NM2 - 20

MONITORING REPORTS YEAR(S):

1998

Peñasco Irrigation Report
4-Dinkus Ranch
Artesia, New Mexico

YATES PETROLEUM CORPORATION

prepared for:

Yates Petroleum Corporation
105 South Fourth Street
Artesia, New Mexico 88210

May 1998

COVENANT TECHNICAL ASSOCIATES, INC.

12258 Mountain Haze NE, Albuquerque, NM 87122 (505) 856-1755

COVENANT TECHNICAL ASSOCIATES, INC.

12258 Mountain Haze NE, Albuquerque, NM 87122 (505) 856-1755

May 28, 1998

Mr. John F. Brown
Operations Engineer
Yates Petroleum Corporation
105 South Fourth Street
Artesia, New Mexico 88210

Re: Peñasco Irrigation Report, 4-Dinkus Ranch

Dear Mr. Brown:

Enclosed with this letter please find five copies of the final report for the proposed irrigation project at the Yates 4-Dinkus Ranch. Geologically, the site is suitable for irrigation with produced water since first groundwater is at a depth of approximately 130 feet and protected by at least 70 feet of clay. Additionally, significant thicknesses of unsaturated gravel overlie the clay and can be monitored for unanticipated seepage of irrigation water from the soil zone. Soils at the site are loamy with high amounts of silt and clay. They do not transmit water rapidly and may become salt impacted if application of irrigation water is not managed properly. Yates is strongly encouraged to utilize the services of an agriculture engineer or soil scientist to plan crop use and water application rates.

If you decide to proceed with the project, Yates will need to submit an application to the NM Oil Conservation Division for approval of a Surface Waste Management Facility in accordance with OCD Rule 711. The enclosed report will be an integral part of the application and provides geological/hydrological evidence that a properly designed and managed irrigation project will not adversely impact fresh water. I remain available to assist in preparation of the OCD application, and to present and discuss the report with agency staff if so desired.

It has been a pleasure to work again with the Yates Petroleum organization. If you have any questions on the report or need additional services, please contact me at (505) 281-8591.

Sincerely,

David G. Boyer, P.G.
Hydrogeologist

enc.

Peñasco Irrigation Report
4-Dinkus Ranch
Artesia, New Mexico

YATES PETROLEUM CORPORATION

prepared for:

Yates Petroleum Corporation
105 South Fourth Street
Artesia, New Mexico 88210

May 1998

David G. Boyer, P.G.
Project Manager

COVENANT TECHNICAL ASSOCIATES, INC.

12258 Mountain Haze NE, Albuquerque, NM 87122 (505) 856-1755

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1.0 INTRODUCTION

Yates Petroleum Corporation (Yates) extracts oil and natural gas from the Dagger Draw gas field located south of Artesia and west of Highway 285. The oil is separated at the well site, while the gas and natural gas liquids are piped to the Peñasco Gas Plant for processing. Additionally, the wells produce up to 110,000 barrels (4.6 million gallons) per day of water which is injected into ten salt water disposal wells regulated and permitted by the NM Oil Conservation Division's (NMOCD) Class II Underground Injection Control (UIC) program. The wastewater, although generally poor in quality, is sufficient for use in irrigation of salt tolerant grasses, provided that most of the suspended and dissolved organic constituents are removed prior to use.

Yates desires to irrigate with produced water up to 640 acres of land southwest of Atoka, New Mexico, located on the 4-Dinkus Ranch owned by Yates (Figure 1). Salt-resistant grass would be grown using center pivot irrigation with water applied directly at the surface instead of by sprayers. NMOCD conditions for surface management of oilfield waste, including produced water, are provided in Rule 711 which require submittal of a Form C-137 together with applicable supporting documentation including management, contingency and closure plans and financial assurance. Critical to the documentation is geological and hydrological evidence, including depth to and quality of groundwater beneath the site, demonstrating that disposal of oilfield wastes will not adversely impact fresh water which is defined as water having total dissolved solids concentrations of 10,000 mg/L (ppm) or less.

In January 1998, Yates contracted with Covenant Technical Associates to conduct a investigation at the site with the goal of determining the near-surface geological and hydrological conditions and the suitability of the site for irrigation with water having elevated concentrations of dissolved salts. The investigation consisted of drilling shallow and deep boreholes for lithological characterization, collection of surface soil samples for analysis of agricultural properties, and installation of one deep and four shallow groundwater monitoring wells The water quality of nearby water wells used for livestock and domestic purposes was tested and, for comparison purposes, a detailed chemical analysis was performed on the produced water proposed for irrigation. Finally, potential interactions between the water and soil were examined to identify possible soil salinity problems that will need to be addressed in the design and operation of an irrigation management program.

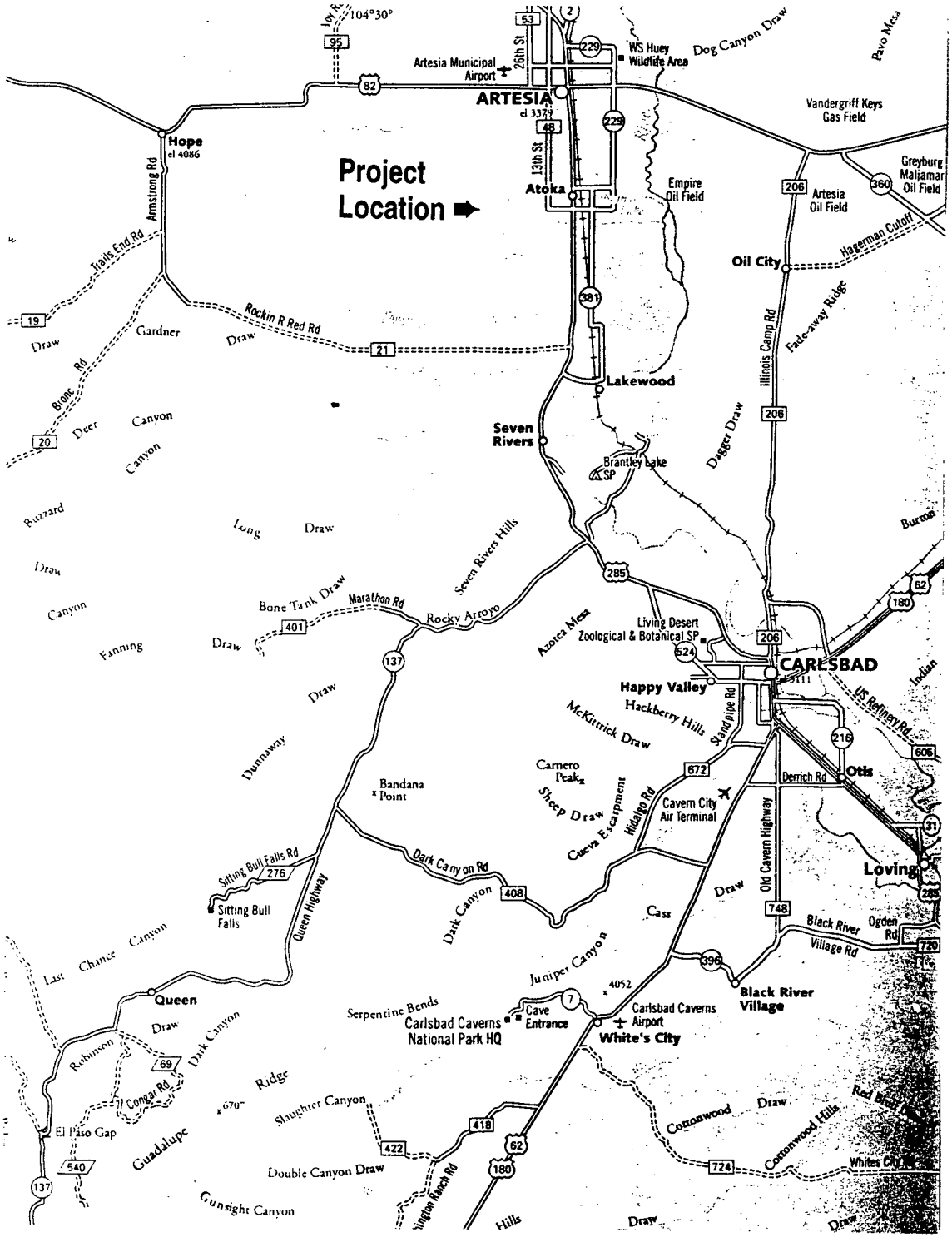


Figure 1. Location Map, Peñasco Irrigation Project, 4-Dinkus Ranch

2.0 ENVIRONMENTAL SETTING

2.1 Climatology

The Artesia, New Mexico area has a semiarid continental climate, characterized by hot summers and mild winters. Measurable rainfall occurs approximately 42 days per year and annual snowfall averages 3-8 in. to yield an average annual precipitation of 10-14 in., with nearly 80% falling from May through October. Lake evaporation in the Eddy County area is 66-72 in. per year, of which two-thirds also takes place from May through October. Thus, the net loss between precipitation and evaporation ranges from 52-62 in. per year. Minimum temperatures are typically 44.0°-49.0°F, but can fall below 0°F in winter; maximum temperatures can exceed 100°F on summer days. The frost-free season is April to October (NOAA, 1982).

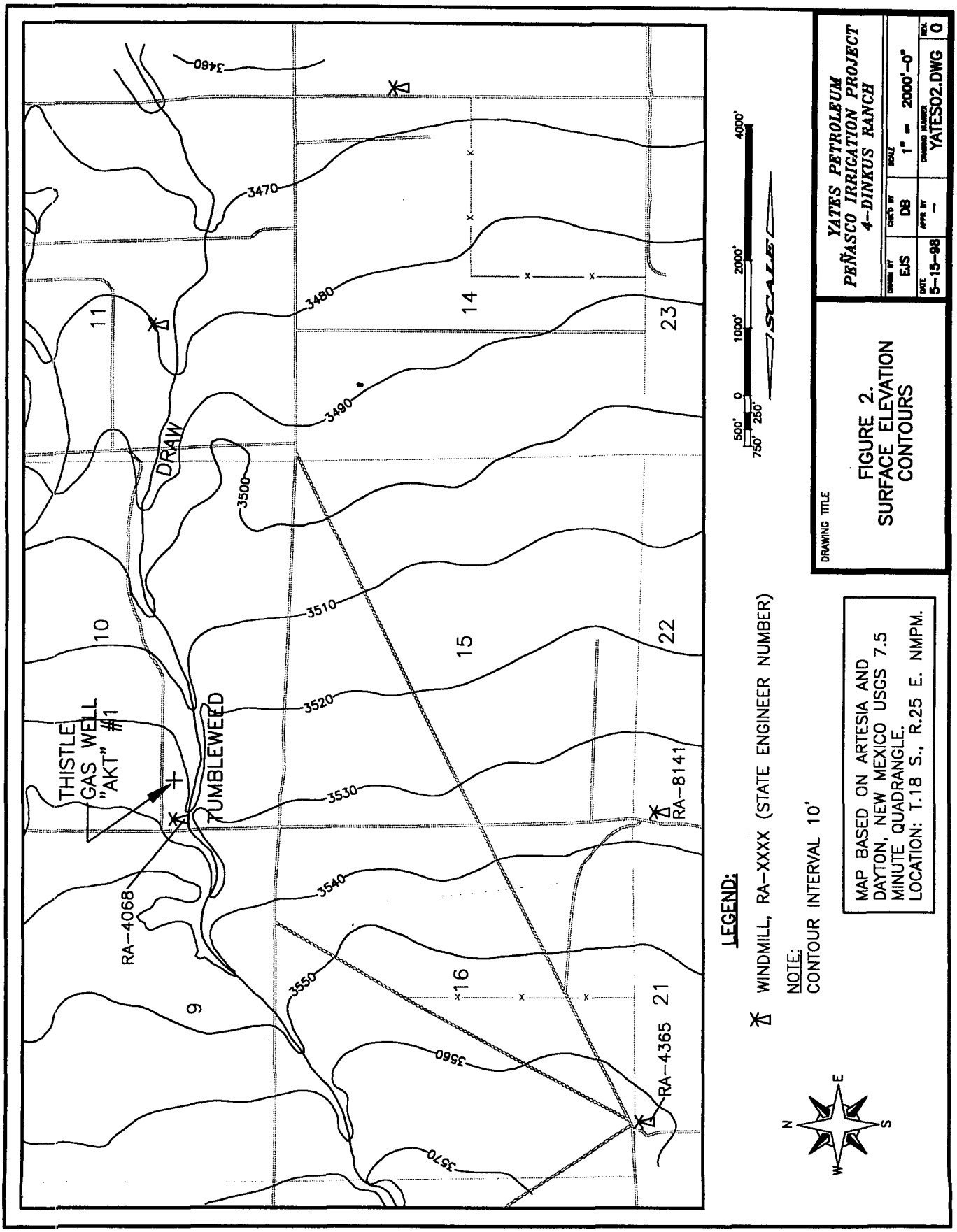
2.2 Topography and Surface Water

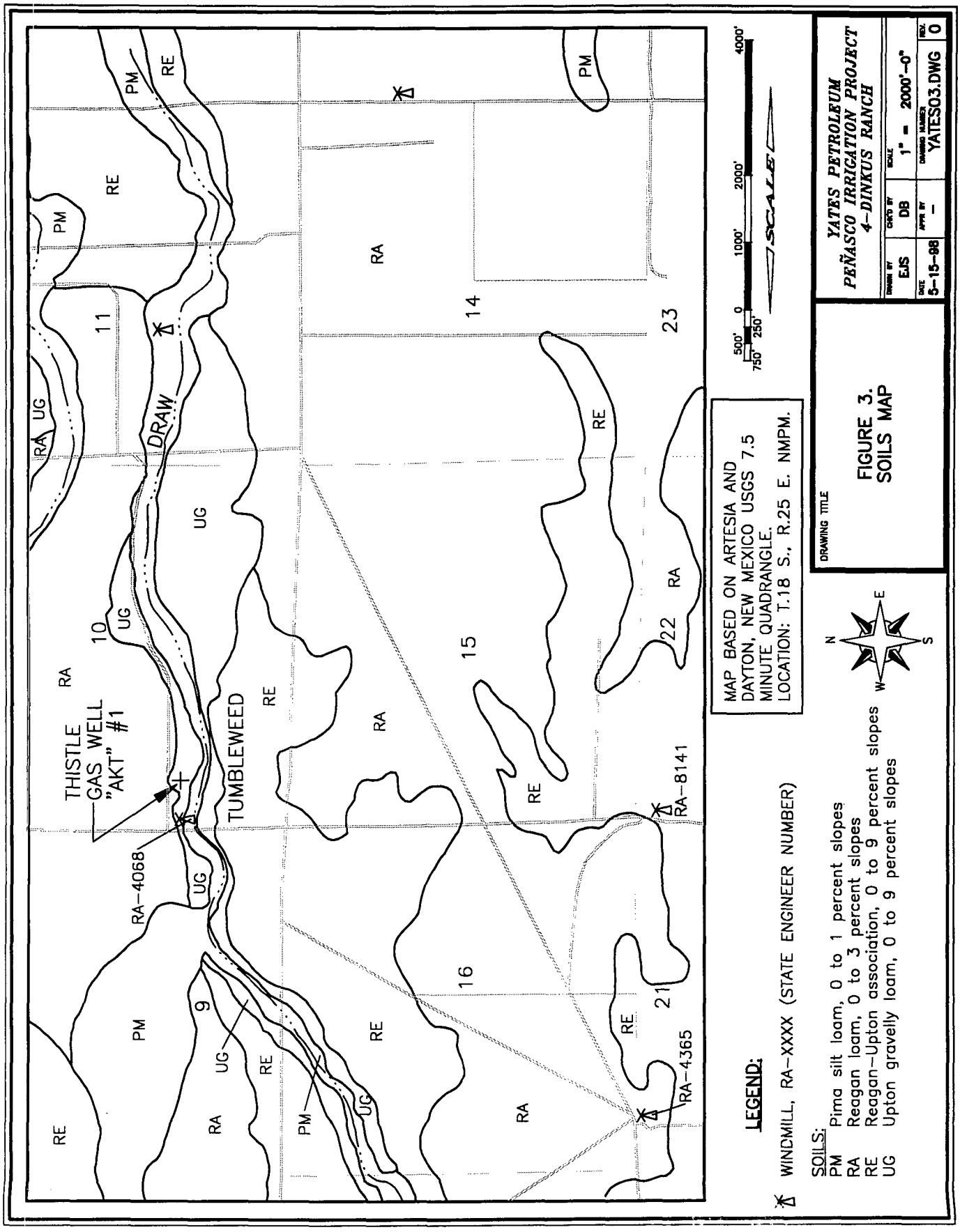
The 4-Dinkus Ranch is located approximately 6 miles south of Artesia and 4 miles west of U.S. Highway 285 (Figure 1). The area proposed to be irrigated is in portions of Sections 14, 15, and 16 of Township 18 South, Range 25 East. The average elevation of area of the ranch to be irrigated ranges from 3,550 to 3,470 feet above mean sea level (MSL) (Figure 2). The plain on which the ranch lies slopes eastward at about 30 feet per mile. Surface drainage is dominated by small ephemeral creeks and arroyos that flow eastward to the Pecos River, located approximately 8 miles east of the facility.

Natural surface drainage at the location is to the east. The major drainages in the immediate area of the site are the Rio Peñasco to the south, and Tumbleweed Draw to the north. The Rio Peñasco is a major watercourse originating in the Sacramento Mountains over 80 miles to the west. It runs northwest to southeast at a distance of from one-half to one mile south of the site, but flows only in response to heavy precipitation. Nearer its source, the Rio Peñasco is perennial and water is diverted for irrigation. Tumbleweed Draw is located about one-half mile north of the site and has its origin about 10 miles to the west near the community of Hope. Both watercourses continue easterly and drain into the Pecos River.

2.3 Soils

Soils at proposed irrigation site are primarily of the Reagan series (Figure 3). The Reagan series consists of deep, well-drained, moderately dark colored, calcareous loams that have developed in old alluvium derived from calcareous sedimentary rocks of the uplands to the west. These soils commonly occur on plains west of the Pecos River. Soils of the Reagan series typically have a surface layer of brown loam about 8 inches thick with an underlying light-brown, heavy loam up to about 24 inches thick. The next lower layers are enriched with calcium carbonate to a depth of more than 60 inches. The soils are un-eroded or only slightly eroded. Runoff from these soils is slow, permeability is moderate, and the water holding capacity is high. The soils are moderately fertile, but organic matter content is low. The frost-free season for Reagan soils is 200 to 220 days. Extended periods of cold weather are rare and frost action potential is slight. In general, soils in the area do not freeze at depths greater than a few inches for more than a few days at a time (USDA-SCS, 1971).


3460
3470
3480
3490
3500
3510
3520
3530
3540
3550
3560
3570
DRAW
TUMBLEWEED
THISTLE GAS WELL "AKT" #1
RA-4068
RA-8141
RA-4365
9
10
11
14
15
16
21
22
23
0 500' 1000' 2000' 4000'
250' 750'
SCALE
LEGEND:
WINDMILL, RA-XXXX (STATE ENGINEER NUMBER)
NOTE:
CONTOUR INTERVAL 10'
MAP BASED ON ARTESIA AND DAYTON, NEW MEXICO USGS 7.5 MINUTE QUADRANGLE.
LOCATION: T.18 S., R.25 E. NMPM.
N
E
S
W
DRAWING TITLE
FIGURE 2.
SURFACE ELEVATION CONTOURS
YATES PETROLEUM
PEÑASCO IRRIGATION PROJECT
4-DINKUS RANCH
DRAWN BY EJS
CHK'D BY DB
SCALE 1" = 2000'-0"
DATE 5-15-98
APPR. BY -
DRAWING NUMBER YATES02.DWG
REV. 0


THISTLE GAS WELL "AKT" #1
RA-4068
TUMBLEWEED
DRAW
RA-8141
RA-4365
RA
RE
PM
UG
9
10
11
14
15
16
21
22
23
0
500'
1000'
2000'
4000'
750'
250'
SCALE
N
S
E
W
MAP BASED ON ARTESIA AND DAYTON, NEW MEXICO USGS 7.5 MINUTE QUADRANGLE.
LOCATION: T.18 S., R.25 E. NMPM.
LEGEND:
WINDMILL, RA-XXXX (STATE ENGINEER NUMBER)
SOILS:
PM Pima silt loam, 0 to 1 percent slopes
RA Reagan loam, 0 to 3 percent slopes
RE Reagan-Upton association, 0 to 9 percent slopes
UG Upton gravelly loam, 0 to 9 percent slopes
DRAWING TITLE
FIGURE 3.
SOILS MAP
YATES PETROLEUM
PEÑASCO IRRIGATION PROJECT
4-DINKUS RANCH
DRAWN BY EJS
CHK'D BY DB
APP'D BY –
DATE 5-15-98
SCALE 1" = 2000'-0"
DRAWING NUMBER YATES03.DWG
REV. 0

At the 4-Dinkus Ranch, the Reagan loam with 0 to 3 percent slopes occupies about two-thirds of the proposed irrigation area. The remainder is taken up by the Reagan-Upton association. Reagan loam with 0 to 3 percent slopes makes up 60 to 85 percent of the Reagan-Upton acreage, and Upton gravelly loam with 0 to 9 percent slopes makes up 15 to 40 percent.

Reagan soils are used for irrigated crops, native pasture, and wildlife habitat. When irrigated, these are among the most productive soils in the Artesia area. However, they have limitations which can impact crop growth when irrigated using water having elevated salt content. Soil permeabilities are low relative to other soils. The listed values range from 0.8 to 2.5 inches per hour ($5.6x10^{-4}$ to $1.8x10^{-3}$ cm/sec, respectively). The soil shrink-swell potential is moderate and the soil is susceptible to accumulation of salt. The SCS classifies the soil in a group consisting of soils with a slow rate of infiltration when thoroughly wetted due to moderately fine to fine texture, or due to the presence of a layer impeding downward movement. The Unified soil classification system (USCS) ranking for the soil is a clay (CL).

2.4 Geology

The 4-Dinkus Ranch is located on the Northwest Shelf of the Permian Basin. In this region, the deposits are comprised of approximately 250 feet of Quaternary alluvium unconformably overlying approximately 2,000 feet of Permian clastic and carbonate rocks. These Permian deposits unconformably overlie Precambrian syenite, gneiss, and diabase crystalline rocks (Kelley, 1971; Welder, 1983). The relationship between the sedimentary deposits is shown in Figure 4 and discussed below.

2.4.1 San Andres Formation

The San Andres Formation, oldest of the Permian units discussed in this report, lies immediately above the Precambrian crystalline basement rocks and beneath the Grayburg and Queen Formations. The San Andres Formation is composed mainly of limestone and dolomite containing irregular and erratic solution cavities, which range up to several feet in diameter. Its thickness is greater than 700 feet The upper portion of the formation is composed of oolitic dolomite with some anhydrite cement. Deep well lithologic logs from the Artesia area indicate that the San Andres Formation is primarily carbonate (logged by drillers as lime or limerock) and probably includes both limestone and dolomite.

2.4.2 Permian Artesian Group

The Permian Artesian Group is comprised of five formations (in ascending order): the Grayburg, Queen, Seven Rivers, Yates, and Tansill Formations. In northern Eddy County these sedimentary units previously were considered members of a formation known as the Chalk Bluff formation. In 1962 the terminology was changed to make the units formations within the Artesia Group although the Chalk Bluff terminology appears in earlier reports. The Yates and Tansill Formations outcrop at the surface east of the Pecos River while the Seven Rivers Formation thins and pinches out beneath the alluvium in the vicinity of highway U.S. 285. These three members of the group are not present at depth in the vicinity of the project area. The Permian formations dip 1° to 3° toward the southeast, without any reported major structural features (Lyford, 1973; Welder, 1983).

EXPLANATION

Qal	Alluvial deposits– Not mapped in detail might include rocks of Pliocene age and part of the Gatuna Formation of Pleistocene age. Contains the main part of the shallow aquifer of the Roswell basin.
Pt	Tansill Formation
Pya	Yates Formation
Psr	Seven Rivers Formation– (A large part of the shallow aquifer near Lake McMillan)
Pqgb	Queen and Grayburg Formations, undivided. Includes upper part of San Andres Limestone where it is solution altered.
Psa	San Andres Limestone– Contains the main part of the artesian aquifer north of T. 19N. Also includes the "Slaughter zone" (local usage)

Formation contact--Dashed where approximately located; queried where probable

Water-level surface in the shallow aquifer of the Roswell basin, January 1975

Potentiometric surface--Shows level to which water will rise in wells tapping the artesian aquifer of the Roswell basin, January 1975

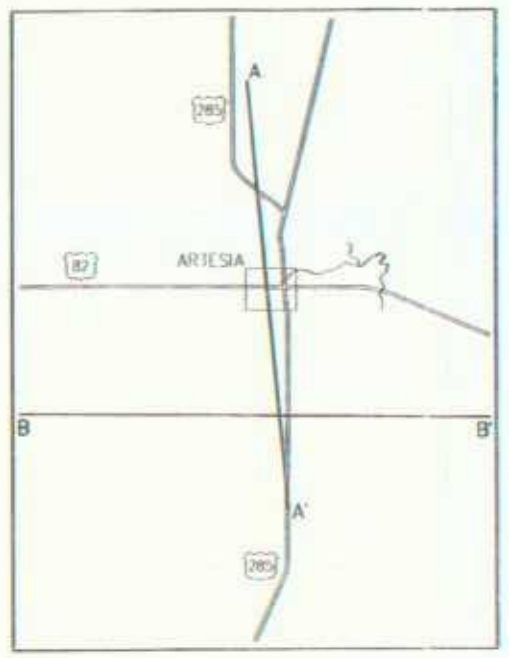
Water-level surface and potentiometric surface--Where the two are separated by less than about 20 feet.

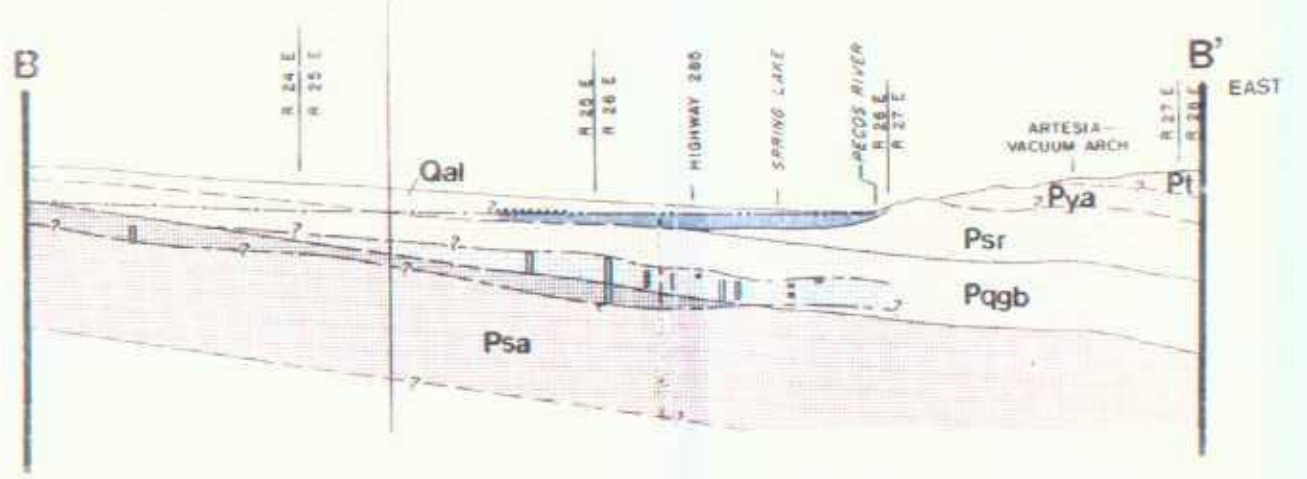
Aquifer boundary--Marks the generalized boundaries of the shallow and artesian aquifers of the Roswell basin where their boundaries do not coincide with a formation contact; queried where probable.

Water-producing interval--Projected into the sections from wells generally less than 2 miles away.

Shallow aquifer of the Roswell basin. Shows general distribution only. Contains some nonproductive zones.

Artesian aquifer of the Roswell basin. Shows general distribution only. Contains some nonproductive zones.





0 1 2 3 4 5 6 7 8 9 10 MILES

VERTICAL EXAGGERATION X 10
NATIONAL GEODETIC VERTICAL DATUM OF 1929

NOTE: MODIFIED FROM WELDER (1983)

DRAWING TITLE
FIGURE 4.
GEOLOGIC CROSS-SECTION SHOWING THE SHALLOW AND ARTESIAN AQUIFERS IN THE VICINITY

YATES PETROLEUM
PEÑASCO IRRIGATION PROJECT
4-DINKUS RANCH

DRAWN BY	CHK'D BY	SCALE
EJS	DB	AS SHOWN
DATE	APP'D BY	DRAWING NUMBER / REV.
5-15-98	–	YATES04.DWG / 0

In the area of the 4-Dinkus Ranch the Grayburg and Queen Formations have been mapped as a single unit by geologists as collectively consisting of about 700 feet of interbedded dolomite and calcareous dolomite, gypsum, fine-grained sandstone, carbonates, siltstone, and mudstone. Lithologies of the Queen Formation are similar to those of the Grayburg Formation with the principal difference being a higher proportion of clastics in the Queen, which conformably overlies and grades into the Grayburg Formation. The Grayburg is thought to disconformably overlie the San Andres Formation. In locations where the Seven Rivers Formation is absent, the upper portion of the Queen acts as a confining bed between the deep artesian aquifer and the valley fill aquifer.

2.4.3 Quaternary Alluvium

The Quaternary alluvium in the Pecos River valley is dominantly comprised of clays, silts, sands, and gravels deposited in valley fill deposits. These deposits extend in a north-south belt approximately 20 miles wide, generally west of the Pecos River. The thickness of the valley fill varies from a thin veneer on the western margins of the Pecos River valley to a maximum of 300 feet in several depressions which have resulted from dissolution of the underlying Permian carbonates and evaporates. The depth to the base of the valley fill in the project area is estimated to between 230 and 290 feet.

The sedimentology and mineralogy of the valley fill deposits can be divided into three units: the underlying quartzose unit, the interbedded clay unit, and the uppermost carbonate gravel unit. The quartzose unit is principal water-bearing unit of the valley fill with thicknesses generally less than 250 feet. The quartzose unit unconformably overlies Permian rocks and is correlative with the quartzose conglomerate described by Fiedler and Nye (1933), and Morgan (1938). The lower quartzose gravels are commonly used for groundwater production.

The clay unit is not laterally continuous throughout the valley fill deposits, but occurs in isolated lenses generally overlying the quartzose unit. The clay unit is comprised of light- to medium-gray clays and silts deposited in localized ponds and lakes. These ponds and lakes may have formed in conjunction with dissolution and collapse of the underlying Permian rocks.

The carbonate gravel unit blankets the other valley fill units and forms a fairly uniform slope from the Permian rock outcrop areas on the west side of the valley east to the Pecos River floodplain. The unit consists of coarse-grained carbonate gravel deposits along major drainageways to the Pecos River which grade into brown calcareous silts and thin masses of caliche in the interstream regions.

2.5 Groundwater

The principal aquifers in the Artesia area are within the carbonate San Andres Formation and the valley fill alluvium (Welder, 1983). Within the valley fill in the city of Artesia is a near-surface water-bearing zone, apparently limited in vertical extent, that is shallow with respect to the surface and also exhibits artesian properties at some monitor wells. This first water-bearing zone in the valley fill aquifer, referred to as the "near-surface saturated zone", is not present at the project site and is not discussed further.

2.5.1 Deep Artesian Aquifer

The deep artesian aquifer is closely related to the Permian San Andres Limestone and generally consists of one or more water-producing zones of variable permeability located in the upper portion of the carbonate rocks. However, in the Artesia area, the producing interval rises stratigraphically and includes lower sections of the overlying Grayburg and Queen Formations. The depth to the top of the producing interval is estimated to be between 380 and 440 feet beneath the project area, and the producing zone thickness is estimated at 250 to 300 feet across the area. The upper sections of the Grayburg/Queen Formations are generally considered confining beds with a thickness of approximately 150 feet beneath the project area..

The deep artesian aquifer has been extensively developed for industrial, municipal, and agricultural use. The quality of water from this aquifer ranges from 500 to more than 5,000 ppm total dissolved solids (TDS) depending on location. In the area of Artesia, water is generally derived from depths ranging from 850 to 1,250 feet below ground surface. The aquifer is recharged in the Sacramento Mountains to the west of Artesia. Extensive use of this aquifer in recent decades has lowered the potentiometric head in the aquifer in some locations to 50 to 80 feet below ground level, although extensive rainfall in 1991 brought the water levels in some wells close to, or above, the surface.

2.5.2 Valley Fill Aquifer

Quaternary alluvial deposits of sand, silt, clay, and gravel are the main components of the valley fill aquifer. These sediments are estimated to be about 230 to 290 feet thick in the project area (Welder, 1983). As described above, the three principal units in the valley fill are quartzose, clay, and carbonate gravel. The quartzose unit is considered the primary production unit in the valley fill aquifer while the clay unit may yield small amounts of water to wells from coarser grained lenses contained within the unit.

The carbonate gravel unit is the uppermost alluvial unit in the valley fill. Coarse-grained gravels deposited in the major tributaries to the Pecos River grade to calcareous silts and thin zones of caliche in the interstream areas. Near the surface, groundwater is localized in thin discontinuous gravel beds typical of braided channel material deposited during flood events originating in the foothills and Sacramento Mountains to the west.

The area proposed for irrigation is at the west end of the valley fill alluvial deposits associated with the Pecos River. Drilling logs for two wells immediately north and west of the project area, RA-4068 and RA-4365 (Figure 5), show the base of the alluvium to be 295 feet or less. RA-4068 has a water sand from 275 to 295 feet while RA-4365 has gravel zones from 230 to a total depth of 265 feet. Copies of the available drilling logs are provided in Appendix C. Although a notation on log RA-4068 indicates that the primary water zone is the Chalk Bluff formation in the artesian aquifer, based on the above discussion, it is likely that the completion depth is still in the alluvium. The depth to water upon completion for the two wells was 168 and 150 feet, respectively, providing saturated thicknesses of 115 to 127 feet. Further to the west, the valley fill and the zone of saturation pinches out and may not be present except in isolated alluvial zones recharged by the major drainageways such as the Rio Peñasco.

Generalized groundwater movement in the vicinity of the project site was shown by Hendrickson and Jones (1952), to be easterly towards the Pecos River with a slight southerly component. However, due to the lack of current water level data, it is unclear whether groundwater in the alluvium in the vicinity of the site flows in the same direction or whether it may move directly eastward toward areas of the valley fill aquifer which are heavily pumped.

Near the Pecos River, recharge of the shallow valley fill aquifer is generally attributed to irrigation return flow from pumpage of the aquifers and from infiltration from the Pecos River. In areas of the valley where the San Andres and the valley fill aquifers are hydraulically connected in the subsurface, water tends to flow up from the deep to the shallow aquifer except in areas of heavy San Andres pumpage. Further to the west, recharge is from runoff along intermittent losing streams that flow eastward to the river and by subsurface underflow where fractures or dissolution features allow upwards migration from the underlying artesian aquifer.

3.0 INVESTIGATION ACTIVITIES

Site investigation commenced on February 2, 1998 with the drilling of a deep boring (B-1) to 148 feet that that was to become monitor well MW-1. Subsequently, four shallow borings were drilled to depths between 65 and 71 feet that were completed as monitor wells MW-2 through MW-5 with total depths ranging between 44 and 63 feet (Figure 5). Finally, ten surficial soil borings were drilled with maximum depths not exceeding 23 feet (Figure 6). Drilling was completed on February 7, 1998. The results of the drilling program are discussed in Section 4.0.

All borings were drilled by Atkins Engineering Associates of Roswell using an Ingersoll-Rand A-300 truck mounted hollow-stem auger. The augers used in the borings were 5 feet in length with a 3-1/4 inch I.D. and a 6-5/8 inch O.D. Soil samples were initially collected using a 5-foot long, 3-inch diameter core barrel which allowed for continuous sampling in areas of unconsolidated material. However, the barrel was not effective in the gravel zones encountered at shallow depth, nor in hard clay or caliche. In these instances samples were logged from cuttings, or a 2-foot long splitspoon was utilized to collect samples ahead of the drill bit.

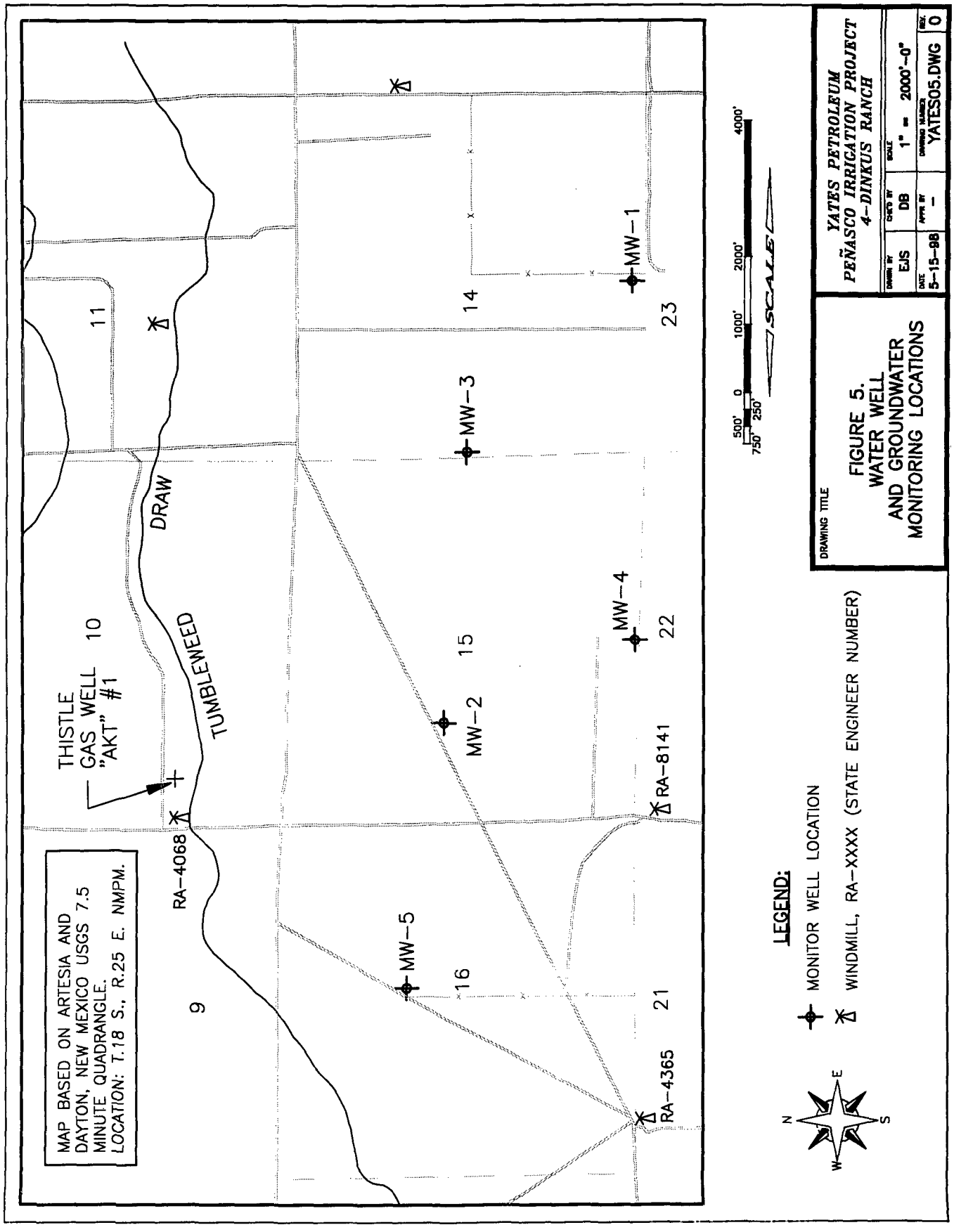
3.1 Hydrogeological Investigation

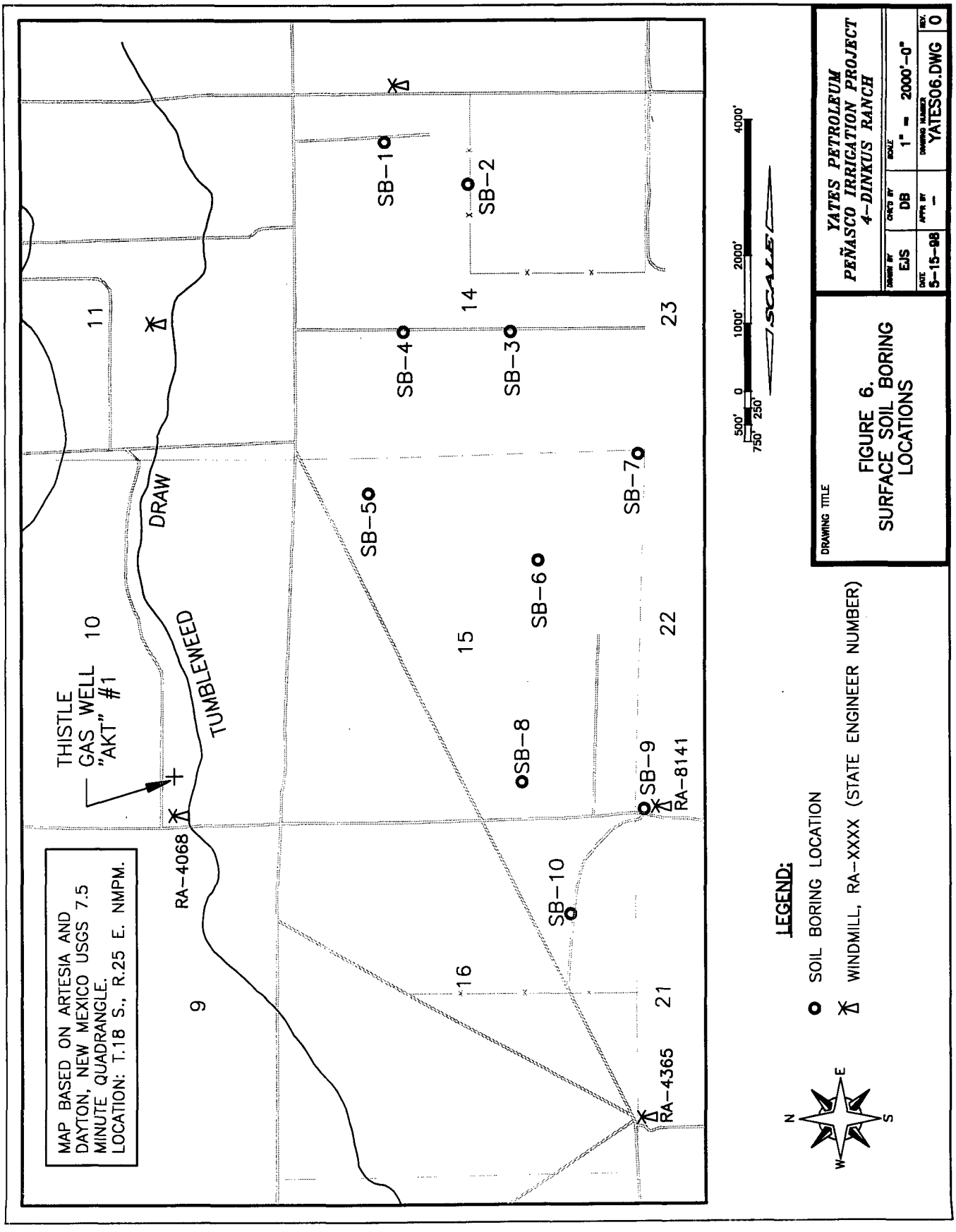
Only one well (MW-1) was completed in a water bearing zone. This well was developed by surging and bailing on February 7, 1998, and sampled on February 9. Water quality samples were obtained from two windmills north of the site, and one windmill and a domestic well southwest of the site on February 8 and 9. Water levels were not available at any of these four sampling sites. Samples were collected to determine concentrations of metals and other Water Quality Control Commission (WQCC) constituents except organics. Additional analyses were performed for several other general water chemistry parameters (e.g. sodium, potassium, calcium, magnesium and carbonate/bicarbonate) not regulated under OCD or WQCC rules to ascertain the compositional makeup of the underlying groundwater. The water sample from MW-1 was filtered to obtain a dissolved sample while the water well samples were submitted to the laboratory as total samples. Metals samples were preserved using nitric acid. A sample of produced water was obtained on March 4 for analysis for comparison purposes. Analyses were performed by Environmental Lab of Texas, Inc., of Odessa using EPA standard methodology. Copies of organic and H_2S analyses of produced water samples which had been previously tested by Yates were provided for evaluation.

On March 2, the five monitor wells were checked for standing water. As discussed in Section 4.2.1, moisture was detected in all five wells, but in four of the wells, it was present only in the endcaps. The results of the water level measurements and water quality testing program are presented in Section 4.2.

3.2 Soils Investigation

Soil samples from various depths were obtained at soil boring locations located throughout the proposed project area. In addition to the five boring locations associated with monitor well placement, surface soil sampling was performed at ten additional sites. At all 15 sites samples were collected at depths of 1, 3 and 6 feet and preserved in plastic storage bags. A total of 42 soil samples were submitted for testing to Western Agricultural Laboratories, Inc. of Lubbock, Texas. The soils were analyzed for numerous physical and agricultural properties including grain size, soil texture, field capacity, wilting point, exchangeable cations, exchange capacity, organic matter and available nutrients. In conjunction with the produced water analyses, the soil data will be used to formulate an irrigation plan for growing salt tolerant plants while minimizing salt buildup in the root zone.


MAP BASED ON ARTESIA AND DAYTON, NEW MEXICO USGS 7.5 MINUTE QUADRANGLE.
LOCATION: T.18 S., R.25 E. NMPM.
THISTLE GAS WELL "AKT" #1
TUMBLEWEED
DRAW
RA-4068
RA-8141
RA-4365
MW-1
MW-2
MW-3
MW-4
MW-5
9
10
11
14
15
16
21
22
23
LEGEND:
MONITOR WELL LOCATION
WINDMILL, RA-XXXX (STATE ENGINEER NUMBER)
N
E
S
W
SCALE
0
500'
1000'
2000'
4000'
750'
250'
DRAWING TITLE
FIGURE 5.
WATER WELL
AND GROUNDWATER
MONITORING LOCATIONS
YATES PETROLEUM
PEÑASCO IRRIGATION PROJECT
4-DINKUS RANCH
DRAWN BY EJS
CHKD BY DB
APPR BY -
SCALE 1" = 2000'-0"
DATE 5-15-98
DRAWING NUMBER YATES05.DWG
REV. 0


MAP BASED ON ARTESIA AND DAYTON, NEW MEXICO USGS 7.5 MINUTE QUADRANGLE.
LOCATION: T.18 S., R.25 E. NMPM.
THISTLE GAS WELL "AKT" #1
TUMBLEWEED
DRAW
RA-4068
RA-8141
RA-4365
SB-1
SB-2
SB-3
SB-4
SB-5
SB-6
SB-7
SB-8
SB-9
SB-10
9
10
11
14
15
16
21
22
23
LEGEND:
SOIL BORING LOCATION
WINDMILL, RA-XXXX (STATE ENGINEER NUMBER)
N
E
S
W
SCALE
0
500'
1000'
2000'
4000'
750'
250'
DRAWING TITLE
FIGURE 6.
SURFACE SOIL BORING LOCATIONS
YATES PETROLEUM
PEÑASCO IRRIGATION PROJECT
4-DINKUS RANCH
DRAWN BY EJS
CHK'D BY DB
SCALE 1" = 2000'-0"
DATE 5-15-98
APPR BY -
DRAWING NUMBER YATES06.DWG
REV. 0

4.0 INVESTIGATION RESULTS

4.1 Geology

The investigation confirmed the alluvial nature of the site sediments to at least 150 feet. Most notable was the occurrence of widespread gravels at shallow depths throughout the project site. These gravels are intermediate between the surficial soils and the clay beds encountered at depth. Lithologic boring logs showing the location and depth of the gravel and clay zones are presented in Appendix A-1. Photographs of the samples are shown in Appendix C.

4.1.1 Gravel Zones

The gravels were encountered at depths between 3 and 25 feet beneath the surface in every hole that was drilled. The gravels consisted of rounded limestone rock varying in size between ¼ inch to 3 inches. Sometimes the gravels were mixed with varying amounts of clay and sand, but just as frequently they were clean, although of mixed sizes. At several locations, zones of uniform pea-sized gravel was encountered. Depth, elevation, and thickness information for the gravel zones are summarized in Table 1.

Depth to the base of the gravel varied between 28 and 57 feet, but the average depth was about 45 feet. The minimum thickness of the gravel was 25 feet with an average thickness of about 32 feet. The maximum thickness observed was 44 feet at boring B-5 (MW-5).

Table 1. Physical Properties of the Gravel Zone

Boring Number	Ground Surface Elevation (ft)	Depth to top of gravel (ft)	Elevation Top of Gravel (ft)	Depth to Bottom of Gravel (ft)	Elevation Bottom of Gravel (ft)	Thickness of Gravel (ft)
B-1	3,487	3	3,484	28	3,459	25
B-2	3,524	8.5	3,516	43	3,481	35
B-3	3,497	15	3,482	47.5	3,450	33
B-4	3,520	25	3,495	50	3,470	25
B-5	3,555	13	3,542	57	3,498	44
SB-1	3,471	7	3,464	--	--	--
SB-2	3,474	9.5	3,465	--	--	--
SB-3	3,489	7.5	3,482	--	--	--
SB-4	3,486	7.5	3,479	--	--	--
SB-5	3,501	10	3,491	--	--	--
SB-6	3,513	23	3,490	--	--	--
SB-7	3,504	12.5	3,492	--	--	--
SB-8	3,532	10.5	3,522	--	--	--
SB-9	3,537	21	3,516	--	--	--
SB-10	3,546	10	3,536	--	--	--

Figures 7 through 10 graphically show the elevation of the top and bottom of the gravel zone, the depth to the top of the gravels, and the gravel thickness. Generally, the gravels slope easterly at about 30 feet per mile which is about the same gradient as the surface topography. However in Section 14, a slight northeasterly orientation in slope was noted.

The depth to the top of the gravels is greatest in the southwestern portion of Section 15 (Figure 7). Depths in excess of 20 feet were seen in three borings. In Section 14 gravels are much closer to the surface; depths average about 8 feet in the eastern portion of the project area.. Gravel thickness appears to increase northward from a minimum of 25 feet in B-4 (MW-4) to 44 feet in B-5 (MW-5). The gravel thickness map shown is generalized due to having only five control points. Information is especially lacking for the northeast quarter of Section 14.

4.1.2 Clay Zones

Clay and caliche zones were encountered beneath the gravel zones in the five holes that were drilled through the gravels. To verify that the base of the gravels had been located, drilling continued into the clays at depths from 8 to 20 feet below the last gravel encountered. In B-4 (MW-4) clay was found at 50 feet but gravels were then encountered at 54 feet. Thick clay was again found at 63 feet and continued to total depth of 71 feet.

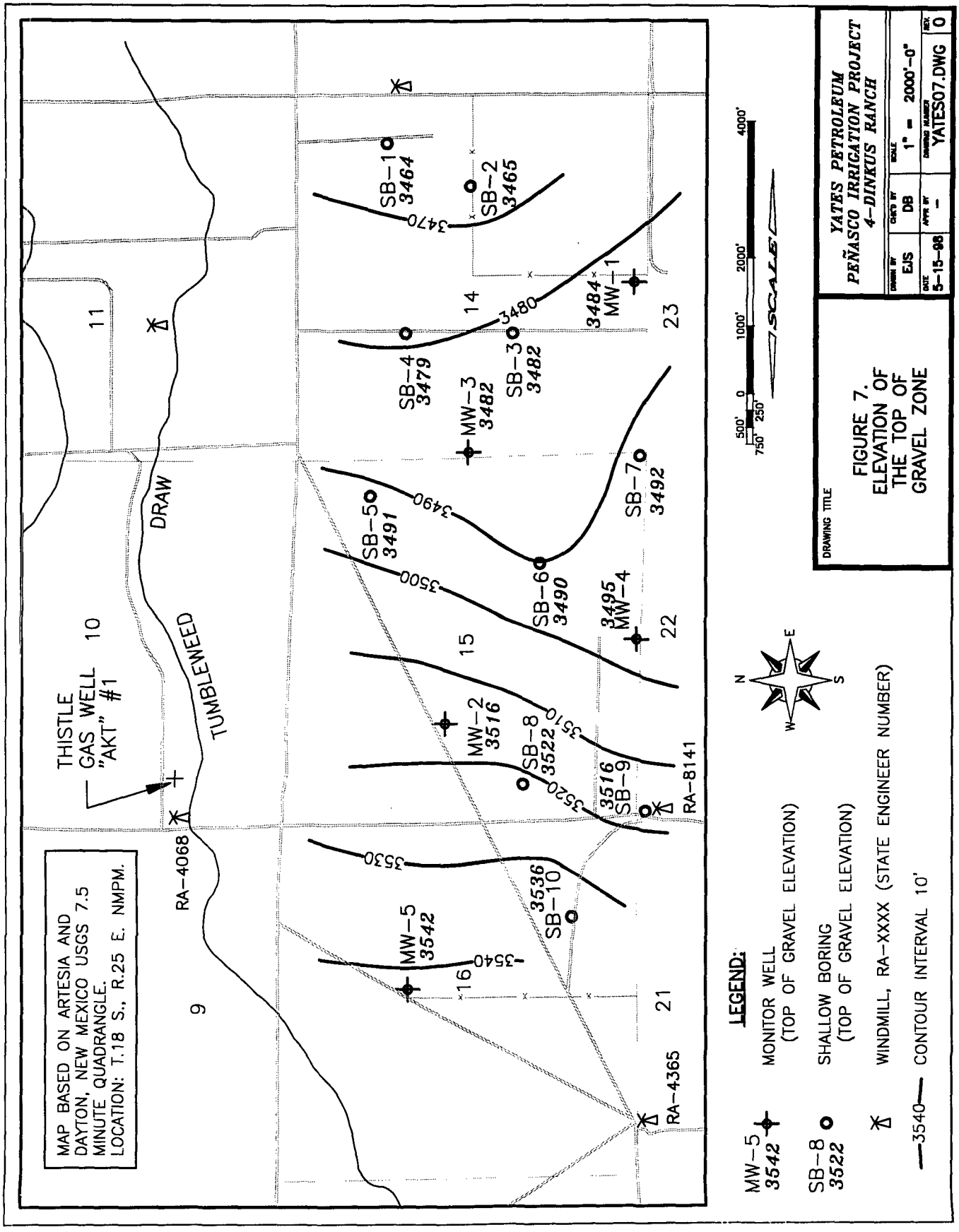
The clays were generally brown in color, stiff, and plastic. Caliche streaks, caliche inclusions, and limestone fragments were commonly noted in splitspoon samples. Only occasionally did the clay contain sufficient coarse grained material to have it noted in the drilling logs. The clays were dry with the exception of boring B-1 (MW-1) where increasing moisture was noted beginning at 138 feet.

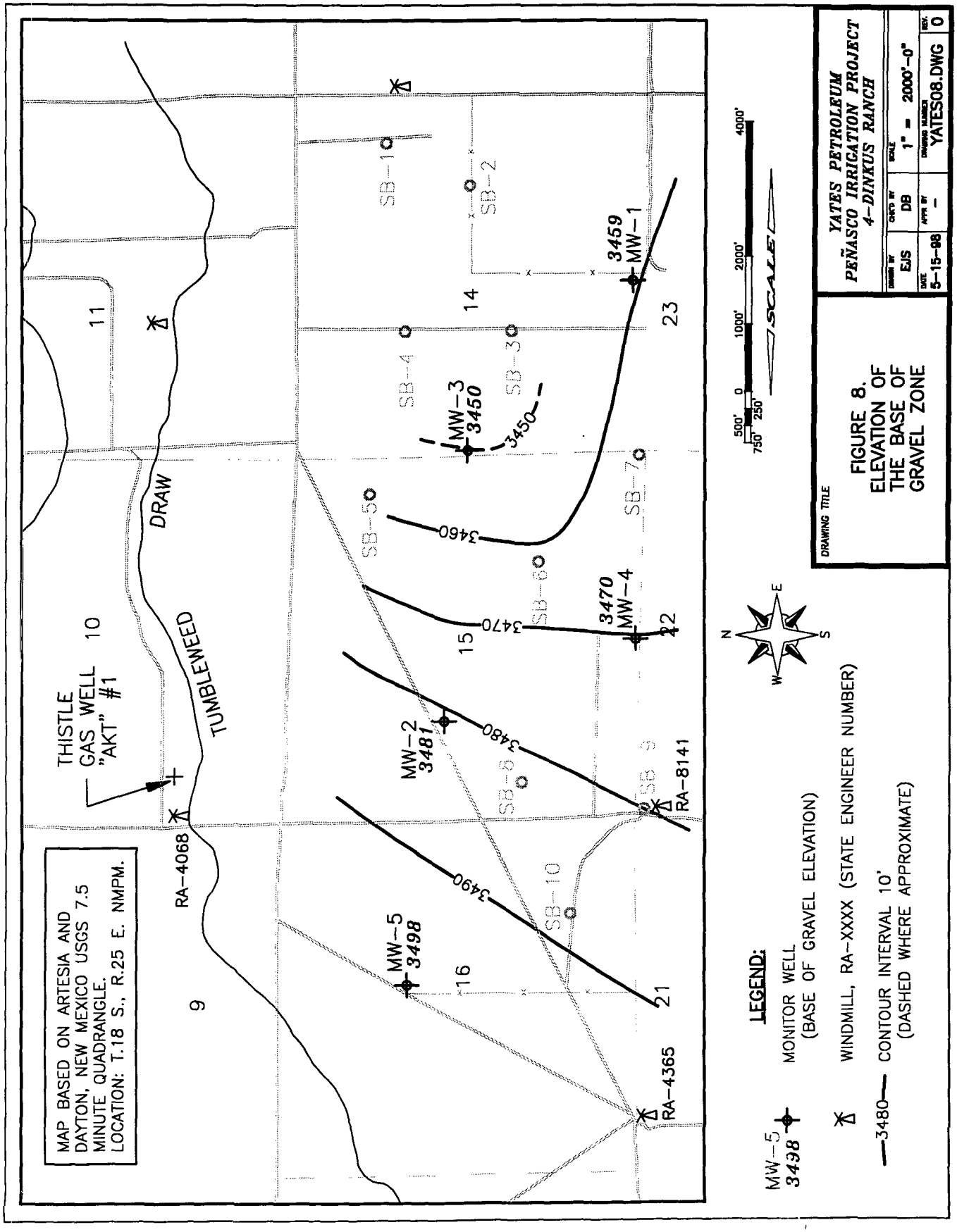
4.2 Groundwater

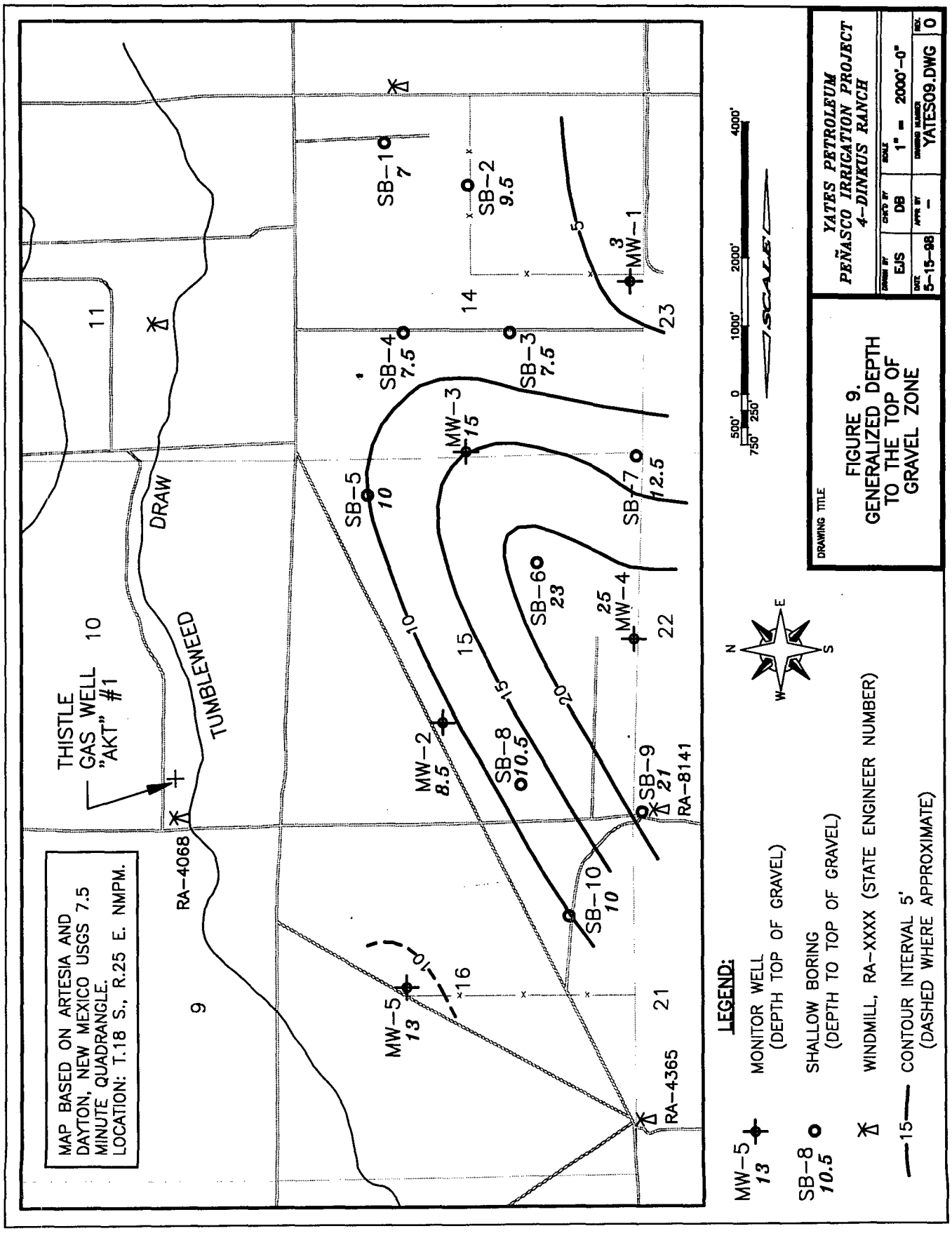
4.2.1 Occurrence

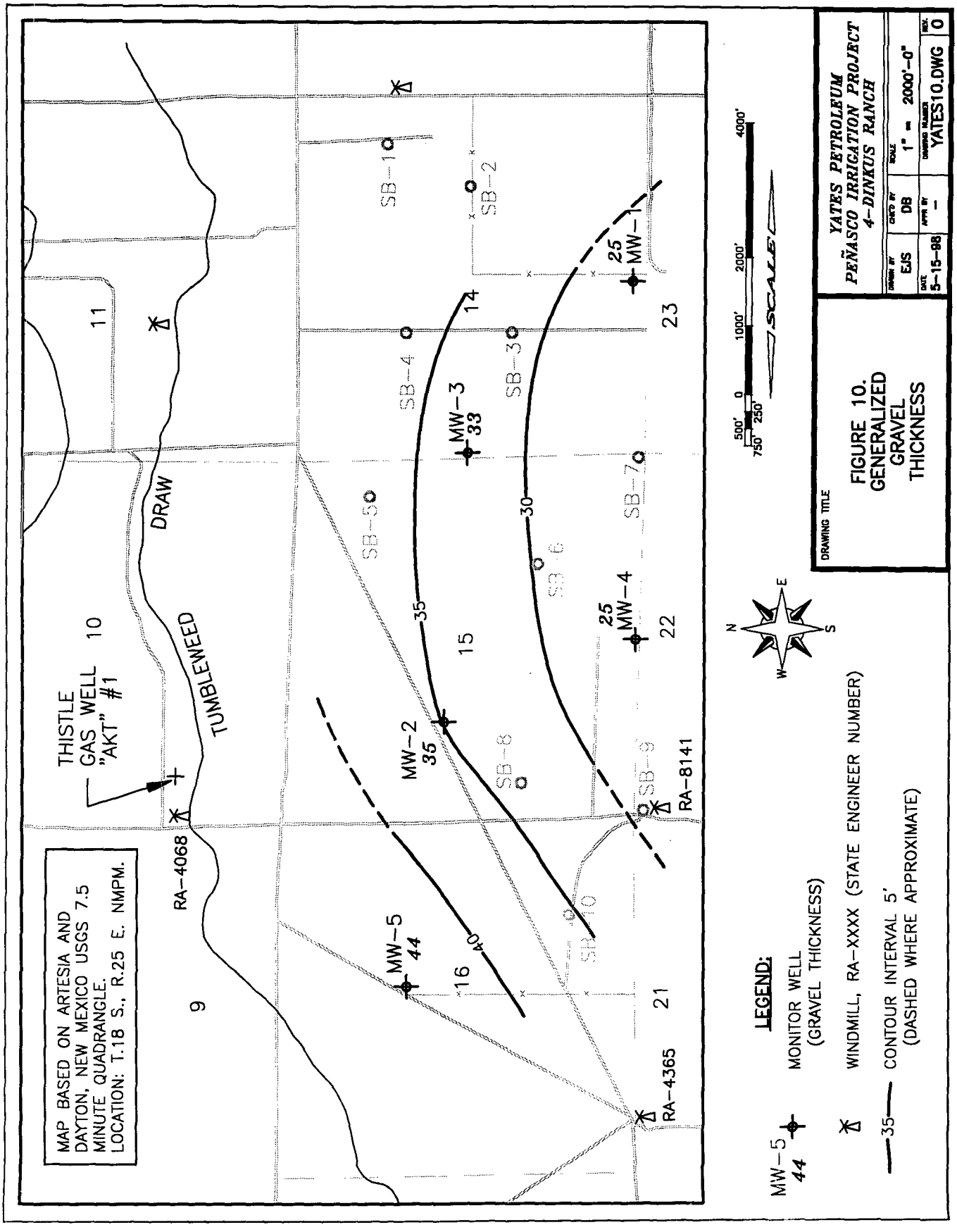
Groundwater was encountered in only one boring at the site. Boring B-1, completed as MW-1, detected moisture at 138 feet and saturation was observed at 143 feet on February 2, 1998. The following morning, water had risen to 133 feet and the well installation was completed. To have the screen opposite the uppermost producing zone, the well was screened over the interval from 133 to 148 feet and several extra feet of sand were placed above the top of the screen ending at 127 feet. However, during the following several days water levels continued to rise and on February 7, water had risen a total 17 feet to 126 below the surface.

The specific zone which is producing the groundwater was not obvious. At 143 feet, a splitspoon sample contained clay, caliche and caliche fragments. The rise in water levels may mean the water is occurring under slightly artesian conditions, or a thin waterbearing lens at a higher elevation may have been masked by the extensive clay zones encountered during drilling. Whatever the source of the water, it is not exceedingly productive. During well development on February 7, the water level declined 5 feet after removing only 7.5 gallons of water.


MAP BASED ON ARTESIA AND DAYTON, NEW MEXICO USGS 7.5 MINUTE QUADRANGLE.
LOCATION: T.18 S., R.25 E. NMPM.
THISTLE GAS WELL "AKT" #1
TUMBLEWEED
DRAW
RA-4068
RA-4365
RA-8141
SB-1 3464
SB-2 3465
SB-3 3482
SB-4 3479
SB-5 3491
SB-6 3490
SB-7 3492
SB-8 3522
SB-9 3516
SB-10 3536
MW-1 3484
MW-2 3516
MW-3 3482
MW-4 3495
MW-5 3542
3470
3480
3490
3500
3510
3520
3530
3540
9
10
11
14
15
16
21
22
23
SCALE
500' 0 1000' 2000' 4000'
750' 250'
N
E
S
W
LEGEND:
MW-5 3542 MONITOR WELL (TOP OF GRAVEL ELEVATION)
SB-8 3522 SHALLOW BORING (TOP OF GRAVEL ELEVATION)
WINDMILL, RA-XXXX (STATE ENGINEER NUMBER)
3540 CONTOUR INTERVAL 10'
DRAWING TITLE
FIGURE 7. ELEVATION OF THE TOP OF GRAVEL ZONE
YATES PETROLEUM
PEÑASCO IRRIGATION PROJECT
4-DINKUS RANCH
DRAWN BY EJS
CHK'D BY DB
SCALE 1" = 2000'-0"
DATE 5-15-98
APP'D BY -
DRAWING NUMBER YATES07.DWG
REV. 0


MAP BASED ON ARTESIA AND DAYTON, NEW MEXICO USGS 7.5 MINUTE QUADRANGLE. LOCATION: T.18 S., R.25 E. NMPM.
THISTLE GAS WELL "AKT" #1
TUMBLEWEED
DRAW
RA-4068
RA-8141
RA-4365
MW-1 3459
MW-2 3481
MW-3 3450
MW-4 3470
MW-5 3498
SB-1
SB-2
SB-3
SB-4
SB-5
SB-6
SB-7
SB-8
SB-10
3460
3470
3480
3490
3450
9
10
11
14
15
16
21
22
23
N
E
S
W
0
500'
1000'
2000'
4000'
750'
250'
SCALE
LEGEND:
MW-5 3498 MONITOR WELL (BASE OF GRAVEL ELEVATION)
WINDMILL, RA-XXXX (STATE ENGINEER NUMBER)
3480 CONTOUR INTERVAL 10' (DASHED WHERE APPROXIMATE)
DRAWING TITLE
FIGURE 8. ELEVATION OF THE BASE OF GRAVEL ZONE
YATES PETROLEUM
PEÑASCO IRRIGATION PROJECT
4-DINKUS RANCH
DRAWN BY EJS
CHK'D BY DB
SCALE 1" = 2000'-0"
DATE 5-15-98
APPR BY -
DRAWING NUMBER YATES08.DWG
REV. 0


MAP BASED ON ARTESIA AND DAYTON, NEW MEXICO USGS 7.5 MINUTE QUADRANGLE.
LOCATION: T.18 S., R.25 E. NMPM.
THISTLE GAS WELL "AKT" #1
TUMBLEWEED
DRAW
RA-4068
RA-8141
RA-4365
SB-1 7
SB-2 9.5
SB-3 7.5
SB-4 7.5
SB-5 10
SB-6 23
SB-7 12.5
SB-8 10.5
SB-9 21
SB-10 10
MW-1 3
MW-2 8.5
MW-3 15
MW-4 25
MW-5 13
LEGEND:
MONITOR WELL (DEPTH TOP OF GRAVEL)
SHALLOW BORING (DEPTH TO TOP OF GRAVEL)
WINDMILL, RA-XXXX (STATE ENGINEER NUMBER)
CONTOUR INTERVAL 5' (DASHED WHERE APPROXIMATE)
SCALE
DRAWING TITLE
FIGURE 9. GENERALIZED DEPTH TO THE TOP OF GRAVEL ZONE
YATES PETROLEUM PEÑASCO IRRIGATION PROJECT 4-DINKUS RANCH
DRAWN BY EJS
CHK'D BY DB
SCALE 1" = 2000'-0"
DATE 5-15-98
APPR BY -
DRAWING NUMBER YATES09.DWG
REV. 0


MAP BASED ON ARTESIA AND DAYTON, NEW MEXICO USGS 7.5 MINUTE QUADRANGLE.
LOCATION: T.18 S., R.25 E. NMPM.
THISTLE GAS WELL "AKT" #1
TUMBLEWEED
DRAW
RA-4068
RA-8141
RA-4365
SB-1
SB-2
SB-3
SB-4
SB-5
SB-6
SB-7
SB-8
SB-9
SB-10
MW-1
MW-2
MW-3
MW-4
MW-5
25
35
33
44
40
30
14
15
16
21
22
23
9
10
11
LEGEND:
MW-5 44 MONITOR WELL (GRAVEL THICKNESS)
WINDMILL, RA-XXXX (STATE ENGINEER NUMBER)
35 CONTOUR INTERVAL 5' (DASHED WHERE APPROXIMATE)
SCALE
0 500' 250' 750' 1000' 2000' 4000'
N E S W
DRAWING TITLE
FIGURE 10. GENERALIZED GRAVEL THICKNESS
YATES PETROLEUM
PEÑASCO IRRIGATION PROJECT
4-DINKUS RANCH
DRAWN BY EJS
CHK'D BY DB
SCALE 1" = 2000'-0"
DATE 5-15-98
APPR. BY -
DRAWING NUMBER YATES10.DWG
REV. 0

At the other four boring locations, groundwater was not encountered during drilling, and dry monitor wells (MW-2 through 5) were completed at the base of the gravel zone. These wells were installed with 10 feet of screen except at MW-4 where an intermediate clay zone had been encountered from 50 to 54 feet below the surface. At this well 20 feet of screen was installed to detect any water within gravels above or below the clay. Monitor well completion logs are shown in Appendix A-2.

Water levels were again measured on March 2, 1998. In addition to water being present in MW-1, water was also detected in the other wells (Table 2). However, closer examination indicates that the water is present only in the PVC end caps placed at the base of the screen since the saturated thickness of the water is less than 0.5 feet in wells MW-3, MW-4, and MW-5. In MW-2, the saturated thickness is slightly less than 1 foot; at this well the cap and bottom of the screen are slightly into the clay at the base of the gravel. It is believed that the moisture detected in the four wells is from either condensation on the inside of the pipe, or possibly from the five gallons of water which were used to hydrate the bentonite seal placed at the top of the sand pack at each well. Because the bentonite was placed opposite the thick gravels in each well, it is possible that some of the water moved into the gravel and migrated around the bentonite and into the sandpack or screen. Water levels in MW-2 and the other wells should be checked over the coming months to confirm the above scenario.

Table 2. Monitor Well Water Level Elevations

Sample Location	Ground Surface Elevation (ft.)	Depth of Well (ft. BTOC)	Depth to Water (ft. BTOC)	Saturated Thickness (ft.)	Top of Casing (ft. ALS)	Depth to Water (ft. BLS)	Water Level Elevation (ft.)
MW-1	3,487	150.89	129.51	21.38	2.40	127.11	3359.9
MW-2	3,524	47.77	46.78	0.99	2.75	44.03	3480.0
MW-3	3,497	51.54	51.11	0.43	2.35	48.76	3448.2
MW-4	3,520	66.70	66.30	0.40	2.30	64.00	3456.0
MW-5	3,555	60.31	59.85	0.46	2.65	57.20	3497.8

Notes:
Sample Date March 2, 1998.
Abbreviations: BTOC – below top of casing; ALS – above land surface; BLS – below land surface.
MW-1: On 2/7/98 initial DTW 126.5 ft. Surged and bailed 7.5 gallons, final DTW 131.4 ft. BLS, no depth to water measurement on 2/8/98 due to broken probe
MW-2: End cap and bottom 6 in. of screen in clay.
Water levels in MW-2 to MW-5 are water in PVC end caps.

4.2.2 Water Quality

Water in MW-1 and in four water wells was sampled to determine background water quality in the alluvial zone. Three of the wells sampled are used as stock wells and one sample is from a domestic water supply. Samples were analyzed for water chemistry parameters and metal constituents. For comparison purposes, a sample of produced water proposed for irrigation use was collected and analyzed. Results of the sampling program are shown in Tables 3 through 5. Copies of the laboratory reports are shown in Appendix D.

4.2.2.1 Water Chemistry

Overall water quality of the groundwater in the vicinity of proposed irrigation project is good (Table 3). MW-1, the Section 11 windmill, and the Ranch Headquarters well have water with total dissolved solids (TDS) concentrations averaging 735 mg/L which is less than the WQCC standard of 1,000 mg/L. The remaining two wells, the Section 10 and Section 22 windmills have an average TDS of about 2,475 mg/L. The major difference in the water quality is the presence of increased calcium and sulfate concentrations. The completion interval for the Section 22 windmill is not known, but the Section 10 well is completed in a sand immediately above an anhydrite (gypsum) zone occurring at 295 feet. Based on the examination of the drilling log, this depth is believed to be the boundary between the base of the alluvium and the top of the Permian rocks at this location. Although no log is available for the Section 11 windmill, the Ranch Headquarters well is completed in a sand and gravel zone that extends from about 230 to 265 feet. The Section 11, Ranch Headquarters, and MW-1 wells are low in calcium and sulfate confirming their completion in the alluvium.

Table 3. Results of Water Quality Sampling -- Water Chemistry

	Groundwater					*Produced Water*	*WQCC Standard*
Sample Location:	**MW-1**	**Section 10 Windmill**	**Section 11 Windmill**	**Section 22 Windmill**	**Ranch Head-quarters**	**Mimosa SWD #1**	
Sample Date:	09-Feb-98	08-Feb-98	08-Feb-98	08-Feb-98	09-Feb-98	04-Mar-98	- -
Sodium (mg/L)	27	170	25	25	25	2,230	- -
Potassium (mg/L)	5.4	2.3	2.1	1.8	1.8	81	- -
Calcium (mg/L)	147	676	211	656	144	480	- -
Magnesium (mg/L)	43	51	36	31	35	110	- -
Chloride (mg/L)	31	18	20	23	18	**3,191**	250
Sulfate (mg/L)	440	**1,700**	380	**1,550**	410	**1,200**	600
Bicarbonate (mg/L)	159	134	220	220	207	830	- -
Carbonate (mg/L)	0	0	0	0	0	0	- -
Nitrate-Nitrogen (mg/L)	<1.0	<1.0	2.0	5.5	<1.0	3.8	10.0
Fluoride (mg/L)	<1.0	1.5	1.0	1.2	<1.0	1.3	1.6
TDS (mg/L)	746	**2,610**	746	**2,337**	714	**8,206**	1,000
Lab pH (S.U.)	7.3	6.3	6.7	6.8	7.2	7.3	6 - 9
Lab Specific Conductance (uS/cm)	1,022	2,540	1,009	2,410	990	11,690	- -
Sodium Adsorption Ratio(SAR)	0.5	1.7	0.4	0.3	0.5	23.9	- -

Notes:

The Section 10 Windmill is listed on the chain-of-custody and in analytical results as Section 9 because the well location was not precisely known at the time of sampling.

A number shown in **Bold** format exceeds WQCC Standard.

Of interest is the low concentration of chlorides in all five wells. Chloride concentration ranges from 18 to 31 mg/L which is well below the WQCC standard of 250 mg/L. If the irrigation project proceeds, chloride will be a constituent recommended for monitoring since the concentration in the produced water is about 3,200 mg/L.

In addition to chloride, several other produced water constituents are similarly elevated. These include sodium at 2,230 mg/L, sulfate at 1,200 mg/L and magnesium at 830 mg/L. TDS of the produced water is about 8,200 mg/L which is considered brackish or moderately saline. The water is too high in salts for human consumption but is comparable in quality to the Pecos River at low flow. However, its water chemistry quality is such that could be used for occasional stock watering if no other source of supply was available.

4.2.2.2 Metals

Groundwater at the site was elevated above WQCC standards for cadmium, iron and lead (Table 4). The water wells and the produced water sample were found to have concentrations at about twice the cadmium standard of 0.01 mg/L. Since the concentrations were elevated in all samples, the possibility of laboratory error can not be ruled out and resampling should be performed to verify the concentrations observed. Iron was elevated in the windmill samples which can be expected since the steel well casings are at least 30 years old. Lead was found elevated at 2 to 3 times the WQCC standard in two windmills while in the produced water it was elevated at 5 times the WQCC standard. Since the levels were elevated in both the groundwater and produced water samples, the water should be re-sampled to verify the concentrations.

The only other metals constituent elevated in the produced water was boron at 1.9 mg/L which is about twice the WQCC standard. Boron is a plant nutrient, but only at low concentrations; higher levels are toxic to many plants. For boron tolerant crops, irrigation water with concentrations as high as 3.0 mg/L are permissible.

4.2.2.3 Organics and Hydrogen Sulfide

Samples of produced water were analyzed for benzene and related aromatic constituents (Table 5). Levels of benzene, toluene, ethylbenzene, and total xylenes (BTEX) were greatly elevated compared to WQCC standards. However, Yates is anticipating treating this water to lower constituent concentrations to the relevant WQCC standard or just above. Similarly, Yates is planning on treating the water to remove hydrogen sulfide (H_2S) since levels are elevated to the extent that the concentrations are considered to be immediately dangerous to life and health by OSHA. Lessor H_2S concentrations released to the atmosphere are regulated by the NM Oil Conservation Division and the NM Environment Department Air Quality Bureau.

Because the objective of the study was to determine the suitability of the site for irrigation using produced water and Yates is planning on treating the produced water to remove or greatly reduce aromatic organics and H_2S, groundwater at the site was not tested for these constituents. However, it would be prudent to re-sample for BTEX constituents before beginning actual irrigation. Further, it is expected that the NMOCD will require that BTEX be included in a routine sampling program for the shallow groundwater monitoring wells.

Table 4. Results of Water Quality Sampling -- Metals

	Groundwater					*Produced Water*	*WQCC Standard*
Sample Location:	**MW-1**	**Section 10 Windmill**	**Section 11 Windmill**	**Section 22 Windmill**	**Ranch Head-quarters**	**Mimosa SWD #1**	
Sample Date:	09-Feb-98	08-Feb-98	08-Feb-98	08-Feb-98	09-Feb-98	04-Mar-98	- -
Aluminum (mg/L)	0.22	0.24	0.19	0.25	0.21	0.19	5.0
Arsenic (mg/L)	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	0.1
Barium (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	1.0
Boron (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	**1.9**	0.75
Cadmium (mg/L)	**0.017**	**0.021**	**0.015**	**0.023**	**0.019**	**0.021**	0.01
Chromium (mg/L)	<0.03	<0.03	<0.03	0.03	<0.03	0.03	0.05
Cobalt (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.05	0.05
Copper (mg/L)	0.02	0.06	0.03	0.04	0.02	0.02	1.0
Iron (mg/L)	0.05	**1.44**	**1.21**	0.99	0.12	0.20	1.0
Lead (mg/L)	<0.10	**0.16**	<0.10	**0.11**	<0.10	**0.27**	0.05
Manganese (mg/L)	0.06	0.05	<0.01	0.02	0.02	0.08	0.2
Total Mercury (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002
Molybdenum (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	1.0
Nickel (mg/L)	<0.04	<0.04	<0.04	<0.04	<0.04	0.16	0.2
Selenium (mg/L)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.05
Silver (mg/L)	0.02	<0.01	<0.01	0.01	<0.01	0.02	0.05
Strontium (mg/L)	1.7	6.9	1.9	4.7	1.9	5.4	- -
Uranium (mg/L)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	5.0
Zinc (mg/L)	0.012	0.419	0.282	0.134	0.019	0.012	10.0

Notes:

The Section 10 Windmill is listed on the chain-of-custody and in analytical results as Section 9 because the well location was not precisely known at the time of sampling.

Water from MW-1 field filtered using 0.45 micron filter for dissolved concentration; all other samples show total concentrations.

A number shown in **Bold** format exceeds WQCC Standard.

Table 5. Results of Water Quality Sampling -- Organics

	Produced Water			*WQCC Standard*
Sample Location:	**Mohave Transfer Station**	**Bates Transfer Station**	**Patriot Transfer Station**	
Sample Date:	29-Aug-97	29-Aug-97	29-Aug-97	- -
Constituent:				
Benzene (mg/L)	**855**	**1,131**	**1,988**	0.01
Toluene (mg/L)	**550**	**585**	**514**	0.75
Ethylbenzene (mg/L)	**12.7**	**11.7**	**10.46**	0.75
m,p-Xylene (mg/L)	**69.0**	**62.6**	**60.6**	- -
o-Xylene (mg/L)	**42.8**	**44.6**	**45.2**	- -
Total Xylenes (mg/L)	**111.8**	**107.2**	**105.7**	0.62
H_2S (ppm)*	330	330	320	- -
Total Dissolved Solids (mg/L)	**5,940**	**6,130**	**6,840**	1,000

Notes:
A number shown in **Bold** format exceeds WQCC Standard
* H_2S (Hydrogen Sulfide) concentrations in excess of 300 ppm are considered to be immediately dangerous to life and health by OSHA. Release of lessor concentrations to the atmosphere are regulated by the NM Oil Conservation Division and NMED Air Quality Bureau.

4.3 Soils

The near-surface soils at the project site were fine grained and generally uniform in texture. Western Agricultural Laboratories, Inc. performed particle size analysis on the 42 soil samples obtained at depths of 1, 3 and 6 feet at the 15 boring locations. Table 6 provides a summary of the more important soil physical and chemical parameters. Copies of the soil analyses are shown in Appendix E. The average percentages of sand, silt and clay determined by the particle size analysis were 16, 68 and 16 percent, respectively. Silt and clay total 84 percent of the average sample. Figure 11 shows the textural triangle used by the US Department of Agriculture (USDA) to classify soils. The most predominant soil texture was silt loam (17 samples) followed by silt (15 samples) and clay-loam mixtures (9 samples). Only one sample (B-3, 3 foot interval) was classified as a clay. Vertically, clay-loam mixtures were slightly more common at shallow depths (3 feet or less), and silts were more frequently found at a depth of 6 feet.

The hydraulic conductivity of fine grained silt/clay soil mixtures such as found at the project site is quite low. Although conductivity testing was not performed, hydraulic conductivity of such materials typically ranges from 10^{-4} to 10^{-6} cm/sec (Driscoll, 1986). The Eddy County soil survey report estimates the infiltration rate of native undisturbed soil at 0.8 to 2.5 inches/hour (5.6×10^{-4} to 1.8×10^{-3} cm/second). The report further characterizes the soil as having a slow infiltration rate when thoroughly wetted due to its fine to moderately fine texture.

Because of their high percentage of fine grained material, the soils have elevated cation exchange capacities (CEC), which is the total quantity of cations (sodium, potassium, calcium, magnesium, and other positively charged ions) which a soil can adsorb by cation exchange. Further, the actual amount of sodium available for exchange is relatively low (about 1 to 2%) compared to the availability of calcium. This means that the clays are probably in a flocculated condition and the soil structure is likely to remain open and permeable to infiltration of water from precipitation or from low sodium irrigation water.

If water containing high sodium is applied, the usual result is dispersion of clays, lowering of soil permeability and formation of alkali soils. However, water containing both high sodium and high concentrations of total salts may retard clay dispersion, and partially maintain a favorable soil structure for infiltration. Although soil science specialists can provide further interpretation on the impact of produced water on soils at the project site, bench tests of soil samples and produced water may be necessary to determine specific impacts on the soils of water containing both high sodium and high total salts.

Application of irrigation water containing the slightly elevated concentrations of metals observed in the produced water sample should not cause environmental problems. Cadmium may be adsorbed by soil clay minerals, carbonates or hydrous oxides of iron and manganese, or may be precipitated as cadmium carbonate, hydroxide, and phosphate. At pH values greater than 6, cadmium is adsorbed by the soil solid phase or is precipitated. Soluble lead added to the soil reacts with clays, phosphates, sulfates, carbonates, hydroxides, and organic matter such that lead solubility is greatly reduced. At pH values above 6, lead is either adsorbed on clay surfaces or forms lead carbonate. Of all the trace metals analyzed, lead is retained by soils and soil constituents to the greatest extent under the conditions described (McLean and Bledsoe, 1992).

Table 7 provides a summary of soil nutrient properties. The soil is generally low in organic matter, and low to very low in nitrogen, available phosphorus, manganese, and zinc. Iron, copper and boron nutrients are low to medium in available nutrients. Available sulfur is medium to high, while free lime is high throughout all soil intervals. As previously mentioned in Section 2.3, when managed properly, these soils are among the most productive in the Artesia area.

Table 6. Summary of Soil Physical and Chemical Properties

Sample Location and Depth	Sample Date (1998)	Lab No.	Percent Sand	Percent Silt	Percent Clay	Soil Texture	Field Capacity	Wilting Point	Soluble Salts (mmhos/cm)	Exchangeable Potassium (PPM)	Exchangeable Calcium (PPM)	Exchangeable Magnesium (PPM)	Exchangeable Sodium (PPM)	Cation Exchange Capacity (Meq/100g)	Exchange. Sodium Percentage (ESP)
B-1, 1 ft.	02-02	7671	22	72	6	silt loam	17.4	9.5	0.48	320	6,750	420	89	38.5	1.0%
B-1, 3 ft.	02-02	7676	22	52	26	silt loam	24.7	13.6	0.42	235	6,700	510	176	39.1	2.0%
B-1, 6 ft.	02-02	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
B-2, 1 ft.	02-04	7672	10	64	26	silt loam	26.6	14.6	0.26	620	7,460	310	53	41.7	0.6%
B-2, 3 ft.	02-04	7677	24	40	36	clay loam	28.1	15.4	0.45	210	6,600	690	195	40.1	2.1%
B-2, 6 ft.	02-04	7681	4	88	8	silt	21.0	11.5	0.29	240	6,500	910	240	41.7	2.5%
B-3, 1 ft.	02-05	7673	20	52	28	clay loam	25.8	14.2	0.25	620	7,100	260	51	39.5	0.6%
B-3, 3-4 ft	02-05	7678	14	40	46	clay	33.4	18.3	0.39	175	6,640	490	105	38.2	1.2%
B-3, 6 ft.	02-05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
B-4, 1 ft.	02-06	7674	20	50	30	clay loam	26.5	2.2	0.23	310	7,280	305	53	40.0	0.6%
B-4, 3-4 ft	02-06	7679	14	58	28	silty clay loam	26.7	14.7	0.42	310	6,470	420	72	37.0	0.8%
B-4, 6 ft.	02-06	7682	12	40	48	clay	34.4	18.9	0.31	240	6,250	740	86	38.4	1.0%
B-5, 1 ft.	02-06	7675	24	48	28	clay loam	25.1	13.8	0.19	320	6,980	250	48	38.0	0.5%
B-5, 3-4 ft	02-06	7680	14	54	32	silty clay loam	28.2	15.5	0.30	190	6,250	360	85	35.1	1.1%
B-5, 6 ft.	02-06	7683	28	56	16	silt loam	20.1	11.0	0.29	150	5,720	680	217	35.6	2.7%

Note:
Analyses by Western Agricultural Laboratories, Inc., Lubbock, Texas
NS – No sample

Table 6. Summary of Soil Physical and Chemical Properties (Continued)

Sample Location and Depth	Sample Date (1998)	Lab No.	Percent Sand	Percent Silt	Percent Clay	Soil Texture	Field Capacity	Wilting Point	Soluble Salts (mmhos/cm)	Exchange-able Potassium (PPM)	Exchange-able Calcium (PPM)	Exchange-able Magnesium (PPM)	Exchange-able Sodium (PPM)	Cation Exchange Capacity (Meq/100g)	Exchange. Sodium Percent-age (ESP)
SB-1, 1 ft.	02-07	7642	24	50	26	silt loam	24.4	13.4	0.27	490	6,400	180	55	35.0	0.7%
SB-1, 3 ft.	02-07	7652	12	82	6	silt	18.9	10.4	0.29	330	7,240	250	72	39.4	0.8%
SB-1, 6 ft.	02-07	7661	24	72	4	silt loam	16.3	8.9	0.49	235	7,140	530	80	41.1	0.8%
SB-2, 1 ft.	02-07	7643	28	56	16	silt loam	20.1	11.0	0.20	420	7,200	210	53	39.1	0.6%
SB-2, 3 ft.	02-07	7653	12	84	4	silt	18.2	10.0	0.32	235	6,980	270	87	38.1	1.0%
SB-2, 6 ft.	02-07	7662	12	84	4	silt	18.2	10.0	0.36	195	6,330	480	96	36.6	1.1%
SB-3, 1 ft.	02-07	7644	22	46	32	clay loam	26.9	14.8	0.22	520	7,310	220	56	40.0	0.6%
SB-3, 3 ft.	02-07	7654	4	92	4	silt	19.5	10.7	0.38	260	7,250	420	98	40.8	1.0%
SB-3, 6 ft.	02-07	7663	12	84	4	silt	18.2	10.0	0.43	220	6,620	740	210	40.7	2.2%
SB-4, 1 ft.	02-07	7645	22	52	26	silt loam	24.7	13.6	0.20	470	7,200	225	52	39.3	0.6%
SB-4, 3 ft.	02-07	7655	20	74	6	silt loam	17.7	9.7	0.33	250	7,020	390	88	39.4	1.0%
SB-4, 6 ft.	02-07	7664	24	70	6	silt loam	16.3	8.9	0.29	225	6,600	690	110	39.8	1.2%
SB-5, 1 ft.	02-07	7646	24	50	26	silt loam	24.4	13.4	0.18	450	7,250	220	60	39.5	0.7%
SB-5, 3 ft.	02-07	7656	14	80	6	silt loam	18.6	10.2	0.30	210	6,760	380	95	37.9	1.1%
SB-5, 6 ft.	02-07	7665	10	84	6	silt	19.3	10.6	0.35	240	6,600	780	226	41.1	2.4%
SB-6, 1 ft.	02-07	7647	12	58	30	silty clay loam	27.8	15.3	0.22	500	7,750	265	57	42.5	0.6%
SB-6, 3 ft.	02-07	7657	8	88	4	silt	18.9	10.4	0.30	340	7,820	475	101	44.4	1.0%
SB-6, 6 ft.	02-07	7666	10	84	6	silt	19.3	10.6	0.35	245	6,720	850	215	42.2	2.2%
SB-7, 1 ft.	02-07	7648	18	58	24	silt loam	24.6	13.5	0.19	480	6,060	255	52	33.9	0.7%
SB-7, 3 ft.	02-07	7658	10	86	4	silt	18.6	10.2	0.45	350	7,400	750	203	45.0	2.0%
SB-7, 6 ft.	02-07	7667	14	80	6	silt loam	18.6	10.2	0.56	320	6,960	730	205	42.6	2.1%

Note:
Analyses by Western Agricultural Laboratories, Inc., Lubbock, Texas
NS – No sample

Table 7. Summary of Soil Nutrient Properties

Sample Location and Depth	Sample Date	Lab No.	Soil pH	Free Lime	Percent Organic Matter	Nitrogen (PPM)	Phosphorus (PPM)	Phosphorus Available (PPM)	Iron, Available (PPM)	Manganese, Available (PPM)	Zinc, Available (PPM)	Copper, Available (PPM)	Boron, Available (PPM)	Sulfur, Available (PPM)
B-1, 1 ft.	02-02	7671	8.1	H	1.8	4 VL	3 VL	4 L	5.9 L	4.2 L	0.3 VL	0.5 M	0.9 M	112 H
B-1, 3 ft.	02-02	7676	8.2	H	1.7	4 VL	4 VL	4 L	7.6 M	2.7 L	0.2 VL	0.6 M	0.7 L	112 H
B-1, 6 ft.	02-02	--	--	--	--	--	--	--	--	--	--	--	--	--
B-2, 1 ft.	02-04	7672	8.2	H	1.9	4 VL	4 VL	4 L	4.4 L	4.0 L	0.4 VL	0.3 L	0.9 M	15 M
B-2, 3 ft.	02-04	7677	8.2	H	1.2	5 VL	4 VL	4 L	6.1 M	2.9 L	0.2 VL	0.4 L	0.7 L	65 H
B-2, 6 ft.	02-04	7681	8.4	H	2.0	4 VL	4 VL	4 L	8.3 M	2.4 L	0.2 VL	0.8 M	0.7 L	26 H
B-3, 1 ft.	02-05	7673	8.3	H	1.9	4 VL	11 L	35 L	2.9 L	4.0 L	0.7 L	0.2 L	0.8 M	15 M
B-3, 3-4 ft.	02-05	7678	8.1	H	1.4	5 VL	4 VL	4 L	4.4 L	1.6 VL	0.2 VL	0.5 M	0.8 M	50 H
B-3, 6 ft.	02-05	--	--	--	--	--	--	--	--	--	--	--	--	--
B-4, 1 ft.	02-06	7674	8.3	H	2.0	4 VL	8 L	9 L	6.3 M	2.5 L	0.2 VL	0.2 L	0.8 M	15 M
B-4, 3-4 ft.	02-06	7679	7.9	H	1.7	35 VH	4 VL	4 L	5.8 L	2.1 L	0.2 VL	0.7 M	0.8 M	20 M
B-4, 6 ft.	02-06	7682	8.0	H	1.6	5 VL	4 VL	4 L	7.0 M	2.5 L	0.3 VL	0.7 M	0.7 L	15 M
B-5, 1 ft.	02-06	7675	8.3	H	1.5	4 VL	4 VL	4 L	3.3 L	2.3 L	0.2 VL	0.2 L	0.9 M	15 M
B-5, 3-4 ft.	02-06	7680	8.1	H	1.4	4 VL	4 VL	4 L	5.0 L	2.3 L	0.2 VL	0.5 M	0.8 M	20 M
B-5, 6 ft.	02-06	7683	8.3	H	1.0	4 VL	4 VL	4 L	4.4 L	1.4 VL	0.1 VL	0.4 L	0.7 L	15 M
SB-1, 1 ft.	02-07	7642	8.1	H	1.5	5 VL	4 VL	6 L	7.2 M	7.8 M	0.5 VL	0.8 M	0.9 M	18 M
SB-1, 3 ft.	02-07	7652	8.2	H	1.5	5 VL	4 VL	4 L	8.3 M	3.9 L	0.2 VL	0.8 M	0.8 M	18 M
SB-1, 6 ft.	02-07	7661	8.0	H	1.2	10 L	4 VL	4 L	6.3 M	1.9 VL	0.2 VL	0.6 M	0.6 L	15 M
SB-2, 1 ft.	02-07	7643	8.1	H	1.5	5 VL	4 VL	4 VL	5.3 L	3.2 L	0.2 VL	0.6 M	0.8 M	18 M
SB-2, 3 ft.	02-07	7653	8.0	H	1.4	5 VL	3 VL	4 L	8.6 M	3.6 L	0.2 VL	0.8 M	0.7 L	18 M
SB-2, 6 ft.	02-07	7662	8.2	H	1.1	4 VL	3 VL	4 L	5.4 L	2.0 VL	0.4 VL	0.2 L	0.6 L	26 H
SB-3, 1 ft.	02-07	7644	8.2	H	1.7	5 VL	4 VL	6 L	5.2 L	3.5 L	0.4 VL	0.5 M	0.9 M	18 M
SB-3, 3 ft.	02-07	7654	8.1	H	1.6	5 VL	4 VL	4 L	8.5 M	3.1 L	0.1 VL	0.8 M	0.9 M	62 H
SB-3, 6 ft.	02-07	7663	8.1	H	1.3	4 VL	4 VL	4 L	6.1 M	2.0 VL	0.1 VL	0.5 M	0.8 M	62 H
SB-4, 1 ft.	02-07	7645	8.1	H	1.6	5 VL	4 VL	4 L	6.0 M	3.2 L	0.2 VL	0.5 M	0.7 L	18 M
SB-4, 3 ft.	02-07	7655	8.1	H	1.5	5 VL	3 VL	4 L	5.2 L	2.7 L	0.1 VL	0.5 M	0.7 M	26 H
SB-4, 6 ft.	02-07	7664	8.2	H	1.2	4 VL	4 VL	5 L	6.6 M	1.9 VL	0.3 VL	0.3 L	0.8 M	35 H

Notes:
Analyses by Western Agricultural Laboratories, Inc., Lubbock, Texas
Abbreviations: H – high, M – medium, L – low, VL – very low

5.0 DISCUSSION

5.1 Groundwater Protection

The subsurface investigation determined that groundwater is not present at shallow depths beneath the site. Further, extensive thicknesses of low permeability clays provide protection for the first detected groundwater at a depth in excess of 125 feet. The extensive unsaturated gravel beds beneath the site provide an opportunity to detect water which may migrate from the overlying soil. However, the gravels themselves hinder fluid migration by acting as a capillary barrier at the soil-gravel interface. Before water can flow into the gravels, the overlying soil must be saturated so as to overcome the very significant capillary forces holding the water in the fine grained pores of the silt and clay. Whether the fine grained soil can transmit significant volumes of water to the gravels even under an irrigation scenario is questionable.

5.1.1 Groundwater Monitoring

The groundwater monitoring wells installed at the base of the gravels during the investigation phase of this study will serve to detect significant fluid migration from the shallow soil due to over application of irrigation water. At least two more wells are necessary to characterize and monitor the shallow gravels in Section 14 of the project area. One well should be located in the northeast quarter of the section and the other should be placed adjacent to MW-1. Additional wells may be required as a condition of approval by the NMOCD.

5.1.2 Vadose Zone Monitoring

Tensiometers, which measure fluid potential, should be installed at a depth which is below the normal operating range for irrigation management. At this depth, they will be available to detect relatively large changes in the soil-water fluid potential such as might be caused by over application of water followed by deep percolation of water. At shallower depths tensiometers should be used to determine irrigation scheduling. A soil scientist should be consulted for particulars on tensiometer installation, use and maintenance.

5.2 Irrigation Management

The most important element that will determine the success of the irrigation project is irrigation management. Because of the physical and chemical changes in the soil resulting from applications of water containing high salt concentrations, it will be necessary to monitor carefully how often water is applied and what volumes are applied. The goal of irrigation management is to avoid salt buildup at the crop root zone which would prevent uptake of water by the plant. On the other hand, downward flushing of salt laden water below the root zone may cause negative regulatory impacts if such water migrates from the soil zone into the underlying gravels.

To prevent migration of water from the soil zone, water applications must be balanced against plant moisture requirements, evapotranspiration, precipitation and drainage requirements for prevention of salt buildup in the root zone. The goal is to establish a "plane of zero liquid flux" at some point beneath the root zone and above the gravels. Above this plane or surface,

soil-water movement is upward due to evapotranspiration, and below this plane water moves downward only in response to capillary forces and gravity. At the zero flux plane, the hydraulic gradient is zero. If water is over-applied at the site, there is not a plane of zero flux and the hydraulic gradient is downward throughout the soils profile. This will cause movement of water lower into the soil zone and may eventually saturate the soil immediately above the gravel such that water will discharge into the gravel zone. The services of an agricultural engineer or soil scientist should be utilized to design irrigation application rates and cycles such that a plane of zero liquid flux is maintained at a depth that is protective of the plant roots and that also prevents further downward water movement in the soil.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The investigation produced the following conclusions regarding the suitability of the site for use for irrigation with produced water from natural gas formations:

1. The location selected for the irrigation project is expected to provide adequate protection for the underlying groundwater due to the presence of thick and extensive clays at depths between 60 and at least 140 feet where the first groundwater is encountered.
2. Groundwater was measured at a depth of 130 feet in the deep monitor well installed to determine the depth to and quality of water beneath the project site.
3. The quality of the water in the monitor well is quite good with a TDS concentration of 750 mg/L, and cadmium the only constituent exceeding WQCC standards.
4. Between the bottom of the soil profile (located at a depth from 3 to 25 feet) and the top of the clay zone, extensive unsaturated gravel zones were located that will be useful for detection of any fluids that might migrate from the soil zone.
5. The soil profile itself is fine-grained with soil particles having an average composition of 84 percent silt plus clay content and an estimated hydraulic conductivity of 10^{-4} to 10^{-6} cm/sec for undisturbed soil.
6. Slightly elevated concentrations of cadmium and lead metals in the irrigation water will not pose an environmental hazard since these constituents will be adsorbed onto the clay particles in the soil.
7. Treatment of the produced water to remove high concentrations of BTEX and H_2S will be necessary before land application of the water will be authorized by the NMOCD.
8. The quality of the proposed irrigation water (approximately 8,200 mg/L TDS) will likely cause changes in the soil structure that will reduce further the hydraulic conductivity and cause difficulty in irrigation management including salt buildup within the root zone.
9. Proper irrigation management will require that the application of the irrigation water be balanced by crop growth needs, evapotranspiration from soil and plant surfaces, salt management in the root zone, and the need to prevent water movement downward to the gravel zone.

6.2 Recommendations

The following recommendations are suggested for implementation if the irrigation project proceeds to the design and construction stage:

1. Two additional shallow monitoring wells should be installed in the project area prior to beginning operations:
   a) The first well would be located in the northeast quarter of Section 14 where the elevation of the base of the gravels is anticipated to be at its lowest such that any water seepage into the gravel zone will migrate northeasterly towards this location, and
   b) The second well would be adjacent to MW-1 to provide water detection in the gravels in the southern portion of Section 14.
2. Groundwater flow direction at the site should be determined by modifying the surface casing on nearby windmills so that access for groundwater level measurements can be obtained.
3. Resampling of the produced water and the following water wells should be performed for the reasons listed:
   a) Produced water, MW-1, Section 10 windmill, and Ranch Headquarters well for cadmium and/or lead due elevated levels of one or both constituents in the initial samples.
   b) MW-1 and Ranch Headquarters wells for BTEX since baseline levels were not established during the initial investigation.
4. An agricultural engineer or soil scientist should be consulted to further evaluate the results of the soil testing so that an irrigation schedule suitable for the site conditions, crop(s) to be grown, and the quality of the irrigation water might be designed. As part of this work the following activities are suggested:
   a) Perform bench-scale tests on soil samples (preferably undisturbed samples) to determine changes in soil structure and hydraulic conductivities following applications of irrigation water;
   b) Using the results of the bench-scale tests, and available information on 1) plant moisture requirements for crop growth, 2) evapotranspiration from soil and plant surfaces, and 3) salt management in the root zone, estimate the depth at which the salts should be immobilized to allow crop growth and to prevent migration of soluble salts downwards to the gravel zone; and
   c) suggest depths for installation of tensiometers to monitor moisture deficiency in the upper soil zone for scheduling of irrigation, and moisture surplus in the lower zone that would indicate undesirable downward movement of water toward the gravel zone.
5. Before a large scale irrigation system is built, a pilot project should be initiated that would utilize the data collected from bench-scale test together with other relevant technical information to determine actual soil and plant impacts at the irrigation site.

7.0 REFERENCES

Driscoll, F. G., 1986. Groundwater and Wells, Second Edition. Johnson Division, St. Paul, Minnesota, 1089 pages.

Fiedler, A. G., and Nye, S. S., 1933. "Geology and Ground-Water Resources of the Roswell Artesian Basin, New Mexico," U.S. Geological Survey Water Supply Paper 639, U.S. Govt. Printing Office, Washington, DC.

Hendrickson, G. E., and R. S. Jones, 1952. "Geology and Ground-Water Resources of Eddy County, New Mexico," Groundwater Report, 3, New Mexico Bureau of Mines & Mineral Resources, Socorro, NM.

Kelley, V. C., 1971. "Geology of Pecos Country, Southeastern New Mexico," New Mexico Bureau of Mines & Mineral Resources - Memoir 24, University of New Mexico Printing Plant, Socorro, NM.

Lyford, F. P., 1973. "Valley Fill in the Roswell-Artesia Area, New Mexico," Open File Report 73-163, USGS Open File Services, Denver, CO.

McLean, J., and B. Bledsoe. 1992. "Ground Water Issues, Behavior of Metals in Soils", USEPA, Superfund Technology Support Center for Ground Water, Robert S. Kerr Environmental Research Laboratory, Ada Oklahoma.

Morgan, A. M., 1938. "Geology and Shallow-Water Resources of the Roswell Artesian Basin", New Mexico State Engineer Bulletin No. 5, Santa Fe, NM.

New Mexico Water Quality Control Commission (WQCC), 1996. "New Mexico Water Quality Control Commission Regulations". New Mexico Water Quality Control Commission, Santa Fe, November 15.

National Oceanic and Atmospheric Administration (NOAA), 1982. "Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1951-1980", Natural Climatic Data Center, Asheville, NC.

U.S. Department of Agriculture Soil Conservation Service (USDA-SCS), 1971. "Soil Survey Eddy County Area", New Mexico, U.S. Government Printing Office, Washington, DC.

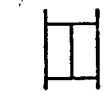
Welder, G. E., 1983. "Geohydrologic Framework of the Roswell Ground-Water Basin, Chaves and Eddy Counties, New Mexico", USGS Technical Report 42, University of New Mexico Printing Plant, Socorro, NM.

APPENDIX A

LITHOLOGIC AND MONITOR WELL COMPLETION LOGS

KEY TO SYMBOLS AND SOIL CLASSIFICATION

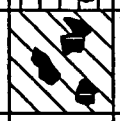
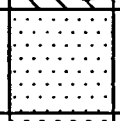
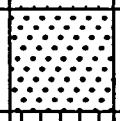
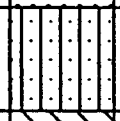
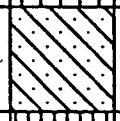
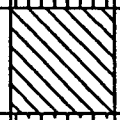
SAMPLE TYPES



Thin-walled Tube | Split-barrel | Rock Core w/Testable Sample | Disturbed | No Recovery

COMPRESSIVE STRENGTH TESTS

Hand Penetrometer | Torvane | Unconfined | U-U Triaxial

Major Divisions			Group Symbols		Typical Names	Consistency Terms
COARSE-GRAINED SOILS: More Than Half of Material Is LARGER Than No. 200 Sieve Size.	GRAVELS: More Than Half of Coarse Fraction is LARGER Than No. 4 Sieve Size.	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.	
		Gravels With Fines (Appreciable Amount of Fines)	GM		Silty Gravels, Gravel-Sand-Silt Mixtures.	
			GC		Clayey Gravels, Gravel-Sand-Clay Mixtures.	
	SANDS: More Than Half of Coarse Fraction is SMALLER Than No. 4 Sieve Size.	Clean Sands (Little or no Fines)	SW		Well-Graded Sands, Gravelly Sands, Little or no Fines.	
			SP		Poorly-Graded Sands, Gravelly Sands, Little or no Fines.	
		Sands With Fines (Appreciable Amount of Fines)	SM		Silty Sands, Sand-Silt Mixtures.	
			SC		Clayey Sands, Sand-Clay Mixtures.	
FINE-GRAINED SOILS: More Than Half of Material is SMALLER Than No. 200 Sieve Size.	SILTS and CLAYS	Liquid Limit Less Than 50	ML		Inorganic Silts & 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 & Organic Silty Clays of Low Plasticity.	
		Liquid Limit Greater Than 50	MH		Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils, Elastic Silts.	
			CH		Inorganic Clays of High Plasticity, Fat Clays.	
			OH		Organic Clays of Medium to High Plasticity, Organic Silts.	

Penetration Resistance, Blows/Foot*	Descriptive Term
0-4	Very Loose
4-10	Loose
10-30	Medium Dense
30-50	Dense
Over 50	Very Dense

* Based on driving a split-barrel sampler with a 140 lb. weight dropped 30 in.

Compressive Strength, ton/sq ft	Descriptive Term
0 to 0.25	Very Soft
0.25 to 0.50	Soft
0.50 to 1.00	Firm
1.00 to 2.00	Stiff
2.00 to 4.00	Very Stiff
Over 4.00	Hard

Ref. Unified Soil Classification System (ASTM D 2487)

APPENDIX A1

LITHOLOGIC LOGS OF MONITOR WELLS AND SOIL BORINGS

LOG OF BORING B-1

YATES PETROLEUM CORPORATION

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/02/98, 0945	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/04/98, 1230	Drill Equipment	: Ingersoll-Rand A-300
Location	: SE,SE,SW Sec 14	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3487	Sample From:	Blows / Length (ft)	Recvy. (ft)	USCS	DESCRIPTION
0						
	3485	CT			ML	0-3 ft. Top soil, clayey silt becoming silty clay at 3 ft., brown, moist, very plastic
		CB		0.5	GW	3-5 ft. Gravel, limestone, rounded, 1/4 - 1 1/2 in.
5						5-7 ft. Gravel
	3480	CB		0.7		7-8 ft. Soft
10		CB, CT		0.3	GM	8-13 ft. Gravel with clayey sand, light brown Auger refusal at 10 ft. Switch to drill bit - log from cuttings.
	3475					
15		CT			GC	13-18 ft. Gravel with clay and sand, gravel to 2 in., rounded, uniform.
	3470					18-20 ft. Gravel with clay & sand, very hard drilling @20'
20		CT			GP	20-21 ft. Gravel, pea-sized, 1/4-3/8 in., uniform.
	3465				GW	23-25 ft. Very hard drilling, cobble-sized gravel chips returned 23-25 ft. 25-28 ft. Cobble sized gravels returned, but drilling easier
25		CT				
	3460					
30		CT			CL	28-33 ft. Gravelly clay, soft drilling
	3455					33-38 ft. Installed 5 ft. core barrel. 33-34.3 ft. Clay, brown, stiff, plastic w/ caliche inclusions 34.3-34.8 ft. Caliche, white with clay and limestone fragments and chips. (Photo taken)
35		CB		1.8		
	3450					
40		CB		0.8		38-43 ft. Caliche clay, white with limestone inclusions
	3445					
45		CT				43-48 ft. Switch to drill bit - log from cuttings. Clay, brown, soft, plastic with some sand grains
	3440					
50		CT				48-53 ft. Clay, brown, very plastic, no sand grains.

05-28-1998 C:\Mtech46\Yatestb-1.bor

YATES PETROLEUM CORPORATION

LOG OF BORING B-1

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/02/98, 0945	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/04/98, 1230	Drill Equipment	: Ingersoll-Rand A-300
Location	: SE,SE,SW Sec 14	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3487	Sample From:	Blows / Length (ft)	Recvy. (ft)	USCS	DESCRIPTION
50	3435	CT			CL	48-53 ft. Clay, brown, very plastic, no sand grains.
55	3430	CT				53-58 ft. Clay, same as above, becoming lighter in color, slightly moist.
60	3425	SS	--	1		58-60 ft. Splitspoon sample, clay, brown, soft, plastic with caliche inclusions (Photo taken)
		CT				60-63 ft. Clay, same as above, stiffer
65	3420	CT				63-68 ft. Clay, same as above, some inclusions
70	3415	CT				68-73 ft. Clay, same as above, soft, plastic, occassional large sand grains
75	3410	CT				73-78 ft. Clay, same as above then very hard at 76.5 ft., possible gravel(?)
80	3405	CT			CA	78-83 ft. Very hard drilling, but no gravel returns. Possibly hard clay or caliche. Returns have ground rock fragments, occassional small gravel.
85	3400	SS	50/3.5"	0		83-85 ft. Splitspoon sample, no recovery, possible caliche or cemented limestone 85-86 ft. Ground rock fragments
		CT				86-88 ft. Soft drilling, no chatter. Clay, light brown, very plastic, with small chip fragments and/or coarse sand.
90	3395	CT			CL	88-93 ft. Clay, brown, soft, plastic, very cohesive, occassional large sand grains
95	3390	CT				93-98 ft. Clay, same as above with occassional small gravel. Shut down for night 1730 02/03/98, on-site 0815, no moisture or clay swelling in hole overnight
100		CT				98-103 ft. Clay, same as above

05-28-1998 C:\Mtech46\Yateslb-1.bor

LOG OF BORING B-1

YATES PETROLEUM CORPORATION

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/02/98, 0945	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/04/98, 1230	Drill Equipment	: Ingersoll-Rand A-300
Location	: SE,SE,SW Sec 14	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3487	Sample From:	Blows / Length (ft)	Recvy. (ft)	USCS	DESCRIPTION
100		CT				98-103 ft. Clay, same as above
	3385					
105		CT				103-108 ft. Clay, light brown, stiff, very plastic, slightly more moist at bottom
	3380					
110		CT				108-113 ft. Clay, same as above
	3375					
		SS	50/1.8'	1.8		113-115 ft. Spltspoon sample. Clay brown with silt (silty clay), stiff, plastic, with frequent inclusions of caliche and limestone fragments, no moisture on inside of barrel. (Photo taken)
115		CT				115-118 ft. Clay, light brown, same as above
	3370					
						118-123 ft. Clay, light brown, same as above
120		CT				118-123 ft. Clay, light brown, same as above
	3365					
					CL	
125						123-128 ft. Clay, light brown, same as above
	3360	CT				
130						128-133 ft. Clay, light brown, same as above
	3355					
135		CT				133-138 ft. Clay, light brown, same as above
	3350					
						138-143 ft. Clay, light brown, same as above. Pulled out for split spoon, moisture on rod at 138 ft.
140		CT				143-143.4 ft. Clay, very light brown, plastic, very cohesive.
	3345					143.4-143.7 ft. Clay and caliche, saturated, caliche frag.
		SS	50/1.6'	1.6		143.7-144.7 ft. Clay, light brown (buff) (Photo taken)
145		CT				Depth to water 142.57 ft. BLS, conductivity, 1100 umhos at 72°F, pH 6.8 strip
	3340					145-148 ft. Clay, same as above
						Offsite at 1430 for water into hole before setting screen.
150						

Depth to water at 0800 02/04/98 is 133 ft. below land surface. See MW-1 log for well completion details

05-28-1998 C:\Mtech46\Yates\b-1.bor

LOG OF BORING B-2

YATES PETROLEUM CORPORATION

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/04/98, 1340	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/05/98, 1115	Drill Equipment	: Ingersoll-Rand A-300
Location	: NE,NW,SW Sec 15	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3524	Sample From:	Blows / Length (ft)	Recvy. (ft)	USCS	DESCRIPTION
0		CB		1.2	ML	0-5 ft. Top soil, clayey silt, light brown with roots and white streaks
5	3520	CB		0		5-8.5 ft. Clayey silt, light brown with increasing small gravel.
10	3515	CT			GW	At 8.5 ft. core barrel became stuck in gravel and torqued into corkscrew, no recovery (Photo taken)
		CT				10-15 ft. Limestone gravel to 1 1/2 in., rounded, with clay
15	3510					
		CT				15-20 ft. Limestone gravel to 2 in., mixed size, little clay
20	3505					
		CT				20-25 ft. Gravel, same as above, size to 3 in.
25	3500					
		CT				25-30 ft. Gravel, same as above
30	3495					
		CT				30-35 ft. Gravel, same as above Pea gravel at 33 ft.
35	3490					
		CT			GC	35-40 ft. Clayey gravel with increasing clay at 40 ft.
40	3485					
		CT				40-43 ft. Gravel to 43 ft. then clay
45	3480	SS	--	1.3	CL	44-46 ft. Splitspoon. Silty clay, brown, stiff, dry, crumbly, very plastic when wetted. (Photo taken)
		CT				46-50 ft. Clay, dry, same as above
50	3475					
		CT				50-55 ft. Hard drilling at 52 ft., no gravel "chatter", returns are gravel from upper zones
55	3470	SS	50/10"	0.8		55-57 ft. Splitspoon. Clay with caliche, occassional limestone inclusions, clay brown with white specks, brown staining and black (iron?) streaks.
60	3465	CT				
		CT				57-65 ft. Clay with caliche, same as above.
65	3460					
		SS	50/5"	0.3		65-67 ft. Splitspoon. Caliche clay, very light brown, with limestone pebbles and fragments, dry, crumbly
70	3455					
75	3450					

Notes:
Boring dry. Backfilled with bentonite to 63 ft. Backfilled with cuttings to 46 ft. then with bentonite flour to 44 ft. Completed as monitor well. See MW-2 log for well completion details.

05-28-1998 C:\Mtech46\Yates\b-2.bor

LOG OF BORING B-3

YATES PETROLEUM CORPORATION

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/05/98, 1130	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/05/98, 1700	Drill Equipment	: Ingersoll-Rand A-300
Location	: NE,NE,SE Sec 15	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3497	Sample From:	Blows / Length (ft)	Recvy. (ft)	USCS	DESCRIPTION
0						
	3495	CB		1.5	ML	0-5 ft. Clayey silt, brown grading to very light brown at base with increasing clay. Plant roots. Core barrel shows brown clay with caliche, dry, crumbly (Photo taken)
5						
	3490	CT			CL	5-10 ft. Silty clay, light brown. Gravel lens at 9 ft.
10						
	3485	CT				10-15 ft. Silty clay, light brown with occassional gravel
15						
	3480	CT			GW	15-20 ft. Gravel, sized from 3/4 in. - 2 in., non-uniform
20						
	3475	CT				20-25 ft. Gravel, same as above
25						
	3470	CT				25-30 ft. Gravel, some pea gravel
30						30-33 ft. Gravel, same as above
	3465	CT				
35					GC	33-35 ft. Gravel with clay at 33 ft. Very hard drilling, possible caliche
	3460	CT				35-40 ft. Gravel with silty clay, very hard drilling, lots of drill chatter, auger catching, likely cemented gravel and caliche
40						
	3455	CT				40-45 ft. Clayey gravel, same as above
45						45-47.5 ft. Clayey gravel, same as above
	3450	CT				
50		SS	50/9"	0.6	CL	47.5-50.5 ft. Soft drilling, splitspoon sample. Clay, very light brown becoming brown at base, stiff, very plastic
	3445	CT				50.5-55 ft. Clay, same as above, returns dusty
55						
	3440	CT				55-60 ft. Silty clay, cuttings show some small gravels and very coarse sand
60						
	3435	CT				60-65 ft. Clay to 63 ft. then hard drilling, possible caliche.
65						
	3430					Notes: Boring dry. Backfill to 51ft. then bentonite to 49 ft. for casing set. Completed as monitor well. See MW-3 log for well completion details.
70						

05-28-1998 C:\Mtech46\Yates\b-3.bor

YATES PETROLEUM CORPORATION

LOG OF BORING B-4

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/06/98, 0800	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/06/98, 1345	Drill Equipment	: Ingersoll-Rand A-300
Location	: SE,SE,SW Sec 15	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3520	Sample From:	Blows / Length (ft)	Recvy. (ft)	USCS	DESCRIPTION
0		CB		2.0	ML	0-5 ft. Clayey silt, brown grading to very light brown at base with increasing clay. Plant roots. Core barrel shows brown clay with caliche, dry, crumbly
5	3515	CT			CL	5-10 ft. Silty clay, light brown, with very fine grained sand and occassional coarse grains.
10	3510	CT				
15	3505	CT			GC	17-19 ft. Gravel lens then silty clay
20	3500	CT			CL	19-25 ft. Silty Clay, light brown
25	3495	CT			GC	25-33 ft. Gravel, 3/4" - 2" with silty clay matrix
30	3490	CT				
35	3485	SS	50/6"	0.5	CL	33-35 ft. Soft at 33 ft. Splitspoon sample: Clay, light brown with very fine-grained sand. Gravel in tip.
40	3480	CT			CG	35-40 ft. Clayey gravel with very fine-grained sand

05-28-1998 C:\Mtech46\Yates\b-4.bor

YATES PETROLEUM CORPORATION

LOG OF BORING B-4

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/06/98, 0800	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/06/98, 1345	Drill Equipment	: Ingersoll-Rand A-300
Location	: SE,SE,SW Sec 15	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3520	Sample From:	Blows / Length (ft)	Recvy. (ft)	USCS	DESCRIPTION
40		CT			GW	40-42 ft. Gravel (pea gravel size), uniform with some clay
		SS	50/5"	0.5	CG	42-45 ft. Soft at 42-42.7ft. Splitspoon sample: Gravelly clay, very light brown to chalk color, gravel mixed sizes, rounded, some cementing between gravels (possible precurser to caliche?). Very hard drilling 43-45 ft.
45	3475	CT			GW	45-50 ft. Gravel, cuttings returned mixed size gravels.
50	3470	SS	50/13"	1.1	CL	50-54 ft. Soft drilling, clay returns, splitspoon sample: Clay, light brown, stiff, plastic, with occassional limestone inclusion and caliche streaks. Dry but moisture on barrel. (Photo taken)
		CT			GW	54-57 ft. Gravel to 57 feet. Very dry, added 5 gallons water at 57 ft. for cuttings return.
55	3465	CT				57-63 ft. Very hard drilling to 63 feet. Possible clayey gravel or caliche
60	3460	CT			CL	63-69 ft. soft at 63 ft. Clay returns 63-69 ft.
65	3455	CT				
70	3450	SS	50/1'	1.2		69-71 ft. Splitspoon sample: Clay, brown, dry, crumbly, plastic, low silt. (Photo taken)
75	3445					
80	3440					

Notes:
Boring dry. Completed as monitor well. See MW-4 log for well completion details.

05-28-1998 C:\Mtech46\Yateslb-4.bor

LOG OF BORING B-5

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/06/98, 1415	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/06/98, 1930	Drill Equipment	: Ingersoll-Rand A-300
Location	: NW,SW,NE Sec 16	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Sample Condition: Remoulded, Undisturbed, Lost, Rock Core

Sample From: SS Split Spoon, ST Shelby Tube, CT Auger Cuttings, CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3555	Sample From:	Blows / Length (ft)	Recvy. (ft)	USCS	DESCRIPTION
0		CB		1.4	CL	0-5 ft. Top soil, silty clay, dark brown grading to light brown at base. (Photo taken)
5	3550	CT				5-10 ft. Silty clay, light brown, clean
10	3545	CT				10-13 ft. Silty clay, light brown
15	3540	CT			GC	Gravel 13-14 ft. grading to clayey gravel at 15 ft. 15-20 ft. Gravel with silty clay, limestone gravels to 3 in., rounded
20	3535	CT				20-25 ft. Gravel, same as above, mixed sizes
25	3530	CT			GW	25-30 ft. Gravel, mixed sizes, clean
30	3525	CT				30-35 ft. Gravel (Photo taken)
35	3520	CT				35-40 ft. Gravel, same as above, more pea gravel, very few fines
40	3515	CT				40-45 ft. Gravel, same as above, very clean
45	3510	CT				45-50 ft. Gravel, pea gravel at 47.5 ft.
50	3505	CT				50-55 ft. Gravel, softer drilling, pea gravel at 53 ft.
55	3500	CT				55-57 ft. Gravel, pea gravel, increasing clay
60	3495	SS	50/9.5"	0.8	CL	57-59 ft. Splitspoon. Clay, brown, plastic, slightly moist (Photo taken)
65	3490	CT				59-67 ft. Clay, brown, plastic, slightly moist
70	3485	SS	50/3"	--		67.5-69.5 ft. Splitspoon. Clay, brown, same as above
75	3480					

Notes:
Boring dry. Completed as monitor well. Backfill to 59 ft. then bentonite to 57 ft. See MW-5 log for well completion details.

05-28-1998 C:\Mtech46\Yates\b-5.bor

YATES PETROLEUM CORPORATION

LOG OF BORING SB-1

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date Bored	: 02/07/98	Drilling Method	: Hollow Stem Auger
Location	: SW,NE,NE Sec 14	Drill Equipment	: Ingersoll-Rand A-300
Hole Diameter	: 6-5/8 in.	Drilled By	: Atkins Eng. Assoc.
		Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3471	Samples	Sample From:	Blows / Length (ft)	Recvy. (ft)	GRAPHIC	USCS	DESCRIPTION
0			CT				ML	0-1 ft. Clayey silt, brown, with roots and some organic matter, clay clods, friable, with some surface gravels
	3470		SS	17/2'	1.1			1-3 ft. Clayey silt to silty clay with frequent gravel Gravel lens at 3 ft.
			SS	33/2'	1.8		CL	3-5 ft. Silty clay with occassional limestone gravel at 4 ft.
5			SS	39/2'	--			5-7 ft. silty clay, light brown (buff), occassional small gravel or caliche pebble
	3465		CT				GC	7-9 ft. Gravel
10	3460							
15	3455							
20	3450							
25								

Notes:
Located on west side of gas well road 0.25 mile south of paved road to ranch headquarters. Collected sample at 1, 3 and 6 feet below surface. Boring dry. Total depth 9 feet. Backfilled with cuttings.

05-28-1998 C:\Mtech46\Yates\sb-01.bor

LOG OF BORING SB-2

YATES PETROLEUM CORPORATION

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date Bored	: 02/07/98	Drilling Method	: Hollow Stem Auger
Location	: SE,SW,NE Sec 14	Drill Equipment	: Ingersoll-Rand A-300
Hole Diameter	: 6-5/8 in.	Drilled By	: Atkins Eng. Assoc.
		Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3474	Samples	Sample From:	Blows / Length (ft)	Recvy. (ft)	GRAPHIC	USCS	DESCRIPTION
0							ML	0-1 ft. Clayey silt, brown, with roots and some organic matter, clay clods, friable
			CT				CL	3 ft. Silty clay, light brown with occassional small gravel
	3470						GC	4-6 ft. Gravel lens
5			CT				CL	6 ft. Silty clay, light brown with frequent small gravel
	3465						GC	Gravel zone 9.5 ft. Cease drilling.
10								
	3460							
15								
	3455							
20								
	3450							
25								

Notes:
Located on north side of fence 0.25 mile east of Section 14 quarter section post at center of section. Collected samples at 1, 3 and 6 feet below surface. Boring dry. Backfilled with cuttings.

05-28-1998 C:\Mtech46\Yates\sb-02.bor

LOG OF BORING SB-3

YATES PETROLEUM CORPORATION

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date Bored	: 02/07/98	Drilling Method	: Hollow Stem Auger
Location	: SW,NE,SW Sec 14	Drill Equipment	: Ingersoll-Rand A-300
Hole Diameter	: 6-5/8 in.	Drilled By	: Atkins Eng. Assoc.
		Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3489	Samples	Sample From:	Blows / Length (ft)	Recvy. (ft)	GRAPHIC	USCS	DESCRIPTION
0							ML	0-1 ft. Clayey silt, brown, with roots and some organic matter, clay clods, friable
			CT				CL	3 ft. Silty clay, light brown with occassional hard clay clods
	3485							
5			CT					6 ft. Silty clay, light brown with occassional small gravel
							GC	Gravel zone 7.5 ft. Cease drilling.
	3480							
10								
	3475							
15								
	3470							
20								
	3465							
25								

Notes:
Located opposite tank battery on west side of gas well road 0.6 mile south of paved road to ranch headquarters.
Collected samples at 1, 3 and 6 feet below surface.
Boring dry. Backfilled with cuttings.

05-28-1998 C:\Mtech46\Yates\sb-03.bor

LOG OF BORING SB-4

YATES PETROLEUM CORPORATION

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date Bored	: 02/07/98	Drilling Method	: Hollow Stem Auger
Location	: NW,SE,NW Sec 14	Drill Equipment	: Ingersoll-Rand A-300
Hole Diameter	: 6-5/8 in.	Drilled By	: Atkins Eng. Assoc.
		Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3486	Samples	Sample From:	Blows / Length (ft)	Recvy. (ft)	GRAPHIC	USCS	DESCRIPTION
0							ML	0-1 ft. Clayey silt, brown, with roots and some organic matter, clay clods, friable
	3485		CT				CL	3 ft. Silty clay, light brown, dry crumbly, very plastic when wet
5								
	3480		CT					6 ft. Silty clay, light brown with occassional small caliche gravel
							GC	Gravel zone 7.5 ft. Cease drilling.
10	3475							
15	3470							
20	3465							
25								

Notes:
Located on west side of gas well road 0.3 mile south of paved road to ranch headquarters. Collected samples at 1, 3 and 6 feet below surface. Boring dry. Backfilled with cuttings.

05-28-1998 C:\Mtech46\Yates\sb-04.bor

LOG OF BORING SB-5

YATES PETROLEUM CORPORATION

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date Bored	: 02/07/98	Drilling Method	: Hollow Stem Auger
Location	: SW,NE,NE Sec 15	Drill Equipment	: Ingersoll-Rand A-300
Hole Diameter	: 6-5/8 in.	Drilled By	: Atkins Eng. Assoc.
		Logged By	: D.G. Boyer

Sample Condition:
- Remoulded
- Undisturbed
- Lost
- Rock Core

Sample From:
- SS Split Spoon
- ST Shelby Tube
- CT Auger Cuttings
- CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3501	Sample From:	Blows / Length (ft)	Recvy. (ft)	USCS	DESCRIPTION
0	3500	CT			ML	0-1 ft. Clayey silt, brown, with roots and some organic matter, clay clods, friable
5	3495	CT			CL	3 ft. Silty clay, light brown, dry crumbly, very plastic when wet 6 ft. Silty clay, light brown, dry crumbly, very plastic when wet
10	3490				GC	Gravel zone 10 ft. Cease drilling.
15	3485					
20	3480					
25						

Notes:
Located 0.1 mile west of pipeline road dividing Sections 15 and 14, and 0.2 mile south of paved road to ranch headquarters. Collected samples at 1, 3 and 6 feet below surface. Boring dry. Backfilled with cuttings.

05-26-1998 C:\Mtech46\Yatestsb-05.bor

LOG OF BORING SB-6

YATES PETROLEUM CORPORATION

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date Bored	: 02/07/98	Drilling Method	: Hollow Stem Auger
Location	: SE,NW,SE Sec 15	Drill Equipment	: Ingersoll-Rand A-300
Hole Diameter	: 6-5/8 in.	Drilled By	: Atkins Eng. Assoc.
		Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3513	Samples	Sample From:	Blows / Length (ft)	Recvy. (ft)	GRAPHIC	USCS	DESCRIPTION
0							ML	0-1 ft. Clayey silt, light brown, with roots and some organic matter, clay clods, friable
			CT					3 ft. Silty clay, light brown, dry crumbly, very plastic when wet
5								
			CT					6 ft. Silty clay, light brown, dry crumbly, very plastic when wet
10								
			CT				CL	
	3500							
15								6-23 ft. Silty clay, light brown
			CT					
	3495							
20								
			CT					
	3490						GC	Gravel zone 23 ft. Cease drilling.
25								Notes: Located 0.3 mile west of pipeline road dividing Sections 15 and 14, and 0.3 mile north of dirt road dividing Sections 15 and 22. Collected samples at 1, 3 and 6 feet below surface. Boring dry. Backfilled with cuttings.

05-28-1998 C:\Mtech46\Yates\sb-06.bor

LOG OF BORING SB-7

YATES PETROLEUM CORPORATION

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date Bored	: 02/07/98	Drilling Method	: Hollow Stem Auger
Location	: SE,NW,SE Sec 15	Drill Equipment	: Ingersoll-Rand A-300
Hole Diameter	: 6-5/8 in.	Drilled By	: Atkins Eng. Assoc.
		Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3504	Samples	Sample From:	Blows / Length (ft)	Recvy. (ft)	GRAPHIC	USCS	DESCRIPTION
0							ML	0-1 ft. Clayey silt, brown, with roots and some organic matter, clay clods, friable
			CT					3 ft. Silty clay, brown, dry crumbly, very plastic when wet
	3500							
5								6 ft. Silty clay, brown, dry crumbly, very plastic when wet
			CT				CL	
	3495							
10			CT					
							GC	Gravel zone 12.5 ft. Cease drilling.
	3490							
15								
	3485							
20								
	3480							
25								

Notes:
Located ~50 ft. west of pipeline road dividing Sections 15 and 14, and ~100 ft. north of dirt road dividing Sections 15 and 22. Collected samples at 1, 3 and 6 feet below surface. Boring dry. Backfilled with cuttings.

05-28-1998 C:\Mtech46\Yates\sb-07.bor

LOG OF BORING SB-8

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date Bored	: 02/07/98	Drilling Method	: Hollow Stem Auger
Location	: SW,NW,SW Sec 15	Drill Equipment	: Ingersoll-Rand A-300
Hole Diameter	: 6-5/8 in.	Drilled By	: Atkins Eng. Assoc.
		Logged By	: D.G. Boyer

Sample Condition:
- Remoulded
- Undisturbed
- Lost
- Rock Core

Sample From:
- SS Split Spoon
- ST Shelby Tube
- CT Auger Cuttings
- CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3532	Samples	Sample From:	Blows / Length (ft)	Recvy. (ft)	GRAPHIC	USCS	DESCRIPTION
0							ML	0-1 ft. Clayey silt, brown, with roots and some organic matter, clay clods, friable
	3530		CT					3 ft. Silty clay, brown, dry crumbly, very plastic when wet
5							CL	
	3525		CT					6 ft. Silty clay, brown, dry crumbly, very plastic when wet
10							GC	Gravel zone at 10.5 ft. Cease drilling.
	3520							
15								
	3515							
20								
	3510							
25								

Notes:
Located 0.2 mile north of oil field road, and 0.1 mile east of dirt road dividing Sections 15 and 16. Collected samples at 1, 3 and 6 feet below surface. Boring dry. Backfilled with cuttings.

05-28-1998 C:\Mtech46\Yates\sb-08.bor

LOG OF BORING SB-9

YATES PETROLEUM CORPORATION

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date Bored	: 02/07/98	Drilling Method	: Hollow Stem Auger
Location	: NW,NW,NW Sec 22	Drill Equipment	: Ingersoll-Rand A-300
Hole Diameter	: 6-5/8 in.	Drilled By	: Atkins Eng. Assoc.
		Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3537	Samples	Sample From:	Blows / Length (ft)	Recvy. (ft)	GRAPHIC	USCS	DESCRIPTION
0								
	3535		CT				ML	0-1 ft. Clayey silt, brown, with roots and some organic matter, clay clods, friable 3 ft. Clayey silt, brown, with roots and some organic matter, clay clods, friable (light brown clay zone deeper at this location, possiby due to cattle impact near windmill)
5								
	3530		CT					6 ft. Silty clay, light brown, dry crumbly, very plastic when wet
10								
	3525		CT				CL	
15								6-23 ft. Silty clay, light brown
	3520		CT					
20								
	3515						GC	Gravel zone 21 ft. Cease drilling.
25								

Notes:
Located ~25 ft. north of corral gates north of Section 22 windmill and south of dirt road dividing Sections 15 and 22. Collected samples at 1, 3 and 6 feet below surface. Boring dry. Backfilled with cuttings.

05-28-1998 C:\Mtech46\Yates\sb-09.bor

YATES PETROLEUM CORPORATION

LOG OF BORING SB-10

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date Bored	: 02/07/98	Drilling Method	: Hollow Stem Auger
Location	: NE,SW,SE Sec 16	Drill Equipment	: Ingersoll-Rand A-300
Hole Diameter	: 6-5/8 in.	Drilled By	: Atkins Eng. Assoc.
		Logged By	: D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample From: SS Split Spoon; ST Shelby Tube; CT Auger Cuttings; CB 5 ft. Core Barrel

Depth in Feet	Surf. Elev. 3546	Samples	Sample From:	Blows / Length (ft)	Recvy. (ft)	GRAPHIC	USCS	DESCRIPTION
0							ML	0-1 ft. Clayey silt, brown, with roots and some organic matter, clay clods, friable
	3545		CT					3 ft. Silty clay, light brown, dry crumbly, very plastic when wet
5							CL	
	3540		CT					6 ft. Silty clay, light brown, dry crumbly, very plastic when wet
10							GC	Gravel zone at 10 ft. Cease drilling.
	3535							
15								
	3530							
20								
	3525							
25								

Notes:
Boring is located 0.2 miles east of cattle guard crossing (of paved road leading to ranch headquarters) on dirt road leading to Section 22 windmill. Collected samples at 1, 3 and 6 feet below surface. Boring dry. Backfilled with cuttings.

05-28-1998 C:\Mtech46\Yates\sb-10.bor

APPENDIX A2

MONITOR WELL COMPLETION LOGS

LOG OF WELL MW-1

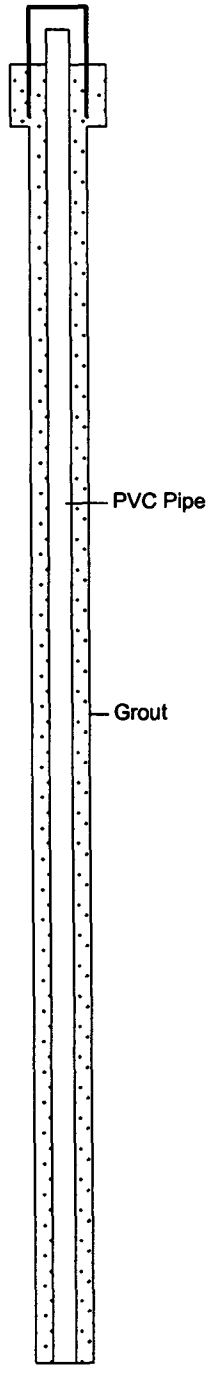
YATES PETROLEUM CORPORATION

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/02/98, 0945	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/04/98, 1230	Drill Equipment	: Ingersoll-Rand A-300
Location	: SE,SE,SW Sec 14	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Depth in Feet	Surf. Elev. 3487	GRAPHIC	USCS	DESCRIPTION
0			ML	0-3 ft. Top soil, clayey silt becoming silty clay at 3 ft., brown, moist, very plastic
	3485			
5			GW	3-5 ft. Gravel, limestone, rounded, 1/4 - 1 1/2 in. 5-7 ft. Gravel 7-8 ft. Soft
	3480			
10			GM	8-13 ft. Gravel with clayey sand, light brown Auger refusal at 10 ft. Switch to drill bit - log from cuttings.
	3475			
15			GC	13-18 ft. Gravel with clay and sand, gravel to 2 in., rounded, uniform.
	3470			18-20 ft. Gravel with clay & sand, very hard drilling @20'
20			GP	20-21 ft. Gravel, pea-sized, 1/4-3/8"
	3465			
			GW	23-25 ft. Very hard drilling, cobble-sized gravel chips returned
25				25-28 ft. Cobble sized gravels returned, but drilling easier
	3460			
30				28-33 ft. Gravelly clay, soft drilling
	3455			
				33-38 ft. Installed 5 ft. core barrel. 33-34.3 ft. Clay, brown, stiff, plastic w/ caliche inclusions 34.3-34.8 ft. Caliche, white with clay and limestone fragments and chips.
35			CL	
	3450			
40				38-43 ft. Caliche clay, white with limestone inclusions
	3445			
45				43-48 ft. Switch to drill bit - log from cuttings. Clay, brown, soft, plastic with some sand grains
	3440			48-53 ft. Clay, brown, very plastic, no sand grains.
50				

Well: MW-1
Elev.: 3489.4



Well Construction Information

DRILLING INFORMATION

Date completed	: 02/04/98
Hole diameter	: 8 1/4 in.
Depth Hole BLS	: 148.5 ft.
Drilling Method	: HSA
Drilled by	: Atkins Engineering
Logged by	: D. G. Boyer

CASING, SCREEN & CAP

Material, joints	: PVC, threaded
Diameter	: 2 in. ID
Screen type	: Johnson Slotted
Screen length	: 15 ft.
Screen opening	: 0.020 slot
Scrn. placement	: 133 - 148 ft. BLS
Bottom Cap	: 0.2 ft PVC
Protector Casing	: Above-ground steel

SEALS & SAND PACK

Cement seal type	: El Toro Type II : Portland, 26 bags
Seal placement	: 0 - 125 ft. BLS
Annular seal type	: Med. bentonite : chips, ("Pure Gold")
Seal placement	: 125 - 127 ft. BLS
Sand pack type	: 08-16 CSSI silica : sand
Sand placement	: 127-148 ft. BLS

ELEVATIONS

Ground elevation	: 3,487 ft. (approx.)
Inner casing, top	: 3,489.4 ft. (approx.)
Outer casing, top	:

NOTES

Notes:
Depth to water 1700, 02/03/98, 142.57 ft. below land surface (BLS), conductivity 1,100 umhos @ 72°F, pH ~6.8.
Depth to water at 0800, 02/04 is 133 ft. BLS (shown on diagram).
On 2/7/98 well was developed by surging and bailing. Approximately 7.5 gallons of water were removed and the water had a final conductivity of 1,250 umhos/cm with a pH of ~6.8. During deveolpment, water levels declined from 126.5 to 131.4 ft. BLS.
On 2/9 the well was sampled after purging an additional 2.5 gallons. No water level was avaliable due to probe failure. Final conductivity 1,250 umhos/cm, pH 6.5.
On 03/02/98, DTW is 129.51 ft. below top of casing (BTC).

05-28-1998 C:\Mtech46\Yates\mon_well\mw-1.bor

LOG OF WELL MW-2

YATES PETROLEUM CORPORATION

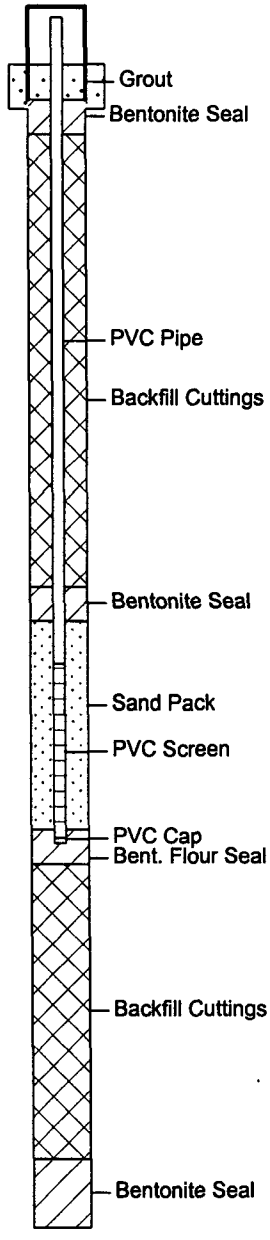
Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/04/98, 1340	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/05/98, 1115	Drill Equipment	: Ingersoll-Rand A-300
Location	: NE,NW,SW Sec 15	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Depth in Feet	Surf. Elev. 3524	GRAPHIC	USCS	DESCRIPTION
0			ML	0-5 ft. Top soil, clayey silt, light brown with roots and white streaks
5	3520			5-8.5 ft. Clayey silt, light brown with increasing small gravel.
10	3515		GW	At 8.5 ft. core barrel became stuck in gravel and torqued into corkscrew, no recovery (Photo taken)
15	3510			10-15 ft. Limestone gravel to 1 1/2 in., rounded, with clay
20	3505			15-20 ft. Limestone gravel to 2 in., mixed size, little clay
25	3500			20-25 ft. Gravel, same as above, size to 3 in.
30	3495			25-30 ft. Gravel, same as above
35	3490			30-35 ft. Gravel, same as above Pea gravel at 33 ft.
40	3485		GC	35-40 ft. Clayey gravel with increasing clay at 40 ft.
45	3480			40-43 ft. Gravel to 43 ft. then clay
50	3475		CL	44-46 ft. Splitspoon. Silty clay, brown, stiff, dry, crumbly, very plastic when wetted. (Photo taken)
55	3470			46-50 ft. Clay, dry, same as above
60	3465			50-55 ft. Hard drilling at 52 ft., no gravel "chatter", returns are gravel from upper zones
65	3460			55-57 ft. Splitspoon. Clay with caliche, occassional limestone inclusions, clay brown with white specks, brown staining and black (iron?) streaks.
70	3455			57-65 ft. Clay with caliche as above.
75	3450			65-67 ft. Splitspoon. Caliche clay, very light brown, with limestone pebbles and fragments, dry, crumbly

Notes:
Boring dry. Backfilled with bentonite to 63 ft. Backfilled with cuttings to 46 ft. then with bentonite flour to 44 ft. Completed as monitor well. See B-2 log for drilling and lithologic details.

Well: MW-2
Elev.: 3526.75



Well Construction Information

DRILLING INFORMATION

Date completed	: 02/04/98
Hole diameter	: 8 1/4 in.
Depth Hole BLS	: 67 feet
Drilling Method	: HSA
Drilled by	: Atkins Engineering
Logged by	: D. G. Boyer

CASING, SCREEN & CAP

Material, joints	: PVC, threaded
Diameter	: 2 in. ID
Screen type	: Johnson Slotted
Screen length	: 10 ft.
Screen opening	: 0.020 slot
Scrn. placement	: 34.5 - 44.5 ft. BLS
Bottom Cap	: 0.2 ft PVC
Protector Casing	: Above-ground steel

SEALS & SAND PACK

Cement seal type	: Type II Portland
Seal placement	: 0 - 2 ft. BLS
Annular seal type	: Med. Bentonite chips
Seal placement	: 2 - 4 ft. BLS
Annular seal type	: Cuttings
Seal placement	: 4 - 30 ft. BLS
Annular seal type	: Med. Bentonite chips
Seal placement	: 30 - 32 ft. BLS
Sand pack type	: 08-16 CSSI silica
Sand placement	: 32 - 44 ft. BLS

ELEVATIONS

Ground elevation	: 3,524 ft. (approx.)
Inner casing, top	: 3,526.8 ft. (approx.)

NOTES

Boring dry on 02/05/98. On 03/02/98 DTW was 44 ft. BLS. This is water in casing cap which is appoximately 1 ft. into clay zone at base of gravels. Water is likely "sweat" from casing condensation plus water which was put into hole opposite gravel zone to hydrate bentonite.

05-28-1998 C:\Mtech46\Yates\mon_well\mw-2.bor

LOG OF WELL MW-3

YATES PETROLEUM CORPORATION

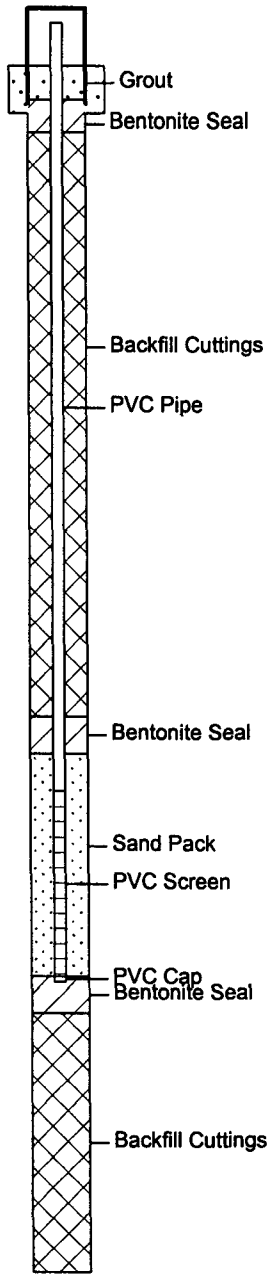
Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/05/98, 1130	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/05/98, 1700	Drill Equipment	: Ingersoll-Rand A-300
Location	: NE,NE,SE Sec 15	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Depth in Feet	Surf. Elev. 3497	GRAPHIC	USCS	DESCRIPTION
0	3495		ML	0-5 ft. Clayey silt, brown grading to very light brown at base with increasing clay. Plant roots. (Photo taken)
5	3490		CL	5-10 ft. Silty clay, light brown. Gravel lens at 9 ft.
10	3485			10-15 ft. Silty clay, light brown with occassional gravel
15	3480		GW	15-20 ft. Gravel, sized from 3/4 in. - 2 in., non-uniform
20	3475			20-25 ft. Gravel, same as above
25	3470			25-30 ft. Gravel, some pea gravel
30	3465			30-33 ft. Gravel, same as above
35	3460		GC	33-35 ft. Gravel with clay at 33 ft. Very hard drilling, possible caliche
40	3455			35-40 ft. Gravel with silty clay, very hard drilling, lots of drill chatter, auger catching, likely cemented gravel and caliche
45	3450			40-45 ft. Clayey gravel, as above
50	3445		CL	45-47.5 ft. Clayey gravel, as above
55	3440			47.5-50.5 ft. Soft drilling, splitspoon sample. Clay, very light brown becoming brown at base, stiff, very plastic
60	3435			50.5-55 ft. Clay, same as above, returns dusty
65	3430			55-60 ft. Silty clay, cuttings show some small gravels and very coarse sand
70				60-65 ft. Clay to 63 ft. then hard drilling, possible caliche.

Notes:
Boring dry. Backfill to 51ft. then bentonite to 49 ft. for casing set. See B-3 log for drilling and lithologic details.

Well: MW-3
Elev.: 3499.35



Well Construction Information

DRILLING INFORMATION

Date completed	: 02/05/98
Hole diameter	: 8 1/4 in.
Depth Hole BLS	: 65 feet
Drilling Method	: HSA
Drilled by	: Atkins Engineering
Logged by	: D. G. Boyer

CASING, SCREEN & CAP

Material, joints	: PVC, threaded
Diameter	: 2 in. ID
Screen type	: Johnson Slotted
Screen length	: 10 ft.
Screen opening	: 0.020 slot
Scrn. placement	: 39 - 49 ft. BLS
Bottom Cap	: 0.2 ft PVC
Protector Casing	: Above-ground steel

SEALS & SAND PACK

Cement seal type	: Type II Portland
Seal placement	: 0 - 1.8 ft. BLS
Annular seal type	: Med. Bentonite chips
Seal placement	: 1.8 - 3.5 ft. BLS
Annular seal type	: Cuttings
Seal placement	: 3.5 - 35 ft. BLS
Annular seal type	: Med. Bentonite chips
Seal placement	: 35 - 37 ft. BLS
Sand pack type	: 08-16 CSSI silica
Sand placement	: 37 - 49 ft. BLS

ELEVATIONS

Ground elevation	: 3,497 ft. (approx.)
Inner casing, top	: 3,499.4 ft. (approx.)

NOTES

Boring dry on 02/05/98. On 03/02/98 DTW was 48.8 ft. BLS. This is water in casing cap which is appoximately 1 ft. into clay zone at base of gravels. Water is likely "sweat" from casing condensation plus water which was put into hole opposite gravel zone to hydrate bentonite.

05-28-1998 C:\Mtech46\Yates\mon_well\mw-3.bor

LOG OF WELL MW-4

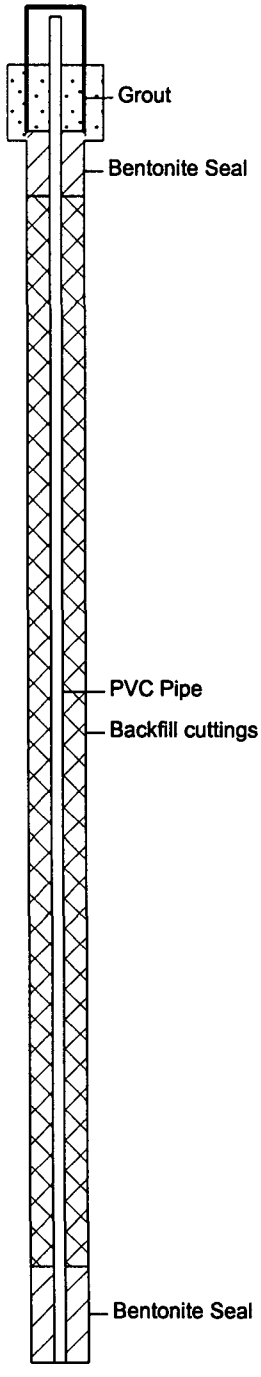
YATES PETROLEUM CORPORATION

Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/06/98, 0800	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/06/98, 1345	Drill Equipment	: Ingersoll-Rand A-300
Location	: SE,SE,SW Sec 15	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Depth in Feet	Surf. Elev. 3520	GRAPHIC	USCS	DESCRIPTION
0			ML	0-5 ft. Clayey silt, brown grading to very light brown at base with increasing clay. Plant roots. Core barrel shows brown clay with caliche, dry, crumbly
5	3515		CL	5-10 ft. Silty clay, light brown, with very fine grained sand and occassional coarse grains.
10	3510			
15	3505			10-17 ft. Silty clay, light brown, same as above
			GC	17-19 ft. Gravel lens then silty clay
20	3500		CL	19-25 ft. Silty Clay, light brown
25	3495		GC	25-33 ft. Gravel, 3/4" - 2" with silty clay matrix
30	3490			
			CL	33-35 ft. Soft at 33 ft. Splitspoon sample: Clay, light brown with very fine-grained sand. Gravel in tip.
35	3485		CG	35-40 ft. Clayey gravel with very fine-grained sand
40	3480			

Well: MW-4
Elev.: 3522.3



Well Construction Information

DRILLING INFORMATION

Date completed	: 02/06/98
Hole diameter	: 8 1/4 in.
Depth Hole BLS	: 69 feet
Drilling Method	: HSA
Drilled by	: Atkins Engineering
Logged by	: D. G. Boyer

CASING, SCREEN & CAP

Material, joints	: PVC, threaded
Diameter	: 2 in. ID
Screen type	: Johnson Slotted
Screen length	: 20 ft.
Screen opening	: 0.020 slot
Scrn. placement	: 43 - 63 ft. BLS
Bottom Cap	: 0.3 ft PVC
Protector Casing	: Above-ground steel

SEALS & SAND PACK

Cement seal type	: Type II Portland
Seal placement	: 0 - 2 ft. BLS
Annular seal type	: Med. Bentonite chips
Seal placement	: 2 - 4 ft. BLS
Annular seal type	: Cuttings
Seal placement	: 4 - 37 ft. BLS
Annular seal type	: Med. Bentonite chips
Seal placement	: 37 - 41 ft. BLS
Sand pack type	: 08-16 CSSI silica
Sand placement	: 41 - 63 ft. BLS

ELEVATIONS

Ground elevation	: 3,520 ft. (approx.)
Inner casing, top	: 3,522.3 ft. (approx.)

NOTES

Boring dry on 02/06/98. On 03/02/98 DTW was 64 ft. BLS. This is water in casing cap which is appoximately 1 ft. into clay zone at base of gravels. Water is likely "sweat" from casing condensation plus water which was put into hole opposite gravel zone to hydrate bentonite.

05-28-1998 C:\Mtech46\Yates\mon_well\mw-4.bor

LOG OF WELL MW-4

YATES PETROLEUM CORPORATION

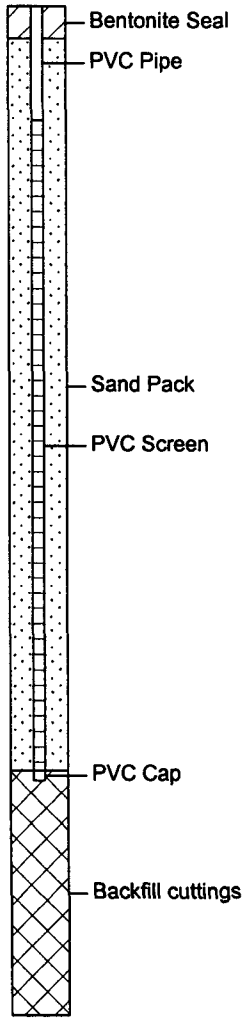
Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/06/98, 0800	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/06/98, 1345	Drill Equipment	: Ingersoll-Rand A-300
Location	: SE,SE,SW Sec 15	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Depth in Feet	Surf. Elev. 3520	GRAPHIC	USCS	DESCRIPTION
40			GW	40-42 ft. Gravel (pea gravel size), uniform with some clay
			CG	42-45 ft. Soft at 42-42.7ft. Splitspoon sample: Gravelly clay, very light brown to chalk color, gravel mixed sizes, rounded, some cementing between gravels (possible precurser to caliche?). Very hard drilling 43-45 ft.
45	3475		GW	45-50 ft. Gravel, cuttings returned mixed size gravels.
50	3470		CL	50-54 ft. Soft drilling, clay returns, splitspoon sample: Clay, light brown, stiff, plastic, with occassional lime-stone inclusion and caliche streaks. Dry but moisture on barrel. (Photo)
55	3465		GW	54-57 ft. Gravel to 57 feet. Very dry, added 5 gallons water at 57 ft. for cuttings return.
60	3460			57-63 ft. Very hard drilling to 63 feet. Possible clayey gravel or caliche
65	3455		CL	63-69 ft. soft at 63 ft. Clay returns 63-69 ft.
70	3450			69-71 ft. Splitspoon sample: Clay, brown, dry, crumbly, plastic, low silt. (Photo taken)
75	3445			
80	3440			

Notes:
Boring dry. See B-4 log for drilling and lithologic details.

Well: MW-4
Elev.: 3522.3



Well Construction Information

DRILLING INFORMATION

Date completed	: 02/06/98
Hole diameter	: 8 1/4 in.
Depth Hole BLS	: 69 feet
Drilling Method	: HSA
Drilled by	: Atkins Engineering
Logged by	: D. G. Boyer

CASING, SCREEN & CAP

Material, joints	: PVC, threaded
Diameter	: 2 in. ID
Screen type	: Johnson Slotted
Screen length	: 20 ft.
Screen opening	: 0.020 slot
Scrn. placement	: 43 - 63 ft. BLS
Bottom Cap	: 0.3 ft PVC
Protector Casing	: Above-ground steel

SEALS & SAND PACK

Cement seal type	: Type II Portland
Seal placement	: 0 - 2 ft. BLS
Annular seal type	: Med. Bentonite chips
Seal placement	: 2 - 4 ft. BLS
Annular seal type	: Cuttings
Seal placement	: 4 - 37 ft. BLS
Annular seal type	: Med. Bentonite chips
Seal placement	: 37 - 41 ft. BLS
Sand pack type	: 08-16 CSSI silica
Sand placement	: 41 - 63 ft. BLS

ELEVATIONS

Ground elevation	: 3,520 ft. (approx.)
Inner casing, top	: 3,522.3 ft. (approx.)

NOTES

Boring dry on 02/06/98. On 03/02/98 DTW was 64 ft. BLS. This is water in casing cap which is appoximately 1 ft. into clay zone at base of gravels. Water is likely "sweat" from casing condensation plus water which was put into hole opposite gravel zone to hydrate bentonite.

05-28-1998 C:\Mtech46\Yates\mon_well\mw-4.bor

LOG OF WELL MW-5

YATES PETROLEUM CORPORATION

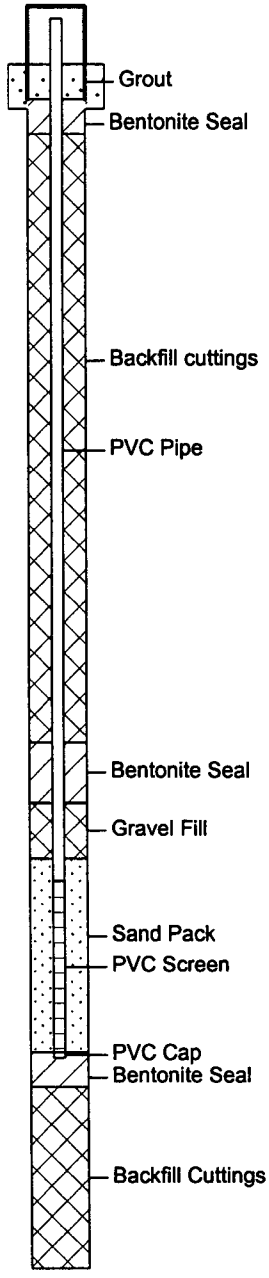
Yates Petroleum Corporation
Penasco Irrigation Project
4-Dinkus Ranch

Date, Time Start	: 02/06/98, 1415	Drilling Method	: Hollow Stem Auger
Date, Time Finish	: 02/06/98, 1930	Drill Equipment	: Ingersoll-Rand A-300
Location	: NW,SW,NE Sec 16	Drilled By	: Atkins Eng. Assoc.
Hole Diameter	: 6-5/8 in.	Logged By	: D.G. Boyer

Depth in Feet	Surf. Elev. 3555	GRAPHIC	USCS	DESCRIPTION
0				
5	3550		CL	0-5 ft. Top soil, silty clay, dark brown grading to light brown at base. (Photo taken)
10	3545			5-10 ft. Silty clay, light brown, clean 10-13 ft. Silty clay, light brown
15	3540		GC	Gravel 13-14 ft. grading to clayey gravel at 15 ft. 15-20 ft. Gravel with silty clay, limestone gravels to 3 in., rounded
20	3535			20-25 ft. Gravel, same as above, mixed sizes
25	3530		GW	25-30 ft. Gravel, mixed sizes, clean
30	3525			30-35 ft. Gravel (Photo taken)
35	3520			35-40 ft. Gravel, same as above, more pea gravel, very few fines
40	3515			40-45 ft. Gravel, same as above, very clean
45	3510			45-50 ft. Gravel, pea gravel at 47.5 ft.
50	3505			50-55 ft. Gravel, softer drilling, pea gravel at 53 ft.
55	3500			55-57 ft. Gravel, pea gravel, increasing clay
60	3495		CL	57-59 ft. Splitspoon. Clay, brown, plastic, slightly moist (Photo taken)
65	3490			59-67 ft. Clay, brown, plastic, slightly moist 67.5-69.5 ft. Splitspoon. Clay, brown, same as above
70	3485			Notes: Boring dry. Backfill to 59 ft. then bentonite to 57 ft. See B-5 log for drilling and lithologic details.
75	3480			

Well: MW-5

Elev.: 3557.65



Well Construction Information

DRILLING INFORMATION

Date completed	: 02/06/98
Hole diameter	: 8 1/4 in.
Depth Hole BLS	: 69 feet
Drilling Method	: HSA
Drilled by	: Atkins Engineering
Logged by	: D. G. Boyer

CASING, SCREEN & CAP

Material, joints	: PVC, threaded
Diameter	: 2 in. ID
Screen type	: Johnson Slotted
Screen length	: 10 ft.
Screen opening	: 0.020 slot
Scrn. placement	: 47 - 57 ft. BLS
Bottom Cap	: 0.3 ft PVC
Protector Casing	: Above-ground steel

SEALS & SAND PACK

Cement seal type	: Type II Portland
Seal placement	: 0 - 2 ft. BLS
Annular seal type	: Med. Bentonite chips
Seal placement	: 2 - 4 ft. BLS
Annular seal type	: Cuttings
Seal placement	: 4 - 39 ft. BLS
Annular seal type	: Med. Bentonite chips
Seal placement	: 39 - 42.5 ft. BLS
Sand pack type	: 08-16 CSSI silica
Sand placement	: 45.7 - 57 ft. BLS

ELEVATIONS

Ground elevation	: 3,555 ft. (approx.)
Inner casing, top	: 3,557.65 ft. (approx.)

NOTES

Boring dry on 02/06/98. On 03/02/98 DTW was 57 ft. BLS. This is water in casing cap which is appoximately 0.5 ft. into clay zone at base of gravels. Water is likely "sweat" from casing condensation plus water which was put into hole opposite gravel zone to hydrate bentonite.

05-28-1998 C:\Mtech46\Yates\mon_well\mw-5.bor

APPENDIX B

COPIES OF AVAILABLE DRILLER'S LOGS

Form W LOG FILED STATE ENGINEER OFFICE

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(Plat of 640 acres)

(A) Owner of well E. R. Powell

Street and Number Rt. 1 Box 202

City Artesia State New Mex

Well was drilled under Permit No. LM* 4060 and is located in the NW ¼ SW ¼ of Section 10 Twp. 18 S Rge. 25 E

(B) Drilling Contractor D. N. Gray License No. WD-19

Street and Number 1007 No.

City Artesia State New Mex.

Drilling was commenced July 17 19 59

Drilling was completed Aug. 9 19 59

Elevation at top of casing in feet above sea level Total depth of well 300 Ft.

State whether well is shallow or artesian shallow Artesian Depth to water upon completion 168

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	275	295	20	Sand (Chalk Bluff)
2				
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
7		10	0	234	234	collar		
5 OD			225	300	75	none	243	300

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor License No.

Street and Number City State

Tons of Clay used Tons of Roughage used Type of roughage

Plugging method used Date Plugged 19

Plugging approved by:

State Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received 1959 AUG 26 PM 1:38

File No. LM-4068 Use Dom. Location No. 18.25.10.310

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	4	4		Soil
4	135	131		Gravel & Boulders
135	150	15		Clay
150	180	30		Gravel & Boulders
180	200	20		Sand & Gravel Blue clay mixed
200	272	72	Blue	Clay
272	275	3	Red	Clay
275	295	20		Sand
295	300	5		Anhydrite
	Base of valley fill			190 ±

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Lon M. Gray
Well Driller

(This form is to be executed in triplicate)

WELL RECORD

Date of Receipt ..... Permit No. RA-3159

Name of permitee, George Mellen

Street or P. O. Artesia, City and State New Mexico

1. Well location and description: The ..... (shallow or artesian) well is located in ..... ¼, ... ¼, ... ¼ of Section ....., Township ....., Range .....; Elevation of top of casing above sea level, ... feet; diameter of hole, 6¼ inches; total depth, 270 feet; depth to water upon completion, 230 feet; drilling was commenced Dec., 19 53, and completed Jan., 19 54; name of drilling contractor W. A. Nelson

Rt. 2, Box 179; Address, Roswell; Driller's License No. 157

2. Principal Water-bearing Strata:

	Depth in Feet From	To	Thickness	Description of Water-bearing Formation
No. 1	245	250	5	gray shale
No. 2				
No. 3				
No. 4				
No. 5				

3. Casing Record:

Diameter in Inches	Pounds per ft.	Threads per inch	Depth of Casing or Liner Top	Bottom	Feet of Casing	Type of Shoe	Perforation From	To
7 O.D.			35	5 inch	72		230	250

4. If above construction replaces old well to be abandoned, give location: ..... ¼, ... ¼, ... ¼ of Section ....., Township ....., Range .....; name and address of plugging contractor,

.....

.....

date of plugging ....., 19.....; describe how well was plugged: .....

.....

.....

.....

Sent copy to S.F. - 1-11-56

RA-3159

18.25.18.110

RA-3159

5. Log of Well:

Depth in Feet From	Depth in Feet To	Thickness in feet	Description of Formation
0	50	50	gravel and white clay
50	110	60	red bed
110	150	40	gray clay
150	240	90	Red bed
240	270	30	yellow sand and sand rock

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

W. G. Melson
Licensed Well Driller

Instructions

This form shall be executed, preferably typewritten, in triplicate and filed with the State Engineer's Office at Roswell, New Mexico, within 10 days after drilling has been completed. Data on water-bearing strata and on all formations encountered should be as complete and accurate as possible.

LOG FILED

Form WR-23 STATE ENGINEER OFFICE

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(Plat of 640 acres)

(A) Owner of well Lincoln County Livestock Co.
Street and Number Box 660
City Roswell State N. Mex.
Well was drilled under Permit No. RA-4344 and is located in the NW ¼ NW ¼ ¼ of Section 21 Twp. 18 S Rge. 25 E
(B) Drilling Contractor C. F. Smith License No. WD-28
Street and Number 306 W Chisum
City Artesia State N. Mex.
Drilling was commenced Dec. 2 19 60
Drilling was completed " 13 19 60

Elevation at top of casing in feet above sea level ____ Total depth of well 381
State whether well is shallow or artesian Rock Depth to water upon completion 220'

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1				Reamed out from 280' to 381'
2				
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor ____ License No. ____
Street and Number ____ City ____ State ____
Tons of Clay used ____ Tons of Roughage used ____ Type of roughage ____
Plugging method used ____ Date Plugged ____ 19 ____
Plugging approved by: ____ Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received 1/10 JAN 26 1961 8:29 AM

File No. RA-4344 Use Stock Dom. Location No. 18.25.21.110

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

C. F. Smith

Well Driller

RA-4344

Form WR-23 STATE ENGINEER OFFICE

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(A) Owner of well Lincoln County Livestock Co.
Street and Number Box 660
City Roswell State N. Mex.
Well was drilled under Permit No. RA 4365 and is located in the NW ¼ NW ¼ ¼ of Section 21 Twp. 18S Rge. 25E
(B) Drilling Contractor G. F. Smith License No. WD-38
Street and Number 306 W Chisum
City Artesia State N. M.
Drilling was commenced Jan 21 19 61
Drilling was completed Feb. 1 19 61

(Plat of 640 acres)

Elevation at top of casing in feet above sea level ____ Total depth of well 265'
State whether well is shallow or artesian Rock Depth to water upon completion 150'

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	230	240	10	sand & gravel
2				
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
7"					247	None	207'	247'

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor ____ License No. ____
Street and Number ____ City ____ State ____
Tons of Clay used ____ Tons of Roughage used ____ Type of roughage ____
Plugging method used ____ Date Plugged ____ 19 ____
Plugging approved by: ____ Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY
Date Received ____
STATE ENGINEER OFFICE
DISTRICT II
FEB 16 AM 8:23 1961

File No. RA 4365 Use Dom. & Stock Location No. 18.25.21.110

Section 6

LOG OF WELL

RA-4365

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	10	10		soil
10	20	10		gravel
20	50	30		gravel
50	70	20		Clay
70	90	20		Rock
90	105	15		Gravel
105	185	80		Clay
185	230	45		Clay sandy
230	240	10		Gravel
240	265	25		Gravel

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

R. F. Smith

Well Driller

Revised December 1975

IMPORTANT — READ INSTRUCTIONS ON BACK BEFORE FILLING OUT THIS FORM.

Declaration of Owner of Underground Water Right

ROSWELL/ARTESIA
BASIN NAME

Declaration No. RA-8141 Date received December 9, 1992

'93 FEB 19 AM ROSWELL

STATEMENT

1. Name of Declarant Yates Petroleum Corp
   Mailing Address 105 South 4th Street, Artesia, NM 88210
   County of Eddy, State of New Mexico
2. Source of water supply shallow water aquifer
   (artesian or shallow water aquifer)
3. Describe well location under one of the following subheadings:
   a. NW ¼ NW ¼ NW ¼ of Sec. 22 Twp. 18 S Rge. 25 E N.M.P.M., in Eddy County. (East well)
   b. Tract No. - of Map No. _____ of the _____
   c. X = - feet, Y = _____ feet, N. M. Coordinate System _____ Zone in the - Grant.
   On land owned by -
4. Description of well: date drilled 1920 ± driller unknown depth 300 feet. outside diameter of casing 7 inches; original capacity unknown gal. per min.; present capacity ≈ 2 gal. per min.; pumping lift unk feet; static water level unk feet (above) (below) land surface; make and type of pump none at this time
   make, type, horsepower, etc., of power plant -
   Fractional or percentage interest claimed in well 100%
5. Quantity of water appropriated and beneficially used 1 (acre feet per acre) 3 (acre feet per annum) for livestock & domestic purposes.
6. Acreage actually irrigated n/a acres, located and described as follows (describe only lands actually irrigated):

Subdivision	Sec.	Twp.	Range	Acres Irrigated	Owner
n/a					

(Note: location of well and acreage actually irrigated must be shown on plat on reverse side.)

'93 FEB 25 AM 9 54 STATE ENGINEER OFFICE SANTA FE NEW MEXICO

7. Water was first applied to beneficial use 1 (month) 1 (day) 1921± (year) and since that time has been used fully and continuously on all of the above described lands or for the above described purposes except as follows: n/a

'92 DEC 9 AM 3 55 STATE ENGINEER OFFICE ROSWELL NEW MEXICO

8. Additional statements or explanations n/a

Yates Petroleum Corporation bought ranch in 1985

I, _____ being first duly sworn upon my oath, depose and say that the above is a full and complete statement prepared in accordance with the instructions on the reverse side of this form and submitted in evidence of ownership of a valid underground water right, that I have carefully read each and all of the items contained therein and that the same are true to the best of my knowledge and belief.

Yates Petroleum Corp., declarant.

by: Jack McCaw

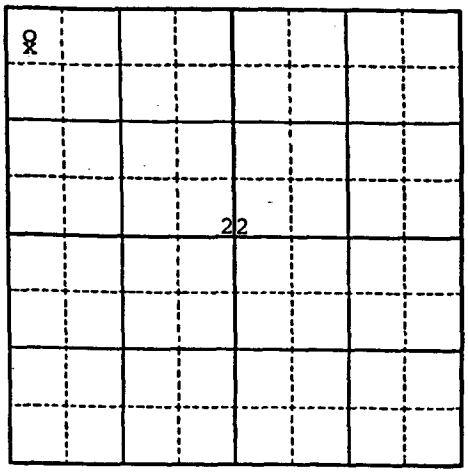
Subscribed and sworn to before me this 1st day of December, A.D. 19 92

My commission expires 3/9/96 Rhonda A. Becker Notary Public

FILED
UNDER NEW MEXICO LAW A DECLARATION IS ONLY A STATEMENT OF DECLARANT'S CLAIM. ACCEPTANCE FOR FILING DOES NOT CONSTITUTE APPROVAL OR REJECTION OF THE CLAIM.

Locate well and areas actually irrigated as accurately as possible on following plat:

Section (s) 22, Township 18 S, Range 25 E N. M. P. M.



INSTRUCTIONS

Declaration shall be executed (preferably typewritten) in triplicate and must be accompanied by a $1.00 filing fee. Each of triplicate copies must be properly signed and attested.

A separate declaration must be filed for each well in use.

All blanks shall be filled out fully. Required information which cannot be sworn to by declarant shall be supplied by affidavit of person or persons familiar with the facts and shall be submitted herewith.

Secs. 1-3. Complete all blanks.

Sec. 4. Fill out all blanks applicable as fully as possible.

Sec. 5. Irrigation use shall be stated in acre feet of water per acre per year applied on the land. If used for domestic, municipal. or other purposes, state total quantity in acre feet used annually.

Sec. 6. Describe only the acreage actually irrigated. When necessary to clearly define irrigated acreages, describe to nearest 2½ acre subdivision. If located on unsurveyed lands. describe by legal supdivision "as projected" from the nearest government survey corners, or describe by metes and bounds and tie survey to some permanent, easily-located natural object.

Sec. 7. Explain and give dates as nearly as possible of any years when all or part of acreage claimed was not irrigated.

Sec. 8. If well irrigates or supplies supplemental water to any other land than that described above, or if land is also irrigated from any other source, explain under this section. Give any other data necessary to fully describe water right.

If additional space is necessary, use a separate sheet or sheets and attach securely hereto.

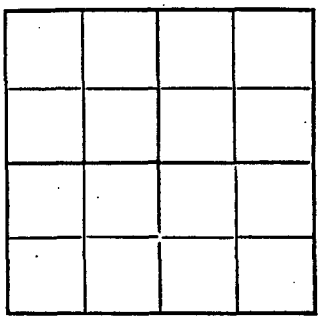
RA-8141

Form WR-23 STATE ENGINEER OFFI

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1



(Plat of 640 acres)

(A) Owner of well Geo. W. Chrisholm

Street and Number

City Artesia, State New Mexico

Well was drilled under Permit No. and is located in the

¼ NW ¼ NE ¼ of Section 23 Twp. 18 Rge. 25

(B) Drilling Contractor License No.

Street and Number

City State

Drilling was commenced January 1, 19 04

Drilling was completed June 19 04

Elevation at top of casing in feet above sea level Total depth of well 525 ft.

State whether well is shallow or artesian Depth to water upon completion

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1				
2				
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor License No.

Street and Number City State

Tons of Clay used Tons of Roughage used Type of roughage

Plugging method used Date Plugged 19

Plugging approved by:

Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received

File No. Use Location No. 18.25.23.210

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	6			Soil
6	13			Boulders and gravel
13	53			Yellow clay and gravel
53	153			Red clay
153	157			Quicksand
157	177			Red sand and sandstone
177	227			Soft yellowish sand stone
227	267			Hard limestone
267	450			Red sandy clay alternating with soft red sandstone, which gives place to porous limestone in the lower half of the series first flow
450	500			Soft red sandstone
500	525			Porous limestone
525	535			Soft, red sandstone

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Well Driller

18, 25, 23, 21D

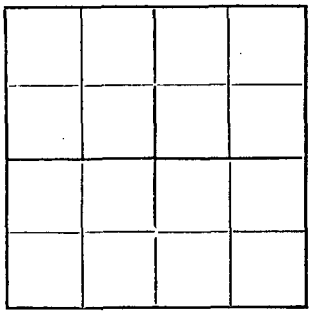
LOG FILED

Form WR-23 STATE ENGINEER OFFICE

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1



(Plat of 640 acres)

(A) Owner of well David Fasken

Street and Number 608 1st National Bank Bldg.

City Midland, State Texas 79701

Well was drilled under Permit No. RA-5620 and is located in the SW ¼ NE ¼ SE ¼ of Section 24 Twp. 18s Rge. 25e. Eddy

(B) Drilling Contractor Floyd M. Osbourn License No. WD-353

Street and Number 1011 Hermosa Dr.

City Artesia, State New Mexico.

Drilling was commenced Dec 9, 19 70

Drilling was completed Dec 13 19 70

3418 ??

Elevation at top of casing in feet above sea level 4156 Total depth of well 204 ft.

State whether well is shallow or artesian Shallow Depth to water upon completion 158 ft.

3418 158 3260

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	155	203	48	Gravel
2				
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
7" OD.	26	8 R.	0	205.	205	None	161	204

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor License No.

Street and Number City State

Tons of Clay used Tons of Roughage used Type of roughage

Plugging method used Date Plugged 19

Plugging approved by:

Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received

File No. RA-5620 Use OWD Location No. 18-25-24.4234

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	6	6	Brown	Soil
6	10	4	White	Gyp
10	45	35	Blue	Gravel
45	65	20	Yellow	Sand
65	155	65	Blue	Gravel
155	203	49	Blue	Gravel-Water.
203	204	1	Red	Clay
TD.	204 ft.			

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Well Driller

RA-5620

APPENDIX C

PHOTOGRAPHIC LOG

Photograph 1. Boring B-1 (MW-1), 33 - 38 feet (02-02-98).

Photograph 2. Boring B-1 (MW-1), 58 - 59 feet (02-02-98).

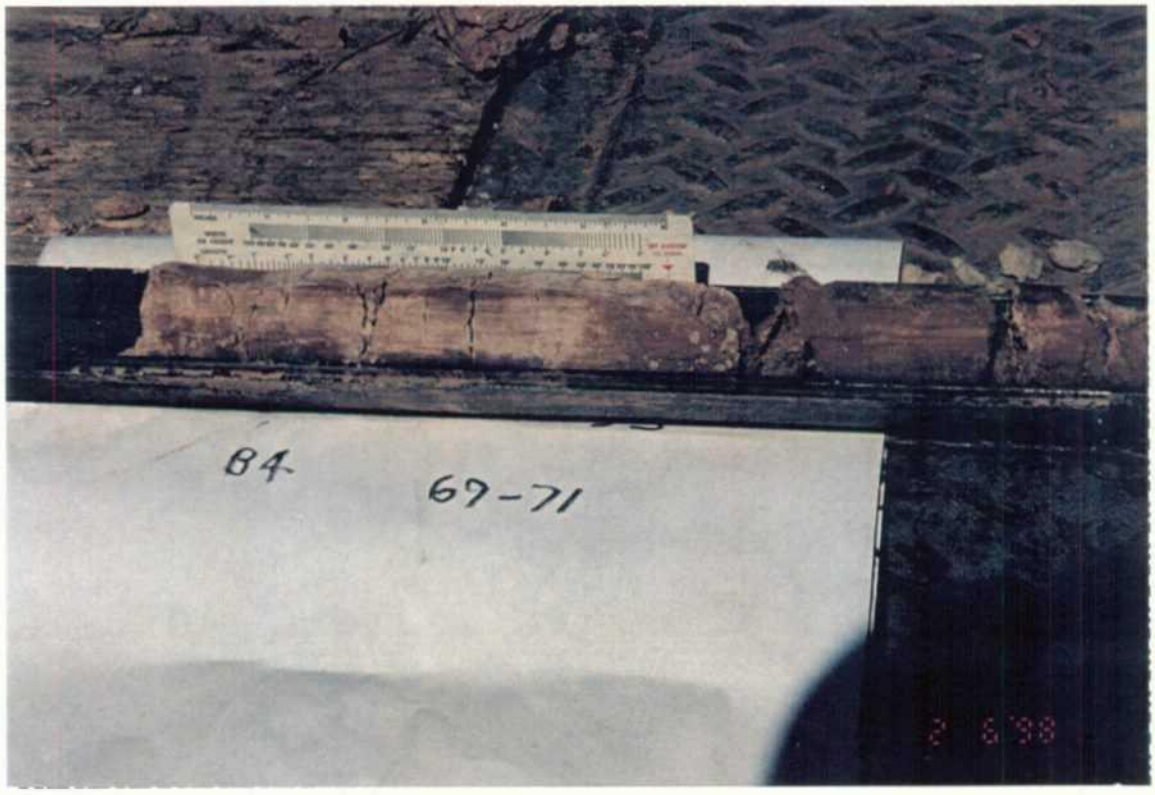
Photograph 3. Boring B-1 (MW-1), 113 - 115 feet (02-03-98).

Photograph 4. Boring B-1 (MW-1), 143 -145 feet (02-03-98).

Photograph 5. Boring B-2 (MW-2), 44 - 46 feet (02-05-98).

Photograph 6. Boring B-3 (MW-3), 0 - 3 feet (02-05-98).

Photograph 7. Boring B-4 (MW-4), 51 - 53 feet (02-06-98).



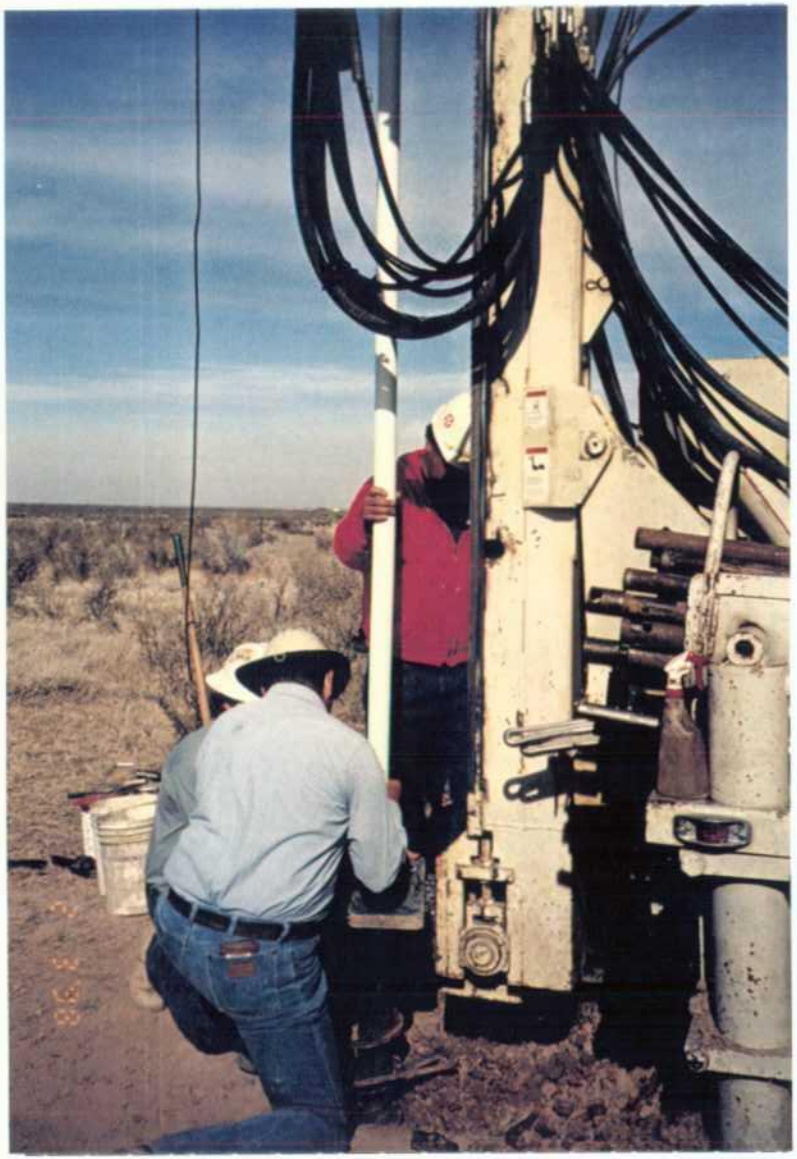
Photograph 8. Boring B-4 (MW-4), 69 - 71 feet (02-06-98).

Photograph 9. Boring B-5 (MW-5), 0 - 5 feet (02-06-98).

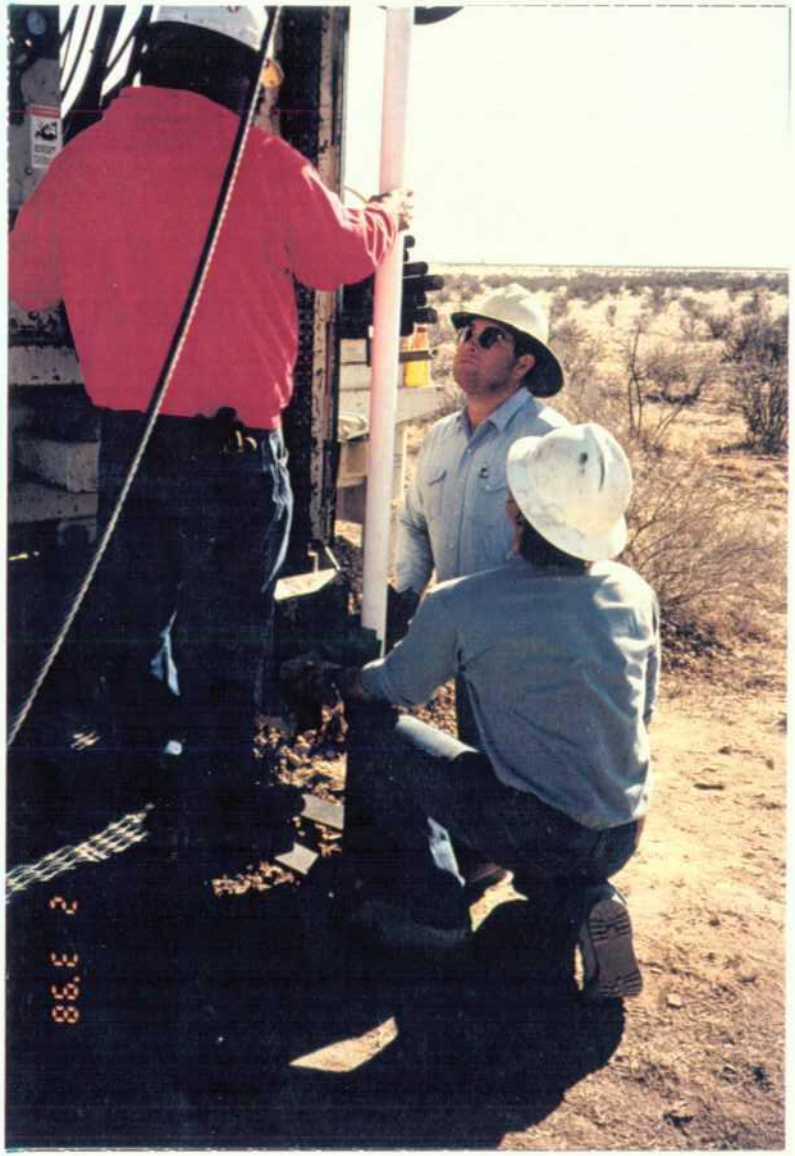
Photograph 10. Boring B-5 (MW-5), 30 - 35 feet (02-06-98).

Photograph 11. Boring B-5 (MW-5), 57 - 59 feet (02-06-98).

Photograph 12. Drilling Operation (02-02-98)



Photograph 13. Monitor Well Installation (02-03-98)



Photograph 14. Monitor Well Installation (02-03-98)

Photograph 15. Core Barrel Damage, Boring B-2 (MW-2), 8.5 feet (02-05-98)

APPENDIX D

WATER QUALITY ANALYSES

ENVIRONMENTAL LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

RECEIVED
MAR - 2 1998

YATES PETROLEUM
ATTN: MR. DAVID BOYER
105 S. FOURTH
ARTESIA, NEW MEXICO 88210
FAX: 505-281-1335

Receiving Date: 02/13/98
Sample Type: WATER
Project : 4 - DINKUS RANCH
Project Location: ARTESIA, NEW MEXICO

Analysis Date: 02/18/98
Sampling Date:02/08/98,02/09/98
Sample Condition: Intact/HCl

ELT#	Field Code	F mg/L	NO3-N *mg/L	TDS mg/L	pH s.u.	Specific Conductance uS/cm	Cl mg/L	SO4 mg/L	CO3 mg/L	HCO3 mg/L
13669	SECTION 9 WINDMILL	1.51	<1.0	2,610	6.30	2,540	18	1,700	0	134
13670	SECTION 11 WINDMILL	1.00	2.0	746	6.71	1,009	20	380	0	220
13671	SECTION 22 WINDMILL	1.15	5.5	2,337	6.80	2,410	23	1,550	0	220
13672	MW # 1	1.35	<1.0	746	7.33	1,022	31	440	0	159
13673	RANCH HEADQUARTERS	0.92	<1.0	714	7.23	990	18	410	0	207
	QUALITY CONTROL	0.95	9.50	**	7.09	1,370	4,998	55	**	**
	TRUE VALUE	1.00	10.00	**	7.00	1,413	5,000	50	**	**
	% PRECISION	95	95	**	101	97	100	110	**	**

METHODS: EPA 340.1,352.1,160.1,150.1,120.1,325.3,375.4,310.1.

*NOTE: samples received past holding time.

Michael R. Fowler

2-23-98
Date

ENVIRONMENTAL LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

YATES PETROLEUM
ATTN: MR. DAVID BOYER
105 S. FOURTH
ARTESIA, NEW MEXICO 88210
FAX; 505-281-1335

Receiving Date: 02/13/98
Sample Type: WATER
Project : 4 - DINKUS RANCH
Project Location: ARTESIA, NEW MEXICO

Analysis Date: 02/22/98
Sampling Date:02/08/98,02/09/98
Sample Condition: Intact/HCl

ELT#	Field Code	Total Hg
13669	SECTION 9 WINDMILL	<0.001
13670	SECTION 11 WINDMILL	<0.001
13671	SECTION 22 WINDMILL	<0.001
13672	MW # 1	<0.001
13673	RANCH HEADQUARTERS	<0.001
	Minimum Detection Limit (MDL)	0.001
	% IA	100
	% EA	108

METHODS: EPA SW 846-3005, 7470

Michael R. Fowler

2-23-98
Date

ENVIRONMENTAL LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

YATES PETROLEUM
ATTN: MR. DAVID BOYER
105 S. FOURTH
ARTESIA, NEW MEXICO 88210
FAX: 505-281-1335

Receiving Date: 02/13/98
Sample Type: WATER
Project : 4 - DINKUS RANCH
Project Location: ARTESIA, NEW MEXICO

Analysis Date: 02/18/98
Sampling Date:02/08/98,02/09/98
Sample Condition: Intact/HCl

DISSOLVED METALS (ppm)

ELT#	Field Code	U	B	Mo	Al	Co	Sr
13669	SECTION 9 WINDMILL	<0.20	<0.10	<0.10	0.24	<0.10	6.9
13670	SECTION 11 WINDMILL	<0.20	<0.10	<0.10	0.19	<0.10	1.9
13671	SECTION 22 WINDMILL	<0.20	<0.10	<0.10	0.25	<0.10	4.7
13672	MW # 1	<0.20	<0.10	<0.10	0.22	<0.10	1.7
13673	RANCH HEADQUARTERS	<0.20	<0.10	<0.10	0.21	<0.10	1.9
	Reporting Limit	0.20	0.10	0.10	0.20	0.10	0.10
	% IA	98	100	100	110	99	99
	% EA	93	105	105	95	105	100

METHODS: EPA 200.7

Michael R. Fowler

2-23-98
Date

12600 West I-20 East • Odessa, Texas 79765 • (915) 563-1800 • Fax (915) 563-1713

ENVIRONMENTAL LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

YATES PETROLEUM
ATTN: MR. DAVID BOYER
105 S. FOURTH
ARTESIA, NEW MEXICO 88210
FAX: 505-281-1335

Receiving Date: 02/13/98
Sample Type: WATER
Project : 4 - DINKUS RANCH
Project Location: ARTESIA, NEW MEXICO

Analysis Date: see below
Sampling Date:02/08/98,02/09/98
Sample Condition: Intact/HCl

DISSOLVED METALS (ppm)

ELT#	Field Code	Ag	As	Ba	Cd	Cr	Cu	Pb	Se
13669	SECTION 9 WINDMILL	<0.01	0.003	<0.10	0.021	<0.03	0.06	0.16	<0.002
13670	SECTION 11 WINDMILL	<0.01	<0.002	<0.10	0.015	<0.03	0.03	<0.10	<0.002
13671	SECTION 22 WINDMILL	0.01	<0.002	<0.10	0.023	0.03	0.04	0.11	<0.002
13672	MW # 1	0.02	<0.002	<0.10	0.017	<0.03	0.02	<0.10	<0.002
13673	RANCH HEADQUARTERS	<0.01	<0.002	<0.10	0.019	<0.03	0.02	<0.10	<0.002
	Reporting Limit	0.01	0.002	0.10	0.005	0.03	0.01	0.10	0.002
	% IA	103	96	103	98	104	101	103	99
	% EA	110	104	94	92	84	99	95	117
	Analysis Date	2/19/98	2/20/98	2/19/98	2/19/98	2/19/98	2/19/98	2/19/98	2/20/98

METHODS: EPA SW 846-3005, 7760, 7062, 7080, 7130, 7190, 7210, 7420, 7742

Michael R. Fowler

2-23-98
Date

ENVIRONMENTAL LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

YATES PETROLEUM
ATTN: MR. DAVID BOYER
105 S. FOURTH
ARTESIA, NEW MEXICO 88210
FAX: 505-281-1335

Receiving Date: 02/13/98
Sample Type: WATER
Project : 4 - DINKUS RANCH
Project Location: ARTESIA, NEW MEXICO

Analysis Date: see below
Sampling Date:02/08/98,02/09/98
Sample Condition: Intact/HCl

DISSOLVED METALS (ppm)

ELT#	Field Code	Ca	Fe	K	Mg	Mn	Na	Ni	Zn
13669	SECTION 9 WINDMILL	676	1.44	2.28	51	0.05	170	<0.04	0.419
13670	SECTION 11 WINDMILL	211	1.21	2.12	36	<0.01	25	<0.04	0.282
13671	SECTION 22 WINDMILL	656	0.99	1.75	31	0.02	25	<0.04	0.134
13672	MW # 1	147	0.05	5.44	43	0.06	27	<0.04	0.012
13673	RANCH HEADQUARTERS	144	0.12	1.80	35	0.02	25	<0.04	0.019
	Reporting Limit	0.01	0.03	0.01	0.005	0.01	0.10	0.04	0.005
	% IA	104	101	102	98	100	98	100	96
	% EA	**	81	92	**	83	**	98	96
	Analysis Date	2/19/98	2/19/98	2/19/98	2/19/98	2/19/98	2/19/98	2/19/98	2/19/98

METHODS: EPA SW 846-3005, 7140,7380,7610,7450,7460,7770,7520,7950.

Michael R. Fowler

2-23-98
Date

12600 West I-20 East • Odessa, Texas 79765 • (915) 563-1800 • Fax (915) 563-1713

Environmental Lab of Texas, Inc.

12600 West I-20 East Odessa, Texas 79763
(915) 563-1800 FAX (915) 563-1713

CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST

Project Manager: David Boyer	**Phone #:** (505) 281-8591
	FAX #: (505) 281-1335
Company Name & Address: Yates Petroleum, 105 S. Fourth, Artesia NM 88210	
Project #: 4- Dinkus Ranch	**Project Name:**
Project Location: Artesia, NM	**Sampler Signature:** David W Boyer

ANALYSIS REQUEST

LAB # (LAB USE ONLY)	FIELD CODE	# CONTAINERS	Volume/Amount	MATRIX: WATER	SOIL	AIR	SLUDGE	OTHER	PRESERVATIVE METHOD: HCL	HNO3	ICE	NONE	OTHER	SAMPLING: DATE	TIME	BTEX 8020/5030	TPH 418.1	TCLP Metals Ag As Ba Cd Cr Pb Hg Se	Total Metals Ag As Ba Cd Cr Pb Hg Se	TCLP Volatiles	TCLP Semi Volatiles	TDS	RCI	Total Metals as per FAX	Water Chemistry as per FAX	Total Measured Metals as per FAX	Dissolved Metals as per FAX
13669	Section 9 Windmill	3		X					X			X		2/8/98	1615									✓	✓	✓	
13670	Section 11 Windmill	3		X					X			X		"	1645									✓	✓	✓	
13671	Section 22 Windmill	3		X					X			X		"	1715									✓	✓	✓	
13672	MW # 1	3		X					X			X		2/9/98	1730										✓	✓	✓
13673	Ranch Headquarters	3		X					X			X		2/8/98	1815									✓	✓	✓	

Relinquished by: W Boyer	**Date:** 2/9/98	**Times:** 1840	**Received by:**	**REMARKS**
Relinquished by:	**Date:** 02-13-98	**Times:** 1200	**Received by:** D McMurrey	
Relinquished by:	**Date:**	**Times:**	**Received by Laboratory:**	

ENVIRONMENTAL LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

YATES PETROLEUM
ATTN: MR. JOHN BROWN
105 S. FOURTH
ARTESIA, NEW MEXICO 88210
FAX: 505-281-1335

Sample Type: WATER
Project: NONE GIVEN
Project Location: MIMOSA #1 SWD

Receiving Date: 3/5/98
Sample Condition: Intact
Sampling Date:3/04/98

ELT#	Field Code	F mg/L	NO3-N *mg/L	TDS mg/L	pH s.u.	Specific Conductance uS/cm	Cl mg/L	SO4 mg/L	CO3 mg/L	HCO3 mg/L
13872	WATER	1.3	3.8	8,206	7.25	11,690	3,191	1,200	0	830
	QUALITY CONTROL	1.0	9.2	**	7.01	1366	4,998	55	**	**
	TRUE VALUE	1.0	10.0	**	7.00	1413	5,000	50	**	**
	% PRECISION	100	92	**	100	97	100	110	**	**
	Analysis Date	3/11/98	3/6/98	3/5/98	3/5/98	3/5/98	3/11/98	3/5/98	3/5/98	3/5/98

METHODS: EPA 340.1,352.1,160.1,150.1,120.1,325.3,375.4,310.1.

Michael R. Fowler

3-24-98
Date

ENVIRONMENTAL LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

YATES PETROLEUM
ATTN: MR. JOHN BROWN
105 S. FOURTH
ARTESIA, NEW MEXICO 88210
FAX: 505-281-1335

Sample Type: WATER
Project : MIMOSA #1 SWD
Project Location: MIMOSA #1 SWD

Sampling Date:03/4/98
Sample Condition: Intact
Receiving Date: 3/5/98

DISSOLVED METALS (ppm)

ELT#	Field Code	Ca	Fe	K	Mg	Na	Mn	Mo	Ni	Zn
13872	WATER	480	0.20	81	110	2230	0.08	<0.10	0.16	0.012
	Reporting Limit	0.01	0.03	0.10	0.001	0.05	0.01	0.10	0.04	0.005
	% IA	98	102	99	99	100	102	103	102	96
	% EA	**	78	**	**	**	71	93	91	97
	Analysis Date	3/6/98	3/11/98	3/6/98	3/6/98	3/6/98	3/11/98	3/11/98	3/11/98	3/11/98

METHODS: EPA SW 846-3005, 7140,7380,7610,7450,7770,7460,7480,7520,7950.

Michael R. Fowler

3-24-98
Date

ENVIRONMENTAL LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

YATES PETROLEUM
ATTN: MR. JOHN BROWN
105 S. FOURTH
ARTESIA, NEW MEXICO 88210
FAX; 505-281-1335

Sample Type: WATER
Project : MIMOSA #1 SWD
Project Location: MIMOSA #1 SWD

Receiving Date: 3/5/98
Sampling Date: 3/4/98
Sample Condition: Intact

DISSOLVED METALS (ppm)

ELT#	Field Code	Ag	As	Ba	Cd	Cr	Cu	Pb	Se
13872	WATER	0.02	<0.002	<0.10	0.021	0.03	0.02	0.27	<0.002
	Reporting Limit	0.01	0.002	0.10	0.005	0.03	0.01	0.10	0.002
	% IA	102	106	96	102	104	105	99	105
	% EA	98	94	116	97	94	99	96	89
	Analysis Date	3/11/98	3/12/98	3/11/98	3/11/98	3/11/98	3/11/98	3/11/98	3/12/98

METHODS: EPA SW 846-3005, 7760, 7062, 7080, 7130, 7190, 7210, 7420, 7742

Michael R. Fowler

3-24-98
Date

ENVIRONMENTAL LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

YATES PETROLEUM
ATTN: MR. JOHN BROWN
105 S. FOURTH
ARTESIA, NEW MEXICO 88210
FAX: 505-281-1335

Receiving Date: 03/05/98
Sample Type: Water
Project : Mimosa #1 swd
Project Location: Mimosa #1 SWD

Analysis Date: 03/12/98
Sampling Date: 03/04/98
Sample Condition: Intact

ELT#	FIELD CODE	Total Hg ppm
13872	Water	<0.001

BLANK	0.001
% INSTRUMENT ACCURACY	106
% EXTRACTION ACCURACY	86

Methods: EPA SW 846-3005, 7470.

Michael R. Fowler

3-24-98
Date

ENVIRONMENTAL LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

YATES PETROLEUM
ATTN: MR. JOHN BROWN
105 S. FOURTH
ARTESIA, NEW MEXICO 88210
FAX: 505-748-4585

Sample Type: WATER
Project : NONE GIVEN
Project Location: MIMOSA #1 SWD

Sampling Date: 3/5/98
Sample Condition: Intact
Receiving Date: 3/5/98
Analysis Date: 3/18/98

DISSOLVED METALS (mg/l)

ELT#	Field Code	U	B	Sr	Al	Co
13872	WATER	<0.10	1.9	5.4	0.19	<0.05
	Reporting Limit	0.10	0.10	0.10	0.10	0.05
	% IA	102	101	97	93	10
	% EA	93	105	95	95	87

METHODS: EPA SW 846-3015,6010B

Michael R. Fowler

3-24-98
Date

ENVIRONMENTAL LAB OF , INC.

"Don't Treat Your Soil Like Dirt!"

BAKER PETROLITE
ATTN: MR. ANDY R. MILLER
422 WEST MAIN STREET
ARTESIA, NM 88210-2041
FAX: 505-746-3580

Receiving Date: 09/04/97
Sample Type: LIQUID
Project: YATES PETROLEUM
Project Location: ARTESIA, NM

Analysis Date: 09/08/97
Sampling Date: 08/29/97
Sample Condition: Intact

ELT#	FIELD CODE	TDS mg/l	Sodium Chloride mg/l	Iron mg/l	Total Hardness mg/l
12457	Mojave Transfer Station	5,940	3,629	0.05	850
12458	Bates Transfer Station	6,130	4,125	0.07	1,200
12459	Patriot Transfer Station	6,840	4,784	0.07	1,250

METHODS: Iron by AA, Salinity by Argentometric, Hardness by Titration

Michael R. Fowler

Michael R. Fowler

9-8-97

Date

Post-it™ brand fax transmittal memo 7671 | # of pages ▸ 6

To Dave Boyer	From John Brown
Co.	Co. YPC
Dept.	Phone # 505-748-1471
Fax # 505-281-1335	Fax # 505-748-4585

12600 West I-20 East • Odessa, Texas 79765 • (915) 563-1800 • Fax (915) 563-1713

ENVIRONMENTAL LAB OF TEXAS, INC.

"Don't Treat Your Soil Like Dirt!"

BAKER PETROLITE
ATTN: MR. ANDY R. MILLER
422 WEST MAIN STREET
ARTESIA, NM 88210-2041
FAX: 505-746-3580

Receiving Date: 09/04/97
Sample Type: LIQUID
Project: YATES PETROLEUM
Project Location: ARTESIA, NM

Analysis Date: 09/05/97
Sampling Date: 08/29/97
Sample Condition: Intact

ELT#	FIELD CODE	BENZENE mg/l	TOLUENE mg/l	ETHYLBENZENE mg/l	m,p-XYLENE mg/l	o-XYLENE mg/l
12457	Mojave Transfer Station	855	550	12.71	68.95	42.82
12458	Bates Transfer Station	1131	585	11.74	82.58	44.58
12459	Patriot Transfer Station	1988	514	10.46	80.56	45.15
	% IA	108	108	108	107	108
	% EA	109	118	109	109	112
	BLANK	<0.001	<0.001	<0.001	<0.001	<0.001

METHODS: SW 846-8020,5030

Michael R. Fowler

Michael R. Fowler

9-8-97

Date

APPENDIX E

SOIL ANALYSES

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By:	YATES PETRO
Address:	105 SOUTH 4TH ST ARTESIA NM
Grower:	KEITH MORRIS
Address:	
Date:	3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7642	Sample No.	SB1-1		
Soil pH	8.1	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.27	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.5	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	6 L				
Potassium Exchangeable - K	490 VH	Potash K_2O			
Calcium - Ca Exchangeable	6400 VH	Lime			
Magnesium - Mg Exchangeable	180 M	Magnesium Oxide			
Sodium - Na Exchangeable	55 VL	Gypsum			
CEC Meq/100g	35	Sulfur - S Elemental			
Iron Available - Fe	7.2 M	Iron - Fe			
Manganese - Mn Available	7.8 M	Manganese Mn			
Zinc - Zn Available	0.5 VL	Zinc - Zn			
Copper - Cu Available	0.8 M	Copper - Cu			
Boron - B Available	0.9 M	Boron - B			
Sulfur - SO_4 Available	18 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	24	% Silt	50	% Clay	26	
	Soil Texture	SILT LOAM					
% H Saturation Ideal: 0-5%	0		% Ca Saturation Ideal: 65-75%	91.4			
% K Saturation Ideal: 5-7%	3.6		% Na Saturation Ideal: 0-2%	.6			
% Mg Saturation Ideal: 13-20%	4.3						

Field Capacity	24.4	
Wilting Point	13.4	
Available Water (Top Foot)	1.9	in.

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
105 S 4TH ST
Address: ARTESIA NM

Grower: KEITH MORRIS

Address:

Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7643	Sample No.	SB2-1		
Soil pH	8.1	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.20	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.5	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	420 VH	Potash K_2O			
Calcium - Ca Exchangeable	7200 VH	Lime			
Magnesium - Mg Exchangeable	210 H	Magnesium Oxide			
Sodium - Na Exchangeable	53 VL	Gypsum			
CEC Meq/100g	39.1	Sulfur - S Elemental			
Iron Available - Fe	5.3 L	Iron - Fe			
Manganese - Mn Available	3.2 L	Manganese Mn			
Zinc - Zn Available	0.2 VL	Zinc - Zn			
Copper - Cu Available	0.6 M	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	18 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	28	% Silt	56	% Clay	16
	Soil Texture	SILT LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	92.2
% K Saturation Ideal: 5-7%	2.8	% Na Saturation Ideal: 0-2%	.5
% Mg Saturation Ideal: 15-20%	4.5		

Field Capacity	20.1	
Wilting Point	11.0	
Available Water (Top Foot)	1.5	in.

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST
ARTESIA NM

Grower: KEITH MORRIS

Address:

Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7644	Sample No.	SB3-1		
Soil pH	8.2	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.22	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.7	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	6 L				
Potassium Exchangeable - K	520 VH	Potash K_2O			
Calcium - Ca Exchangeable	7310 VH	Lime			
Magnesium - Mg Exchangeable	220 H	Magnesium Oxide			
Sodium - Na Exchangeable	56 VL	Gypsum			
CEC Meq/100g	40	Sulfur - S Elemental			
Iron Available - Fe	5.2 L	Iron - Fe			
Manganese - Mn Available	3.5 L	Manganese Mn			
Zinc - Zn Available	0.4 VL	Zinc - Zn			
Copper - Cu Available	0.5 M	Copper - Cu			
Boron - B Available	0.9 M	Boron - B			
Sulfur - SO_4 Available	18 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	22	% Silt	46	% Clay	32
	Soil Texture	CLAY LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	91.5
% K Saturation Ideal: 5-7%	3.3	% Na Saturation Ideal: 0-2%	.5
% Mg Saturation Ideal: 15-20%	4.6		

Field Capacity	26.9	
Wilting Point	14.8	
Available Water (Top Foot)	2.1	in.

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By:	YATES PETRO
Address:	105 S 4TH ST ARTESIA NM
Grower:	KEITH MORRIS
Address:	
Date:	3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7645	Sample No.	SB4-1		
Soil pH	8.1	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos cm)	0.20	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.6	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	470 VH	Potash K_2O			
Calcium - Ca Exchangeable	7200 VH	Lime			
Magnesium - Mg Exchangeable	225 H	Magnesium Oxide			
Sodium - Na Exchangeable	52 VL	Gypsum			
CEC Meq/100g	39.3	Sulfur - S Elemental			
Iron Available - Fe	6.0 M	Iron - Fe			
Manganese - Mn Available	3.2 L	Manganese Mn			
Zinc - Zn Available	0.2 VL	Zinc - Zn			
Copper - Cu Available	0.5 M	Copper - Cu			
Boron - B Available	0.7 L	Boron - B			
Sulfur - SO_4 Available	18 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	22	% Silt	52	% Clay	26
	Soil Texture	SILT LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	91.6
% K Saturation Ideal: 3-7%	3.1	% Na Saturation Ideal: 0-2%	.5
% Mg Saturation Ideal: 15-20%	4.8		

Field Capacity	24.7	
Wilting Point	13.6	
Available Water (Top Foot)	2.0	in.

BY Glenys Cobb

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By:	YATES PETRO
Address:	105 S 4TH ST ARTESIA NM
Grower:	KEITH MORRIS
Address:	
Date:	3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7646	Sample No.	SB5-1		
Soil pH	8.2	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.18	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.8	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	450 VH	Potash K_2O			
Calcium - Ca Exchangeable	7250 VH	Lime			
Magnesium - Mg Exchangeable	220 H	Magnesium Oxide			
Sodium - Na Exchangeable	60 VL	Gypsum			
CEC Meq/100g	39.5	Sulfur - S Elemental			
Iron Available - Fe	6.1 M	Iron - Fe			
Manganese - Mn Available	3.6 L	Manganese Mn			
Zinc - Zn Available	0.3 VL	Zinc - Zn			
Copper - Cu Available	0.3 L	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	18 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	24	% Silt	50	% Clay	26
	Soil Texture	SILT LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	91.8
% K Saturation Ideal: 5-7%	2.9	% Na Saturation Ideal: 0-2%	.6
% Mg Saturation Ideal: 15-20%	4.6		

Field Capacity	24.4
Wilting Point	13.4
Available Water (Top Foot)	1.9 in

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KEITH MORRIS
Address:

Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7647	Sample No.	SB6-1		
Soil pH	8.1	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.22	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.9	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	500 VH	Potash K_2O			
Calcium - Ca Exchangeable	7750 VH	Lime			
Magnesium - Mg Exchangeable	265 H	Magnesium Oxide			
Sodium - Na Exchangeable	57 VL	Gypsum			
CEC Meq/100g	42.5	Sulfur - S Elemental			
Iron Available - Fe	8.4 M	Iron - Fe			
Manganese - Mn Available	8.4 M	Manganese Mn			
Zinc - Zn Available	0.3 VL	Zinc - Zn			
Copper - Cu Available	0.6 M	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	18 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	12	% Silt	58	% Clay	30
	Soil Texture	SILTY CLAY LOAM				
% H Saturation Ideal: 0-5%	0		% Ca Saturation Ideal: 65-75%	91.2		
% K Saturation Ideal: 3-7%	3		% Na Saturation Ideal: 0-2%	.6		
% Mg Saturation Ideal: 15-20%	5.2					

Field Capacity	27.8
Wilting Point	15.3
Available Water (Top Foot)	2.2 in.

BY Glenda Glass

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By:	YATES PETRO
Address:	105 S 4TH ST ARTESIA NM
Grower:	KIETH MORRIS
Address:	
Date:	3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7648	Sample No.	SB7-1		
Soil pH	8.2	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.19	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.4	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	5 L				
Potassium Exchangeable - K	480 VH	Potash K_2O			
Calcium - Ca Exchangeable	6060 VH	Lime			
Magnesium - Mg Exchangeable	255 H	Magnesium Oxide			
Sodium - Na Exchangeable	52 VL	Gypsum			
CEC Meq/100g	33.9	Sulfur - S Elemental			
Iron Available - Fe	7.4 M	Iron - Fe			
Manganese - Mn Available	5.2 M	Manganese Mn			
Zinc - Zn Available	0.3 VL	Zinc - Zn			
Copper - Cu Available	0.6 M	Copper - Cu			
Boron - B Available	0.7 L	Boron - B			
Sulfur - SO_4 Available	18 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	18	% Silt	58	% Clay	24
	Soil Texture	SILT LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	89.4
% K Saturation Ideal: 3-7%	3.6	% Na Saturation Ideal: 0-2%	.6
% Mg Saturation Ideal: 15-20%	6.3		

Field Capacity	24.6
Wilting Point	13.5
Available Water (Top Foot)	2.0 in.

BY Craig Dossey

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
105 S 4TH ST
ARTESIA NM
Address:

Grower: KIETH MORRIS

Address:

Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7649	Sample No.	SB8-1		
Soil pH	8.2	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.21	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.7	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	460 VH	Potash K_2O			
Calcium - Ca Exchangeable	6200 VH	Lime			
Magnesium - Mg Exchangeable	210 H	Magnesium Oxide			
Sodium - Na Exchangeable	56 VL	Gypsum			
CEC Meq/100g	34.2	Sulfur - S Elemental			
Iron Available - Fe	5.2 L	Iron - Fe			
Manganese - Mn Available	3.4 L	Manganese Mn			
Zinc - Zn Available	0.3 VL	Zinc - Zn			
Copper - Cu Available	0.5 M	Copper - Cu			
Boron - B Available	0.9 M	Boron - B			
Sulfur - SO_4 Available	18 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	24	% Silt	56	% Clay	20
	Soil Texture	SILT LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	90.7
% K Saturation Ideal: 3-7%	3.5	% Na Saturation Ideal: 0-2%	.7
% Mg Saturation Ideal: 15-20%	5.1		

Field Capacity	22.2
Wilting Point	12.2
Available Water (Top Foot)	1.8 in

BY Gayle Reddy

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KIETH MORRIS
Address:

Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7650	Sample No.	SB9-1		
Soil pH	8.3	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.23	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.9	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	5 VL	Phosphate P_2O_5			
Available Bray P2	5 L				
Potassium Exchangeable - K	600 VH	Potash K_2O			
Calcium - Ca Exchangeable	6860 VH	Lime			
Magnesium - Mg Exchangeable	290 H	Magnesium Oxide			
Sodium - Na Exchangeable	55 VL	Gypsum			
CEC Meq/100g	38.5	Sulfur - S Elemental			
Iron Available - Fe	5.0 L	Iron - Fe			
Manganese - Mn Available	0.6 VL	Manganese Mn			
Zinc - Zn Available	0.7 L	Zinc - Zn			
Copper - Cu Available	0.6 M	Copper - Cu			
Boron - B Available	0.6 L	Boron - B			
Sulfur - SO_4 Available	18 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	18	% Silt	64	% Clay	18
	Soil Texture	SILT LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	89.1
% K Saturation Ideal: 5-7%	4	% Na Saturation Ideal: 0-2%	.5
% Mg Saturation Ideal: 15-20%	6.3		

Field Capacity	22.4
Wilting Point	12.3
Available Water (Top Foot)	1.8 in.

BY Glynn Reed

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services
P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KIETH MORRIS
Address:

Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7631	Sample No.	SB10-1		
Soil pH	8.3	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos/cm)	0.23	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.8	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	490 VH	Potash K_2O			
Calcium - Ca Exchangeable	7690 VH	Lime			
Magnesium - Mg Exchangeable	285 H	Magnesium Oxide			
Sodium - Na Exchangeable	57 VL	Gypsum			
CEC Meq/100g	42.3	Sulfur - S Elemental			
Iron Available - Fe	5.2 L	Iron - Fe			
Manganese - Mn Available	3.2 L	Manganese Mn			
Zinc - Zn Available	0.3 VL	Zinc - Zn			
Copper - Cu Available	0.5 M	Copper - Cu			
Boron - B Available	0.7 L	Boron - B			
Sulfur - SO_4 Available	18 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	14	% Silt	66	% Clay	20
	Soil Texture	SILT LOAM				
% H Saturation Ideal: 0-5%	0		% Ca Saturation Ideal: 65-75%	90.8		
% K Saturation Ideal: 5-7%	3		% Na Saturation Ideal: 0-2%	.5		
% Mg Saturation Ideal: 13-20%	5.6					

Field Capacity	23.8
Wilting Point	13.1
Available Water (Top Foot)	1.9 in

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By:	YATES PETRO
Address:	105 S 4TH ST ARTESIA NM
Grower:	KIETH MORRIS
Address:	
Date:	3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7652	Sample No.	SB1-3		
Soil pH	8.2	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.29	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.5	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	330 H	Potash K_2O			
Calcium - Ca Exchangeable	7240 VH	Lime			
Magnesium - Mg Exchangeable	250 H	Magnesium Oxide			
Sodium - Na Exchangeable	72 VL	Gypsum			
CEC Meq/100g	39.4	Sulfur - S *Elemental*			
Iron Available - Fe	8.3 M	Iron - Fe			
Manganese - Mn Available	3.9 L	Manganese Mn			
Zinc - Zn Available	0.2 VL	Zinc - Zn			
Copper - Cu Available	0.8 M	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	18 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	12	% Silt	82	% Clay	6
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	91.8
% K Saturation Ideal: 3-7%	2.1	% Na Saturation Ideal: 0-2%	.7
% Mg Saturation Ideal: 15-20%	5.3		

Field Capacity	18.9
Wilting Point	10.4
Available Water (Top Foot)	1.5 in.

BY Glenda Crosby

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services
P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM
Grower: KIETH MORRIS
Address:
Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7653	Sample No.	SB2-3		
Soil pH	8.0	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.32	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.4	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	3 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	235 M	Potash K_2O			
Calcium - Ca Exchangeable	6980 VH	Lime			
Magnesium - Mg Exchangeable	270 H	Magnesium Oxide			
Sodium - Na Exchangeable	87 VL	Gypsum			
CEC Meq/100g	38.1	Sulfur - S Elemental			
Iron Available - Fe	8.6 M	Iron - Fe			
Manganese - Mn Available	3.6 L	Manganese Mn			
Zinc - Zn Available	0.2 VL	Zinc - Zn			
Copper - Cu Available	0.8 M	Copper - Cu			
Boron - B Available	0.7 L	Boron - B			
Sulfur - SO_4 Available	50 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	12	% Silt	84	% Clay	4
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	91.5
% K Saturation Ideal: 3-7%	1.6	% Na Saturation Ideal: 0-2%	1
% Mg Saturation Ideal: 16-20%	5.9		

Field Capacity	18.2
Wilting Point	10.0
Available Water (Top Foot)	1.4 in

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services
P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST
ARTESIA NM

Grower: KIETH MORRIS
Address:

Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7654	Sample No.	SB3-3		
Soil pH	8.1	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.38	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.6	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	260 H	Potash K_2O			
Calcium - Ca Exchangeable	7250 VH	Lime			
Magnesium - Mg Exchangeable	420 VH	Magnesium Oxide			
Sodium - Na Exchangeable	98 VL	Gypsum			
CEC Meq/100g	40.8	Sulfur - S Elemental			
Iron Available - Fe	8.5 M	Iron - Fe			
Manganese - Mn Available	3.1 L	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.8 M	Copper - Cu			
Boron - B Available	0.9 M	Boron - B			
Sulfur - SO_4 Available	62 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	4	% Silt	92	% Clay	4
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	88.8
% K Saturation Ideal: 5-7%	1.6	% Na Saturation Ideal: 0-2%	1
% Mg Saturation Ideal: 15-20%	8.600001		

Field Capacity	19.5
Wilting Point	10.7
Available Water (Top Foot)	1.5 in.

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KIETH MORRIS
Address:

Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7655	Sample No.	SB4-3		
Soil pH	8.1	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.33	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.5	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	3 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	250 H	Potash K_2O			
Calcium - Ca Exchangeable	7020 VH	Lime			
Magnesium - Mg Exchangeable	390 H	Magnesium Oxide			
Sodium - Na Exchangeable	88 VL	Gypsum			
CEC Meq/100g	39.4	Sulfur - S Elemental			
Iron Available - Fe	5.2 L	Iron - Fe			
Manganese - Mn Available	2.7 L	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.5 M	Copper - Cu			
Boron - B Available	0.7 L	Boron - B			
Sulfur - SO_4 Available	26 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	20	% Silt	74	% Clay	6
	Soil Texture	SILT LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	89.1
% K Saturation Ideal: 5-7%	1.6	% Na Saturation Ideal: 0-2%	1
% Mg Saturation Ideal: 15-20%	8.3		

Field Capacity	17.7
Wilting Point	9.7
Available Water (Top Foot)	1.4 in.

BY Gregg Reed

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services
P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KIETH MORRIS
Address:
Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7656	Sample No.	SB5-3		
Soil pH	8.0	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.30	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.3	Nitrogen N			
Nitrogen - NO_3	6 VL				
Phosphorus Bray P1	3 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	210 M	Potash K_2O			
Calcium - Ca Exchangeable	6760 VH	Lime			
Magnesium - Mg Exchangeable	380 H	Magnesium Oxide			
Sodium - Na Exchangeable	95 VL	Gypsum			
CEC Meq/100g	37.9	Sulfur - S Elemental			
Iron Available - Fe	5.1 L	Iron - Fe			
Manganese - Mn Available	2.2 L	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.2 L	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	44 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	14	% Silt	80	% Clay	6
	Soil Texture	SILT LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	89.1
% K Saturation Ideal: 5-7%	1.4	% Na Saturation Ideal: 0-2%	1.1
% Mg Saturation Ideal: 15-20%	8.399999		

Field Capacity	18.6
Wilting Point	10.2
Available Water (Top Foot)	1.5 in.

BY Gayle Reddy

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By:	YATES PETRO
Address:	105 S 4TH ST ARTESIA NM
Grower:	KIETH MORRIS
Address:	
Date:	3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7657	Sample No.	SB6-3		
Soil pH	8.1	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.30	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.6	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	340 H	Potash K_2O			
Calcium - Ca Exchangeable	7820 VH	Lime			
Magnesium - Mg Exchangeable	475 VH	Magnesium Oxide			
Sodium - Na Exchangeable	101 L	Gypsum			
CEC Meq/100g	44.4	Sulfur - S Elemental			
Iron Available - Fe	7.5 M	Iron - Fe			
Manganese - Mn Available	3.2 L	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.7 M	Copper - Cu			
Boron - B Available	0.6 L	Boron - B			
Sulfur - SO_4 Available	35 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	8	% Silt	88	% Clay	4
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	88.1
% K Saturation Ideal: 3-7%	2	% Na Saturation Ideal: 0-2%	1
% Mg Saturation Ideal: 15-20%	8.899999		

Field Capacity	18.9
Wilting Point	10.4
Available Water (Top Foot)	1.5 in.

BY [signature]

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST
ARTESIA NM

Grower: KIETH MORRIS
Address:
Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7658	Sample No.	SB7-3		
Soil pH	8.3	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.45	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.7	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	5 L				
Potassium Exchangeable - K	350 H	Potash K_2O			
Calcium - Ca Exchangeable	7400 VH	Lime			
Magnesium - Mg Exchangeable	750 VH	Magnesium Oxide			
Sodium - Na Exchangeable	203 M	Gypsum			
CEC Meq/100g	45	Sulfur - S Elemental			
Iron Available - Fe	10.4 M	Iron - Fe			
Manganese - Mn Available	4.2 L	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.8 M	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	75 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	10	% Silt	86	% Clay	4
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	82.2
% K Saturation Ideal: 5-7%	2	% Na Saturation Ideal: 0-2%	1.9
% Mg Saturation Ideal: 15-20%	13.9		

Field Capacity	18.6
Wilting Point	10.2
Available Water (Top Foot)	1.5 in.

BY Glynn Reddy

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KIETH MORRIS
Address:

Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7639	Sample No.	SB8-3		
Soil pH	8.2	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.32	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.2	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	210 M	Potash K_2O			
Calcium - Ca Exchangeable	6870 VH	Lime			
Magnesium - Mg Exchangeable	490 VH	Magnesium Oxide			
Sodium - Na Exchangeable	110 L	Gypsum			
CEC Meq/100g	39.5	Sulfur - S Elemental			
Iron Available - Fe	5.4 L	Iron - Fe			
Manganese - Mn Available	2.5 L	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.5 M	Copper - Cu			
Boron - B Available	0.9 M	Boron - B			
Sulfur - SO_4 Available	20 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	14	% Silt	82	% Clay	4
	Soil Texture	SILT				

% H Saturation Ideal: 0-8%	0	% Ca Saturation Ideal: 65-75%	87.1
% K Saturation Ideal: 5-7%	1.4	% Na Saturation Ideal: 0-2%	1.1
% Mg Saturation Ideal: 15-20%	10.4		

Field Capacity	17.9
Wilting Point	9.8
Available Water (Top Foot)	1.4 in.

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KIETH MORRIS
Address:

Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7660	Sample No.	SB9-3		
Soil pH	7.9	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.70	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.6	Nitrogen N			
Nitrogen - NO_3	70 VH				
Phosphorus Bray P1	3 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	320 H	Potash K_2O			
Calcium - Ca Exchangeable	7080 VH	Lime			
Magnesium - Mg Exchangeable	510 VH	Magnesium Oxide			
Sodium - Na Exchangeable	93 VL	Gypsum			
CEC Meq/100g	40.9	Sulfur - S Elemental			
Iron Available - Fe	9.8 M	Iron - Fe			
Manganese - Mn Available	4.9 L	Manganese Mn			
Zinc - Zn Available	0.3 VL	Zinc - Zn			
Copper - Cu Available	0.6 M	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	75 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	14	% Silt	82	% Clay	4
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	86.6
% K Saturation Ideal: 5-7%	2	% Na Saturation Ideal: 0-2%	1
% Mg Saturation Ideal: 15-20%	10.4		

Field Capacity	17.9	
Wilting Point	9.8	
Available Water (Top Foot)	1.4	in.

BY Glenn Green

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services
P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KIETH MORRIS
Address:
Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7661	Sample No.	SB1-6		
Soil pH	8.0	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.49	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.2	Nitrogen N			
Nitrogen - NO_3	10 L				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	235 M	Potash K_2O			
Calcium - Ca Exchangeable	7140 VH	Lime			
Magnesium - Mg Exchangeable	530 VH	Magnesium Oxide			
Sodium - Na Exchangeable	80 VL	Gypsum			
CEC Meq/100g	41.1	Sulfur - S Elemental			
Iron Available - Fe	6.3 M	Iron - Fe			
Manganese - Mn Available	1.9 VL	Manganese Mn			
Zinc - Zn Available	0.2 VL	Zinc - Zn			
Copper - Cu Available	0.6 M	Copper - Cu			
Boron - B Available	0.6 L	Boron - B			
Sulfur - SO_4 Available	15 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	24	% Silt	72	% Clay	4
	Soil Texture	SILT LOAM				
% H Saturation Ideal: 0-5%	0		% Ca Saturation Ideal: 65-75%	86.9		
% K Saturation Ideal: 5-7%	1.5		% Na Saturation Ideal: 0-2%	.7		
% Mg Saturation Ideal: 16-20%	10.8					

Field Capacity	16.3
Wilting Point	8.9
Available Water (Top Foot)	0.8 in.

BY Gregg Reddy

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services
P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By:	YATES PETRO
Address:	105 S 4TH ST ARTESIA NM
Grower:	KIETH MORRIS
Address:	
Date:	3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7662	Sample No.	SB2-6		
Soil pH	8.2	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.36	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.1	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	3 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	195 M	Potash K_2O			
Calcium - Ca Exchangeable	6330 VH	Lime			
Magnesium - Mg Exchangeable	480 VH	Magnesium Oxide			
Sodium - Na Exchangeable	96 VL	Gypsum			
CEC Meq/100g	36.6	Sulfur - S Elemental			
Iron Available - Fe	5.4 L	Iron - Fe			
Manganese - Mn Available	2.0 VL	Manganese Mn			
Zinc - Zn Available	0.4 VL	Zinc - Zn			
Copper - Cu Available	0.2 L	Copper - Cu			
Boron - B Available	0.6 L	Boron - B			
Sulfur - SO_4 Available	26 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	12	% Silt	84	% Clay	4
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	86.6
% K Saturation Ideal: 5-7%	1.4	% Na Saturation Ideal: 0-2%	1.1
% Mg Saturation Ideal: 15-20%	10.9		

Field Capacity	18.2
Wilting Point	10.0
Available Water (Top Foot)	1.4 in.

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By:	YATES PETRO
Address:	105 S 4TH ST ARTESIA NM
Grower:	KIETH MORRIS
Address:	
Date:	3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7663	Sample No.	SB3-6		
Soil pH	8.1	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmnos / cm)	0.43	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.3	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	220 M	Potash K_2O			
Calcium - Ca Exchangeable	6620 VH	Lime			
Magnesium - Mg Exchangeable	740 VH	Magnesium Oxide			
Sodium - Na Exchangeable	210 M	Gypsum			
CEC Meq/100g	40.7	Sulfur - S Elemental			
Iron Available - Fe	6.1 M	Iron - Fe			
Manganese - Mn Available	2.0 VL	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.5 M	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	62 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	12	% Silt	84	% Clay	4
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	81.2
% K Saturation Ideal: 5-7%	1.4	% Na Saturation Ideal: 0-2%	2.3
% Mg Saturation Ideal: 15-20%	15.1		

Field Capacity	18.2	
Wilting Point	10.0	
Available Water (Top Foot)	1.4	in.

BY Glenda Crabtree

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KIETH MORRIS

Address:

Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7664	Sample No.	SB4-6		
Soil pH	8.2	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.29	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.2	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	5 L				
Potassium Exchangeable - K	225 M	Potash K_2O			
Calcium - Ca Exchangeable	6600 VH	Lime			
Magnesium - Mg Exchangeable	690 VH	Magnesium Oxide			
Sodium - Na Exchangeable	110 L	Gypsum			
CEC Meq/100g	39.8	Sulfur - S Elemental			
Iron Available - Fe	6.6 M	Iron - Fe			
Manganese - Mn Available	1.9 VL	Manganese Mn			
Zinc - Zn Available	0.3 VL	Zinc - Zn			
Copper - Cu Available	0.3 L	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	35 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	24	% Silt	70	% Clay	6
	Soil Texture	SILT LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	82.9
% K Saturation Ideal: 3-7%	1.4	% Na Saturation Ideal: 0-2%	1.3
% Mg Saturation Ideal: 15-20%	14.4		

Field Capacity	16.3
Wilting Point	8.9
Available Water (Top Foot)	0.8 in.

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST
ARTESIA NM

Grower: KIETH MORRIS

Address:

Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7665	Sample No.	SB5-6		
Soil pH	8.2	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.35	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.5	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	240 M	Potash K_2O			
Calcium - Ca Exchangeable	6600 VH	Lime			
Magnesium - Mg Exchangeable	780 VH	Magnesium Oxide			
Sodium - Na Exchangeable	226 M	Gypsum			
CEC Meq/100g	41.1	Sulfur - S Elemental			
Iron Available - Fe	6.9 M	Iron - Fe			
Manganese - Mn Available	1.9 VL	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.5 M	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	44 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	10	% Silt	84	% Clay	6
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	80.3
% K Saturation Ideal: 3-7%	1.5	% Na Saturation Ideal: 0-2%	2.3
% Mg Saturation Ideal: 15-20%	15.8		

Field Capacity	19.3	
Wilting Point	10.6	
Available Water (Top Foot)	1.5	in

BY Gary Donley

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KIETH MORRIS
Address:

Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7666	Sample No.	SB6-6		
Soil pH	8.1	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.35	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.3	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	3 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	245 M	Potash K_2O			
Calcium - Ca Exchangeable	6720 VH	Lime			
Magnesium - Mg Exchangeable	850 VH	Magnesium Oxide			
Sodium - Na Exchangeable	215 M	Gypsum			
CEC Meq/100g	42.2	Sulfur - S Elemental			
Iron Available - Fe	6.2 M	Iron - Fe			
Manganese - Mn Available	1.9 VL	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.5 M	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	62 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	10	% Silt	84	% Clay	6
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	79.5
% K Saturation Ideal: 5-7%	1.5	% Na Saturation Ideal: 0-2%	2.1
% Mg Saturation Ideal: 15-20%	16.8		

Field Capacity	19.3	
Wilting Point	10.6	
Available Water (Top Foot)	1.5	in.

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KIETH MORRIS

Address:

Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7667	Sample No.	SB7-6		
Soil pH	8.3	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos/cm)	0.56	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.5	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	320 H	Potash K_2O			
Calcium - Ca Exchangeable	6960 VH	Lime			
Magnesium - Mg Exchangeable	730 VH	Magnesium Oxide			
Sodium - Na Exchangeable	205 M	Gypsum			
CEC Meq/100g	42.6	Sulfur - S Elemental			
Iron Available - Fe	7.5 M	Iron - Fe			
Manganese - Mn Available	2.7 L	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.8 M	Copper - Cu			
Boron - B Available	0.6 L	Boron - B			
Sulfur - SO_4 Available	75 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	14	% Silt	80	% Clay	6
	Soil Texture	SILT LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	81.7
% K Saturation Ideal: 5-7%	1.9	% Na Saturation Ideal: 0-2%	2.1
% Mg Saturation Ideal: 15-20%	14.3		

Field Capacity	18.6	
Wilting Point	10.2	
Available Water (Top Foot)	1.5	in

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KIETH MORRIS
Address:

Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7668	Sample No.	SB8-6		
Soil pH	8.3	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.43	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.4	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	210 M	Potash K_2O			
Calcium - Ca Exchangeable	6370 VH	Lime			
Magnesium - Mg Exchangeable	850 VH	Magnesium Oxide			
Sodium - Na Excnangeable	213 M	Gypsum			
CEC Meq/100g	40.4	Sulfur - S Elemental			
Iron Available - Fe	5.8 L	Iron - Fe			
Manganese - Mn Available	2.0 VL	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.3 L	Copper - Cu			
Boron - B Available	0.7 L	Boron - B			
Sulfur - SO_4 Available	35 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	10	% Silt	80	% Clay	10
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	78.8
% K Saturation Ideal: 5-7%	1.3	% Na Saturation Ideal: 0-2%	2.3
% Mg Saturation Ideal: 15-20%	17.5		

Field Capacity	20.8
Wilting Point	11.4
Available Water (Top Foot)	1.6 in.

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST
ARTESIA NM

Grower: KIETH MORRIS
Address:
Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7669	Sample No.	SB9-6		
Soil pH	8.2	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.35	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.2	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	5 VL	*Phosphate* P_2O_5			
Available Bray P2	6 L				
Potassium Exchangeable - K	190 M	Potash K_2O			
Calcium - Ca Exchangeable	5920 VH	Lime			
Magnesium - Mg Exchangeable	770 VH	Magnesium Oxide			
Sodium - Na Exchangeable	92 VL	Gypsum			
CEC Meq/100g	36.9	Sulfur - S Elemental			
Iron Available - Fe	4.9 L	Iron - Fe			
Manganese - Mn Available	1.7 VL	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.3 L	Copper - Cu			
Boron - B Available	0.6 L	Boron - B			
Sulfur - SO_4 Available	35 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	4	% Silt	90	% Clay	6
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	80.2
% K Saturation Ideal: 5-7%	1.3	% Na Saturation Ideal: 0-2%	1.1
% Mg Saturation Ideal: 15-20%	17.4		

Field Capacity	20.2
Wilting Point	11.1
Available Water (Top Foot)	1.6 in

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KIETH MORRIS
Address:
Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7670	Sample No.	SB10-6		
Soil pH	8.3	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.32	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.3	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	240 M	Potash K_2O			
Calcium - Ca Exchangeable	6500 VH	Lime			
Magnesium - Mg Exchangeable	730 VH	Magnesium Oxide			
Sodium - Na Exchangeable	170 L	Gypsum			
CEC Meq/100g	39.9	Sulfur - S Elemental			
Iron Available - Fe	5.3 L	Iron - Fe			
Manganese - Mn Available	2.2 L	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.3 L	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	35 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	4	% Silt	90	% Clay	6
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	81.4
% K Saturation Ideal: 3-7%	1.5	% Na Saturation Ideal: 0-2%	1.8
% Mg Saturation Ideal: 15-20%	15.2		

Field Capacity	20.2	
Wilting Point	11.1	
Available Water (Top Foot)	1.6	in

BY Gary Donaldson

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KIETH MORRIS
Address:

Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7671	Sample No.	B1-1		
Soil pH	8.1	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.48	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.8	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	3 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	320 H	Potash K_2O			
Calcium - Ca Exchangeable	6750 VH	Lime			
Magnesium - Mg Exchangeable	420 VH	Magnesium Oxide			
Sodium - Na Exchangeable	89 VL	Gypsum			
CEC Meq/100g	38.5	Sulfur - S Elemental			
Iron Available - Fe	5.9 L	Iron - Fe			
Manganese - Mn Available	4.2 L	Manganese Mn			
Zinc - Zn Available	0.3 VL	Zinc - Zn			
Copper - Cu Available	0.5 M	Copper - Cu			
Boron - B Available	0.9 M	Boron - B			
Sulfur - SO_4 Available	112 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	22	% Silt	72	% Clay	6
	Soil Texture	SILT LOAM				
% H Saturation Ideal: 0-5%	0		% Ca Saturation Ideal: 65-75%	87.8		
% K Saturation Ideal: 5-7%	2.1		% Na Saturation Ideal: 0-2%	1		
% Mg Saturation Ideal: 15-20%	9.100001					

Field Capacity	17.4
Wilting Point	9.5
Available Water (Top Foot)	1.3 in.

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KEITH MORRIS
Address:

Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7672	Sample No.	B2-1		
Soil pH	8.2	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.26	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.9	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	620 VH	Potash K_2O			
Calcium - Ca Exchangeable	7460 VH	Lime			
Magnesium - Mg Exchangeable	310 H	Magnesium Oxide			
Sodium - Na Exchangeable	53 VL	Gypsum			
CEC Meq/100g	41.7	Sulfur - S Elemental			
Iron Available - Fe	4.4 L	Iron - Fe			
Manganese - Mn Available	4.0 L	Manganese Mn			
Zinc - Zn Available	0.4 VL	Zinc - Zn			
Copper - Cu Available	0.3 L	Copper - Cu			
Boron - B Available	0.9 M	Boron - B			
Sulfur - SO_4 Available	15 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	10	% Silt	64	% Clay	26
	Soil Texture	SILT LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	89.4
% K Saturation Ideal: 3-7%	3.8	% Na Saturation Ideal: 0-2%	.5
% Mg Saturation Ideal: 15-20%	6.2		

Field Capacity	26.6	
Wilting Point	14.6	
Available Water (Top Foot)	2.1	in.

BY Glays Reed

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KEITH MORRIS

Address:

Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7673	Sample No.	B3-1		
Soil pH	8.3	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soiuble Salts (mmhos / cm)	0.25	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.9	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	11 L	Phosphate P_2O_5			
Available Bray P2	35 L				
Potassium Exchangeable - K	620 VH	Potash K_2O			
Calcium - Ca Exchangeable	7100 VH	Lime			
Magnesium - Mg Exchangeable	260 H	Magnesium Oxide			
Sodium - Na Exchangeable	51 VL	Gypsum			
CEC Meq/100g	39.5	Sulfur - S Elemental			
Iron Available - Fe	2.9 L	Iron - Fe			
Manganese - Mn Available	4.0 L	Manganese Mn			
Zinc - Zn Available	0.7 L	Zinc - Zn			
Copper - Cu Available	0.2 L	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	15 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	20	% Silt	52	% Clay	28
	Soil Texture	CLAY LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	89.9
% K Saturation Ideal: 5-7%	4	% Na Saturation Ideal: 0-2%	.5
% Mg Saturation Ideal: 15-20%	5.5		

Field Capacity	25.8
Wilting Point	14.2
Available Water (Top Foot)	2.0 in.

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KEITH MORRIS
Address:

Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7674	Sample No.	B4 0-1		
Soil pH	8.3	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.23	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	2.0	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	8 L	Phosphate P_2O_5			
Available Bray P2	9 L				
Potassium Exchangeable - K	310 H	Potash K_2O			
Calcium - Ca Exchangeable	7280 VH	Lime			
Magnesium - Mg Exchangeable	305 H	Magnesium Oxide			
Sodium - Na Exchangeable	53 VL	Gypsum			
CEC Meq/100g	40	Sulfur - S Elemental			
Iron Available - Fe	6.3 M	Iron - Fe			
Manganese - Mn Available	2.5 L	Manganese Mn			
Zinc - Zn Available	0.2 VL	Zinc - Zn			
Copper - Cu Available	0.2 L	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	15 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	20	% Silt	50	% Clay	30
	Soil Texture	CLAY LOAM				
% H Saturation Ideal: 0-5%	0		% Ca Saturation Ideal: 65-75%	91.1		
% K Saturation Ideal: 5-7%	2		% Na Saturation Ideal: 0-2%	.5		
% Mg Saturation Ideal: 15-20%	6.4					

Field Capacity	26.5
Wilting Point	14.6
Available Water (Top Foot)	2.2 in

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KEITH MORRIS
Address:
Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7675	Sample No.	B5-1		
Soil pH	8.3	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.19	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.5	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	320 H	Potash K_2O			
Calcium - Ca Exchangeable	6980 VH	Lime			
Magnesium - Mg Exchangeable	250 H	Magnesium Oxide			
Sodium - Na Exchangeable	48 VL	Gypsum			
CEC Meq/100g	38	Sulfur - S Elemental			
Iron Available - Fe	3.3 L	Iron - Fe			
Manganese - Mn Available	2.3 L	Manganese Mn			
Zinc - Zn Available	0.2 VL	Zinc - Zn			
Copper - Cu Available	0.2 L	Copper - Cu			
Boron - B Available	0.9 M	Boron - B			
Sulfur - SO_4 Available	15 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	24	% Silt	48	% Clay	28
	Soil Texture	CLAY LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	91.8
% K Saturation Ideal: 3-7%	2.2	% Na Saturation Ideal: 0-2%	.5
% Mg Saturation Ideal: 15-20%	5.5		

Field Capacity	25.1	
Wilting Point	13.8	
Available Water (Top Foot)	2.0	in

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services
P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KEITH MORRIS
Address:
Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7676	Sample No.	B1-3

Soil pH	8.2	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.42	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.7	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	235 M	Potash K_2O			
Calcium - Ca Exchangeable	6700 VH	Lime			
Magnesium - Mg Exchangeable	510 VH	Magnesium Oxide			
Sodium - Na Exchangeable	176 L	Gypsum			
CEC Meq/100g	39.1	Sulfur - S Elemental			
Iron Available - Fe	7.6 M	Iron - Fe			
Manganese - Mn Available	2.7 L	Manganese Mn			
Zinc - Zn Available	0.2 VL	Zinc - Zn			
Copper - Cu Available	0.6 M	Copper - Cu			
Boron - B Available	0.7 L	Boron - B			
Sulfur - SO_4 Available	112 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	22	% Silt	52	% Clay	26
	Soil Texture	SILT LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	85.6
% K Saturation Ideal: 5-7%	1.5	% Na Saturation Ideal: 0-2%	2
% Mg Saturation Ideal: 15-20%	10.9		

Field Capacity	24.7	
Wilting Point	13.6	
Available Water (Top Foot)	2.0	in

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KEITH MORRIS
Address:
Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7677	Sample No.	B2-3
Soil pH	8.2	Crop	
Buffer pH		Yield Goal	
Free Lime	H		
Soluble Salts (mmhos / cm)	0.45	Nutrient Recommendations (lbs/Acre)	
% Organic Matter	1.2	Nitrogen N	
Nitrogen - NO_3	5 VL		
Phosphorus Bray P1	4 VL	Phosphate P_2O_5	
Available Bray P2	4 L		
Potassium Exchangeable - K	210 M	Potash K_2O	
Calcium - Ca Exchangeable	6600 VH	Lime	
Magnesium - Mg Exchangeable	690 VH	Magnesium Oxide	
Sodium - Na Exchangeable	195 L	Gypsum	
CEC Meq/100g	40.1	Sulfur - S Elemental	
Iron Available - Fe	6.1 M	Iron - Fe	
Manganese - Mn Available	2.9 L	Manganese Mn	
Zinc - Zn Available	0.2 VL	Zinc - Zn	
Copper - Cu Available	0.4 L	Copper - Cu	
Boron - B Available	0.7 L	Boron - B	
Sulfur - SO_4 Available	62 H	Sulfate Sulfur	

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	24	% Silt	40	% Clay	36
	Soil Texture	CLAY LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	82.2
% K Saturation Ideal: 3-7%	1.3	% Na Saturation Ideal: 0-2%	2.2
% Mg Saturation Ideal: 15-20%	14.3		

Field Capacity	28.1
Wilting Point	15.4
Available Water (Top Foot)	2.2 in

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KEITH MORRIS
Address:
Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7678	Sample No.	B3 / 3-4		
Soil pH	8.1	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.39	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.4	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	175 M	Potash K_2O			
Calcium - Ca Exchangeable	6640 VH	Lime			
Magnesium - Mg Exchangeable	490 VH	Magnesium Oxide			
Sodium - Na Exchangeable	105 L	Gypsum			
CEC Meq/100g	38.2	Sulfur - S Elemental			
Iron Available - Fe	4.4 L	Iron - Fe			
Manganese - Mn Available	1.6 VL	Manganese Mn			
Zinc - Zn Available	0.2 VL	Zinc - Zn			
Copper - Cu Available	0.5 M	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	50 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	14	% Silt	40	% Clay	46
	Soil Texture	CLAY				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	86.9
% K Saturation Ideal: 5-7%	1.2	% Na Saturation Ideal: 0-2%	1.1
% Mg Saturation Ideal: 15-20%	10.7		

Field Capacity	33.4
Wilting Point	18.3
Available Water (Top Foot)	2.6 in

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KEITH MORRIS
Address:

Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7679	Sample No.	B4 / 3-4		
Soil pH	7.9	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmnos / cm)	0.42	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.7	Nitrogen N			
Nitrogen - NO_3	35 VH				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	310 H	Potash K_2O			
Calcium - Ca Exchangeable	6470 VH	Lime			
Magnesium - Mg Exchangeable	420 VH	Magnesium Oxide			
Sodium - Na Exchangeable	72 VL	Gypsum			
CEC Meq/100g	37	Sulfur - S Elemental			
Iron Available - Fe	5.8 L	Iron - Fe			
Manganese - Mn Available	2.1 L	Manganese Mn			
Zinc - Zn Available	0.2 VL	Zinc - Zn			
Copper - Cu Available	0.7 M	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	20 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand 14	% Silt 58	% Clay 28
	Soil Texture SILTY CLAY LOAM		
% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	87.5
% K Saturation Ideal: 5-7%	2.2	% Na Saturation Ideal: 0-2%	.8
% Mg Saturation Ideal: 15-20%	9.5		

Field Capacity	26.7
Wilting Point	14.7
Available Water (Top Foot)	2.1 in.

BY [signature]

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services
P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KEITH MORRIS
Address:
Date: 3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7680	Sample No.	B5 / 3-4		
Soil pH	8.1	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.30	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.4	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	190 M	Potash K_2O			
Calcium - Ca Exchangeable	6250 VH	Lime			
Magnesium - Mg Exchangeable	360 H	Magnesium Oxide			
Sodium - Na Exchangeable	85 VL	Gypsum			
CEC Meq/100g	35.1	Sulfur - S Elemental			
Iron Available - Fe	5.0 L	Iron - Fe			
Manganese - Mn Available	2.3 L	Manganese Mn			
Zinc - Zn Available	0.2 VL	Zinc - Zn			
Copper - Cu Available	0.5 M	Copper - Cu			
Boron - B Available	0.8 M	Boron - B			
Sulfur - SO_4 Available	20 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	14	% Silt	54	% Clay	32
	Soil Texture	SILTY CLAY LOAM				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	89
% K Saturation Ideal: 5-7%	1.4	% Na Saturation Ideal: 0-2%	1
% Mg Saturation Ideal: 15-20%	8.5		

Field Capacity	28.2
Wilting Point	15.5
Available Water (Top Foot)	2.2 in.

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services
P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST
ARTESIA NM

Grower: KEITH MORRIS
Address:
Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7681	Sample No.	B2-6		
Soil pH	8.4	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.29	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	2.0	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	240 M	Potash K_2O			
Calcium - Ca Exchangeable	6500 VH	Lime			
Magnesium - Mg Exchangeable	910 VH	Magnesium Oxide			
Sodium - Na Exchangeable	240 M	Gypsum			
CEC Meq/100g	41.7	Sulfur - S Elemental			
Iron Available - Fe	8.3 M	Iron - Fe			
Manganese - Mn Available	2.4 L	Manganese Mn			
Zinc - Zn Available	0.2 VL	Zinc - Zn			
Copper - Cu Available	0.8 M	Copper - Cu			
Boron - B Available	0.7 L	Boron - B			
Sulfur - SO_4 Available	26 H	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	4	% Silt	88	% Clay	8
	Soil Texture	SILT				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	77.9
% K Saturation Ideal: 3-7%	1.5	% Na Saturation Ideal: 0-2%	2.3
% Mg Saturation Ideal: 13-20%	18.2		

Field Capacity	21.0
Wilting Point	11.5
Available Water (Top Foot)	1.6 in.

BY

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

Submitted By: YATES PETRO
Address: 105 S 4TH ST ARTESIA NM

Grower: KEITH MORRIS
Address:

Date: 3/3/98

SOIL ANALYSIS REPORT

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7682	Sample No.	B4-6		
Soil pH	8.0	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.31	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.6	Nitrogen N			
Nitrogen - NO_3	5 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	240 M	Potash K_2O			
Calcium - Ca Exchangeable	6250 VH	Lime			
Magnesium - Mg Exchangeable	740 VH	Magnesium Oxide			
Sodium - Na Exchangeable	86 VL	Gypsum			
CEC Meq/100g	38.4	Sulfur - S Elemental			
Iron Available - Fe	7.0 M	Iron - Fe			
Manganese - Mn Available	2.5 L	Manganese Mn			
Zinc - Zn Available	0.3 VL	Zinc - Zn			
Copper - Cu Available	0.7 M	Copper - Cu			
Boron - B Available	0.7 L	Boron - B			
Sulfur - SO_4 Available	15 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture
0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	12	% Silt	40	% Clay	48
	Soil Texture	CLAY				

% H Saturation Ideal: 0-5%	0	% Ca Saturation Ideal: 65-75%	81.4
% K Saturation Ideal: 3-7%	1.6	% Na Saturation Ideal: 0-2%	.8
% Mg Saturation Ideal: 15-20%	16.1		

Field Capacity	34.4	
Wilting Point	18.9	
Available Water (Top Foot)	2.7	in.

By Dwayne Wood

WESTERN AGRICULTURAL LABORATORIES, INC.

Agricultural Testing & Consulting Services

P.O. Box 64666 5173 69th
LUBBOCK, TEXAS 79464
Phone: 806—794-4888

SOIL ANALYSIS REPORT

Submitted By:	YATES PETRO
Address:	105 S 4TH ST ARTESIA NM
Grower:	KEITH MORRIS
Address:	
Date:	3/3/98

Results are expressed in Parts Per Million: For approximate lbs./acre multiply by 2.

Lab. No.	7683	Sample No.	B5-6		
Soil pH	8.3	Crop			
Buffer pH		Yield Goal			
Free Lime	H				
Soluble Salts (mmhos / cm)	0.29	Nutrient Recommendations (lbs/Acre)			
% Organic Matter	1.0	Nitrogen N			
Nitrogen - NO_3	4 VL				
Phosphorus Bray P1	4 VL	Phosphate P_2O_5			
Available Bray P2	4 L				
Potassium Exchangeable - K	150 M	Potash K_2O			
Calcium - Ca Exchangeable	5720 VH	Lime			
Magnesium - Mg Exchangeable	680 VH	Magnesium Oxide			
Sodium - Na Exchangeable	217 M	Gypsum			
CEC Meq/100g	35.6	Sulfur - S Elemental			
Iron Available - Fe	4.4 L	Iron - Fe			
Manganese - Mn Available	1.4 VL	Manganese Mn			
Zinc - Zn Available	0.1 VL	Zinc - Zn			
Copper - Cu Available	0.4 L	Copper - Cu			
Boron - B Available	0.7 L	Boron - B			
Sulfur - SO_4 Available	15 M	Sulfate Sulfur			

COMMENTS:

Approximate Relation of CEC to Soil Texture

0-8 Sand
8-12 Loamy Sand
12-20 Sandy/Silt Loam
20-28 Loam
28-40 Clay Loam
40 + Clay

Particle Size Analysis	% Sand	28	% Silt	56	% Clay	16
	Soil Texture	SILT LOAM				
% H Saturation Ideal: 0-5%	0		% Ca Saturation Ideal: 65-75%	80.3		
% K Saturation Ideal: 5-7%	1.1		% Na Saturation Ideal: 0-2%	2.6		
% Mg Saturation Ideal: 15-20%	15.9					

Field Capacity	20.1
Wilting Point	11.0
Available Water (Top Foot)	1.5 in.

BY Gregg Wood