03	0.002	9	1500	
OW-12	7.5	746	120	100	<0.1	0.52	0.1	<0.01	0.7	0.004	<0.01	11	310	0.08	0.03			7.1
OW-13	8.5	659	19	207	<0.1	1.0	<0.1	<0.01	0.6	0.009	<0.01	6.5	270	0.06	0.03	13	1150	
OW-14	7.3	839	210	104	<0.1	0.62	0.2	<0.01	0.2	0.008	<0.01	34	290	0.06	0.02	11	1425	6.4
OW-16	7.6	799	230	15	<0.1	0.9	3.7	0.01	1.0	0.003	0.03	24	270	0.06				4.0
OW-17	7.4	818	86	319	<0.1	0.47	0.8	<0.01	0.5	0.02	0.02	400	250	4.2	0.5	11	1400	25.0
OW-20	11.6	841	100	214	<0.1	0.40	1.3	<0.01	0.3	0.1	<0.01	6.6	320	0.02	0.04	13	1950	5.5
OW-24	7.8	784	33	72	<0.1	0.70	0.5	<0.01	0.2	0.001	<0.01	23	310	0.3	0.03	9	1200	
NIPDWR[2]						2.4	10	0.01		0.05	0.05	-	-		0.05			
PSDWS[3]		500	250	250	0.2				0.3			-	-	0.05				

[1] Standard units

[2] National Interim Primary Drinking Water Regulations

[3] Proposed Secondary Drinking Water Standards

[4] Electrical conductivity

[5] Hydrocarbons - oil and grease

wells should be re-sampled after flushing to ascertain whether the results indicate ground-water contamination, sample contamination, or possible errors in analysis.

Most of the wells discussed above tap the near-surface aquifer in the vicinity of the plant area. The wells in the pond area and down-gradient from it exhibit no clear evidence of contamination in the near-surface aquifer. However, these wells should be analyzed for lead.

Wells OW-3, OW-7 and OW-24 penetrate only the shale above the near-surface aquifer. With the possible exception of lead in OW-24, these wells show no indication of being contaminated.

In the wells closest to the refinery product treatment and storage facilities, no evidence of appreciable hydrocarbons was found at the water table. However, gases of as yet undetermined composition were present in OW-14 and OW-20. The nature and source of these gases should be determined. Other wells completed in this area also should be checked for such gases.

In about 1970, Shell Oil Company installed 58 shallow monitor wells at the Ciniza property. Most of these wells were spaced at intervals of a few tens of feet along the toes of the dikes bounding the evaporation ponds on the west and south. Depths below ground ranged generally from 5 to 10 feet. The well casings extended above ground in most cases from 1.5 to 4 feet. When water levels in these wells were measured on September 30, 1980, 24 were found to be dry. In the other wells, the depth of the water ranged from about 1 to 9 feet below ground. Because geologic logs were not available, and because the method of well completion and present condition were unknown, water samples from these wells were not collected for analysis. Samples analyzed from three of these wells in December, 1976, indicated that

the water in some of the wells was contaminated. Based on the more recent drilling completed as part of the program described herein, it is fairly certain that all of the original 58 monitor wells penetrated only clay or weathered shale, and not an aquifer. It is probable that the contaminated water in these wells originated from seepage entering the well from the ground surface, and in some cases, from the ponds.

Agree

6.0 CONCLUSIONS

6.1 GENERAL

The primary objective of this investigation has been to comply with provisions of the Resources Conservation and Recovery Act of 1976 (RCRA), whose aim is to protect the nation's water resources from contamination. Generators of hazardous waste materials must satisfy regulations which require a thorough knowledge as to the chemical nature of the waste products, an understanding of the geohydrologic system which would be susceptible to contamination from these products, and an effective means of monitoring hazardous waste facilities to detect possible changes in the unsaturated zone or in ground water resulting from such operations.

6.2 GEOHYDROLOGIC REGIME

Based on the results of the present investigation, the physical aspects of the geohydrologic regime at the Ciniza Refinery are now fairly well understood.

Some contamination appears to exist in five of the observation wells, and in two of these wells, one constituent exceeds the Primary

Drinking Water Standard. Four of the five contaminated wells, including the two wells which exceed the standard, are located near the main plant and tank storage area and penetrate the near-surface aquifer.

Unless the wells were inadequately flushed following their completion, or the samples were inadvertently contaminated, it must be assumed that seepage from the plant has reached the near-surface aquifer. The mechanism responsible for this condition if it actually exists is not clear, considering the amount of hydrostatic head in the aquifer and the presence of overlying layers of low permeability clay and shale.

In the following section, recommendations are offered to confirm whether contamination is actually present in the aquifer or only apparent due to other causes.

The system of observation wells installed during this program can be utilized for future monitoring or ground-water conditions at the plant, although their main purpose was to gather baseline geohydrologic information. Evaluation of these data has indicated certain other locations in the general plant area which would be useful as monitoring sites but which are not essential for RCRA compliance.

6.3 LAND TREATMENT

In addition to overall ground-water characterization and monitoring at the Ciniza plant, the land treatment program undertaken by Shell Oil Company comes under the purview of the RCRA regulations. Paragraph 265.278 of Subpart M of the Interim Status Standards (Appendix C) sets forth the requirements for Interim Status compliance in a land treatment

area. Pursuant to this regulation, our studies evaluated the baseline or background physical and chemical characteristics of the soil and rock meterials in the unsaturated zone as well as the ground-water depth and quality. Also, a generalized plan was prepared for monitoring the unsaturated zone. This plan has been refined based on data obtained during the investigative program. In the land treatment area, 29 feet of low permeability clay and decomposed shale comprise the unsaturated zone above the water table. The water table itself is the piezometric surface of the near-surface (uppermost) aquifer, which lies below 100 feet of depth in this area.

No evidence of contamination in EP metals was detected in the surficial soils or the ground water beneath the land treatment site. OW-4 was not analyzed for lead, however, and there is an indication of slight lead contamination (0.03 mg/1) in OW-24 which penetrates the shale a few hundred feet downgradient (north) from the land treatment area.

The hydrostatic pressure head of the aquifer at this location is 71 feet above the top of the formation, thus affording little opportunity for the entry of contaminants even if they succeeded in reaching the base of the unsaturated zone. In our opinion, the near-surface aquifer is effectively isolated from any surface soil contamination which may result from land treatment operations due to the low permeability and chemical absorptivity of the natural medium which overlies the aquifer and to the substantial piezometric head above the aquifer.

7.0 RECOMMENDATIONS

7.1 GROUND-WATER MONITORING PROGRAM

7.1.1 Existing Wells

Sixteen observation wells are now available for monitoring ground-water conditions at the Ciniza Refinery. Several of these wells should be used for future quality sampling and water table measurement.

A small submersible pump of about 10 to 15 gpm capacity at a lift of 150 feet (approximate maximum depth to the top of the perforations) should be appropriate for flushing the monitor wells and obtaining samples for analysis. The pump should fit in the 4-inch PVC casing and its intake should be set just above the top of the perforated section. A pump setting at the bottom of the perforated section would be preferable but the wells have not been completely surge developed or properly screened. Pumping from this lower position would be more likely to induce sand inflow which, in time, could fill the perforated section. This problem may still occur even with the recommended pump setting, because the observation wells were not designed as permanent monitor wells.

The wells should be pumped until approximately three equivalents of the well volume below the water table have been removed. This process will serve to flush the formation and to clean the pump of possible contamination from the previous well sampled. An additional precaution would be to wash the pump with uncontaminated water after each sampling before installing it in the next well. A final washing at the conclusion of the sampling sequence would also be desirable before placing the pump in storage.

In the wells penetrating the near-surface aquifer, recovery time between pumping stages should be reasonably short. Wells completed in the shale, however, will require a much longer recovery period between pumping stages.

Each well should be allowed to recover after pumping before a sample is taken. One or two liter samples should be collected for each type of preparation required, using the appropriate container and preservation method described on Page 6.

Evidence of contamination was found in wells OW-12, 13, 17, 20 and 24. These wells should be re-sampled as soon as possible to confirm the preliminary results. In addition, wells OW-1 through OW-10 should be analyzed for Pb.

It is further recommended that wells OW-1, 2, 3, 4, 12, 17 and 20 be sampled every three months and the depth of the water table recorded. The samples should be analyzed for Cl, Fe, Mn, Na, SO_4, Cr, Cr^{+6}, Pb, F, As, Se, Cd and Ba. Some of these analyses may be discontinued after several samplings. Eventually, certain wells may be omitted or their sampling frequency extended.

7.1.2 Additional Monitor Wells

For RCRA

For the overall refinery complex, we believe that the existing network of observation wells will serve adequately for future monitoring.

Within the complex, however, the land treatment area has been designated as a hazardous waste facility under the RCRA criteria. As such, it must be considered separately from the other portions of the plant in determining the need for additional monitor wells. Monitoring of the land treatment facility is discussed in the next section of this report.

7.2 LAND TREATMENT AREA MONITORING PROGRAM

7.2.1 Monitor Wells

RCRA rules require that the uppermost aquifer beneath a hazardous waste facility be monitored with at least three downgradient wells and no less than one upgradient well. If adequate hydrogeological justification can be provided that there is low potential for the migration of contaminants from the hazardous waste facility into this aquifer, a waiver of the monitor well request can be granted.

In the present case, the extra monitor well (OW-4) in the land treatment area shows no evidence of contamination with the possible exception of fluoride. However, OW-4 would not be expected to show such contamination, in view of the recent start-up date of the facility.

Due to the 71-foot confining head above the aquifer in the land treatment area and the 100-foot layer of clay and shale overlying the aquifer, it is our opinion that the likelihood of contaminant migration into the near-surface aquifer from the land treatment facility is minimal. We therefore believe that the facility should be exempt from the four-well minimum monitoring requirement prescribed under RCRA.

However, we recommend that one monitor well be completed north of the land treatment area as shown on Plate 1. The well should be extended to a depth of five feet into the shale below the aquifer.

Sampling of the proposed monitor well should be on a quarterly basis and the samples should be analyzed for the same parameters listed in Section 7.1.1 for the selected existing wells.

OW-5 cannot be utilized effectively to monitor ground-water conditions in the near-surface aquifer upgradient from the land treatment

facility. Although OW-5 did penetrate the aquifer, problems developing during construction of this well resulted in the perforated casing being dislocated from the aquifer position.

RCRA regulations specify certain substantiating data which must be provided by the operator of a hazardous waste facility which justify an exemption from the monitor well requirement. These data must include an evaluation of the water balance factors (hydrologic budget) and other characteristics of the facility. Some of the required information has been provided in this report. A water balance study lies outside the present scope of work, as does an assessment of current water use down-gradient from the Ciniza Refinery.

7.2.2 Unsaturated Zone Monitoring

Paragraph 265.278 of the RCRA regulations stipulates the requirements for monitoring the unsaturated zone beneath a land treatment facility. The soils must be monitored using soil cores, and soil pore water must be monitored using devices such as lysimeters.

At least one soil core should be collected beneath the area where land treatment was first commenced. In addition, one or more soil cores should be recovered approximately midway between the oldest part of the treatment area and its active perimeter.

After the sampling site is cleaned of disturbed soil material, a shallow pit about three feet in diameter and two feet deep should be excavated and cleared of loose soil. A soil auger should then be utilized to collect one sample from three to four feet of depth and one sample from five to six feet. The pits should be backfilled with uncontaminated, low permeability soil which is compacted in place.

Due to the low permeability of these soils, core sampling more frequently than every three months appears unwarranted. The samples should be analyzed for the EP metals and total organic carbon in the same fashion as done for the present survey.

As the treated perimeter advances, new locations for taking soil cores should be selected. The locations of the coring sites should be indicated on a map of suitable scale.

Lysimeters should be utilized for sampling soil pore water, although we anticipate that collection of sufficient pore water for analysis will be difficult in the low permeability soils present under the land treatment area.

We believe that initially, two lysimeters would be sufficient. These devices would be installed at a depth of five feet in the same general locations as the coring sites. Monitoring of the lysimeters would be conducted at three-month intervals.

At about six-month intervals, if the treatment perimeter has advanced sufficiently, at least one new lysimeter installation should be emplaced and the monitoring continued according to the same schedule observed for the initial lysimeters.

Over a period of years, selected lysimeters comprising the entire network can probably be abandoned.

The procedure for installing and sampling lysimeters involves details which are not presented in this report.

As in the case of the soil cores, samples of pore water from the lysimeters should be analyzed for the EP metals and total organic carbon.

8.0 REFERENCES

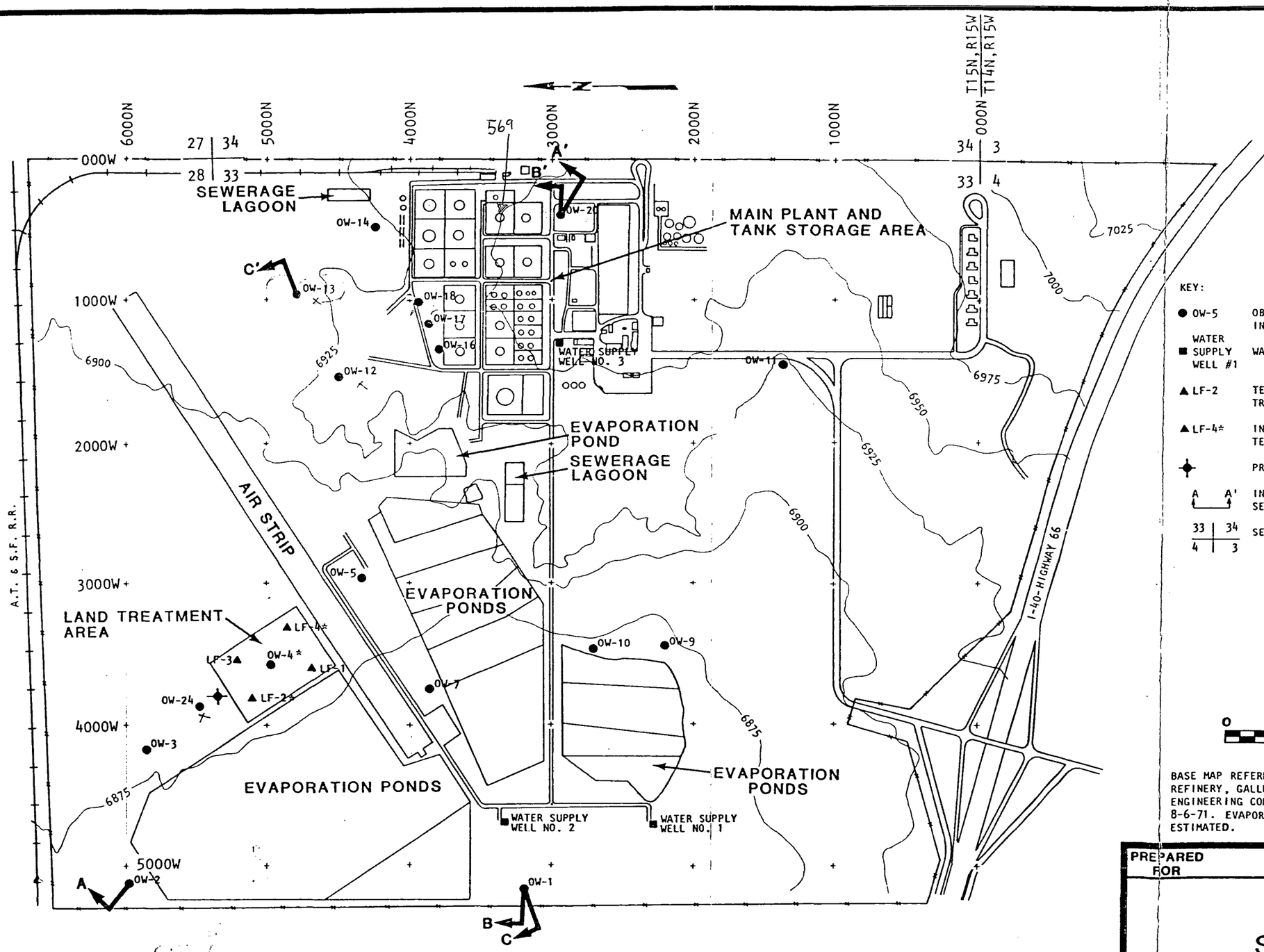
Darton, N.H., 1928, "Red beds" and associated formations in New Mexico: U.S. Geological Survey Bulletin 794, 356 p.

Kelly, V.C., 1967, Tectonics of the Zuni - Defiance region, New Mexico and Arizona: New Mexico Geological Society 18th Field Conference Guidebook of Defiance - Zuni - Mt. Taylor region, Arizona and New Mexico, pp. 28-31.

O'Sullivan, R.B., 1977, Triassic rocks in the San Juan Basin of New Mexico and adjacent areas: New Mexico Geological Society 28th Field Conference Guidebook of the San Juan Basin III, pp.139-146.

Shomaker, John W., 1971, Water Resources of Fort Wingate Army Depot and Adjacent Areas, McKinley County, New Mexico: U.S.G.S. Water Resources Division open file report, 230 p.

Woodward, L.A., and Callender, J.F., 1977, Tectonic Framework of the San Juan Basin: New Mexico Geological Society 28th Field Conference Guidebook of the San Juan Basin III, pp.209-212.



KEY:

● OW-5	OBSERVATION WELL INSTALLED BY DAMES & MOORE
■ WATER SUPPLY WELL #1	WATER SUPPLY WELL
▲ LF-2	TEST PIT IN LAND TREATMENT AREA
▲ LF-4*	INDICATES INFILTROMETER TEST SITE
✦	PROPOSED MONITOR WELL
A A'	INDICATES CROSS SECTION LINE SEE PLATES 5A AND 5B
33 | 34 / 4 | 3	SECTION CORNER

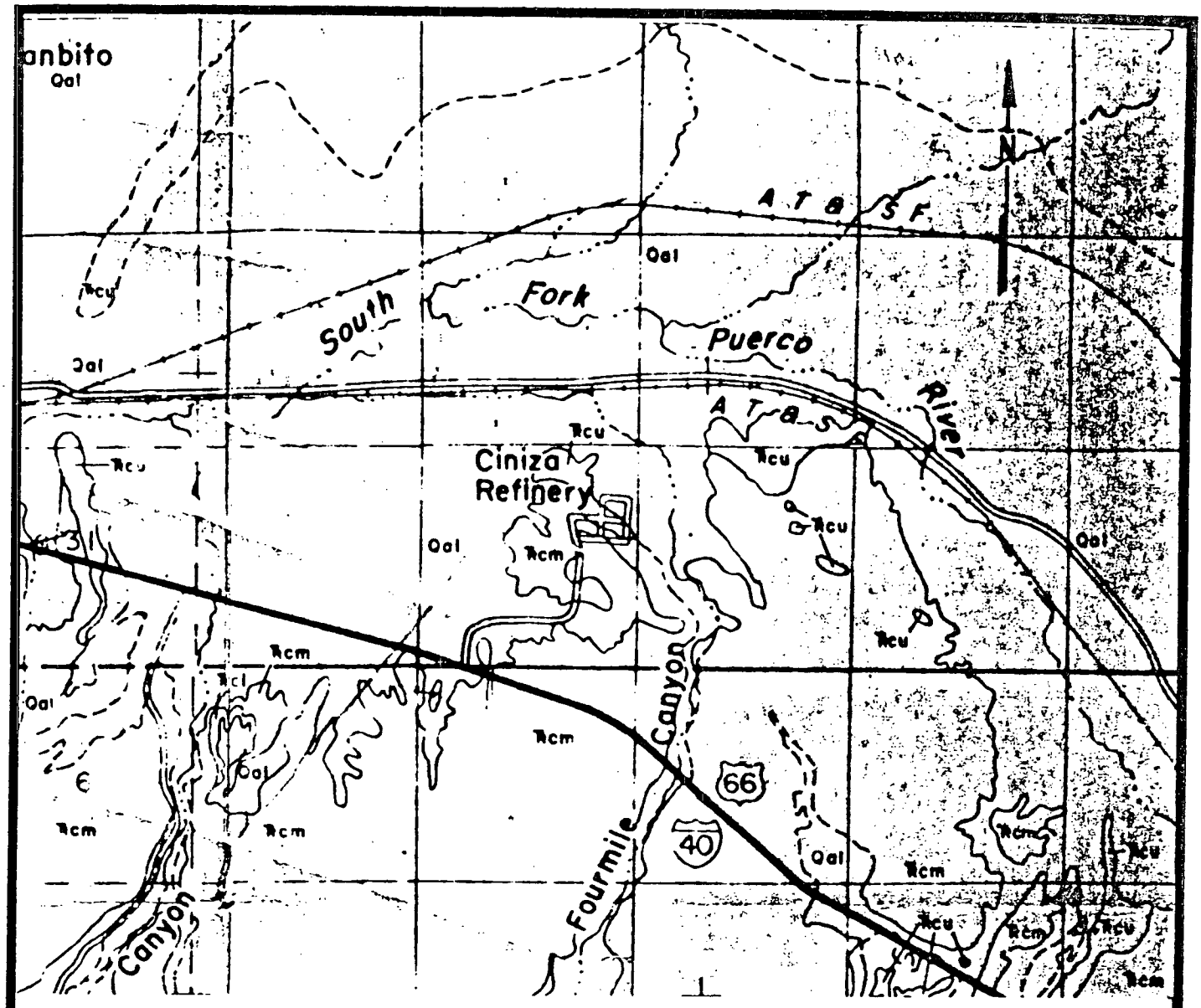
SCALE
0 500 1000
FEET

BASE MAP REFERENCE: MASTER PLAN, CINIZA REFINERY, GALLUP, NEW MEXICO, SOUTHWESTERN ENGINEERING COMPANY, ZZ-02-122-EP, REVISION 8-6-71. EVAPORATION POND BOUNDARIES ARE ESTIMATED.

PREPARED FOR **Shell Oil Co.**

SITE MAP

BY **Dames & Moore** Plate 1



Explanation:

QUATERNARY

Qal

Alluvium

Unconsolidated sand, silt, and clay with lenses of fine gravel. Yields are erratic, but can be 50 gpm or more where alluvium is thick and contains a relatively high proportion of gravel.

UPPER TRIASSIC

Tcu	Tcm	Tcl	Tcs

Chinle Formation

Tcu — Rocks above Sonsela Sandstone Bed, siltstone and mudstone with coarse-grained sandstone lenses. Not known to yield water to wells within study area.

Tcm — Sonsela Sandstone Bed, crossbedded sandstone and pebble conglomerate. Yields a small amount of poor-quality water to wells within study area.

Tcl — Rocks between Sonsela Sandstone Bed and Shinarump Member, siltstone and mudstone. Yields a small amount of poor-quality water to wells within study area.

Tcs — Shinarump Member, sandstone and conglomerate with minor claystone. Yields as much as 70 gpm of good-quality water; wells tapping the Shinarump Member generally also tap the Glorieta Sandstone.

SCALE

0 2000 4000

FEET

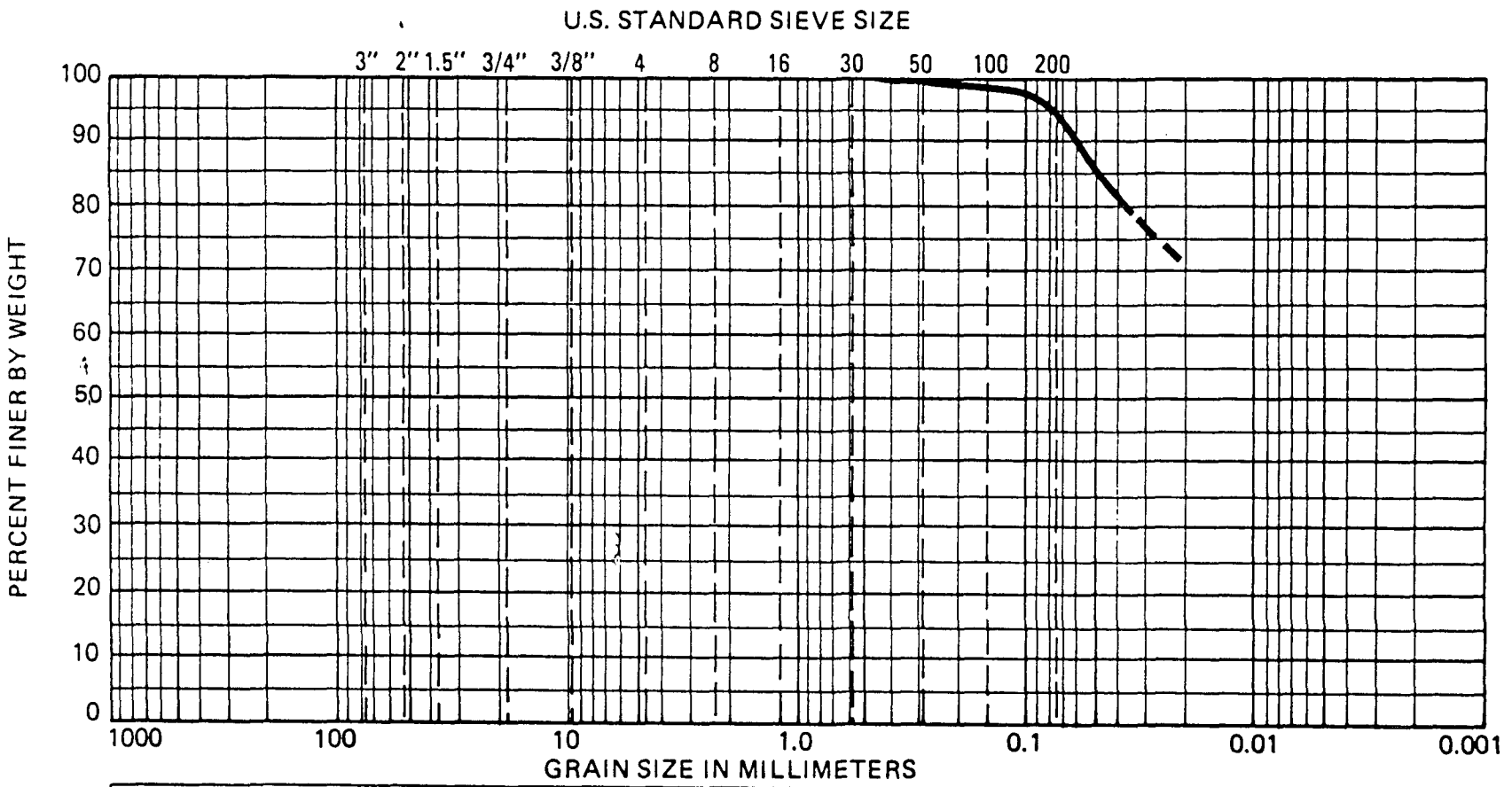
MAP REFERENCE: MODIFIED FROM SHOMAKER, 1971.

PREPARED FOR Shell Oil Co.

REGIONAL GEOLOGY MAP

BY Dames & Moore

Plate 2



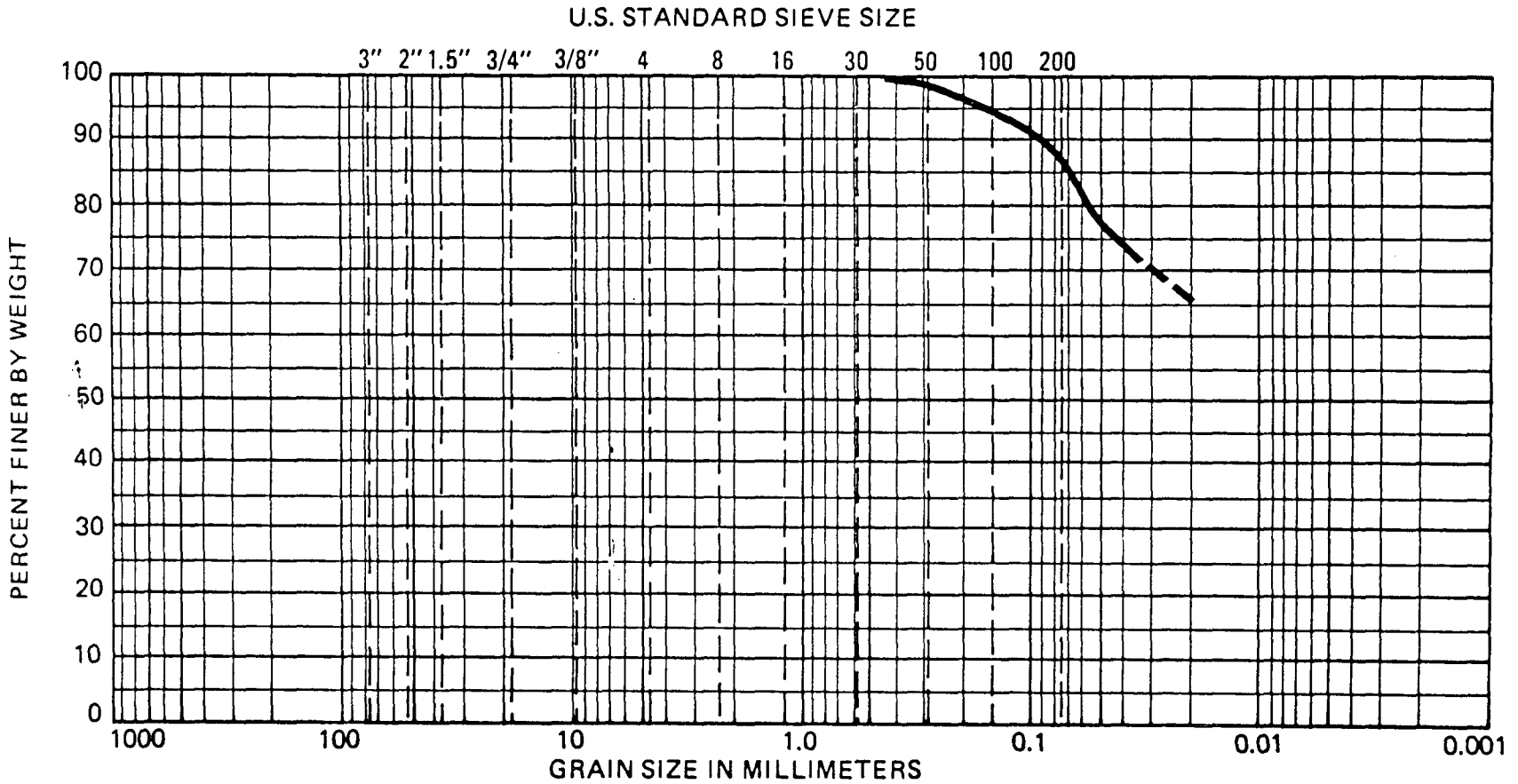
	DEPTH	CLASSIFICATION		NAT. W C	LL	PL	PI	
LF-1+LF-2 COMPOSITE	0-12"	CL	SILTY CLAY (17.0% SAND)					

SIEVE ANALYSIS

0.2%	0.25-0.50 mm
1.0%	0.10-0.25 mm
15.8%	0.043-0.10 mm
83.0%	LESS THAN 0.043 mm

GRADATION CURVE

DAMES & MOORE



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

	DEPTH	CLASSIFICATION		NAT. W C	LL	PL	PI	
LF-3+LF-4	0-12"	CL	SILTY CLAY (25.0% SAND)					

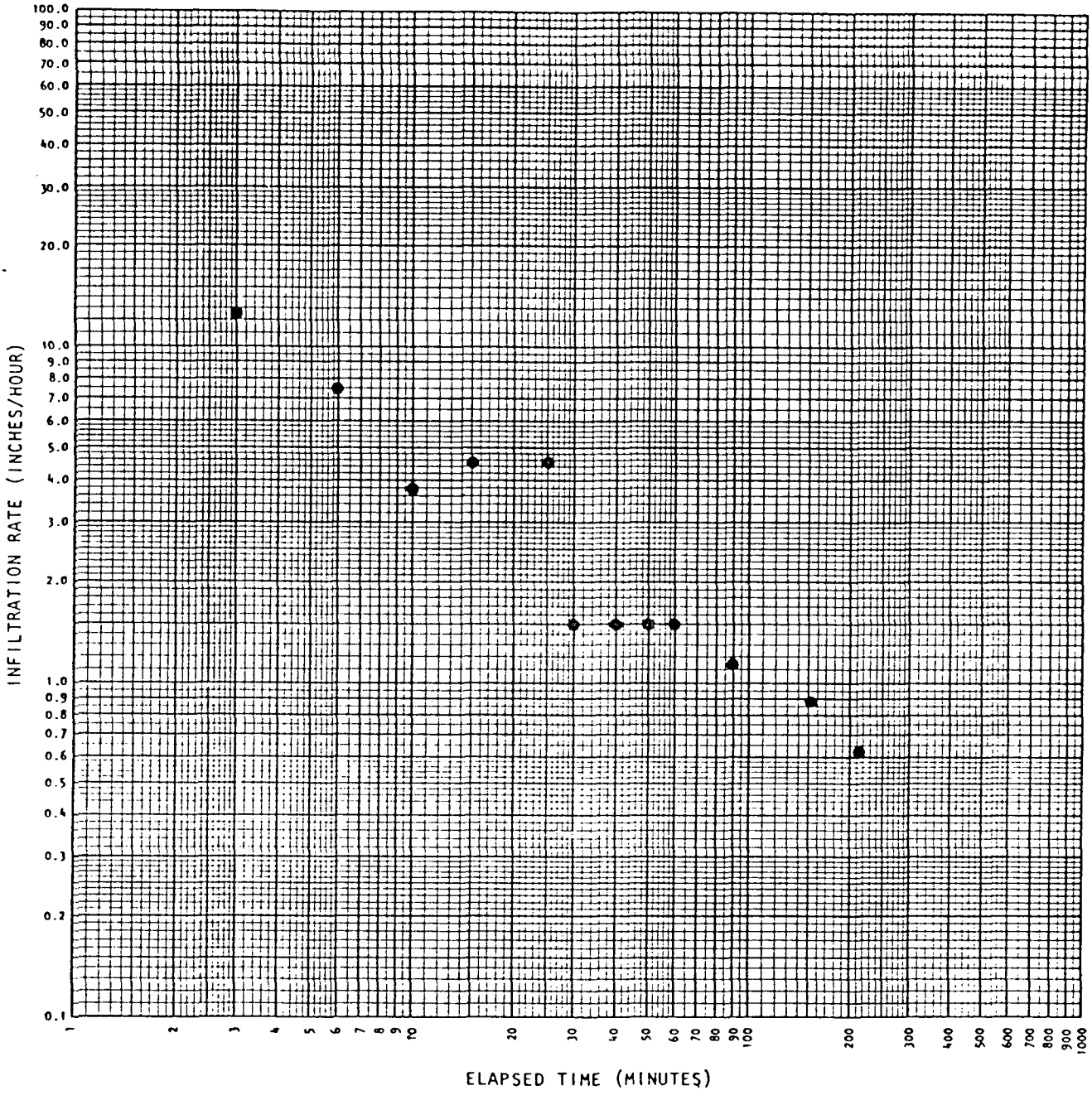
+OW-4
COMPOSITE

GRADATION CURVE

SIEVE ANALYSIS

2.4%	0.25-0.50 mm
5.7%	0.10-0.25 mm
16.9%	0.043-0.10 mm
75.0%	LESS THAN 0.043 mm

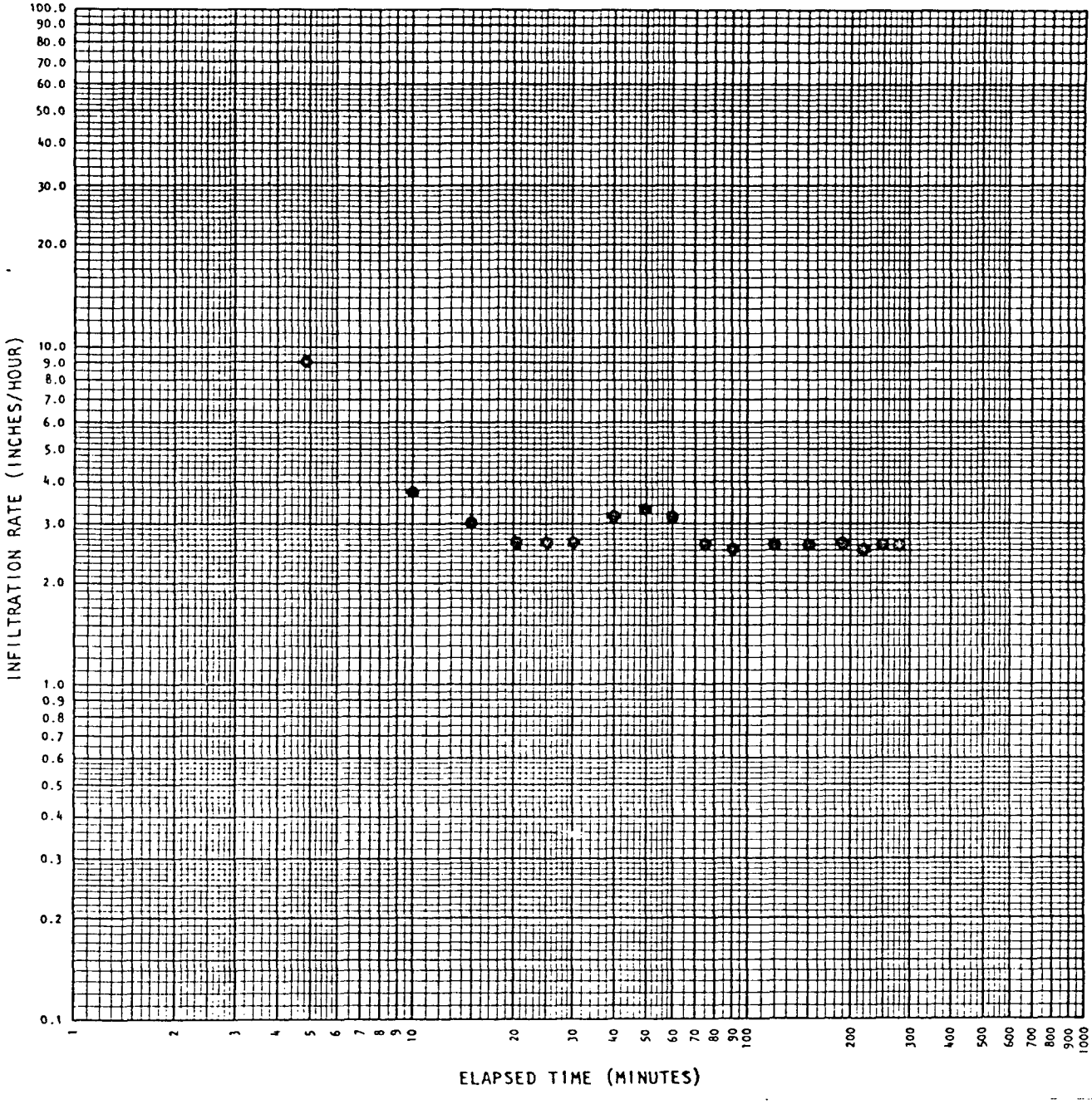
DAMES & MOORE



PREPARED FOR **Shell Oil Co.**

INFILTROMETER TEST LAND TREATMENT AREA SITE LF-2

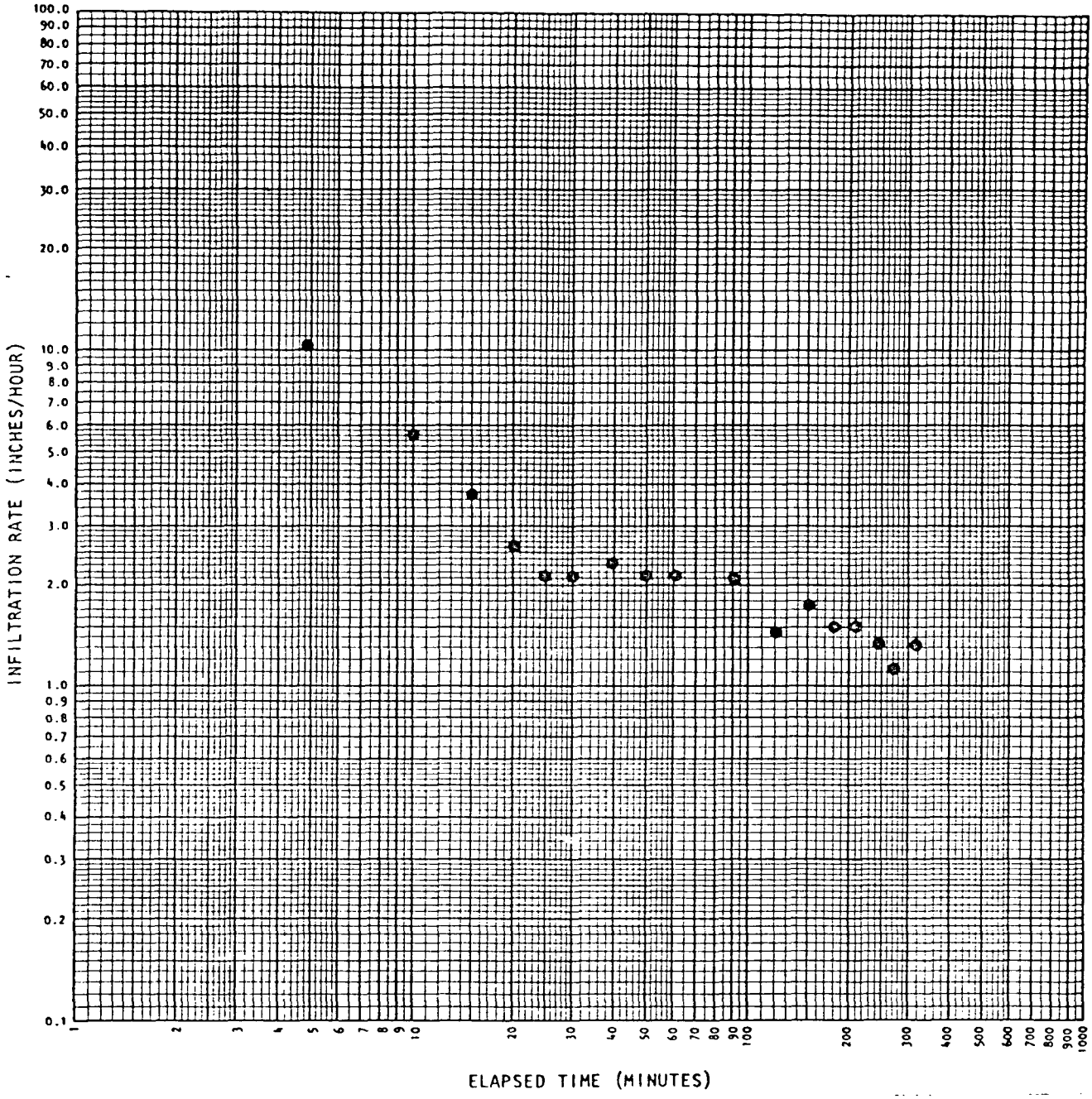
BY **Dames & Moore** Plate 4A



PREPARED FOR **Shell Oil Co.**

INFILTROMETER TEST LAND TREATMENT AREA SITE LF-4

BY **Dames & Moore** Plate 4B

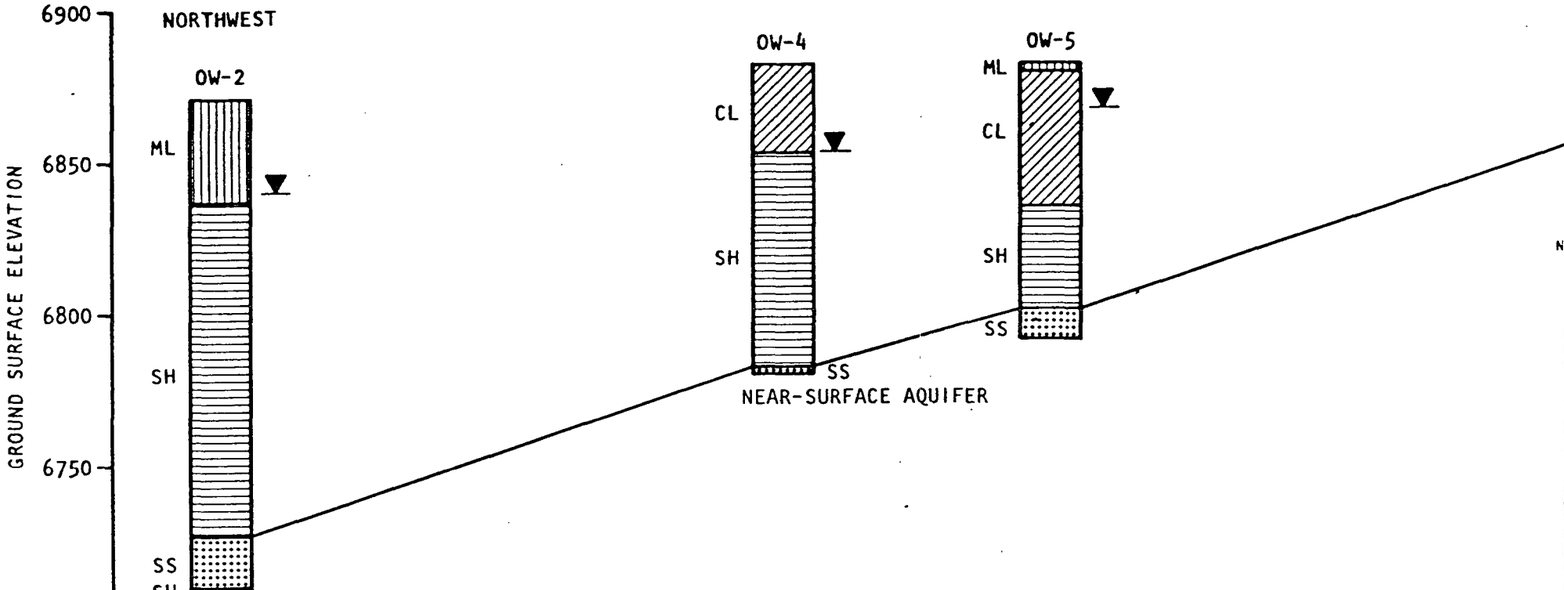


PREPARED FOR **Shell Oil Co.**

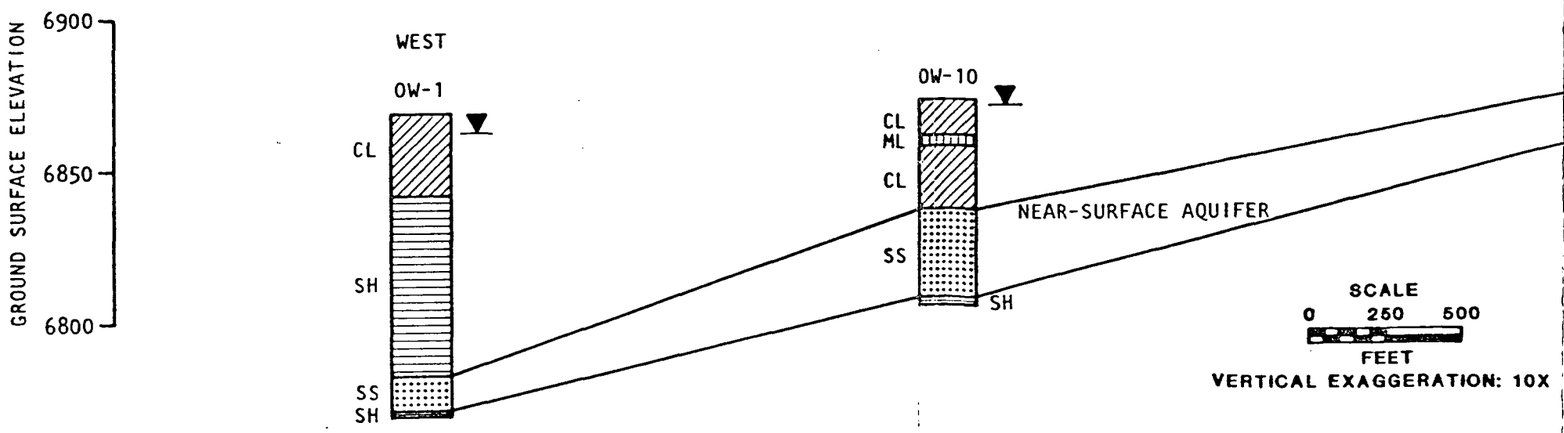
INFILTROMETER TEST LAND TREATMENT AREA SITE OW-4

BY **Dames & Moore** Plate 4C

SECTION A–A'



SECTION B–B'



NOTES:

1. SEE PLATE 1 FOR CROSS SECTION LOCATIONS.
2. SOIL AND ROCK CONDITIONS SHOWN EXIST ONLY AT BORING LOCATIONS. CONTACTS ARE INTERPOLATED, AND CONDITIONS BETWEEN BORINGS MAY BE DIFFERENT THAN SHOWN.
3. GROUND WATER LEVELS ARE INDICATED BY ▼ AND WERE MEASURED ON JANUARY 5, 1981.

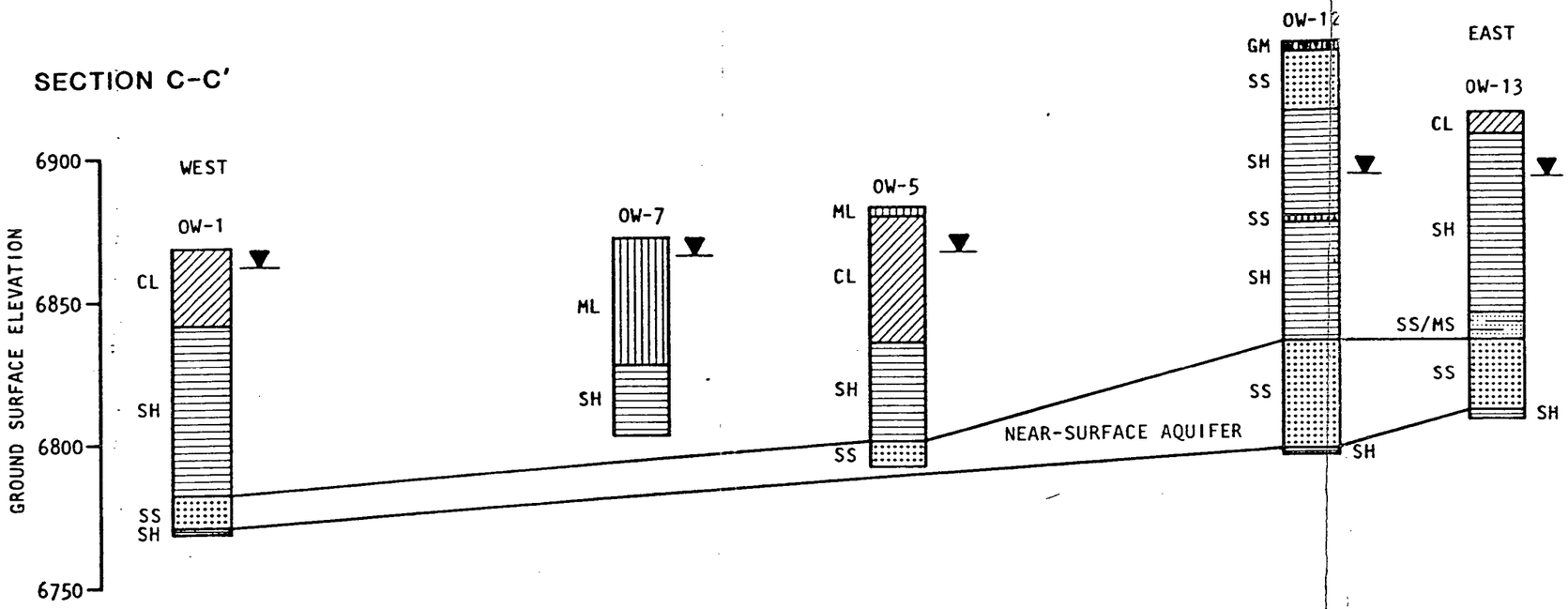
SCALE
0 250 500
FEET
VERTICAL EXAGGERATION: 10X

PREPARED FOR **Shell Oil Co.**

CROSS SECTIONS A–A' AND B–B'

BY **Dames & Moore** Plate 5A

SECTION C-C'



SCALE
0 250 500
FEET
VERTICAL EXAGGERATION: 10X

NOTES:

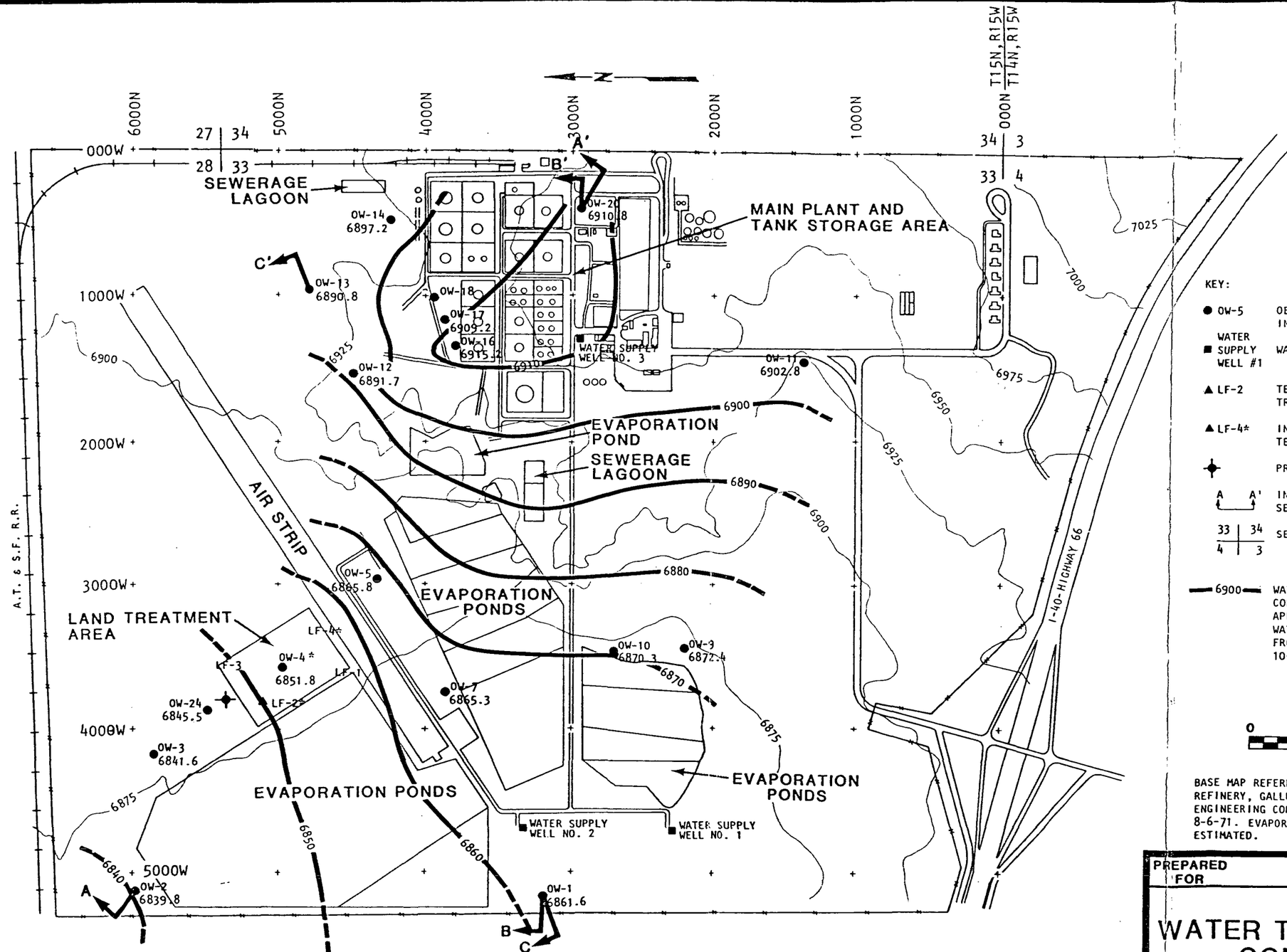
1. SEE PLATE 1 FOR CROSS SECTION LOCATIONS.
2. SOIL AND ROCK CONDITIONS SHOWN EXIST ONLY AT BORING LOCATIONS. CONTACTS ARE INTERPOLATED, AND CONDITIONS BETWEEN BORINGS MAY BE DIFFERENT THAN SHOWN.
3. GROUND WATER LEVELS ARE INDICATED BY ▼ AND WERE MEASURED ON JANUARY 5, 1981.

PREPARED FOR Shell Oil Co.

CROSS SECTION C-C'

BY Dames & Moore

Plate 5B



KEY:

- ● OW-5 — OBSERVATION WELL INSTALLED BY DAMES & MOORE
- ■ WATER SUPPLY WELL #1 — WATER SUPPLY WELL
- ▲ LF-2 — TEST PIT IN LAND TREATMENT AREA
- ▲ LF-4* — INDICATES INFILTROMETER TEST SITE
- ✦ — PROPOSED MONITOR WELL
- A — A' — INDICATES CROSS SECTION LINE SEE PLATES 5A AND 5B
- 33 | 34 / 4 | 3 — SECTION CORNER
- 6900 — WATER TABLE ELEVATION CONTOUR (DASHED WHERE APPROXIMATE), BASED ON WATER TABLE MEASUREMENTS FROM JANUARY 5, 1981. 10-FOOT CONTOUR INTERVAL

SCALE

0 500 1000

FEET

BASE MAP REFERENCE: MASTER PLAN, CINIZA REFINERY, GALLUP, NEW MEXICO, SOUTHWESTERN ENGINEERING COMPANY, ZZ-02-122-EP, REVISION 8-6-71. EVAPORATION POND BOUNDARIES ARE ESTIMATED.

PREPARED FOR Shell Oil Co.

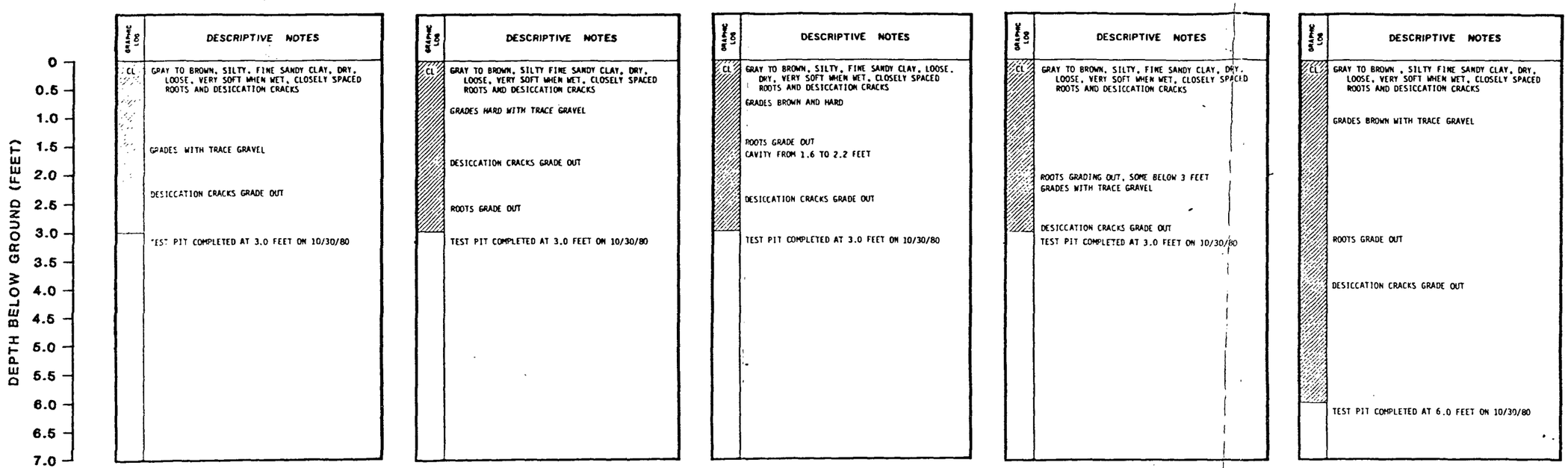
WATER TABLE ELEVATION CONTOUR MAP JANUARY 5, 1981

BY Dames & Moore

Plate 6

APPENDIX A-1

LOGS OF TEST PITS



PREPARED FOR **Shell Oil Co.**

LAND TREATMENT AREA TEST PITS

BY **Dames & Moore**

Plate A1-1

APPENDIX A-2

LOGS OF

OBSERVATION WELLS

NOTE: Numerical sequence is broken because originally planned observation well sites were pre-numbered and certain of these sites were later deleted from program.

MAJOR DIVISIONS			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

UNIFIED SOIL CLASSIFICATION SYSTEM

KEY TO SYMBOLS ON LOG OF BORING

■ DEPTH AT WHICH UNDISTURBED SAMPLE WAS RECOVERED

⊠ DEPTH AT WHICH DISTURBED SAMPLE WAS RECOVERED

□ DEPTH AT WHICH SAMPLING ATTEMPTED WITH NO RECOVERY

CONSOL CONSOLIDATION TEST

PERM LABORATORY PERMEABILITY TEST

SG SPECIFIC GRAVITY

SIEVE SIEVE ANALYSIS

TXCUPP CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST WITH PORE PRESSURE MEASUREMENTS

BORING OW-1

SURFACE ELEVATION: 6868 FEET

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)
0									
10									
20									
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									
130									
140									
150									
160									

PENETRATION RATE MINUTES/FOOT	SYMBOLS	DESCRIPTION
6.0	CL	TRIASSIC PERIOD CHINLE FORMATION RED TO REDDISH BROWN CLAY WITH TRACE TO SOME SILT, CALCAREOUS, HIGHLY WEATHERED
5.0		
4.0		
4.2		
3.8	SHALE	27 FEET: SHALE, REDDISH BROWN, SILTY, CALCAREOUS, SOFT, FRESH
4.1		GRADES HARD FROM 33 FEET
5.6		GRADES WITH OCCASIONAL THIN LIMESTONE INTERBEDS FROM 40 TO 50 FEET
5.0		GRADES WITH THIN SANDSTONE INTERBEDS FROM 45 TO 50 FEET
4.2		
4.6		
5.4		
4.2		GRADES SOFT FROM 65 FEET
3.6		
4.0		GRADES WITH THIN SANDSTONE AND LIMESTONE INTERBEDS FROM 75 FEET, HARD
5.4		
8.0		
5.2	SS	86 FEET: SANDSTONE, VARIEGATED BROWN TO LIGHT GRAY, FINE GRAINED, SILTY, SOFT, WITH ROUNDED TO SUBROUNDED, CLEAR TO FROSTED QUARTZ GRAINS, MICACEOUS, FRESH
4.2		
3.6		SHALE 98 FEET: SHALE, REDDISH BROWN, SILTY, SOFT, FRESH

BORING COMPLETED AT 99.3 FEET ON 11/10/80.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 89.3 TO 99.3 FEET.
GRAVEL PLACED FROM 88.0 TO 99.3 FEET AND SEALED WITH CEMENT AND BENTONITE TO SURFACE.
GROUND WATER LEVEL MEASURED AT 6.4 FEET BELOW GROUND ON 1/5/81.

KEY TO BORINGS
ROCK SYMBOLS

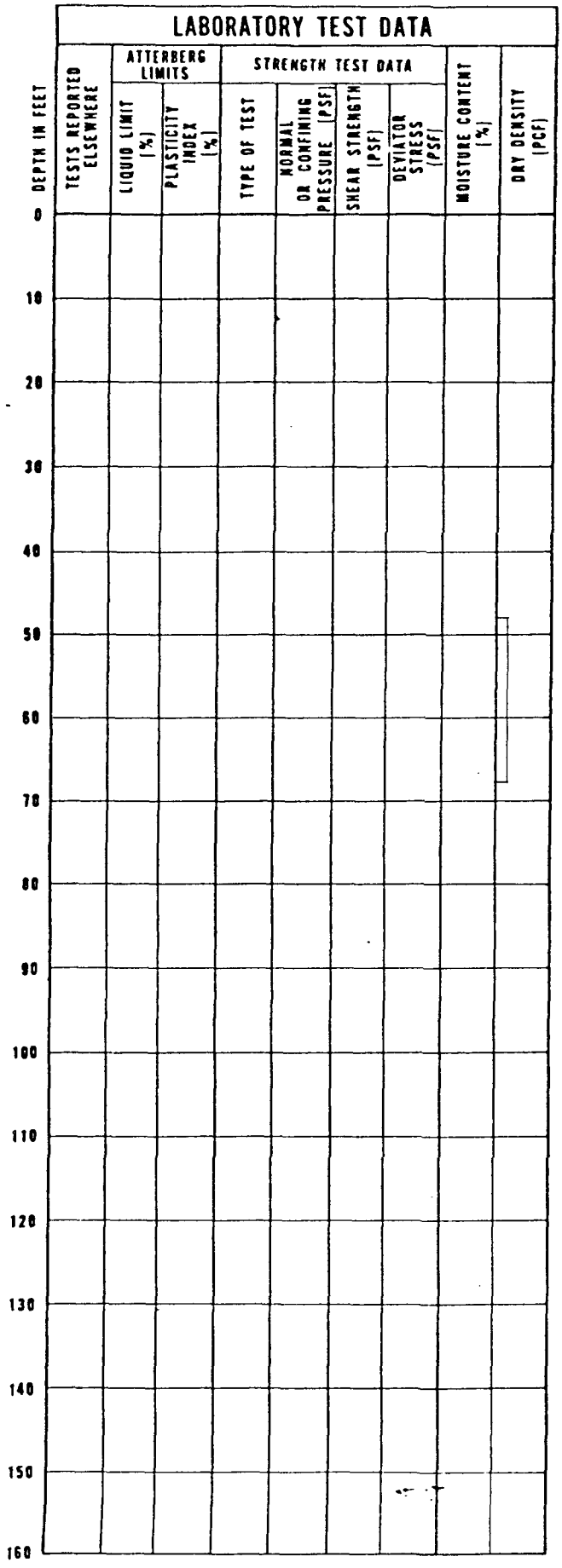
NOTES:
1. PENETRATION RATE IN MINUTES PER FOOT WAS DETERMINED BY THE TIME REQUIRED TO DRILL EACH INTERVAL SHOWN WITH A CABLE TOOL RIG.
2. ESTIMATES OF SOIL CONSISTENCY AND ROCK STRENGTH ARE BASED ON PENETRATION RATE USING THE FOLLOWING CRITERIA:
   < 4.2 MIN./FT.-SOFT
   > 4.2 MIN./FT.-HARD
3. ELEVATION GIVEN IN FEET ABOVE MEAN SEA LEVEL.
4. SOIL CLASSIFICATION IS BASED ON UNIFIED SOIL CLASSIFICATION SYSTEM (PLATE A2-1).
5. ALL DEPTHS REFER TO DEPTH BELOW GROUND.
6. SEE PLATE 1 FOR LOCATION OF WELLS.

LOG OF BORINGS

DAMES & MOORE

BORING OW-2

SURFACE ELEVATION: 6871 FEET



PENETRATION RATE MINUTES/FOOT

SYMBOLS	DESCRIPTION
ML	TRIASSIC PERIOD CHINLE FORMATION REDDISH BROWN SILTY CLAY, SOFT, HIGHLY WEATHERED
1.8	
2.0	
3.0	
SHALE	34 FEET: SHALE, REDDISH BROWN, SILTY, CALCAREOUS, SOFT, FRESH
4.0	
2.4	
3.5	
1.9	GRADES BROWN FROM 50 FEET
2.0	GRADES WITH SOME FINE SAND FROM 58 FEET
1.4	
2.0	SILT AND FINE SAND GRADES OUT FROM 70 FEET
1.4	GRADES DARK GRAY FROM 75 FEET
1.0	GRADES WITH TRACE TO SOME SILT FROM 80 FEET
2.3	
2.5	
SHALE	83 FEET: SHALE, DARK BROWN TO BLACK, WITH SOME SAND AND GRAVEL-SIZED FRAGMENTS OF PETRIFIED WOOD, HARD
10.0	
7.8	GRADES GRAY FROM 88 FEET
11.2	
7.5	GRADES PURPLE TO GRAY FROM 100 FEET
7.0	
5.0	GRADES SOFT FROM 110 FEET
3.4	
4.4	
5.0	GRADES HARD FROM 120 TO 125 FEET
3.8	GRADES REDDISH BROWN FROM 125 FEET, SOFT
5.0	GRADES HARD FROM 130 FEET
5.4	GRADES TO PURPLE AND REDDISH BROWN FROM 135 FEET
5.0	
SS	143 FEET: SANDSTONE, BROWN, FINE-GRAINED, SUBANGULAR, CALCAREOUS, WELL SORTED, SOFT
4.0	
SHALE	162.5 FEET: SHALE, PURPLE TO REDDISH BROWN, WITH SOME SILT, HARD
3.6	
4.4	
5.0	

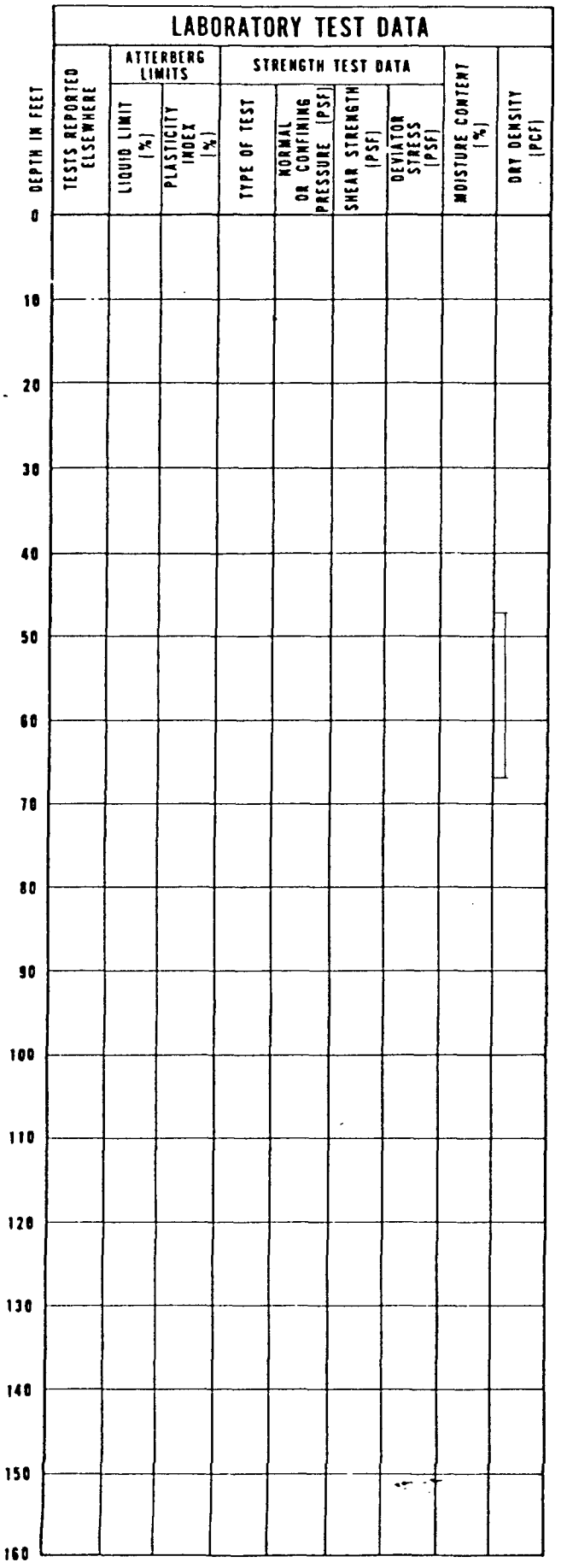
BORING COMPLETED AT 163.0 FEET ON 10/31/80.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 48.0 TO 68.0 FEET.
GRAVEL PLACED FROM 43.0 TO 68.0 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 31.2 FEET BELOW GROUND 1/5/81.

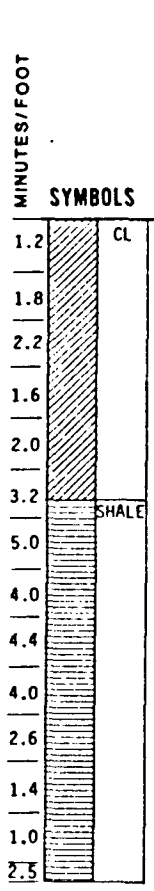
LOG OF BORINGS

DAMES & MOORE

BORING OW-3

SURFACE ELEVATION: 6876 FEET





DESCRIPTION

TRIASSIC PERIOD

CHINLE FORMATION

REDDISH BROWN CLAY WITH SOME FINE SAND, SOFT, HIGHLY WEATHERED

GRADES WITH SILT FROM 15 FEET

FINE SAND GRADES OUT FROM 25 FEET

28 FEET: SHALE, RED TO REDDISH BROWN, SILTY, CALCAREOUS, HARD, FRESH

GRADES SOFT FROM 35 FEET

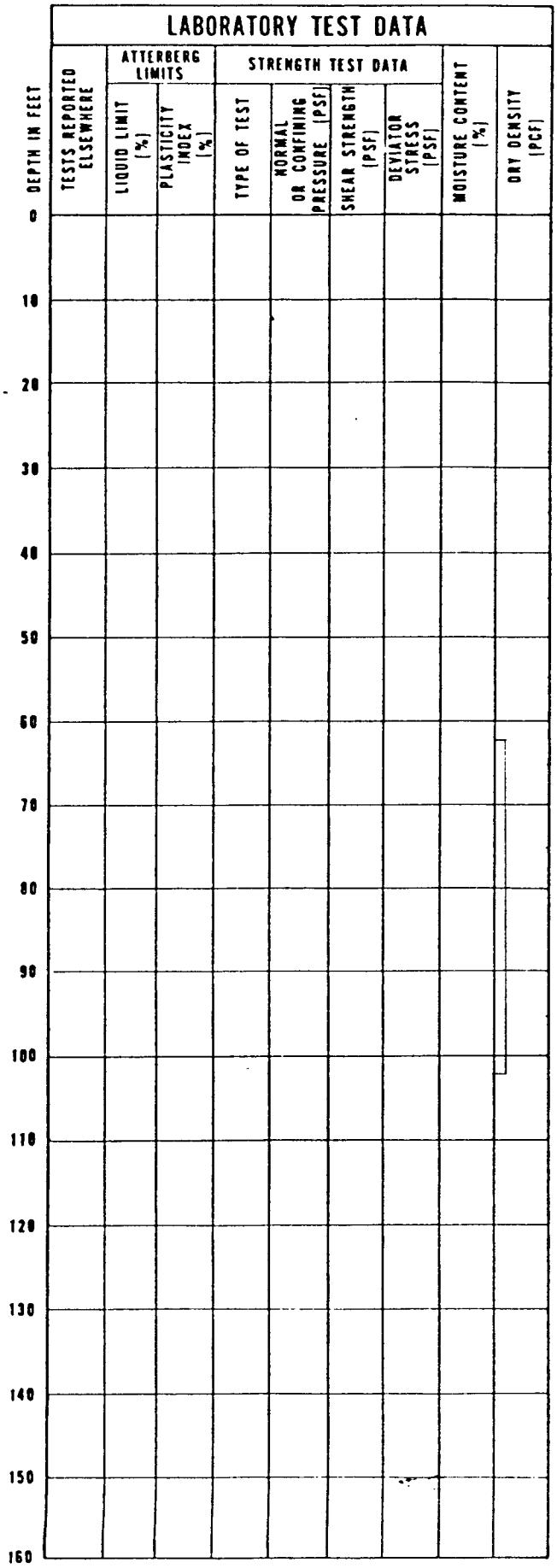
GRADES WITH SOME FINE SAND FROM 50 FEET

BORING COMPLETED AT 67.0 FEET ON 11/4/80.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 47.0 TO 67.0 FEET.
GRAVEL PLACED FROM 36.0 TO 67.0 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 34.4 FEET BELOW GROUND ON 1/5/81.

LOG OF BORINGS

BORING OW-4

SURFACE ELEVATION: 6881 FEET



PENETRATION RATE MINUTES/FOOT

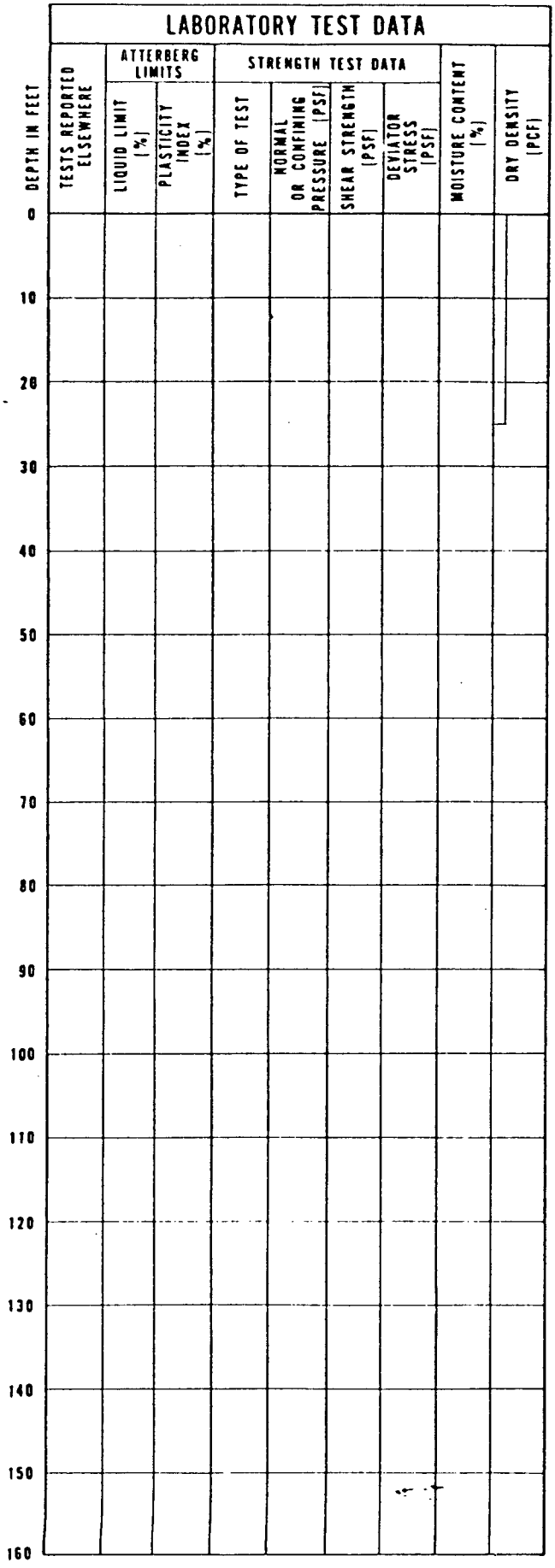
SYMBOLS	DESCRIPTION
2.0, 2.4, 3.0, 2.8, 3.4, 4.0 — CL	TRIASSIC PERIOD CHINLE FORMATION REDDISH BROWN SILTY CLAY, SOFT, HIGHLY WEATHERED GRADES WITH SOME FINE SAND FROM 15 FEET
4.0, 5.0, 4.4, 5.0, 5.4, 5.0, 12.2, 7.0, 8.0, 5.0, 6.0, 6.4, 5.4, 5.0, 4.4 — SHALE	28 FEET: SHALE, REDDISH BROWN, SILTY, WITH SOME FINE-GRAINED SAND, CALCAREOUS, HARD, FRESH GRADES GRAY FROM 60 FEET GRADES WITH THIN LIMESTONE INTERBEDS FROM 85 TO 100 FEET
17.5 — SS	100 FEET: SANDSTONE, LIGHT TO DARK BROWN, FINE-GRAINED, HARD, FRESH

BORING COMPLETED AT 102.0 FEET ON 11/7/80.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 62.0 TO 102.0 FEET.
GRAVEL PLACED FROM 62.0 TO 102.0 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 29.2 FEET BELOW GROUND ON 1/5/81.

LOG OF BORINGS

BORING OW-5

SURFACE ELEVATION: 6882 FEET



PENETRATION RATE MINUTES/FOOT

SYMBOLS	DESCRIPTION
0.8	ML — TRIASSIC PERIOD
1.3	CHINLE FORMATION
3.4	CL — BROWN TO REDDISH BROWN FINE SAND WITH SOME SILT AND CLAY, SOFT, HIGHLY WEATHERED
3.0	3.5 FEET: REDDISH BROWN SILTY CLAY, SOFT, HIGHLY WEATHERED
1.6	GRADES WITH GRAVEL-SIZED FRAGMENTS OF SANDSTONE AND LIMESTONE FROM 15 TO 25 FEET
1.4	
2.0	
2.3	
4.0	
2.5	
3.3	SHALE — 48 FEET: SHALE, REDDISH BROWN, SILTY, WITH SOME SAND, SOFT, FRESH
3.2	GRADES WITH OCCASIONAL THIN INTERBEDS OF SANDSTONE AND LIMESTONE FROM 55 FEET
4.5	
3.8	
3.6	
4.0	
4.0	
5.0	SS — 82 FEET: SANDSTONE, REDDISH BROWN, VERY FINE-GRAINED, INTERBEDS OF WHITE TO GRAY FINE GRAINED SANDSTONE, SOME MICA, SOFT, FRESH
4.2	

BORING COMPLETED AT 92.0 FEET ON 11/12/80.
BORING CAVED FROM 25.3 TO 92.0 FEET.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 0 TO 25.3 FEET.
GRAVEL PLACED FROM 17.4 TO 25.3 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 16.2 FEET BELOW GROUND ON 1/5/81.

LOG OF BORINGS

DAMES & MOORE

BORING OW-7

SURFACE ELEVATION: 6872 FEET

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)
0									
10									
20									
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									
130									
140									
150									
160									

PENETRATION RATE MINUTES/FOOT

SYMBOLS	DESCRIPTION
3.2 – 3.6 – 4.4 – 4.8 – 4.8 – 4.6 – 3.8 – 5.0 – 4.4 – ML	TRAISSIC PERIOD CHINLE FORMATION REDDISH BROWN SILTY CLAY WITH SOME FINE SAND, SOFT, HIGHLY WEATHERED GRADES HARD FROM 15 TO 30 FEET GRADES WITH TRACE COARSE SAND FROM 30 TO 40 FEET GRADES HARD FROM 35 FEET
5.6 – 6.0 – 7.0 – 6.2 – 6.6 – SHALE	44 FEET: SHALE, RED, WITH SOME SAND AND SILT, HARD, FRESH GRADES WITH OCCASIONAL THIN LIMESTONE INTERBEDS FROM 55 FEET

BORING COMPLETED AT 70.0 FEET ON 11/18/80.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 50.0 TO 70.0 FEET.
GRAVEL PLACED FROM 45.0 TO 70.0 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 6.7 FEET BELOW GROUND ON 1/5/81.

LOG OF BORINGS

DAMES & MOORE

BORING OW-9

SURFACE ELEVATION: 6873 FEET

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)
0									
10									
20									
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									
130									
140									
150									
160									

PENETRATION RATE MINUTES/FOOT

	SYMBOLS	DESCRIPTION
1.6 1.2 1.0 3.2 3.3	CL	TRIASSIC PERIOD CHINLE FORMATION REDDISH BROWN SILTY CLAY, SOFT, HIGHLY WEATHERED GRADES GRAY FROM 6 FEET
6.7 8.5 3.2 4.2 4.0	SS	23 FEET: SANDSTONE, BROWN, FINE-TO COARSE-GRAINED, WITH GRAVEL-SIZED FRAGMENTS OF LIMESTONE AND CHERT, CLEAR TO FROSTED QUARTZ GRAINS, HARD, FRESH GRADES SOFT FROM 30 FEET GRADES GRAYISH BROWN FROM 40 FEET
4.0 3.2	SHALE	46 FEET: SHALE, GRAY, SANDY (FINE-GRAINED) WITH OCCASIONAL THIN INTERBEDS OF LIMESTONE, SOFT, FRESH
3.5	SS	58 FEET: SANDSTONE, REDDISH BROWN, FINE-GRAINED, THIN LAYERED, SOFT, FRESH

BORING COMPLETED AT 60.0 FEET ON 11/21/80.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 23.0 TO 43.0 FEET.
GRAVEL PLACED FROM 19.0 TO 60.0 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 0.6 FEET BELOW GROUND ON 1/5/81.

LOG OF BORINGS

DAMES & MOORE

BORING OW-10

SURFACE ELEVATION: 6872 FEET

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)
0									
10									
20									
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									
130									
140									
150									
160									

PENETRATION RATE MINUTES/FOOT

PENETRATION RATE	SYMBOLS	DESCRIPTION
1.0	CL	TRIASSIC PERIOD CHINLE FORMATION REDDISH BROWN SILTY CLAY, SOFT, HIGHLY WEATHERED
1.4		GRADES WITH TRACE TO SOME MEDIUM TO FINE-GRAINED SAND-SIZED PARTICLES OF CHERT, PETRIFIED WOOD, AND LIMESTONE FROM 5 FEET
1.4	ML	10 FEET: REDDISH BROWN SILTY FINE-GRAINED SAND, WITH SOME CLAY, SOFT, HIGHLY WEATHERED
2.0	CL	13 FEET: REDDISH BROWN SILTY CLAY WITH SOME SAND, SOFT, HIGHLY WEATHERED SAND GRADES OUT FROM 16 FEET GRADES WITH SAND FROM 24 FEET GRADES WITH OCCASIONAL THIN INTERBEDS OF SANDSTONE FROM 28 FEET
2.0		
2.8	SS	34 FEET: SANDSTONE, COLOR VARIES FROM DARK AND REDDISH BROWN TO WHITE TO LIGHT GRAY, SILTY, FINE-GRAINED, NONCALCAREOUS, SOFT, FRESH
3.0		
6.7		GRADES BROWN FROM 45 FEET
2.9		
4.6		
5.0	SHALE	63 FEET: SHALE, GRAY TO PURPLISH GRAY, SILTY, WITH OCCASIONAL THIN INTERBEDS OF TAN TO BROWN, FINE-GRAINED, CALCAREOUS SANDSTONE, HARD, FRESH

BORING COMPLETED AT 68.0 FEET ON 11/25/80.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 40.0 TO 60.0 FEET.
GRAVEL PLACED FROM 36.0 TO 68.0 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 1.7 FEET BELOW GROUND ON 1/5/81.

LOG OF BORINGS

DAMES & MOORE

BORING OW-11

SURFACE ELEVATION: 6923 FEET

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)
0									
10									
20									
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									
130									
140									
150									
160									

LABORATORY TEST DATA

PENETRATION RATE MINUTES/FOOT	SYMBOLS	DESCRIPTION
	SM	TRIASSIC PERIOD CHINLE FORMATION REDDISH BROWN SILTY FINE SAND, SOFT, HIGHLY WEATHERED
1.6		GRADES WITH GRAVEL-SIZED FRAGMENTS OF FINE SANDSTONE AND LIMESTONE FROM 7 FEET
1.4	SHALE	13 FEET: SHALE, GRAY, SILTY, WITH OCCASIONAL THIN INTERBEDS OF WHITE SANDSTONE, SOFT, FRESH
2.4		GRADES WITH REDDISH BROWN SANDSTONE INTERBEDS FROM 20 FEET
3.0		
6.5		GRADES WITH LAYER OF WHITE, FINE-GRAINED SANDSTONE FROM 23 TO 24 FEET
2.4		
12.5	SS	30 FEET: SANDSTONE, WHITE, FINE-GRAINED, WITH GRAVEL-SIZED FRAGMENTS OF CHERT, OCCASIONAL THIN INTERBEDS OF REDDISH BROWN FINE-GRAINED SANDSTONE, THINLY BEDDED, HARD, FRESH
4.4		
5.5		
4.0	SHALE	40 FEET: SHALE, GRAY TO PURPLE, SILTY AND SANDY, SOFT, FRESH
3.1		GRADES WITH SOME SAND FROM 47 FEET
4.3		GRADES GRAY AND HARD FROM 50 TO 55 FEET
5.0		
8.0		GRADES WHITE TO LIGHT GRAY FROM 55 FEET, SOFT
2.5		
3.3		
4.0		
2.3		
3.6		GRADES PURPLE FROM 68 FEET
2.3		
4.3		GRADES GRAY FROM 78 FEET
4.5		
2.7		
3.0		
3.5		
4.0		GRADES WITH OCCASIONAL THIN INTERBEDS OF LIMESTONE AND GRAVEL-SIZED FRAGMENTS OF CHERT FROM 92 FEET
4.3		
3.5		
3.3		
4.5		GRADES REDDISH BROWN FROM 103 FEET
2.7		
4.5		
2.0		GRADES GRAY AND HARD FROM 110 FEET
6.5		
5.0		GRADES SOFT WITH NO INTERBEDS FROM 114 FEET
2.3		
2.3		GRADES PURPLISH GRAY FROM 117 FEET
2.7		
3.0		
2.2		
2.3		
2.2		
2.7		GRADES GRAY FROM 140 FEET
3.3		
2.7		
2.2		

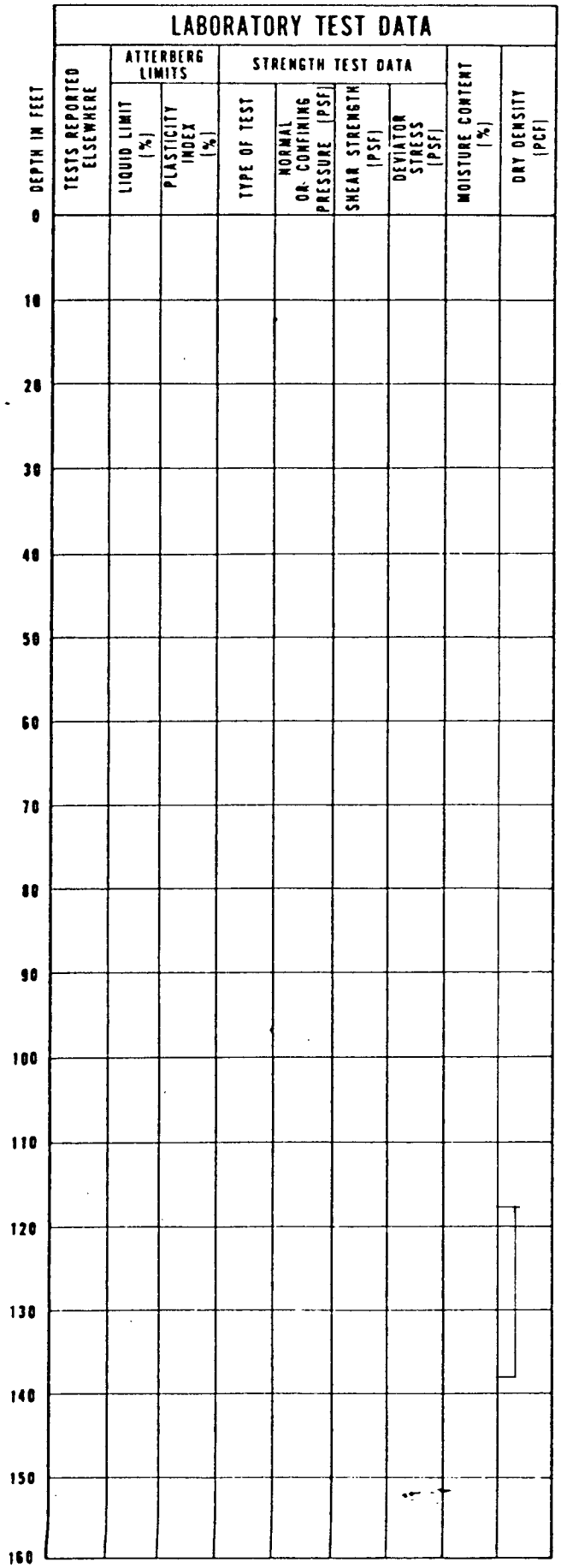
BORING COMPLETED AT 150.0 FEET ON 12/30/80.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 43.0 TO 65.0 FEET.
GRAVEL PLACED FROM 35.0 TO 65.0 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 20.2 FEET BELOW GROUND ON 1/5/81.

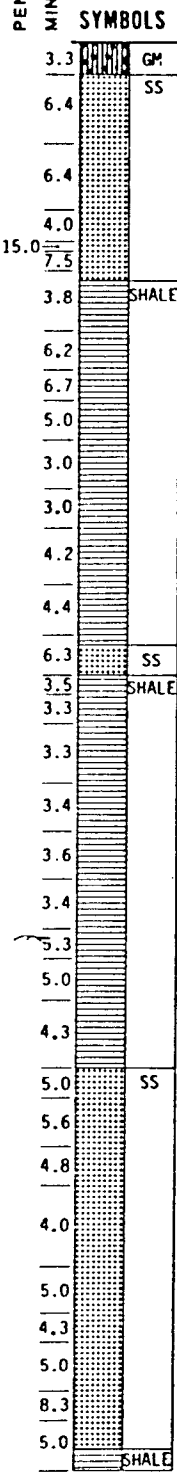
LOG OF BORINGS

DAMES & MOORE

BORING OW-12

SURFACE ELEVATION: 6939 FEET





SYMBOLS	DESCRIPTION
GM	TRIASSIC PERIOD
SS	CHINLE FORMATION LIGHT BROWN FINE SAND WITH GRAVEL-SIZED FRAGMENTS OF CHERT, LIMESTONE, AND PETRIFIED WOOD, SOFT, HIGHLY WEATHERED
	3 FEET: SANDSTONE, LIGHT BROWN, FINE-GRAINED WITH SOME MEDIUM TO COARSE GRAINS, COMPOSED OF QUARTZ WITH MINOR CHERT AND LIMESTONE, HARD, FRESH
	GRADES SOFT FROM 17 FEET
	GRADES HARD FROM 20 TO 24 FEET
SHALE	24 FEET: SHALE, REDDISH BROWN, SILTY, SANDY, WITH GRAVEL-SIZED FRAGMENTS OF PETRIFIED WOOD AND LIMESTONE, SOFT, FRESH
	GRADES HARD FROM 29 FEET
	GRADES SOFT FROM 40 FEET
	GRADES HARD FROM 49 FEET
SS	61 FEET: SANDSTONE, GRAY, SILTY, FINE-TO MEDIUM-GRAINED, CALCAREOUS, HARD, FRESH
SHALE	64 FEET: SHALE, GRAY, SILTY, SANDY, SOFT, FRESH
	GRADES HARD FROM 90 FEET
SS	104 FEET: SANDSTONE, GRAY TO BLUISH GRAY, FINE-GRAINED, THINLY BEDDED, NONCALCAREOUS, WITH INTERBEDDED REDDISH BROWN SANDY MUDSTONE, HARD, FRESH
	GRADES BROWN FROM 112 FEET
SHALE	143 FEET: SHALE, GRAY, SILTY, SANDY, HARD, FRESH

BORING COMPLETED AT 145.0 FEET ON 12/15/80.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 117.8 TO 137.8 FEET.
GRAVEL PLACED FROM 105.0 TO 137.8 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 47.3 FEET BELOW GROUND ON 1/5/81.

LOG OF BORINGS

DAMES & MOORE

BORING OW-13

SURFACE ELEVATION: 6914 FEET

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)
0									
10									
20									
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									
130									
140									
150									
160									

PENETRATION RATE MINUTES/FOOT	SYMBOLS	DESCRIPTION
1.4	CL	TRIASSIC PERIOD CHINLE FORMATION REDDISH BROWN SILTY FINE SANDY CLAY, SOFT, HIGHLY WEATHERED
2.6	SHALE	GRADES WITH GRAVEL FROM 3 TO 6 FEET 8 FEET: SHALE, REDDISH BROWN, SILTY WITH SOME FINE SAND, SOFT, FRESH
3.6		
4.0		
3.0		
3.0		GRADES WITH THIN LIMESTONE INTERBEDS FROM 26 TO 32 FEET
3.3		
4.4		GRADES GRAY AND HARD FROM 40 FEET
4.8		
4.6		
4.0		GRADES REDDISH BROWN FROM 55 FEET
4.3		
7.5		
6.7		
5.0		
6.5	SS/MS	70 FEET: SANDSTONE, WHITE TO GRAY, FINE-GRAINED, INTERBEDDED WITH REDDISH BROWN SANDY MUDSTONE, THIN BEDDED, HARD, FRESH
6.7		
6.0		
5.0	SS	79 FEET: SANDSTONE, LIGHT BROWN, FINE-GRAINED WITH SOME MEDIUM TO COARSE GRAINS, SLIGHTLY CALCAREOUS, COMPOSED OF QUARTZ WITH MINOR LIMESTONE, HARD, FRESH
6.0		
6.7		
10.0		
8.0		
6.4		
	SHALE	104 FEET: SHALE, REDDISH BROWN, SANDY, WITH OCCASIONAL THIN INTERBEDS OF SANDSTONE AND LIMESTONE, HARD, FRESH

BORING COMPLETED AT 108.0 FEET ON 12/10/80.
BORING ALLOWED TO CAVE FROM 98.2 TO 104.0 FEET.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 78.2 TO 98.2 FEET.
GRAVEL PLACED FROM 74.0 TO 98.2 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 23.2 FEET BELOW GROUND ON 1/5/81.

LOG OF BORINGS

DAMES & MOORE

BORING OW-14

SURFACE ELEVATION: 6023 FEET

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)
0									
10									
20									
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									
130									
140									
150									
160									

PENETRATION RATE MINUTES/FOOT	SYMBOLS	DESCRIPTION
2.0	CL	TRIASSIC PERIOD CHINLE FORMATION REDDISH BROWN SILTY, FINE SANDY CLAY, CALCAREOUS, SOFT, HIGHLY WEATHERED
1.7		
1.6		
1.7		
2.6		
2.2	SM	24 FEET: REDDISH BROWN SILTY, VERY FINE SAND, SOFT, HIGHLY WEATHERED
2.6		
2.4		
5.0	SS	39 FEET: SANDSTONE, BROWN, FINE-TO COARSE-GRAINED SILTY, WITH OCCASIONAL THIN INTERBEDS OF LIMESTONE, HARD, FRESH
4.0		

BORING COMPLETED AT 45.0 FEET ON 12/17/80.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 35.0 TO 45.0 FEET.
GRAVEL PLACED FROM 30.0 TO 45.0 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 25.8 FEET BELOW GROUND ON 1/5/81.

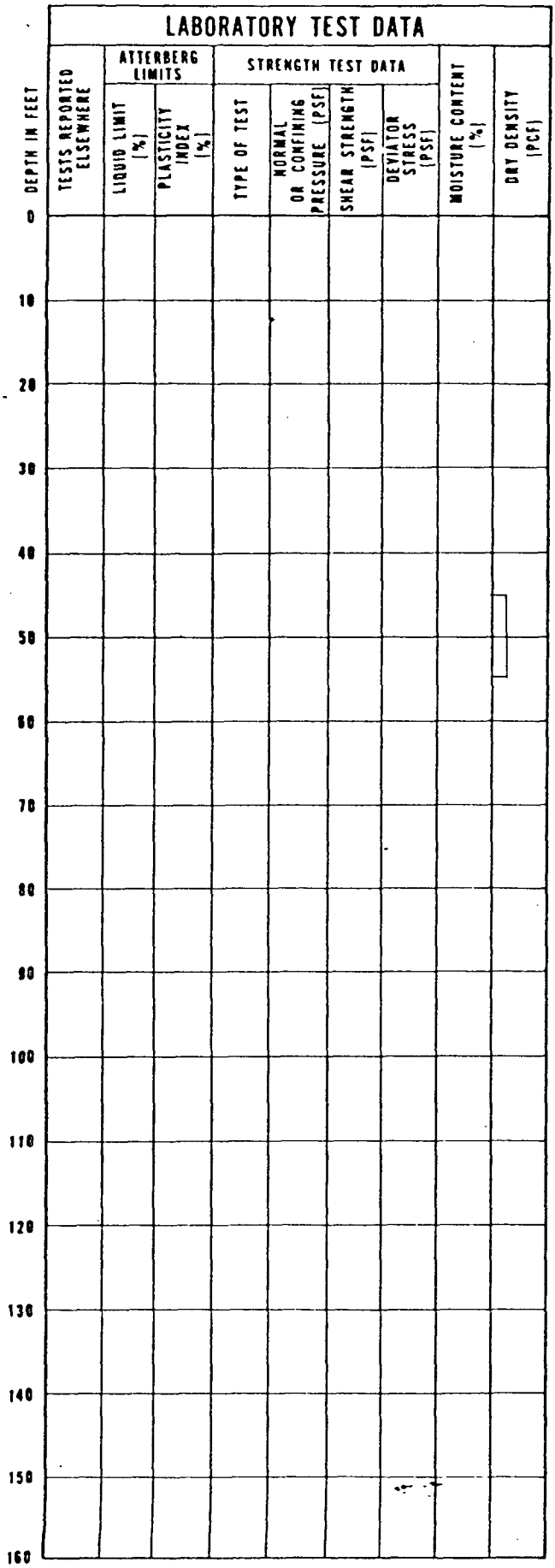
LOG OF BORINGS

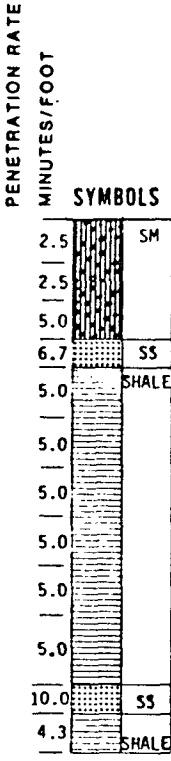
DAMES & MOORE

PLATE A2-13

BORING OW-16

SURFACE ELEVATION: 6942 FEET





DESCRIPTION

TRIASSIC PERIOD

CHINLE FORMATION

REDDISH BROWN SILTY FINE SAND WITH SOME GRAVEL, SOFT, HIGHLY WEATHERED

12 FEET: SANDSTONE, RED, FINE-GRAINED, HARD, FRESH

15 FEET: SHALE, RED, SANDY, HARD, FRESH

47 FEET: SANDSTONE, GRAY, FINE-TO MEDIUM-GRAINED, CALCAREOUS, HARD, FRESH

50 FEET: SHALE, GRAY, SILTY, WITH SOME FINE SAND, HARD, FRESH

BORING COMPLETED AT 54.6 FEET ON 12/2/80.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 44.6 TO 54.6 FEET.
GRAVEL PLACED FROM 36.0 TO 54.6 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 26.8 FEET BELOW GROUND ON 1/5/81.

LOG OF BORINGS

DAMES & MOORE

BORING OW-17

SURFACE ELEVATION: 6941 FEET

DEPTH IN FEET	LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)
0									
10									
20									
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									
130									
140									
150									
160									

PENETRATION RATE MINUTES/FOOT

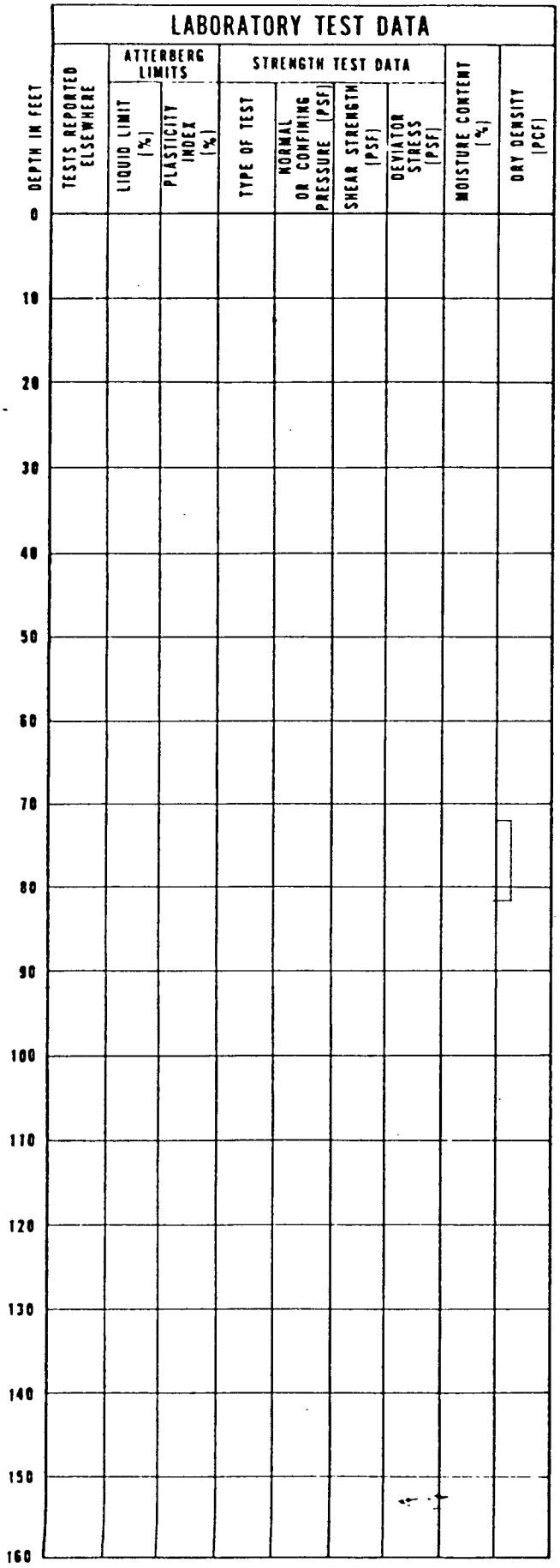
SYMBOLS		DESCRIPTION
3.0 / 3.2	SM	TRIASSIC PERIOD CHINLE FORMATION REDDISH BROWN SILTY FINE SAND WITH SOME GRAVEL-SIZED FRAGMENTS OF LIMESTONE AND SANDSTONE, SOFT, HIGHLY WEATHERED
6.0	SS	11 FEET: SANDSTONE, REDDISH BROWN, FINE-GRAINED, NONCALCAREOUS, HARD, FRESH
2.9 / 5.6 / 2.8 / 3.8 / 3.2 / 3.3	SHALE	13 FEET: SHALE, REDDISH BROWN, SANDY, SOFT, FRESH GRADES HARD FROM 27.5 TO 30.0 FEET GRADES GRAY FROM 31 FEET GRADES WITH THIN LIMESTONE AND SANDSTONE INTERBEDS FROM 39 FEET
4.3	SS	40 FEET: SANDSTONE, GRAY, FINE-GRAINED, SILTY, CALCAREOUS, HARD, FRESH
5.0 / 4.3 / 4.0	SHALE	42 FEET: SHALE, GRAY, SILTY, SANDY, WITH SOME GRAVEL-SIZED FRAGMENTS OF CHERT AND LIMESTONE AND OCCASIONAL THIN INTERBEDS OF LIMESTONE, HARD, FRESH

BORING COMPLETED AT 50.0 FEET ON 1/3/81.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 38.0 TO 50.0 FEET.
GRAVEL PLACED FROM 24.0 TO 50.0 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 31.8 FEET BELOW GROUND ON 1/5/81.

LOG OF BORINGS

BORING OW-18

SURFACE ELEVATION: 6932 FEET



PENETRATION RATE MINUTES/FOOT

SYMBOLS	DESCRIPTION
0.7 1.0 1.2 1.7	SM — TRIASSIC PERIOD CHINLE FORMATION REDDISH BROWN SILTY FINE SAND, SOFT, HIGHLY WEATHERED
3.0 3.2 6.0 3.0 4.8 4.0	SHALE — 17 FEET: SHALE, REDDISH BROWN, SANDY, WITH SOME GRAVEL-SIZED FRAGMENTS OF CHERT AND PETRIFIED WOOD, OCCASIONAL THIN INTERBEDS OF LIMESTONE AND SANDSTONE, SOFT, FRESH GRADES HARD FROM 30 TO 32 FEET GRADES GRAY FROM 32 FEET GRADES HARD FROM 37 TO 41 FEET
4.0 3.0 2.9	SS 0.5 FOOT LAYER OF FINE-GRAINED, BROWN, CALCAREOUS SANDSTONE FROM 49 FEET
6.3 3.0 2.8 3.6	SS — 61 FEET: SANDSTONE, BROWN, FINE-GRAINED, THIN BEDDED WITH OCCASIONAL THIN INTERBEDS OF BLUISH GRAY MUDSTONE, NONCALCAREOUS, HARD, FRESH MUDSTONE INTERBEDS GRADE OUT FROM 65 FEET, GRADES SOFT

BORING COMPLETED AT 82.0 FEET ON 12/4/80.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 72.0 TO 82.0 FEET.
GRAVEL PLACED FROM 67.0 TO 82.0 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 27.0 FEET BELOW GROUND ON 12/5/80.

LOG OF BORINGS

DAMES & MOORE

BORING OW-20

SURFACE ELEVATION: 6981 FEET

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)
0									
10									
20									
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									
130									
140									
150									
160									

LABORATORY TEST DATA

PENETRATION RATE MINUTES/FOOT	SYMBOLS	DESCRIPTION
5.0	FILL	FILL
1.2		
1.3	CL	TRIASSIC PERIOD CHINLE FORMATION GRAY SILTY, FINE SANDY CLAY, SOFT, HIGHLY WEATHERED
1.7		
1.5		
1.5		GRADES WITH SOME GRAVEL-SIZED FRAGMENTS OF LIMESTONE FROM 29 FEET
1.9		
3.3	SHALE	40 FEET: SHALE, REDDISH BROWN, SILTY, WITH SOME FINE SAND, AND OCCASIONAL THIN INTERBEDS OF SANDSTONE AND LIMESTONE, SOFT, FRESH
3.0		
2.7		
4.0		
2.3		
3.4		
1.6	MS	60 FEET: MUDSTONE, REDDISH BROWN, INTERBEDDED WITH LAMINAE OF WHITE TO LIGHT BROWN SANDSTONE, SOFT, FRESH
3.2		
6.3	SS	70 FEET: SANDSTONE, BROWN, COARSE-GRAINED, COMPOSED OF QUARTZ WITH MINOR CHERT, AND LIMESTONE, HARD, FRESH
6.0		
6.3		
		SHALE 82 FEET: SHALE, GRAY, SILTY WITH SOME FINE SAND, HARD, FRESH

BORING COMPLETED AT 83.0 FEET ON 12/19/80.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 54.0 TO 64.0 FEET.
GRAVEL PLACED FROM 50.0 TO 64.0 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 50.2 FEET BELOW GROUND ON 1/5/81.

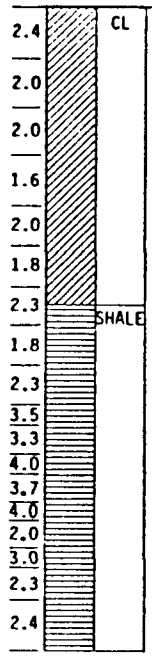
LOG OF BORINGS

DAMES & MOORE

BORING OW-24

SURFACE ELEVATION: 6878 FEET

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	STRENGTH TEST DATA: TYPE OF TEST	STRENGTH TEST DATA: NORMAL OR CONFINING PRESSURE (PSF)	STRENGTH TEST DATA: SHEAR STRENGTH (PSF)	STRENGTH TEST DATA: DEVIATOR STRESS (PSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)
0									
10									
20									
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									
130									
140									
150									
160									



SYMBOLS	DESCRIPTION
CL	TRIASSIC PERIOD CHINLE FORMATION REDDISH BROWN, VERY FINE SANDY CLAY, SOFT, HIGHLY WEATHERED
SHALE	30 FEET: SHALE, REDDISH BROWN, SANDY, SOFT, FRESH

BORING COMPLETED AT 65.0 FEET ON 1/2/81.
4-INCH PVC PIEZOMETER INSTALLED WITH PERFORATIONS FROM 41.0 TO 61.0 FEET.
GRAVEL PLACED FROM 28.0 TO 61.0 FEET AND BORING SEALED WITH BENTONITE AND CEMENT TO SURFACE.
GROUND WATER LEVEL MEASURED AT 32.5 FEET BELOW GROUND ON 1/5/81.

LOG OF BORINGS

DAMES & MOORE

APPENDIX B-1

SOILS IN LAND TREATMENT AREA

E P TOXICITY

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics)

Sample Identification	Type of Analysis	mg/liter
LF-1 0-1 Ft.	Arsenic	< 0.01
	Barium	< 10
	Cadmium	0.002
	Chromium	< 0.001
	Chromium 6+	< 0.01
	Lead	< 0.001
	Mercury	< 0.0004
	pH	8.6
	Selenium	0.01
	Silver	< 0.01
	Total Organic Carbon	4800 ug/gm

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr
12/11/80 PAGE 1 OF 19 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
VOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80	CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics) "Corrected Report"

Sample Identification	Type of Analysis		mg/liter
LF-1 1-2 ft.	Arsenic	<	0.01
	Barium	<	10
	Cadmium		0.001
	Chromium	<	0.001
	Chromium 6+	<	0.01
	Lead		0.003
	Mercury	<	0.0004
	Selenium	<	0.01
	Silver	<	0.01
	Total Organic Carbon		4700 ug/gm

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr
12/11/80

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
VOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics) "Corrected Report"

Sample Identification	Type of Analysis		mg/liter
LF-1 2-3 ft.	Arsenic	<	0.01
	Barium	<	10
	Cadmium		0.001
	Chromium	<	0.001
	Chromium 6+	<	0.01
	Lead		0.002
	Mercury	<	0.0004
	Selenium	<	0.01
	Silver	<	0.01
	Total Organic Carbon		4700 ug/gm

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr.
12/11/80

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
VOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics)

Sample Identification	Type of Analysis		mg/liter
LF-2 0-1 Ft.	Arsenic	<	0.01
	Barium	<	10
	Cadmium		0.001
	Chromium	<	0.001
	Chromium 6+	<	0.01
	Lead		0.001
	Mercury	<	0.0004
	pH		8.4
	Selenium	<	0.01
	Silver	<	0.01
	Total Organic Carbon		4800 ug/gm

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr
12/11/80 PAGE 2 OF 19 PAGE

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
VOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80

CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics) "Corrected Report"

Sample Identification	Type of Analysis	mg/liter
LF-2 1-2 ft.	Arsenic	< 0.01
	Barium	< 10
	Cadmium	0.002
	Chromium	< 0.001
	Chromium 6+	< 0.01
	Lead	< 0.001
	Mercury	< 0.0004
	Selenium	< 0.01
	Silver	< 0.01
	Total Organic Carbon	4700 ug/gm

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr
12/11/80 PAGE 7 OF 19 PAGE

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics)

Sample Identification	Type of Analysis	mg/liter
LF-2 2-3 Ft.	Arsenic	< 0.01
	Barium	< 10
	Cadmium	< 0.001
	Chromium	< 0.001
	Chromium 6+	< 0.01
	Lead	0.002
	Mercury	< 0.0004
	Selenium	< 0.01
	Silver	< 0.01
	Total Organic Carbon	4700 ug/gm

APPROVED BY
Elmer D. Martinez, Operations Division Mgr.
12/11/80

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
IVOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics) "Corrected Report"

Sample Identification	Type of Analysis		mg/liter
LF-3 0-1 ft.	Arsenic	<	0.01
	Barium	<	10
	Cadmium		0.002
	Chromium	<	0.001
	Chromium 6+	<	0.01
	Lead	<	0.001
	Mercury	<	0.0004
	pH		8.9
	Selenium	<	0.01
	Silver	<	0.01
	Total Organic Carbon		4700 ug/gm

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
JOB NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics)

Sample Identification	Type of Analysis	mg/liter
LF-3 1-2 Ft.	Arsenic	< 0.01
	Barium	< 10
	Cadmium	0.002
	Chromium	< 0.001
	Chromium 6+	< 0.01
	Lead	< 0.001
	Mercury	< 0.0004
	Selenium	< 0.01
	Silver	< 0.01
	Total Organic Carbon	4700 ug/gm

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr.
12/11/80 PAGE 8 OF 10 PAGE

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
VOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics)

Sample Identification	Type of Analysis	mg/liter
LF-4 0-1 Ft.	Arsenic	< 0.01
	Barium	< 10
	Cadmium	0.001
	Chromium	< 0.001
	Chromium 6+	< 0.01
	Lead	< 0.001
	Mercury	< 0.0004
	pH	8.7
	Selenium	< 0.01
	Silver	< 0.01
	Total Organic Carbon	4800 ug/gm

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr.
12/11/80

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics)

Sample Identification	Type of Analysis	mg/liter
LF-4 1-2 Ft.	Arsenic	< 0.01
	Barium	< 10
	Cadmium	< 0.001
	Chromium	< 0.001
	Chromium 6+	< 0.01
	Lead	< 0.001
	Mercury	< 0.0004
	Selenium	< 0.01
	Silver	< 0.01
	Total Organic Carbon	4700 ug/gm

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr.
12/11/80

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
VOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics) "Corrected Report"

Sample Identification	Type of Analysis		mg/liter
LF-4 2-3 ft.	Arsenic	<	0.01
	Barium	<	10
	Cadmium		0.002
	Chromium	<	0.001
	Chromium 6+	<	0.01
	Lead		0.002
	Mercury	<	0.0004
	Selenium	<	0.01
	Silver	<	0.01
	Total Organic Carbon		4700 ug/gm

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr
12/11/80

RECEIVED

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
VOICE NO Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics)

Sample Identification	Type of Analysis	mg/liter
OW-4 0-1 Ft.	Arsenic	< 0.01
	Barium	< 10
	Cadmium	0.001
	Chromium	< 0.001
	Chromium 6+	< 0.01
	Lead	0.003
	Mercury	< 0.0004
	pH	8.5
	Selenium	< 0.01
	Silver	< 0.01
	Total Organic Carbon	4800 ug/gm

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr.
12/11/80

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics)

Sample Identification	Type of Analysis	mg/liter
OW-4 1-2 Ft.	Arsenic	< 0.01
	Barium	< 10
	Cadmium	< 0.001
	Chromium	< 0.001
	Chromium 6+	< 0.01
	Lead	0.003
	Mercury	< 0.0004
	Selenium	< 0.01
	Silver	< 0.01
	Total Organic Carbon	4700 ug/gm

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr
12/11/80 PAGE 10 OF 19 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502
Telephone 505/982-9841

ISTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. NE Suite 398W
CITY City Center
TENTION Albuquerque, NM 87110
ICE NO. William Mead
101057

REPORT OF ANALYSIS

SAMPLES RECEIVED	CUSTOMER ORDER NUMBER

PE OF ANALYSIS Soil CORRECTED COPY

Sample Identification	Type of Analysis	ug/g
LF-2 1-2 ft.	Arsenic, Total	50
	Barium, Total	1,100
	Cadmium, Total	0.3
	Chromium, Total	39
	Chromium 6+, Total	1
	Lead, Total	26
	Mercury, Total	0.1
	Selenium, Total	< 1
	Silver, Total	1.4
LF-3 1-2 ft.	Arsenic, Total	50
	Barium, Total	970
	Cadmium, Total	0.2
	Chromium, Total	45
	Chromium 6+, Total	< 1
	Lead, Total	24
	Mercury, Total	0.9
	Selenium, Total	< 1
	Silver, Total	< 1.0

APPROVED BY

1/20/81 Elmer D. Martinez, Operations Division Manager

ontrols for Environmental Pollution, Inc.
O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil (EP Toxicity Inorganics)

Sample Identification	Type of Analysis	mg/liter
OW-4 2-3 Ft.	Arsenic	< 0.01
	Barium	< 10
	Cadmium	< 0.001
	Chromium	< 0.001
	Chromium 6+	< 0.01
	Lead	< 0.001
	Mercury	< 0.0004
	Selenium	< 0.01
	Silver	< 0.01
	Total Organic Carbon	4700 ug/gm

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr.
12/11/80 PAGE 18 OF 19 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502
Telephone 505/982-9841

TOTAL METALS

JSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. NE Suite 398W
CITY City Center
TENTION Albuquerque, NM 87110
CE NO. William Mead
101057

REPORT OF ANALYSIS

SAMPLES RECEIVED	CUSTOMER ORDER NUMBER

PE OF ANALYSIS Soil

Sample Identification	Type of Analysis	ug/g
LF-1 2-3 ft.	Arsenic, Total	50
	Barium, Total	860
	Cadmium, Total	0.2
	Chromium, Total	34
	Chromium 6+, Total	< 1
	Lead, Total	24
	Mercury, Total	0.05
	Selenium, Total	< 1
	Silver, Total	2.2
LF-2 2-3 ft.	Arsenic, Total	50
	Barium, Total	940
	Cadmium, Total	< 0.1
	Chromium, Total	36
	Chromium 6+, Total	< 1
	Lead, Total	23
	Mercury, Total	< 0.04
	Selenium, Total	< 1
	Silver, Total	< 1.0

APPROVED BY
1/20/81 Elmer D. Martinez, Operations Division Manager

ontrols for Environmental Pollution, Inc.
.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

'STOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. NE Suite 398W
CITY City Center
TENTION Albuquerque, NM 87110
IN CE NO. William Mead
101057

REPORT OF ANALYSIS

SAMPLES RECEIVED	CUSTOMER ORDER NUMBER

PE OF ANALYSIS Soil

CORRECTED COPY

Sample Identification	Type of Analysis	ug/g
OW-4 0-1 Ft.	Arsenic, Total	40
	Barium, Total	930
	Cadmium, Total	0.2
	Chromium, Total	30
	Chromium 6+, Total	< 1
	Lead, Total	29
	Mercury, Total	< 0.04
	Selenium, Total	< 1
	Silver, Total	< 1.0
LF-1 1-2 ft.	Arsenic, Total	50
	Barium, Total	970
	Cadmium, Total	0.2
	Chromium, Total	34
	Chromium 6+, Total	1
	Lead, Total	27
	Mercury, Total	< 0.04
	Selenium, Total	< 1
	Silver, Total	< 1.0

APPROVED BY

1/20/81 Elmer D. Martinez, Operations Division Manager

ontrols for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. NE Suite 398W
CITY City Center
ATTENTION Albuquerque, NM 87110
INVOICE NO. William Mead
101057

REPORT OF ANALYSIS

SAMPLES RECEIVED Soil

CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS CORRECTED COPY

Sample Identification	Type of Analysis	ug/g
LF-1 0-1 ft	Arsenic, Total	20
	Barium, Total	980
	Cadmium, Total	0.2
	Chromium, Total	34
	Chromium 6+, Total	< 1
	Lead, Total	26
	Mercury, Total	0.04
	Selenium, Total	< 1
	Silver, Total	7.8
LF-2 0-1 ft.	Arsenic, Total	40
	Barium, Total	970
	Cadmium, Total	0.2
	Chromium, Total	29
	Chromium 6+, Total	< 1
	Lead, Total	28
	Mercury, Total	< 0.04
	Selenium, Total	< 1
	Silver, Total	2.0

1/20/81 APPROVED BY Elmer D. Martinez, Operations Division Manager

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

STOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. NE Suite 398W
CITY City Center
TENTION Albuquerque, NM 87110
CE NO. William Mead
101057

REPORT OF ANALYSIS

SAMPLES RECEIVED	CUSTOMER ORDER NUMBER

PE OF ANALYSIS Soil

CORRECTED COPY

Sample Identification	Type of Analysis	ug/g
LF-3 0-1 ft.	Arsenic, Total	40
	Barium, Total	1,000
	Cadmium, Total	0.4
	Chromium, Total	34
	Chromium 6+, Total	1
	Lead, Total	26
	Mercury, Total	< 0.04
	Selenium, Total	< 1
	Silver, Total	< 1.0
LF-4 0-1 ft.	Arsenic, Total	50
	Barium, Total	880
	Cadmium, Total	0.2
	Chromium, Total	36
	Chromium 6+, Total	< 1
	Lead, Total	29
	Mercury, Total	< 0.04
	Selenium, Total	< 1
	Silver, Total	2.7

APPROVED BY

1/20/81 Elmer D. Martinez, Operations Division Manager

ontrols for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

JSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. NE Suite 398W
CITY City Center
TENTION Albuquerque, NM 87110
ICE NO. William Mead
101057

REPORT OF ANALYSIS

SAMPLES RECEIVED	CUSTOMER ORDER NUMBER

PE OF ANALYSIS Soil

CORRECTED COPY

Sample Identification	Type of Analysis	ug/g
LF-3 2-3 Ft.	Arsenic, Total	40
	Barium, Total	870
	Cadmium, Total	0.2
	Chromium, Total	40
	Chromium 6+, Total	< 1
	Lead, Total	26
	Mercury, Total	0.04
	Selenium, Total	< 1
	Silver, Total	< 1.0
LF-4 2-3 ft	Arsenic, Total	50
	Barium, Total	880
	Cadmium, Total	0.2
	Chromium, Total	23
	Chromium 6+, Total	2
	Lead, Total	28
	Mercury, Total	0.05
	Selenium, Total	< 1
	Silver, Total	< 1.0

1/20/81 APPROVED BY Elmer D. Martinez, Operations Division Manager

ontrols for Environmental Pollution, Inc.
.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

USTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. NE Suite 398W
CITY City Center
TTENTION Albuquerque, NM 87110
OICE NO. William Mead
101057

REPORT OF ANALYSIS

SAMPLES RECEIVED	CUSTOMER ORDER NUMBER

PE OF ANALYSIS Soil

CORRECTED COPY

Sample Identification	Type of Analysis	ug/g
LF-4 1-2 ft.	Arsenic, Total	50
	Barium, Total	1,000
	Cadmium, Total	0.1
	Chromium, Total	33
	Chromium 6+, Total	< 1
	Lead, Total	23
	Mercury, Total	0.09
	Selenium, Total	< 1
	Silver, Total	< 1.0
OW-4 1-2 ft.	Arsenic, Total	50
	Barium, Total	970
	Cadmium, Total	< 0.1
	Chromium, Total	34
	Chromium 6+, Total	< 1
	Lead, Total	23
	Mercury, Total	0.05
	Selenium, Total	< 1
	Silver, Total	3.2

APPROVED BY

1/20/81 Elmer D. Martinez, Operations Division Manager

ontrols for Environmental Pollution, Inc.
O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

JSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. NE Suite 398W
CITY City Center
ITTENTION Albuquerque, NM 87110
'CE NO. William Mead
101057

REPORT OF ANALYSIS

SAMPLES RECEIVED	CUSTOMER ORDER NUMBER

'PE OF ANALYSIS Soil

CORRECTED COPY

Sample Identification	Type of Analysis	ug/g
OW-4 2-3 ft.	Arsenic, Total	50
	Barium, Total	890
	Cadmium, Total	0.3
	Chromium, Total	29
	Chromium 6+, Total	< 1
	Lead, Total	25
	Mercury, Total	< 0.04
	Selenium, Total	< 1
	Silver, Total	< 1.0

APPROVED BY
1/20/81 Elmer D. Martinez, Operations Division Manager

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

MISCELLANEOUS

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
NVOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil

Sample Identification	Type of Analysis	ug/gm
OW-4 3-4 Ft.	Chromium (Total Content)	20

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr
12/11/80

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
NVOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80	CUSTOMER ORDER NUMBER
TYPE OF ANALYSIS Soil	

Sample Identification	Type of Analysis	ug/gm
OW-4 4-5 Ft.	Chromium (Total Content)	20

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr.
12/11/80 PAGE 12 OF 19 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil

Sample Identification	Type of Analysis	ug/gm
OW-4 5-6 Ft.	Chromium (Total Content)	30

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr.
12/11/80 PAGE 13 OF 19 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd., N.E.
CITY Suite 398W - City Center
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012220

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/8/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil

Sample Identification	Type of Analysis	
CLF 1 & 2 0-1 FT.	Sieve Analysis (Texture)	*
	Nitrogen Content	420 ug/gm
	Phosphorus Content	180 ug/gm
	Cation Exchange Capacity	43.9 meq/100 gm
	Sodium Absorption Ratio	9.5
CLF-3.4 OW 4 0-1 FT.	Sieve Analysis (Texture)	*
	Nitrogen Content	540 ug/gm
	Phosphorus Content	180 ug/gm
	Cation Exchange Capacity	42.8 meq/100 gm
	Sodium Absorption Ratio	18.4

* To be reported at a later date.

APPROVED BY
12/31/80 Elmer D. Martinez, Operations Divisi Manag

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. N.E. Suite 398W
CITY City Center
Albuquerque, NM 87110
ATTENTION William Mead
INVOICE NO. 101082

REPORT OF ANALYSIS

SAMPLES RECEIVED 1/9/81 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil Bulk

Sample Identification	Type of Analysis	mm	Name	%
CLF- 1 & 2 #3				
0 to 1 foot	Sieve	0.5-0.25	Medium Sand	0.3
		0.25-0.1	Fine Sand	1.4
		0.1-0.043	Very Fine Sand	25.2
		0.043	Silt and Clay	73.1
CLF - 1 & 2 #2				
0 to 1 foot	Sieve	0.5-0.25	Medium Sand	0.2
		0.25-0.1	Fine Sand	1.0
		0.1-0.043	Very Fine Sand	15.8
		0.043	Silt & Clay	83.0
CLF-3,4, OW 4 #2				
0 to 1 foot	Sieve	0.5-0.25	Medium Sand	0.3
		0.25-0.1	Fine Sand	1.6
		0.1-0.043	Very Fine Sand	16.6
		0.043	Silt & Clay	81.5
CLF-3, 4, OW 4 #3				
0 to 1 foot				
by: Dames & Moore	Sieve	0.5-0.25	Medium Sand	2.4
		0.25-0.1	Fine Sand	5.7
		0.1-0.43	Very Fine Sand	16.9
		0.043	Silt & Clay	75.0

APPROVED BY
1/22/81 James J. Mueller, President
PAGE 1 OF 1 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

RECEIVED JAN 23 1981

CUSTOMER Dames & Moore
ADDRESS 6400 Updown Blvd. N.E.
CITY Albuquerque, NM 87110
ATTENTION Bill Mead
INVOICE NO. 101220

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/10/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Soil Analysis -

Sample Identification	Analysis	Cm/hr*	% Moisture
LF-1 6" to 12" Depth	Vertical Permeability	0.070 (0.0276 in/hr)	
	Moisture Content		10.2
LR-4 6" to 24" Depth	Vertical Permeability	0.080 (0.0312 in/hr)	
	Moisture Content		9.1
OW-4 18" to 24" Depth	Vertical Permeability	0.059 (0.0232 in/hr)	
	Moisture Content		10.6
LF-2 6" to 12" Depth	Vertical Permeability	0.059 (0.0232 in/hr)	
	Moisture Content		9.3
OW-4 18" to 24" Depth	Vertical Permeability	0.114 (0.0450 in/hr)	
	Moisture Content		10.1

*Cm/hr = cc/hr/Cm^2.

APPROVED BY
James J. Mueller, President
2/19/81 PAGE 1 OF 1 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

APPENDIX B-2

GROUND WATER IN

OBSERVATION WELLS

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. N.E. Suite 398W
CITY City Center
ATTENTION Albuquerque, NM 87110
INVOICE NO. William Mead
012256

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/5/80

CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/l
OW-1 Shell Oil Ciniza Refinery Pres. w/Nitric Acid	Arsenic	< 0.01
	Calcium	7.6
	Chromium	0.007
	Iron	0.07
	Manganese	0.04
	Selenium	< 0.01
	Sodium	270
OW-4 Shell Oil Ciniza Refinery Pres. w/10 ml Conc. Nitric Acid	Arsenic	< 0.01
	Calcium	14
	Chromium	0.005
	Iron	0.1
	Manganese	0.07
	Selenium	< 0.01
	Sodium	230

APPROVED BY Elmer D. Martinez
12/31/80 Elmer D. Martinez, Operations Divisi
PAGE 1 OF 1 PAGE Manager

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. N.E. Suite 398W
CITY City Center
ATTENTION Albuquerque, NM 87110
INVOICE NO. William Mead
012158

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/5/80

CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/l
OW-1 Shell Oil - Ciniza Pres. w/10 ml of 1 N Sodium Hydroxide	Cyanide	< 0.1
OW-4 Shell Oil - Ciniza Refinery pres. w/10 ml of 1 N Sodium Hydroxide	Cyanide	< 0.1

APPROVED BY

12/22/80 Elmer D. Martinez, Operations Division Manager

PAGE 1 OF 1 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
INVOICE NO Bill Mead
012180

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/5/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/liter
OW-1 Shell Oil - Ciniza Refinery	Chlorides	28
	Fluorides	0.55
	pH units	7.8
	Solids, Total Dissolved	776
	Sulfates	167
OW-4 Shell Oil - Ciniza Refinery	Chlorides	57
	Fluorides	1.0
	pH units	8.1
	Solids, Total Dissolved	741
	Sulfates	188

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr
12/24/80 PAGE 1 OF 1 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER: Dames & Moore
ADDRESS: 6400 Uptown Blvd., N.E.
CITY: Suite 398W, City Center
ATTENTION: Albuquerque, NM 87110
INVOICE NO.: Bill Mead
012206

REPORT OF ANALYSIS

SAMPLES RECEIVED: 12/5/80
CUSTOMER ORDER NUMBER:

TYPE OF ANALYSIS: Water

Sample Identification	Type of Analysis	mg/l
OW-1 - Shell Oil - Ciniza Refinery pres. w/10 ml. conc. sulfuric acid	Nitrogen, Nitrate (as N)	0.5
OW-4 - Shell Oil - Ciniza Refinery pres. w/10 ml. conc. sulfuric acid	Nitrogen, Nitrate (as N)	0.2

APPROVED BY
12/31/80 Elmer D. Martinez, Operations Divisio
PAGE 1 OF 1 PAGE Manage

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012045

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/20/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis		mg/liter
Well # OW-3 Location: Ciniza Owner-Shell Pres. w/10ml of IN Soln. sodium Hydroxide	Cyanide	<	0.1
Well # OW-3 Location: Ciniza Owner-Shell (Pre. w/10ml. Conc. Sulfuric Acid)	Nitrogen, Nitrate (as N)	<	0.1
Ciniza Refinery - Well #OW-2 Preserved w/10ml. Sod. hydroxide, 1 Normal	Cyanide	<	0.1
Ciniza Refinery-Well # OW-2 preserved w/10ml. conc. Nitric Acid	Arsenic	<	0.01
	Calcium		~~2000~~ 20
	Chromium (Total)		0.003
	Iron		1.1
	Manganese		0.2
	Selenium		0.01
	Sodium		390
Ciniza Refinery - Well # OW-2 preserved w/10ml. conc. Sulfuric Acid	Nitrogen, Nitrates (as N)		0.1
Ciniza Refinery - Well # OW-2	Chlorides		39
	Fluoride		1.6
	pH		7.6
	Solids, Total Dissolved		856
	Sulfates		16

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr.
12/11/80 PAGE 1 OF 1 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012045

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/20/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water "CORRECTED REPORT"

Sample Identification	Type of Analysis	mg/liter
Ciniza Refinery - Well # OW-2 Preserved w/10 ml. conc. Nitric Acid	Calcium	20

APPROVED BY
12/11/80 Elmer D. Martinez, Operations Divisi Manage

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. N.E. Suite 398W
CITY City Center
ATTENTION Albuquerque, NM 87110
INVOICE NO. William Mead
012055

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/20/80	CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/l
Well #OW-3 Location: Ciniza Owner - Shell	Chlorides	36
	Fluoride	1.4
	pH Units	7.7
	Solids, Total Dissolved	876
	Sulfates	79

12/11/80 APPROVED BY E. D. Martinez
Elmer D. Martinez, Operations Division Mgr

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012125

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/20/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/liter
Well # OW-3	Arsenic	< 0.01
Location: Ciniza	Calcium	3.4
Owner: Shell	Chromium (Total)	0.007
(Pres. w/10ml. conc.	Iron	1.8
nitric acid)	Manganese	0.003
	Selenium	< 0.01
	Sodium	370

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr.
12/18/80 PAGE 1 OF 1 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER: Dames & Moore
ADDRESS: 6400 Uptown Blvd. N.E.- Suite 398W
CITY: City Center
ATTENTION: Albuquerque, NM 87110
VOICE NO: William Mead
101076

REPORT OF ANALYSIS

SAMPLES RECEIVED: 12/9/80

CUSTOMER ORDER NUMBER:

TYPE OF ANALYSIS: Water

Sample Identification	Type of Analysis	mg/l
OW-9	Arsenic	< 0.01
	Calcium	19
	Chromium, Total	0.004
	Iron	0.02
	Manganese	0.02
	Selenium	< 0.01
	Sodium	350

APPROVED BY

1/21/81 Elmer D. Martinez, Operations Divisic Manager

PAGE 1 OF 1 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd, N.E.
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012266

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/9/80	CUSTOMER ORDER NUMBER
TYPE OF ANALYSIS Water	

Sample Identification	Type of Analysis		mg/liter
OW-7	Arsenic	<	0.01
	Calcium		34
	Chromium (Total)		0.003
	Iron		0.3
	Manganese		0.02
	Selenium	<	0.01
	Sodium		270

APPROVED BY James J. Mueller, President

12/31/80 PAGE 1 OF 1 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. N.E. Suite 398W
CITY City Center
ATTENTION Albuquerque, NM 87110
INVOICE NO. William Mead
012158

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/9/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/l
OW-7	Cyanide	< 0.1
OW-9	Cyanide	< 0.1

APPROVED BY

12/22/80 Elmer D. Martinez, Operations Division Manager

PAGE 1 OF 1 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. N.E.
CITY Suite 398W - City Center
ATTENTION Albuquerque, NM 87110
VOICE NO. Bill Mead
012225

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/9/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/l
OW-7	Chloride	21
	Fluoride	0.37
	pH Units	8.7
	Solids, Total Dissolved	717
	Sulfate	166
OW-9	Chloride	56
	Fluoride	0.80
	pH Units	7.8
	Solids, Total Dissolved	1060
	Sulfate	391

APPROVED BY
12/31/80 Elmer D. Martinez, Operations Divisi
Manag

PAGE 1 OF 1 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd., N.E.
CITY Suite 398W, City Center
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012207

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/9/80

CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/l
OW-7	Nitrogen, Nitrate (as N)	< 0.1
OW-9	Nitrogen, Nitrate (as N)	0.5

APPROVED BY

12/31/80 Elmer D. Martinez, Operations Division Manager

PAGE 1 OF 1 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd, N.E.
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012267

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/17/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/liter
OW-16-Shell Oil-Ciniza Refinery preserved w/10ml of Conc. sulfuric acid	Nitrogen, Nitrate (as N)	3.7
OW-10-Shell Oil- Ciniza Refinery preserved w/10ml Conc. nitric acid	Arsenic	< 0.01
	Calcium	17
	Chromium	0.002
	Iron	0.6
	Manganese	0.03
	Selenium	0.01
	Sodium	360
OW-16-Shell Oil - Ciniza Refinery preserved w/10ml Conc. nitric acid	Arsenic	0.03
	Calcium	24
	Chromium	0.003
	Iron	1.0
	Manganese	0.06
	Selenium	0.01
	Sodium	270

APPROVED BY James J. Mueller, President
12/31/80

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. N.E. Suite 398W
CITY City Center
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
101052

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/17/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water For Cyanide

Sample Identification	mg/liter
OW-10-Shell Oil Ciniza Refinery pres.w/10ml of 1 N Sodium Hydroxide	< 0.1
OW-16-Shell Oil Ciniza Refinery pres.w/10ml of 1 N Sodium Hydroxide	< 0.1

APPROVED BY

Elmer D. Martinez, Div. Mgr.
1/16/81

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd N.E. Suite 398 W
CITY City Center
ATTENTION Albuquerque, NM 87110
OICE NO Bill Mead
101216

REPORT OF ANALYSIS

SAMPLES RECEIVED 1-6-81 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/l
OW-11 Shell Oil Ciniza Refinery	Chloride	88
	Fluoride	0.20
	PH Units	7.8
	Total Dissolved Solids	935
	Sulfate	196
OW-12 Shell Oil Ciniza Refinery	Chloride	120
	Fluoride	0.52
	PH Units	7.5
	Total Dissolved Solids	746
	Sulfate	100
OW-13 Shell Oil Ciniza Refinery	Chloride	19
	Fluoride	1.0
	PH Units	8.5
	Total Dissolved Solids	659
	Sulfate	207
OW-17 Shell Oil Ciniza Refinery	Chloride	86
	Fluoride	0.47
	PH Units	7.4
	Total Dissolved Solids	818
	Sulfate	319
OW-20 Shell Oil Ciniza Refinery	Chloride	100
	Fluoride	0.40
	PH Units	11.6
	Total Dissolved Solids	841
	Sulfate	214

APPROVED BY

Elmer D. Martinez, Operations Division Manager
1/31/81

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd N.E. Suite 398 W
CITY City Center
ATTENTION Albuquerque, NM 87110
'OICE NO. Bill Mead
101216

REPORT OF ANALYSIS

SAMPLES RECEIVED 1-6-81 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/l
OW-14 Shell Oil Ciniza Refinery	Chloride	210
	Fluoride	0.62
	PH Units	7.3
	Total Dissolved Solids	839
	Sulfate	104
OW-14 Shell Oil Ciniza Refinery	Fluoride	0.58
	PH Units	7.3
	Sulfate	102
OW-24 Shell Oil Ciniza Refinery	Chloride	33
	Fluoride	0.70
	PH Units	7.8
	Total Dissolved Solids	784
	Sulfate	72

APPROVED BY
Elmer D. Martinez, Operations Division Manager
1/31/81

eet®
Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. N.E. Suite 398W
CITY City Center
ATTENTION Albuquerque, NM 87110
'VOICE NO. William Mead
101236

REPORT OF ANALYSIS

SAMPLES RECEIVED 1/6/81 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/l
OW-12-Shell Oil Ciniza Refinery	Hydrocarbons	7.1
OW-14 - Shell Oil Ciniza Refinery	Hydrocarbons	6.4
OW-16 - Shell Oil Ciniza Refinery	Hydrocarbons	4.0
OW-17 - Shell Oil Ciniza Refinery	Hydrocarbons	25
OW 20 - Shell Oil - Ciniza Refinery	Hydrocarbons	5.5

2/4/81

APPROVED BY Elmer D. Martinez, Operations Division Manag

PAGE 1 OF 1 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd., N.E.
CITY Suite 398W, City Center
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012205

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/17/80

CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/l
OW-10 - Shell Oil - Ciniza Refinery preserved w/10 ml. of conc. sulfuric acid	Nitrogen, Nitrate (as N)	0.3

APPROVED BY

12/31/80 Elmer D. Martinez, Operations Divis
Manag

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. NE
CITY Albuquerque, NM 87100
ATTENTION Bill Mead
VOICE NO. 101091

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/17/80	CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water Analysis -

Sample Identification	Analysis	mg/l
OW-10 Shell Oil Ciniza Refinery	Chlorides	79
	Fluorides	0.64
	pH Units	7.6
	Total Dissolved Solids	1030
	Sulfates	331

APPROVED BY E D Martinez
Elmer D. Martinez, Operations Division Mgr
1/23/81 PAGE 1 OF 4 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

RECEIVED JAN

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. NE
CITY Albuquerque, NM 87100
ATTENTION Bill Mead
INVOICE NO. 101091

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/17/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water Analysis -

Sample Identification	Analysis	mg/l
OW-10 Shell Oil Ciniza Refinery	Chlorides	76
	Fluorides	0.64
	pH Units	7.7
	Total Dissolved Solids	1040
	Sulfates	247

APPROVED BY Elmer D. Martinez, Operations Division Mgr.
1/23/81

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502
Telephone 505/982-9841

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. NE
CITY Albuquerque, NM 87100
ATTENTION Bill Mead
INVOICE NO. 101091

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/17/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water Analysis -

Sample Identification	Analysis	mg/l
OW-16 Shell Oil Ciniza Refinery	Chlorides	110
	Fluorides	0.86
	pH Units	7.7
	Total Dissolved Solids	759
	Sulfates	81

APPROVED BY E D Martinez
Elmer D. Martinez, Operations Division Mgr
1/23/81

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. NE
CITY Albuquerque, NM 87100
ATTENTION Bill Mead
INVOICE NO. 101091

REPORT OF ANALYSIS

SAMPLES RECEIVED 12/17/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water Analysis -

Sample Identification	Analysis	mg/l
OW-16 Shell Oil Ciniza Refinery	Chlorides	230
	Fluorides	0.9
	pH Units	7.6
	Total Dissolved Solids	799
	Sulfates	15

APPROVED BY E D Martinez
Elmer D. Martinez, Operations Division Mg
1/23/81

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames and Moore
ADDRESS Suite 398 W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
VOICE NO Bill Mead
101110

REPORT OF ANALYSIS

SAMPLES RECEIVED 1/6/81 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/liter
OW-11-Shell Oil-Ciniza Refinery Sample preserved w/10ml of Nitric Acid	Arsenic	< 0.01
	Calcium	11
	Chromium	0.003
	Iron	0.3
	Lead	0.002
	Manganese	0.03
	Selenium	< 0.01
	Sodium	380
OW-12-Shell Oil-Ciniza Refinery preserved w/10ml of conc. Nitric Acid	Arsenic	< 0.01
	Calcium	11
	Chromium	0.004
	Iron	0.7
	Lead	0.03
	Manganese	0.08
	Selenium	< 0.01
	Sodium	310
OW-13-Shell Oil-Ciniza Refinery preserved w/10ml of conc. Nitric Acid	Arsenic	< 0.01
	Calcium	6.5
	Chromium	0.009
	Iron	0.6
	Lead	0.03
	Manganese	0.06
	Selenium	< 0.01
	Sodium	270
OW-14-Shell Oil-Ciniza Refinery pres. w/10ml of conc. Nitric Acid	Arsenic	< 0.01
	Calcium	34
	Chromium	0.008
	Iron	0.2
	Lead	0.02
	Manganese	0.06
	Selenium	< 0.01
	Sodium	290

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr.
1/24/81

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502
Telephone 505/982-9841

RECEIVED JAN 26 1981

CUSTOMER Dames and Moore
ADDRESS Suite 398 W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
NVOICE NO. Bill Mead
101110

REPORT OF ANALYSIS

SAMPLES RECEIVED 1/6/81 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/liter
OW-17-Shell Oil- Ciniza Refinery pres. w/10ml of conc. Nitric Acid	Arsenic	0.02
	Calcium	400
	Chromium	0.02
	Iron	4.5
	Lead	0.5
	Manganese	4.2
	Selenium	< 0.01
	Sodium	250
OW-20-Shell Oil-Ciniza Refinery pres. w/10ml of conc. Nitric Acid	Arsenic	< 0.01
	Calcium	6.6
	Chromium	0.1
	Iron	0.3
	Lead	0.04
	Manganese	0.02
	Selenium	< 0.01
	Sodium	320
OW-24-Shell Oil-Ciniza Refinery pres. w/10ml Conc. Nitric Acid	Arsenic	< 0.01
	Calcium	23
	Chromium	0.001
	Iron	0.2
	Lead	0.03
	Manganese	0.3
	Selenium	< 0.01
	Sodium	310

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr.
1/24/81

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

RECEIVED JAN 26 1981

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. N.E. Suite 398W
CITY City Center
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
101053

REPORT OF ANALYSIS

SAMPLES RECEIVED 1/6/81 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water for Cyanide

Sample Identification	mg/liter
OW-11-Shell Oil Ciniza Refinery Pres.w/10ml of 1 N Sodium Hydroxide	< 0.1
OW-12-Shell Oil Ciniza Refinery Pres.w/10ml of 1 N Sodium Hydroxide	< 0.1
OW-13-Shell Oil Ciniza Refinery Pres.w/10ml of 1 N Sodium Hydroxide	< 0.1
OW-14-Shell Oil Ciniza Refinery Pres.w/10ml of 1 N Sodium Hydroxide	< 0.1
OW-17-Shell Oil Ciniza Refinery Pres.w/10ml of 1 N Sodium Hydroxide	< 0.1
OW-20-Shell Oil Ciniza Refinery Pres.w/10ml of 1 N Sodium Hydroxide	< 0.1
OW-24-Shell Oil Ciniza Refinery Pres.w/10ml of 1 N Sodium Hydroxide	< 0.1

APPROVED BY

Elmer D. Martinez, Div. Mgr.
1/16/81

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

CUSTOMER Dames & Moore
ADDRESS 6400 Uptown Blvd. N.E. - Suite 398W
CITY City Center
ATTENTION Albuquerque, NM 87110
INVOICE NO. William Mead
101190

REPORT OF ANALYSIS

SAMPLES RECEIVED 1/6/81 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Water

Sample Identification	Type of Analysis	mg/l
OW-11-Shell Oil Ciniza Refinery - Pres. w/10 ml of conc. Sulfuric Acid	Nitrogen, Nitrate (as N)	1.8
OW-12-Shell Oil - Ciniza Refinery - Pres. w/10 ml of conc. Sulfuric Acid	Nitrogen, Nitrate (as N)	0.1
OW-13-Shell Oil - Ciniza Refinery - Pres. w/10 ml of conc. Sulfuric Acid	Nitrogen, Nitrate (as N)	< 0.1
OW-14-Shell Oil - Ciniza Refinery - Pres. w/10 ml of conc. Sulfuric Acid	Nitrogen, Nitrate (as N)	0.2
OW-17-Shell Oil - Ciniza Refinery - Pres. w/10 ml of Sulfuric Acid	Nitrogen, Nitrate (as N)	0.8
OW-20-Shell Oil - Ciniza Refinery - Pres. w/10 ml of conc. Sulfuric Acid	Nitrogen, Nitrate (as N)	1.3
OW-24-Shel Oil - Ciniza Refinery - Pres. w/10 ml of conc. Sulfuric Acid	Nitrogen, Nitrate (as N)	0.5

APPROVED BY
1/29/81 Elmer D. Martinez, Operations Divisi
PAGE 1 OF 1 PAGE Manage

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502

RECEIVED JAN 30 1981

APPENDIX B-3

PLANT WASTES

CUSTOMER Dames & Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
NVOICE NO. Bill Mead
012179

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/10/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Sludge (Date Collected 11/6/80)

Sample Identification	Type of Analysis	mg/liter
API Seperator Emulsion	Arsenic	< 0.01
	Barium	< 10
	Cadmium	< 0.001
	Chromium	0.006
	Chromium 6+	< 0.01
	Lead (Total)	6.1
	Mercury	< 0.004
	Selenium	< 0.01
	Silver	< 0.01
	Total Chrome	200 ug/gm
		percent by weight
	Total Organic Carbon	17.8

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr.
12/24/80 PAGE 1 OF 1 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502
Telephone 505/982-9841

CUSTOMER Dames and Moore
ADDRESS Suite 398W, City Center
CITY 6400 Uptown Blvd., N.E.
ATTENTION Albuquerque, NM 87110
INVOICE NO. Bill Mead
012050

REPORT OF ANALYSIS

SAMPLES RECEIVED 11/10/80 | CUSTOMER ORDER NUMBER

TYPE OF ANALYSIS Sludge

Sample Identification	Type of Analysis	
Leaded Tank Sludge;	Lead (Total)	690 ug/g
Tank 59	EP Lead	0.08 mg/liter
Date Collected 11/4/80	Total Organic Lead	2.4 ug/gm

APPROVED BY
Elmer D. Martinez, Operations Division, Mgr
12/11/80 PAGE 19 OF 19 PAGE

Controls for Environmental Pollution, Inc.
P.O. Box 5351 • 1925 Rosina • Santa Fe, New Mexico 87502
Telephone 505/982-9841

APPENDIX B-4

LABORATORY DETECTION LIMITS

Lower Limits of Detection for Water

Water Analysis	mg/liter
Arsenic	0.01
Barium	0.1
Cadmium	0.001
Calcium	0.1
Chromium	0.001
Chromium 6+	0.01
Cyanide	0.1
Fluoride	0.01
Iron	0.01
Lead	0.001
Manganese	0.001
Mercury	0.0004
Nitrogen, Nitrate (as N)	0.1
Oil & Grease	1.0
Selenium	0.01
Silver	0.01
Sodium	0.01
Solids, Total Dissolved	5.0
Sulfate	5.0

Lower Limits of Detection
for EP Toxicity Analysis

Analysis	mg/liter
Arsenic	0.01
Barium	10
Cadmium	0.001
Chromium	0.001
Chromium +6	0.01
Lead	0.001
Mercury	0.0004
Selenium	0.01
Silver	0.01

Lower Limits of Detection
for Soils

Analysis	ug/gm
Arsenic	1
Barium	10
Cadmium	0.1
Chromium	0.1
Chromium +6	1
Lead	0.1
Mercury	0.04
Selenium	1
Silver	1
Total Organic Carbon	10

APPENDIX B-5

LABORATORY CERTIFICATION

AND

SUMMARY OF QUALITY CONTROL PRACTICES

The ENVIRONMENTAL IMPROVEMENT DIVISION of
The New Mexico Health and Environment Department

Certifies

CONTROLS FOR ENVIRONMENTAL POLLUTION

To perform analyses of water samples as required by the New Mexico Regulations Governing Water Supplies for the following parameters:

MICROBIOLOGICAL: TOTAL COLIFORM

INORGANIC AND ORGANIC: ALL PARAMETERS

May 1, 1980
Date of Certification

May 1, 1981
Date of Expiration

EID Director

Certification Officer

SUMMARY OF QUALITY CONTROL PRACTICES

PREPARED BY:

CONTROLS FOR ENVIRONMENTAL POLLUTION, INC.

P.O. BOX 5351

SANTA FE, NEW MEXICO 87502

RECEIVED FEB 21 1981

Introduction

Quality Control measures are taken from the time the samples arrive to the time data is reported. The following is a brief summary of steps taken during the analysis of your samples.

Basic Function

The Quality Control/Quality Assurance department is responsible for the conduct of the Analytical Laboratory Quality Control program and for taking or recommending measures to ensure the fulfillment of the quality objectives of management and the carrying out of Quality Control policies in the most efficient and economical manner commesurate with ensuring continuing accuracy and precision of data produced.

Responsibilities and Authority

1. Developes and carries out quality control programs, including statistical procedures and techniques, which will help laboratories to meet authorized quality standards at minimum cost; and advises and assists management in the installation, staffing and supervision of such programs.
2. Monitors quality control activities of the laboratory to determine conformance with authorized policy and procedures and with sound practice; and make appropriate recommendations for correction and improvement as may be necessary.
3. Seeks out and evaluates new ideas and current development in the field of quality control and recommends means for their application wherever advisable.
4. Advises management in reviewing technology, methods and equipment, with respect to quality aspects.
5. Advises the Purchasing section regarding quality of purchased materials, reagents and chemicals.
6. Recommends packaging materials and procedures.
7. Performs related duties as assigned.

Quality Control Practices

Upon arrival at the laboratory, each sample is assigned a color-coded number. This code number is placed on all apparatus used for that sample during chemical and radiometric determinations. This code number is recorded in the laboratory receiving report which is filled out at the time that the samples are received. The laboratory receiving report consists of five pages which are distributed to various departments within the company.

Blank and standard spike samples are analyzed routinely as part of Controls for Environmental Pollution's internal quality control program. These samples are indistinguishable from regular samples to prevent samples from receiving preferential treatment. In addition, each chemist prepares known reference samples which he can use to measure his quality of work.

All reagents, carriers and radioactive tracers and instrumentation used in the analysis are calibrated on a scheduled basis as described by the quality assurance plan.

In summary, the methods employed for analyses are those which measure the desired constituent with precision and accuracy and meet the data needs in the presence of the interferences normally encountered. The routine analysis of spiked samples is the measurement of quality while the use of analytical grade reagents is a controls of measure. The quality control program has two primary functions. First the program monitors the reliability of the results reported. The second function is the control of quality in order to meet the program requirements.

APPENDIX C

EXCERPTS FROM RCRA REGULATIONS, PART 265, SUBPART M - LAND TREATMENT

(A)

Soil cation exchange capacity (meq/100g)	Maximum cumulative application (kg/ha)	
	Background soil pH less than 6.5	* Background soil pH greater than 6.5
Less than 5	5	5
5–15	5	10
Greater than 15	5	20

(B) For soils with a background pH of less than 6.5, the cumulative cadmium application rate does not exceed the levels below: *Provided*, that the pH of the waste and soil mixture is adjusted to and maintained at 6.5 or greater whenever food chain crops are grown.

Soil cation exchange capacity (meq/100g)	Maximum cumulative application (kg/ha)
Less than 5	5
5–15	10
Greater than 15	20

(2)(i) The only food chain crop produced is animal feed.

(ii) The pH of the waste and soil mixture is 6.5 or greater at the time of waste application or at the time the crop is planted, whichever occurs later, and this pH level is maintained whenever food chain crops are grown.

(iii) There is a facility operating plan which demonstrates how the animal feed will be distributed to preclude ingestion by humans. The facility operating plan describes the measures to be taken to safeguard against possible health hazards from cadmium entering the food chain, which may result from alternative land uses.

(iv) Future property owners are notified by a stipulation in the land record or property deed which states that the property has received waste at high cadmium application rates and that food chain crops should not be grown, due to a possible health hazard.

[*Comment:* As required by § 265.73, if an owner or operator grows food chain crops on his land treatment facility, he must place the information developed in this Section in the operating record of the facility.]

§ 265.277 [Reserved]

§ 265.278 Unsaturated zone (zone of aeration) monitoring.

(a) The owner or operator must have in writing, and must implement, an unsaturated zone monitoring plan which is designed to:

(1) Detect the vertical migration of hazardous waste and hazardous waste constituents under the active portion of the land treatment facility, and

(2) Provide information on the background concentrations of the hazardous waste and hazardous waste constituents in similar but untreated soils nearby; this background monitoring must be conducted before or in conjunction with the monitoring required under paragraph (a)(1) of this Section.

(b) The unsaturated zone monitoring plan must include, at a minimum:

(1) Soil monitoring using soil cores, and

(2) Soil-pore water monitoring using devices such as lysimeters.

(c) To comply with paragraph (a)(1) of this Section, the owner or operator must demonstrate in his unsaturated zone monitoring plan that:

(1) The depth at which soil and soil-pore water samples are to be taken is below the depth to which the waste is incorporated into the soil;

(2) The number of soil and soil-pore water samples to be taken is based on the variability of:

(i) The hazardous waste constituents (as identified in § 265.273(a) and (b)) in the waste and in the soil; and

(ii) The soil type(s); and

(3) The frequency and timing of soil and soil-pore water sampling is based on the frequency, time, and rate of waste application, proximity to ground water, and soil permeability.

(d) The owner or operator must keep at the facility his unsaturated zone monitoring plan, and the rationale used in developing this plan.

(e) The owner or operator must analyze the soil and soil-pore water samples for the hazardous waste constituents that were found in the waste during the waste analysis under § 265.273 (a) and (b).

[*Comment:* As required by § 265.73, all data and information developed by the owner or operator under this Section must be placed in the operating record of the facility.]

§ 265.279 Recordkeeping.

The owner or operator of a land treatment facility must keep records of the application dates, application rates, quantities, and location of each hazardous waste placed in the facility, in the operating record required in § 265.73.

§ 265.280 Closure and post-closure.

(a) In the closure plan under § 265.112 and the post-closure plan under § 265.118, the owner or operator must address the following objectives and indicate how they will be achieved:

(1) Control of the migration of hazardous waste and hazardous waste constituents from the treated area into the ground water;

(2) Control of the release of contaminated run-off from the facility into surface water;

(3) Control of the release of airborne particulate contaminants caused by wind erosion; and

(4) Compliance with § 265.276 concerning the growth of food-chain crops.

(b) The owner or operator must consider at least the following factors in addressing the closure and post-closure care objectives of paragraph (a) of this Section:

(1) Type and amount of hazardous waste and hazardous waste constituents applied to the land treatment facility;

(2) The mobility and the expected rate of migration of the hazardous waste and hazardous waste constituents;

(3) Site location, topography, and surrounding land use, with respect to the potential effects of pollutant migration (e.g., proximity to ground water, surface water and drinking water sources);

(4) Climate, including amount, frequency, and pH of precipitation;

(5) Geological and soil profiles and surface and subsurface hydrology of the site, and soil characteristics, including cation exchange capacity, total organic carbon, and pH;

(6) Unsaturated zone monitoring information obtained under § 265.278; and

(7) Type, concentration, and depth of migration of hazardous waste constituents in the soil as compared to their background concentrations.

(c) The owner or operator must consider at least the following methods in addressing the closure and post-closure care objectives of paragraph (a) of this Section:

(1) Removal of contaminated soils;

(2) Placement of a final cover, considering: (i) Functions of the cover (e.g., infiltration control, erosion and run-off control, and wind erosion control), and (ii) Characteristics of the cover, including material, final surface contours, thickness, porosity and permeability, slope, length of run of slope, and type of vegetation on the cover;

(3) Collection and treatment of run-off;

(4) Diversion structures to prevent surface water run-on from entering the treated area; and

(5) Monitoring of soil, soil-pore water, and ground water.

(d) In addition to the requirements of § 265.117, during the post-closure care period, the owner or operator of a land treatment facility must:

(1) Maintain any unsaturated zone monitoring system, and collect and analyze samples from this system in a

manner and frequency specified in the post-closure plan;

(2) Restrict access to the facility as appropriate for its post-closure use; and

(3) Assure that growth of food chain crops complies with § 265.276.

§ 265.281 Special requirements for ignitable or reactive waste.

Ignitable or reactive wastes must not be land treated, unless the waste is immediately incorporated into the soil so that (1) the resulting waste, mixture, or dissolution of material no longer meets the definition of ignitable or reactive waste under §§ 261.21 or 261.23 of this Chapter, and (2) § 265.17(b) is complied with.

§ 265.282 Special requirements for incompatible wastes.

Incompatible wastes, or incompatible wastes and materials (see Appendix V for examples), must not be placed in the same land treatment area, unless § 265.17(b) is complied with.

§§ 265.283–265.299 [Reserved]

Subpart N—Landfills

§ 265.300 Applicability.

The regulations in this Subpart apply to owners and operators of facilities that dispose of hazardous waste in landfills, except as § 265.1 provides otherwise. A waste pile used as a disposal facility is a landfill and is governed by this Subpart.

§ 265.301 [Reserved]

§ 265.302 General operating requirements.

(a) Run-on must be diverted away from the active portions of a landfill.

(b) Run-off from active portions of a landfill must be collected.

[*Comment*: If the collected run-off is a hazardous waste under Part 261 of this Chapter, it must be managed as a hazardous waste in accordance with all applicable requirements of Parts 262, 263, and 265 of this Chapter. If the collected run-off is discharged through a point source to waters of the United States, it is subject to the requirements of Section 402 of the Clean Water Act, as amended.]

(c) The date for compliance with paragraphs (a) and (b) of this Section is 12 months after the effective date of this Part.

(d) The owner or operator of a landfill containing hazardous waste which is subject to dispersal by wind must cover or otherwise manage the landfill so that wind dispersal of the hazardous waste is controlled.

[*Comment*: As required by § 265.13, the waste analysis plan must include analyses needed to comply with §§ 265.312 and 265.313. As required by § 265.73, the owner or operator must place the results of these analyses in the operating record of the facility.]

§§ 265.303–265.308 [Reserved]

§ 265.309 Surveying and recordkeeping.

The owner or operator of a landfill must maintain the following items in the operating record required in § 265.73:

(a) On a map, the exact location and dimensions, including depth, of each cell with respect to permanently surveyed benchmarks; and

(b) The contents of each cell and the approximate location of each hazardous waste type within each cell.

§ 265.310 Closure and post-closure.

(a) The owner or operator must place a final cover over the landfill, and the closure plan under § 265.112 must specify the function and design of the cover. In the post-closure plan under § 265.118, the owner or operator must include the post-closure care requirements of paragraph (d) of this Section.

(b) In the closure and post-closure plans, the owner or operator must address the following objectives and indicate how they will be achieved:

(1) Control of pollutant migration from the facility via ground water, surface water, and air;

(2) Control of surface water infiltration, including prevention of pooling; and

(3) Prevention of erosion.

(c) The owner or operator must consider at least the following factors in addressing the closure and post-closure care objectives of paragraph (b) of this Section:

(1) Type and amount of hazardous waste and hazardous waste constituents in the landfill;

(2) The mobility and the expected rate of migration of the hazardous waste and hazardous waste constituents;

(3) Site location, topography, and surrounding land use, with respect to the potential effects of pollutant migration (e.g., proximity to ground water, surface water, and drinking water sources);

(4) Climate, including amount, frequency, and pH of precipitation;

(5) Characteristics of the cover including material, final surface contours, thickness, porosity and permeability, slope, length of run of slope, and type of vegetation on the cover; and

(6) Geological and soil profiles and surface and subsurface hydrology of the site.

(b) In addition to the requirements of § 265.117, during the post-closure care period, the owner or operator of a hazardous waste landfill must:

(1) Maintain the function and integrity of the final cover as specified in the approved closure plan;

(2) Maintain and monitor the leachate collection, removal, and treatment system (if there is one present in the landfill) to prevent excess accumulation of leachate in the system;

[*Comment*: If the collected leachate is a hazardous waste under Part 261 of this Chapter, it must be managed as a hazardous waste in accordance with all applicable requirements of Parts 262, 263, and 265 of this Chapter. If the collected leachate is discharged through a point source to waters of the United States, it is subject to the requirements of Section 402 of the Clean Water Act, as amended.]

(3) Maintain and monitor the gas collection and control system (if there is one present in the landfill) to control the vertical and horizontal escape of gases;

(4) Protect and maintain surveyed benchmarks; and

(5) Restrict access to the landfill as appropriate for its post-closure use.

§ 265.311 [Reserved]

§ 265.312 Special requirements for ignitable or reactive waste.

Ignitable or reactive waste must not be placed in a landfill, unless the waste is treated, rendered, or mixed before or immediately after placement in the landfill so that (1) the resulting waste, mixture, or dissolution of material no longer meets the definition of ignitable or reactive waste under §§ 261.21 or 261.23 of this Chapter, and (2) § 265.17(b) is complied with.

§ 265.313 Special requirements for incompatible wastes.

Incompatible wastes, or incompatible wastes and materials, (see Appendix V for examples) must not be placed in the same landfill cell, unless § 265.17(b) is complied with.

§ 265.314 Special requirements for liquid waste.

(a) Bulk or non-containerized liquid waste or waste containing free liquids must not be placed in a landfill, unless:

(1) The landfill has a liner which is chemically and physically resistant to the added liquid, and a functioning leachate collection and removal system with a capacity sufficient to remove all leachate produced; or

(2) Before disposal, the liquid waste or waste containing free liquids is treated or stabilized, chemically or physically (e.g., by mixing with an absorbent solid),